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Surface Water Operable Unit (On-Site) Site Investigation and Baseline Risk Assessment Report at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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Surface Water Operable Unit (On-Site) Site Investigation and Baseline Risk Assessment Report at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

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Prepared for the
U.S. DEPARTMENT OF ENERGY
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Paducah Remediation Services, LLC
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Paducah, Kentucky 42001
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for the
U.S. DEPARTMENT OF ENERGY

PREFACE

This *Surface Water Operable Unit (On-Site) Site Investigation and Baseline Risk Assessment Report at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0001/&D2/R1, was prepared in accordance with the requirements of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA). In accordance with Section IV of the FFA, this integrated technical document was developed to satisfy applicable requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). Please note that the phases of the investigation process are referenced by CERCLA terminology within this document to reduce the potential for confusion.

The Site Investigation was conducted in accordance with the approved *Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2137&D2/R2. The investigation involved collecting surface soil and sediment samples from ditches and storm sewer discharge water to evaluate those areas within the SWOU having the greatest potential for contaminant discharges to creeks surrounding PGDP. These areas are as follows: PGDP Outfalls 001 (those portions not addressed by the Scrap Metal basin), 002, 008, 010, 011, 012 (those portions downgradient of the storm sewer discharge point), and 015, and associated internal ditches and areas [including Solid Waste Management Unit SWMU 92 and SWMU 97]; NSDD Sections 3, 4, and 5; and PGDP storm water sewer systems associated with C-333-A, C-337-A, C-340, C-535, and C-537.

The results of this investigation will be used, as necessary, to evaluate the need for a removal action to address the SWOU (On-Site) sources of contamination and evaluate the need for additional sediment controls. A separate Engineering Evaluation/Cost Analysis is planned for the SWOU to evaluate the need for a response action for the sediment controls.

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FIGURES

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TABLES

ACRONYMS

amsl	above mean sea level
AOC	Area of Concern
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
BJC	Bechtel Jacobs Company LLC
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COE	U.S. Army Corps of Engineers
COPC	chemical of potential concern
CSM	conceptual site model
CV	coefficient of variation
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
Eh	oxidation reduction potential
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
EU	exposure unit
FFA	Federal Facility Agreement
f_{oc}	soil organic carbon content as mass fraction
GIS	Geographic Information System
GWOU	groundwater operable unit
ha	hectares
HI	hazard index
HU	hydrostratigraphic unit
ICM	interim corrective measure
K_d	adsorption coefficient/distribution coefficient
KEPPC	Kentucky Environmental and Public Protection Cabinet
K_H	Henry's Law constant value
K_{oc}	water partition coefficient
K_{ow}	octanol-water partitioning coefficient
KPDES	Kentucky Pollutant Discharge Elimination System
KSNPC	Kentucky State Nature Preserves Commission
mg/kg	milligrams per kilogram
mgd	million gallons per day
mlpd	million liters per day
NAL	no action level
NFA	no further action
NOV	notice of violation
NRWQC	national recommended water quality criteria
NSDD	North-South Diversion Ditch
OU	operable unit

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picoCurie per gram
pCi/L	picoCurie per liter
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen-ion concentration
POC	pathway of concern
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RI	remedial investigation
SADA	Spatial Analysis and Decision Assistance
SAP	Sampling and Analysis Plan
SE	Site Evaluation
SERA	Screening Ecological Risk Assessment
SHHRA	Screening Human Health Risk Assessment
SI	site investigation
SMDP	scientific/management decision point
SMP	Site Management Plan
SPMD	semipermeable membrane device
SVOA	semivolatile organic analyte
SWMM	Storm Water Management Model
SWMU	solid waste management unit
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxic Characteristic Leaching Procedure
TEF	toxicity equivalence factor
TEQ	toxicity equivalent
TSCA	Toxic Substances Control Act of 1976
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
USEC	United States Enrichment Corporation
USGS	United States Geological Survey
VOC	volatile organic compound
VSP	Visual Sampling Plan
WAC	waste acceptance criteria
WAG	waste area grouping
WKWMA	West Kentucky Wildlife Management Area
µg/kg	micrograms per kilograms
µg/L	micrograms per liter

EXECUTIVE SUMMARY

The Surface Water Operable Unit (OU) (SWOU) refers to source units at the Paducah Gaseous Diffusion Plant (PGDP) that primarily contain surface water contamination or sources such as soil and sediment that potentially contribute to surface water contamination. These units include the North-South Diversion Ditch (NSDD), internal plant outfall ditches, impoundment ponds, Bayou Creek, and Little Bayou Creek. The U. S. Department of Energy (DOE), Environmental Protection Agency (EPA), and Kentucky Environmental and Public Protection Cabinet (KEPPC) have agreed that preventing off-site migration of contaminants is the highest sitewide priority for nonemergency cleanup activities at PGDP (DOE 2005b). Cleanup activities for the SWOU are targeted to be performed as a series of prioritized response actions. This document summarizes the results of the SWOU (On-Site) Site Investigation (SI), the Baseline Human Health Risk Assessment (BHHRA), and the Screening Ecological Risk Assessment (SERA).

The SI was conducted in accordance with the approved *Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (SAP) (DOE 2005a) and focused on the first sequenced response action for on-site portions of the SWOU having the greatest potential for contaminant discharges to creeks surrounding the PGDP. These areas are as follows:

- NSDD Sections 3, 4, and 5 (See Figure 1.1 and Plate 2 in Chapter 4);
- PGDP outfalls 001 (those portions not addressed by the Scrap Metal basin), 002, 008, 010, 011, 012 (those portions downgradient of the storm sewer discharge point), and 015 (See Figure 1.2 and Plate 1 in Chapter 4);
- Internal ditches associated with the outfalls at PGDP listed above [including Solid Waste Management Unit (SWMU) 92 and SWMU 97] (See Figure 1.2 and Plate 1 in Chapter 4); and
- PGDP storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 (See Figures 1.3, 1.4, and 1.5).

The following three specific items define the project objectives:

- Activity 1- Provide data that can be used to identify areas of elevated contaminant concentrations (i.e., identify "hot spots"[1]) in surface soil and sediment along the outfalls and their associated internal ditches and areas and within Sections 3, 4, and 5 of the NSDD and identify the extent of contamination in these areas. For the storm sewers, provide data that can be used to determine (1) if a particular storm sewer system is releasing contamination and (2) target a portion of the storm sewer that is the source of contamination.

- Activity 2 - Provide data that can be used to characterize the average contamination in soil and sediment found in the outfalls and their associated internal ditches and areas and within Sections 3, 4, and 5 of the NSDD. For the storm water sewers, provide data that can be used to characterize the source of contamination.

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[1] A potential "hot spot" is characterized by an area in which one or more indicator chemicals exceeded an indicator level or one or more analytes exceeded an analyte's characterization level as established in the SAP. It should be noted that neither indicator nor characterization levels should be considered cleanup goals. Cleanup goals will be determined in the removal action evaluation process. See text box for explanation of indicator and characterization levels.

- Activity 3 – Utilize Activity 1 data and Activity 2 data and information from other projects (e.g., routine surface water sampling) to complete modeling (i.e., Storm Water Management Model [SWMM]) per the PGDP Methods Document) to determine the potential for migration of contamination from the outfalls and their associated internal ditches and areas and from the stormwater sewers. For the outfalls and their associated ditches and areas, these data will include those collected to meet the previous two objectives and surface water collected at the outfalls during routine monitoring. For the storm sewers, these data will include water samples collected at discharge points (Step 1) and at upgradient points (Step 2) and soil samples collected in suspected source areas (Step 3). Consistent with the investigation objectives for storm sewers, the analyte list will be limited to those analytes that process knowledge indicates are migrating from source areas and to discharge locations. Since Sections 3, 4, and 5 of the NSDD are located outside the industrialized area of the PGDP where direct contact with contaminated sediment by recreational receptors is possible, project scoping determined that the consideration of contaminant migration (i.e., Activity 3) would not apply to those portions of the NSDD. Modeling results also will be used in the BRA to determine risk posed by contaminant migration.

DEFINITION OF A "HOT SPOT"

For the SWOU on-site assessment, a "hot spot" will be characterized by comparing a sample's detected analyte concentrations against indicator (Activity 1 sample) or characterization (Activity 2 sample) levels. Specifically, an area determined to have one or more selected indicator chemicals at concentrations greater than indicator levels (Activity 1 sampling) or one or more other analytes at a concentration greater than the analytes' characterization levels (from Activity 2 sampling) will be deemed a "hot spot." The indicator level is the value to which an indicator's detected concentration is compared. If the indicator chemical has a detected concentration greater than its indicator level, then one or more contaminants may be present at the sampling location at concentrations greater than their characterization level. The characterization level is a risk-based concentration developed to meet the objectives of the SWOU (on-site) project. Please see Appendix C.5 of the SAP (DOE 2005a) for additional information on derivation of indicator and characterization levels.

The initial estimates of the extent of a "hot spot" will be assumed to extend from the nearest upgradient to the nearest downgradient sample that does not contain an analyte exceeding its indicator (Activity 1 sample) or characterization (Activity 2 sample) level. Note, however, that the final extent of the "hot spot" will be identified in the SI and Baseline Risk Assessment (BRA) Report using the Spatial Analysis and Decision Assistance program (University of Tennessee 2004) and action levels defined in that report.

SURFACE WATER OPERABLE UNIT (ON-SITE) STRATEGY

The SWOU is one of five media-specific OUs at PGDP being used to evaluate and implement remedial actions. DOE, EPA, and the Commonwealth of Kentucky have agreed upon five media-specific strategic cleanup initiatives as follows [from Site Management Plan (SMP), DOE 2005b]:

- Burial Grounds OU Strategic Initiative,
- Decontamination and Decommissioning (D&D) OU Strategic Initiative,
- Groundwater OU Strategic Initiative,
- Soils OU Strategic Initiative, and
- SWOU Strategic Initiative.

These initiatives include taking early actions, as necessary, to prevent and reduce exposure and unacceptable risks. This includes completion of a series of prioritized response actions, ongoing site characterization activities to support future response action decisions, and D&D of the currently operating gaseous diffusion plant once it ceases operation. These initiatives will be followed by a comprehensive sitewide evaluation, with implementation of additional and final actions, as needed, to ensure long-term protectiveness. The intended scope, sequence, and timing of the OU initiatives are documented in the

SMP (DOE 2005b) and in the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998a).

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

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

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

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

As described in the SMP (DOE 2005b), the following steps are being used at PGDP to implement the phased approach for the SWOU:

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

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

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

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

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

- Posting of warning signs, fencing, and fish advisories at various ditches and creeks (1993); and

- Implementation of on-site institutional controls (1993).

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

- Installed inverted pipe dams at outfall ditches (mid 1980s);
- Removed approximately 5,000 drums of PCB contaminated soils from vaporizer areas in C-337-A (1985 – 1986) and C-333-A (1987);
- Stabilized and mitigated PCBs in Outfall 011 ditch:
  - Removed approximately 1,300 drums of PCB contaminated sediments (1983);
  - Cleaned ditch and installed fabric liner (1994);
  - Applied liquid boot, bentonite and native clay (1995);
  - Implemented bio-remediation technology (1996);
- Rerouted discharges at the NSDD and initiated treatment of radiologically contaminated waste waters from C-400 prior to discharge (1995);
- Installed fly ash collection basin at C-600 (1995);
- Removed polychlorinated biphenyl (PCB)-contaminated soil at Waste Area Group (WAG) 23 (1997);
- Stabilized and mitigated PCBs in Outfall 011- ditch (1998);
- Completed Drum Mountain Removal Action (2000);
- Installed the C-613 Sedimentation Basin (2003);
- Installed the NSDD Hardpiping Installation (2003);
- Plugged culverts in NSDD at north security fence (2004);
- Completed NSDD Source Removal-Section 1 and Section 2 (2004); and
- Implemented Scrap Yard Removal Action-source removal (in progress, estimated completion date - November 2006).

This SI for the Surface Water (On-Site) supports evaluations regarding Steps 1, 2, 3, and 4 of the phased approach by providing information concerning the identification of hot spots in internal plant ditches and outfalls; the NSDD (Sections 3, 4, and 5); and the storm sewer system that may be contributing to off-site migration and risks to human health and the environment posed by the contamination migrating from these hot spots. The data were used in the SI to develop source terms to support transport modeling and in the BRA to develop exposure point concentrations (EPCs) for each exposure unit (EU). In addition, the SI provides information useful for determining the need for hot spot removal and the evaluation of whether additional sediment control measures are needed, as well as determining actions for potential legacy releases associated with the storm sewer system.

CONTAMINANT NATURE AND EXTENT SUMMARY

Sampling of Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas was conducted to determine which areas contain the greatest potential for surface water discharges of contaminants to the creeks surrounding the industrialized portion of the PGDP as determined by existing data and process knowledge. These areas were characterized using the following strategy:

- Activity 1 – completion of sampling using indicator chemicals (cesium-137, uranium-238, and Total PCBs) that yielded data to identify "hot spots" in surface soil and sediment in each of the outfalls and their associated internal ditches and areas and in Sections 3, 4, and 5 of the NSDD, and identified the extent of contamination in these areas. These data were used in the SI to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU.

- Activity 2 – completion of definitive sampling that yielded data to fully characterize the nature of contamination in soils and sediment found in each of the outfalls and their associated internal ditches and areas and in Sections 3, 4, and 5 of the NSDD. These data were used in the SI to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU.

NSDD

Based on the collection and analysis of 258 Activity 1 samples (and 16 duplicates), the results of NSDD Activity 1 sampling revealed indicator levels were exceeded only in samples collected in Sections 3 and 5. Potential "hot spots" were identified at the following locations:

- Section 3 (EUs 01, 02, and 03); and
- Section 5 (EUs 07, 08, 09, and 10).

There were no exceedances of indicator levels in Activity 1 samples collected in Section 4 (EUs 04, 05, and 06). See Plate 2 and Figures 4.1 through 4.7.

Based on the collection and analysis of 75 Activity 2 samples (and 6 duplicates), 22 Activity 2 samples contained at least one analyte that exceeded its characterization level. Radionuclides that exceeded characterization levels included cesium-137, thorium-228, thorium-230, and neptunium-237. Inorganic analytes exceeding characterization levels included arsenic and manganese. Organic analytes included only Total PCBs exceeding characterization levels. These samples were located in the following areas:

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

No other radionuclide, inorganic, or organic constituent was detected that exceeded its characterization level in the Activity 2 samples.

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

Based on the collection and analysis of 2,076 Activity 1 samples (and 114 duplicates), the results of the sampling of outfalls and their associated internal ditches and areas, identified potential "hot spots" in four of the seven internal plant ditches at the following locations:

- Outfall 001 (EUs 05, 14, 15, 16, 18, and 20);
- Outfall 008 (EUs 08 and 11);
- Outfall 010 (EU 10); and
- Outfall 015 (EUs 01, 02, 03, 04, 07, and 08).

Indicator levels were not exceeded for Outfalls 002, 011, or 012 during Activity 1 sampling.

Based on the collection and analysis of 270 Activity 2 samples (and 25 duplicates) collected from the outfalls and their associated internal ditches and areas, 29 Activity 2 samples contained at least one analyte that exceeded its characterization level. Radionuclides detected that exceeded characterization levels included cesium-137 and uranium. Inorganics detected that exceeded characterization levels included iron, lead, and manganese. Organic analytes detected that exceeded characterization levels included Total polyaromatic hydrocarbons (PAHs) and Total PCBs. These samples were located in the following areas:

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

No other radionuclide, inorganic, or organic constituent was detected in the Activity 2 samples that exceeded its characterization level.

Total potential "hot spot" areas were calculated using geographical computer modeling for each section of the NSDD and outfalls and their associated internal ditches and areas. The size of the potential "hot spot" was compared to the individual source areas (EUs) and the total area investigated (Table ES.1). The Activity 1 potential "hot spot" areas were used in the surface-water modeling presented in Section 5.

Table ES.1. Potential Hot Spot Area/Total Area Comparison

Source Unit	**Potential Hot Spot Area** (acres)	**Total Area** (acres)
NSDD Section 3	1.2	1.9
NSDD Section 4	0	2.1
NSDD Section 5	0.6	2.4
Outfall 001	0.3	13.8
Outfall 002	0	4.2
Outfall 008	0.3	7.8
Outfall 010	0.1	5.8
Outfall 011	0	0.6
Outfall 012	0	0.8
Outfall 015	1.4	5.5
TOTAL	3.9	44.9

Storm Sewer Water Sampling

In order to characterize potential releases at the storm sewer discharge points, which could result in unacceptable levels of risk to current and reasonably anticipated future receptors, a three-step sampling approach was utilized during the SI.

For all locations, except the C-340 storm sewers, all contaminant concentrations in Step 1 water samples were below indicator levels. Due to the uranium exceedance from the C-340 discharge sample, Step 2 sampling was implemented. No contaminants were detected at levels greater than the indicator values in any water sample collected during Step 2 activities. Step 3 sampling was not required.

CONTAMINANT FATE AND TRANSPORT CONCLUSIONS

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

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

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

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

As with Total PCBs, predicted uranium-238 concentrations within the creeks and at creek integrator points did not exceed no action screening levels.

RISK ASSESSMENT CONCLUSIONS

A BHHRA and SERA were prepared as part of this SWOU (On-Site) SI Report. The risk assessments were developed using EPCs for redefined EUs to estimate risks. In these assessments, information collected during the SI was combined with data from previous risk assessments to characterize the baseline risks posed to human health and ecological receptors.

BHHRA

Human health risks were estimated for current industrial workers and current child recreational users using site-specific exposure assumptions. To evaluate human health risks based on exposure to SWOU media, the data were segregated into 13 redefined EUs. Each EU was a distinctive area within the site that, because of similar levels of contamination or because of similar expected human activity patterns, reasonably could be assessed as a single unit using EPCs for COPCs (redefined EUs are presented in Table D.50 of the BHHRA in Appendix D). For the current exposure scenarios, soil hazards [total hazard indexes (HIs)] for the current industrial worker were at or below a cumulative hazard estimate of 1 for all contact exposures associated with soil/sediment. For surface water, HIs were below 1 at all EUs. A cumulative excess lifetime cancer risk (ELCR) greater than 1E-06 was estimated for all EUs. A cumulative ELCR greater than 1E-04 was estimated for two of the EUs for current industrial workers based on direct contact exposures to soil/sediment. Soil/sediment cancer risks (total ELCRs) for the current industrial worker exceeded 1E-04 at the Outfall 011 Hot Spot (EU 01) and Outfall 001 EU 14 Hot Spot. The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

For the current child recreational scenario, the cumulative HI met the hazard limit of 1 and the ELCR was less than 1E-06 at the NSDD, excluding the Hot Spot. The cumulative risk estimates included risks from direct contact with soil/sediment, dermal contact with surface water and ingestion of game. The cumulative hazard estimate for the current child recreational user was greater than 1 at the NSDD Hot Spot (Section 3 EUs 01 and 02). The excess risk was due to dermal contact with soil/sediment and the primary risk drivers were antimony and uranium. The ELCR for a current child recreational user scenario was less than 1E-06 at the NSDD Hot Spot (Section 3 EUs 01 and 02).

Human health risks also were calculated for future industrial workers and excavation workers (the “excavation worker” scenario includes both current and future exposures) using default KEPPC exposure assumptions. Cumulative HIs for the future industrial worker were greater than 1 for all EUs based on soil/sediment contact exposures. Cumulative hazard estimates greater than 1 also were identified for two EUs [Outfall 001 EU 14 Hot Spot; and Within the Fence, Excluding the Hot Spots] due to surface water exposures. A cumulative ELCR greater than 1E-06 for all EUs and greater than 1E-04 at six of the EUs was estimated for future industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the future industrial worker exceeded 1E-04 at Outfall 008 Hot Spot (EUs 08 and 11); Outfall 10 Hot Spot (EU 10); Outfall 011 Hot Spot (EU 01); Outfall 001 EU 14 Hot Spot; Outfall 001 EU15 Hot Spot; and NSDD Hot Spot (Section 3 EUs 01 and 02). The major contaminants driving risk at all EUs were Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

A cumulative HI greater than 1 was estimated for each EU for excavation workers at all EUs, with antimony, iron, uranium, and Total PCBs being the risk drivers and soil/sediment as the only medium of concern. A cumulative ELCR greater than 1E-06 was estimated for all EUs, with a cumulative ELCR greater than 1E-04 estimated for seven EUs [Outfall 008 Hot Spot (EUs 08 and 11); Outfall 010 Hot Spot (EU 10); Outfall 011 Hot Spot (EU 01); Outfall 015 Hot Spot (EUs 01, 02, 03, 04, 07, and 08); Outfall 001 EU 14 Hot Spot; Outfall 001 EU 15 Hot Spot; NSDD Hot Spot (Section 3 EUs 01 and 02)] based on direct contact exposures to soil/sediment. The major contaminants driving risk at all EUs were Total PCBs, Total PAHs (as BaPE), and thorium-230, and the driving medium of concern was soil/sediment.

Finally, human health risks were calculated for future recreational users at the NSDD using default exposure assumptions. HI estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were below a hazard of 1. ELCR estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were at or below 1E-06, with the exception of future teen dermal contact with surface water at the NSDD, Excluding the Hot Spot (Section 3, EU 03; Section 4, all EUs; and Section 5, all EUs). Direct contact with sediment resulted in hazard estimates greater than 1 for future recreational users (adult, teen, and child) under default exposure assumptions at both the NSDD Hot Spot and the NSDD, Excluding the Hot Spot. All ELCRs for direct contact with sediment for each receptor were greater than 1E-06, but below 1E-04. The major contributor to risks for future adults, teens, and children included antimony, iron, uranium, and Total PCBs at both the NSDD Hot Spot (Section 3, EUs 01 and 02) and the NSDD, Excluding the Hot Spot (Section 3, EU 03; Section 4, all EUs; and Section 5, all EUs). The medium of concern was soil/sediment.

Several key uncertainties were discussed in the risk assessment that potentially overestimated human health risks to a significant degree such as unrealistic default exposure assumptions, the inclusion of contaminants that are present due to background sources and overly conservative dermal absorption factors. If the final BHHRA risks are reevaluated adjusting for the key uncertainties, then risks are significantly reduced. Excess risk greater than 1E-04 to current industrial workers at two potential "hot spot" locations (Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot) and current recreational users at the NSDD Hot Spot evaluated using site-specific exposure assumptions would be reduced below cancer and hazard risk limits. Risks to future receptors that were evaluated using default exposure assumptions would be reduced as well. Excess risks greater than 1E-06 to future industrial workers would be reduced from the 13 EU locations to two EU locations (Outfall 008 Hot Spot and Outfall 001 EU 15 Hot Spot). Excess risks to future excavation workers would be reduced from 13 EU locations to 10 EU locations (Outfall 008 Hot Spot; Outfall 010 Hot Spot; Outfall 011 Hot Spot; Outfall 015 Hot Spot; Outfall 001 EU 14 Hot Spot; Outfall 001 EU 15 Hot Spot; Outfall 001 EU 16 Hot Spot; Within the Fence; Excluding the Hot Spots; NSDD Hot Spot; and NSDD, Excluding the Hot Spot). Excess risks to future recreational users would be reduced below risk limits at the NSDD locations.

In summary, cancer risk and noncancer hazard estimates for current industrial workers and current recreational users (outside the security fence) are more appropriate receptors for this OU relative to future risk estimates for industrial workers, excavation workers, and recreational users using default Methods Document exposure assumptions. Cancer risks and noncancer hazards for the current industrial worker were estimated based on a 14-day per year exposure frequency, making it more representative of possible future site risks that would be applicable to the narrow system of drainages ditches that make up the SWOU. Future industrial workers spending 8 hours per day, 250 days per year for 25 years, as the Methods Document directs, in one or more ditches is not realistic. Similarly, the current recreational user visits the NSDD 10 days per year for one year in contrast to the future recreational user that spends 140 days per year for six years.

SERA

Steps 1 and 2 of a SERA were performed during the SI. The objective of the SERA was to identify, qualitatively and quantitatively, where appropriate, the potential environmental risks associated with the SWOU at the PGDP that would exist if no further remedial action were taken.

Conservative assumptions were used in the SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks. Screening of COPCs was completed for surface water, sediment, and soil media in the NSDD (Sections 3, 4, and 5) and the outfalls and their associated internal ditches and areas. Food web modeling was completed for Total PCBs in the NSDD and Outfall 001 to assess the bioaccumulation potential of this chemical for a specific suite of mammalian and avian receptors. This screen provides risk estimates based on direct exposure (direct contact and ingestion) of aquatic and terrestrial biota to contaminated media.

Based upon the ecological screening, a large number of COPCs were found to exceed no action levels and were retained. Additionally, the PCB food web modeling revealed significant risks to several soil- and sediment-based receptors. Per EPA guidance and guidance in the PGDP Methods Document, these results indicate that further evaluation of potential for risk is required. If this further evaluation includes a Baseline Ecological Risk Assessment (BERA), it would include Steps 3-8 of the Ecological Risk Assessment (ERA) process.

DATA QUALITY OBJECTIVE DECISION RULES

Responses to the primary questions (i.e., decision rules) developed during the Data Quality Objective (DQO) process for NSDD Sections 3, 4, and 5; Outfalls 001, 002, 008, 010, 011, 012, and 015 and associated internal plant ditches; and the storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 are presented in Tables ES.2 and ES.3. As shown in these tables, all questions could be answered using the results of the SI.

SUMMARY OF CONCLUSIONS

The following provides a summary of the SWOU conclusions.

- Activity 1 indicator levels were exceeded in various EUs from two sections of the NSDD (Sections 3 and 5) and four internal plant ditches (Outfalls 001, 008, 010, and 015). These areas were designated as “hot spots.”
- Activity 2 characterization levels were exceeded in various EUs from NSDD Sections 3, 4, and 5 and the outfalls and their associated internal ditches and areas (Outfalls 001, 008, 010, and 015).
- For all storm sewer locations, except the C-340 storm sewers, all contaminant concentrations in Step 1 water samples were below indicator levels. Due to the uranium exceedance from the C-340 discharge sample, Step 2 sampling was implemented. No contaminants were detected at levels greater than the indicator values in any water sample collected during Step 2 activities. Step 3 sampling was not required.
- Modeled contaminant transport at downstream receptor locations indicated that the COPC levels for both the average and the maximum concentrations of Total PCBs exceed the child recreational and industrial worker no action screening levels for surface water runoff at Outfall 001, 008, 010, and 015,

and that Total PCBs concentrations did not exceed other risk evaluation criteria. For uranium-238, the only exceedance of the modeled concentrations was in the Outfall 001 runoff for the no action child recreational screening level. No predicted concentrations within the creeks exceeded a no action screening criteria.

- Under site-specific rates of exposure (i.e., under current conditions), the estimated cancer risk for the industrial worker exceeded the upper end of the EPA's acceptable risk range (i.e., ECLR = 1E-06 to 1E-04) for some internal ditch EUs, and the estimated hazard for the recreational user exceeded the EPA hazard limit (HI = 1) for some NSDD EUs. Contaminants driving risks were Total PCBs and Total PAHs (as BaPE) for the industrial worker and antimony and uranium for the recreational user. Under default rates of exposure (i.e., under future conditions), risks and hazards for the industrial worker, recreational user, and excavation worker exceeded either the upper end of EPA's acceptable risk range and/or the EPA hazard limit at multiple EUs. Contaminants driving risks were Total PCBs, Total PAHs (as BaPE), antimony, iron, uranium, and thorium-230.

- The SERA indicated that further evaluation of the potential for risk was required. This conclusion was based on significant and extensive exceedance of no further action levels at multiple locations and the lack of no further action levels for many constituents. If this further evaluation includes a BERA, it would include Steps 3-8 of the ERA process.

Table ES.2 DQO Decisions for NSDD and Internal Plant Ditches and Areas Associated with Outfalls

Decision Rule #1 *If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then call the area sampled a potential "hot spot" and identify this area for possible action depending on the outcome of the BRA and decision-making process.*
NSDD Sections 3, 4, and 5
Of the 258 Activity 1 samples [non-quality control (QC)] collected at Sections 3, 4, and 5 of the NSDD, 69 samples exceeded radionuclide indicator levels and 13 samples exceeded PCB indicator levels. These have been identified as potential "hot spots" in the SWOU SI/BRA report. Total potential "hot spot" areas per section and the percent as compared to the total area per section are as follows: • Section 3: 1.2 acres, 63% • Section 4: 0.0 acres, 0% • Section 5: 0.6 acres, 25%
Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015
Of the 2,076 Activity 1 samples (non-QC) collected at the outfalls and their associated internal ditches and areas, 70 samples exceeded radionuclide indicator levels, and 9 samples exceeded PCB indicator levels. These have been identified as potential "hot spots" in the SWOU SI/BRA report. Total potential "hot spot" areas per outfall and the percent as compared to the total area per outfall are as follows: • Outfall 001: 0.3 acres, 2% • Outfall 002: 0.0 acres, 0% • Outfall 008: 0.3 acres, 4% • Outfall 010: 0.1 acres, 2% • Outfall 011: 0.0 acres, 0% • Outfall 012: 0.0 acres, 0% • Outfall 015: 1.4 acres, 25%
Decision Rule #2 *If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then sample site extending 35 ft away from ditch to determine if source of the "hot spot" contamination is in the associated area; identify areas exceeding indicator levels for possible action depending on the outcome of the BRA and decision-making process.*
NSDD Sections 3, 4, and 5
For those areas identified as potential "hot spots" during Activity 1 sampling, additional soil/sediment samples were collected in accordance with the SWOU SAP to better define the areal extent of hot spots and to aid in determining where contaminant sources are located. Of the 50 contingency samples collected in the NSDD, 8 contingency samples exceeded radionuclide indicator levels. None of the contingency samples exceeded PCB indicator levels. As defined in the SAP, Activity 1 contingency samples were collected from an area adjacent to the potential "hot spot" from a 35 by 35 ft area (1,225 ft^2). Since eight contingency samples exceeded radionuclide indicator levels, the total additional area of the NSDD identified by contingency sampling as potential "hot spots" was 9,800 ft^2 (0.2 acres).
Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015
For those areas identified as potential "hot spots" during Activity 1 sampling, additional soil/sediment samples were collected in accordance with the SWOU SAP to better define the areal extent of hot spots and to aid in determining where contaminant sources are located. Of the 55 contingency samples collected at the Outfalls, five exceeded radionuclide indicator levels and six exceeded PCB indicator levels. As defined in the SAP, Activity 1 contingency samples were collected from an area adjacent to the potential "hot spot" from a 35 by 35 ft area (1,225 ft^2). Since five contingency samples exceeded radionuclide indicator levels and six samples exceeded PCB indicator levels, the total additional area of the outfalls and their associated internal ditches and areas identified by contingency sampling as potential "hot spots" was 13,475 ft^2 (0.3 acres).

Table ES.2 DQO Decisions for NSDD and Internal Plant Ditches and Areas Associated with Outfalls (Continued)

Decision Rule #3

If the average concentration (average defined as the 95% UCL on the mean of sample results) of a contaminant within an EU exceeds its characterization level, then identify the EU as possibly requiring action, pending the outcome of the BRA and the decision-making process.

NSDD Sections 3, 4, and 5

The risk-based characterization levels developed specifically for the NSDD EUs are presented in Appendix C of the SWOU SAP, including the specific criteria used to develop them. The following COPCs exceeded risk-based characterization levels in the NSDD Hot Spot [Section 3 EU 01 (Figure 4.1) and EU 02 (Figure 4.2)]: antimony, Total PCBs, Total PAHs, neptunium-237, thorium-228, thorium-230, and uranium-238. Total PAHs exceeded risk-based characterization levels in the NSDD, Excluding the Hot Spot (Section 3 EU 03, Section 4 All EUs, and Section 5 All EUs).

Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015

Three EUs did not have any COPCs exceeding risk-based characterization levels—Outfall 001 EU 13 Hot Spot, Outfall 001 EU 20 Hot Spot, and the area Within the Fence, Excluding Hot Spots. Each of the remaining eight EUs had at least one COPC exceeding a risk-based characterization level.

- Outfall 001 EU 14 Hot Spot (Figure 4.45): antimony, Total PCBs, and Total PAHs
- Outfall 001 EU 15 Hot Spot (Figure 4.46): lead, uranium, Total PCBs, and Total PAHs
- Outfall 001 EU 16 Hot Spot (Figure 4.47): iron and manganese
- Outfall 001 EU 18 Hot Spot (Figure 4.49): cesium-137
- Outfall 008 Hot Spot [EU 08 (Figure 4.70), EU 09 (Figure 4.71), and EU 11 (Figure 4.73)]: Total PCBs
- Outfall 010 Hot Spot [EU 10 (Figure 4.86)]: Total PAHs and lead
- Outfall 011 Hot Spot [EU 01 (Figure 4.87)]: antimony, lead, and Total PAHs
- Outfall 015 Hot Spot [EU 01 (Figure 4.89), EU 02 (Figure 4.90), EU 03 (Figure 4.91), EU 04 (Figure 4.92), EU 07 (Figure 4.95), and EU 08 (Figure 4.96)]: uranium

Decision Rule #4

If the cumulative cancer risk to human health from contamination within an EU exceeds $1x10^{-6}$ or if the cumulative hazard index for effects on human health from contamination within an EU exceeds 1, then declare site "of concern" and identify the EU as possibly requiring action pending the outcome of the decision-making process.

NSDD Sections 3, 4, and 5

As presented in the SWOU BHHRA, the following EUs exceeded a cumulative $1x10^{-6}$ cancer risk level and/or a cumulative HI of 1, indicating that each is a site of concern and possibly require action:

- NSDD Hot Spot [Section 3 EU 01 (Figure 4.99) and EU 02 (Figure 4.100)]
- NSDD, Excluding the Hot Spot [Section 3 EU 03 (Figure 4.101), Section 4 all EUs (Figures 4.102 – 4.104), and Section 5 all EUs (Figures 4.135-4.138)]

Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015

As presented in the SWOU BHHRA, the following EUs exceeded a cumulative $1x10^{-6}$ cancer risk level and/or a cumulative HI of 1, indicating that each is a site of concern and will be considered for further remedial action:

- Outfall 001 EU 13 Hot Spot (Figure 4.44)
- Outfall 001 EU 14 Hot Spot (Figure 4.45)
- Outfall 001 EU 15 Hot Spot (Figure 4.46)
- Outfall 001 EU 16 Hot Spot (Figure 4.47)
- Outfall 001 EU 18 Hot Spot (Figure 4.49)
- Outfall 001 EU 20 Hot Spot (Figure 4.51)
- Outfall 008 Hot Spot [EU 08 (Figure 4.70) and EU 11 (Figure 4.73)]
- Outfall 010 Hot Spot [EU 10 (Figure 4.86)]
- Outfall 011 Hot Spot [EU 01 (Figure 4.87)]
- Outfall 015 Hot Spot [EU 01 (Figure 4.89), EU 02 (Figure 4.90), EU 03 (Figure 4.91), EU 04 (Figure 4.92), EU 07 (Figure 4.95), and EU 08 (Figure 4.96)]
- Within the Fence, Excluding Hot Spots

UCL = upper confidence limit

Table ES.2 DQO Decisions for NSDD and Internal Plant Ditches and Areas Associated with Outfalls (Continued)

Decision Rule #5 *If the average of contaminant concentrations within the EU exceeds waste acceptance criteria (WAC) for characteristic or listed-hazardous waste or for Toxic Substances Control Act (TSCA) waste, then declare the waste from the EU as potentially hazardous pending further characterization.*
NSDD Sections 3, 4, and 5
Average concentrations of some metals exceed the WAC; therefore, waste may be potentially hazardous and require further characterization when generated to ensure proper disposition. Further characterization may include the collection of toxicity characteristic leaching procedure (TCLP) data.
Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015
Average concentrations of some metals exceed the WAC; therefore, waste may be potentially hazardous and require further characterization when generated to ensure proper disposition. Further characterization may include the collection of TCLP data.
Decision Rule #6 *If the median of contaminant concentrations from samples from Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas exceed authorized limits for the C-746-U Landfill, then either develop plans for alternative disposition of any waste generated or consider refining the authorized limits calculations, as appropriate, prior to any waste disposition.*
NSDD Sections 3, 4, and 5
Median concentrations of plutonium-239/240 and thorium-230 exceeded the authorized limits for the C-746-U Landfill in the NSDD Hot Spot surface soil; therefore, it is necessary either to develop plans for alternative disposition of any waste that may be generated associated with surface soil of the NSDD Hot Spot or to refine the authorized limits calculations prior to any waste disposition. There were no exceedances of the authorized limits for the C-746-U Landfill in the NSDD, excluding the Hot Spot.
Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015
Median concentrations of cesium-137 exceeded the authorized limits for the C-746-U Landfill in Outfall 010; therefore, it is necessary either to develop plans for alternative disposition of any waste generated or to refine the authorized limits calculations prior to any waste disposition. There were no exceedances of the authorized limits for the C-746-U Landfill in any of the other outfalls.
Decision Rule #7 *If modeling performed as part of the baseline human health risk assessment for the ditches associated with Outfalls 001, 002, 008, 010, 011, or 015 or if modeling performed as part of analyses subsequent to any response actions (including a no further action decision) indicates that contaminants migrating from ditches may be impacting human health or the environment at downgradient locations, then evaluate measures to mitigate these impacts, including the evaluation of the potential effectiveness of sediment control basins.*
NSDD Sections 3, 4, and 5
Not applicable
Internal plant ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012 and 015
Modeled contaminant transport at downstream receptor locations indicated that the COPC levels for both the average and the maximum concentrations of Total PCBs exceed the child recreational and industrial worker no action screening levels for surface water runoff at Outfall 001, 008, 010, and 015, and that Total PCBs concentrations did not exceed other risk evaluation criteria. For uranium-238, the only exceedance of the modeled concentrations was in the Outfall 001 runoff for the no action child recreational screening level. No predicted concentrations within the creeks exceeded a no action screening criteria.

Table ES.3 DQO Decisions for Storm Sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537

Decision Rule #1 *If sampling over multiple flow rates at locations where the storm sewer discharges to ditches determines concentrations of PCBs and uranium are in excess of indicator levels for water, then relocate samplers to upgradient locations to delimit the source area(s).*
For all locations, except the C-340 Storm Sewer, all contaminant concentrations in Step 1 water samples were below indicator levels. For the C-340 Storm Sewer, one sample collected during one sampling event exceeded the uranium indicator level. Note: a DQA was performed using previous and current data. This analysis concluded that the noted uranium result was not statistically different from other Step 1 sample analyses from this location (See the Technical Memorandum in Appendix A.9 for additional details). Further, the mean concentration was determined to be well below the indicator level.
Decision Rule #2 *If sampling over multiple flow rates at upgradient locations determines concentrations of PCBs and uranium are in excess of indicator levels for water, then identify source areas.*
Step 2 sampling was conducted at eight locations upgradient of the C-340 discharge every other week during a six-week period. Three sample sets were collected during the sampling event. Concentrations of Total PCBs, TCE, and Total Uranium all were below the indicator levels.
Decision Rule #3 *Once source areas are identified, collect soil samples from suspected source areas. If concentrations of PCBs and uranium are in excess of indicator levels for soil, then identify the nature and extent of the source term for use in later decision documents.*
Based on an absence of contamination detected in water samples above indicator levels, a decision was made not to collect soil samples. Section A.9 of the Technical Memorandum (Appendix A) provides a technical and statistical justification supporting this decision.
Decision Rule #4 *If the average of contaminant concentrations within the source area exceeds WAC for characteristic or listed-hazardous waste or for TSCA waste, then declare any waste from the source as potentially hazardous pending further characterization.*
Based on the results of the SI, the sewer systems are presumed not to be a source of potentially hazardous waste.
Decision Rule #5 *If the median of contaminant concentrations within the source area exceeds authorized limits for the C-746-U Landfill, then either develop plans for alternative disposition of any waste generated or consider refining the authorized limits calculations, as appropriate, prior to any waste disposition.*
Based on the results of the SI, the sewer systems are presumed not to be a source of waste to be disposed of in the C-746-U Landfill.
Decision Rule #6 *If modeling performed as part of the BHHRA for the storm sewers associated with C-333-A, C-337-A, C-340, C-535 and C-537, or if modeling performed as part of analyses subsequent to any response actions (including a no further action decision) indicates that contaminants migrating from storm sewers may be impacting human health or the environment at downgradient locations, then evaluate measures to mitigate these impacts, including the evaluation of the potential effectiveness of sediment control basins.*
Based on the results of the SI, the sewer systems are presumed not to be a source of contamination in the outfalls and their internal ditches and areas.

1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County, is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which is located the electricity generating Shawnee Steam Plant.

PGDP was owned and managed first by the Atomic Energy Commission and then the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation (USEC) assumed management and operation of the PGDP enrichment facilities under a lease agreement with DOE. DOE, however, still owns the enrichment complex and is responsible for environmental management activities associated with past operation of PGDP (CERCLIS# KY8-890-008-982). DOE is the lead agency for remedial actions, and the U.S. Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet (KEPPC) are regulatory oversight agencies.

Source units and areas of contamination at PGDP have been grouped into six operable units (OUs) for evaluation of remedial actions. Each OU is designed to aid in the remediation of contaminated media associated with PGDP.

The Surface Water OU (SWOU) consists of source units that primarily contain surface water contamination or sources such as soil and sediments that potentially contribute to surface water contamination. These units include the North-South Diversion Ditch (NSDD), internal plant outfall ditches, impoundment ponds, Bayou Creek, and Little Bayou Creek. DOE, EPA, and KEPPC have agreed that preventing off-site migration of contaminants is the highest sitewide priority for nonemergency cleanup activities at PGDP (DOE 2005b). Cleanup activities for the SWOU will be performed as a series of prioritized response actions. The first sequenced response action for on-site portions of the SWOU, includes the following areas at PGDP:

- NSDD Sections 3, 4, and 5;
- PGDP outfalls (001, 002, 008, 010, 011, 012, and 015);
- Internal ditches associated with the outfalls at PGDP [including Solid Waste Management Unit (SWMU) 92 and SWMU 97]; and
- PGDP storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537.

1.1 SCOPE OF THE SWOU (ON-SITE) INVESTIGATION WITHIN THE SURFACE WATER STRATEGY

The SWOU is one of five media-specific OUs at PGDP being used to evaluate and implement remedial actions. DOE, EPA, and the Commonwealth of Kentucky have agreed upon five media-specific strategic cleanup initiatives as follows [from Site Management Plan (SMP), DOE 2005b]:

- Burial Grounds OU Strategic Initiative,
- Decontamination and Decommissioning (D&D) OU Strategic Initiative,
- Groundwater OU Strategic Initiative,
- Soils OU Strategic Initiative, and
- SWOU Strategic Initiative.

These initiatives include taking early actions, as necessary, to prevent and reduce exposure and unacceptable risks. This includes completion of a series of prioritized response actions, ongoing site characterization activities to support future response action decisions, and D&D of the currently operating gaseous diffusion plant once it ceases operation. These initiatives will be followed by a comprehensive sitewide evaluation, with implementation of additional and final actions, as needed, to ensure long-term protectiveness. The intended scope, sequence, and timing of the OU initiatives are documented in the SMP (DOE 2005b) and in the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998a).

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

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

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

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

As described in the SMP (DOE 2005b), the following steps are being used at PGDP to implement the phased approach for the SWOU:

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

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

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

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

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

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

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

- Installed inverted pipe dams at outfall ditches (mid 1980s);
- Removed approximately 5,000 drums of PCB contaminated soils from vaporizer areas in C-337-A (1985 - 1986) and C-333-A (1987);
- Stabilized and mitigated PCBs in Outfall 011 ditch:
    - Removed approximately 1,300 drums of PCB contaminated sediments (1983);
    - Cleaned ditch and installed fabric liner (1994);
    - Applied liquid boot, bentonite and native clay (1995);
    - Implemented bio-remediation technology (1996);
- Rerouted discharges at the NSDD and initiated treatment of radiologically contaminated waste waters from C-400 prior to discharge (1995);
- Installed fly ash collection basin at C-600 (1995);
- Removed polychlorinated biphenyl (PCB)-contaminated soil at Waste Area Group (WAG) 23 (1997);
- Completed Drum Mountain Removal Action (2000);
- Installed the C-613 Sedimentation Basin (2003);
- Installed the NSDD Hardpiping Installation (2003);
- Plugged culverts in NSDD at north security fence (2004);
- Completed NSDD Source Removal-Section 1 and Section 2 (2004); and
- Implemented Scrap Yard Removal Action-source removal (in progress, estimated completion date - November 2006).

The SWOU (On-Site) Site Investigation (SI) will support evaluations regarding the phased approach (Steps 1, 2, 3, and 4).

1.2 PURPOSE OF REPORT

The objectives of the SI include the identification of hot spots and the characterization of the nature and extent of contamination in ditches and outfalls, including NSDD (Sections 3, 4, and 5). Also included in the SI is an evaluation of a portion of the PGDP storm sewer system, its role as a potential source of contamination, and whether or not it serves as a conduit for off-site migration of contaminants. Sampling results from the investigation are also used to complete baseline human health and screening ecological risk assessments (SERAs).

The SWOU (On-Site) SI focused on 14 solid waste management units (SWMUs). The following SWMUs were sampled and/or evaluated during the investigation:

- SWMU 58-Sections 3, 4, and 5 of the NSDD
- SWMU 60-Outfall 002
- SWMU 61-Outfall 013
- SWMU 62-Outfall 009
- SWMU 63-Outfall 008
- SWMU 66-Outfall 010
- SWMU 67-Outfall 011
- SWMU 68-Outfall 015
- SWMU 69-Outfall 001
- SWMU 92-PCB Spill
- SWMU 97-C-601 Diesel Spill
- SWMU 102-Plant Storm Sewers
- SWMU 168-Outfall 012
- SWMU 526-Internal Plant Ditches

It should be noted that SWMU 61 (Outfall 013) and SWMU 62 (Outfall 009) were evaluated during development of the Sampling and Analysis Plan (SAP). An assessment of the outfalls, which included a review of historical data, indicated that SWMU 61 and SWMU 62 did not require an early action, and further assessment of SWMU 61 and SWMU 62 would be addressed during the Comprehensive Site-Wide Operable Unit (CSOU). SWMU 92 (PCB Spill) was addressed as part of Outfall 008 and Outfall 010. SWMU 97 (C-601 Diesel Spill) was addressed as part of Outfall 015.

The project objectives for the SI/Baseline Risk Assessment (BRA) of the SWOU are consistent with those established in the FFA (EPA 1998a) and the SMP (DOE 2005b) negotiated among DOE, EPA, and KEPPC. The FFA requires that DOE identify, investigate, and remediate, if necessary, areas of concern (AOCs) and SWMUs that potentially could pose a threat to human health and the environment. As defined in the SMP, the SWOU (On-Site) SI/BRA addresses NSDD Sections 3, 4, and 5; PGDP Outfalls 001 (those portions not addressed by the C-613 Sedimentation basin), 002, 008, 010, 011, 012 (those portions downgradient of the storm sewer discharge point), and 015, and associated internal ditches and areas (including SWMU 92 and SWMU 97); and PGDP storm water sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537.

This SI/BRA had the following three specific objectives:

- Provide data that can be used to identify areas of elevated contaminant concentrations (i.e., identify "hot spots"[1]) in surface soil and sediment along the outfalls, in associated internal ditches and areas, and within Sections 3, 4, and 5 of the NSDD, and identify the extent of contamination in these areas. For the storm sewers, provide data that can be used to determine if a particular storm sewer system is releasing contamination and target a portion of the storm sewer that is the source of contamination.

- Provide data that can be used to characterize contamination in soil and sediment found in the outfalls, their associated internal ditches and areas, and within Sections 3, 4, and 5 of the NSDD.
- Utilize data collected to meet the first two objectives and use information from other projects (e.g., sampling results from routine surface water monitoring) to determine the potential for migration of contamination through the outfalls and their associated internal ditches and areas and from the storm water sewers.

1.3 SITE BACKGROUND

The following subsections present a description of the three general areas included in the SWOU (On-Site) SI/BRA.

1.3.1 Site Descriptions

The following subsections describe the areas that were evaluated during the implementation of the SI. These areas included NSDD Sections 3, 4, and 5; the areas and internal plant ditches related to Outfalls 001, 002, 008, 010, 011, 012 and 015; and the storm sewers from C-333-A, C-337-A, C-340, C-535, and C-537.

1.3.1.1 NSDD Sections 3, 4, and 5

The entire NSDD is located on property owned by DOE. For the purposes of response actions at PGDP, the NSDD has been divided into five sections that are numbered south to north. Sections 1 and 2 (SWMU 59) are within the plant security-fenced area and were not included in this investigation. Sections 3, 4, and 5 (SWMU 58) are outside the security-fenced area (Figure 1.1). The NSDD originates within the north-central portion of PGDP and discharges into Little Bayou Creek to the north of the plant. Little Bayou Creek originates within the West Kentucky Wildlife Management Area (WKWMA), south of PGDP, and flows northward along the east side of the PDGP and joins Bayou Creek near the Ohio River.[2] Little Bayou Creek is intermittent in its upper reaches, becoming perennial downgradient of its confluence with Outfall 010, a continuous flow outfall from PGDP. The confluence of Little Bayou Creek and Outfall 010 is upstream of the NSDD's confluence with Little Bayou Creek.

Sections 3, 4, and 5 of the NSDD are approximately 2,560 m (8,400 ft) long. These sections of the NSDD vary in width from approximately 4.6 to 11 m (15 to 36 ft) with a depth ranging from approximately 1.5 to 4.6 m (5 to 15 ft). The banks of Section 3, 4, and 5 of the NSDD are vegetated with

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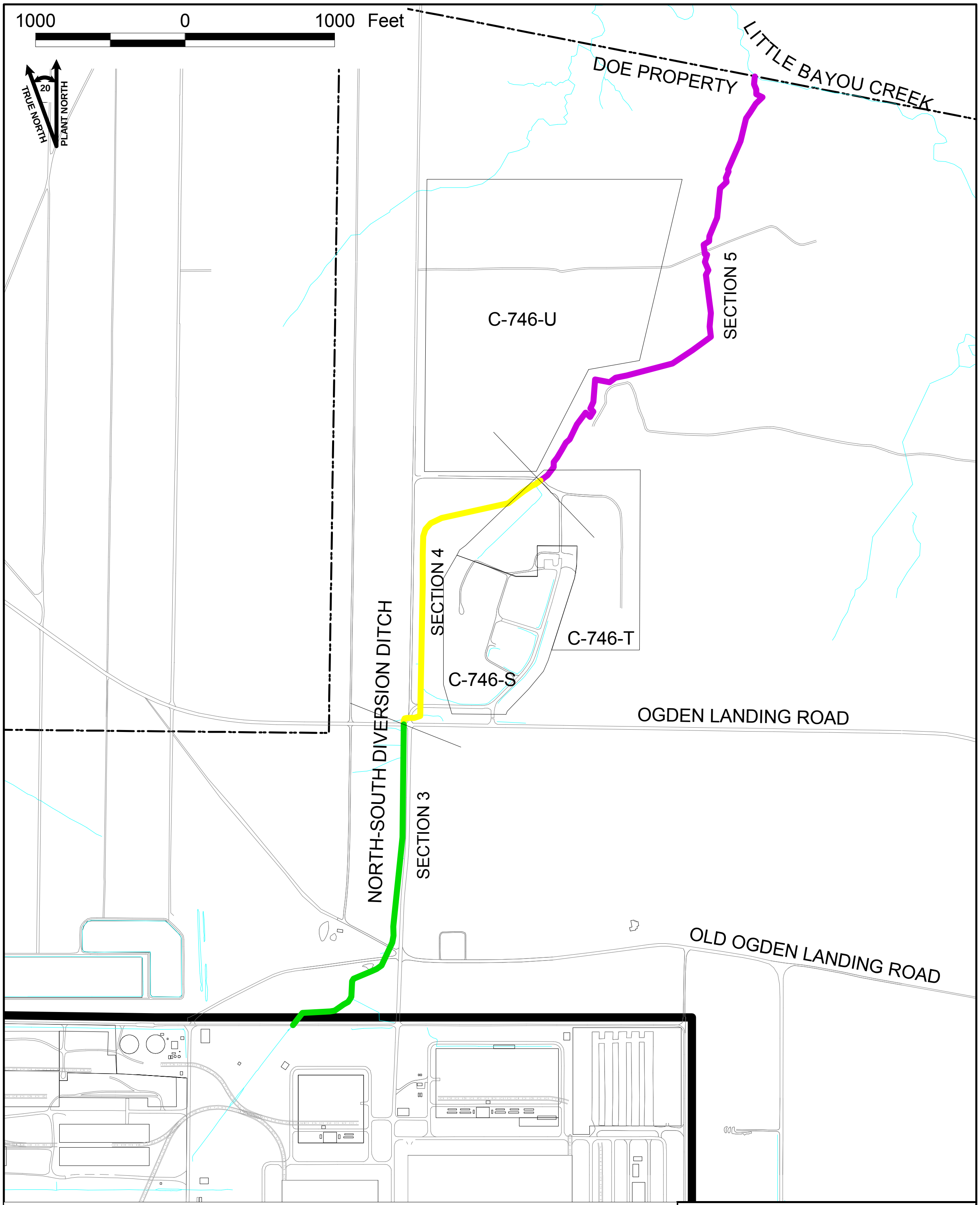
[1] A potential "hot spot" is characterized by an area in which one or more indicator chemicals exceeded an indicator level or one or more analytes exceeded an analyte's characterization level as established in the SAP. It should be noted that neither indicator nor characterization levels should be considered cleanup goals. Cleanup goals will be determined in the removal action evaluation process.

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



LEGEND:

ROAD
SURFACE WATER
PGDP BOUNDARY
DOE BOUNDARY
NSDD SECTION 3
NSDD SECTION 4
NSDD SECTION 5

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Figure 1.1. Sections 3, 4, and 5 of the NSDD

Figure No. C5AC90005sk001.apr
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grasses, brush, and trees. Approximately 914.4 m (3,000 ft) of the NSDD (i.e., that portion nearest to Little Bayou Creek) fall within the 500-year floodplain of the Ohio River, and some portions of NSDD nearest Little Bayou Creek fall within the 100-year floodplain of the Ohio River (COE 1994). In 1982, Section 4 of the NSDD (located north of Ogden Landing Road) was relocated to its present configuration to facilitate construction of the C-726-S and C-746-T Landfills. The former segment of the NSDD was filled and abandoned and now is located under the C-746-S and C-746-T Landfills. It should be noted that the abandoned segment of the ditch is not within the scope of this action. Section 5 of the NSDD, downstream of the C-746-U Landfill access road, is a natural, relatively unmodified, stream channel. Stream flow in this channel is intermittent in the southernmost reaches, but becomes perennial as it flows toward Little Bayou Creek. Upstream of the C-746-U Landfill access road, the NSDD is channeled and bordered by mown grasses (Section 4), except for a short wooded segment immediately downstream of the security fence (Section 3). The NSDD outside of the security-fenced area is posted for radiological contamination [pursuant to 10 *Code of Federal Regulations* (CFR) 835 requirements].

1.3.1.2 Outfalls

Prior to 2002, PGDP had 17 outfalls, which produced a combined average daily flow of approximately 18.5 million liters per day (mlpd) [4.9 million gallons per day (mgd)] (MMES 1992). Outfall 007, the C-611 sewage effluent, has since been replaced with a septic tank and leach field; this specific outfall no longer exists. The 16 remaining outfalls are shown on Figure 1.2. Of the 16 present outfalls, 13 are open and maintained under the current Kentucky Pollutant Discharge Elimination System (KPDES) permits. The remaining three outfalls (Outfalls 003, 005, and 014) 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 specified action or detection limits. Effluent characteristics monitored under the KPDES permits include the following: discharge temperature, flow, hydrogen-ion concentration (pH), phosphorous content, total suspended solids, uranium, trichloroethene (TCE), technetium-99 (^{99}Tc), and PCBs. KPDES permit information for PGDP outfalls, such as monitoring and sampling results, is available at the Environmental Information Center located in the Barkley Centre, Paducah, Kentucky. Outfalls 001, 002, 008, 010, 011, 012, and 015 were investigated during this SWOU (On-Site) SI. A description of each of these outfalls is presented in the following subsections.

Outfall 001. Outfall 001 has the largest watershed at PGDP and receives drainage from an area of about 82.26 hectares (ha) (203 acres), including the internal plant ditches that drain to it (Figure 1.2). The portion of the internal plant ditch system flowing to Outfall 001 drains the northwestern part of the plant and is approximately 6,224 m (20,420 ft) in combined total length, unlined, and approximately 0.15–3.6 m (0.5–12 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The reported monthly average flow through Outfall 001 into Bayou Creek is 10.53 mlpd (2.79 mgd). Outfall 001 became the responsibility of DOE under the KPDES permit in 1997.

Outfall 002. Outfall 002 receives drainage from an area of about 22.44 ha (55 acres), which includes the internal plant ditches that drain to it (Figure 1.2). The internal plant ditch system flowing to Outfall 002 drains the northeastern part of the plant and is about 960 m (3,150 ft) in total length, unlined, and approximately 0.6–0.9 m (2–3 ft) deep. This ditch system was trenched when the PGDP was built in 1951. Flow through Outfall 002 is transferred by a lift-station to Ditch 010 and is discharged through Outfall 010. In the event that a rainfall event exceeds the capacity of the lift-station pumps, Outfall 002 may emit some flow to Little Bayou Creek. During these overflow events, USEC is required to measure and sample the flow. An average of these measurements during 2000 and 2001 indicates that, during overflow events, Outfall 002 averages a discharge of 5.40 mlpd (1.43 mgd). The KPDES permit for Outfall 002 is maintained by USEC.

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 (Figure 1.2). The internal plant ditch system to Outfall 008 drains the western part of the plant and is approximately 3,723 m (12,215 ft) in total length, unlined, and ranges from approximately 0.15 to 1.2 m (0.5 to 4 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The reported monthly average flow through Outfall 008 is 4.6 mlpd (1.22 mgd). The KPDES permit for Outfall 008 is maintained by the USEC.

Outfall 010. Outfall 010 is located on the east side of the PGDP and receives drainage from an area of about 8.78 ha (22 acres) including the internal plant ditches that drain into it (Figure 1.2). The internal plant ditch system flowing to Outfall 010 drains the eastern part of the PGDP and is approximately 2,256 m (7,400 ft) in total length, unlined, and approximately 0.6 m (2 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The reported monthly average flow is 2.11 mlpd (0.56 mgd). Outfall 010 is equipped with a containment dam that can be used, if necessary, during releases. The KPDES permit for Outfall 010 is maintained by USEC.

Outfall 011. Outfall 011 is located on the east side of the PGDP and receives drainage from an area of approximately 12.5 ha (31 acres), including the area of the internal plant effluent ditches. (Figure 1.2) The internal plant ditch system to Outfall 011 drains the eastern part of the PGDP and is approximately 1,646 m (5,400 ft) in total length, unlined, and approximately 0.61 m (2 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The reported monthly average flow for Outfall 011 is 1.28 mlpd (0.34 mgd). The KPDES permit for Outfall 011 is maintained by USEC.

Outfall 012. Outfall 012 lies on the east side of PGDP and receives drainage from an area of approximately 24.76 ha (61 acres), including the internal plant ditches that drain to it (Figure 1.2). The internal plant ditch system flowing to Outfall 012 drains the southeast part of the plant and is approximately 975 m (3,200 ft) in total length, unlined, and is approximately 0.9 m (3 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The KPDES permit for Outfall 012 is maintained by USEC.

Outfall 015. Outfall 015 lies on the west side of PGDP and receives drainage from an area of approximately 19.8 ha (49 acres), including the internal plant ditches that drain to it (Figure 1.2). The internal plant ditch system flowing to Outfall 015 drains the west central part of the plant and is approximately 3,252 m (10,665 ft) in total length, unlined, and ranges from approximately 0.15 to 1.5 m (0.5 to 5 ft) deep. This ditch system was trenched when the PGDP was built in 1951. The reported monthly average flow for Outfall 015 is 1.06 mlpd (0.281 mgd). The KPDES permit for Outfall 015 is maintained by DOE.

Associated Outfall Areas (SWMUs 92 and 97). These SWMUs are associated with internal ditches that drain to Outfalls 008, 010, and 015. The following paragraphs provide descriptions of these SWMUs.

SWMU 92. SWMU 92, a rectangular area of grassy field on the north side of Tennessee Avenue north of the C-331 Building, is located along internal drainage ditches leading to Outfalls 008 and 010. The area was designated a SWMU due to placement of PCB-contaminated soils as fill from the transformer rupture at the C-420 PCB Spill Site (SWMU 78) in 1967.

SWMU 97. SWMU 97 includes the north/south portion of the drainage ditch west of 10th Street at C-600 and the east/west portion of the drainage ditch north of Virginia Avenue from C-600 to west of the plant security fence. SWMU 97 is approximately 955 m (3,135 ft) long, approximately 1.8 m (6 ft) wide,

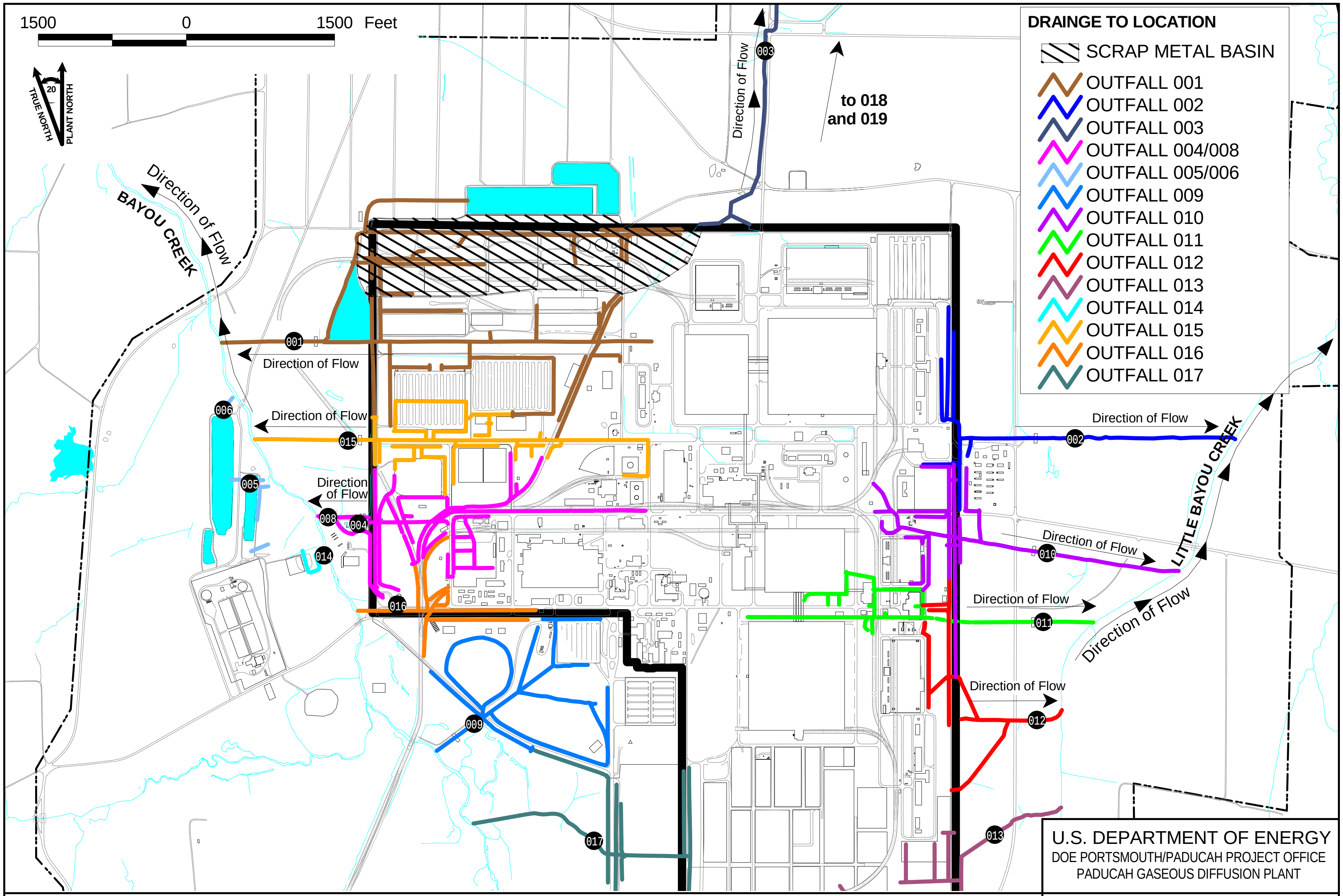

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Figure 1.2. KPDES Outfall Locations and Generalized Surface Water Flow Patterns at PGDP

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and located within Outfall 015 and its associated internal ditches. A diesel oil spill of approximately 64,350 liters (17,000 gallons) occurred at the C-601 fuel oil tank area on March 9, 1979, and was released, via transfer trenches and underground effluent lines, to the C-735-W7 Oil Skimmer Ditch (Outfall 008) and to Outfall 015. Oil removal operations were conducted in the Outfall 015 ditch (location of SWMU 97) from March 9 through March 21, 1979. The oil removal operation was successful with the creek free of oil and the last oil collection booms removed on March 21, 1979.

1.3.1.3 Storm Sewers

The storm sewer system at PGDP has been in operation since 1951 and continues to receive drainage from the plant. The storm sewers consist of a network of buried piping that collects surface drainage and drainage from building roofs and floors and is located approximately 2.7 m (9 ft) below ground surface (bgs). Construction diagrams indicate that the storm sewer is made of vitreous clay tile and reinforced concrete with a diameter ranging from approximately 15 to 152 cm (6 to 60 in.), depending on whether it is a lateral receiving portion or a main trunk portion of the system. Storm sewers on the eastern side of the plant discharge at points upstream of the KPDES outfalls that empty into Little Bayou Creek: Outfalls 002, 010, 011, and 012. Storm sewers on the western side of the plant discharge at points upstream of the KPDES outfalls that empty into Bayou Creek: Outfalls 001, 008, and 009. Storm water sewer systems investigated during the SWOU (On-Site) SI were associated with Buildings C-333-A, C-337-A, C-340, C-535, and C-537.

C-333-A. The C-333-A Vaporizer is located on the south side of the C-333 Process Building. The C-333-A Building is a one-story facility covering approximately 780 m^2 (8,232 ft^2). The main contents of the building are a north and south bank of autoclaves. Building operations began in September 1951. An upgrade of the C-333-A facility was completed in 1987.

The storm sewer system downstream of C-333-A connects with the storm sewer system for the east side of C-333. Surface water, roof, and floor drain runoff enters the system through fourteen 15- and 20-cm (6- and 8-in.) diameter lines that run to a series of larger diameter lines east and south of the building. These lines empty to a 122-cm (48-in.) diameter line that discharges to the Outfall 012 ditch (Figure 1.3).

C-337-A. The C-337-A Vaporizer is located on the east side of the C-337 Process Building. A one-story building, covering approximately 790 m^2 (8,500 ft^2), houses the facility. The main contents of the building are an east and west bank of autoclaves, each containing five units. Building operations began in 1958. An upgrade of the C-337-A facility was completed in 1988.

The storm sewer system adjacent to the south side of C-337-A and the southeast corner of the C-337 Process Building collects surface, roof, and floor drain runoff that discharges to Outfall 002. Runoff enters 15–30-cm (6–12-in.) diameter piping at 12 locations. These lines run into a 152-cm (60-in.) diameter line southeast of the building that discharges to the Outfall 002 ditch (Figure 1.4).

C-340. The C-340 Reduction and Metals Facility was built in 1952 and is located on the east side of the plant. The facility went online on December 28, 1956, and continued operations until 1977, when shutdown of the facility began. In subsequent years, all of the drains leading to the storm sewers were plugged. The building is currently inactive, but was formerly used to reduce uranium hexafluoride (UF_6) to uranium tetrafluoride (UF_4) and to convert green salt (UF_4)to metallic uranium. The C-340 complex has been locked since 1991 and is listed for decontamination and decommissioning.

The storm sewer system for the C-340 Reduction and Metals Facility receives storm water runoff. Runoff enters the system through three 10-cm (4-in.) diameter lines on the east side of the building and

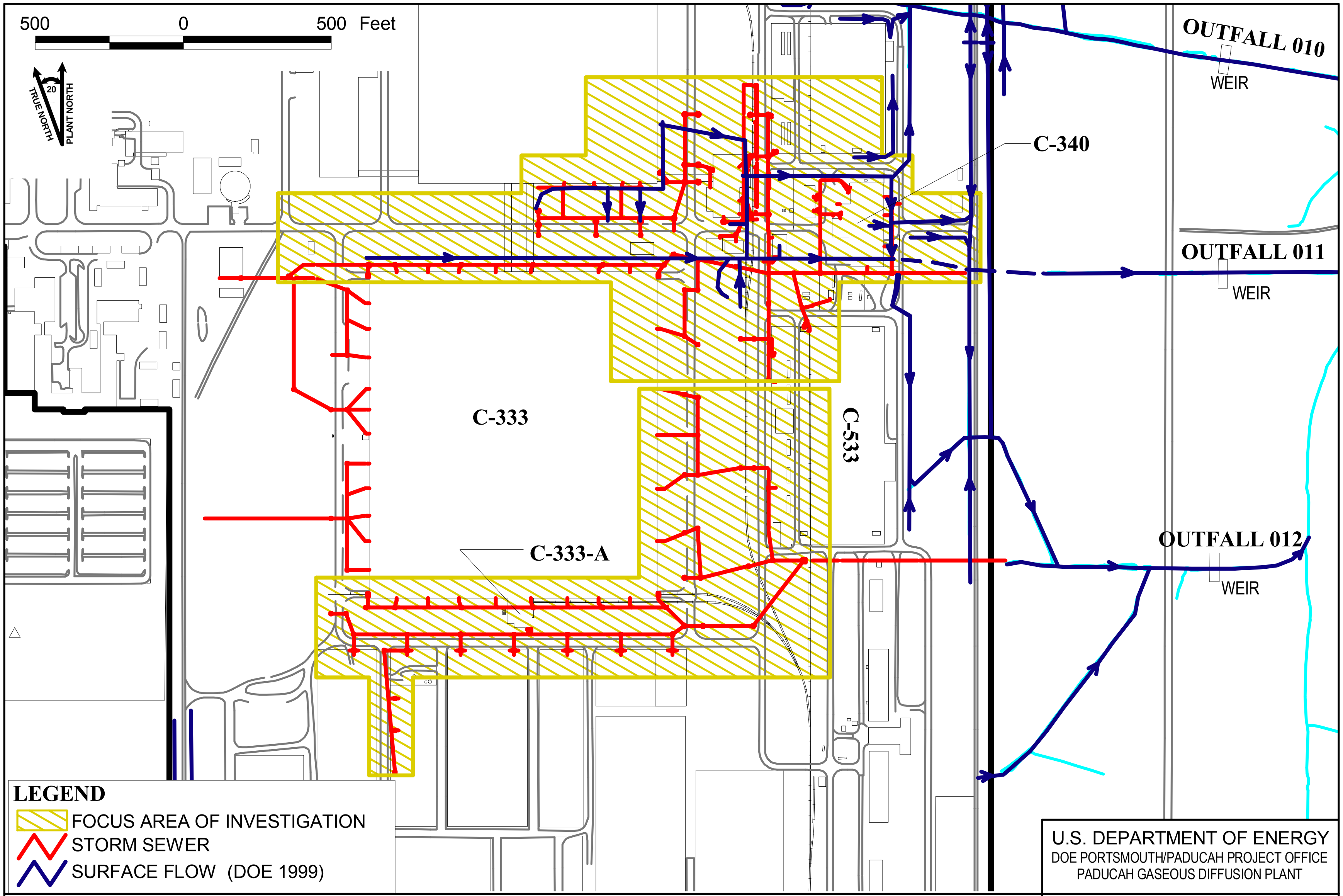

Figure 1.3. Location of Storm Sewers near C-333 and C-340

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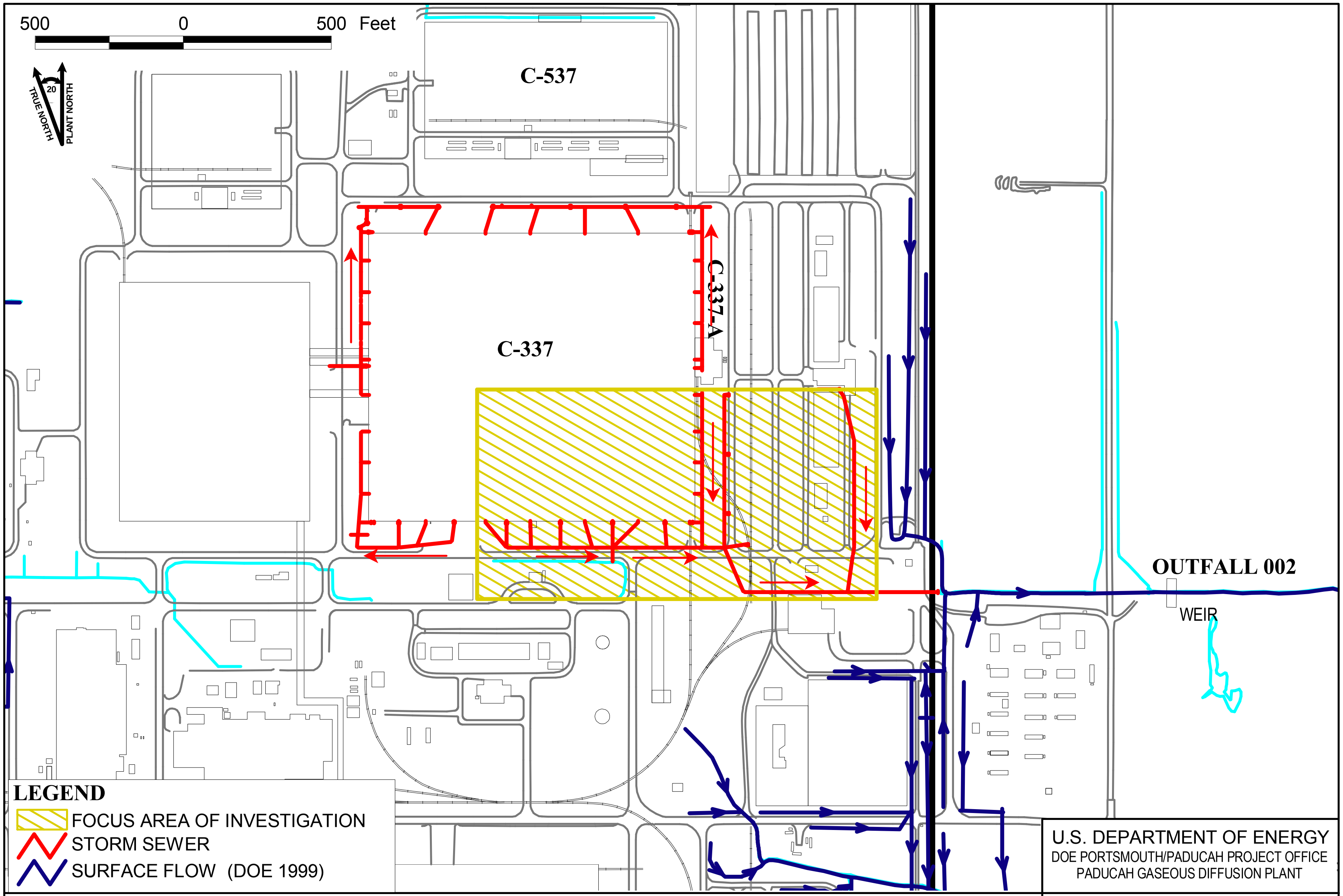

Figure 1.4. Location of Storm Sewers near C-337

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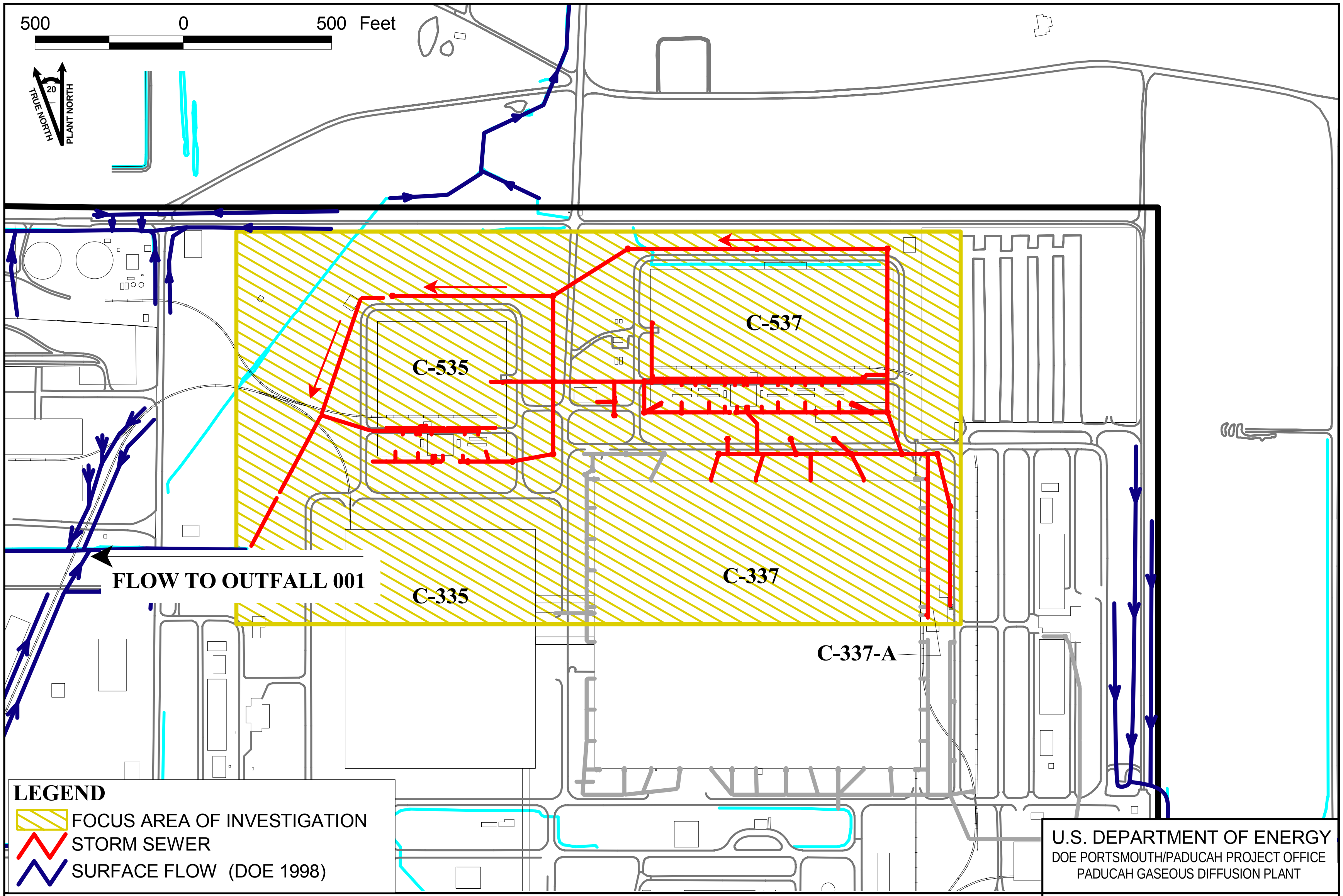

Figure 1.5. Location of Storm Sewers near C-535 and C-537

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two 15-cm (6-in.) diameter lines on the west side of the building. The lines on the east side run to a 30-cm (12-in.) diameter, north-south trending line and the lines on the west side run to a 38-cm (15-in.) diameter, north-south trending line. Both of the north-south trending lines empty to a 122-cm (48-in.) diameter line that discharges to the Outfall 011 ditch (Figure 1.3).

C-535. The C-535 Electrical Switchyard is located in the northeastern portion of PGDP, just north of the C-335 Process Building and inside the fenced perimeter of the plant area. The switchyard has been in operation since April 30, 1954, and remains active today, supplying electrical power to various buildings at the plant. The switchyard is enclosed by 2.4-m (8-ft) tall chain-link fencing to limit access to the facility, and the ground surface is covered with gravel to provide storm water runoff by increasing flow to the subsurface underdrains. Field observations made during a March 1997 site walkover suggested that the switchyards are equipped with underdrain systems designed to collect storm water from the facility and direct it to a series of drainage pipes that discharge to drainage ditches. Drainage ditches for the C-535 switchyard are on the northern side of the facility and eventually discharge to KPDES Outfall 001 (Figure 1.5).

The storm sewer system for the C–535 switchyard collects surface water and roof drain runoff. Runoff enters the system through a series of 15- and 20-cm (6- and 8-in.) diameter, north-south trending lines, which run to larger lines and, ultimately, to a 137-cm (54-in.) diameter line that discharges to the Outfall 001 ditch west of the switchyard.

C-537. The C-537 Electrical Switchyard is located in the northeastern portion of PGDP, just north of the C-337 Process Building and inside the fenced perimeter of the plant area. The switchyard has been in operation since December 24, 1954, and remains active today, supplying electrical power to various buildings at the plant. The switchyard is enclosed by a security fence to limit access to the facility, and the ground surface is covered with gravel to provide storm water drainage. Field observations made during a March 1997 site walkover suggested that the switchyards are equipped with underdrain systems designed to collect storm water from the facility and direct it to a series of drainage pipes that discharge to drainage ditches. Drainage ditches for the C-537 switchyard are on the northern side of the facility and eventually discharge to KPDES Outfall 001 (Figure 1.5).

The storm sewer system for the C-537 switchyard collects surface water and roof drain runoff. Runoff enters the system through a series of 15- and 20-cm (6- and 8-in.) diameter, north-south trending lines, which run to larger lines and, ultimately, to a 137-cm (54-in.) diameter line that discharges to the Outfall 001 ditch west of the switchyard.

1.3.2 Site History

The SWOU (On-Site) integrates contaminants from multiple sources. The histories of each general area are presented in the following subsection.

1.3.2.1 NSDD Sections 3, 4, and 5

The portion of the NSDD outside the plant security-fenced area (SWMU 58), which includes Sections 3, 4, and 5, is approximately 8,400 ft long. This portion of the ditch varies in width from approximately 15 to 36 ft, and the depth ranges from approximately 5 to 15 ft. The banks of the NSDD outside of the plant security-fenced area generally are vegetated with grasses and brush, and trees line some sections of the bank. Section 5 of the NSDD, downstream of the C-746-U Landfill access road, is a natural, relatively unmodified stream channel. Stream flow in this channel is intermittent in the southernmost reaches, but becomes perennial as it approaches Little Bayou Creek. Upstream of the C-746-U Landfill access road, the NSDD is channeled and bordered by mown grasses (Section 4), except for a short wooded segment immediately downstream of the security fence (Section 3). In 1982, Section 4 of the NSDD (located north of Ogden Landing Road) was relocated to its present configuration to facilitate construction of the C-726-S and C-746-T Landfills. The former segment of the NSDD was filled and abandoned and now is located under the C-746-S and C-746-T Landfills. It should be noted that the abandoned segment of the ditch is not within the scope of this action. The NSDD outside of the plant security-fenced area is posted for radiological contamination (pursuant to 10 CFR 835 requirements).

Historically, the NSDD received wastewater from the C-400 Cleaning Building, coal pile runoff, and storm water. The primary functions of the C-400 Cleaning Building included cleaning, metal plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and UF_4 (green salt) pulverization. Sources of storm water runoff to the ditch included a steam plant (C-600), process buildings (C-335 and C-337), a cooling tower (C-635), the north side of the electrical switchyards (C-535 and C-537), a neutralizing pit (C-403), and a feed plant (C-410). As a consequence, the soil and sediment in the ditch have been contaminated. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed nearly filled the southern portion of Section 1 of the NSDD. This caused runoff from heavy rainfall events to overflow the ditch, primarily near 10th Street. In order to restore adequate flow, sediments periodically were dredged from the NSDD, and the spoils were placed near the banks of the ditch.

In 2003 and 2004, the remediation of Sections 1 and 2 of the NSDD was accomplished by the excavation and disposal of soil in those sections of the ditch to a depth of 4 ft bgs and the excavated area was restored to grade with 2 ft of clay, 2 ft of soil, and vegetated. The distal end of Section 2 was plugged to prevent further discharge of any type of flow to downstream portions of the NSDD ditch (Sections 3, 4, and 5). A surge basin was constructed surrounding the C-616-C Lift Station and all flow from Sections 1 and 2 of the NSDD, including effluent of the C-335 and C-337 Process Buildings and the C-535 and C-537 Switchyards that is transferred into the NSDD by the C-616-H Lift Station (Ditch 001 Lift Station), now is transmitted to the C-616-F Full Flow Lagoon for settlement of suspended solids prior to discharge through KPDES Outfall 001.

1.3.2.2 Outfalls

Outfall 001. 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 following: C-612 discharge; the C-335 Process Building; the C-337 Process Building; the C-337-A Vaporizer (SWMU 71); 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, C-415, C-535, C-537, and settling pond areas drains to the NSDD Detention Basin, 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. Historically, Outfall 001 also has received runoff from scrap metal storage yards located in the northwestern portion [approximately 20.4 ha (50.5 acres)] of the Outfall 001 watershed. In 2002, a sediment basin was constructed to collect storm water discharge from the scrap metal storage yards. This storm water is discharged to Outfall 001 following analysis of and, if necessary, treatment for pH and total suspended solids.

Outfall 002. Releases from the internal plant ditches to Outfall 002 are characterized by historical information about the facilities that drain into the ditches and by samples associated with them. Facilities that drain into Outfall 002 include the C-360 Toll Transfer and Sampling Building; the C-637 Buildings (i.e., C-637-1, 2A, 2B, 3, 4, 5, and 6); and the southeastern portion of C-337. The C-637 Buildings and the southeastern portion of the C-337 Building drain to Outfall 002 via the storm sewer system; therefore, they will not contaminate the internal plant ditches to Outfall 002. The C-360 Toll Transfer and Sampling Building, however, discharges to Outfall 002 via internal plant ditches.

The C-360 Toll Transfer and Sampling Building occupies approximately 1,654 m^2 (17,800 ft^2). The facility houses equipment necessary to receive cylinders of UF_6, weigh and sample the contents, and then transfer the cylinders to the process buildings. Numerous sources of potential contamination are present at the C-360 Building, including UF_6, Freon 113, chlorine trifluoride, paint, hydraulic oil, chromated water, and asbestos-containing material. A large release of UF_6 occurred in 1988, and small releases were documented from 1989 until at least 1993. Approximately 379 L (100 gal) of chromated water were released in January 1991 and may have exited the building through the floor drains that flow into the storm sewer system and the elevator shaft. The building has asbestos-containing material in thermal insulation on tanks and pipe insulation [*Report for Environmental Audit Supporting Transition of the Gaseous Diffusion Plants to the United States Enrichment Corporation* (DOE 1993)].

Outfall 008. Outfall 008 receives multiple waste streams from the southwest corner of the plant and discharges into Bayou Creek. Surface water runoff is received from the C-747-C Oil Land Farm (SWMU 1); the C-745-A and C-746-H Cylinder Storage Yards; and the C-747 Burial Yard. Because these waste streams 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 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 Lime House; 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 (discharges through Outfall 004 into Outfall 008); 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.

Outfall 010. Facilities draining into the Outfall 010 drainage area include 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-531-3B 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 may have been carried via surface water and sediments to Outfall 010.

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

The primary concern is sediment and surface water contaminant migration via the storm sewer system; however, sediment and surface water contaminant migration in the ditches to Outfall 010 may occur. Release of contaminants to the ditches may occur 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 may have been carried via surface water and sediments to Outfall 010.

Outfall 011. Historically, the drainage area for Outfall 011 has encompassed the C-315 Surge and Waste Building; the C-331 and C-333 Process Buildings; the C-340 Reduction and Metals Facility; C-532 Relay House; and the C-533-1 Switch House and appurtenant structures. Other areas that drain into Outfall 011 include the C-540-A PCB Staging Area (SWMU 56) and the C-540 PCB Spill Site (SWMU 80) of WAG 23.

Discharges from Outfall 011 are collected in a sump and pumped to the C-617-B Treatment Lagoon 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 waste streams when Lift Station 011 is bypassed due to failures, maintenance activities, or excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls). During such bypass events, the water discharged through Outfall 011 flows to Little Bayou Creek. Maintenance activities include cleaning the underflow weir (installed in 1991), which occurs on an as-needed basis.

Outfall 012. Specific facilities contained in the Outfall 012 drainage area that drain via the internal plant ditches are the C-533-1 Switch House and appurtenant structures (C-533-3A, C-533-3B, C-533-3C, and C-533-3D Fire Valve Houses). A portion of the C-340 Building also drains to Outfall 012 via the internal plant ditches. The C-333 Process Building and the C-633-1 Fire House and appurtenant structures drain to Outfall 012 through the storm sewer system.

Outfall 015. 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.

Associated Outfall Areas (SWMUs 92 and 97). As summarized in the site description subsection, the sources of contamination at SWMUs 92 and 97 were the placement of PCB-contaminated soil as fill and a diesel oil spill, respectively. These SWMUs are associated with the internal ditches that drain to Outfalls 008, 010, and 015.

1.3.2.3 Storm Sewers

C-333-A. In the C-333-A Vaporizer, autoclaves are used to heat transport/storage cylinders containing UF_6 feedstock for the plant, transforming the UF_6 into a gas that can be processed in the C-333 gaseous diffusion cascade. A central hydraulic system in C-333-A opens and closes the autoclaves. Historically, this system used PCBs in the hydraulic fluid (up to 1.4% by weight of PCB-1242). Prior to late 1980, leaks of the hydraulic system onto the concrete floor and into the drains of the C-333-A Building resulted in contamination of underlying soils. The hydraulic system was flushed in October 1980 to significantly reduce PCB concentrations. Samples of the hydraulic fluid in 1986 and 1987 revealed residual PCB levels of 25 and 14 milligrams per kilogram (mg/kg), respectively.

DOE undertook a construction upgrade of the C-333-A Vaporizer in 1987 to provide improved UF_6 containment. This construction required the staged removal of the autoclave banks with demolition and excavation of the concrete floors, trenches, and underlying drain lines. Both PCB and uranium levels were measured in the construction debris and in-place soils to characterize material for disposal and to determine the depth of excavation.

PCBs up to 12,000 mg/kg were discovered in the gravel backfill and soil underlying the center area of the autoclave. The project excavated 0.6–2.4 m (2–8 ft) deep beneath this center portion to attain PCB levels below the cleanup criteria of 25 mg/kg. Along the drain lines within the construction upgrade area, soil samples were collected from areas adjacent to joints in the drain line piping. PCB levels in soil typically were <2 mg/kg, but ranged as high as 22 mg/kg.

Sludge containing PCBs remained in the drain lines outside of the work area. Analyses of the sludge measured PCB levels of 350 mg/kg in the drain line directly beneath the hydraulic reservoir on the west side of the trench and 51 mg/kg downstream, at the manhole in the north truck alley. On the east side, a sludge sample in the drain line leaving the trench area contained 1,000-mg/kg PCBs, and a sludge sample from the drain line running from the south bank had 520-mg/kg PCBs. A sludge sample from a manhole access point to the east drain line, downstream of both samples, contained 490-mg/kg PCBs. A PCB-contaminated drainpipe located east of the autoclaves in C-333-A was removed as a remedial action in April 1989.

C-337-A. As in the C-333-A Vaporizer, the C-337-A autoclaves are used to heat UF_6 feedstock, transforming the UF_6 into a gas that can be processed in the C-337 gaseous diffusion cascade. The C-337-A Vaporizer includes a hydraulic system that formerly contained approximately 5.2% PCB compounds. Leaks of the hydraulic system had spilled onto the concrete floor and into drain lines intended for steam condensate of the C-337-A Building. These spills resulted in contamination of the concrete floor, drain lines, and underlying soils.

DOE began a two-phased construction project in July 1986 to remove and replace the autoclaves, concrete flooring and trenches, underlying gravel base, drain lines, and contaminated dirt of the C-337-A Vaporizer. PCB and uranium levels of waste materials and in-place soil were used to determine proper waste management and the vertical limits of excavation.

Contaminant levels in the gravel base of the west bank ranged up to 1,545-mg/kg PCBs and 144-mg/kg uranium. In general, however, contaminant levels in the underlying soils were much lower (uranium less than 25 mg/kg and PCBs ranging from 1 to 52 mg/kg). Contaminant levels associated with the floor drain system generally were greater than those associated with the west bank. Soil samples collected from below floor drains had PCB levels ranging from 297 to 1,596 mg/kg and uranium levels ranging from less than 25 to 135 mg/kg. Uranium levels in soil along the main drain lines all were less than 25 mg/kg. With the exception of the northeast corner of the west bank, PCB levels in these soil samples were 23 mg/kg or less. PCB levels measured along a main drain line in the northeast corner of the west bank were 2,500 mg/kg at 0.5-m (1.5-ft) depth; 7,020 mg/kg at 0.9-m (3-ft) depth; and 24,100 mg/kg at 1.5-m (5-ft) depth (the depth of the drain line). The upgrade of the west bank removed all soils with greater than 25-mg/kg PCBs, except for the northeast corner where a trench was excavated measuring 1.8 by 3.0 m (6 by 10 ft) wide and 5.8 m (19 ft) deep. At the bottom of the trench, PCB levels were 334 mg/kg.

EPA approved a closure plan for the Phase I upgrade construction project in September 1986. The closure plan required placement of 0.6 m (2 ft) of impermeable clay in the base of the trench, followed by a similar layer of activated charcoal, to be further backfilled with native clay. In addition, DOE agreed to sample existing groundwater wells annually for analysis of dissolved PCB levels.

The Phase II upgrade construction project of the C-337-A Vaporizer, involving the east bank autoclaves, began in April 1987. Again, all soils with greater than 25-mg/kg PCBs were removed with the exception of an area in the northeast corner of the east bank. DOE excavated a trench measuring 1.8 by 4.9 m (6 by 16 ft) wide and 3.7–4.3 m (12–14 ft) deep in an attempt to remove PCB-contaminated soils from the east bank. PCB levels in the soil remained at 60 mg/kg at the base of the trench.

DOE submitted a closure plan that consisted of placement of a 0.3-m (1-ft) layer of activated charcoal at the base of the pit overlaid by a 0.6-m (2-ft) layer of impermeable clay and additional backfill of native clay. EPA approved the closure plan in May 1987.

C-340. Historically, contamination in the C-340 Building consisted of radiological and chemical contaminants (primarily PCBs) remaining from the uranium metal production process previously performed in the building. Historical process knowledge indicates that there was the potential that some of the process feedstock, product material, byproducts, uranium metal scraps, sludges, and ancillary materials were carried outside the building via infiltration, process spills, building ventilation, and the drainage systems. The drainage system by which the C-340 Building potentially contaminated the environment drained into the storm sewer system and discharged to the eastern side of the facility upgradient of Outfall 011 (this flow is pumped to Outfall 010). These drains have been sealed since the facility closed. Because the PCBs are a primary concern in the outfall ditches on the eastern side of the plant, there is the potential that the storm sewers that drain from the C-340 Building have been a heavy contributor to Outfall 010 and Outfall 011 ditches.

C-535 and C-537. Historically, contamination in the C-535 and C-537 switchyards has consisted of chemical contaminants (primarily PCBs) derived from use of transformers and capacitors at the electrical switchyards. Many of the transformers and capacitors used PCB-laden oil as an insulating fluid. Historical process knowledge indicates that there was the potential that some of this PCB-laden fluid was released to the ground surface during occasional transformer rupture or due to the development of slow leaks in capacitors and transformers over a period of time. TCE and mineral spirits also were reportedly used as electrical equipment cleaner and solvent during maintenance and replacement activities. Numerous spills of PCBs, TCE, and mineral spirits have occurred at the switchyard during routine operations and maintenance. In addition, an abandoned underground oil distribution system may contain PCBs.

1.3.3 Previous Investigations

Previous investigations pertaining to on-site portions of the SWOU were reviewed to determine where data gaps exist and to designate those areas where current data adequately characterize contaminant concentrations and the potential for off-site contaminant migration. The previous investigations reviewed and the SWMUs they address are listed in the Table 1. The conclusions of these previous investigations are summarized below. Results of previous risk assessments for the on-site portions of the SWOU are summarized in the Baseline Human Health Risk Assessment (BHHRA) in Appendix D.

Table 1.1. Summary of Previous Investigations of On-Site Portions of SWOU

Previous assessments	SWMUs addressed by investigation
Historical analytical data from NSDD Sections 3, 4, and 5	58
2000/2001 Assessment of Outfalls (DOE 2002)	60, 61, 62, 63, 66, 67, 68, 69, 168, 526
WAG 15	97
WAG 19	92
Investigations of Plant Storm Sewers	102
Phase 1 and Phase II Site Investigation	Sitewide

1.3.3.1 NSDD Sections 3, 4, and 5

Previous investigations and responses for Sections 3, 4, and 5 of the ditch have included the following items:

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

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

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

1.3.3.2 Outfalls

Outfall 001. The previous sampling results for the ditches that flow into Outfall 001 are from Phase II, WAG 22, SWMUs 7 and 30 Remedial Investigation (RI), and the WAG 27 RI. Surface water samples taken at the outfall detected technetium-99 at 99 picocuries per liter (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: technetium-99 at 41 picocuries per gram (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 at 1.4 pCi/g.

The Commonwealth of Kentucky has issued two notices of violation (NOVs) during the past 10 years for this outfall (total residual chlorine in 1997 and whole effluent toxicity in 1999). In addition, due to concerns about the presence of PCBs and radiological contamination in surface water discharged through outfalls at the plant, DOE issued the *Interim Corrective Measure Workplan for Institutional Control of Off-Site Contamination in Surface Water; Outfalls, Creeks, and Lagoons* (DOE 1992). This ICM restricted casual public access to creeks, outfalls (including Outfall 001), 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 posting of warning signs at various off-site locations at 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.

Outfall 002. There are no previous sampling locations for the internal plant ditches to Outfall 002; however, there are locations where surface water samples were collected downgradient that provide useful information. Contamination identified at these surface water sampling locations includes PCBs at 1.1 µg/L and uranium-238 at 1.9 pCi/L. Technetium-99 also has been identified in the downgradient surface water sampling locations at Outfall 002 as high as 60 pCi/L. The only sediment sampling location at SWMU 60 (the Outfall 002 effluent ditch) had Total PCBs of 300 µg/kg.

Outfall 008. Previous investigations were conducted at 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 technetium-99 at one of the three internal ditch samples, detecting the radionuclide at 8 pCi/L. At the outfall, the following detections were found: technetium-99 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, technetium-99 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 report, the WAG 23 RI Addendum, and the WAG 27 RI report.

During the Phase I SI, TCE and other organic products were detected in sediment collected from Outfall Ditch 008. A tributary of 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).

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 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 (Outfall 008 Oil Skimmer Ditch) 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 Measure Workplan for Institutional Control of Off-Site Contamination in Surface Water; Outfalls, Creeks, and Lagoons* (DOE 1992). This work plan was implemented by DOE to restrict public access to creeks, outfalls, and lagoons surrounding 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 contamination. No other remedial actions have been taken to address potential contamination at SWMUs contained within the Outfall 008 drainage area.

Outfall 010. 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 the quality of the discharge water meets KPDES limits. However it should be noted that PCBs have been detected on a sporadic basis. 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 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 (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: technetium-99 has been identified at Outfall 010 surface water as high as 116 pCi/L and TCE at 3 μg/L. PCBs were not detected in the surface water. The primary sediment contaminants found in the Outfall 010 effluent ditch were dioxins, PCBs, and metals.

There have been no 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 Measure Workplan for Institutional Control of Off-Site Contamination in Surface Water, Outfalls, Creeks, and Lagoons* (DOE 1992), DOE restricted casual public access to creeks, outfalls (including Outfall 010), and lagoons surrounding PGDP in 10 locations through the installation of fencing and identified the areas of contamination through the posting of warning signs.

Outfall 011. Several previous investigations have been conducted at 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 possible route of contaminant transport due to the presence of radionuclides (technetium-99, thorium-230, uranium-234, uranium-235, and uranium-238) and organic contaminants in Outfall 011 sediments. The Phase II 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 15.2-m (50-ft) reach of Outfall 011 between Dykes Road and the lift station. The close association of the two contaminants suggests that the two may have a common origin. A PCB study conducted by the COE (1996) confirmed the presence of PCBs in Outfall 011 sediments. Outfall ditch 011 was included in an extensive PCB "hot spot" removal action conducted by DOE at PGDP in 1983. During this action, approximately 1,300 drums of PCB-contaminated sediments were removed sitewide, some of which exhibited PCB concentrations as high as 2,000 mg/kg. Historical records indicate that the PCB cleanup level for the remediation was 25 mg/kg (DOE 1997).

There have been no CERCLA response actions for the internal plant ditches to Outfall 011; however, DOE has implemented several remedial measures and treatability studies in areas of Outfall 011 located outside of the plant security fence. In the early 1980s, DOE excavated the upper 0.46 m (1.5 ft) of 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 Measure Workplan for Institutional Control of Off-Site Contamination in Surface Water; Outfalls, Creeks, and Lagoons* (DOE 1992) due to the continued presence of PCBs and radiological contamination in surface water discharged through outfalls at the plant. The ICM 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, 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 was riprapped and silt fences were installed around areas of known contamination. In 1995, DOE coated the Outfall 011 ditch with a bentonite concentrate to prevent erosion and further contaminant migration.

In an effort to minimize/eliminate further PCB releases at PGDP, DOE performed a Nature's Way bioremediation technology field demonstration in the summer of 1996. A 15.24-m (50-ft) section of the Outfall 011 ditch was chosen as the demonstration-site. During the demonstration, a polyvinyl chloride (PVC) distribution system was installed in the Outfall 011 ditch where the highest levels of PCB contamination (35 mg/kg) were found during the 1995 PCB soil characterization. The system consisted of a series of vertical PVC pipes placed in drilled holes to a depth of 30.48 cm (12 in.) throughout the 15.24-m (50-ft) demonstration area. The vertical pipes were connected to a horizontal manifold system and a nutrient bacteria solution was fed into the manifold system for distribution into the PCB-laden sediment. This application was performed approximately twice per week for the duration of the test from

July 23 through December 15, 1996. Test results were monitored by a series of sampling events conducted during the last two quarters of 1996. For each sampling event, the 15.24-m (50-ft) section test area was divided into three equal sections. A single soil sample then was composited from three randomly chosen sampling locations within each section. Monitoring results indicated that the bacteria were effective for reducing PCB contamination within the 15.24-m (50-ft) demonstration segment to levels of approximately 10 mg/kg; however, test results indicating further reduction of contaminant levels below 10 mg/kg were inconclusive (LMES 1997).

Outfall 012. Contamination in the surface soil, sediments and surface water of Outfall 012 were characterized during the Phase I SI (CH2M HILL 1991). The majority of samples collected during this investigation were nondetects. Xylene was detected in soil from one location at low concentrations. The radionuclides uranium-238, technetium-99, and thorium-230 were detected in surface water samples. TCE was detected in one sediment sample. During the Phase I SI, PCBs were detected at an elevated level (42 mg/kg) in one surface soil sample. Subsequent investigation in that area performed as part of the WAG 23 PCB action (DOE 1997) determined that the maximum Total PCBs in that area was approximately 0.7 mg/kg.

Outfall 015. Contamination in the sediments of Outfall 015 has been characterized in several previous investigations. During the Phase I SI (CH2M HILL 1991) technetium-99, 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 (technetium-99, uranium-234, thorium-230, plutonium-239, 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 in the internal plant ditches feeding Outfall 015 also was included as part of the *Remedial Investigation Addendum for Waste Area Grouping 22 Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1994). 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 1994).

There have been no 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, DOE issued the *Interim Corrective Measures Work Plan for Institutional Control of Off-Site Contamination in Surface Water* (DOE 1992). The ICM restricts 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.

Associated Outfall Areas (SWMUs 92 and 97). During the Phase I and II SIs, three soil samples were collected at SWMU 92 from 0, 1.2, and 1.8 m (0, 4, and 6 ft) bgs, respectively, from each of two sample locations (H225 and H256). PCBs were observed at trace concentrations (0.039 mg/kg) in the surface soil sample from location H255. Other contaminants observed at detectable levels in the samples included metals, semivolatile organic analytes (SVOAs), and radionuclides.

Additional samples (WC-2461 and WC-2550 to WC-2552) were taken at SWMU 92 in December 1993 during soil characterization at the proposed Environmental Restoration Construction Area Utility Sites. All four samples were collected from 2.54 to 45.7 cm (1 to 18 in.) bgs and yielded PCB concentrations ranging from 4.6 to 253 mg/kg. Uranium activity was below the plant limit of 17 pCi/g.

The radionuclides neptunium-237, plutonium-239, technetium-99, and thorium-230 were not detected in the December 1993 samples.

Contaminant concentrations at SWMU 92 were reevaluated in the late 1990s as part of planning for the WAG 19 Site Evaluation (SE). This evaluation concluded that SWMU 92 should not be considered a source of off-site contamination. No risk assessments have been completed for SWMU 92.

During the WAG 15 SE, 18 grid locations were sampled for 23 soil samples for the SWMU 97 investigation. Soil samples were analyzed for PAHs; lead; benzene, toluene, ethylbenzene, and xylene (BTEX); gross alpha/beta; and total uranium. No BTEX compounds or lead were detected in any of the soil samples analyzed. PAHs were detected in some samples, but the WAG 15 SE concluded that these samples were collected upgradient of the SWMU and were not representative of conditions within the SWMU 97 boundaries. No PAHs were detected from samples collected within the area believed to be impacted by the diesel spill. Based upon these results, the WAG 15 SE concluded that SWMU 97 did not include any contamination that required further investigation.

1.3.3.3 Storm Sewers

C-333-A. In the early 1990s, DOE contracted with the U.S. Army Corps of Engineers (COE) to characterize PCB levels in the plant storm sewer and outfall ditch systems that drain to Bayou Creek and Little Bayou Creek. This characterization was conducted over a 1-year period in 1991 and 1992 (COE 1992) and identified the south end of C-333 area as a potential source of PCB contamination with a single detection of 9.1 micrograms per liter (μg/L) PCBs (principally PCB-1260) in water from a manhole access point at the corner of Michigan Avenue and 16th Street (near the southeast corner of C-333)**.**

During February and March 1995, researchers from the Oak Ridge National Laboratory deployed semipermeable membrane devices (SPMDs) in several locations at PGDP to sample average PCB levels in the plant's effluent over a 1-month period (DOE 1996a). Based on the analysis of the SPMDs, the researchers concluded that the drain line along the south side of C-333 appeared to be the principal source of PCBs exiting the plant during the monitoring period. The estimated average dissolved concentration of PCBs was highest (0.125 μg/L) for a SPMD deployed in the storm sewer system at the corner of Michigan Avenue and 16th Street.

C-337-A. Studies to characterize PCB levels in effluent of PGDP by both COE (COE 1992) and the Oak Ridge National Laboratory (DOE 1996b) assessed the C-337 area. While the C-337 area remains a potential source of PCBs, neither study targeted the C-337-A Vaporizer or the C-337 Building as being a major contributor of PCBs to the plant's storm water system.

1.4 REPORT ORGANIZATION

This SI report was prepared following the guidance found in Appendix D of the FFA for PGDP (EPA 1998a). The outline of this report followed the guidance presented in the SWOU SAP (DOE 2005a), Section 6.

These subsections and their location in this report are as follows:

- Chapter 2 summarizes the study area investigation;
- Chapter 3 summarizes the physical characteristics of the SWOU area;
- Chapter 4 describes the nature and extent of contamination, based on the results of this investigation;
- Chapter 5 describes the fate and transport of the contaminants;

- Chapter 6 contains the summary of the BRA;
- Chapter 7 contains the summary and conclusions; and
- Chapter 8 contains references.

The following appendices are included to support the information presented in the text. Appendix A contains a technical memorandum comparing the activities conducted in the field to those planned in the work plan. Appendix B contains an electronic copy of the analytical data generated during this investigation as well as Figures B.1 and B.2. that illustrate Activity 1 and Activity 2 radiological hot spots. Appendix C contains fate and transport modeling associated with the SWOU (On-Site) SI. Appendices D and E present the BHHRA and SERA. Appendix F summarizes the SWOU (On-Site) evaluation of qualified data.

2. STUDY AREA INVESTIGATION

This section presents a description of the study area investigation for the SWOU (On-Site) SI and a summary of the sampling strategy and design for the SI. Specific procedures (soil/sediment sampling, storm sewer sampling, decontamination, etc.) are presented in Appendix A.

2.1 SEDIMENT AND SOIL INVESTIGATIONS

The objective of the SWOU (On-Site) SI was to obtain screening data to identify "hot spots" in the specific ditches and outfalls and to obtain definitive sediment and soil characterization data for development of source terms used in transport modeling and for derivation of exposure point concentrations (EPCs) used in risk assessment. As potential "hot spots" were identified, contingency samples were collected at locations that met the contingency sampling conditions specified in the SAP.

A potential "hot spot" was characterized by comparing a sample's detected analyte concentrations against indicator levels (for Activity 1 samples) and characterization levels (for Activity 2 samples). Specifically, an area determined to have one or more chemicals at concentrations greater than indicator levels (Activity 1 sampling) or characterization levels (from Activity 2 sampling) was deemed a potential "hot spot." The indicator chemicals used for Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas were cesium-137, uranium-238, and Total PCBs.

If an indicator chemical had a detected concentration greater than its indicator level (See Table 2.1), then other contaminants may be present at the sampling location at concentrations greater than their characterization level. The characterization level (See Table 2.2) is a risk-based concentration developed to meet the objectives of the SWOU (On-Site) SI.

Table 2.1. Indicator Chemicals/Levels

	NSDD	Outfalls/Ditches and areas	
Indicator chemical	**Indicator level**	**Indicator level**	**Units**
Cesium-137	1	10	pCi/g
Uranium-238	10	100	pCi/g
Total PCBs	1	20	mg/kg

pCi/g = picoCurie per gram
mg/kg = milligram per kilogram

The initial estimate of the extent of a potential "hot spot" was assumed to extend from the nearest upgradient to the nearest downgradient sample that did not contain an analyte exceeding its indicator (Activity 1 sample) or characterization (Activity 2 sample) levels. The final extent of the potential "hot spot" was identified using the Spatial Analysis and Decision Assistance (SADA) program (University of Tennessee 2004).

Table 2.2. Characterization Levels[a] for Internal Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015 and Sections 3, 4, and 5 of the NSDD

	Risk-based Characterization Level[c]	
Analyte[b]	**Internal Ditches and Areas Associated with Outfalls**	**Sections 3, 4, and 5 of the NSDD**
	Inorganic Chemicals (mg/kg)	
Antimony	1.14E+01	1.05E+01
Arsenic	5.23E+01	7.90E+00
Beryllium	2.85E+01	2.63E+01
Cadmium	6.39E+02	5.91E+02
Chromium	1.07E+04	9.89E+03
Copper	1.48E+04	1.37E+04
Iron	6.20E+04	5.74E+04
Lead	5.00E+01	5.00E+01
Manganese	1.36E+03	1.26E+03
Mercury	2.95E+01	2.73E+01
Molybdenum	2.49E+03	2.31E+03
Nickel	7.25E+03	6.71E+03
Selenium	2.85E+03	2.64E+03
Silver	1.23E+03	1.14E+03
Thallium	2.18E+01	2.02E+01
Uranium	6.07E+02	5.62E+02
Vanadium	9.96E+01	9.22E+01
Zinc	8.18E+04	7.57E+04
	Organic Compounds (mg/kg)	
Acenaphthene	9.48E+03	8.78E+03
Acenaphthylene		
Acrylonitrile	2.16E+01	1.50E+00
Anthracene	1.14E+05	1.05E+05
Benzene	6.86E+01	7.86E+00
Carbon Tetrachloride	1.97E+01	2.83E+00
Chloroform	3.68E+00	3.29E+00
Dichloroethylene, 1,1-	9.59E+00	6.66E-01
Dichloroethylene, 1,2- (Mixed Isomers)	1.98E+03	1.83E+03
Dichloroethylene, 1,2-cis-	4.01E+02	3.71E+02
Dichloroethylene, 1,2-trans-	6.61E+02	6.12E+02
Ethylbenzene	2.12E+03	1.47E+02
Fluoranthene	6.62E+03	6.13E+03
Fluorene	1.02E+04	9.42E+03
Naphthalene	7.09E+02	6.57E+02
Phenanthrene		
Pyrene	4.96E+03	4.60E+03
Tetrachloroethene	3.90E+02	2.71E+01
Total Dioxins/Furans	6.19E-04	4.30E-05
Total PAHs	2.12E+00	1.47E-01
Total PCBs	1.99E+01	1.38E+00
Trichloroethylene	1.41E+02	1.74E+01
Vinyl Chloride	1.34E+01	9.31E-01
Xylene, m-	1.00E+05	2.86E+03
Xylene, Mixture	2.17E+04	1.00E+05
Xylene, o-	1.00E+05	1.00E+05
Xylene, p-		

Table 2.2. Characterization Levels[a] for Internal Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015 and Sections 3, 4, and 5 of the NSDD (Continued)

Analyte[b]	Risk-based Characterization Level[c] Internal Ditches and Areas Associated with Outfalls	Sections 3, 4, and 5 of the NSDD
	Radionuclides (pCi/g)	
Americium-241	4.67E+02	4.28E+01
Cobalt-60	1.77E+00	1.63E-01
Cesium-137	8.58E+00	7.94E-01
Neptunium-237	2.71E+01	2.50E+00
Plutonium-238	6.24E+02	8.13E+01
Plutonium-239	5.63E+02	7.98E+01
Plutonium-240	5.64E+02	7.99E+01
Radium-226	2.56E+00	1.50E+00
Radon-222		
Strontium-90	7.44E+02	6.19E+01
Technetium-99	3.62E+04	2.60E+03
Thorium-228	2.80E+00	1.60E+00
Thorium-230	1.49E+03	1.05E+02
Thorium-232	7.25E+02	9.44E+01
Uranium-234	1.98E+03	1.38E+02
Uranium-235	3.95E+01	3.63E+00
Uranium-238	1.71E+02	1.52E+01

Blank cells indicate that a level could not be calculated or is not available.

[a] Characterization levels presented here were used to develop the sampling plan for ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015 and for Sections 3, 4, and 5 of the NSDD. They should not be considered to be cleanup levels. Cleanup levels will be selected in the decision documents completed subsequent to the SI.

[b] Analytes listed here are those on the PGDP significant COPCs list taken from Table 2.1 of Vol. 1 of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D2.

[c] Taken from Tables C2.2 and C3.2 of the SAP. Details on the derivation of the risk characterization levels can be found in Section C5.3, "Information Sheet – Characterization Level Derivation of PGDP SWOU On-site Assessment Project," of Appendix C.5 of the SWOU SAP.

Sampling of the internal ditches and associated outfalls included in the scope of the SWOU (On-site) SI assessment and Sections 3, 4, and 5 of the NSDD was completed using the following three activities.

- Activity 1—Completion of sampling using indicator analytes that yielded data used to identify "hot spots" in surface soil and sediment in each of the outfalls, their associated internal ditches and areas, and in Sections 3, 4, and 5 of the NSDD, and identify the extent of contamination in these areas. These data also were used in the SI to develop source terms to support transport modeling and in the BRA to develop EPCs for each of the exposure units (EUs).

- Activity 2—Completion of definitive sampling that yielded data that can be used to fully characterize the nature of contamination in soils and sediment found in each of the outfalls, their associated internal ditches and areas, and in Sections 3, 4, and 5 of the NSDD. These data also were used in the SI to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU.

- Activity 3—Use sampling data collected during Activities 1 and 2 and other information (e.g., results from surface water samples collected during routine monitoring) to determine the potential for migration of contamination from the outfalls and their associated internal ditches and areas.

The data quality objective (DQO) analysis determined that Activity 3 did not apply to Sections 3, 4, and 5 of the NSDD because these ditches are located outside the PGDP secure area.

To complete Activity 1, field instruments and grab sampling were used to characterize the EUs and identify the presence of analytes above indicator levels within potential "hot spots" of uniform area (defined in Appendix C.2 of the SAP). The general premise of this activity was that if an analyte was present above its indicator level, then either the analyte or one or more co-contaminants are present at a concentration greater than its characterization level. Activity 1 contingency samples were collected at locations that met the contingency sample conditions from the SAP.

To complete Activity 2, grab samples were collected from EUs and sent to a fixed-base laboratory to generate results for a suite of analytes that included bulk inorganic chemicals, TCE, 1,1,1-trichloroethane (TCA), PAHs, PCBs, and radionuclides. Analysis of TCE and 1,1,1-TCA was not performed on samples collected from Sections 3, 4, and 5 of the NSDD because they were not expected to be present, based on previous sampling results.[1] A full analyte list, including detection limits, is presented in Table 2.3. The general premise of this activity was that these results were representative of the average contaminant concentrations within the EU and were used to complete the BHHRA and SERA. [The average concentration for the EU was the EPC calculated following procedures presented in Section 3 of the PGDP Risk Methods Document (DOE 2001).] In one case where sediment was encountered greater than 2 ft in depth, then an additional Activity 2 sample was collected in accordance with the SAP.

To complete Activity 3, the results from Activities 1 and 2, as well as other information (e.g., results from routine surface water monitoring at outfalls), were used. The general premise of this activity was that average contaminant concentrations within the EUs would be used to complete modeling [i.e., The Modified universal Soil Loss Equation (MUSLE) and the Storm Water Management Model (SWMM) per the PGDP Risk Methods Document (DOE 2001)] that will help determine if contaminants, at levels exceeding those that may impact human health or the environment, could migrate from the EUs and the areas that they represent.

The SWOU SAP presented a complete DQO process to determine environmental data collection activities necessary to conduct the SI. A co-contamination study was included in the SAP that identified the analytes that would be best suited for the indicator analytes and indicator levels for identification of potential "hot spots." The decision rules developed during the DQO process for the SWOU (On-Site) SI can be found in Section 7 of this report. The following sections present a summary of the sampling tasks for each general area included for the SWOU (On-Site) SI.

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[1] Additionally, the cover letter for comments on the D1 revision of the SAP from the Commonwealth of Kentucky Environmental and Public Protection Cabinet, dated July 14, 2004, states that information presented in the sampling plan "adequately supports removal of SWMU 58 (Sections 3, 4, & 5 of the NSDD) from the 'Suspected Listed Wastes SWMUs' at the site," making sampling for TCE and 1,1,1-TCA for waste characterization unnecessary.

Table 2.3. Analytes and Method Detection Limits

Matrix	Method	Analysis	Detection Limit	Detection Limit Units	Comments
SOIL	6010	Aluminum	20	mg/kg	--
SOIL	6010	Antimony	10	mg/kg	--
SOIL	6010	Barium	2.5	mg/kg	--
SOIL	6010	Beryllium	0.5	mg/kg	--
SOIL	6010	Cadmium	2	mg/kg	--
SOIL	6010	Calcium	100	mg/kg	--
SOIL	6010	Chromium	2.5	mg/kg	--
SOIL	6010	Cobalt	2.5	mg/kg	--
SOIL	6010	Copper	2.5	mg/kg	--
SOIL	6010	Iron	20	mg/kg	--
SOIL	6010	Lead	20	mg/kg	--
SOIL	6010	Magnesium	5	mg/kg	--
SOIL	6010	Manganese	2.5	mg/kg	--
SOIL	6010	Molybdenum	5	mg/kg	--
SOIL	6010	Nickel	5	mg/kg	--
SOIL	6010	Potassium	100	mg/kg	--
SOIL	6010	Silver	2.5	mg/kg	--
SOIL	6010	Sodium	200	mg/kg	--
SOIL	6010	Thallium	20	mg/kg	--
SOIL	6020	Uranium	1	mg/kg	--
SOIL	6010	Vanadium	2.5	mg/kg	--
SOIL	6010	Zinc	20	mg/kg	--
SOIL	7060	Arsenic	5	mg/kg	--
SOIL	7471	Mercury	0.1	mg/kg	--
SOIL	6010	Selenium	20	mg/kg	--
SOIL	8260	Trichloroethene[a]	0.01	mg/kg	--
SOIL	8260	1,1,1-Trichloroethane	0.01	mg/kg	--
SOIL	8082	Aroclor-1268	0.08	mg/kg	--
SOIL	8082	PCB-Total	0.13	mg/kg	--
SOIL	8082	PCB-1016	0.1	mg/kg	--
SOIL	8082	PCB-1221	0.13	mg/kg	--
SOIL	8082	PCB-1232	0.1	mg/kg	--
SOIL	8082	PCB-1242	0.06	mg/kg	--
SOIL	8082	PCB-1248	0.1	mg/kg	--
SOIL	8082	PCB-1254	0.09	mg/kg	--
SOIL	8082	PCB-1260	0.1	mg/kg	--
SOIL	8270	Acenaphthene	0.5	mg/kg	--
SOIL	8270	Acenaphthylene	0.5	mg/kg	--
SOIL	8270	Anthracene	0.5	mg/kg	--
SOIL	8270	Benzo(a)anthracene	0.5	mg/kg	--
SOIL	8270	Benzo(a)pyrene	0.5	mg/kg	--
SOIL	8270	Benzo(b)fluoranthene	0.5	mg/kg	--
SOIL	8270	Benzo(g,h,i)perylene	0.5	mg/kg	--

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[a] Analyses for TCE and 1,1,1-TCA were performed on Activity 2 samples collected from the outfalls and their ditches and associated areas only. Analyses of these analytes were not performed for samples from Sections 3, 4, and 5 of the NSDD because they were not expected to be present, based on previous sampling results. Additionally, the cover letter for comments on the D1 revision of the sampling plan from the Commonwealth of Kentucky Environmental and Public Protection Cabinet, dated July 14, 2004, states that information presented in the sampling plan “adequately supports removal of SWMU 58 (Sections 3, 4, & 5 of the NSDD) from the ‘Suspected Listed Wastes SWMUs’ at the site,” making sampling for TCE and 1,1,1-TCA for waste characterization unnecessary.

Table 2.3. Analytes and Method Detection Limits (Continued)

Matrix	Method	Analysis	Detection Limit	Detection Limit Units	Comments
SOIL	8270	Benzo(k)fluoranthene	0.5	mg/kg	--
SOIL	8270	Chrysene	0.5	mg/kg	--
SOIL	8270	Dibenz(a,h)anthracene	0.5	mg/kg	--
SOIL	8270	Fluoranthene	0.5	mg/kg	--
SOIL	8270	Fluorene	0.5	mg/kg	--
SOIL	8270	Indeno(1,2,3-cd)pyrene	0.5	mg/kg	--
SOIL	8270	Naphthalene	0.5	mg/kg	--
SOIL	8270	Phenanthrene	0.5	mg/kg	--
SOIL	8270	Pyrene	0.5	mg/kg	--
SOIL	RL-7111	Alpha Activity	5	pCi/g	Gas Proportional Counter
SOIL	RL-7111	Beta Activity	5	pCi/g	Gas Proportional Counter
SOIL	RL-7116	Technetium-99	8	pCi/g	Liquid Scintillation
SOIL	RL-7128Am	Americium-241	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7124	Cesium-137	0.5	pCi/g	Gamma Spectroscopy
SOIL	RL-7124	Cobalt-60	0.5	pCi/g	Gamma Spectroscopy
SOIL	RL-7128NpPU	Plutonium-238	1	pCi/g	Alpha Spectroscopy
SOIL	RL-7128NpPU	Plutonium-239/240	1	pCi/g	Alpha Spectroscopy
SOIL	RL-7128Th	Thorium-228	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7128Th	Thorium-230	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7128Th	Thorium-232	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7128NpPU	Neptunium-237	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7128U	Activity of U-235	2	pCi/g	Alpha Spectroscopy
SOIL	RL-7128U	Uranium-234	3	pCi/g	Alpha Spectroscopy
SOIL	RL-7128U	Uranium-238	2	pCi/g	Alpha Spectroscopy
SOIL	RL-7128U	Uranium	7	pCi/g	Alpha Spectroscopy
WATER	8082	Aroclor-1268	0.09	µg/L	--
WATER	8082	PCB-Total	0.18	µg/L	--
WATER	8082	PCB-1016	0.17	µg/L	--
WATER	8082	PCB-1221	0.18	µg/L	--
WATER	8082	PCB-1232	0.14	µg/L	--
WATER	8082	PCB-1242	0.1	µg/L	--
WATER	8082	PCB-1248	0.12	µg/L	--
WATER	8082	PCB-1254	0.07	µg/L	--
WATER	8082	PCB-1260	0.05	µg/L	--
WATER	8260	Trichloroethene	1	µg/L	--
WATER	8260	1,1,1-Trichloroethane	5	µg/L	--
WATER	RL-7128U	Uranium	7	pCi/L	Alpha Spectroscopy

Activity 1 (soil): PCBs, Cesium-137, and Uranium-238 (Cesium-137 and Uranium-238 were determined using a field ISOC unit.)
Activity 2 (soil): TCE; 1,1,1-TCA; PAH*; metals*; radionuclides*; and PCB*.
Storm Sewer (water): TCE; PCB*; Total Uranium
* Specific analytes are listed within table.

2.1.1 NSDD Investigation

The following was the problem statement for the NSDD.

> *Past discharges from PGDP may have resulted in the contamination of soil and sediment in and along the NSDD (Sections 3, 4, and 5), potentially resulting in unacceptable levels of risk to current and reasonably anticipated future receptors under some exposure scenarios. Weathering, however, may have led to attenuation of some contamination and the accumulation of contaminated media resulting in the presence of "hot spots." The hypothesis that "hot spots" are present needs to be proved, and the extent of "hot spots" (if present) needs to be determined.*

Both Activity 1 and Activity 2 samples were collected from Sections 3, 4, and 5 of the NSDD during this SI to address the problem statement derived during Step 1 of the DQO process, as stated in the SAP. The analytes for Activity 1 samples and their indicator levels that were used for Sections 3, 4, and 5 of the NSDD are presented in Table 2.1.

As described in Appendix C.2 of the SAP, the optimized "hot spot" area was determined to vary with EU. The "hot spot" sizes chosen (at a 90% probability of identification) were 707 ft^2 for NSDD EUs 7 and 8; 943 ft^2 for EUs 1, 2, and 3; and 1,414 ft^2 for EUs 4, 5, 6, 9, and 10. Utilizing these areas and the probability of "hot spot" identification of 0.90, it was determined that 28, 21, and 14 Activity 1 samples per 0.5 acre of the NSDD were the optimum number of Activity 1 samples when 707, 943, and 1,414 ft^2 are used as the respective "hot spot" sizes.

The number of sample stations planned to be sampled per EU during Activity 2 to meet the DQOs established during project scoping and review varied. For EUs 1, 2, and 3, nine Activity 2 samples were collected per EU; for EUs 4, 5, 6, 9, and 10, six Activity 2 samples were collected per EU; and, for EUs 7 and 8, twelve samples were collected per EU. The analytical list for these samples includes bulk inorganic chemicals, PAHs, PCBs, and radionuclides. A full list of these analytes and their quantitation limits are presented in Table 2.3.

As described in Appendix C.2 of the SAP, collection of Activity 2 samples at the aforementioned rates was expected to yield results that will meet an alpha (α)[2] of 0.10 and a beta (β)[3] of 0.20 for both identification of contamination relative to risk-based characterization levels and waste acceptance criteria (WAC). Results of the planned Activity 2 sampling, therefore, met both the BRA and waste disposal characterization requirements.

2.1.2 Outfalls and Associated Internal Ditches and Areas Investigation

The following was the problem statement for the outfalls and associated internal ditches and areas.

> *Past discharges from PGDP may have resulted in the contamination of soil and sediment in and along the internal ditches associated with Outfalls 001, 002, 008, 010, 011, 012, and 015, potentially resulting in unacceptable levels of risk to current*

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[2] $\alpha = 0.10$ means that 10% of the time we are willing to declare that the site does not have contamination greater than characterization levels when it really does.

[3] $\beta = 0.20$ means that 20% of the time we are willing to declare that the site has contamination greater than characterization levels when it really doesn't.

> *and reasonably anticipated future receptors under some exposure scenarios. Weathering, however, may have led to attenuation of some contamination and the accumulation of contaminated media resulting in the presence of "hot spots." The hypothesis that "hot spots" are present needs to be proved, and the extent of "hot spots" (if present) needs to be determined.*

This sampling task included internal ditches draining to Outfalls 001, 002, 008, 010, 011, 012, and 015. Completion of this sampling and analysis yielded data addressing the problem statement derived during Step 1 of the DQO process and the decision rules derived during Step 5 of the DQO process. The indicator chemicals that were used for the outfalls and their associated internal ditches and areas and indicator levels were presented in Table 2.1.

As described in Appendix C.3 of the SAP, the optimized "hot spot" area chosen (at a 90% probability of identification) was 707 ft^2 for all but selected EUs associated with Outfall 001 (EUs 8 and 9), where a "hot spot" size of 1414 ft^2 was used. Utilizing these areas and the probability of "hot spot" identification of 0.90, it was determined that 28 and 14 Activity 1 samples, respectively, were required per 0.5 acre of the internal ditches and areas associated with the outfalls.

A total of four sample stations was required to be sampled per EU during Activity 2 sampling to meet the DQOs established. The analytical list for these samples includes bulk inorganic chemicals, TCE, 1,1,1-TCA, PAHs, PCBs, and radionuclides. A full list of these analytes and their quantitation limits are presented in Table 2.3.

As described in Appendix C.3, collection of samples at four stations per EU was expected to yield results that will meet an alpha of 0.10 and a beta of 0.20 for both identification of contamination relative to risk-based characterization levels and the WAC. Results of the planned Activity 2 sampling, therefore, met both the BRA and waste disposal characterization requirements.

2.2 STORM SEWER INVESTIGATIONS

The objective of the storm sewer investigation was to collect data that could be used to (1) determine if a particular storm sewer system was releasing contamination above indicator levels, (2) target the portion of the particular storm sewer that was the source of the contamination, and (3) characterize the source of contamination. Storm water samples were collected from storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537.

The following was the problem statement for the storm-sewer investigation.

> *Continuing releases of PCBs and radionuclides (i.e., uranium) at low concentrations in water discharged from the storm sewers is suspected. These releases may result in unacceptable levels of risk to current and reasonably anticipated future receptors under some exposure scenarios. The occurrence of releases (if any) and the source of released material (if any) need to be determined so that an appropriate response action can be selected, as necessary.*

The sampling for storm sewers was completed using the first two of the following three steps. The steps are as follows:

- Step 1—Collect water samples at the point where the storm sewer discharges to an outfall ditch to determine the occurrence of a continuing contaminant release.

- Step 2—Collect water samples at locations upgradient from the storm sewer discharge point to refine the identification of the source location(s). Upgradient locations sampled were where water flow converges.

- Step 3—Collect soil samples from source areas to characterize the nature and extent of contamination. This step was not completed during the investigation. Justification for not completing Step 3 is detailed in the technical memorandum in Appendix A.

When completing Steps 1 and 2, water samples were collected with an autosampler so that sampling was conducted at multiple flow rates. The analyte list for Steps 1 and 2 included Total PCBs, total uranium, and TCE. Table 2.3 includes a listing of these analytes and their detection limits.

Step 1 sampling was conducted by collecting two samples per month for 3 months from each designated Step 1 sampling location (i.e., 6 samples were collected per location). Samples were collected with an autosampler, and attempts were made to perform the sampling, which lasted 1 week per sampling event, over periods that were representative of "dry" and "wet" conditions. The indicator and characterization levels for the water samples collected were as follows:

- Total PCB—0.5 μg/L
- TCE—5 μg/L
- Total Uranium—30 μg/L (20 pCi/L)

If any location yielded sample results that exceed the indicator levels listed above, then the investigation proceed to Step 2 for those locations with Step 1 exceedances. Step 2 of the storm sewer investigation involved collection of water samples using autosamplers located upgradient from storm sewer discharge points that had exceedances identified during Step 1. This sampling was intended to help refine the identification of the locations of source(s) of contamination that may exist along the sewer lines. Step 2 sampling utilized the same indicator chemicals and levels as Step 1. Step 2 sampling was completed only at the storm sewer locations associated with C-340.

Upgradient locations were sampled during Step 2 where water flow converges within the storm sewer system at C-340. This sampling was conducted by collecting a sample every 2 weeks for 6 weeks from each designated Step 2 sampling location (i.e., three samples per location). Samples were collected with an autosampler at the 8 Step 2 sampling locations, and each sampling event lasted 1 week.

2.3 TECHNICAL MEMORANDUM SUMMARY

As stated previously, a technical memorandum regarding specific procedures for the SWOU (On-Site) SI is detailed in Appendix A. The memorandum provides details regarding activities that took place during the sediment/soil and surface water sampling phase of the SI. Activities addressed in the technical memorandum include the following:

- Sampling strategy and sampling procedures (soil/sediment and storm sewers);
- Surveying;
- Decontamination;
- Waste management;
- Environmental, safety, and health;
- Field documentation;
- Justification of no Step 3 sampling of C-340 storm sewer system;

- Deviations from planned sample quantities;
- Deviations from planned sample locations; and
- PCBs detected in SWMU 92 (Outfall Ditch 010, EU 10).

3. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The sections that follow provide a condensed version of the environmental setting for PGDP. The summary in this chapter is intended to provide readers with knowledge of the facility with an overview of relevant information pertaining to location, demography, geology, hydrogeology, ecology, and climatology.

3.1 SURFACE FEATURES

PGDP is located approximately 10 miles west of Paducah, Kentucky (population approximately 26,000), and 3.5 miles south of the Ohio River in the western part of McCracken County (Figure 3.1). The plant is on a 3,556-acre DOE site, of which 748 acres are within a fenced security area, 822 acres are located outside the security fence, and the remaining 1,986 acres are licensed to the Commonwealth of Kentucky as part of the WKWMA. Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a TVA reservation on which the Shawnee Steam Plant is located (Figure 3.2).

The dominant topographic features are nearly level to gently sloping dissected plains with shallow, narrow valleys and ridgetops and with steep ridge slopes and valley sides. The elevations of the stream valleys in the dissected plains are up to 30.5 m (100 ft) lower than the adjoining uplands.

Local elevations range from 88.4 m (290 ft) above mean sea level (amsl) along the Ohio River to 137.2 m (450 ft) amsl southwest of PGDP near Bethel Church Road. Generally, the topography in the PGDP area slopes toward the Ohio River at an approximate gradient of 27 ft per mile (CH2M HILL 1992). Ground surface elevations vary from 109.7 to 118.9 m (360 to 390 ft) amsl within the PGDP plant boundary.

3.2 METEOROLOGY

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

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

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

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

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

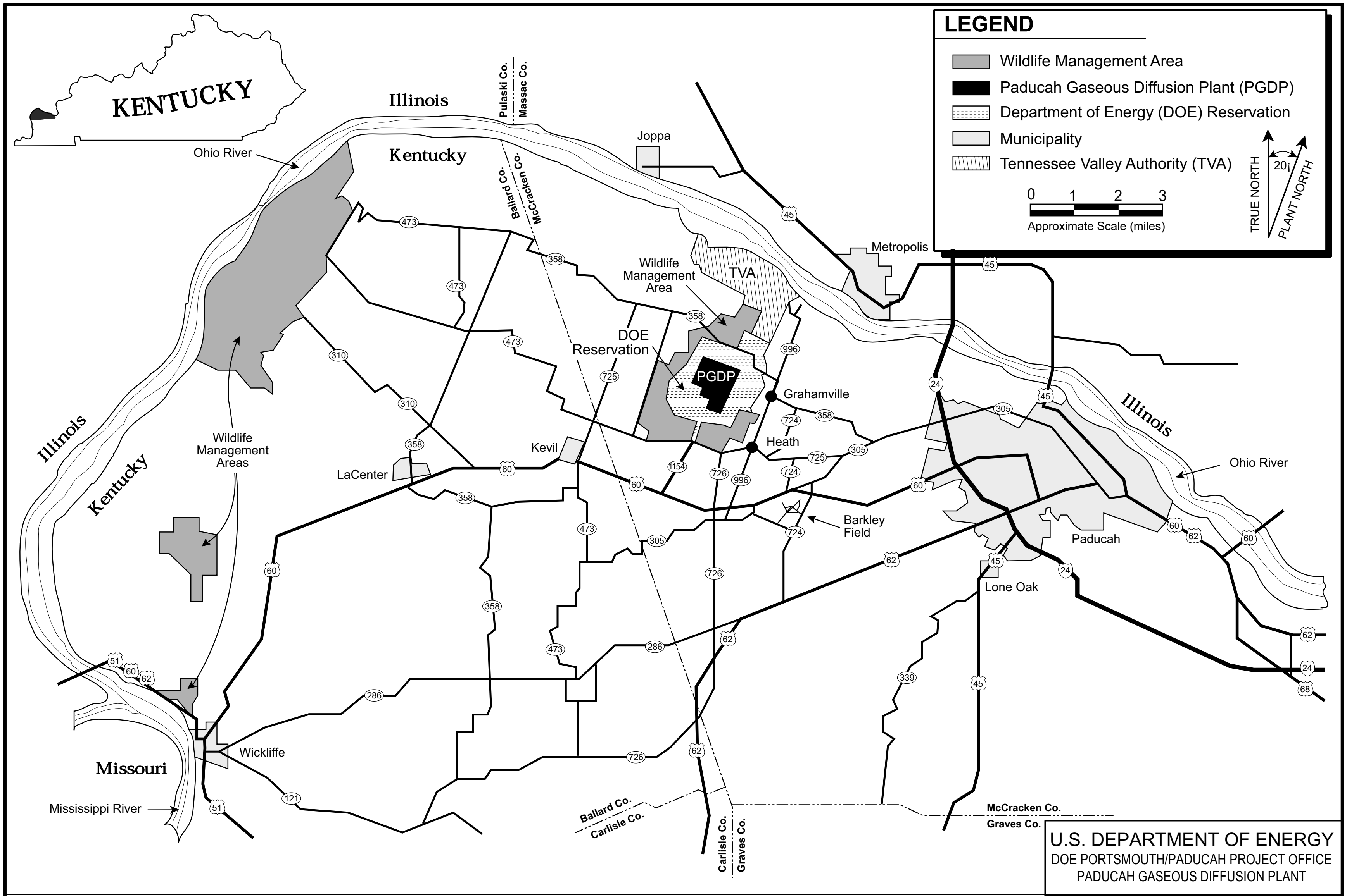

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Figure 3.1. PGDP Site Location

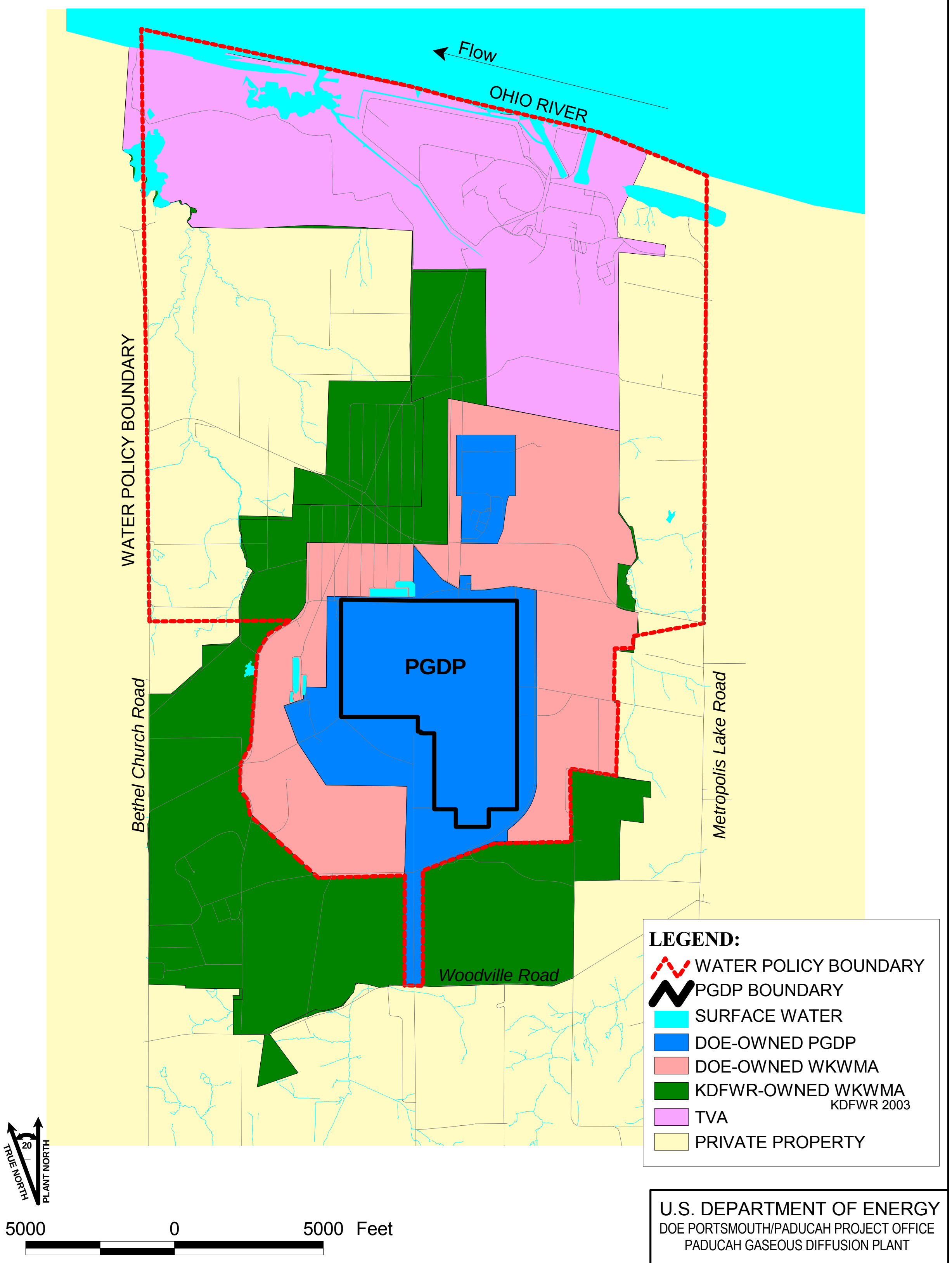

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Figure 3.2. PGDP Land Ownership Map

Figure No. C5AC90005sk003.apr
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3.3 SURFACE WATER HYDROLOGY

PGDP is located in the western portion of the Ohio River basin, approximately 24 km (15 miles) downstream of the confluence of the Ohio River with the Tennessee River and approximately 56 km (35 miles) upstream of the confluence of the Ohio River with the Mississippi River. Multiple groundwater aquifers underlie the PGDP. The shallowest aquifers occur in the Continental Deposits and the McNairy Formation, both of which discharge into the Ohio River north of PGDP. Surface water/groundwater relationships vary significantly across the SWOU.

A shallow water table aquifer, with discharge to the area creeks, occurs to the south of PGDP.[1] Under most of PGDP and the adjacent area to the north, large, downward, vertical hydraulic gradients dominate within the shallow groundwater system, and groundwater infiltrates downward to the Regional Gravel Aquifer (RGA) at a depth of approximately 60 ft (see Section 3.6), limiting the amount of groundwater discharge to the ditches of the PGDP and adjacent creeks. During periods of sustained rainfall, infiltrating water accumulates in the shallow soils and develops an increased throughflow system that discharges infiltrating water temporarily to plant ditches and the area creeks. In the vicinity of the Ohio River, where the land surface is approximately 60 ft lower than at PGDP, Bayou and Little Bayou Creeks cut down to near the potentiometric surface of the RGA. In this area, horizontal groundwater gradients predominate within the water table flow system. Gaining reaches in the creeks are found on Bayou Creek south of PGDP and on both creeks north of PGDP near the Ohio River. While there are no springs near PGDP, seeps are present over a limited stretch of Little Bayou Creek near the Ohio River where hydraulic potential within the RGA exceeds the elevation of the creek. "*Surface Water to Groundwater Interaction at the Paducah Gaseous Diffusion Plant*" (PRS 2007) discusses the conceptual model for surface water/groundwater interactions at PGDP.

Locally, PGDP is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek) and Little Bayou Creek. The Ohio River is located approximately 5.6 km (3.5 miles) north of the PGDP. It is the most significant surface-water feature in the region, carrying over 1.1 million liters/sec (25 billion gallons/day) of water through its banks. Several dams regulate flow in the Ohio River. The Ohio River stage near PGDP is measured at Metropolis, Illinois, by a United States Geological Survey (USGS) gauging station. River stage typically varies between 81 and 102 m (293 and 335 ft) amsl over the course of a year. Water levels on the lower Ohio River generally are highest in late winter and early spring and lowest in late spring and early summer. The entire PGDP is above the historical high water floodplain of the Ohio River (CH2M HILL 1991) and above the local 100-year flood elevation of the Ohio River [101 m (333 ft)].

The plant is situated on the divide between Little Bayou and Bayou Creeks (Figure 3.3). Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River along a 14.5-km (9-mile) course. A 4,820-hectare (11,910-acre) drainage basin supplies Bayou Creek. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River along a 10.5-km (6.5-mile) course within a 2,400-hectare (6,000-acre) drainage basin. Drainage areas for both creeks are generally rural; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and the TVA Shawnee Steam Plant. The confluence of the two creeks is approximately 4.8 km (3 miles) north of the plant site, just upstream of the location at which the combined flow of the creeks discharge into the Ohio River.

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[1] This water table aquifer exists where the top of the Porters Creek Clay occurs near land surface (see Section 3.4.4). The water table aquifer is part of the Terrace Gravel flow system (see Section 3.6). The Porters Creek Clay is absent under most of PGDP and the adjacent area to the north.

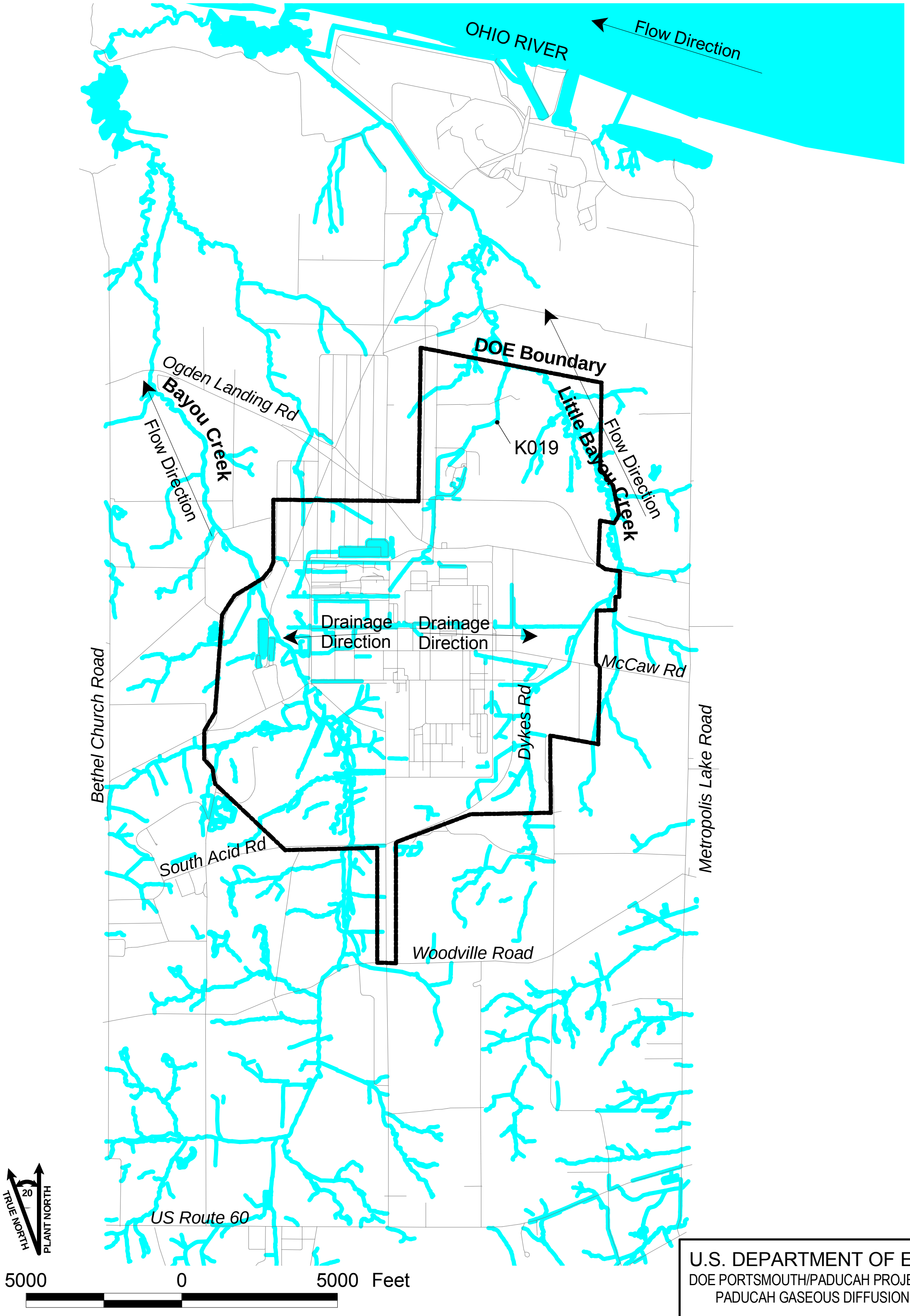

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Figure 3.3. Surface Water Features in the Vicinity of the DOE Site

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The USGS maintains gauging stations on Bayou Creek at 6.6 and 11.7 km (4.1 and 7.3 miles) upstream of the Ohio River and a gauging station on Little Bayou Creek at 3.5 km (2.2 miles) upstream from its confluence with Bayou Creek. The mean monthly discharges vary from 900 to 1,700 liters/sec (20.5 to 38.8 million gallons/day) on Bayou Creek and from 30 to 900 liters/sec (0.7 to 20.5 million gallons/day) on Little Bayou Creek.

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and 100% of flow within Little Bayou Creek. A network of ditches discharge effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the KPDES outfalls prior to discharge into the creeks. Outfalls 002, 010, 011, 012, 013, and 018 receive water from the eastern-most portion of the plant and discharge to Little Bayou Creek. Water from the western portion of the plant drains to Bayou Creek through Outfalls 001, 006, 008, 009, 014, 015, 016, and 017. Outfall 019 monitors runoff discharge to the NSDD from the C-746-U Landfill, located north of PGDP.

Several major surface water impoundments are located within the plant property and are utilized for various sanitary or process water management needs. The C-616 Lagoons are located near the northwest corner of the plant. Effluent from the plant's phosphate water processing facility is discharged into the C-616-F Lagoon, where sludge is allowed to settle. These lagoons discharge through Outfall 001 to Bayou Creek. The C-611 Lagoons are located to the southwest of the main plant complex. These lagoons serve as settling basins for effluent from the C-611 Sanitary Water Processing Plant. Water from the Ohio River is brought into the water plant where it is treated, primarily with water softening agents, and fed to PGDP for multiple uses. These lagoons discharge through Outfalls 006 and 014 to Bayou Creek.

In the fall of 2002 and winter of 2003, DOE constructed a sedimentation basin (C-613 Northwest Storm Water Control Facility) near the northwest corner of the plant to support removal and disposition of scrap metal. Effluent from the C-613 basin discharges through Outfall 001 to Bayou Creek. In March 2004, DOE completed construction of a detention basin in Section 2 of the NSDD (north central area of the plant). This detention basin contains storm-water runoff to the NSDD until it can be transferred to the C-616-F Lagoon for treatment, via the C-616-C Lift Station. Prior to the detention basin construction, three culverts were plugged (Fall 2003) at the north security fence to prevent runoff from exiting the plant via the NSDD; therefore, no effluents from the industrialized areas of PGDP currently flow through Sections 3, 4 and 5 of the NSDD.

Other surface water bodies in the vicinity of PGDP include the following: Metropolis Lake, located east of the Shawnee Steam Plant; several small ponds, clay and gravel pits, and settling basins scattered throughout the area; and a marshy area just south of the confluence of Bayou Creek and Little Bayou Creek. The smaller surface water bodies are expected to have only localized effects on the regional groundwater flow pattern.

3.4 GEOLOGY OF PGDP

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. 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.

Information presented herein regarding the geologic setting at PGDP was derived from the *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992).

Subsequent sections will briefly discuss the formations represented in Figure 3.4 to acquaint the reader with PGDP geology.

3.4.1 Bedrock

The entire PGDP area is underlain by Mississippian carbonates, consisting of dark gray limestone with some interbedded chert and shale.

3.4.2 Rubble Zone

A rubble zone of chert gravel commonly is encountered in soil borings at the top of the bedrock. The age and continuity of the rubble zone remain undefined.

3.4.3 McNairy Formation

The McNairy Formation consists of Upper Cretaceous sediments of grayish-white to dark-gray micaceous silt and clay with interbedded, gray to yellow to reddish-brown, very fine- to medium-grained sand. A basal sand member also is present at PGDP.

3.4.4 Porters Creek Clay/Porters Creek Terrace

The Paleocene Porters Creek Clay occurs in the southern portions of the site and consists of dark-gray to black silt with varying amounts of clay and fine-grained, micaceous, commonly glauconitic, sand. The Porters Creek Clay subcrops along a buried terrace slope that extends east–west across the site. Erosion into the Paleocene Porters Creek Clay, after the deposition of overlying Eocene through Pleistocene sediments (Eocene sands and terrace gravels), resulted in an important hydrogeologic feature known as the Porters Creek terrace. The Porters Creek terrace lies immediately south of PGDP; the terrace slope extends northward toward the southern boundary of the PGDP fenced security area. The Porters Creek terrace is hydrogeologically important because it is believed to mark the southern extent of the lower continental deposits and the RGA, and it forms the aquitard below the RGA along the slope of the Porters Creek terrace and for some distance northward.

3.4.5 Eocene Sands

Eocene sands are found south of PGDP above the Porters Creek Clay. These sands are believed to be composed of undifferentiated sediments of the Claiborne Group and Wilcox Formation. Olive (1980) describes the sands as predominantly clear quartz with minor amounts of gray quartz and chert with interbedded and interlensing silts and clays. The Eocene sands thicken south of PGDP and may serve as a significant water-bearing unit south of the plant.

3.4.6 Continental Deposits

Continental sediments [Pliocene (?) to Pleistocene—a question mark indicates uncertain age] unconformably overlie the Cretaceous through Eocene strata throughout the area. These continental sediments were deposited on an irregular erosional surface exhibiting steps or terraces. The thicker sequences represent valley fill sediments that comprise a fining-upward cycle. The continental sediments have been divided into the two distinct facies described below.

(1) Lower Continental Deposits. The lower continental deposits are a gravel facies consisting of chert pebbles to cobbles in a matrix of poorly sorted sand and silt. The lower continental deposits have been found at three distinct horizons in the PGDP area.

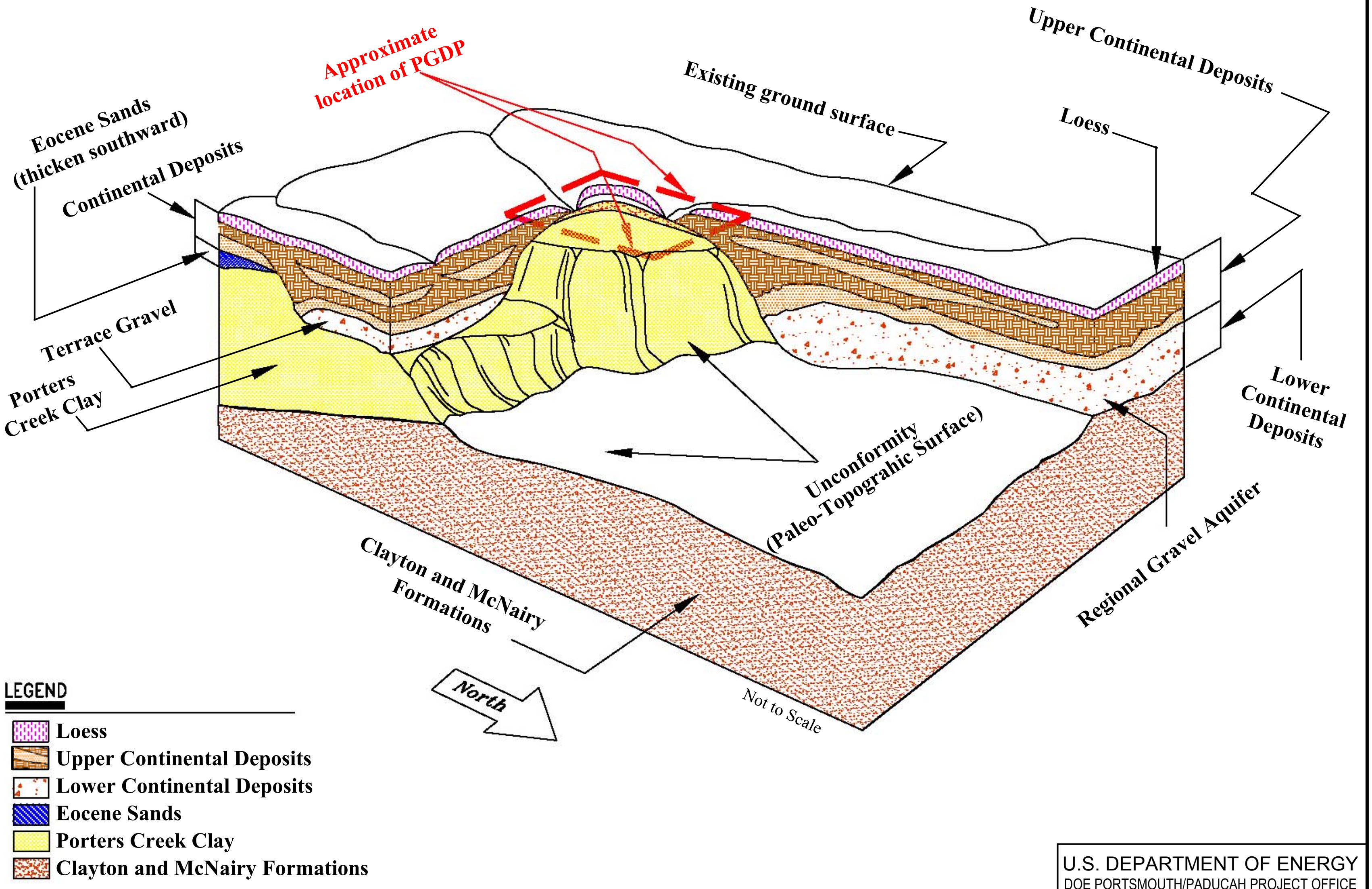

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Figure 3.4. Conceptual Model of the Stratigraphy in the Vicinity of PGDP

- The first horizon consists of the terrace gravels [consisting of a Pliocene (?) gravel ranging in thickness from 0 to 9.1 m (0 to 30 ft)], occurring in the southern portion of PGDP area at elevations greater than 106.7 m (350 ft) amsl, and overlying the Eocene sands and Porters Creek Clay. The terrace gravels are a potential source of the sediments forming the RGA.

- The second gravel horizon is terrace gravels located in the southeastern and eastern portions of the DOE boundary on an erosional surface at approximately 97.5 to 105.2 m (320 to 345 ft) amsl. The thickness of this unit ranges from 4.6 to 6.1 m (15 to 20 ft).

- The third and most prominent of the three horizons consists of a Pleistocene gravel deposit resting on an erosional surface at approximately 85.3 m (280 ft) amsl. This gravel is found throughout the plant area and to the north, but pinches out to the south along the slope of the Porters Creek terrace. The gravel deposit averages approximately 9.1 m (30 ft) in thickness, but some thicker deposits (as much as 15.24 m [50 ft]) exist in deeper scour channels that trend east–west across the site.

(2) Upper Continental Deposits. The upper facies is composed of fine-grained clastics varying in thickness from 4.6 to 16.8 m (15 to 55 ft). These upper continental deposits have been differentiated into three general horizons: (1) an upper silt and clay interval, (2) an inner-bedded sand and gravel interval, and (3) a lower silt and clay interval. The sand and gravel interval appears relatively discontinuous in cross-sections, but portions may be inner-connected.

3.5 SOILS

The surficial deposits found in the vicinity of PGDP are Pleistocene to Recent in age and consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

The loess (wind-blown) deposits overlie the upper continental deposits over the entire PGDP area. Loess deposition probably occurred in upland areas during all stages of the glaciation that extended into the Ohio and Mississippi River Valleys.

3.6 HYDROGEOLOGY OF PGDP

Information presented herein regarding the groundwater setting was derived from the *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992). The discussion is intended to provide the reader with a general overview of the groundwater flow regime for PGDP. The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene terrace gravels, Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. Four specific components have been identified for the groundwater flow system and are defined in the following paragraphs.

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

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

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

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

Five hydrostratigraphic units (HUs) proposed by Douthitt and Phillips (1991) explain groundwater flow at the PGDP site. In descending order, the HUs are as described below.

- Upper Continental Deposits
    - HU 1 (UCRS): Loess that covers the entire site.
    - HU 2 (UCRS): Discontinuous, sand and gravel lenses in a clayey silt matrix.
    - HU 3 (UCRS): Relatively impermeable clay layer that acts as the upper semiconfining-to-confining layer for the RGA. The lithologic composition of this unit varies from clay to sand, but is predominantly clay or silt.
    - HU 4 (RGA): Predominantly continuous sand unit with a clayey silt matrix that directly overlies the RGA. This unit is in hydraulic connection with HU 5 and is included as part of the RGA.
- Lower Continental Deposits
    - HU 5 (RGA): Gravel, sand, and silt.

3.7 DEMOGRAPHY AND LAND USE

PGDP is surrounded by WKWMA and some sparsely populated agricultural lands. The closest communities to the plant are Heath, Grahamville, and Kevil, all of which are located within 3 miles of DOE reservation boundaries. The closest municipalities are Paducah, Kentucky; Cape Girardeau, Missouri, which is approximately 40 miles west of the plant; and the cities of Metropolis and Joppa, Illinois, which are located across the Ohio River from PGDP.

Historically, the economy of Western Kentucky has been based on agriculture, although there has been increased industrial development in recent years. PGDP employs approximately 1,800 people, while the TVA Shawnee Steam Plant employs an additional 500 people (MMES 1987). The total population within a 50-mile radius of PGDP is approximately 500,000; and approximately 66,000 people live within 10 miles of the plant (DOC 1994). The population of McCracken County is estimated to be approximately 65,500 (DOC 2004).

In addition to the residential population surrounding the plant, WKWMA draws thousands of visitors each year for recreational purposes. This area is used by visitors, primarily for hunting and fishing, but other activities include horseback riding, hiking, and bird watching. According to WKWMA management, an estimated 5,000 fishermen visit the area each year.

3.8 ECOLOGICAL SETTING OF PGDP

The following sections give a brief overview of the terrestrial and aquatic systems at PGDP. A more detailed description, including identification and discussion of sensitive habitats and threatened/endangered 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, Volume V: Floodplain Investigation, Part A: Results of Field Survey* (COE 1994).

3.8.1 Terrestrial Systems

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

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

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

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

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

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

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

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

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

3.8.2 Aquatic Systems

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

3.8.3 Wetlands and Floodplains

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

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

4. NATURE AND EXTENT OF CONTAMINATION

This section illustrates and interprets the nature and extent of contamination for each study area. Potential source areas, as determined by the analytical results, are examined, and potential site-related contaminants are identified. A description of the sampling protocol for each area is provided in Section 2, and a more detailed description of the sampling procedures is provided in the technical memorandum found in Appendix A.

4.1 SOURCES OF CONTAMINATION

Past discharges from PGDP have resulted in the deposition of chemicals and radionuclides in soil and sediment in the NSDD and the outfalls and their associated internal ditches and areas. The objective of this report is to determine if this has resulted in unacceptable risks to current and reasonably anticipated future receptors. According to the DQOs for this project, weathering may have led to attenuation of some contamination to and the accumulation of contaminated media resulting in the presence of potential "hot spots." It is necessary to prove the hypothesis that "hot spots" are present. If present, it is necessary to determine the nature and extent of "hot spots" as part of the SWOU (On-Site) SI.

4.2 SOILS AND SEDIMENTS

The sampling protocol for the SWOU (On-Site) SI soils and sediments investigation consisted of the following:

- Activity 1 Samples—A total of 2,714 Activity 1 samples was collected related to Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas. This total included 2,334 primary samples, 111 contingency samples, 130 duplicate samples, and 139 other quality control (QC) samples. Activity 1 sample locations were specified in the SAP.

- Activity 2 Samples—A total of 470 Activity 2 samples was collected related to Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas. This total included 345 primary samples, 1 contingency sample, 31 duplicate samples, and 93 other QC samples. These samples were analyzed for a comprehensive range of constituents (see Table 2.1). Activity 2 sample locations were specified in the SAP.

- Contingency Samples—During Activity 1 sampling of Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches and areas, the SAP specified that contingency samples would be collected under the following conditions:

    (1) Sampling at a planned location fails (e.g., sample is rendered unusable while in the field by bottle breakage, equipment failure, etc.). (Note: "Failure" in this context does not indicate an exceedance of an indicator level.) Result: collection of "replacement" sample.

    (2) A potential "hot spot" is identified at the edge of an internal ditch or area associated with the outfalls or at the edge of Section 3, 4, or 5 of the NSDD. Result: collection of additional "extent" samples.

(3) During field activities, an area with obvious staining is discovered, but a sample from this area is not part of the previously determined sampling plan. The Prime Contractor Project Manager is contacted to make a determination as to whether or not the "stained" area should be sampled. Result: collection of "observation" samples (biased/judgmental) upon direction from project management.

One hundred eleven Activity 1 contingency samples, including the associated QC samples, were collected in areas where a potential "hot spot" was identified at the edge of a ditch (102 primary samples, 7 duplicates) or where obvious staining was present (2 primary samples). No contingency samples were required due to failure.

In addition, the SAP specified that during Activity 2, sampling of Sections 3, 4, and 5 of the NSDD and the ditches and areas associated with outfalls, contingency samples would be collected under the following conditions:

(1) Sampling at a planned location fails (e.g., sample is rendered unusable while in the field by bottle breakage, equipment failure, etc.) (Note: "Failure" in this context does not indicate an exceedance of a characterization level.) Result: collection of "replacement" sample.

(2) During sampling at a planned location, the extent (depth) of nonnative sediments is found to exceed 2 ft bgs. Result: collection of "depth" samples to determine extent of contamination based upon field observation.

(3) During field activities, a unique area is discovered (e.g., stained area, area to which effluent is discharged) that does not contain a planned sample location. The Prime Contractor Project Manager will be contacted to make a determination as to whether or not the "unique" area should be sampled. Result: collection of "biased/judgmental" samples upon direction from project management.

(4) Public comment (e.g., from the Citizens Advisory Board) asks for additional definitive samples from a particular area. Result: collection of "biased/judgmental" samples based on public comment.

One Activity 2 contingency sample was collected during the SI at Outfall 001, EU 4 due to sediment thickness. Table 4.1 provides a detailed breakdown of the samples collected in the SWOU (On-Site) SI.

The purpose of the Activity 1 soil/sediment sampling was to determine if indicator chemicals would yield screening data identifying "hot spots" in surface soil and sediment. This data, coupled with Activity 2 and contingency samples then were used to assist with the characterization of nature and extent of contamination. A potential "hot spot" was identified using simple comparisons between Activity 1 sampling results to indicator levels and Activity 2 sampling results to characterization levels.

When an Activity 1 potential "hot spot" was identified at the edge of the ditch, contingency sample locations were selected, and soil/sediment samples were collected according to the protocol established in the SAP. According to the protocol, the contingency analyses were completed following collection of each round of contingency samples. The final nature and extent of the potential "hot spot" was defined and presented through isopleths for PCB results, which depict concentration gradients in the EUs in the outfall ditches. Activity 2 potential "hot spots" are not depicted on the referenced figures in this section because the risk assessment provides a better overview of the Activity 2 data and presents the information as "risk exceedance areas." "Risk exceedance areas" are a combination of EUs that aid with the evaluation of human health risk. Appendix D presents the risk-based potential "hot spot" areas.

Table 4.1. SWOU (On-Site) SI Samples Collected

Sample type	Activity 1 sampling	Activity 2 sampling	Totals
Sample totals for the NSDD			
Soil samples	258	75	333
Duplicates	16	6	22
Contingency	53[a]	0	53
Other QC	19	12[b]	31
Totals for NSDD	346	93	439
Sample totals for the outfalls and associated ditches			
Soil samples	2,076	270	2,346
Duplicates	114	25	139
Contingency	58[c]	1	59
Other QC	120	81[d]	201
Totals for outfalls	2,368	377	2,745
Sample totals for the NSDD and the outfalls and associated ditches			
Total soil samples (totals for NSDD plus totals for outfalls)	2,714	470	3,184

[a] Three of the 53 contingency samples are duplicates and two are due to stained soils.
[b] Other QC samples include six field blanks, six equipment blanks, and no trip blanks. Trip blanks were not collected at NSDD due to volatile organic analytes not being collected.
[c] Four of the 58 contingency samples are duplicates.
[d] Other QC samples include 24 field blanks, 24 equipment blanks, and 33 trip blanks.

Total potential "hot spot" areas were calculated using geographical computer modeling for each section of the NSDD and outfalls and their associated internal ditches and areas. The size of the potential "hot spot" areas was compared to the individual source areas (EUs) and the total area investigated (See Table 4.2). The Activity 1 potential "hot spot" areas were used in the surface-water modeling presented in Section 5. It should be noted that modeling was performed using only data from the outfalls and their associated internal ditches and areas.

Table 4.2. Potential Hot Spot Area/Total Area Comparison

Source Unit	**Potential Hot Spot Area** (acres)	**Total Area** (acres)
NSDD Section 3	1.2	1.9
NSDD Section 4	0	2.1
NSDD Section 5	0.6	2.4
Outfall 001	0.3	13.8
Outfall 002	0	4.2
Outfall 008	0.3	7.8
Outfall 010	0.1	5.8
Outfall 011	0	0.6
Outfall 012	0	0.8
Outfall 015	1.4	5.5
TOTAL	3.9	44.9

Of the 44.9 acres of total source area investigated, 3.9 acres are considered potential “hot spots.” This constitutes 8.7 percent of the total area for all areas investigated during the SI. For NSDD, 28.1 percent of these areas is considered a potential “hot spot.” For the outfalls and their associated internal ditches and areas, 5.5 percent of these areas is considered a potential “hot spot.”

The EUs investigated in this report are displayed on Plates 1 and 2, which are located at the end of Section 4. Preceding these plates are detail maps showing the sampling locations at each of the EUs.

4.2.1 NSDD Sections 3, 4, and 5

The following subsections present tables and figures for exceedances of indicator and characterization levels for NSDD Activity 1 and Activity 2 samples that were collected during the SI. Appendix B provides a complete data set, including data qualifiers, for all samples collected during the SI.

4.2.1.1 Activity 1 sampling

For Sections 3, 4, and 5 of the NSDD, Activity 1 data was used to identify areas of elevated contaminant concentrations (potential “hot spots”) and to identify the nature and extent of contamination in surface soil and sediment. The indicator chemicals used for Sections 3, 4, and 5 of the NSDD and their associated indicators levels were as follows:

- Uranium-238—10 pCi/g
- Cesium-137—1 pCi/g
- Total PCBs—1 mg/kg

A total of 258 Activity 1 samples and 16 duplicate samples was collected from Sections 3, 4, and 5 of the NSDD. Sixty-nine samples exceeded radionuclide indicator levels (48 samples were a combination of cesium-137 and uranium-238, 9 samples for uranium-238 only, and 12 for cesium-137 only), and 13 samples exceeded PCB indicator levels. These specific samples with their corresponding analytical results are presented in Tables 4.3 and 4.4.

Due to exceedances of indicator chemicals, 48 contingency samples and 3 duplicate samples were collected at the edge of the NSDD for the purpose of determining the nature and extent of contamination. Sample locations where contingency samples were collected are identified with an asterisk in Tables 4.3 and 4.4. Two contingency samples were collected in NSDD Section 4, EU 04 due to stained soil observed in an area not included in the planned sampling. None of the contingency samples collected due to staining exceeded the indicator levels.

Indicator levels were exceeded only in samples collected from Sections 3 and 5 of the NSDD. The samples were located in EUs 01, 02, and 03, near the PGDP security fence, and at the northern end in EUs 07, 08, 09, and 10.

Indicator levels were not exceeded in Activity 1 samples collected in Section 4 (EUs 04, 05, and 06) of the NSDD. Figures 4.1 through 4.7 present the locations of exceedances identified at the NSDD in Section 3 EU 01, 02, and 03, Section 5 EUs 07, 08, 09, and 10, respectively.

Table 4.3. Activity 1 Exceedances for Radionuclides at the NSDD

Exceedances at NSDD for Cesium-137

EU	Station	Result	Units
Section 3			
EU 01	NSDDA-004*	4.73	pCi/g
EU 01	NSDDA-013	1.63	pCi/g
EU 01	NSDDA-015	1.01	pCi/g
EU 01	NSDDA-019	7.64	pCi/g
EU 01	NSDDA-020*	1.23	pCi/g
EU 01	NSDDA-025	4.06	pCi/g
EU 01	NSDDA-026	2.24	pCi/g
EU 01	NSDDA-027	1.61	pCi/g
EU 02	NSDDA-039*	1.36	pCi/g
EU 02	NSDDA-046	1.27	pCi/g
EU 02	NSDDA-048	1.13	pCi/g
EU 02	NSDDA-049	2.13	pCi/g
EU 02	NSDDA-050	2.37	pCi/g
EU 02	NSDDA-052*	1.06	pCi/g
EU 02	NSDDA-053	1.34	pCi/g
EU 02	NSDDA-055*	3.19	pCi/g
EU 02	NSDDA-058*	2.72	pCi/g
EU 03	NSDDA-060	3.33	pCi/g
EU 03	NSDDA-061*	1.11	pCi/g
EU 03	NSDDA-062	4.88	pCi/g
EU 03	NSDDA-064	3.95	pCi/g
EU 03	NSDDA-066*	2.1	pCi/g
EU 03	NSDDA-068*	3.16	pCi/g
EU 03	NSDDA-071*	6.76	pCi/g
EU 03	NSDDA-073	1.04	pCi/g
EU 03	NSDDA-076*	1.16	pCi/g
Section 3 Contingency			
EU 03	NSDDAC-909	1.18	pCi/g
EU 03	NSDDAC-929	1.52	pCi/g
Section 5			
EU 07	NSDDA-151*	1.64	pCi/g
EU 07	NSDDA-156*	1.26	pCi/g
EU 08	NSDDA-184	1.42	pCi/g
EU 08	NSDDA-185*	1.56	pCi/g
EU 08	NSDDA-207*	1.54	pCi/g
EU 08	NSDDA-219*	3.56	pCi/g
EU 08	NSDDA-224*	1.61	pCi/g
EU 09	NSDDA-229*	1.63	pCi/g
EU 09	NSDDA-232*	4.9	pCi/g
EU 10	NSDDA-251*	1.02	pCi/g
Section 5 Contingency			
EU 07	NSDDAC-913	1.59	pCi/g
EU 09	NSDDAC-941	1.05	pCi/g
EU 09	NSDDAC-945	1.05	pCi/g
EU 10	NSDDAC-950	1.05	pCi/g

Exceedances at the NSDD for Uranium-238

EU	Station	Result	Units
Section 3			
EU 01	NSDDA-004*	30.07	pCi/g
EU 01	NSDDA-008	11.04	pCi/g
EU 01	NSDDA-011	22.46	pCi/g
EU 01	NSDDA-012*	14.21	pCi/g
EU 01	NSDDA-013	36.42	pCi/g
EU 01	NSDDA-015	19.85	pCi/g
EU 01	NSDDA-019	214.97	pCi/g
EU 01	NSDDA-024	11.14	pCi/g
EU 01	NSDDA-025	74.29	pCi/g
EU 01	NSDDA-026	31.98	pCi/g
EU 01	NSDDA-027	23.64	pCi/g
EU 02	NSDDA-039*	17.93	pCi/g
EU 02	NSDDA-040	11.34	pCi/g
EU 02	NSDDA-049	11.97	pCi/g
EU 02	NSDDA-050	23.59	pCi/g
EU 02	NSDDA-053	22.84	pCi/g
EU 02	NSDDA-055*	41.18	pCi/g
EU 02	NSDDA-058*	20.12	pCi/g
EU 03	NSDDA-060	14.92	pCi/g
EU 03	NSDDA-062	36.35	pCi/g
EU 03	NSDDA-064	24.02	pCi/g
EU 03	NSDDA-066*	27.07	pCi/g
EU 03	NSDDA-068*	33.28	pCi/g
EU 03	NSDDA-071*	69.39	pCi/g
EU 03	NSDDA-073	10.84	pCi/g
EU 03	NSDDA-077	10.15	pCi/g
Section 5			
EU 07	NSDDA-146*	14.53	pCi/g
EU 07	NSDDA-160	10.18	pCi/g
EU 08	NSDDA-192	11.47	pCi/g
EU 08	NSDDA-219*	55.42	pCi/g
EU 09	NSDDA-224*	16.53	pCi/g
EU 09	NSDDA-229*	25.88	pCi/g
EU 09	NSDDA-232*	71.15	pCi/g
Section 5 Contingency			
EU 09	NSDDAC-943	10.09	pCi/g
EU 09	NSDDAC-944	10.68	pCi/g

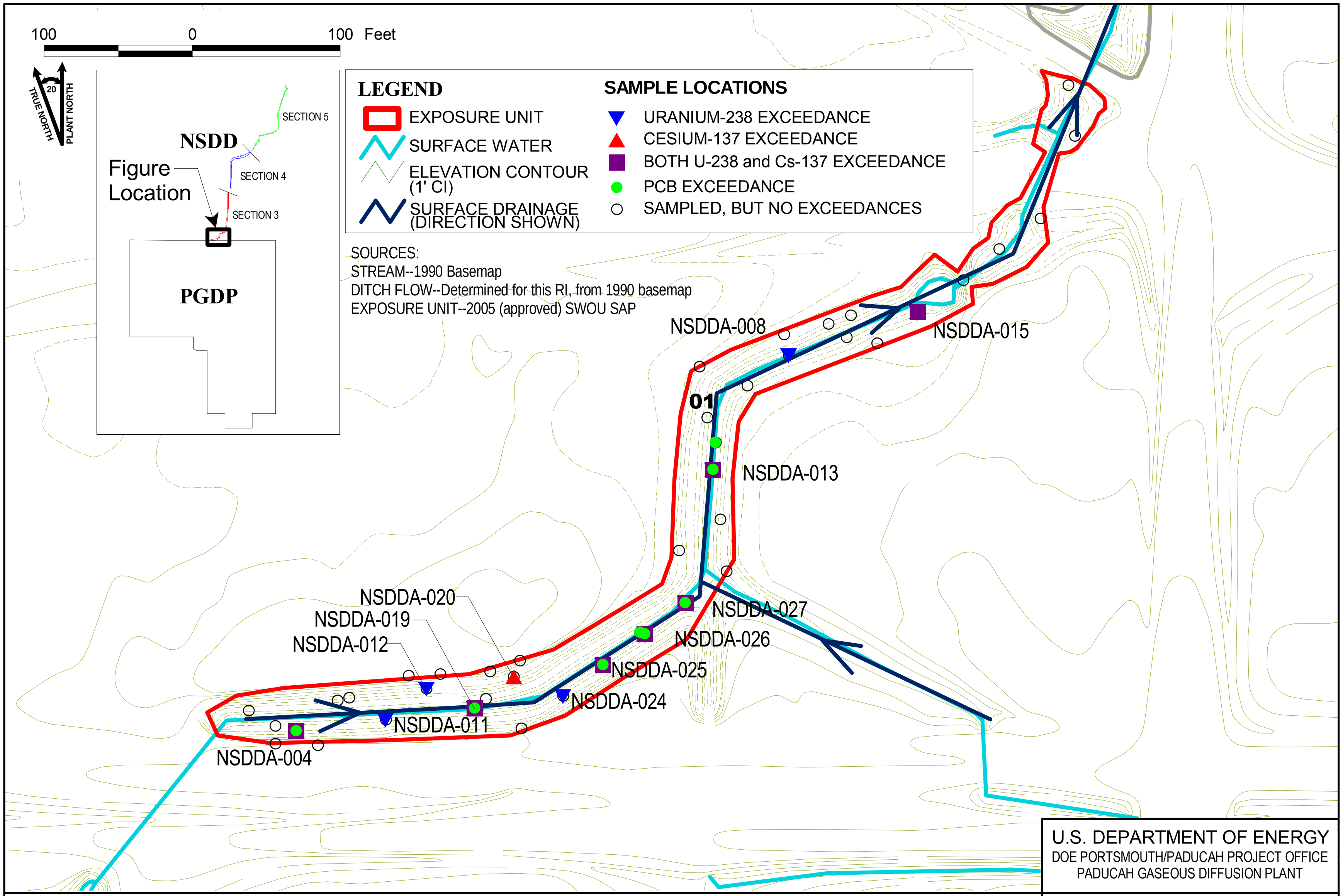
* - Denotes contingency samples were collected at this location

Table 4.4. Activity 1 Exceedances for Total PCBs at the NSDD

Exceedances at the NSDD for PCB total

EU	Station	Result	Units
Section 3			
EU 01	NSDDA-004*	28.9	mg/kg
EU 01	NSDDA-013	5.02	mg/kg
EU 01	NSDDA-015	1.0	mg/kg
EU 01	NSDDA-019	4.63	mg/kg
EU 01	NSDDA-025	2.36	mg/kg
EU 01	NSDDA-026	2.6	mg/kg
EU 01	NSDDA-027	2.48	mg/kg
EU 02	NSDDA-050	3.48	mg/kg
EU 03	NSDDA-066*	1.59	mg/kg
EU 03	NSDDA-077	3.42	mg/kg
Section 5			
EU 08	NSDDA-219*	1.27	mg/kg
EU 09	NSDDA-232*	2.47	mg/kg
EU 10	NSDDA-250*	1.38	mg/kg

* - Denotes contingency samples were collected at this location



LEGEND

- EXPOSURE UNIT
- SURFACE WATER
- ELEVATION CONTOUR (1' CI)
- SURFACE DRAINAGE (DIRECTION SHOWN)

SAMPLE LOCATIONS

- ▼ URANIUM-238 EXCEEDANCE
- ▲ CESIUM-137 EXCEEDANCE
- ■ BOTH U-238 and Cs-137 EXCEEDANCE
- ● PCB EXCEEDANCE
- ○ SAMPLED, BUT NO EXCEEDANCES

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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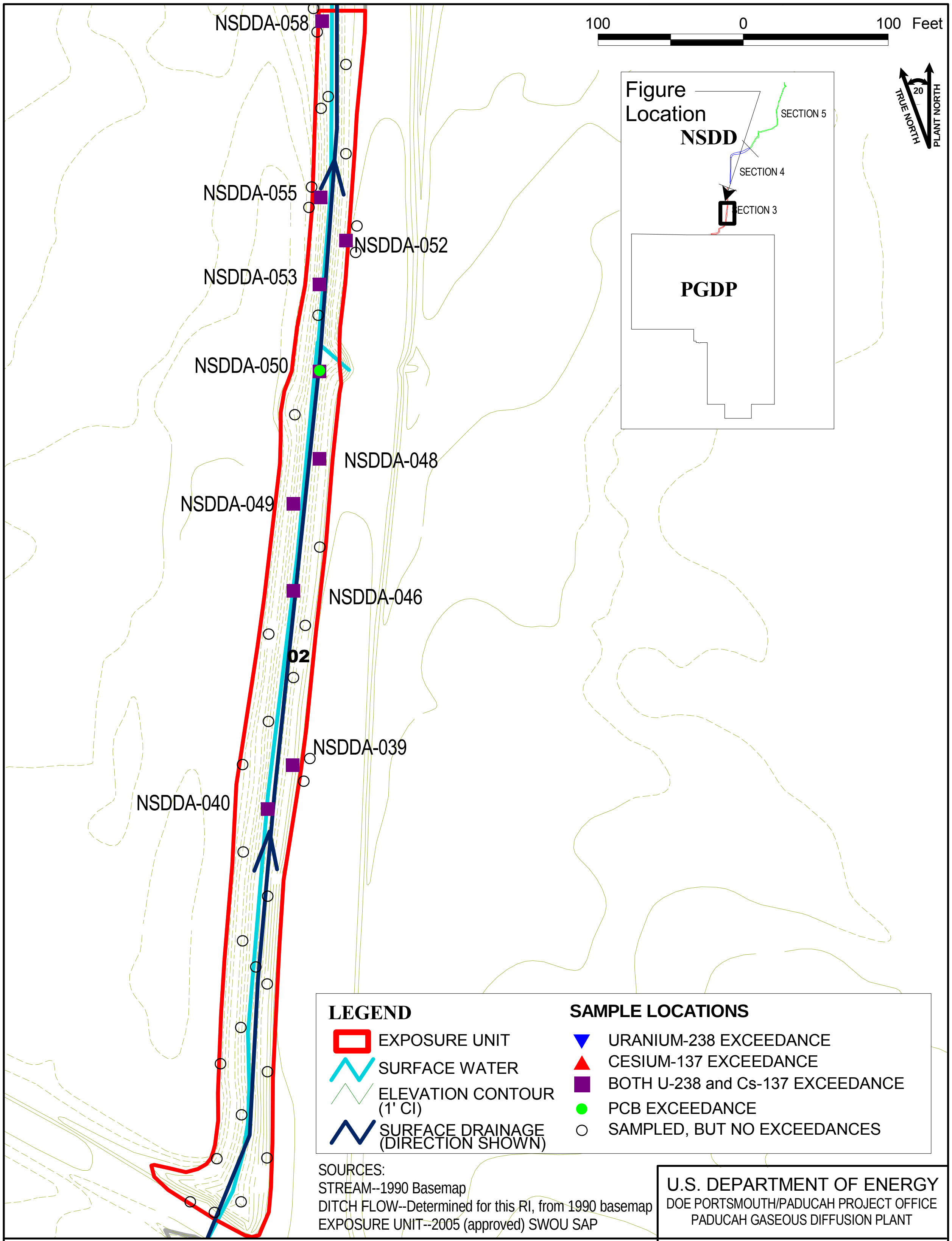
Figure 4.1. Exceedances Identified at the NSDD Section 3 EU 01

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

U.S. DEPARTMENT OF ENERGY
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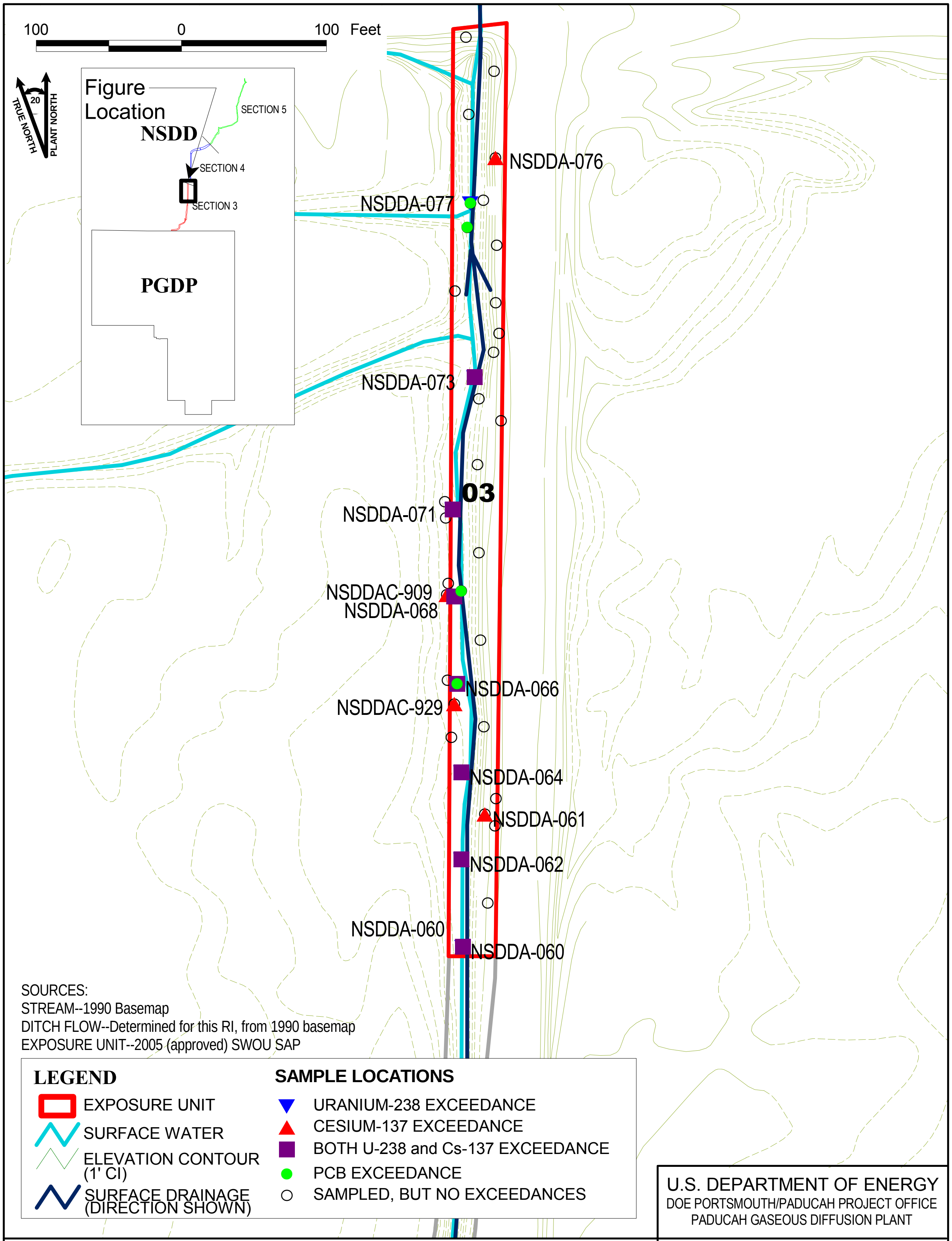
Figure 4.2. Exceedances Identified at the NSDD Section 3 EU 02

PADUCAH
Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.3. Exceedances Identified at the NSDD Section 3 EU 03

PADUCAH
Remediation Services
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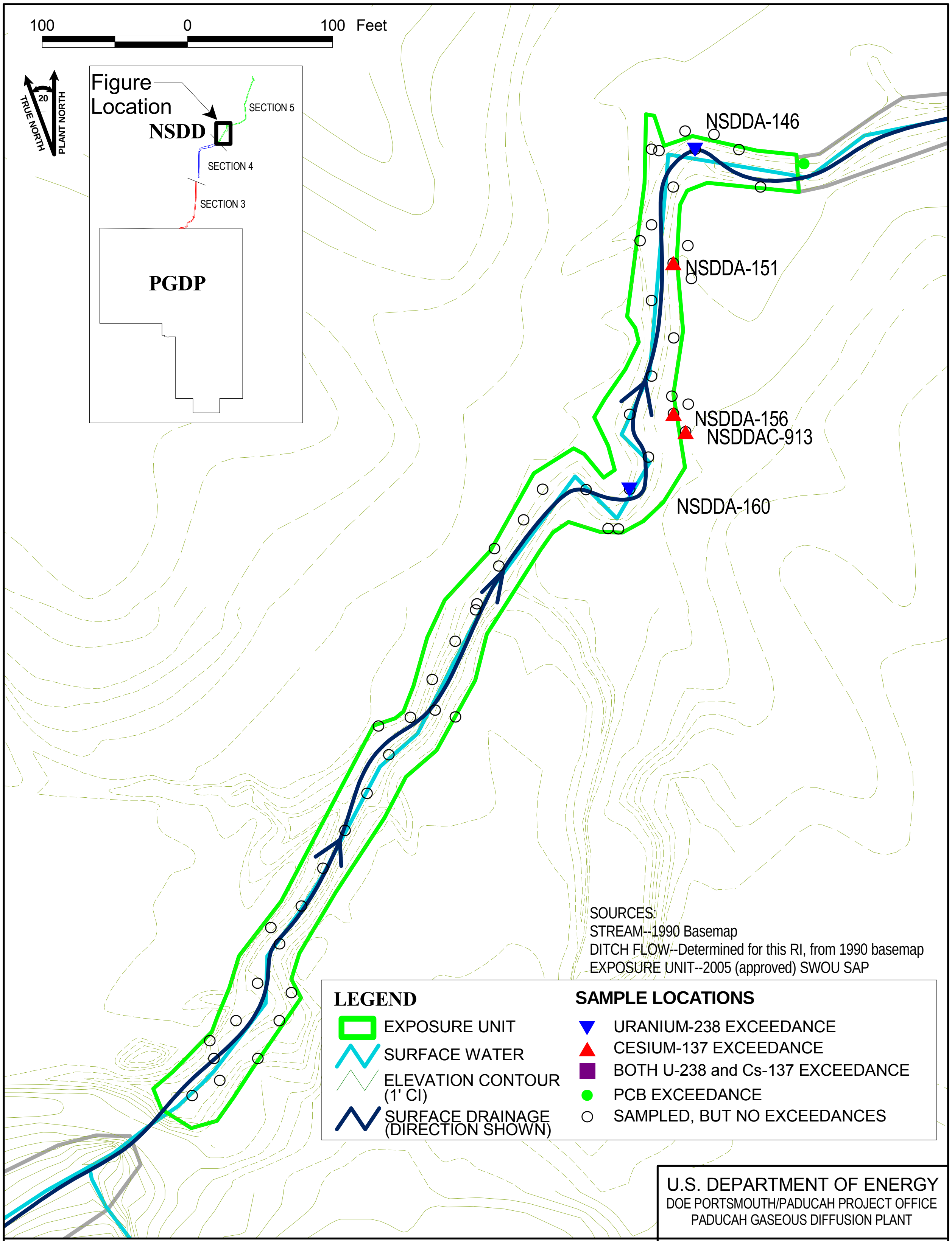
Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.4. Exceedances Identified at the NSDD Section 5 EU 07

PADUCAH
Remediation Services
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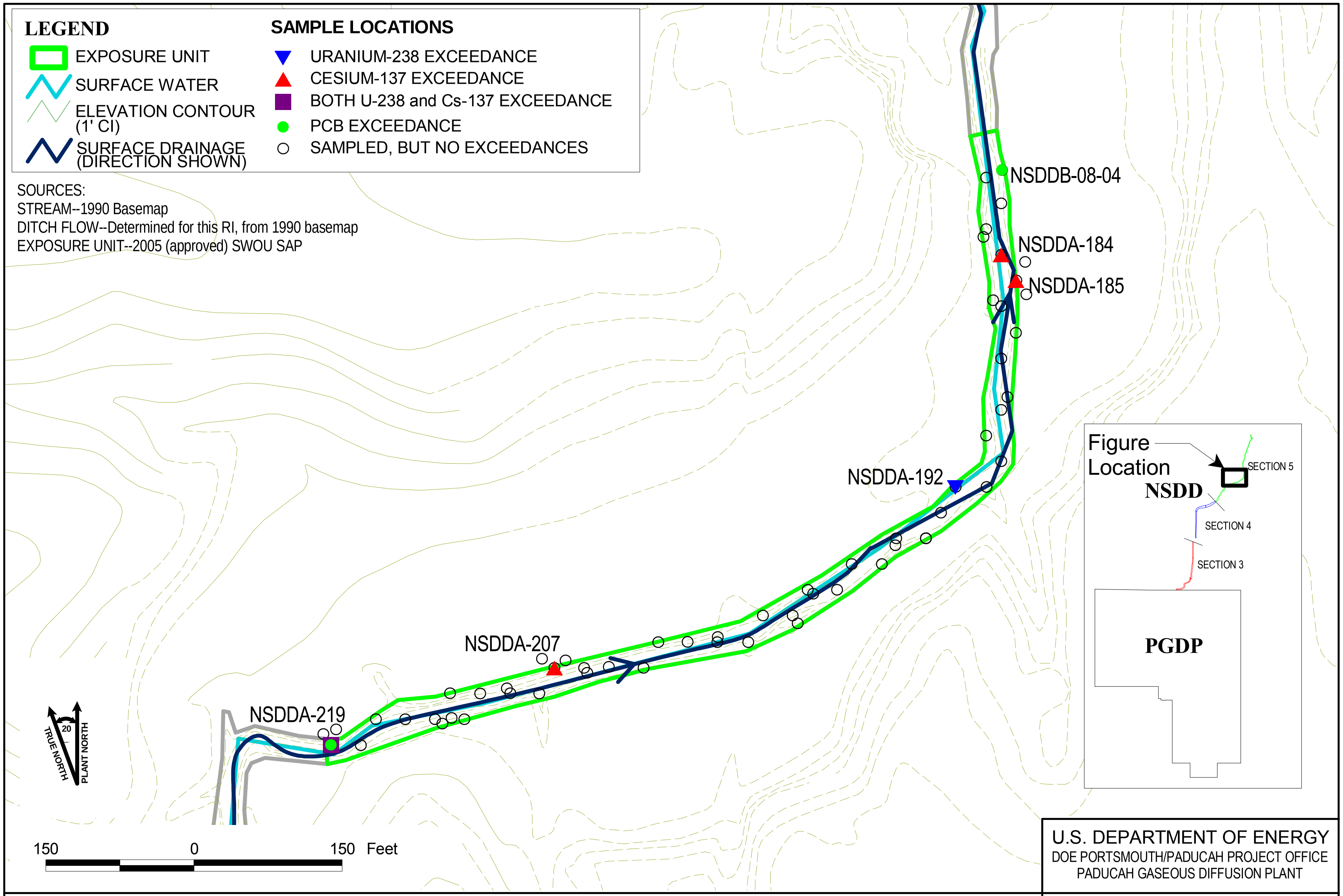
Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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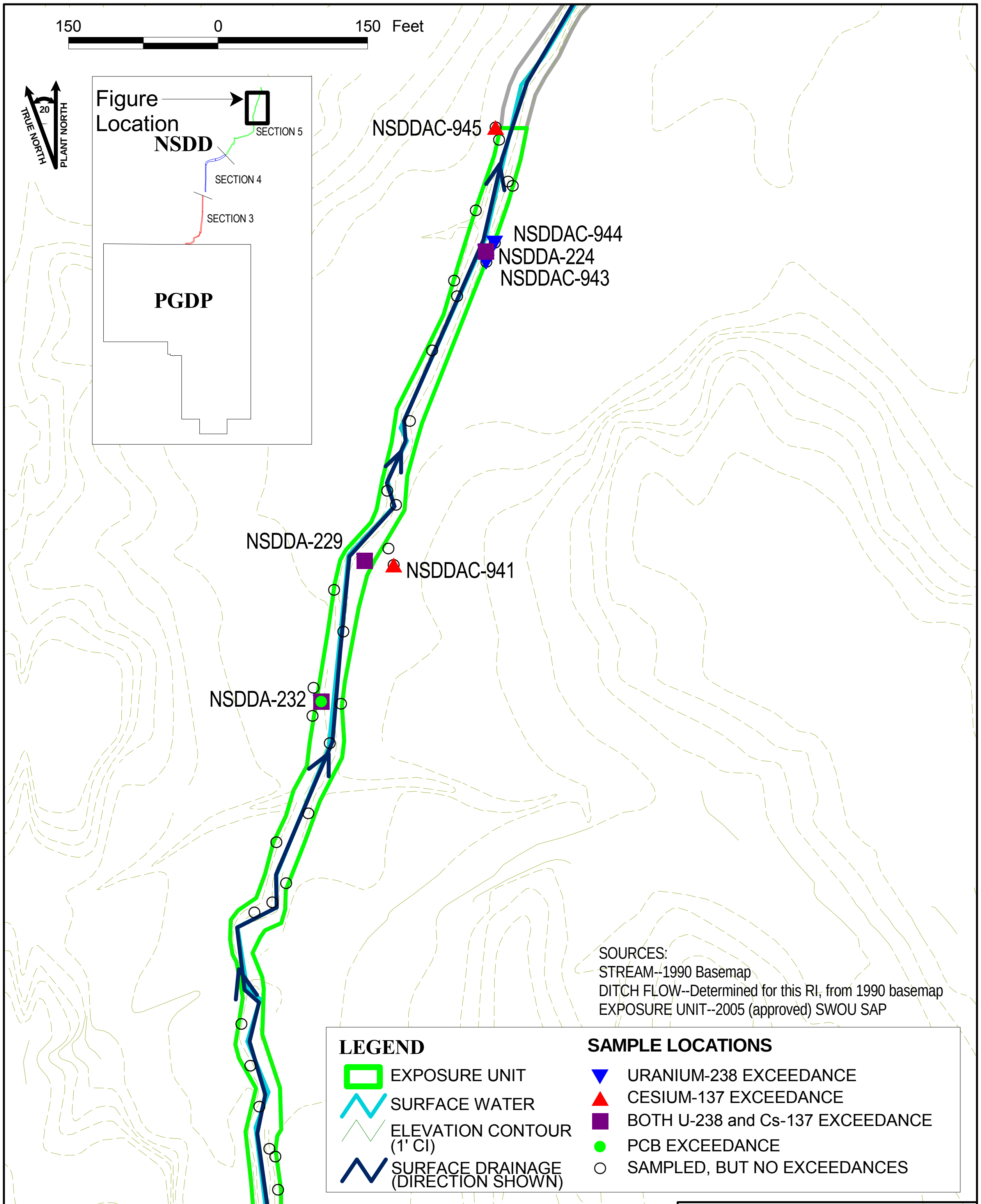
Figure 4.5. Exceedances Identified at the NSDD Section 5 EU 08

Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.6. Exceedances Identified at the NSDD Section 5 EU 09

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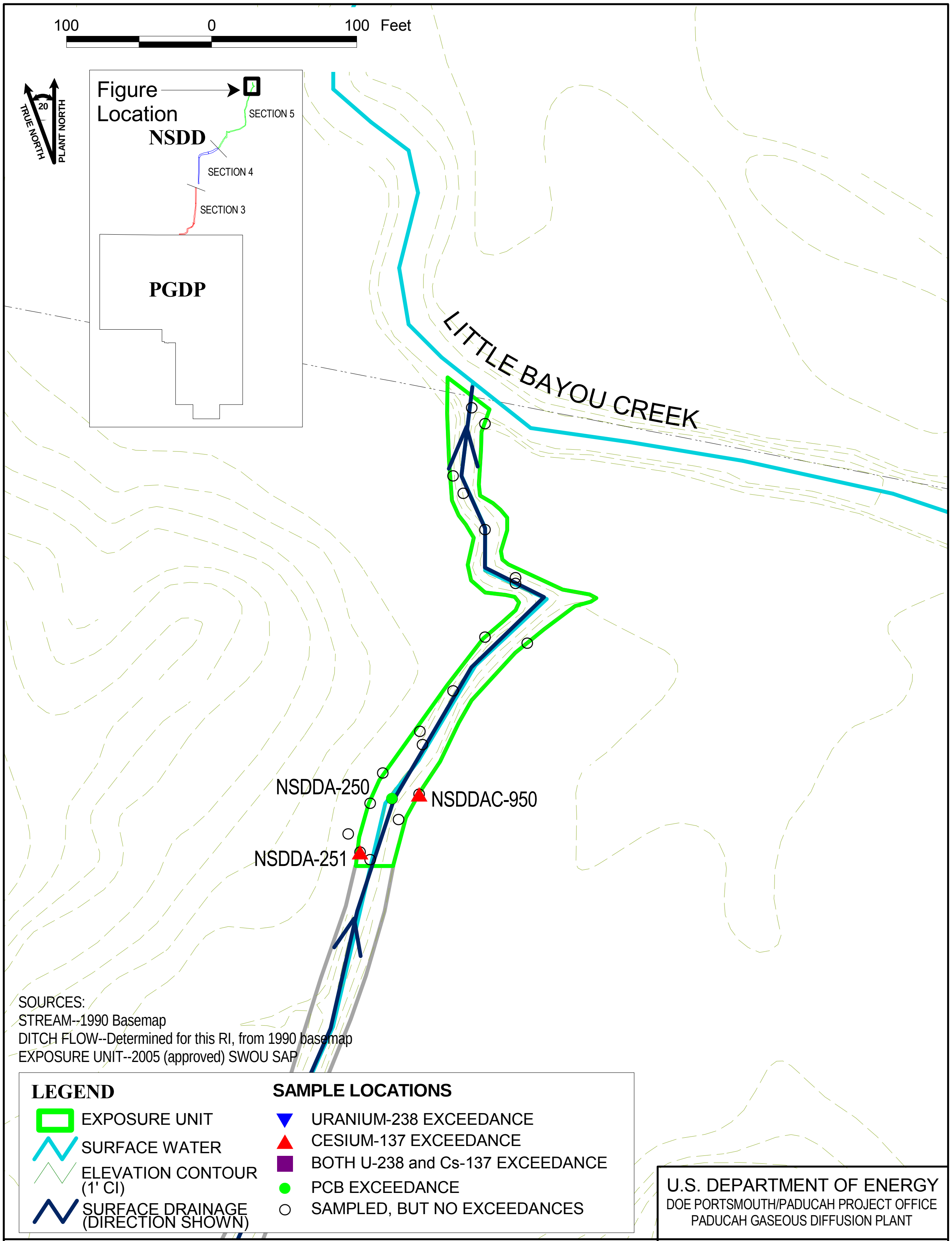
Figure No. \SWOU\NSDD.apr
DATE 08-21-06



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.7. Exceedances Identified at the NSDD Section 5 EU 10

Figure No. \SWOU\NSDD.apr
DATE 08-21-06

4.2.1.2 Activity 2 sampling

A total of 75 Activity 2 samples and 6 duplicate samples was collected from Sections 3, 4, and 5 of the NSDD. Activity 2 sample data have been used to further characterize the nature and extent of the contamination in soils and sediments by comparing the analytical results to risk-based characterization levels. Table 4.5 provides the characterization levels established for the NSDD.

Table 4.5. Characterization Levels[a] for Sections 3, 4, and 5 of the NSDD

Analyte[b]	**Risk-based Characterization Level[c]**
Inorganic Chemicals (mg/kg)	
Antimony	1.05E+01
Arsenic	7.90E+00
Beryllium	2.63E+01
Cadmium	5.91E+02
Chromium	9.89E+03
Copper	1.37E+04
Iron	5.74E+04
Lead	5.00E+01
Manganese	1.26E+03
Mercury	2.73E+01
Molybdenum	2.31E+03
Nickel	6.71E+03
Selenium	2.64E+03
Silver	1.14E+03
Thallium	2.02E+01
Uranium	5.62E+02
Vanadium	9.22E+01
Zinc	7.57E+04
Organic Compounds (mg/kg)	
Acenaphthene	8.78E+03
Acenaphthylene	
Acrylonitrile	1.50E+00
Anthracene	1.05E+05
Benzene	7.86E+00
Carbon Tetrachloride	2.83E+00
Chloroform	3.29E+00
Dichloroethylene, 1,1-	6.66E-01
Dichloroethylene, 1,2- (Mixed Isomers)	1.83E+03
Dichloroethylene, 1,2-cis-	3.71E+02
Dichloroethylene, 1,2-trans-	6.12E+02
Ethylbenzene	1.47E+02
Fluoranthene	6.13E+03
Fluorene	9.42E+03
Naphthalene	6.57E+02
Phenanthrene	
Pyrene	4.60E+03
Tetrachloroethylene	2.71E+01
Total Dioxins/Furans	4.30E-05
Total PAHs	1.47E-01
Total PCBs	1.38E+00
Trichloroethylene	1.74E+01
Vinyl Chloride	9.31E-01
Xylene, m-	2.86E+03
Xylene, Mixture	1.00E+05
Xylene, o-	1.00E+05
Xylene, p-	

Table 4.5. Characterization Levels[a] for Sections 3, 4, and 5 of the NSDD (Continued)

Analyte[b]	Risk-based Characterization Level[c]
Radionuclides (pCi/g)	
^{241}Am	4.28E+01
^{60}Co	1.63E-01
^{137}Cs	7.94E-01
^{237}Np	2.50E+00
^{238}Pu	8.13E+01
^{239}Pu	7.98E+01
^{240}Pu	7.99E+01
^{226}Ra	1.50E+00
^{222}Rn	
^{90}Sr	6.19E+01
^{99}Tc	2.60E+03
^{228}Th	1.60E+00
^{230}Th	1.05E+02
^{232}Th	9.44E+01
^{234}U	1.38E+02
^{235}U	3.63E+00
^{238}U	1.52E+01

Blank cells indicate that a level could not be calculated or is not available.

[a] Characterization levels presented were used to develop the sampling plan for Sections 3, 4, and 5 of the NSDD. They should not be considered to be cleanup levels. Cleanup levels will be selected in the decision documents completed subsequent to the SI.

[b] Analytes listed here are those on the PGDP significant COPCs list taken from Table 2.1 of Vol. 1 of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1506&D2).

[c] Taken from Tables C2.2 and C3.2 of the SAP. Details on the derivation of the risk characterization levels can be found in Section C5.3, "Information Sheet – Characterization Level Derivation of PGDP SWOU On-site Assessment Project," of Appendix C.5 of the SWOU SAP.

Of the 81 Activity 2 samples collected and analyzed from the NSDD (including the QA duplicate samples), 22 samples contained at least one analyte that exceeded its characterization level. Table 4.6 presents the Activity 2 samples that exceeded characterization levels in Sections 3, 4, and 5 of the NSDD and associated EUs. The samples were located in EUs 01, 02, 03, 06, 07, 08, 09, and 10. Characterization levels were not exceeded in Section 4 EUs 04 and 05.

4.2.2 Internal Plant Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015

The following subsections present tables and figures for exceedances of indicator and characterization levels for the outfalls and their associated internal ditches and areas samples that were collected during the SI.

4.2.2.1 Activity 1 sampling

For the outfalls and their associated internal ditches and areas, Activity 1 sample data were used to identify potential "hot spots" and to delineate the nature and extent of contamination in surface soil and sediment. The indicator chemicals used and their associated indicators levels were as follows:

- Uranium-238—100 pCi/g
- Cesium-137—10 pCi/g
- Total PCBs—20 mg/kg

Table 4.6. Risk-based Characterization Level Exceedances in the NSDD for Activity 2 Sampling

Section	EU	Station	Analysis	Result	Units
3	01	NSDDB-01-02	Cesium-137	0.848	pCi/g
3	01	NSDDB-01-08	Cesium-137	4.01	pCi/g
3	01	NSDDB-01-09	Cesium-137	1.78	pCi/g
3	01	NSDDB-01-08	Neptunium-237	2.54	pCi/g
3	01	NSDDB-01-09	Neptunium-237	5.3	pCi/g
3	01	NSDDB-01-08	Thorium-228	2.08	pCi/g
3	01	NSDDB-01-08	Thorium-230	199	pCi/g
3	01	NSDDB-01-09	Thorium-230	105	pCi/g
3	01	NSDDB-01-09	Total PCB	1830	ug/kg
3	01	NSDDB-01-08	Total PCB	5020	ug/kg
3	02	NSDDB-02-05	Arsenic	7.94	mg/kg
3	02	NSDDB-02-04	Cesium-137	2.02	pCi/g
3	02	NSDDB-02-09	Cesium-137	1.62	pCi/g
3	02	NSDDB-02-05	Cesium-137	4.1	pCi/g
3	02	NSDDB-02-05	Neptunium-237	3.96	pCi/g
3	02	NSDDB-02-09	Neptunium-237	2.9	pCi/g
3	02	NSDDB-02-04	Thorium-230	111	pCi/g
3	02	NSDDB-02-05	Thorium-230	124	pCi/g
3	03	NSDDB-03-01	Cesium-137	1.76	pCi/g
3	03	NSDDB-03-06	Cesium-137	3.93	pCi/g
3	03	NSDDB-03-03	Cesium-137	2.34	pCi/g
3	03	NSDDB-03-05	Cesium-137	1.2	pCi/g
3	03	NSDDB-03-06	Neptunium-237	2.75	pCi/g
3	03	NSDDB-03-03	Neptunium-237	2.82	pCi/g
3	03	NSDDB-03-01	Thorium-230	129	pCi/g
3	03	NSDDB-03-03	Thorium-230	139	pCi/g
4	06	NSDDB-06-03	Arsenic	13.6	mg/kg
4	06	NSDDB-06-02	Arsenic	11.1	mg/kg
4	06	NSDDB-06-02	Manganese	2880	mg/kg
5	07	NSDDB-07-04	Arsenic	19.2	mg/kg
5	07	NSDDB-07-08	Cesium-137	1.02	pCi/g
5	08	NSDDB-08-04	Arsenic	8.17	mg/kg
5	08	NSDDB-08-07	Arsenic	8.14	mg/kg
5	08	NSDDB-08-06	Arsenic	29.7	mg/kg
5	08	NSDDB-08-04	Cesium-137	3.42	pCi/g
5	08	NSDDB-08-07[a]	Cesium-137	1.38	pCi/g
5	08	NSDDB-08-07	Cesium-137	1.55	pCi/g
5	08	NSDDB-08-02	Cesium-137	1.12	pCi/g
5	08	NSDDB-08-07	Thorium-228	1.73	pCi/g
5	08	NSDDB-08-07[a]	Thorium-230	157	pCi/g
5	08	NSDDB-08-07	Thorium-230	164	pCi/g
5	08	NSDDB-08-04	Total PCB	1600	ug/kg
5	09	NSDDB-09-04	Arsenic	10	mg/kg
5	09	NSDDB-09-01	Cesium-137	1.11	pCi/g
5	10	NSDDB-10-03	Cesium-137	0.939	pCi/g

[a] Duplicate Sample

A total of 2,076 Activity 1 samples and 114 duplicate samples was collected during the SWOU sampling. Seventy samples exceeded radionuclide indicator levels (4 samples were a combination of cesium-137 and uranium-238, 19 samples were uranium-238 only, and 47 samples were cesium-137 only), and nine exceeded PCB indicator levels. These are presented in Tables 4.7 and 4.8.

Table 4.7. Activity 1 Exceedances for Radionuclides at the Outfalls and Associated Internal Plant Ditches

Exceedances for Cesium-137

EU	Station	Result	Units
Outfall 001			
EU 18	OF01A-548*	20.48	pCi/g
Outfall 001 Contingency			
EU 18	OF01AC-907	18.99	pCi/g
EU 18	OF01AC-908	11.48	pCi/g
Outfall 008			
EU 08	OF08A-220	54.56	pCi/g
EU 08	OF08A-221	72.41	pCi/g
EU 08	OF08A-223	20.28	pCi/g
EU 08	OF08A-227	11.49	pCi/g
Outfall 015			
EU 01	OF15A-003*	11.14	pCi/g
EU 01	OF15A-004*	13.5	pCi/g
EU 01	OF15A-300*	16.07	pCi/g
EU 02	OF15A-035	71.16	pCi/g
EU 02	OF15A-036	46.51	pCi/g
EU 02	OF15A-037	99.05	pCi/g
EU 02	OF15A-038	46.26	pCi/g
EU 02	OF15A-039	59.39	pCi/g
EU 02	OF15A-040	67.72	pCi/g
EU 02	OF15A-041	74.7	pCi/g
EU 02	OF15A-042	50.23	pCi/g
EU 02	OF15A-043	47.95	pCi/g
EU 02	OF15A-044	39.36	pCi/g
EU 02	OF15A-045	41.28	pCi/g
EU 02	OF15A-046	76.74	pCi/g
EU 02	OF15A-047	62.9	pCi/g
EU 02	OF15A-048	31.92	pCi/g
EU 02	OF15A-049	35.97	pCi/g
EU 02	OF15A-050	12.81	pCi/g
EU 02	OF15A-051	39.07	pCi/g
EU 02	OF15A-052	21.1	pCi/g
EU 02	OF15A-053	17.61	pCi/g
EU 02	OF15A-054	34.61	pCi/g
EU 02	OF15A-055	29.15	pCi/g
EU 02	OF15A-056	54.17	pCi/g
EU 02	OF15A-057	62.71	pCi/g
EU 02	OF15A-058	34.25	pCi/g
EU 02	OF15A-059	43.06	pCi/g
EU 02	OF15A-061	30.14	pCi/g
EU 02	OF15A-062	19.25	pCi/g
EU 03	OF15A-079	14.91	pCi/g
EU 03	OF15A-080	16.29	pCi/g
EU 03	OF15A-082	20.53	pCi/g
EU 03	OF15A-083	11.15	pCi/g
Outfall 015			
EU 03	OF15A-084	19.84	pCi/g
EU 03	OF15A-085	49.55	pCi/g
EU 03	OF15A-086	15.99	pCi/g
EU 03	OF15A-087	50.11	pCi/g
EU 03	OF15A-088	70.95	pCi/g
EU 03	OF15A-089	22.97	pCi/g
EU 04	OF15A-093	18.64	pCi/g
EU 04	OF15A-094	11.74	pCi/g
EU 04	OF15A-096	11.8	pCi/g
EU 04	OF15A-122*	14.55	pCi/g

Exceedances for Uranium-238

EU	Station	Result	Units
Outfall 001			
EU 05	OF01A-132	113	pCi/g
EU 15	OF01A-462	903.43	pCi/g
EU 16	OF01A-490	159.78	pCi/g
EU 18	OF01A-548*	234.26	pCi/g
EU 20	OF01A-635	770.61	pCi/g
EU 20	OF01A-637	105.16	pCi/g
EU 20	OF01A-638	112.14	pCi/g
Outfall 001 contingency			
EU 18	OF01AC-907	1,830	pCi/g
EU 18	OF01AC-908	1,41.3	pCi/g
Outfall 008			
EU 11	OF08A-335*	175.72	pCi/g
EU 11	OF08A-337*	125.44	pCi/g
Outfall 015			
EU 03	OF15A-080	166.87	pCi/g
EU 07	OF15A-152	170.6	pCi/g
EU 07	OF15A-153*	152.71	pCi/g
EU 07	OF15A-154*	154.67	pCi/g
EU 07	OF15A-155*	123.67	pCi/g
EU 07	OF15A-156*	241.16	pCi/g
EU 07	OF15A-157*	593.42	pCi/g
EU 07	OF15A-158*	219.17	pCi/g
EU 07	OF15A-159*	120.91	pCi/g
EU 07	OF15A-166*	125.11	pCi/g
EU 07	OF15A-168*	545.98	pCi/g
EU 07	OF15A-176	172.48	pCi/g
Outfall 015 contingency			
EU 07	OF15AC-912	486	pCi/g
EU 07	OF15AC-919	176	pCi/g
EU 07	OF15AC-920	590	pCi/g

* - Denotes contingency samples were collected at this location

Table 4.8. Activity 1 Exceedances for Total PCBs at the Outfalls and Associated Internal Plant Ditches

EU	Station	Result	Units
Outfall 001			
EU 14	OF01A-433	22.8	mg/kg
EU 15	OF01A-463*	48.9	mg/kg
EU 15	OF01A-466*	21.4	mg/kg
Outfall 008			
EU 11	OF08A-337*	61.2	mg/kg
Outfall 008 contingency			
EU 11	OF08AC-903	36.9	mg/kg
Outfall 010			
EU 10	OF10A-297*	24.2	mg/kg
EU 10	OF10A-299*	61.8	mg/kg
EU 10	OF10A-301*	90.1	mg/kg
EU 10	OF10A-303*	60.2	mg/kg
Outfall 010 contingency			
EU 10	OF10AC-901	244	mg/kg
EU 10	OF10AC-901**	278	mg/kg
EU 10	OF10AC-902	489	mg/kg
EU 10	OF10AC-903	609	mg/kg
EU 10	OF10AC-904	380	mg/kg
EU 10	OF10AC-906	103	mg/kg
Outfall 015			
EU 08	OF15A-190*	262	mg/kg

* - Contingency samples were collected at this location

** - This sample is a field duplicate.

Fifty-four contingency "extent" samples and four contingency duplicate samples were collected for the purpose of determining the nature and extent of the contamination. Sample locations where contingency samples were collected are identified with an asterisk in Tables 4.7 and 4.8. Samples that exceeded indicator levels were localized within the EUs at four of the internal plant ditches and outfalls:

- Outfall 001 (EUs 05, 14, 15, 16, 18, and 20);
- Outfall 008 (EUs 08 and 11);
- Outfall 010 (EU 10); and
- Outfall 015 (EUs 01, 02, 03, 04, 07, and 08).

Contingency samples were required at only seven of the 15 EUs with samples exceeding indicator levels. Indicator levels were not exceeded in any Activity 1 samples collected at Outfalls 002, 011, or 012.

Figures 4.8 through 4.22 present the locations of those samples exceeding indicator levels.

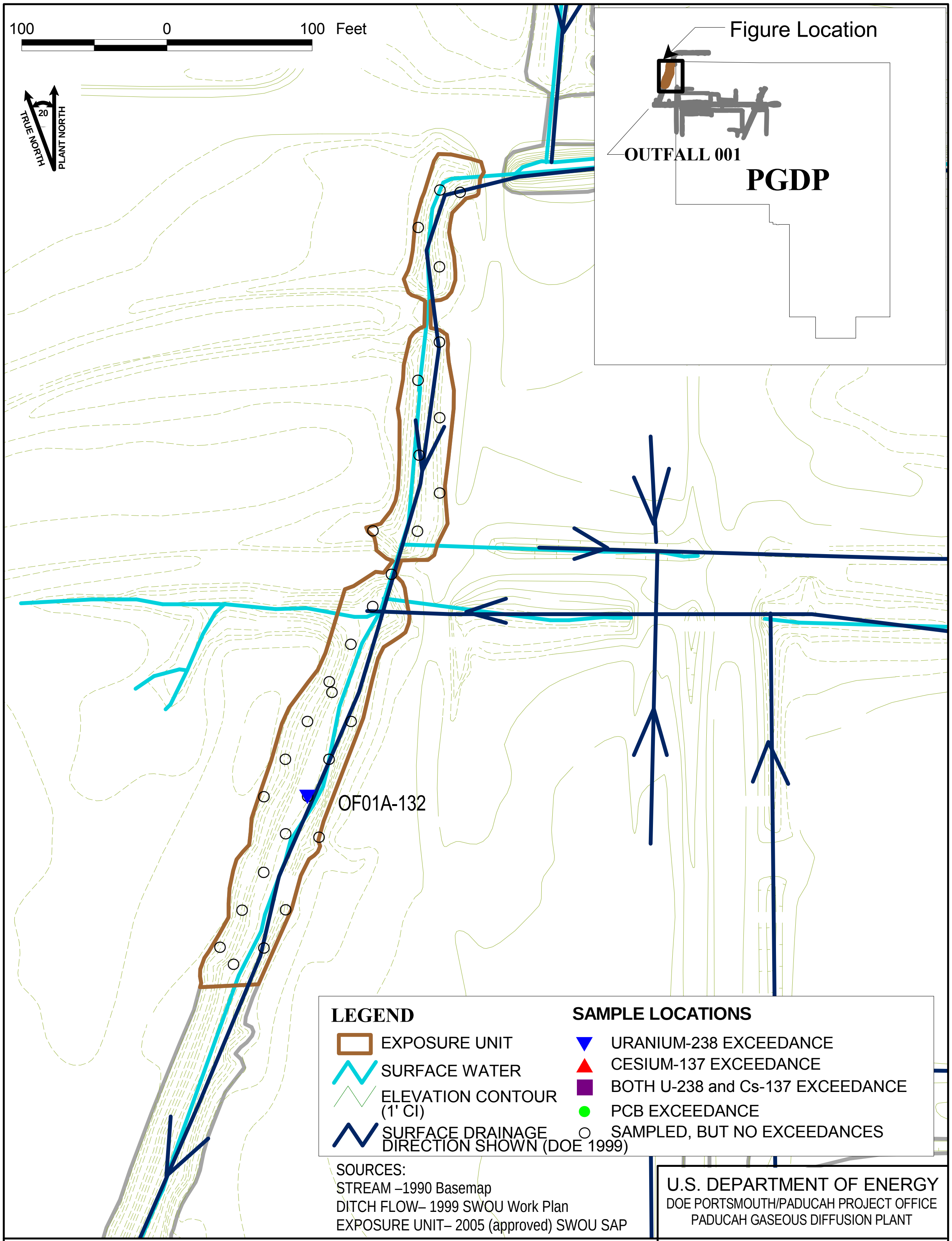

Figure 4.8. Exceedances Identified at the Outfall 001 EU 05

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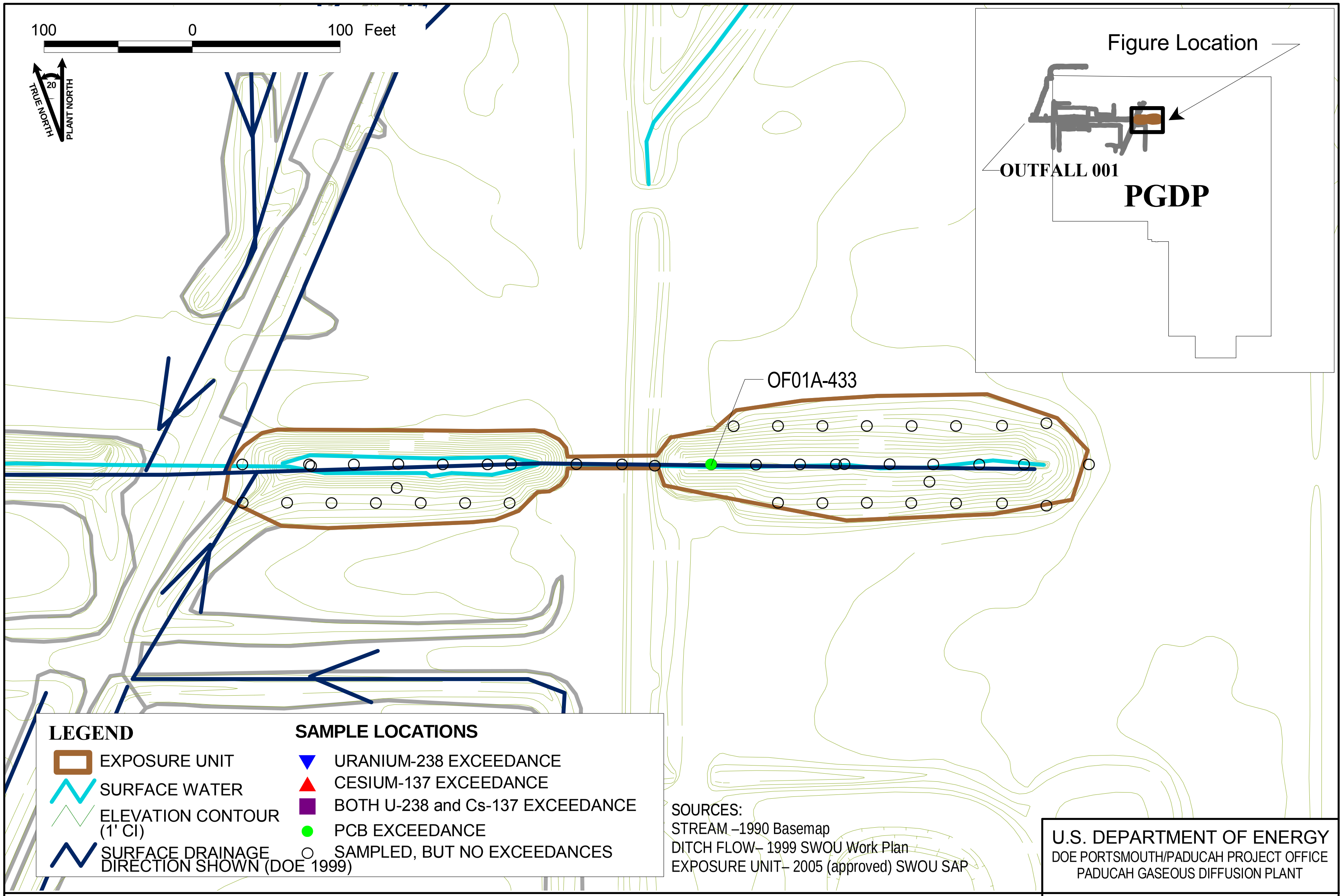
DATE 08-01-06



SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
EXPOSURE UNIT– 2005 (approved) SWOU SAP

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Figure 4.9. Exceedances Identified at the Outfall 001 EU 14

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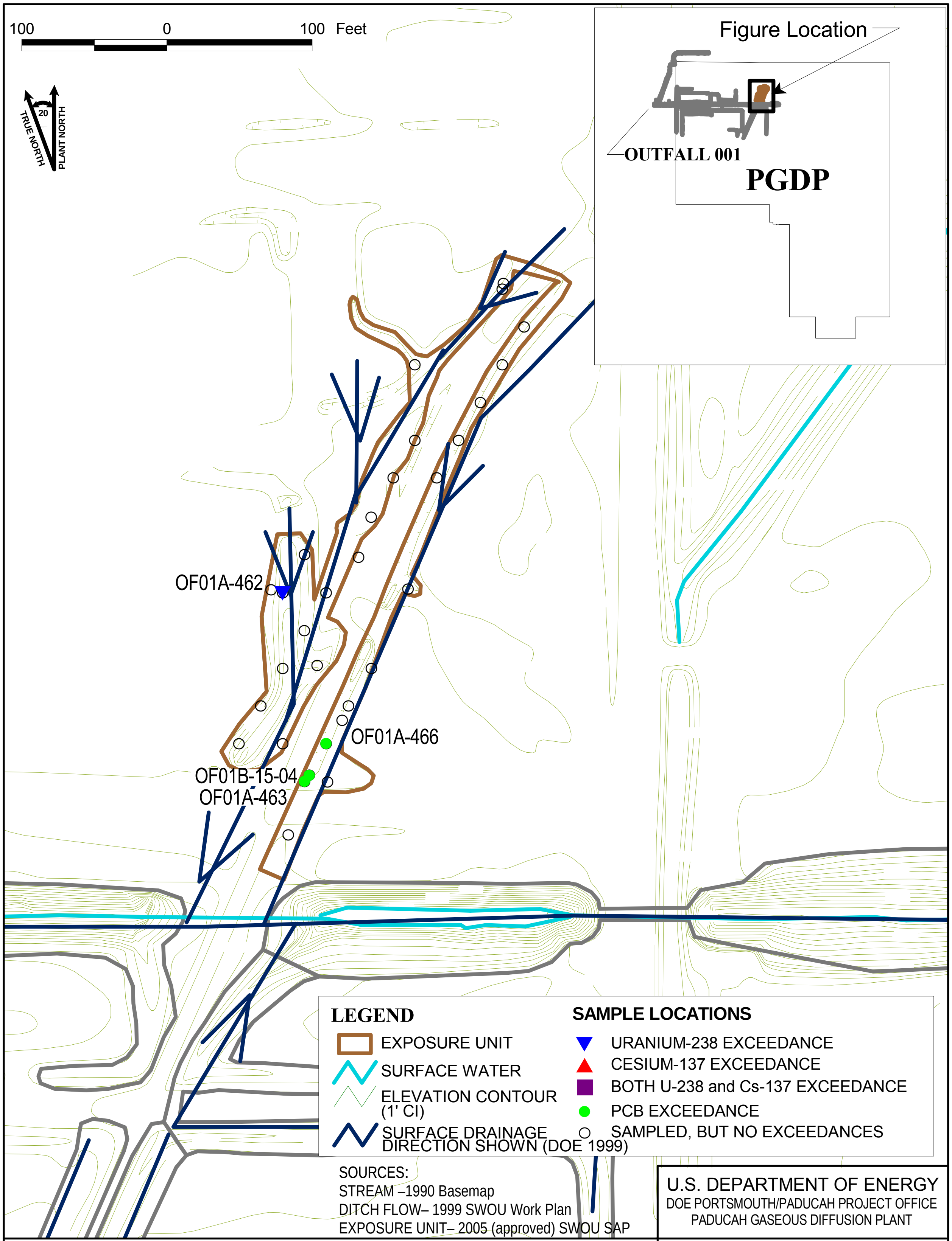

SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
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Figure 4.10. Exceedances Identified at the Outfall 001 EU 15

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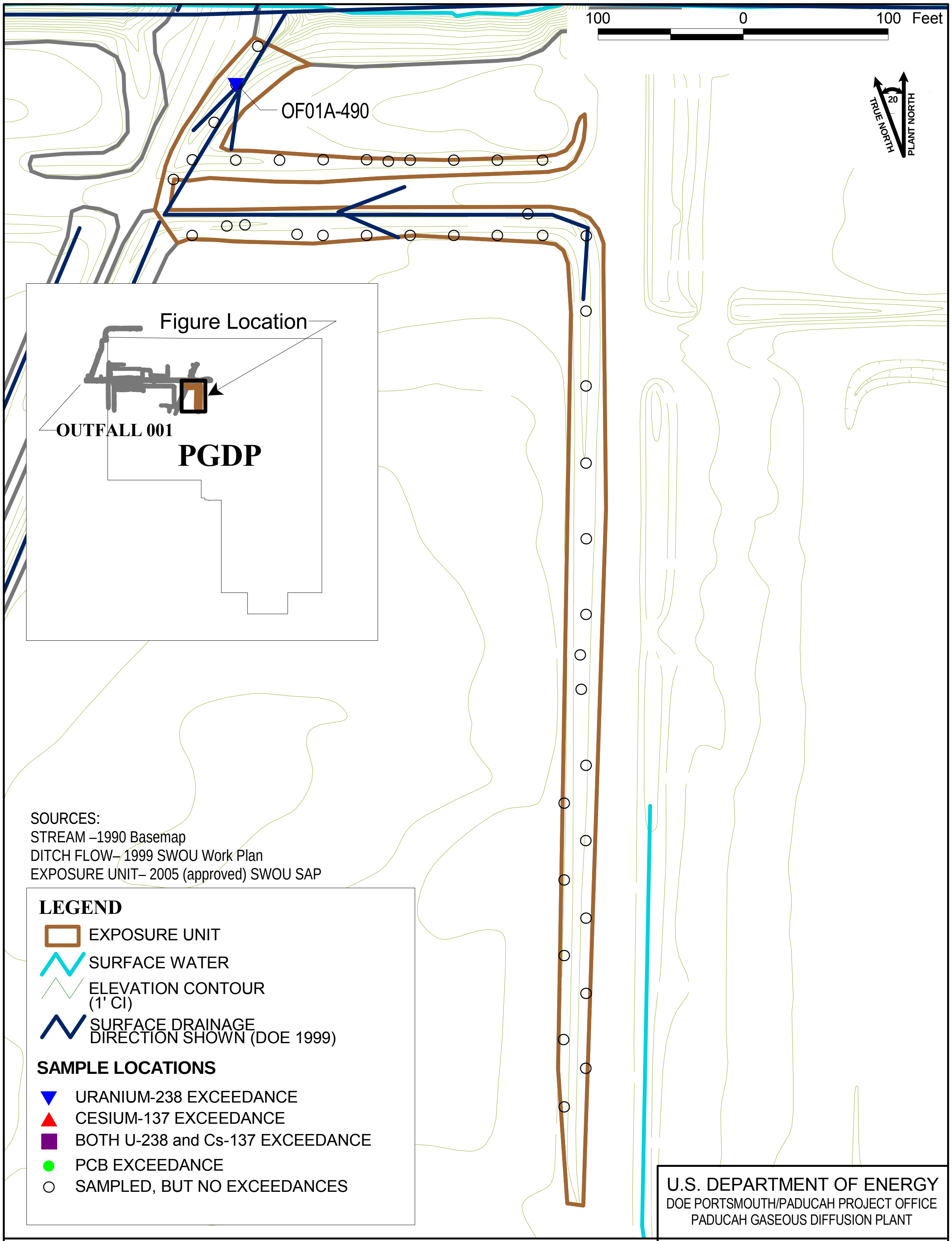

SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
EXPOSURE UNIT– 2005 (approved) SWOU SAP

LEGEND

- ▭ EXPOSURE UNIT
- SURFACE WATER
- ELEVATION CONTOUR (1' CI)
- SURFACE DRAINAGE DIRECTION SHOWN (DOE 1999)

SAMPLE LOCATIONS

- ▼ URANIUM-238 EXCEEDANCE
- ▲ CESIUM-137 EXCEEDANCE
- ■ BOTH U-238 and Cs-137 EXCEEDANCE
- ● PCB EXCEEDANCE
- ○ SAMPLED, BUT NO EXCEEDANCES

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Figure 4.11. Exceedances Identified at the Outfall 001 EU 16

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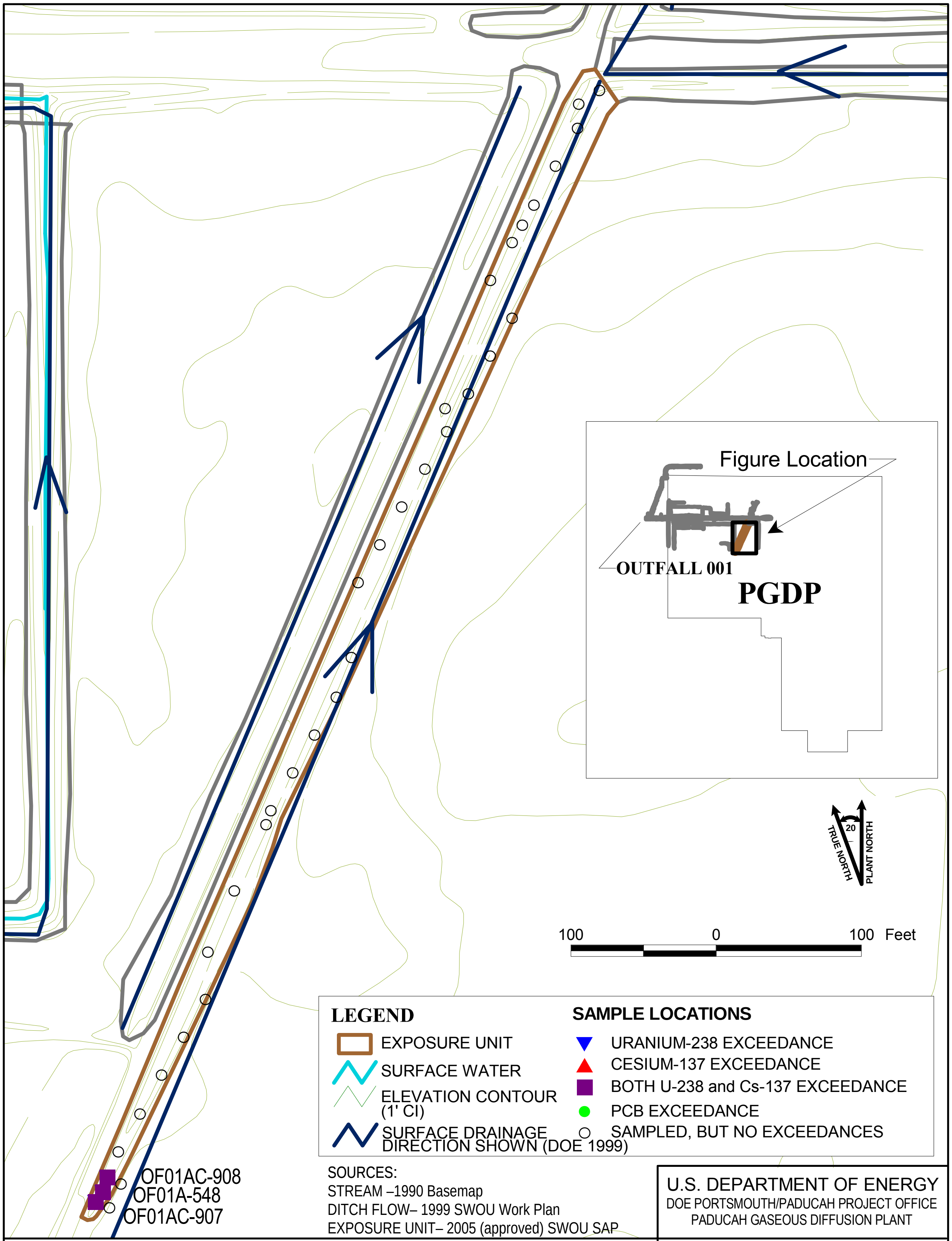

SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
EXPOSURE UNIT– 2005 (approved) SWOU SAP

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Figure 4.12. Exceedances Identified at the Outfall 001 EU 18

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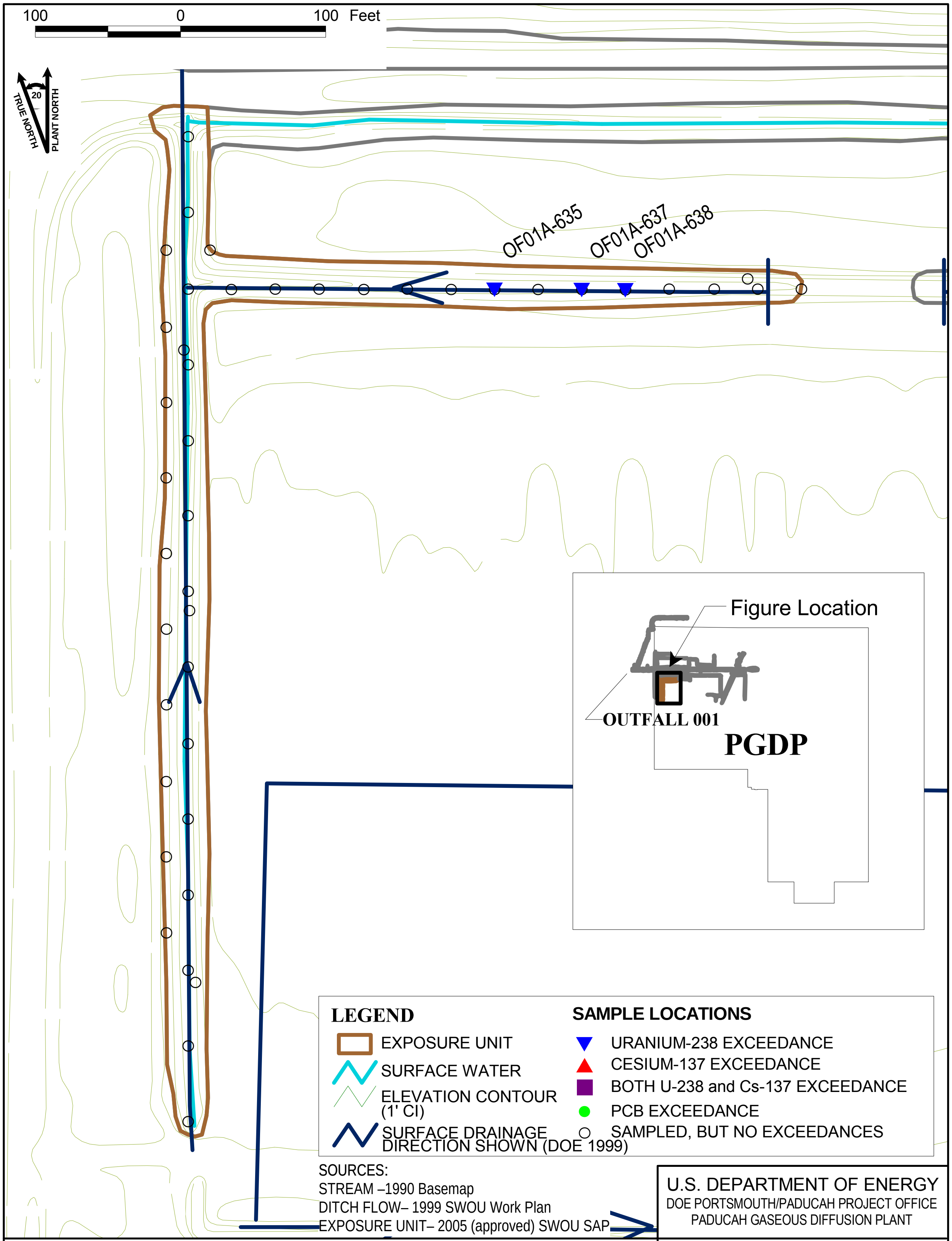

SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
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Figure 4.13. Exceedances Identified at the Outfall 001 EU 20

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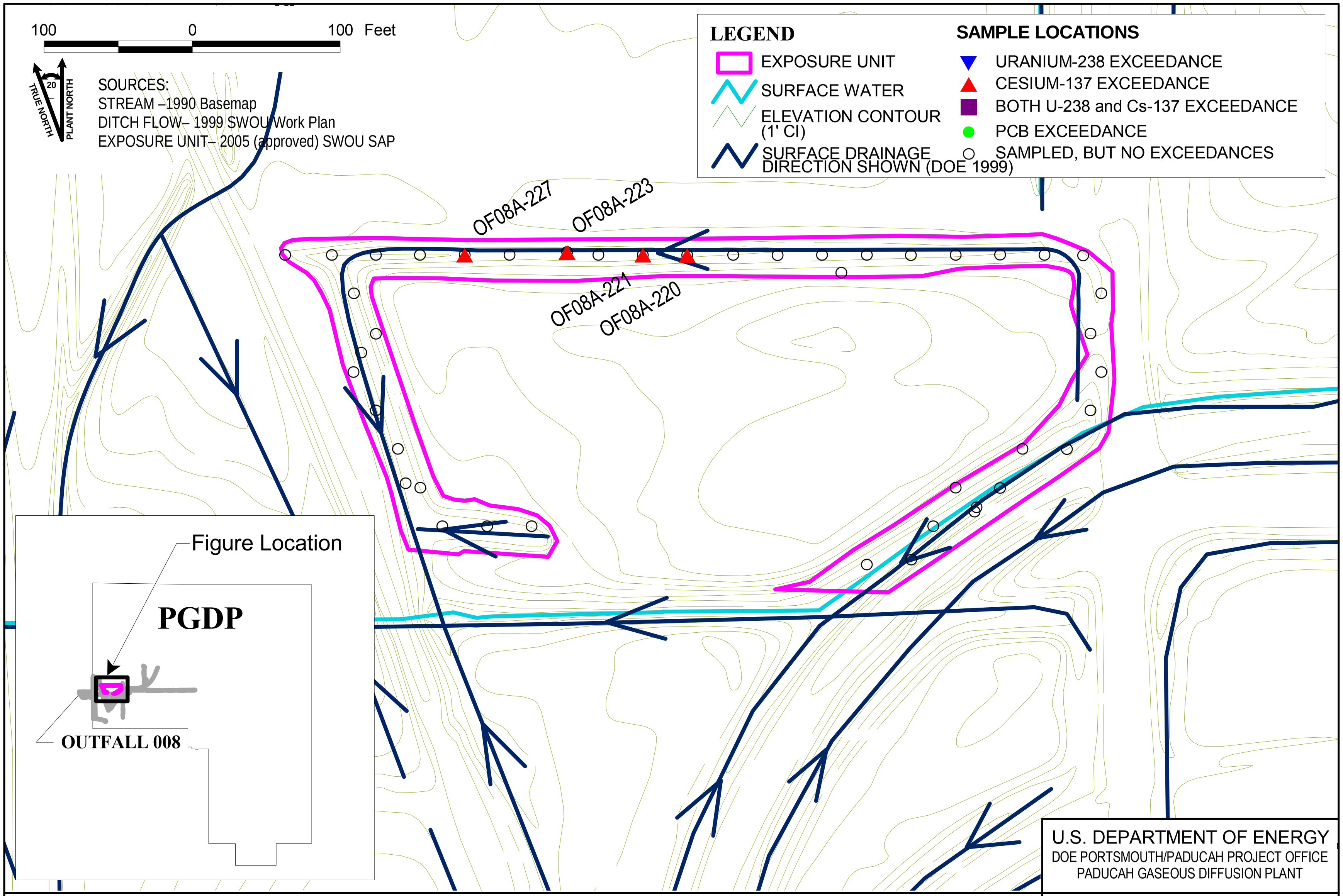

Figure 4.14. Exceedances Identified at the Outfall 008 EU 8

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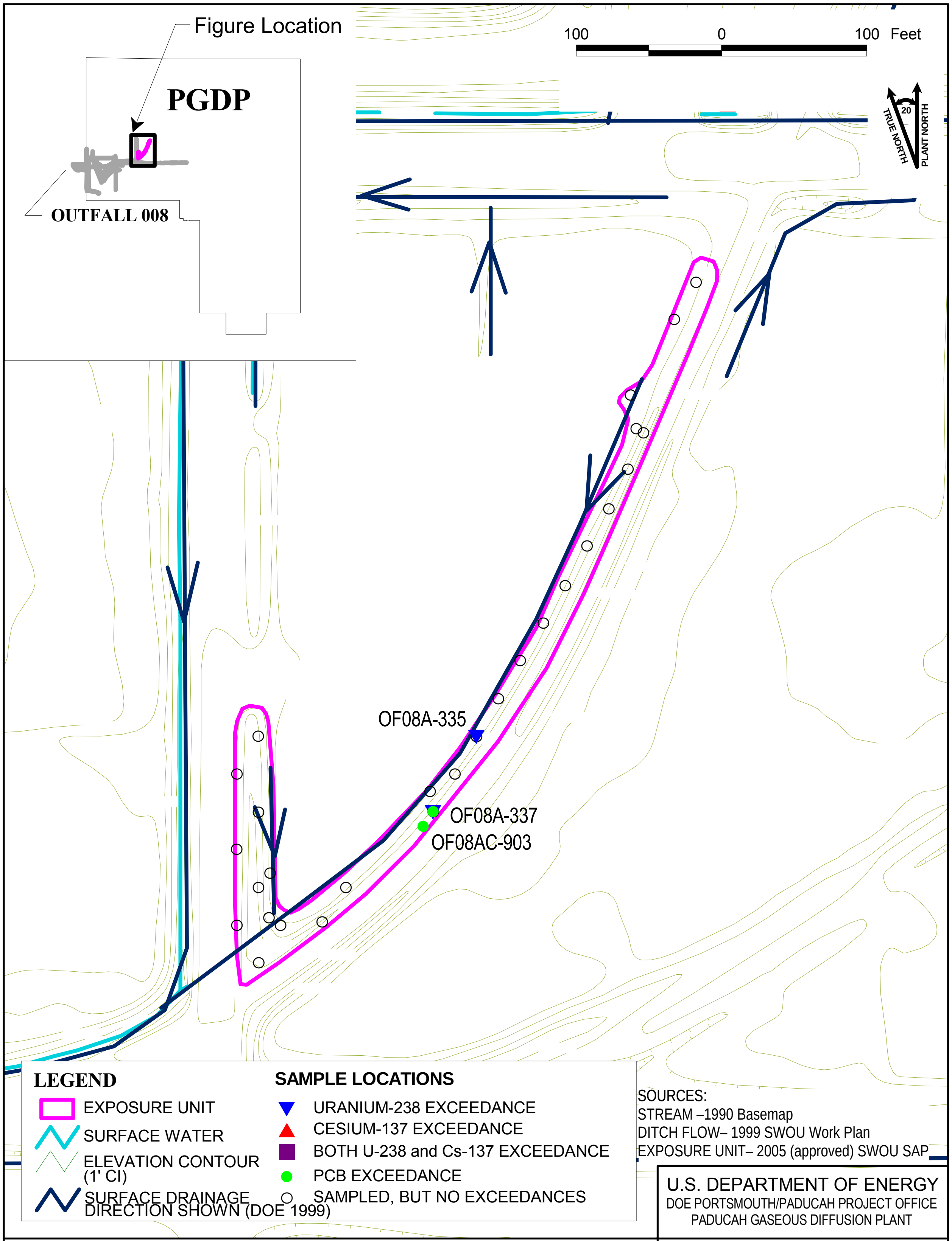
Figure No. \SWOU\008.apr
DATE 08-01-06



SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
EXPOSURE UNIT– 2005 (approved) SWOU SAP

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Figure 4.15. Exceedances Identified at the Outfall 008 EU 11

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Figure No. \SWOU\001.apr
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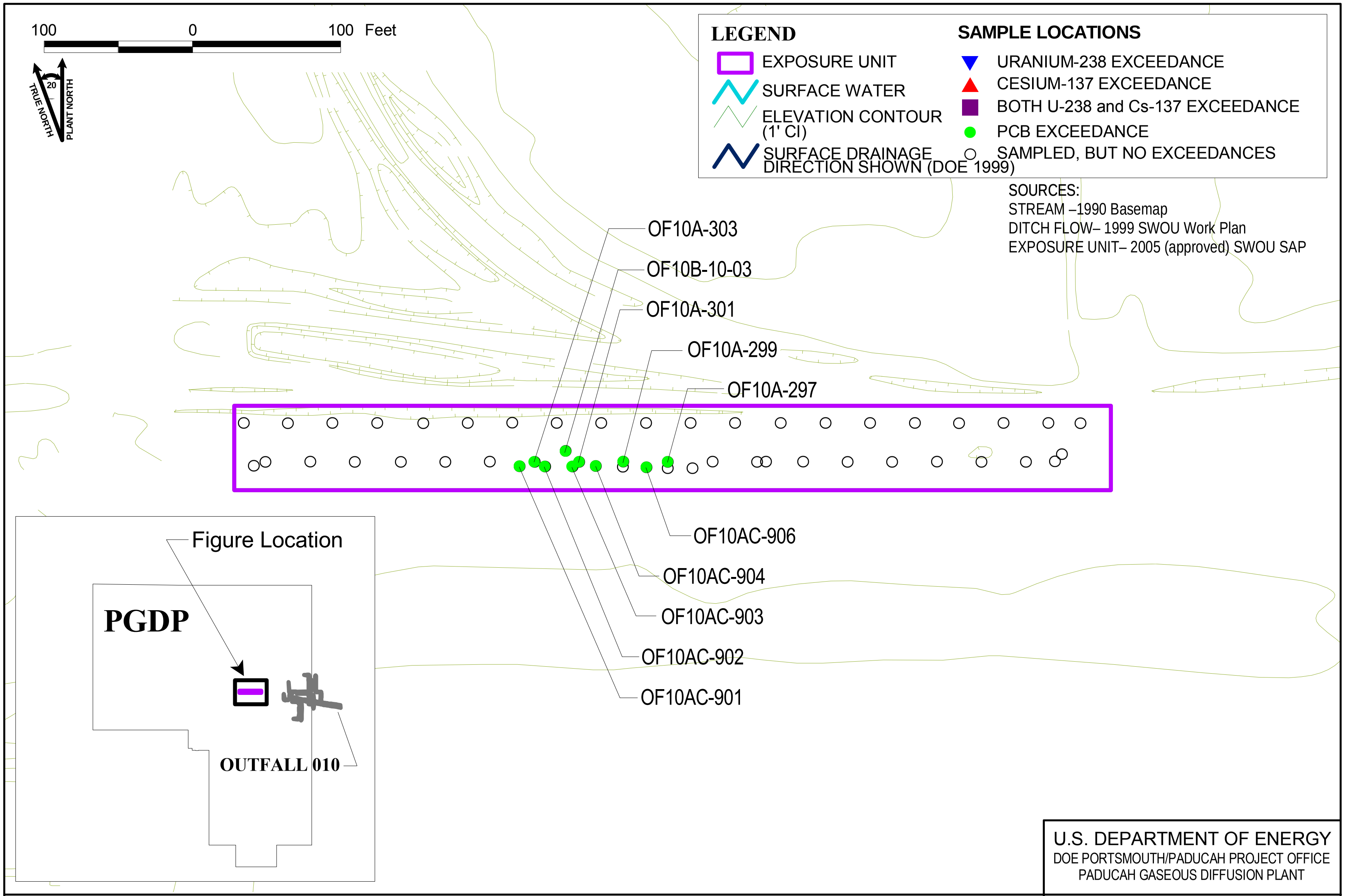

SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
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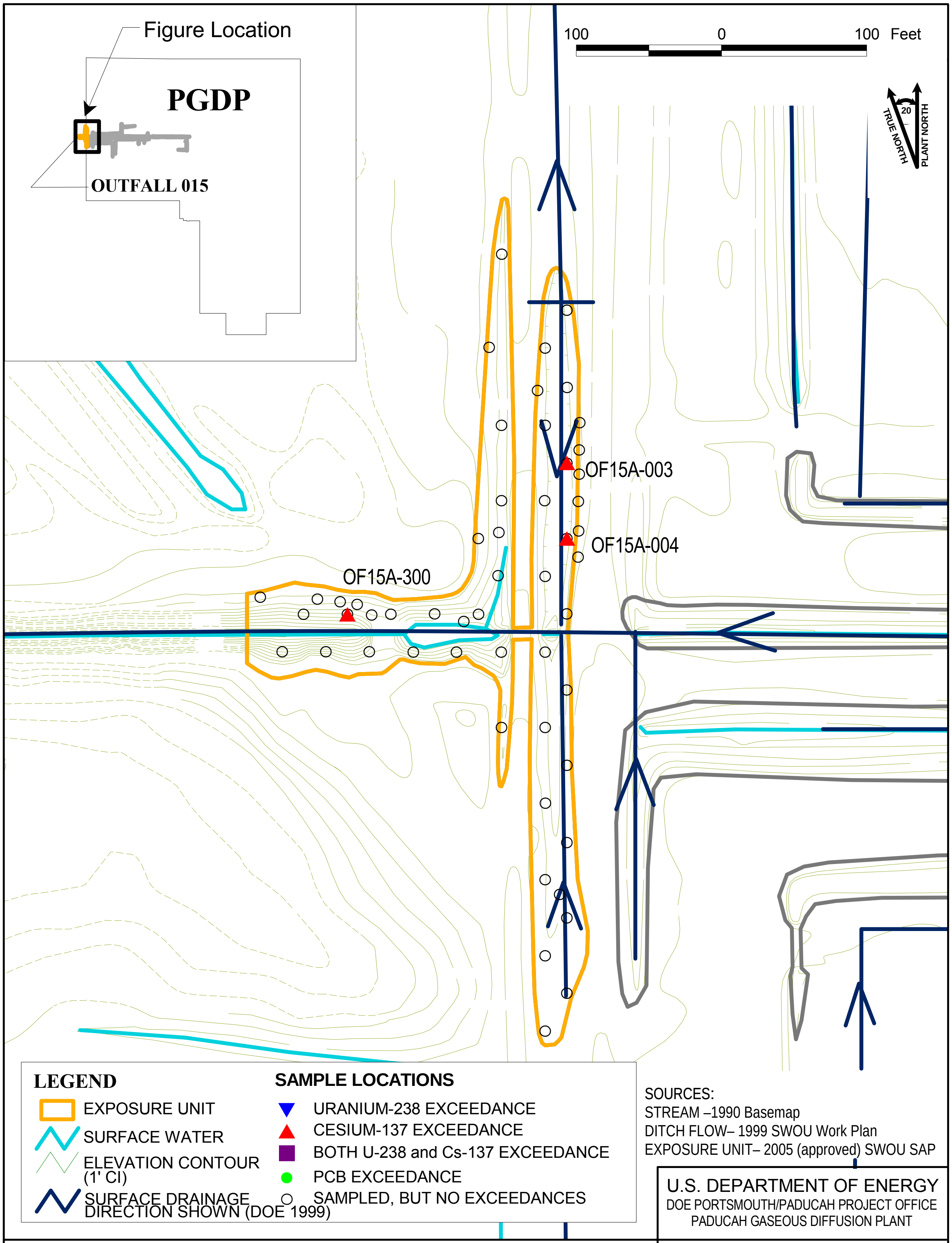
Figure 4.16. Exceedances Identified at the Outfall 010 EU 10

Figure No. \SWOU\010.apr
DATE 08-01-06



SOURCES:
STREAM –1990 Basemap
DITCH FLOW– 1999 SWOU Work Plan
EXPOSURE UNIT– 2005 (approved) SWOU SAP

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Figure 4.17. Exceedances Identified at the Outfall 015 EU 1

Figure No. \SWOU\015.apr
DATE 08-21-06

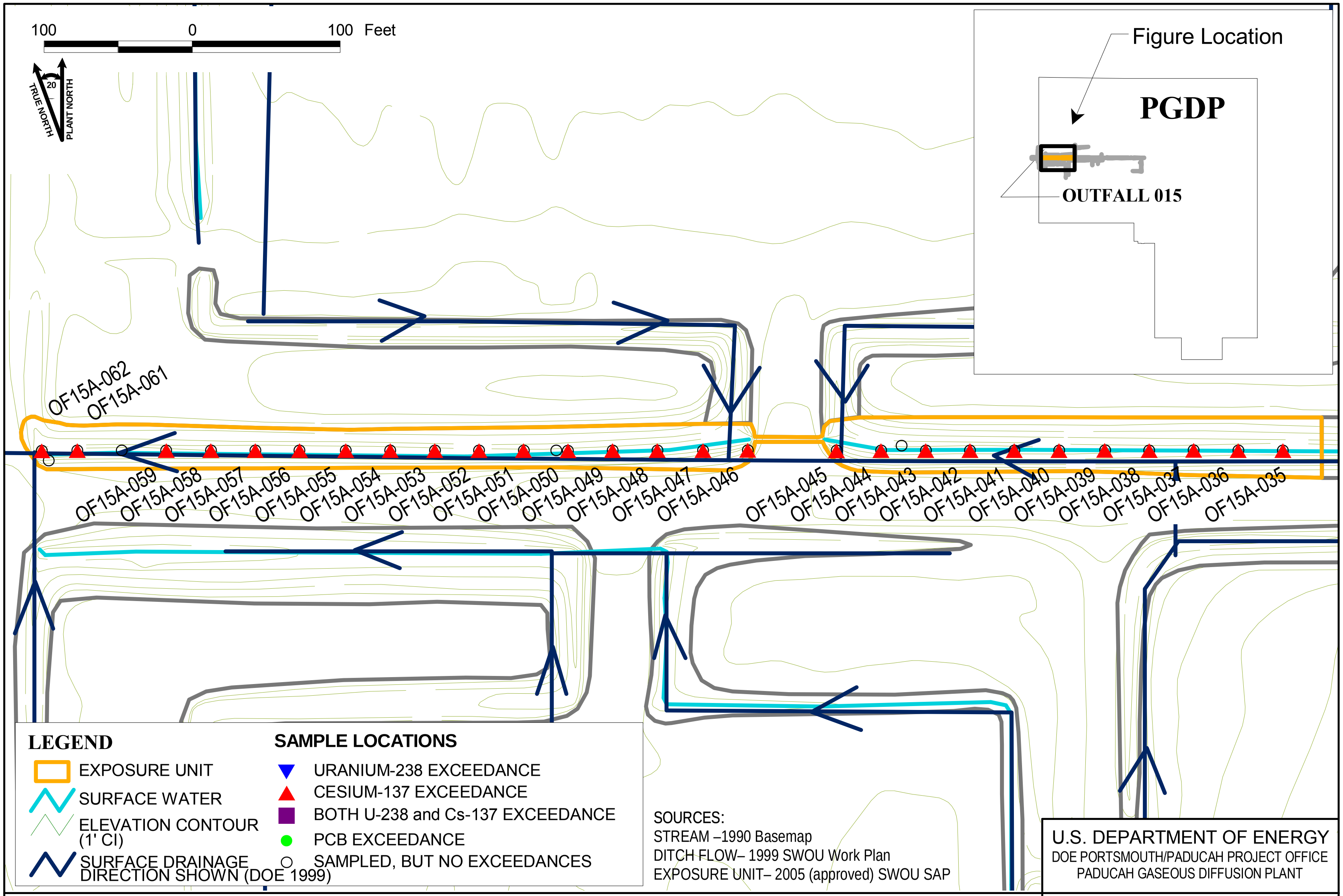

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Figure 4.18. Exceedances Identified at the Outfall 015 EU 2

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DATE 08-21-06

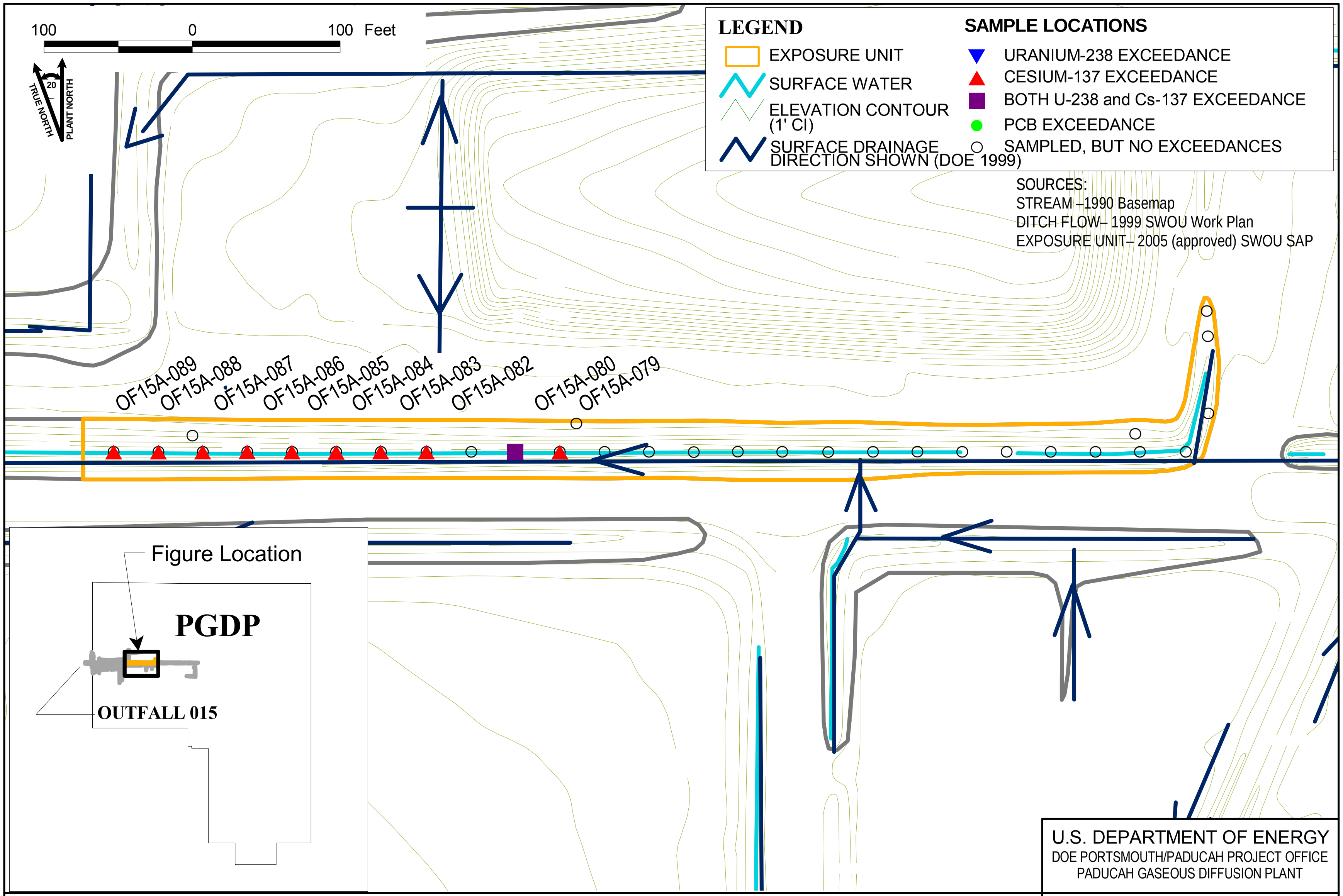

Figure 4.19. Exceedances Identified at the Outfall 015 EU 3

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DATE 08-21-06

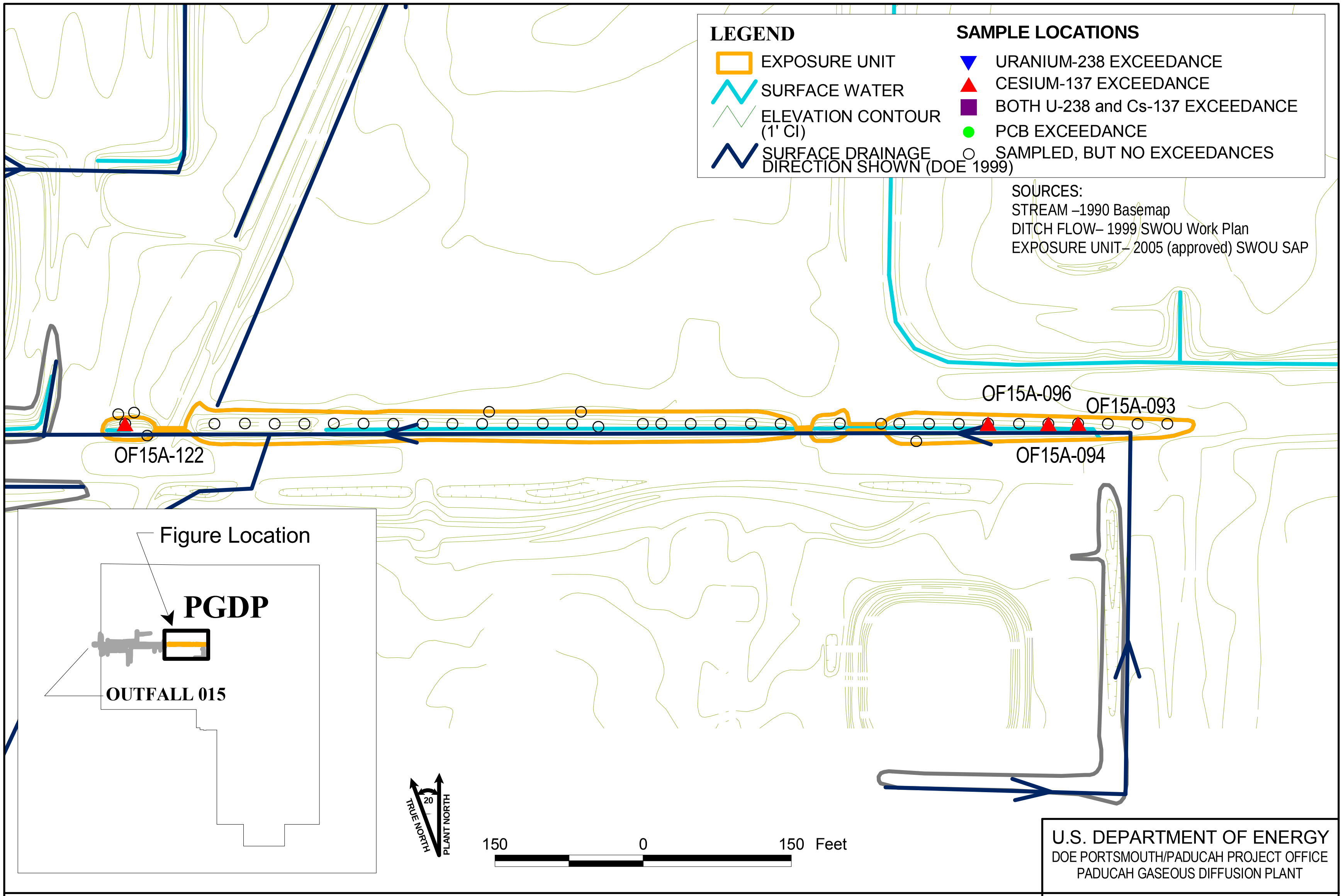

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Figure 4.20. Exceedances Identified at the Outfall 015 EU 4

Figure No. \SWOU\015.apr
DATE 08-21-06

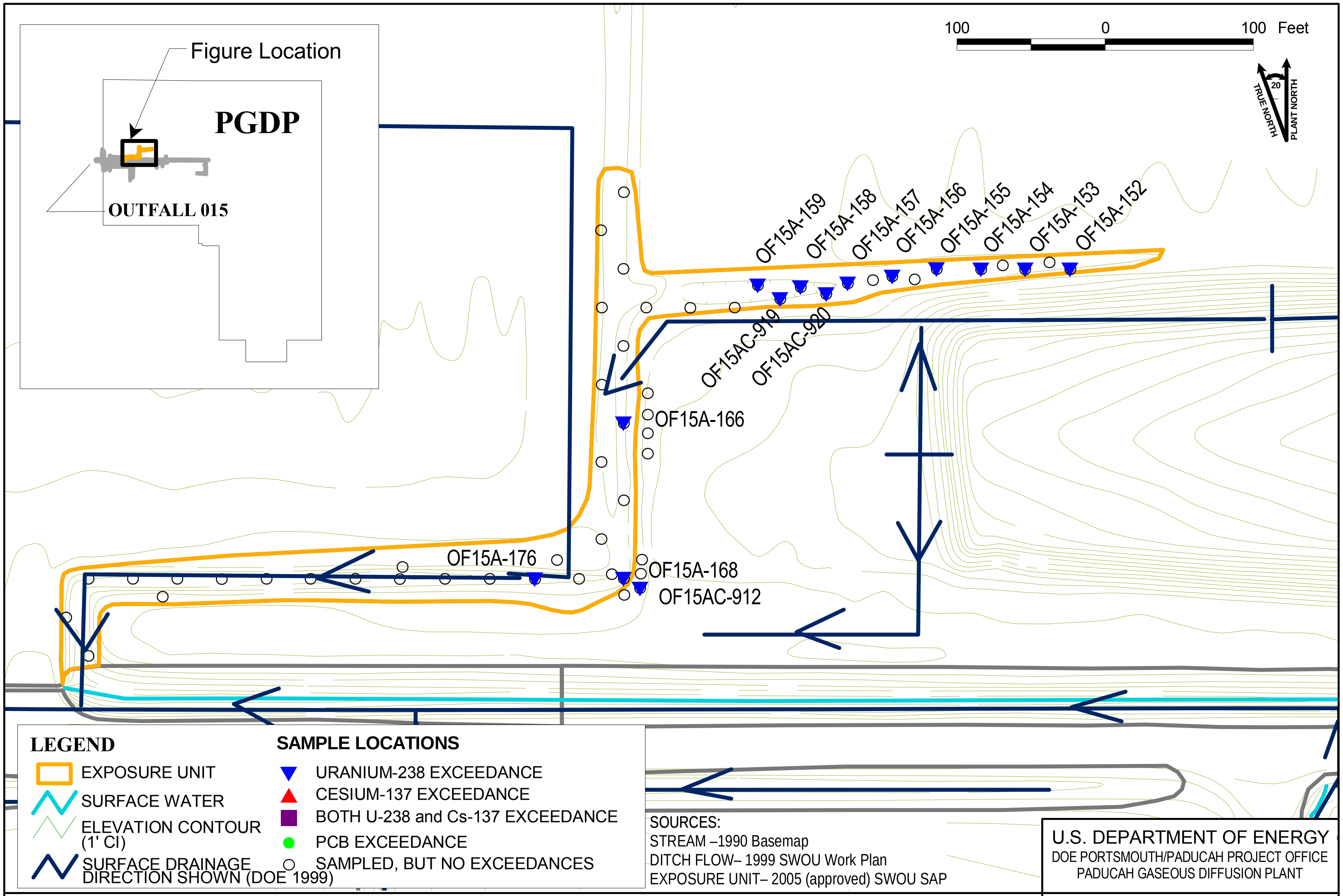

Figure 4.21. Exceedances Identified at the Outfall 015 EU 7

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DATE 08-21-06

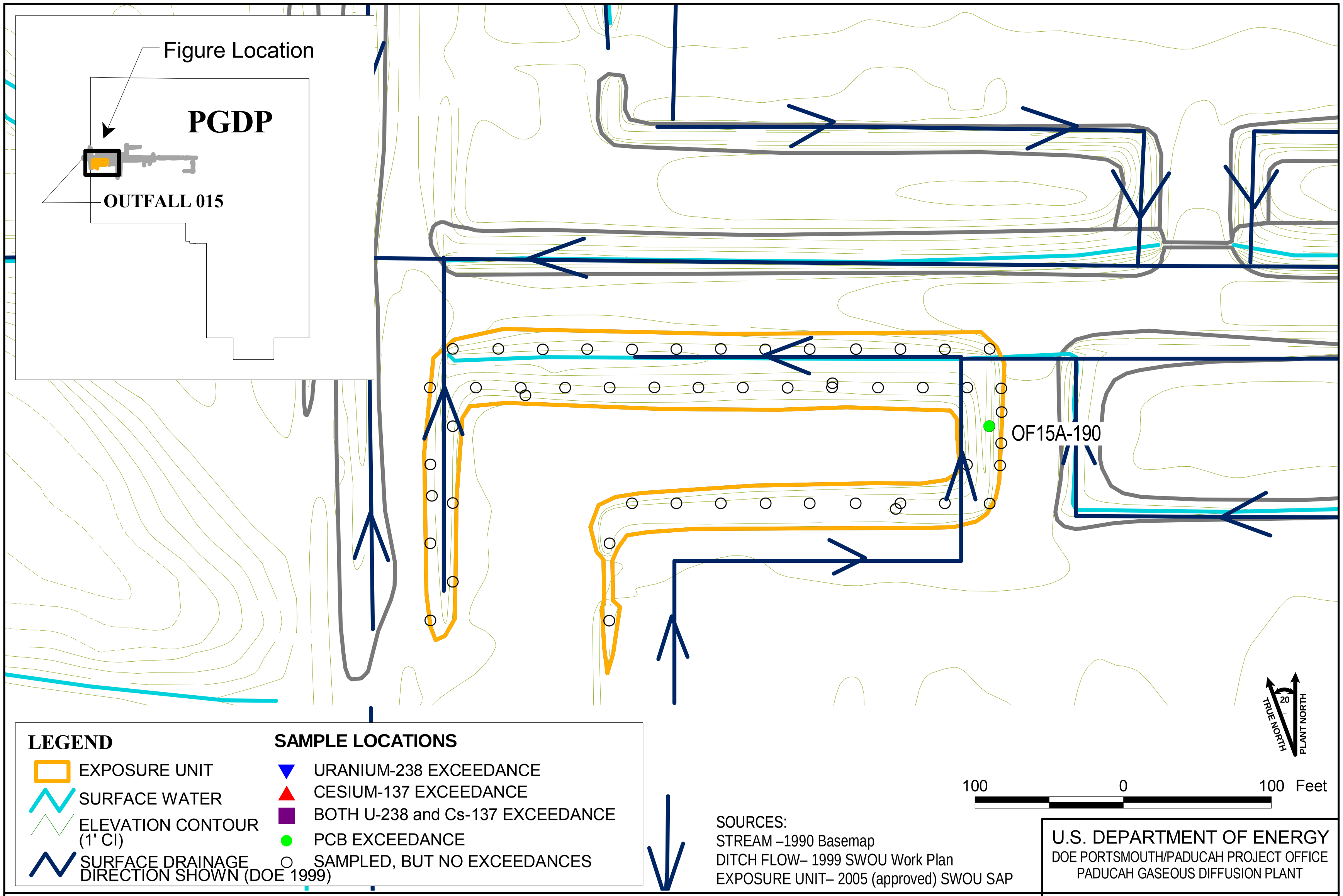

Figure 4.22. Exceedances Identified at the Outfall 015 EU 8

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Figure No. \SWOU\015.apr
DATE 08-21-06

4.2.2.2 Activity 2 sampling

A total of 270 Activity 2 samples and 25 duplicate samples was collected during the SWOU SI. One Activity 2 contingency sample was collected at Outfall 001, EU 04, at a 0.6-m (2-ft) depth where thick sediment deposits were present. This was the only Activity 2 contingency sample required.

Activity 2 sample data have been used to further characterize the nature and extent of the contamination in soils and sediments by comparing the analytical results to the risk-based characterization levels. Table 4.9 provides the characterization levels established for the outfalls and their associated internal ditches and areas.

Table 4.9. Characterization Levels[a] for Internal Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015

Analyte[b]	Risk-based Characterization Level[c]
Inorganic Chemicals (mg/kg)	
Antimony	1.14E+01
Arsenic	5.23E+01
Beryllium	2.85E+01
Cadmium	6.39E+02
Chromium	1.07E+04
Copper	1.48E+04
Iron	6.20E+04
Lead	5.00E+01
Manganese	1.36E+03
Mercury	2.95E+01
Molybdenum	2.49E+03
Nickel	7.25E+03
Selenium	2.85E+03
Silver	1.23E+03
Thallium	2.18E+01
Uranium	6.07E+02
Vanadium	9.96E+01
Zinc	8.18E+04
Organic Compounds (mg/kg)	
Acenaphthene	9.48E+03
Acenaphthylene	
Acrylonitrile	2.16E+01
Anthracene	1.14E+05
Benzene	6.86E+01
Carbon Tetrachloride	1.97E+01
Chloroform	3.68E+00
Dichloroethylene, 1,1-	9.59E+00
Dichloroethylene, 1,2- (Mixed Isomers)	1.98E+03
Dichloroethylene, 1,2-cis-	4.01E+02
Dichloroethylene, 1,2-trans-	6.61E+02
Ethylbenzene	2.12E+03
Fluoranthene	6.62E+03
Fluorene	1.02E+04
Naphthalene	7.09E+02
Phenanthrene	
Pyrene	4.96E+03
Tetrachloroethylene	3.90E+02
Total Dioxins/Furans	6.19E-04
Total PAHs	2.12E+00
Total PCBs	1.99E+01
Trichloroethylene	1.41E+02
Vinyl Chloride	1.34E+01

Table 4.9. Characterization Levels[a] for Internal Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015 (Continued)

Analyte[b]	Risk-based Characterization Level[c]
Xylene, m-	1.00E+05
Xylene, Mixture	2.17E+04
Xylene, o-	1.00E+05
Xylene, p-	
Radionuclides (pCi/g)	
^{241}Am	4.67E+02
^{60}Co	1.77E+00
^{137}Cs	8.58E+00
^{237}Np	2.71E+01
^{238}Pu	6.24E+02
^{239}Pu	5.63E+02
^{240}Pu	5.64E+02
^{226}Ra	2.56E+00
^{222}Rn	
^{90}Sr	7.44E+02
^{99}Tc	3.62E+04
$^{228\text{Th}}$	2.80E+00
$^{230\text{Th}}$	1.49E+03
^{232}Th	7.25E+02
^{234}U	1.98E+03
^{235}U	3.95E+01
^{238}U	1.71E+02

Blank cells indicate that a level could not be calculated or is not available.

[a] Characterization levels presented here were used to develop the sampling plan for ditches and areas associated with Outfalls 001, 002, 008, 010, 011, 012, and 015. They should not be considered to be cleanup levels. Cleanup levels will be selected in the decision documents completed subsequent to the SI.

[b] Analytes listed here are those on the PGDP significant COPCs list taken from Table 2.1 of Vol. 1 of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1506&D2).

[c] Taken from Tables C2.2 and C3.2 of the SAP. Details on the derivation of the risk characterization levels can be found in Section C5.3, "Information Sheet – Characterization Level Derivation of PGDP SWOU On-site Assessment Project," of Appendix C.5 of the SWOU SAP.

Of the 295 Activity 2 samples collected and analyzed from the internal ditches and areas (including the duplicate QA samples), 29 samples contained at least one analyte that exceeded its characterization level. Table 4.10 presents the Activity 2 samples from the EUs of the outfalls and associated internal ditches and areas with analytes that exceeded characterization levels.

Characterization levels were exceeded in the following EUs of the outfalls and their associated internal ditches and areas:

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

Characterization levels were not exceeded in any Activity 2 samples collected from Outfalls 002 or 012.

Table 4.10. Risk-based Characterization Level Exceedances in the Outfall and Associated Internal Ditches and Areas for Activity 2 Sampling

Outfall	EU	Station	Analysis	Result	Units
001	07	OF01B-07-03	Manganese	2450	mg/kg
001	14	OF01B-14-01	TOTAL PAHs	3427	ug/kg
001	14	OF01B-14-01[a]	TOTAL PAHs	183794	ug/kg
001	15	OF01B-15-04[a]	Lead	64.6	mg/kg
001	15	OF01B-15-04	Lead	59.3	mg/kg
001	15	OF01B-15-02	TOTAL PAHs	5161.8	ug/kg
001	15	OF01B-15-04	TOTAL PAHs	5114.7	ug/kg
001	15	OF01B-15-04[a]	Total PCB	38100	ug/kg
001	15	OF01B-15-04	Total PCB	41100	ug/kg
001	15	OF01B-15-02	Uranium	642	mg/kg
001	16	OF01B-16-01	Iron	182000	mg/kg
001	16	OF01B-16-01	Manganese	1540	mg/kg
001	18	OF01B-18-01	Cesium-137	9.38	pCi/g
001	19	OF01B-19-03	Manganese	2230	mg/kg
001	21	OF01B-21-01[a]	Manganese	1470	mg/kg
008	13	OF08B-13-03	TOTAL PAHs	4177.5	ug/kg
010	04	OF10B-04-01	TOTAL PAHs	3158.3	ug/kg
010	06	OF10B-06-04	Lead	60.6	mg/kg
010	10	OF10B-10-04	Lead	67.1	mg/kg
010	10	OF10B-10-01	Lead	75.2	mg/kg
010	10	OF10B-10-01	TOTAL PAHs	2624.3	ug/kg
010	10	OF10B-10-02	TOTAL PAHs	8470	ug/kg
010	10	OF10B-10-03	Total PCB	102000	ug/kg
011	01	OF11B-01-01[a]	Lead	62	mg/kg
011	01	OF11B-01-01	TOTAL PAHs	37375	ug/kg
011	01	OF11B-01-01[a]	TOTAL PAHs	58191	ug/kg
011	01	OF11B-01-03	TOTAL PAHs	2125.9	ug/kg
011	01	OF11B-01-01[a]	Uranium	611	mg/kg
015	02	OF15B-02-03	Cesium-137	11.2	pCi/g
015	02	OF15B-02-01	Cesium-137	30	pCi/g
015	02	OF15B-02-04	Cesium-137	19	pCi/g
015	03	OF15B-03-01[a]	Lead	303	mg/kg
015	03	OF15B-03-01	Lead	238	mg/kg
015	04	OF15B-04-01	Cesium-137	11.2	pCi/g
015	04	OF15B-04-03	Cesium-137	10.8	pCi/g
015	06	OF15B-06-04	Cesium-137	9.78	pCi/g
015	07	OF15B-07-02	Uranium	920	mg/kg
015	10	OF15B-10-01	Lead	62.4	mg/kg

[a] Duplicate Sample

4.3 STORM SEWER SAMPLING

Sampling of water from PGDP storm sewers was conducted to determine if releases from the discharge points could result in unacceptable risks to current site users and reasonably anticipated future receptors. The storm sewer discharges that were sampled included C-333-A, C-337-A, C-340, C-535, and C-537. In order to characterize these storm sewers, a three-step sampling approach was planned. These steps are described in more detail in Section 2 of this report. These steps were as follows:

- Step 1 involved sampling of water at storm sewer discharge points followed by comparison of key contaminant concentrations in water against indicator levels (i.e., PCBs = 0.5 µg/L, total uranium = 30 µg/L, and TCE = 5 µg/L, respectively). Step 1 was conducted to determine if releases had occurred.

- Step 2 involved sampling of water at locations upgradient of the discharge points and within the storm sewer systems, followed by comparison of key contaminant concentrations against indicator levels. Step 2 was completed to identify areas within the storm sewers that may be sources of PCBs, uranium, and/or TCE.

- Step 3 involved sampling of soil along the storm sewers in areas identified as potential sources during Steps 1 or 2, followed by comparison of key contaminant concentrations in soil against indicator levels. Step 3 was to be conducted to confirm source identification.

Step 1 samples were collected twice a month for three months (July, August, and September 2005) during SAP implementation. This sampling resulted in the collection of 26 samples, including two field duplicates.

For all locations, except the C-340 storm sewers, contaminant concentrations in Step 1 water samples were below indicator levels. For the C-340 storm sewer, one sample, collected on July 19, 2005, had a total uranium result (35.3 µg/L) greater than the indicator level. All results for Total PCBs and TCE and all other total uranium results were less than their respective indicator levels. Tables 4.11–4.13 present the results from the Step 1 C-340 storm sewer sampling. Due to the uranium exceedance from the C-340 discharge sample, Step 2 sampling was implemented at upgradient locations.

Table 4.11. Total PCB Analysis for Step 1 of the C-340 Storm sewer
(PCB Indicator Level = 0.5 µg/L)

Date Collected	Chemical	Results
7/19/2005	PCB, total	ND
8/2/2005	PCB, total	ND
8/23/2005	PCB, total	ND
8/31/2005	PCB, total	ND
9/21/2005	PCB, total	ND
9/29/2005	PCB, total	ND

ND = Nondetect.

Table 4.12. TCE Analysis for Step 1 of the C-340 Storm Sewer (TCE Indicator Level = 5 µg/L)

Date Collected	Chemical	Results
7/19/2005	Trichloroethene	ND
8/2/2005	Trichloroethene	ND
8/23/2005	Trichloroethene	ND
8/31/2005	Trichloroethene	ND
9/21/2005	Trichloroethene	ND
9/29/2005	Trichloroethene	ND

ND = Nondetect.

Table 4.13. Total Uranium Analysis for Step 1 of the C-340 Storm Sewer (Total Uranium Indicator Level = 30 µg/L)

Date Collected	Chemical	Results	Rad error
7/19/2005	Total uranium mass	35.3 µg/L	18.4
8/2/2005	Total uranium mass	ND at 5.5 µg/L	5.94
8/23/2005	Total uranium mass	13.4 µg/L	7.3
8/31/2005	Total uranium mass	19.1 µg/L	NA
9/21/2005	Total uranium mass	15.9 µg/L	11.5
9/21/2005	Total uranium mass	ND at 14 µg/L (duplicate)	21.5
9/29/2005	Total uranium mass	22.7 µg/L	11

NA = Not available due to analytical method utilized.

ND = Nondetect.

Step 2 sampling was conducted at eight locations upgradient of the C-340 storm sewer discharge point every other week over 6 weeks (October and November 2005). A total of three samples was collected from each Step 2 location, except W340-07, which did not yield a sample during the first sampling event due to the absence of water. Figure 4.23 shows the locations where the C-340 storm sewer was sampled. Tables 4.14–4.16 present the results from the Step 2 C-340 storm sewer sampling.

As Tables 4.14 and 4.15 show, neither Total PCBs nor TCE were detected in Step 2 samples. In addition, two of the three Step 2 sampling events (October 21 and November 4, 2005) showed no detectable total uranium (Table 4.16). The samples collected on October 7, 2005, had detectable uranium in four of the eight samples collected; however, all were below the indicator level of 30 µg/L. The locations with detectable total uranium are depicted in Figure 4.23.

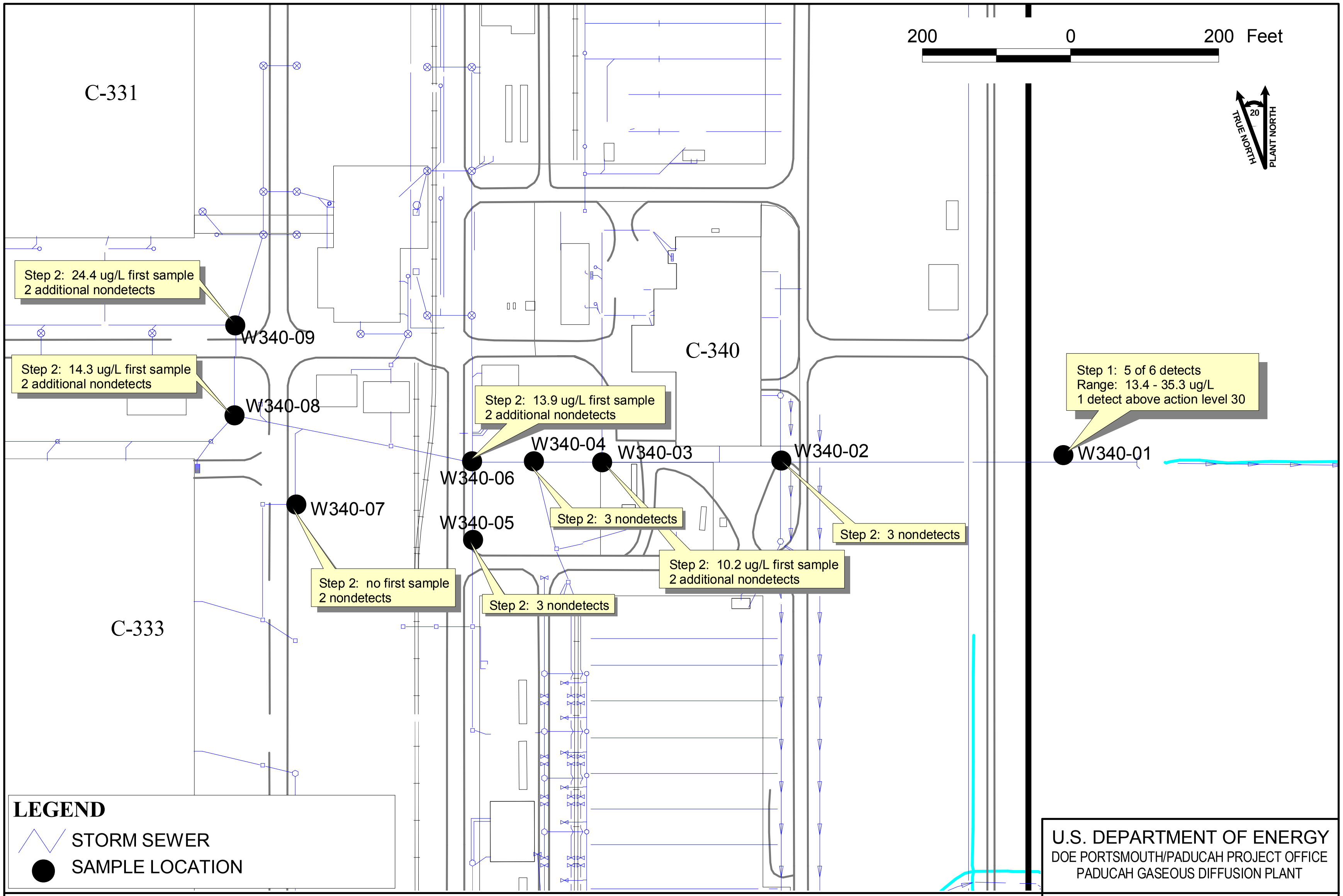

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Figure 4.23. Uranium Analysis for Step 2 of the C-340 Storm Sewer

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Table 4.14. Total PCB Analysis for Step 2 of the C-340 Storm Sewer
(PCB Indicator Level = 0.5 μg/L)

Location	Date collected	Chemical	Results
W340-02	10/7/2005	PCB, Total	ND
W340-02	10/21/2005	PCB, Total	ND
W340-02	11/4/2005	PCB, Total	ND
W340-03	10/7/2005	PCB, Total	ND
W340-03	10/21/2005	PCB, Total	ND
W340-03	11/4/2005	PCB, Total	ND
W340-04	10/7/2005	PCB, Total	ND
W340-04	10/21/2005	PCB, Total	ND
W340-04	11/4/2005	PCB, Total	ND
W340-05	10/7/2005	PCB, Total	ND
W340-05 (Duplicate)	10/7/2005	PCB, Total	ND
W340-05	10/21/2005	PCB, Total	ND
W340-05	11/4/2005	PCB, Total	Not enough volume
W340-06	10/7/2005	PCB, Total	ND
W340-06	10/21/2005	PCB, Total	ND
W340-06	11/4/2005	PCB, Total	ND
W340-07	10/7/2005	Dry – No sample	
W340-07	10/21/2005	PCB, Total	ND
W340-07	11/4/2005	PCB, Total	ND
W340-08	10/7/2005	PCB, Total	ND
W340-08	10/21/2005	PCB, Total	ND
W340-08	11/4/2005	PCB, Total	ND
W340-09	10/7/2005	PCB, Total	ND
W340-09	10/21/2005	PCB, Total	ND
W340-09	11/4/2005	PCB, Total	ND

ND = Nondetect.

Table 4. 15. TCE Analysis for Step 2 of the C-340 Storm Sewer
(TCE Indicator Level = 5 μg/L)

Location	Date collected	Chemical	Results
W340-02	10/7/2005	Trichloroethene	ND
W340-02	10/21/2005	Trichloroethene	ND
W340-02	11/4/2005	Trichloroethene	ND
W340-03	10/7/2005	Trichloroethene	ND
W340-03	10/21/2005	Trichloroethene	ND
W340-03	11/4/2005	Trichloroethene	ND
W340-04	10/7/2005	Trichloroethene	ND
W340-04	10/21/2005	Trichloroethene	ND
W340-04	11/4/2005	Trichloroethene	ND
W340-05	10/7/2005	Trichloroethene	ND
W340-05 (Duplicate)	10/7/2005	Trichloroethene	ND
W340-05	10/21/2005	Trichloroethene	ND
W340-05	11/4/2005	Trichloroethene	ND
W340-06	10/7/2005	Trichloroethene	ND
W340-06	10/21/2005	Trichloroethene	ND

Table 4.15. TCE Analysis for Step 2 of the C-340 Storm Sewer (Continued)
(TCE Indicator Level = 5 µg/L)

Location	Date collected	Chemical	Results
W340-06	11/4/2005	Trichloroethene	ND
W340-07	10/7/2005	Dry – No sample	
W340-07	10/21/2005	Trichloroethene	ND
W340-07	11/4/2005	Trichloroethene	ND
W340-08	10/7/2005	Trichloroethene	ND
W340-08	10/21/2005	Trichloroethene	ND
W340-08	11/4/2005	Trichloroethene	ND
W340-09	10/7/2005	Trichloroethene	ND
W340-09	10/21/2005	Trichloroethene	ND
W340-09	11/4/2005	Trichloroethene	ND

ND = Nondetect.

Table 4.16. Total Uranium Analysis for Step 2 of the C-340 Storm Sewer
(Total Uranium Indicator Level = 30 µg/L)

Location	Date collected	Chemical	Results*	Rad error
W340-02	10/7/2005	Total uranium mass	ND at 9.98 µg/L	19.5
W340-02	10/21/2005	Total uranium mass	ND at 6.22 µg/L	6.67
W340-02	11/4/2005	Total uranium mass	ND at 1.77 µg/L	2.66
W340-03	10/7/2005	Total uranium mass	10.2 µg/L	7.4
W340-03	10/21/2005	Total uranium mass	ND at 11.9 µg/L	17.5
W340-03	11/4/2005	Total uranium mass	ND at 0.199 µg/L	0.504
W340-04	10/7/2005	Total uranium mass	ND at 1.09 µg/L	1.6
W340-04	10/21/2005	Total uranium mass	ND at 0.198 µg/L	0.317
W340-04	11/4/2005	Total uranium mass	ND at 0.0305 µg/L	0.0852
W340-05	10/7/2005	Total uranium mass	ND at 0.672 µg/L	1.44
W340-05 (Duplicate)	10/7/2005	Total uranium mass	ND at 0.516 µg/L	0.53
W340-05	10/21/2005	Total uranium mass	ND at 0.0774 µg/L	0.192
W340-05	11/4/2005	Total uranium mass	ND at 0.148 µg/L	0.161
W340-06	10/7/2005	Total uranium mass	13.9 µg/L	10.5
W340-06	10/21/2005	Total uranium mass	ND at 7.93 µg/L	7.66
W340-06	11/4/2005	Total uranium mass	ND at 2.54 µg/L	3.8
W340-07	10/7/2005	Dry – no sample		
W340-07	10/21/2005	Total uranium mass	ND at 0.101 µg/L	0.234
W340-07	11/4/2005	Total uranium mass	ND at 0.127 µg/L	0.214
W340-08	10/7/2005	Total uranium mass	14.3 µg/L	7.59
W340-08	10/21/2005	Total uranium mass	ND at 0.386 µg/L	0.652
W340-08	11/4/2005	Total uranium mass	ND at 0.283 µg/L	0.62
W340-09	10/7/2005	Total uranium mass	24.4 µg/L	11
W340-09	10/21/2005	Total uranium mass	ND at 1.98 µg/L	3.02
W340-09	11/4/2005	Total uranium mass	ND at 2.57 µg/L	5.36

ND = Nondetect.

4.4 SAMPLING AND DATA ADEQUACY

4.4.1 Sampling Adequacy

The following sections include statistical evaluations of sampling adequacy for characterization of the EUs and for the number of samples collected during the SI.

4.4.1.1 SADA Evaluation

Statistical and sample design functions in SADA were used to evaluate the adequacy of sediment sampling conducted for the SWOU SI/BRA. The SADA tools were used first with the historic sediment and soil data to identify sample gaps. These sample gaps were areas where detections of contaminants were not bounded by samples within 50 feet, the minimum size of hot spot delineation for this project. The result of this assessment was consistent with previous findings and determined that additional sampling was necessary. Activity 2 sampling, based in part on results of Activity 1 sampling, was intended to fill these data gaps and to ensure that small hot spots were not missed during the characterization of the EUs. The SWOU Activity 1 task provided collection and analysis of 2,714 Activity 1 samples, including primary, contingency, and QC samples, for each of the three indicator chemicals (PCBs, cesium-137, and uranium-238).

The SI data set is intended to completely characterize the EUs and is the appropriate data set for evaluation of data adequacy. When the same statistical analyses were rerun combining the historic and SI sediment sampling data, the SADA tool did not determine that any additional samples were needed within the EUs or ditch systems to complete the characterization. All the potential "hot spots" were fully delineated by bounding samples closer than 50 feet and within the extent of the ditches. Inclusion of the 29 historic soil samples with the historical and project-specific sediment samples had no effect on the analysis, demonstrating further that no additional samples were needed. This statistical analysis using the SADA software indicated that the sampling plan and final data are adequate to meet the project goals that were established in the Appendix C of the SAP.

4.4.1.2 Power and Confidence Evaluation

The following provides an analysis of the power and confidence for samples collected for the SWOU, comparing the sample collection with key objectives in the SAP.

Power and Confidence Evaluation—NSDD. The number of samples collected during the SWOU SI was based on an analysis of the EUs using the Visual Sampling Plan (VSP) software and inputs from limited numbers of historical analyses that were available for soil and sediment samples from ditches and drainage ways within the SWOU. As described in the SAP, the estimated numbers of samples needed to properly characterize the site were based on achieving an α[1] of 0.1 and a β[2] of 0.2 for an δ[3] equal to one-half the risk-based characterization level required to define false positive and false negative error rates. The number of samples necessary to achieve these levels depended, in part, on assumed variability of constituent concentrations within the area to be sampled.

The SAP provides descriptive statistics for the SWOU indicator chemicals for samples collected from the NSDD prior to sampling for the SWOU SI (Table C.2.6 for the SWOU SAP). These statistics were used to assess the adequacy of the SI results to address the SAP objectives. The evaluation of the

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[1] - false positive rate

[2] - false negative rate

[3] - threshold level to determine if risk based concentration has been exceeded

post-SI data set assumes that, if specified α and β levels were met during the Activity 1 and 2 sampling, variability in recent data should be similar to that assumed during sample planning. Thus, this assessment evaluates whether specific α and β levels were achieved by comparing descriptive statistics for pre- and post-sampling data sets (Table 4.17).

Manganese and uranium-238 were identified in Appendix C of the SAP to be the most appropriate analytes on which to base an assessment of the number of samples to be collected. For both analytes, the mean and standard deviation for pre- and post-SI data are similar. The largest difference is noted for the means of the data. Pre-SI data suggests a mean manganese concentration of approximately 800 mg/kg, while post-SI data suggests a mean of less than half that value (approximately 355 mg/kg). Likewise, pre-SI activity of uranium-238 is approximately 8 pCi/g, while in the post-SI data, this mean is closer to 4 pCi/g. Lower means for these chemicals suggest less likelihood for exceedance of the target levels, if other aspects of the data set remain constant.

Table 4.17. Comparison of Descriptive Statistics for the NSDD, Sections 3, 4, and 5 for Pre- and Post-SI Data Sets (Based on Risk-Based Characterization Levels)

	Pre-SI Data[1]	**Post-SI Data[2]**
Statistic	**Manganese**	
Number of Samples	24	88
Mean	800	355
Standard Deviation	958	356
Coefficient of Variation[3]	1.2	1.0
	Uranium-238	
Number of Samples	26	88
Mean	8.06	3.9
Standard Deviation	11.9	6.0
Coefficient of Variation[3]	1.5	1.5

[1] Taken from Table C.2.6 of the SAP; δ = 1/2 the risk-based characterization level.

[2] Calculated from the risk assessment data sets for the NSDD provided in Appendix B or the risk assessment technical memorandum. All data used in these calculations are from surface soil samples. Activity 2 sample analytical data were incorporated into this evaluation. For the purposes of evaluating the post-SI data, analytical results that were nondetectable were considered one-half the value of the detection limit.

[3] Calculated as the ratio of the standard deviation to the mean.

Possible reasons for the differences between pre-SI and post SI data sets are as follows:

- Post-SI data are reported from samples collected from random locations. Earlier data were based on samples collected from locations biased toward where contamination was thought to be present; therefore, lower means are anticipated using the SI data set.
- Significantly larger data sets for the post-SI analysis are available to calculate the sample variance. Typically, variance decreases as the number of independent data points increases. Pre-SI, biased data could have been expected to have a smaller variance if all areas sampled were, in fact, contaminated. Uncontaminated samples and samples with low levels of contamination also were present in these older data making the ranges of results in the pre- and post-SI data sets comparable; therefore, the smaller variances and corresponding standard deviations observed in all the comparisons presented in this section are not unexpected.

An important statistic for the estimation of numbers of samples is the coefficient of variation (CV). The CV is defined as the ratio of the standard deviation to the mean. It is a measure of dispersion of a probability distribution. This value helps to define variation in concentrations relative to the mean and is critical when sampling for hot spots, which are defined as concentrations above a specific threshold. CVs for manganese and uranium-238 essentially are the same for the pre- and post-SI data sets, suggesting that the α and β levels of 0.1 and 0.2, respectively, were met for these two constituents. Since these two constituents drove the selection of sample numbers for Activity 2, a reasonable conclusion is that the objectives of the sampling, in terms of statistical power to identify hot spots, were met.

The number of samples needed for Activity 2 efforts also were estimated using a δ of 1/2 the waste-disposition level. Numbers of samples estimated (2 or fewer) were much fewer than the number of samples needed, based on 1/2 the risk-based characterization level (12 for both manganese and uranium-238); thus, since the α and β levels were met for the latter, they also were met for the former.

Power and Confidence Evaluation—Outfalls. The hypothesis for evaluating outfall data is similar to the evaluation of data from the NSDD, in that, if specified α and β levels were met during the Activity 1 and 2 sampling, variability in the SI data should be similar to that in the SAP data set. Descriptive statistics were provided in the SAP for analyses of indicator chemicals in sediment and soil samples of the Outfall ditches prior to SI sampling (Table C.3.6 of the SWOU SAP). The descriptive statistics for pre- and post-SI sampling data sets again were compared to assess whether specific α and β levels were achieved (Table 4.18).

Antimony, manganese, and uranium-238 were identified in Appendix C of the SAP to be the most appropriate analytes on which to assess the number of samples to be collected; however, only the mean and standard deviation for the pre- and post-SI manganese data set appear to be comparable. Significant differences are identified for data sets for both antimony and uranium-238.

The mean and standard deviations for uranium-238 for pre- and post-SI data are substantially different. This likely is due to differences in the quantitation of uranium-238 from pre-SI analyses to those of the SI. The uranium-238 data acquired during the SI employed field screening techniques to quantify activity levels. Activity 2 data were obtained using a fixed-base laboratory. When the two data sets are compared, the pre-SI data set suggests statistical parameters about 6 times higher than do the post-SI data. A lower mean and standard deviation for the SI data suggests that the concentrations of uranium-238 within the outfalls and their associated internal ditches and areas are less likely to exceed risk-based concentration levels than implied by the pre-SI data.

Similarly, the comparison of antimony results for the pre- and post-SI data sets yields a large variation. The largest difference is noted for mean concentrations of antimony. Pre-SI data suggests a mean antimony concentration of 5.6 mg/kg, while post-SI data suggests a mean that is approximately twice that value (10.4 mg/kg). A higher mean for antimony suggests a greater likelihood of exceedance of the target level, if other aspects of the data set remain constant.

Table 4.18. Comparison of Descriptive Statistics for Outfalls 001, 002, 008, 011, 012 and 015 for Pre- and Post-SI Data Sets (Based on Risk-Based Characterization Levels)

Statistic	Pre-SI Data[1]	Post-SI Data[2]
	Antimony	
Number of Samples	113	324
Mean	5.6	10.4
Standard Deviation	4.5	3.1
Coefficient of Variation[3]	0.8	0.3
	Manganese	
Number of Samples	114	324
Mean	476	327
Standard Deviation	541	266
Coefficient of Variation[3]	1.1	0.8
	Uranium-238	
Number of Samples	109	313
Mean	26.7	4.2
Standard Deviation	61.2	9.9
Coefficient of Variation[3]	2.3	2.3

[1] Taken from Table C.3.6 of the SWOU SAP, $\delta = 1/2$ the risk-based characterization level.

[2] Calculated from the risk assessment data sets for the NSDD provided in Appendix B or the risk assessment technical memorandum. All data used in these calculations were from surface soil samples. Activity 2 sample analytical data were incorporated into this evaluation. For the purposes of evaluating the post-SI data, analytical results that were nondetectable were considered one-half the value of the detection limit.

[3] Calculated as the ratio of the standard deviation to the mean.

Since the evaluations of descriptive statistics from pre- and post-SI data sets for antimony did not clearly indicate that sampling objectives were met, additional analysis of the post-SI data was performed. This analysis was performed by entering descriptive statistics from the post-SI data set into Visual Sampling Plan (i.e., Sampling Goals/Compare Average to Fixed Threshold). Values input were $\alpha = 0.10$; $\beta = 0.2$; $\delta = 5.68$; Action Level = 11.4, and a standard deviation of 3.1. (Action Level and δ are from Table C.3.6 of the SAP. The standard deviation is from the post-SI data set.) Using these values resulted in the calculation of a sampling requirement of 3 samples for antimony. Because 324 Activity 2 samples were collected for antimony as part of the SI, the requirement for 3 samples was greatly exceeded, indicating that the sampling objectives for antimony were met.

Possible reasons for the differences in descriptive statistics described above were similar to those discussed for the NSDD results.

An important statistic for the estimation of the number of samples that are required is the CV. CVs for antimony differ by a factor of almost 3, with post-SI data being less variable relative to the mean. The lower variability of antimony in the post-SI data set offsets the significance of its higher estimated mean.

CVs for manganese and uranium-238 essentially are the same for the pre- and post-SI data sets, suggesting that α and β levels of 0.1 and 0.2, respectively, have been met for these two constituents. Since these two constituents were key in the selection of sample numbers for Activity 2, a reasonable conclusion is that the objectives of the sampling, in terms of statistical power to identify hot spots, were met.

The number of samples needed for Activity 2 efforts also was estimated using a δ of 1/2 the waste disposition characterization level. Numbers of samples estimated (2 or fewer) were less than the number of samples needed, based on 1/2 the risk-based characterization level (4 for manganese and uranium-238). Since α and β levels were met for the latter, they also were met for the former.

4.4.2 Data Adequacy

Data generated as a result of the SI underwent a formal data review process that included data verification, data validation, and data assessment. This review process indicated that the data are consistent and any uncertainty associated with specific data sets is adequate for the intended use. As a result, it has been confirmed that the data associated with the SI are data of known quality and are acceptable for use in decision making.

The data review process noted that a subset of the PCB data generated during the SI exceeded the established calibration range or limit of linearity during the analysis of PCBs. The resulting uncertainty associated with these data sets is minimal, and it was determined that the qualified data sets are of known quality. Appendix F presents information that provides additional details of the uncertainties associated with the PCB data. It should be noted that since the qualified data sets for PCBs exhibit a low bias to the quantified values (e.g. the reported values are lower than the true values), the data user will need to consider the low bias when making decisions for areas where results are close to the removal action level (i.e., Outfall 001, EU 13 and Outfall 011, EU 01).

4.5 SUMMARY

The SI sampling strategy was designed to determine the nature and extent of contamination. Activity 1 samples were collected to identify potential “hot spots” by comparing measured results with pre-determined indicator levels; Activity 2 samples were collected to identify potential “hot spots” by comparing to characterization levels and to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU. Contingency samples were collected to further delineate both the nature and extent of contamination. Figure 4.24 displays the locations of identified potential “hot spots.” Additionally, isopleth maps were created depicting concentration of PCB contamination in sediment along the EUs in the outfalls and their associated internal ditches and areas. This section also presents a summary of the storm sewer sampling.

4.5.1 NSDD and Outfalls Hot Spot Identification

This section presents a summary of the potential “hot spots” identified during comparison of the analytical results to indicator levels (Activity 1) or characterization levels (Activity 2).

4.5.1.1 Activity 1 Hot Spots

Potential “hot spots” were identified from Activity 1 sample results exceeding radiological indicator levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 5 (EUs 07, 08, 09, and 10)
- Outfall 001 (EUs 05, 15, 16, 18, and 20)
- Outfall 008 (EUs 08 and 11)
- Outfall 015 (EUs 01, 02, 03, 04, and 07)

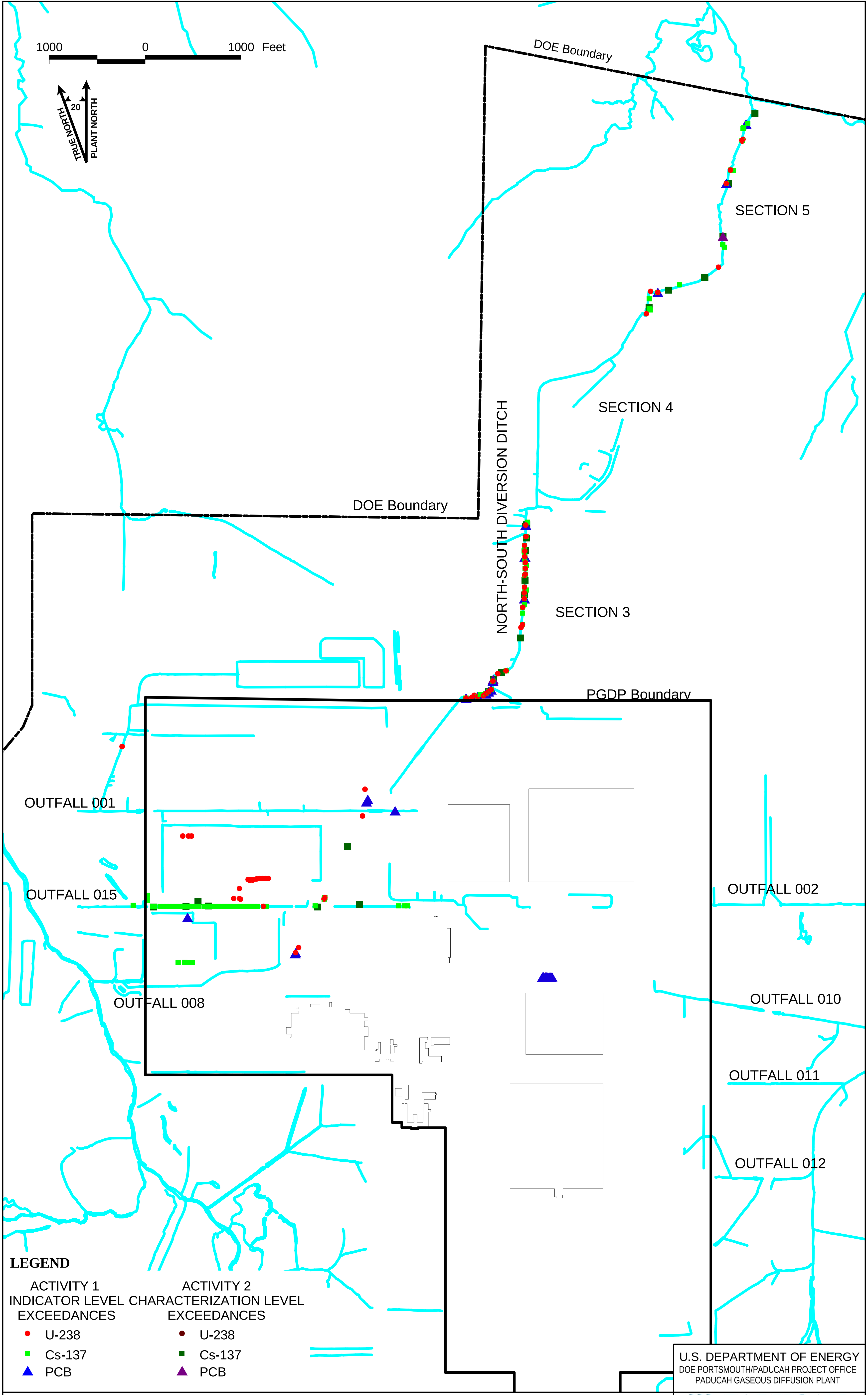

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Figure 4.24. SWOU Hot Spots

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Potential “hot spots” were identified from Activity 1 sample results exceeding PCB indicator levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 5 (EUs 08, 09, and 10)
- Outfall 001 (EUs 14 and 15)
- Outfall 008 (EU 11)
- Outfall 010 (EU 10)
- Outfall 015 (EU 08)

4.5.1.2 Activity 2 Hot Spots

Potential “hot spots” were identified from Activity 2 sample results exceeding radiological characterization levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03
- NSDD Section 5 (EUs 07, 08, 9, and 10)
- Outfall 001 (EU 18)
- Outfall 015 (EUs 02, 04, and 06)

Potential “hot spots” were identified from Activity 2 sample results exceeding PCB characterization levels at the following locations:

- NSDD Section 3 (EU 01)
- NSDD Section 5 (EU 08)
- Outfall 001 (EU 15)
- Outfall 010 (EU 10)

Potential “hot spots” were identified from Activity 2 sample results exceeding metals characterization levels at the following locations:

- NSDD Section 3 (EU 02)
- NSDD Section 4 (EU 06)
- NSDD Section 5 (EUs 07, 08, and 09)
- Outfall 001 (EUs 07, 15, 16, 19, and 21)
- Outfall 010 (EUs 06 and 10)
- Outfall 011 (EU 01)
- Outfall 015 (EUs 03, 07, and 10)

Potential “hot spots” were identified from Activity 2 sample results exceeding PAH characterization levels at the following locations:

- Outfall 001 (EUs 14 and 15)
- Outfall 008 (EU 13)
- Outfall 010 (EUs 04 and 10)
- Outfall 011 (EU 01)

4.5.2 NSDD and Outfalls Contingency Sampling

Of the 50 contingency samples collected from Sections 3, 4 and 5 of the NSDD, eight had activity levels of uranium-238 or cesium-137 that exceeded indicator levels. There were no contingency samples required for PCBs collected during Activity 1 sampling, as all exceedances of the indicator levels were located in the base of the ditches.

Of the 54 contingency samples collected from internal ditches and areas associated with outfalls 001, 008, 010 and 015, seven showed uranium-238 and/or cesium-137 activity exceeding indicator levels. Six contingency samples and one duplicate sample showed elevated PCB concentrations in the outfalls. This was most notable in Outfall 010, EU 10, where all five of the contingency samples contained Total PCB concentrations in excess of 100 mg/kg each.

4.5.3 Storm Sewers

Step 2 sampling was conducted in the C-340 storm sewer system because Total Uranium was detected above the SI indicator level during Step 1 characterization. None of the Step 2 sample concentrations exceeded indicator levels. Based on a review of the C-340 storm sewer data, a decision was made not to conduct the Step 3 sampling.

As justification, a data quality assessment (DQA) was completed using the existing data. The DQA concluded that the Step 1 Total Uranium exceedance was not statistically different from the indicator level, with the average of all total uranium results acquired during Step 1 sampling being less than the indicator level. The complete DQA is provided in Appendix A.

4.5.4 Isopleths and SI Sample Location Maps

The final nature and extent of the potential “hot spots” was defined and presented through isopleths for PCB results. These isopleths depict concentration gradients within the EUs for the outfall ditches using direct contact risk levels of 1×10^{-4} to 1×10^{-6}. The isopleth maps for the outfall ditches and associated areas are shown in Figures 4.25 through 4.31 and for the NSDD Sections 3, 4 and 5 in Figures 4.32 through 4.34. All locations sampled during the SI, along with historical sample locations utilized for the SI, are depicted in Figures 4.35 to 4.112.

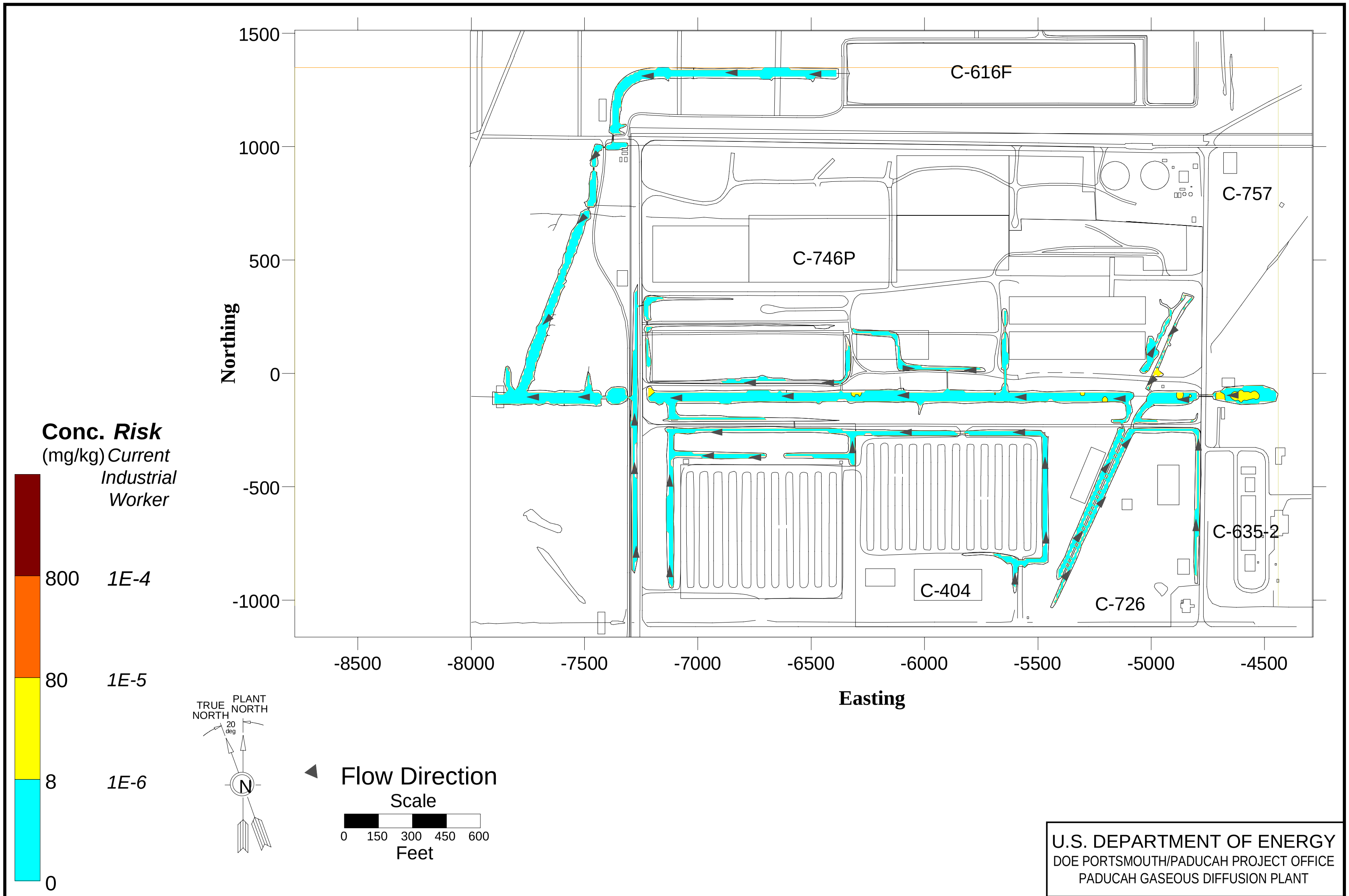

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Figure 4.25. PCB in Outfall 001 Sediment

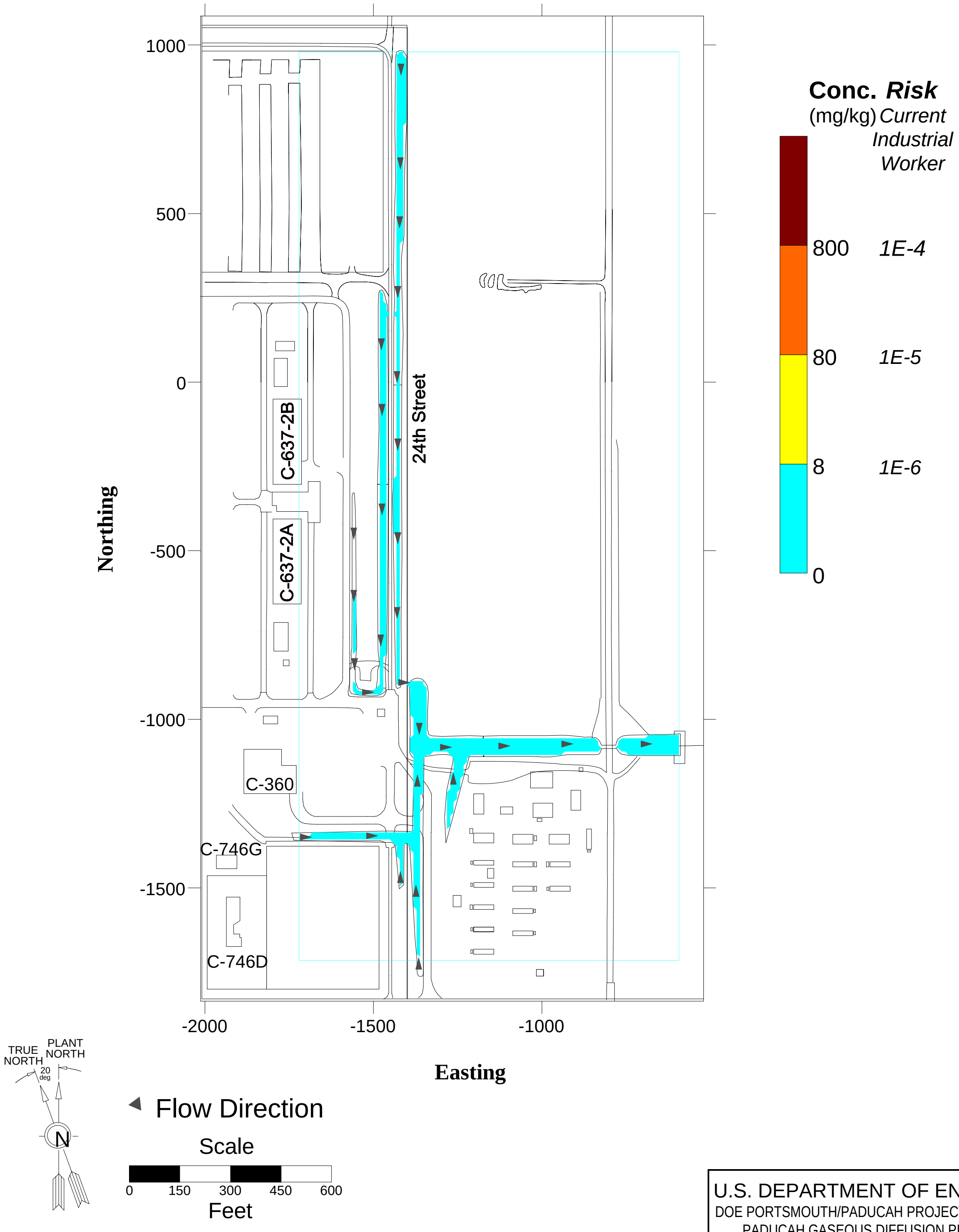

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Figure 4.26. PCB in Outfall 002 Sediment

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Figure 4.27. PCB in Outfall 008 Sediment

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Figure 4.28. PCB in Outfall 010 Sediment

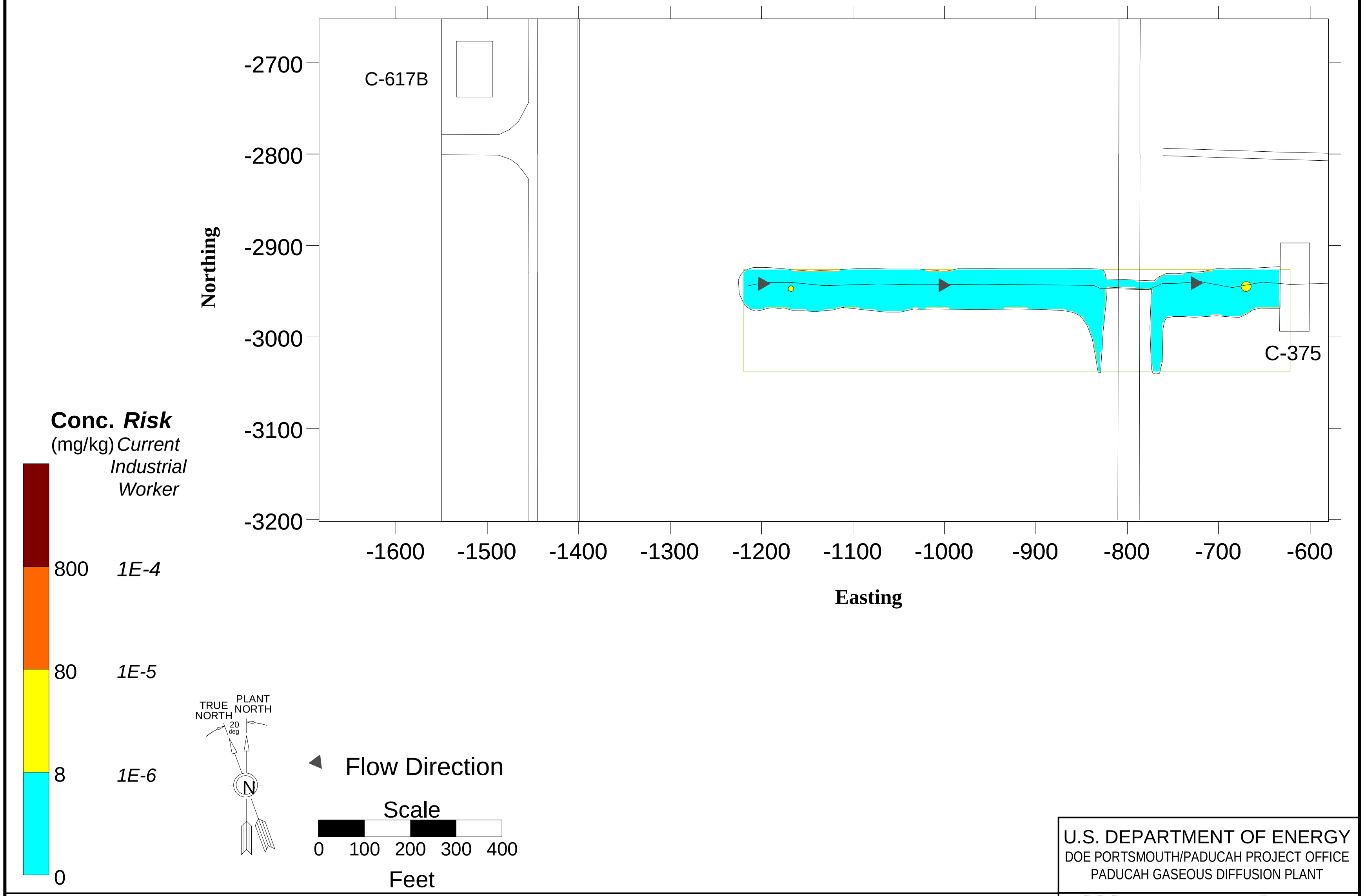

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Figure 4.29. PCB in Outfall 011 Sediment

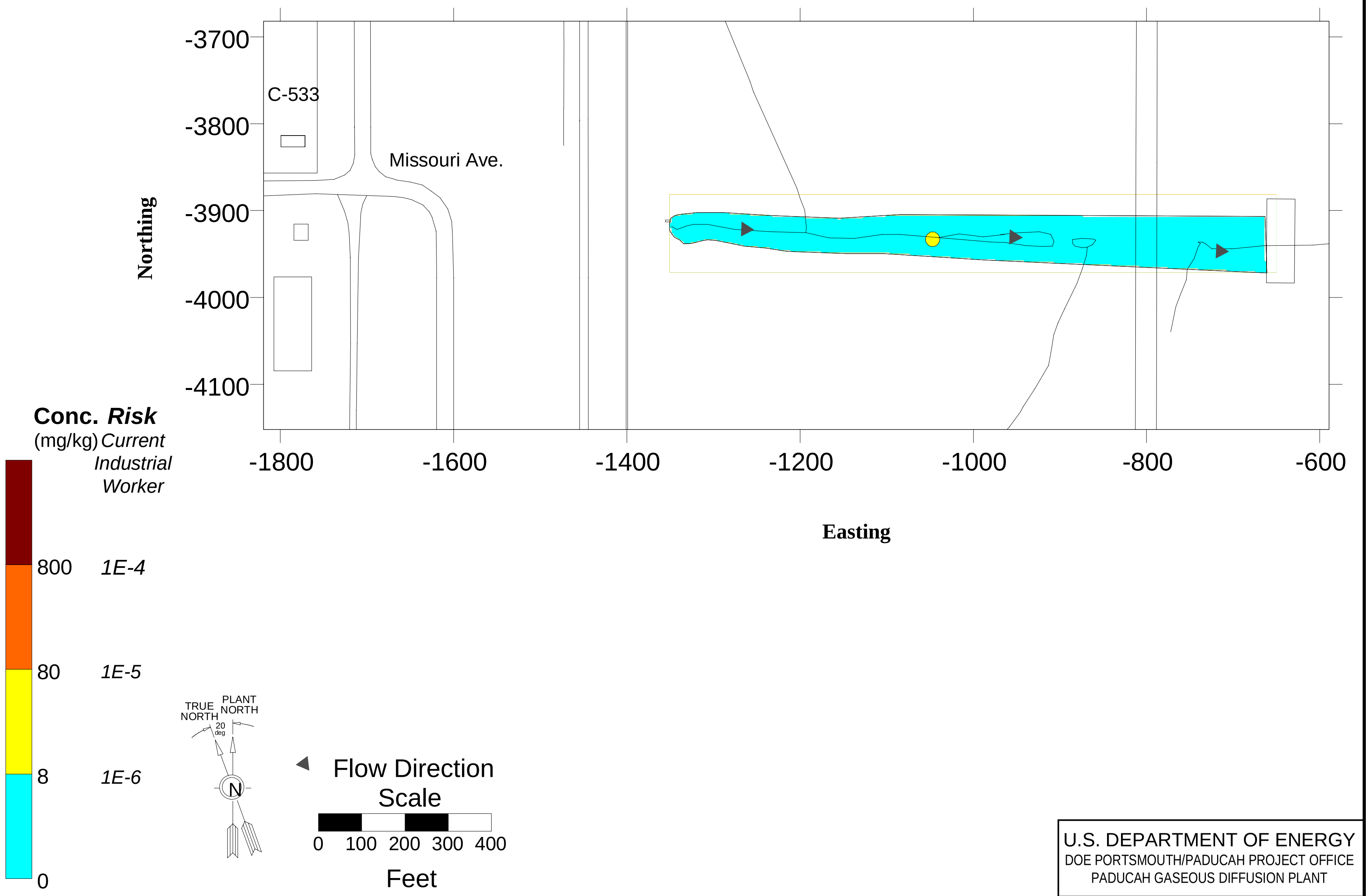

Figure 4.30. PCB in Outfall 012 Sediment

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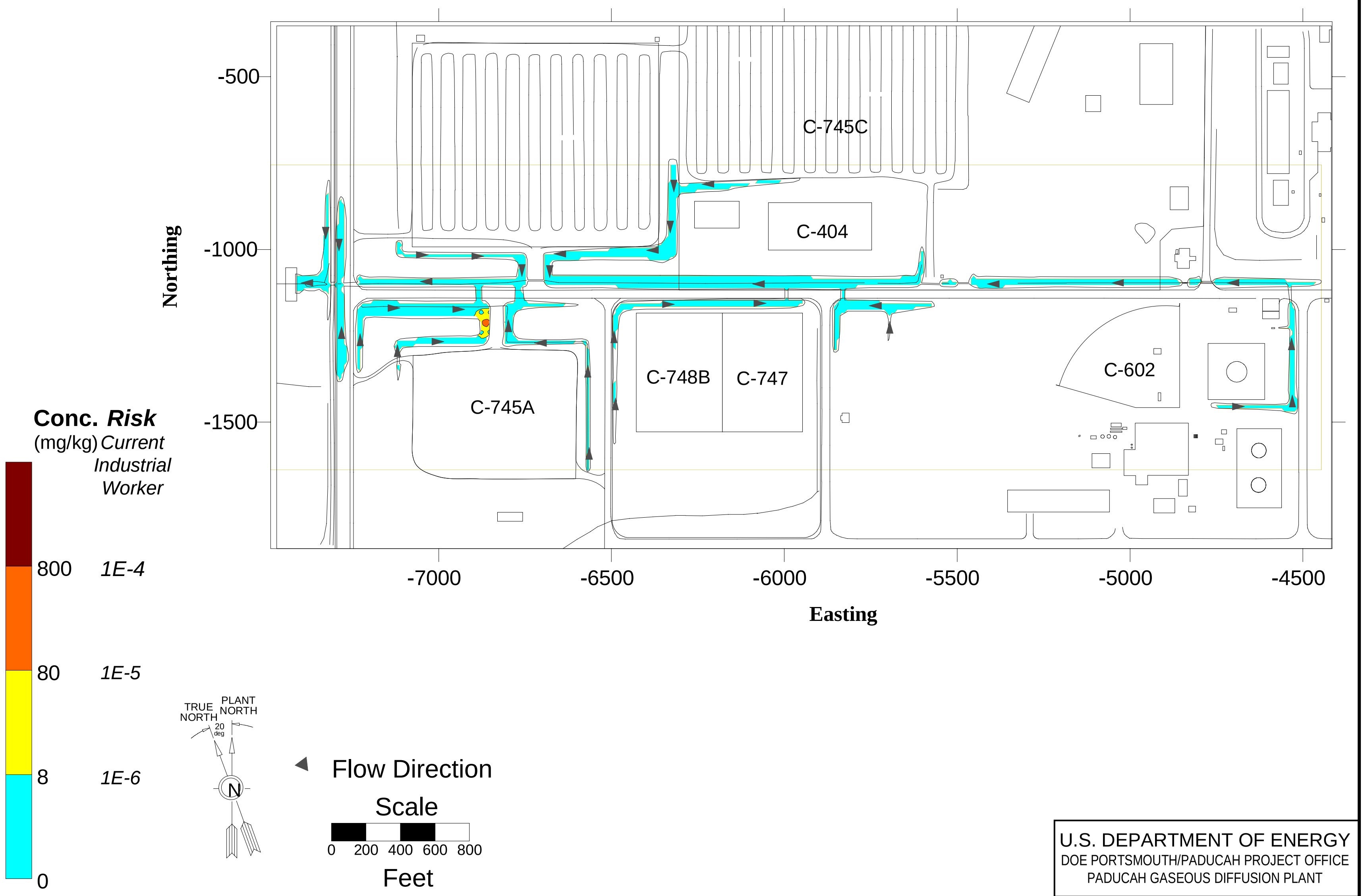

Figure 4.31. PCB in Outfall 015 Sediment

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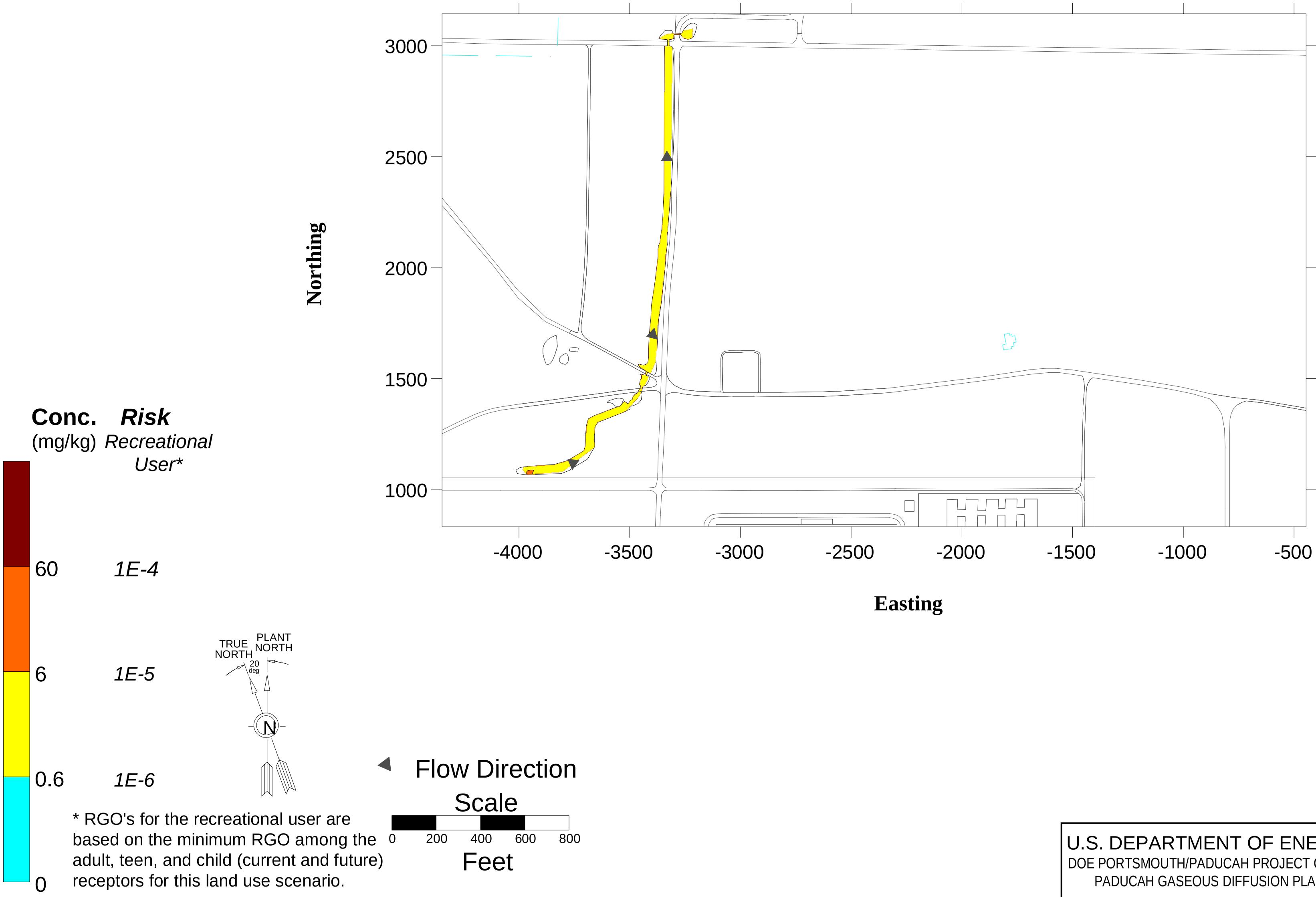

Figure 4.32. PCB in NSDD Section 3 Sediment

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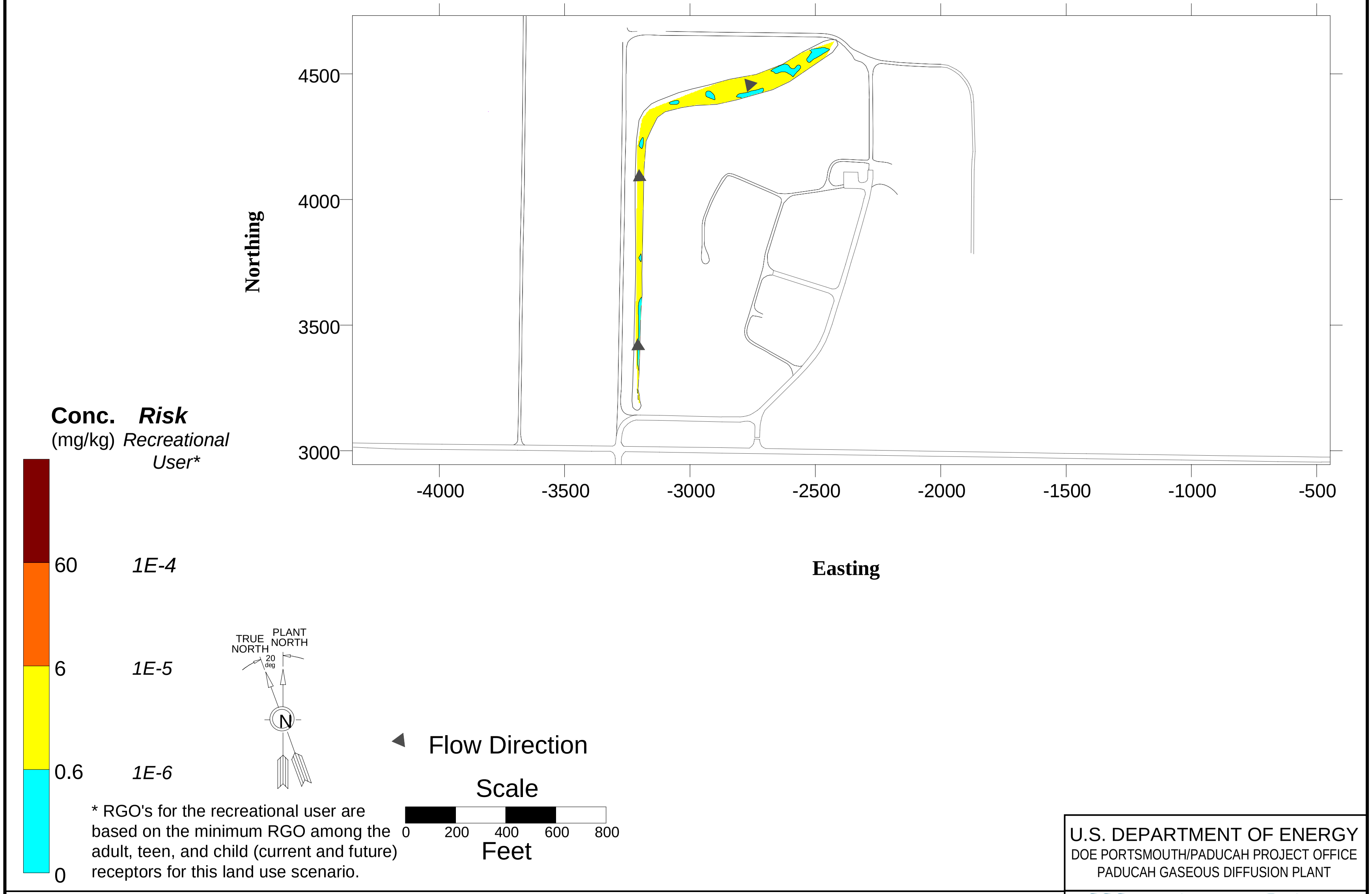

* RGO's for the recreational user are based on the minimum RGO among the adult, teen, and child (current and future) receptors for this land use scenario.

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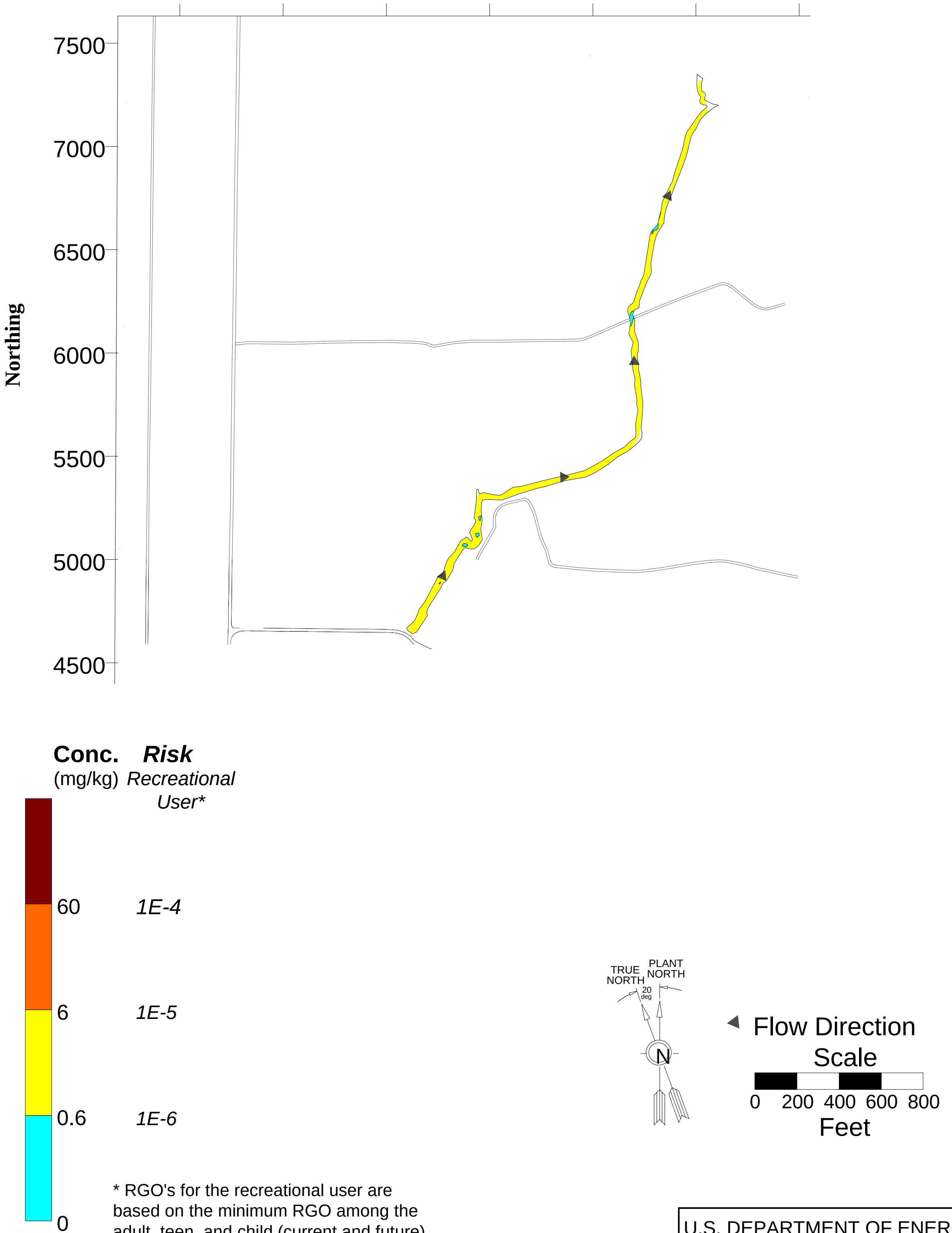
Figure 4.33. PCB in NSDD Section 4 Sediment



* RGO's for the recreational user are based on the minimum RGO among the adult, teen, and child (current and future) receptors for this land use scenario.

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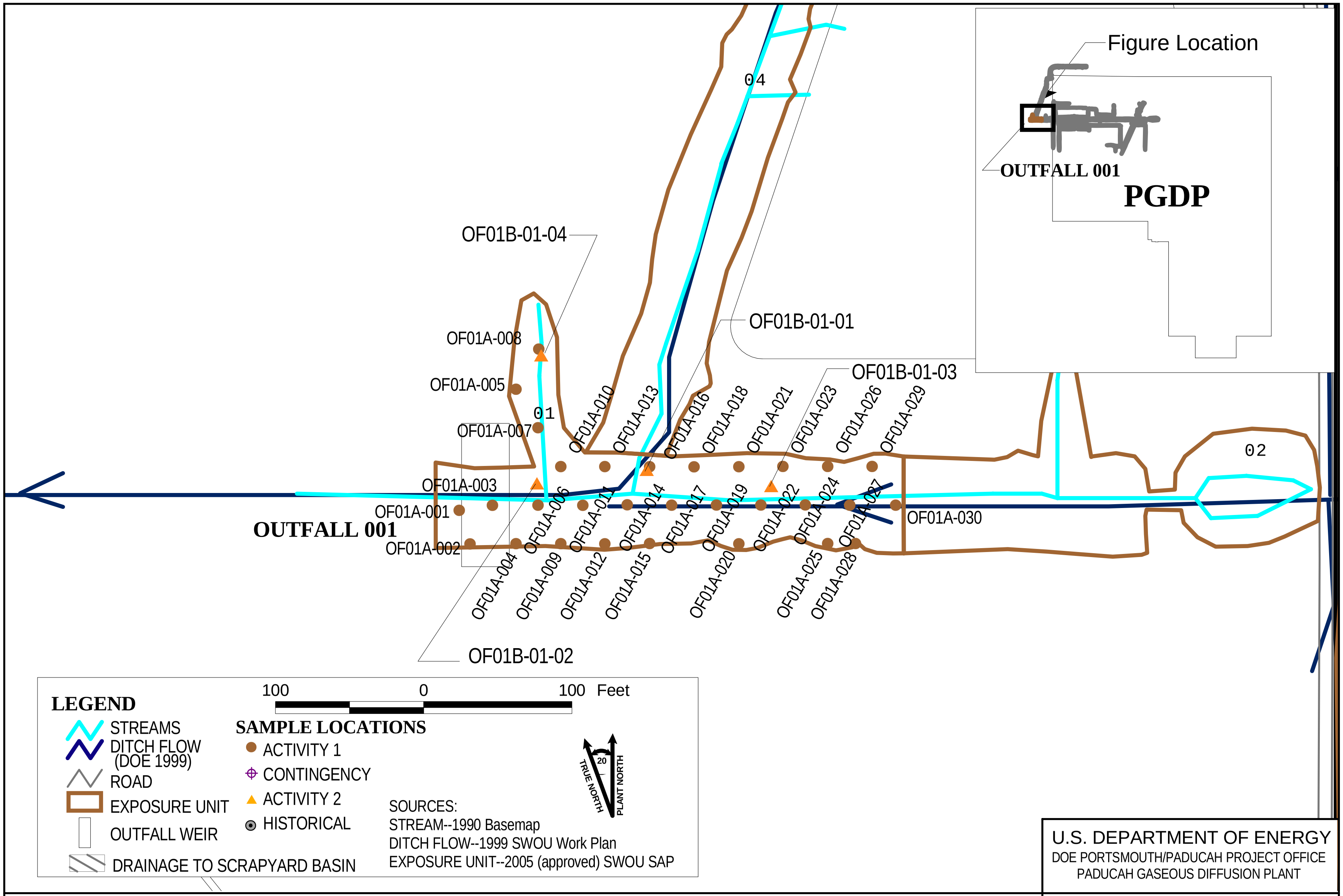
Figure 4.34. PCB in NSDD Section 5 Sediment



SOURCES:
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DITCH FLOW--1999 SWOU Work Plan
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Figure 4.35. Outfall 001 EU 01 - Locations of RI and Historical Samples

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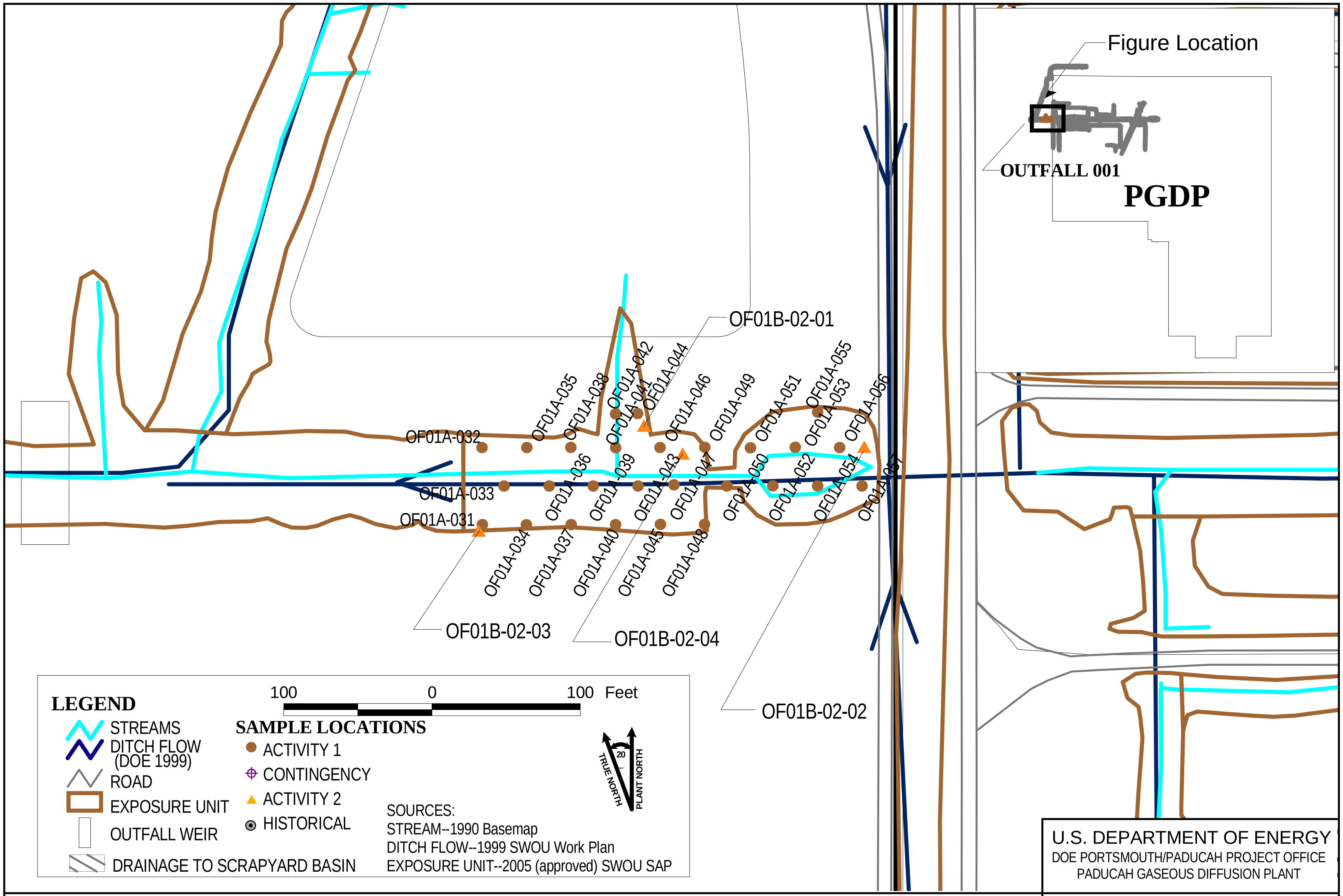

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
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Figure 4.36. Outfall 001 EU 02 - Locations of RI and Historical Samples

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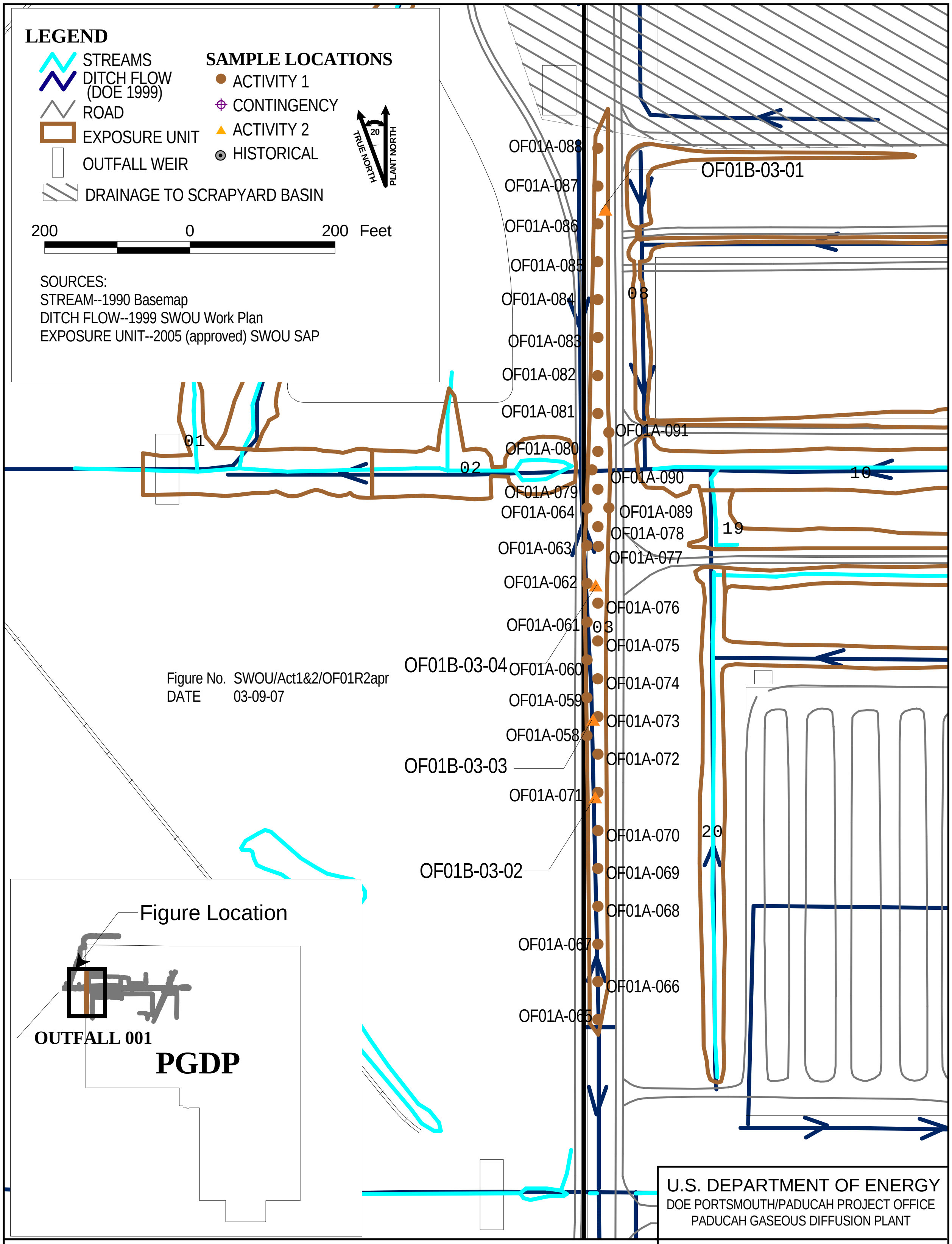

Figure 4.37. Outfall 001 EU 03 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF01R2apr
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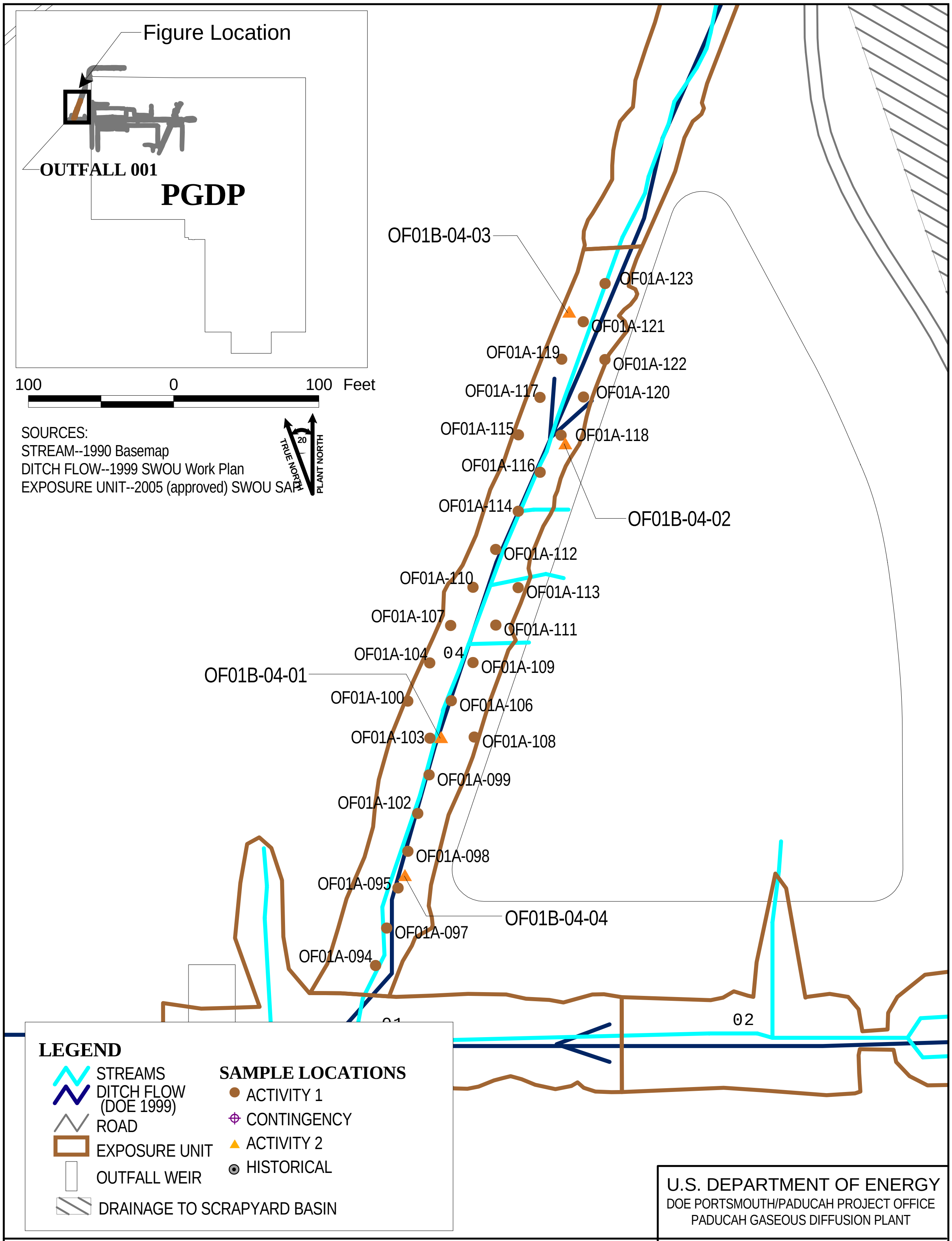

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Figure 4.38. Outfall 001 EU 04 - Locations of RI and Historical Samples

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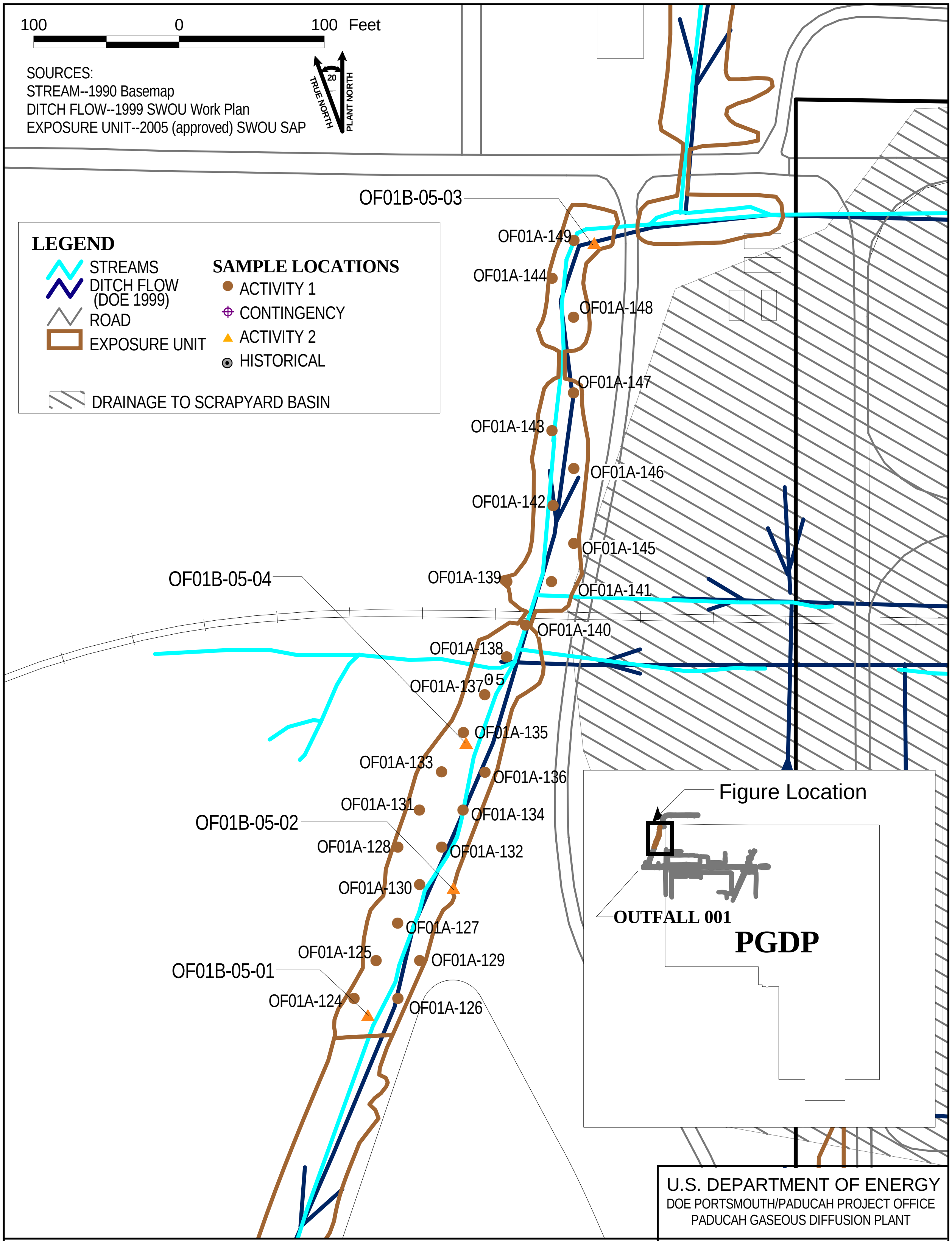

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Figure 4.39. Outfall 001 EU 05 - Locations of RI and Historical Samples

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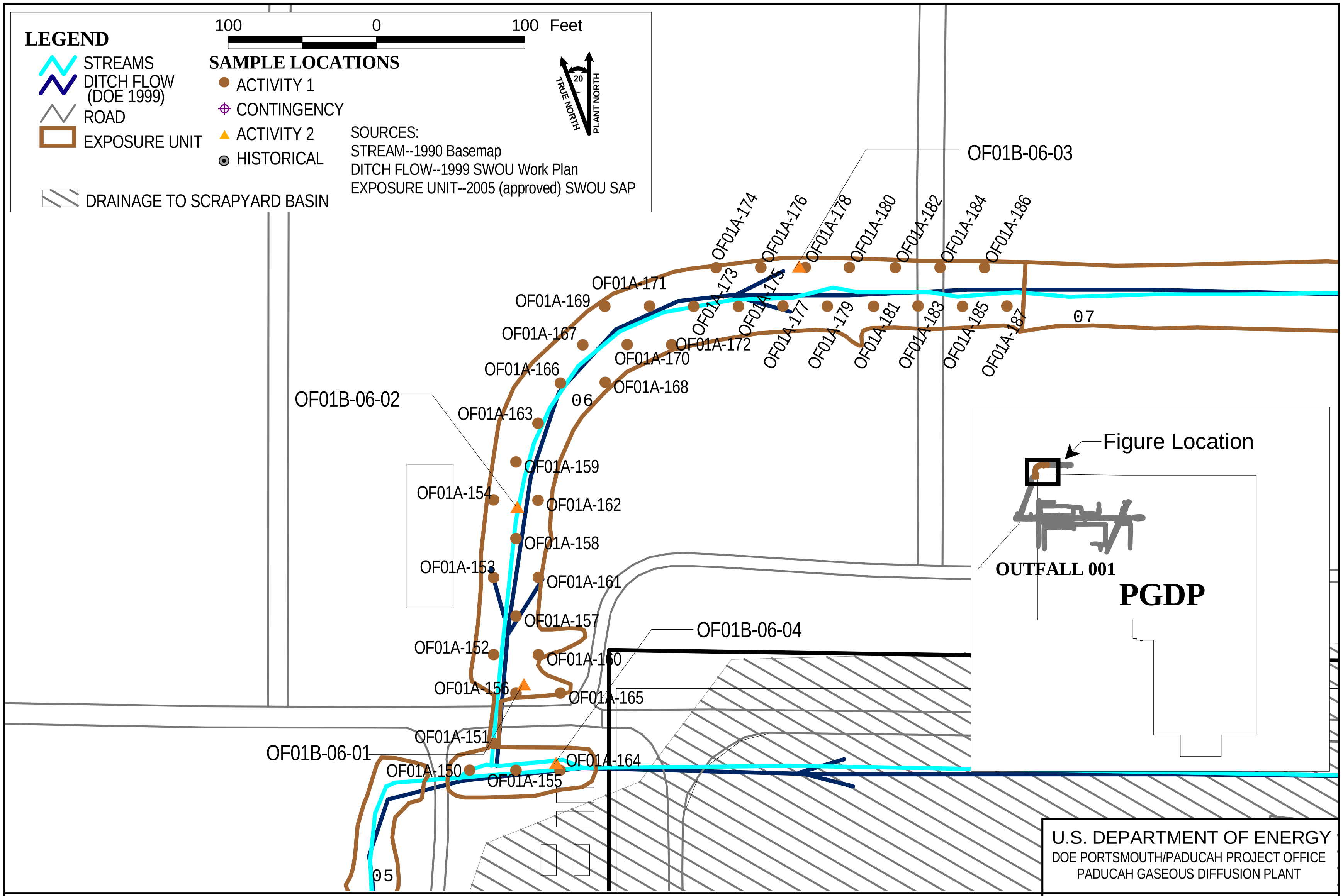

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Figure 4.40. Outfall 001 EU 06 - Locations of RI and Historical Samples

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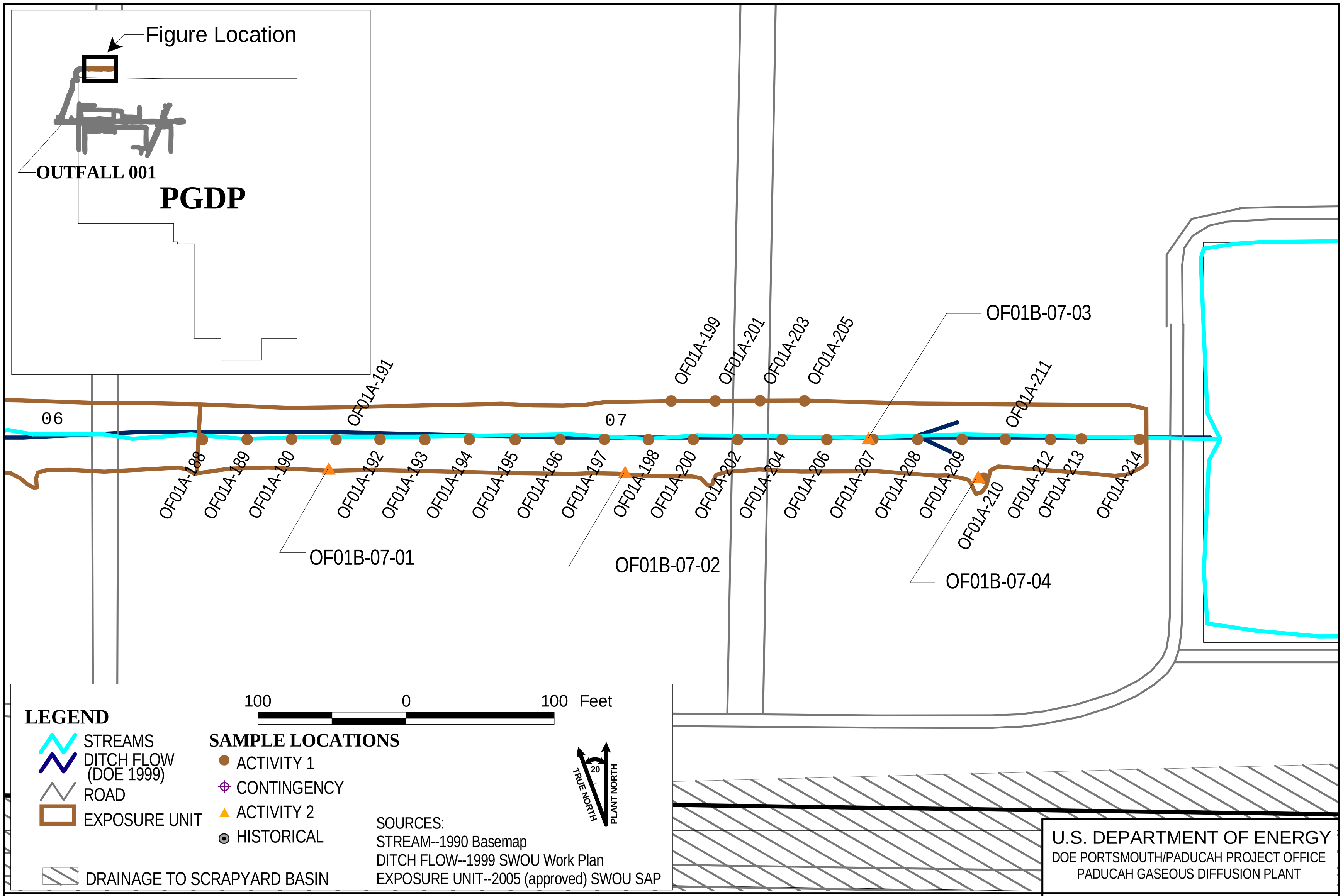

Figure 4.41. Outfall 001 EU 07 - Locations of RI and Historical Samples

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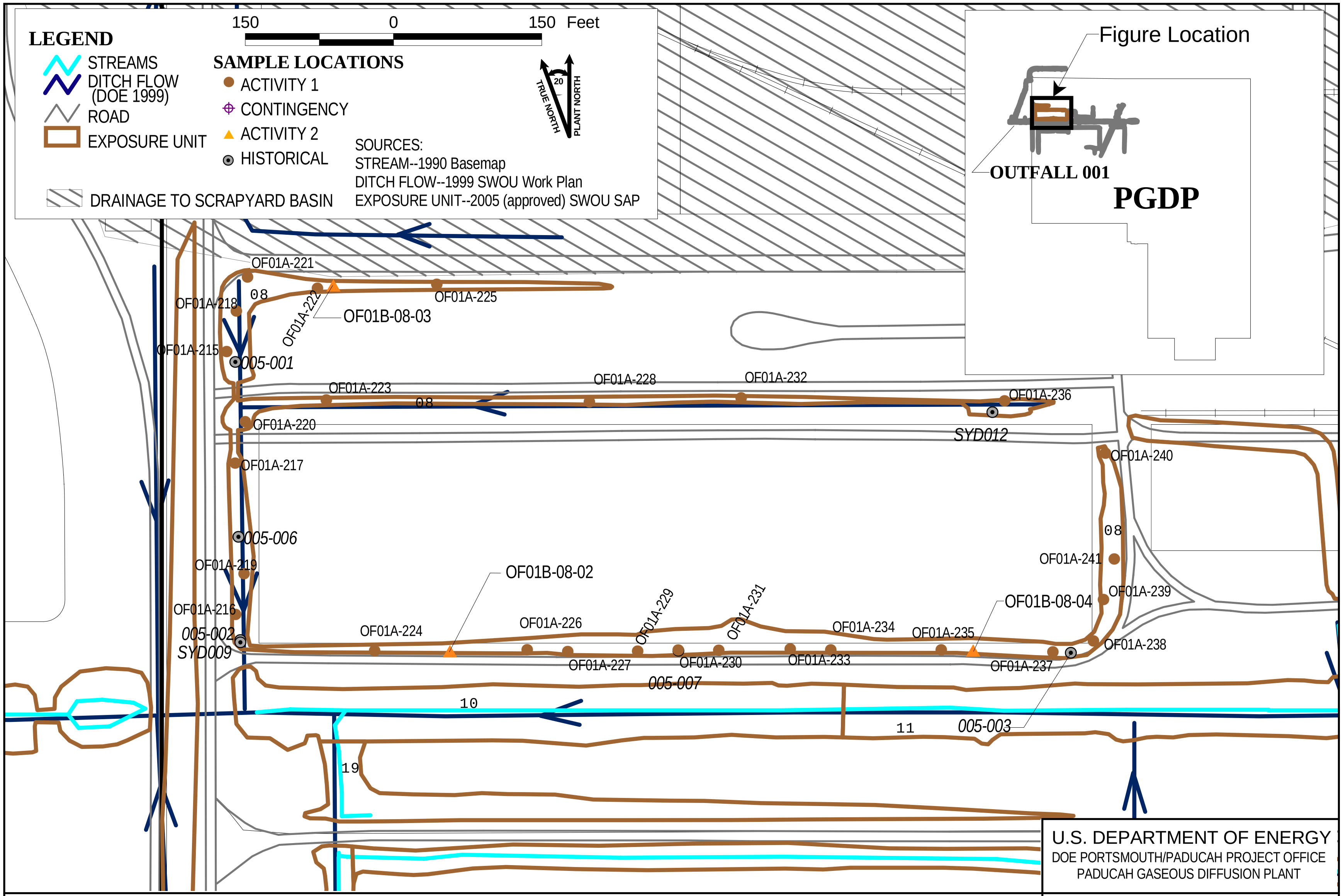

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Figure 4.42. OUTFALL 001 EU 08 - Locations of RI and Historical Samples

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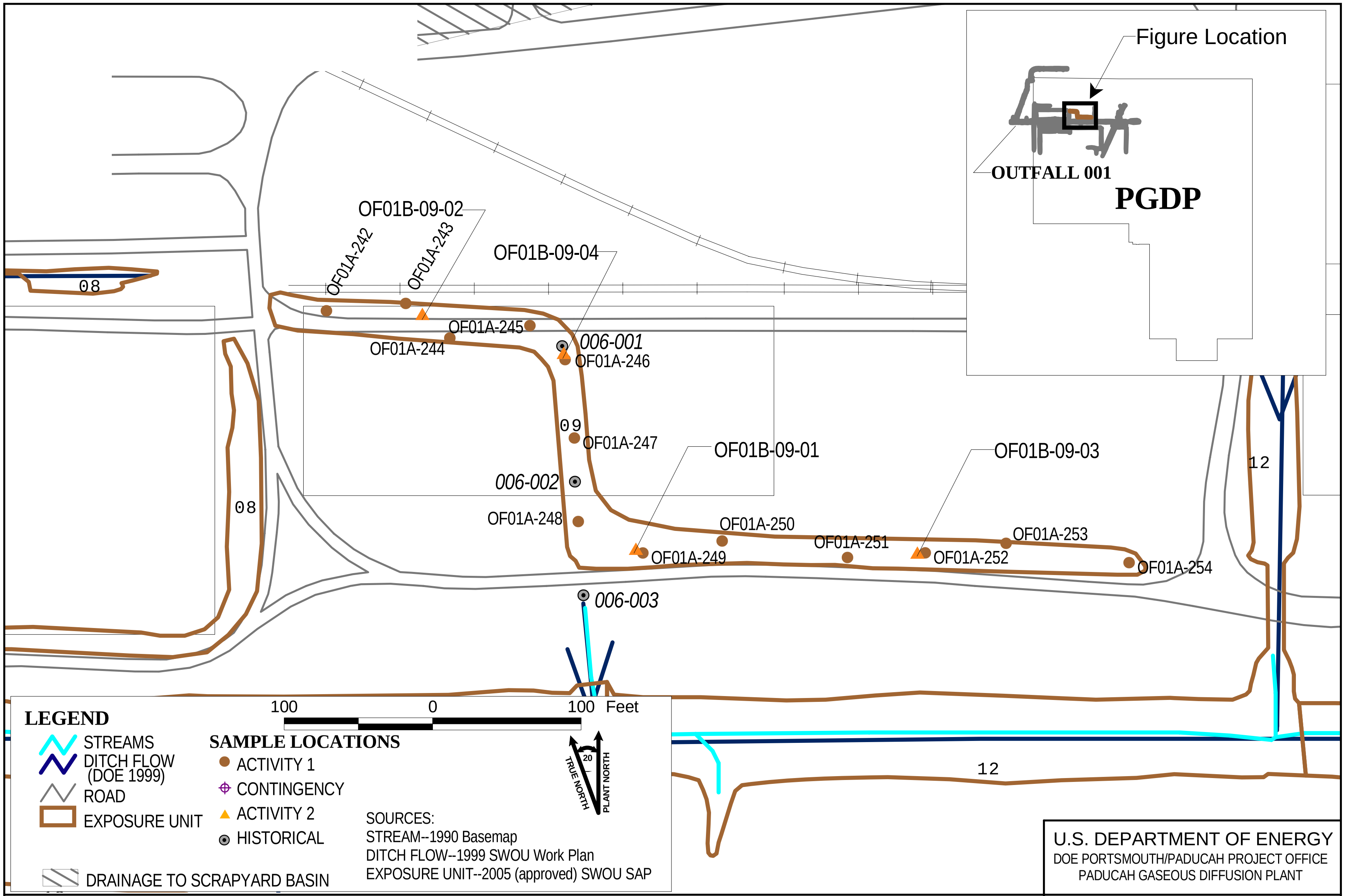

Figure 4.43. Outfall 001 EU 09 - Locations of RI and Historical Samples

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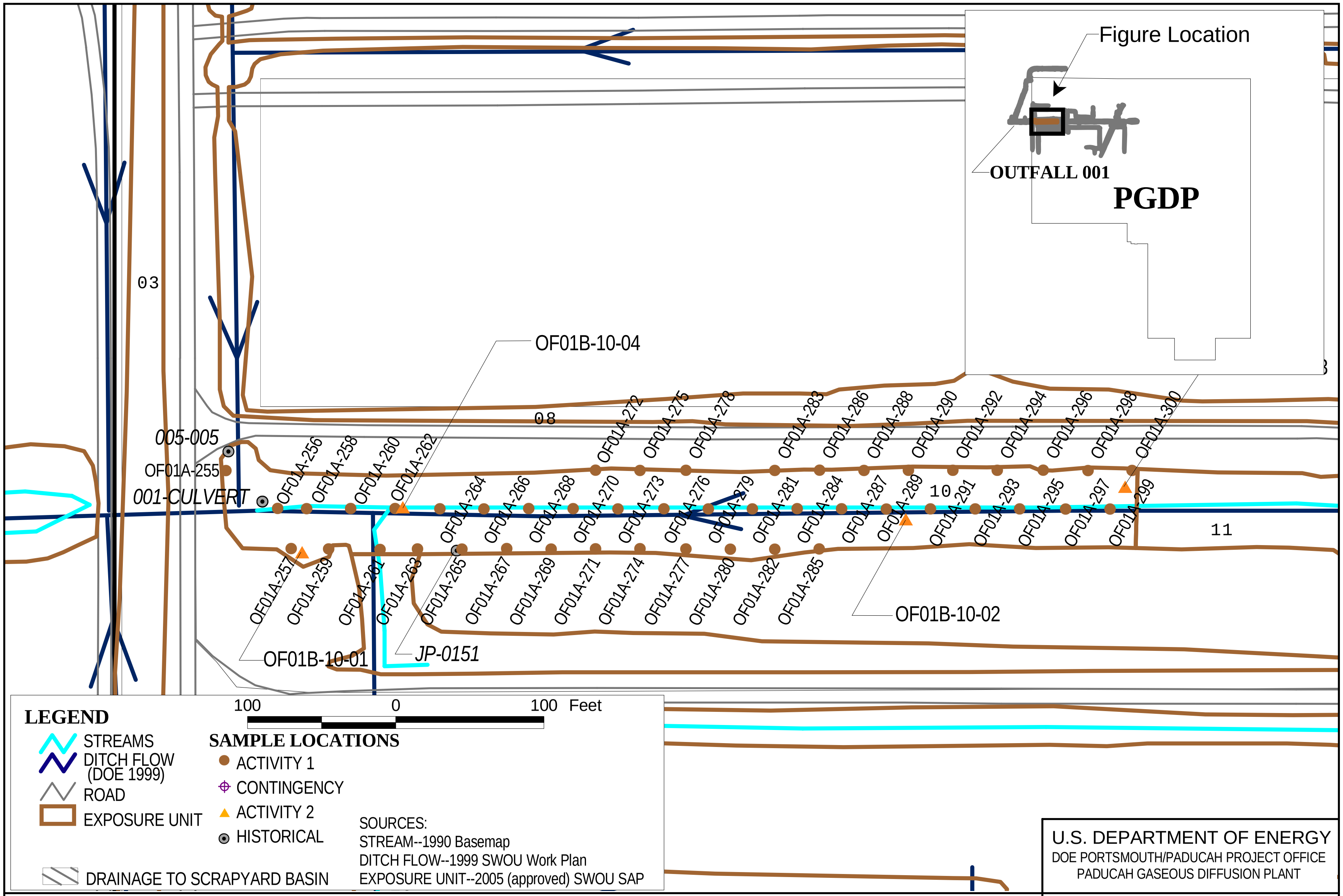

Figure 4.44. Outfall 001 EU 10 - Locations of RI and Historical Samples

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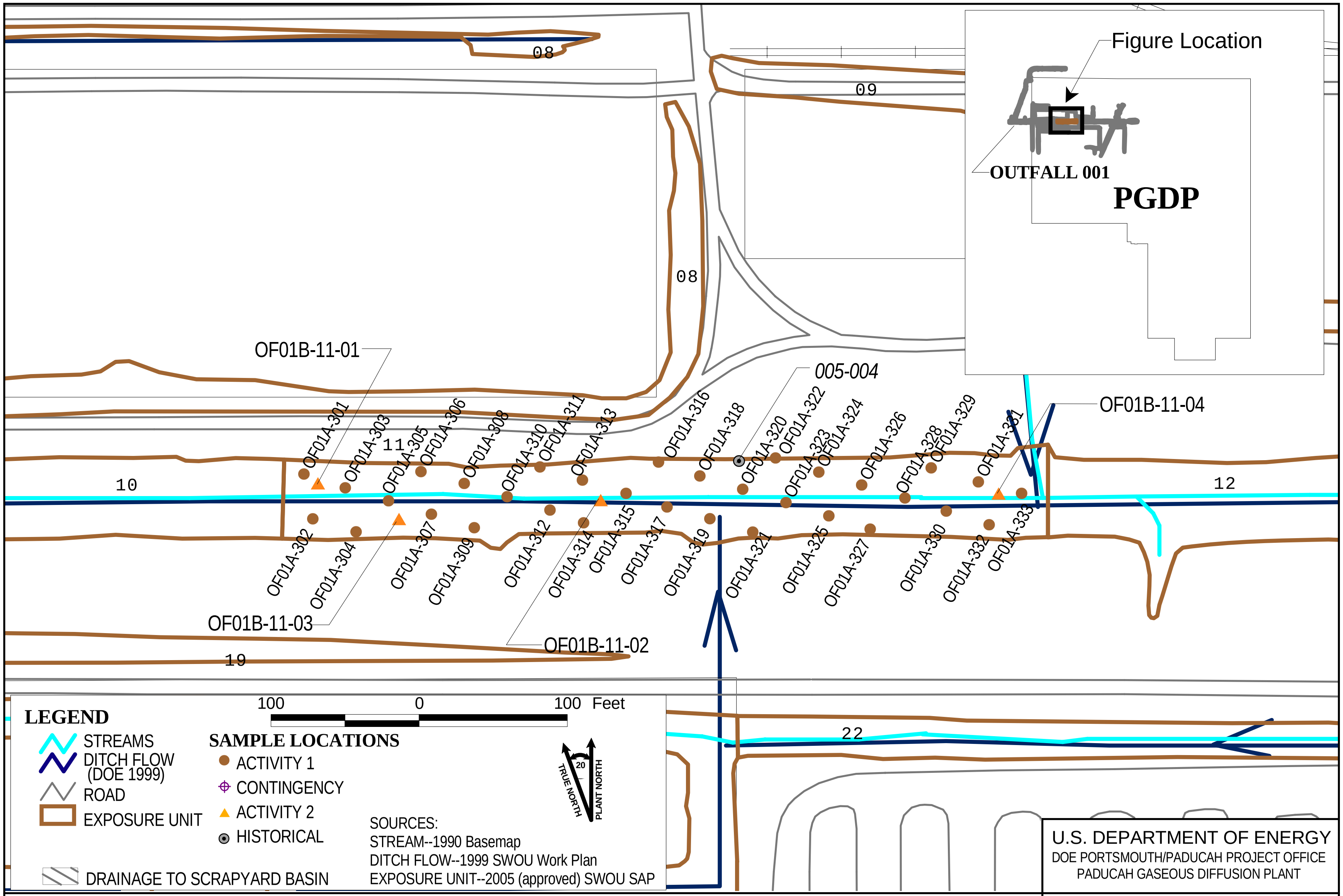

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Figure 4.45. Outfall 001 EU 11 - Locations of RI and Historical Samples

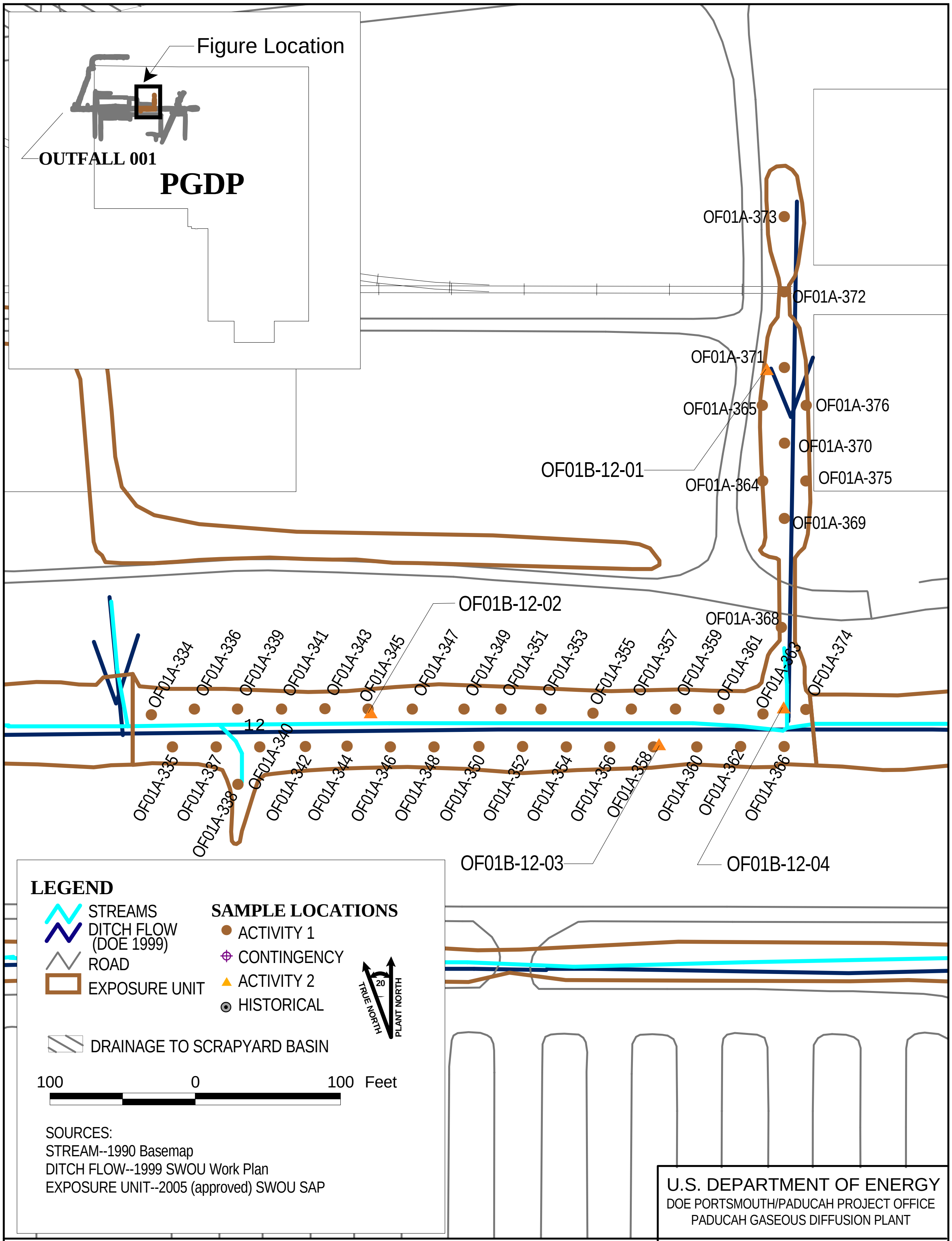

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Figure 4.46. Outfall 001 EU 12 - Locations of RI and Historical Samples

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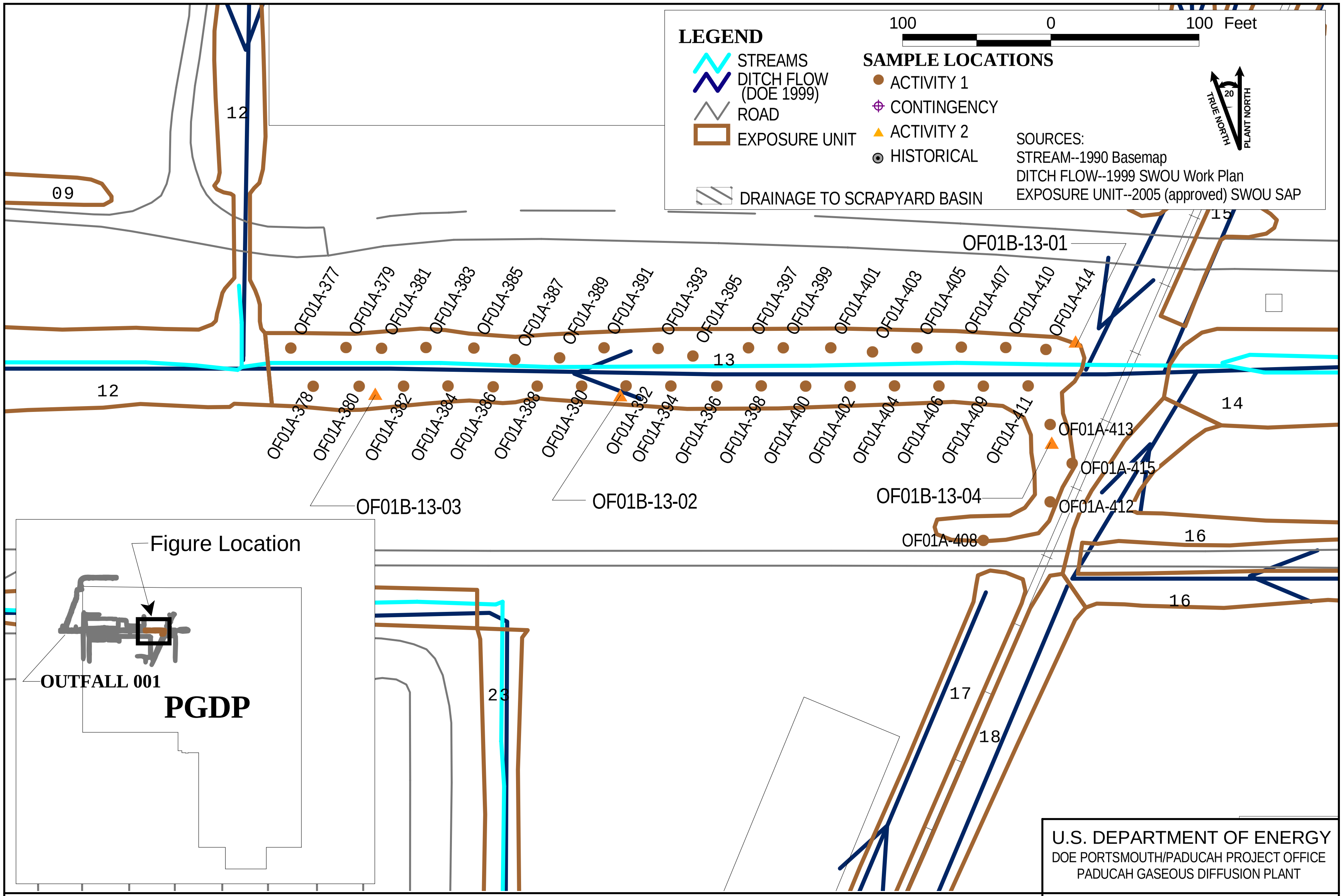

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Figure 4.47. Outfall 001 EU 13 - Locations of RI and Historical Samples

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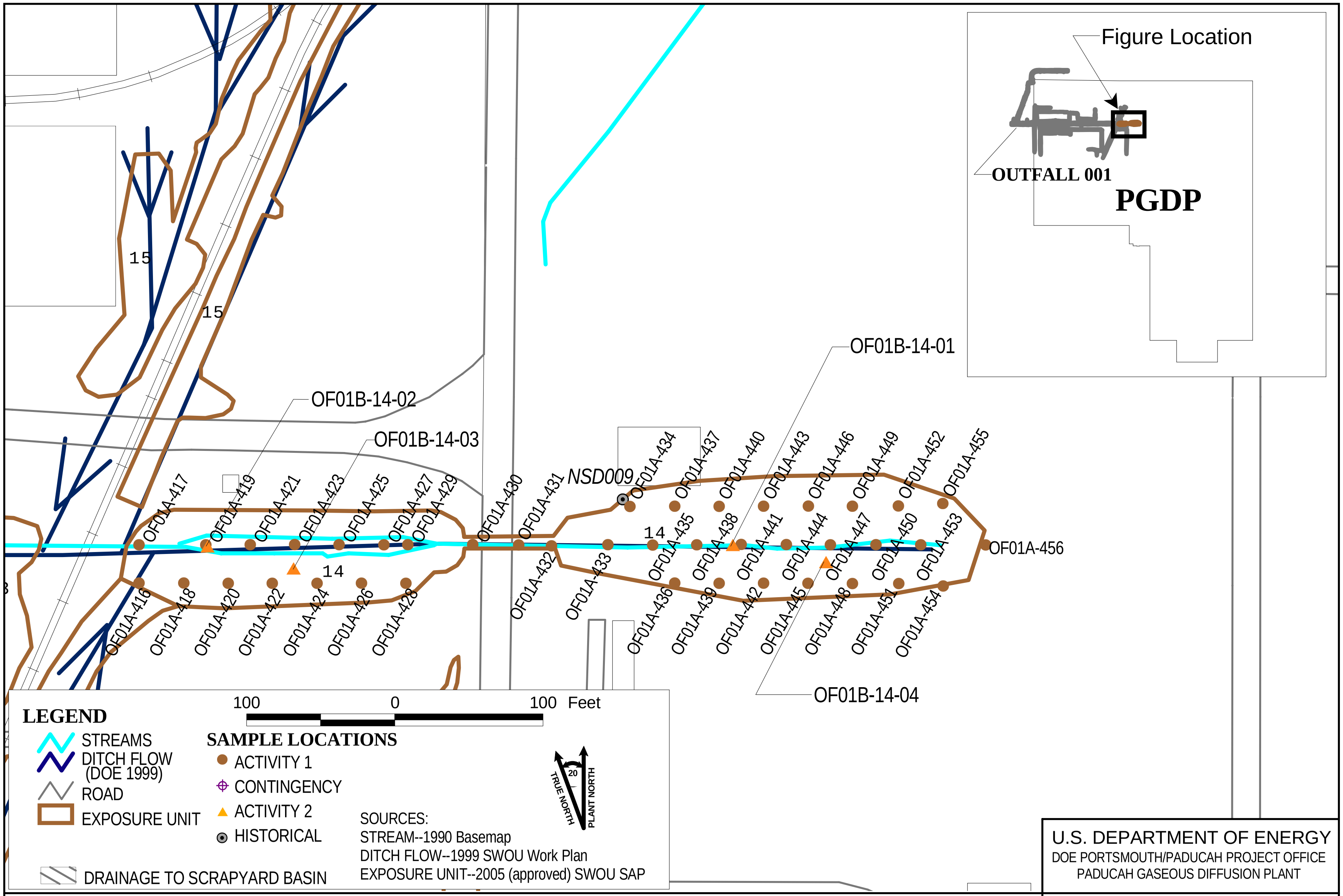

Figure 4.48. Outfall 001 EU 14 - Locations of RI and Historical Samples

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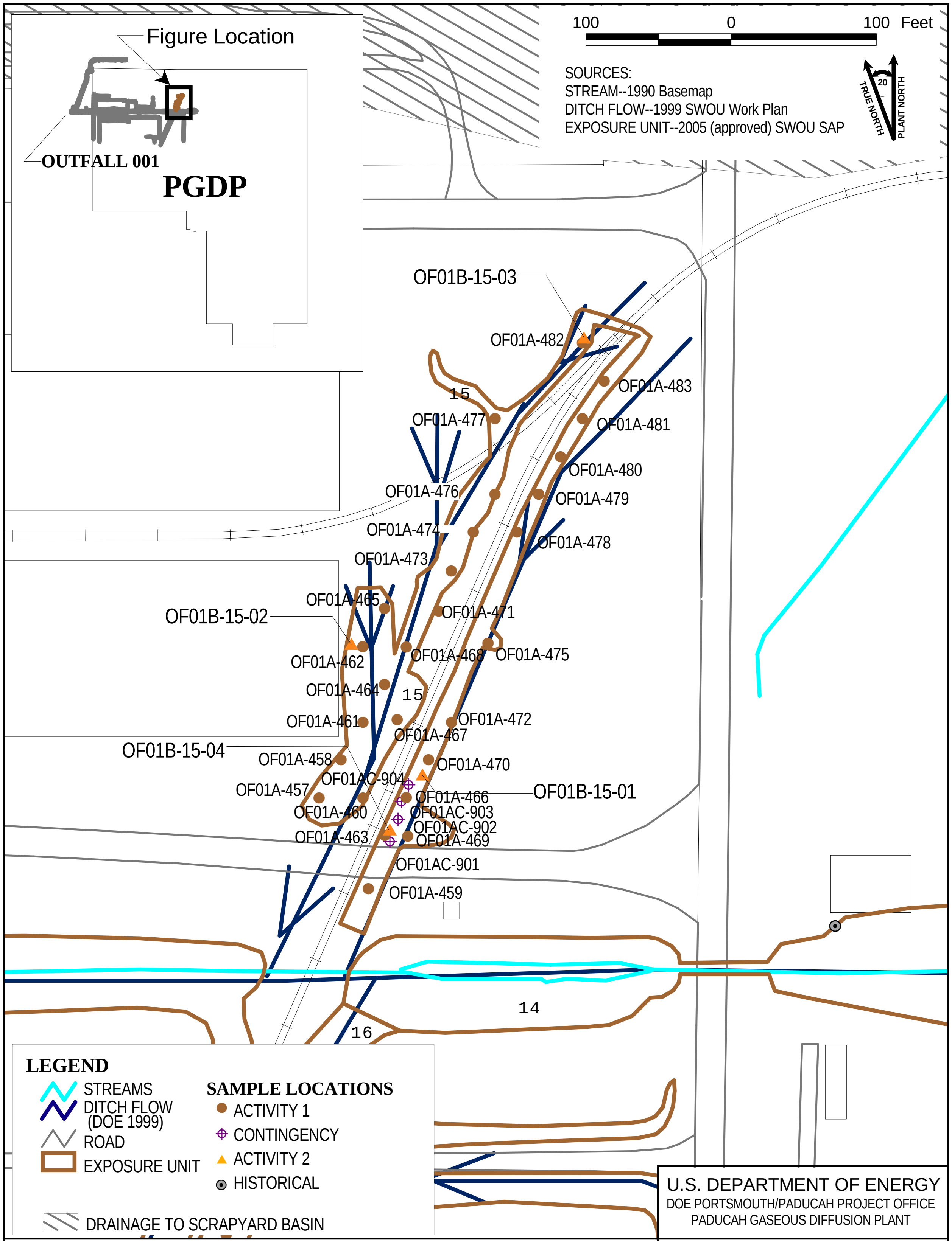

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Figure 4.49. Outfall 001 EU 15 - Locations of RI and Historical Samples

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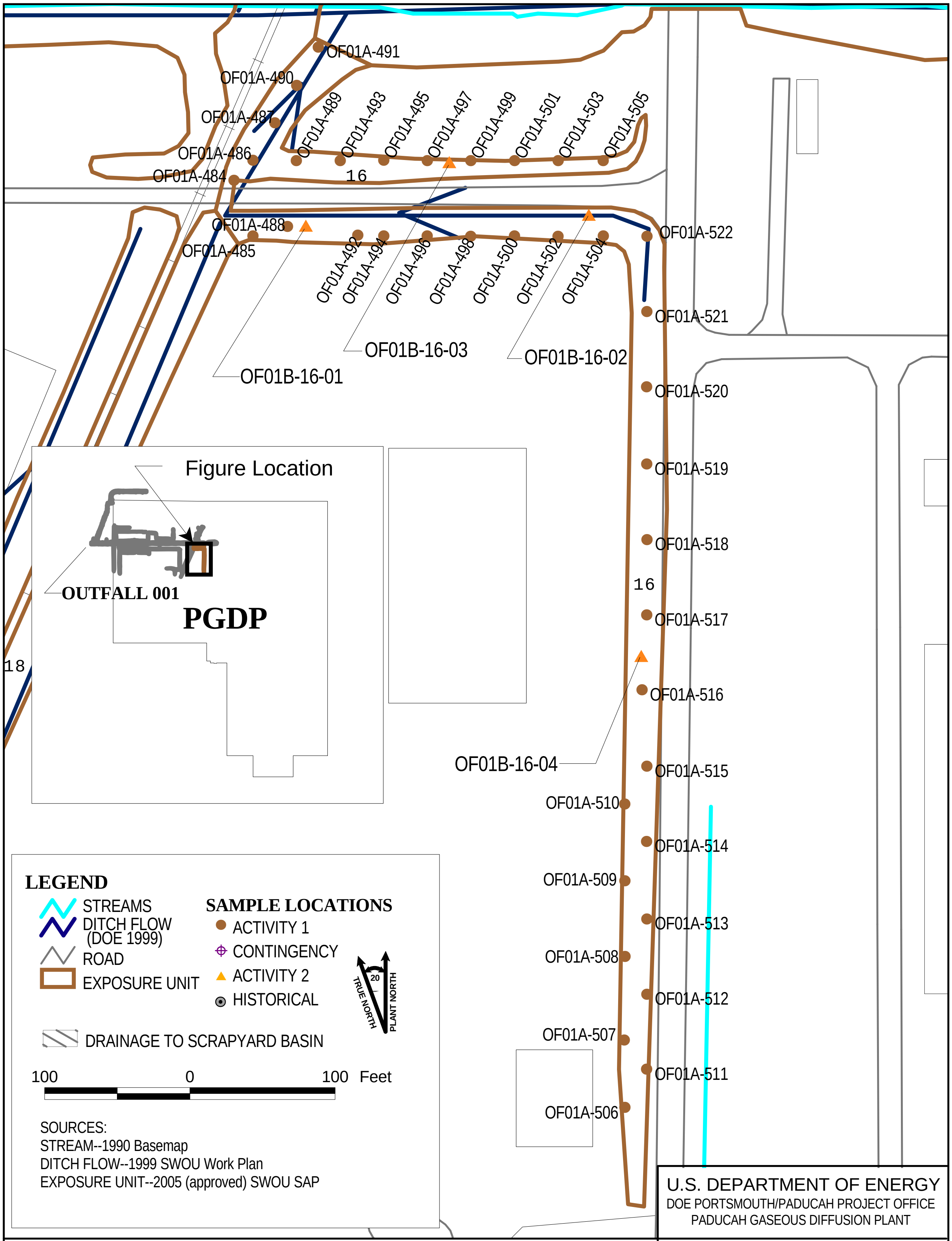

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Figure 4.50. Outfall 001 EU 16 - Locations of RI and Historical Samples

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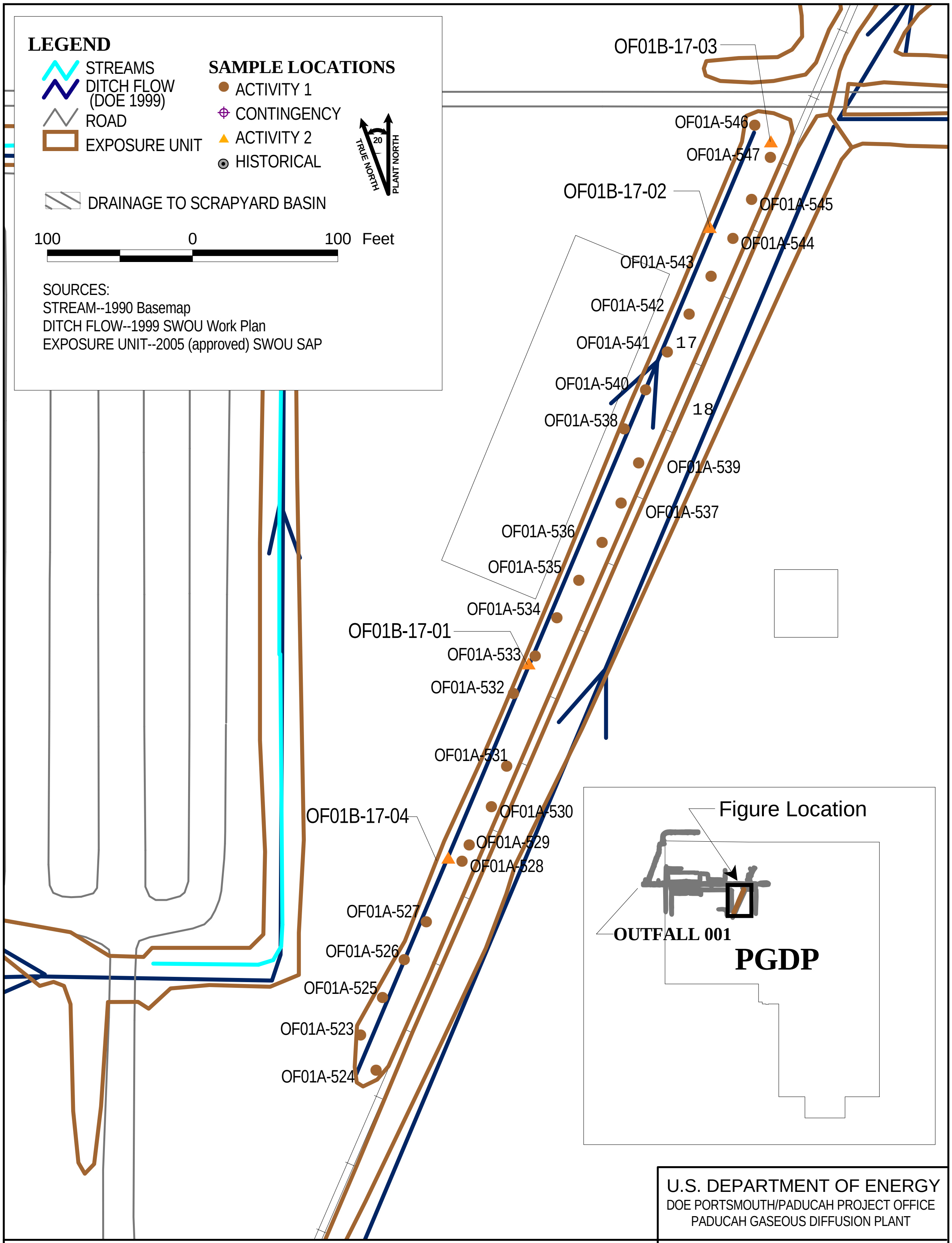

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Figure 4.51. Outfall 001 EU 17 - Locations of RI and Historical Samples

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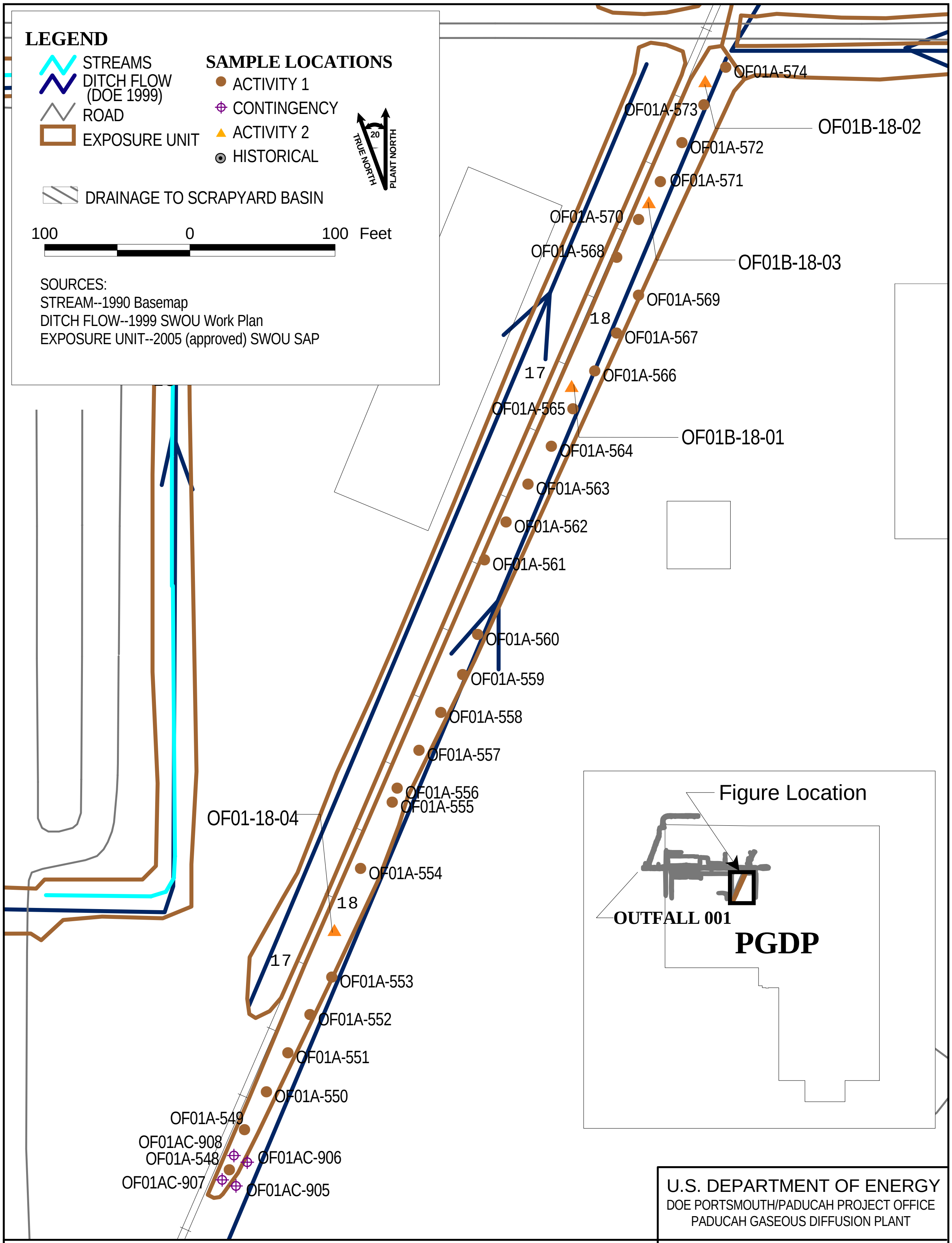

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Figure 4.52. Outfall 001 EU 18 - Locations of RI and Historical Samples

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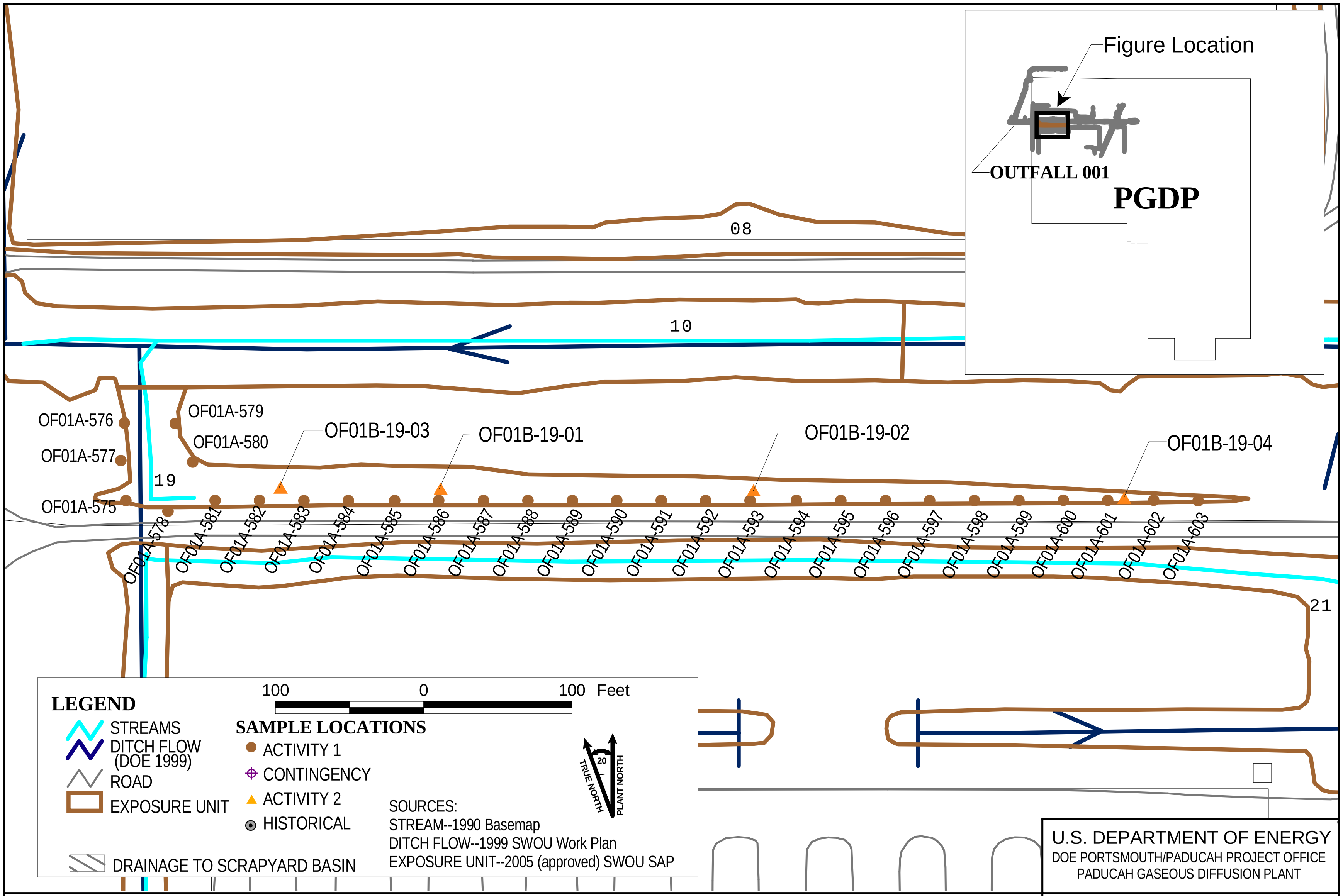

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.53. Outfall 001 EU 19 - Locations of RI and Historical Samples

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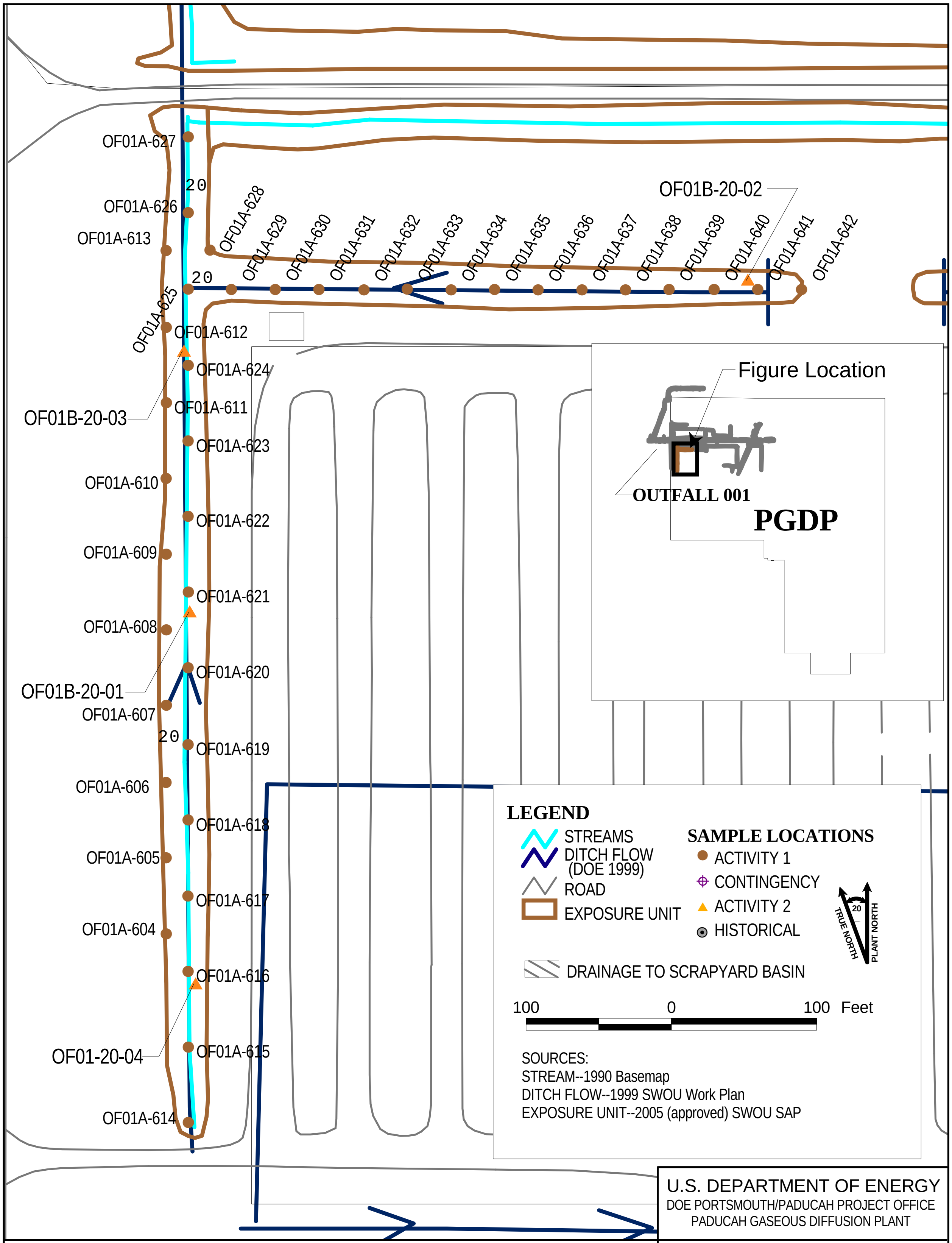

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Figure 4.54. Outfall 001 EU 20 - Locations of RI and Historical Samples

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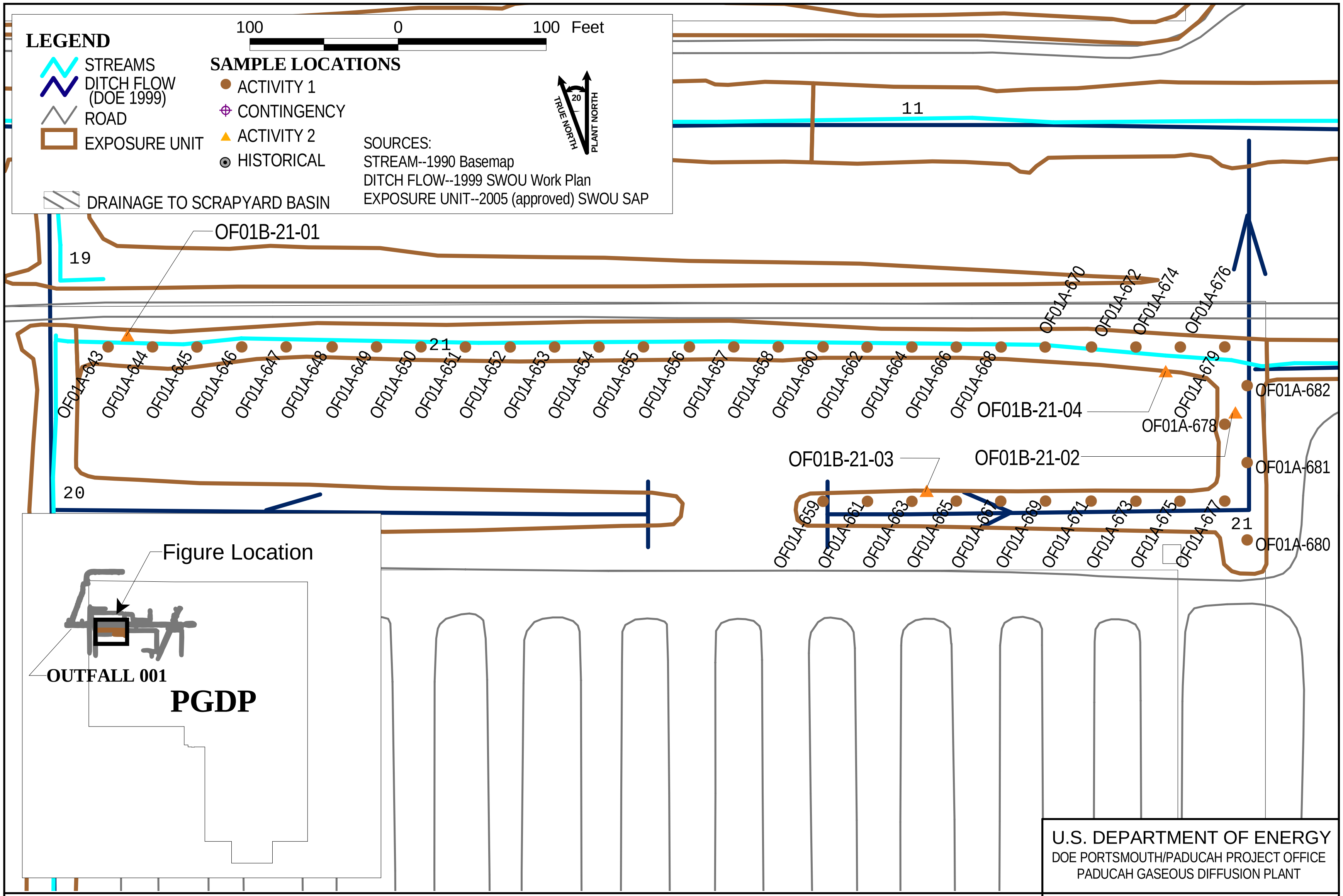

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Figure 4.55. Outfall 001 EU 21 - Locations of RI and Historical Samples

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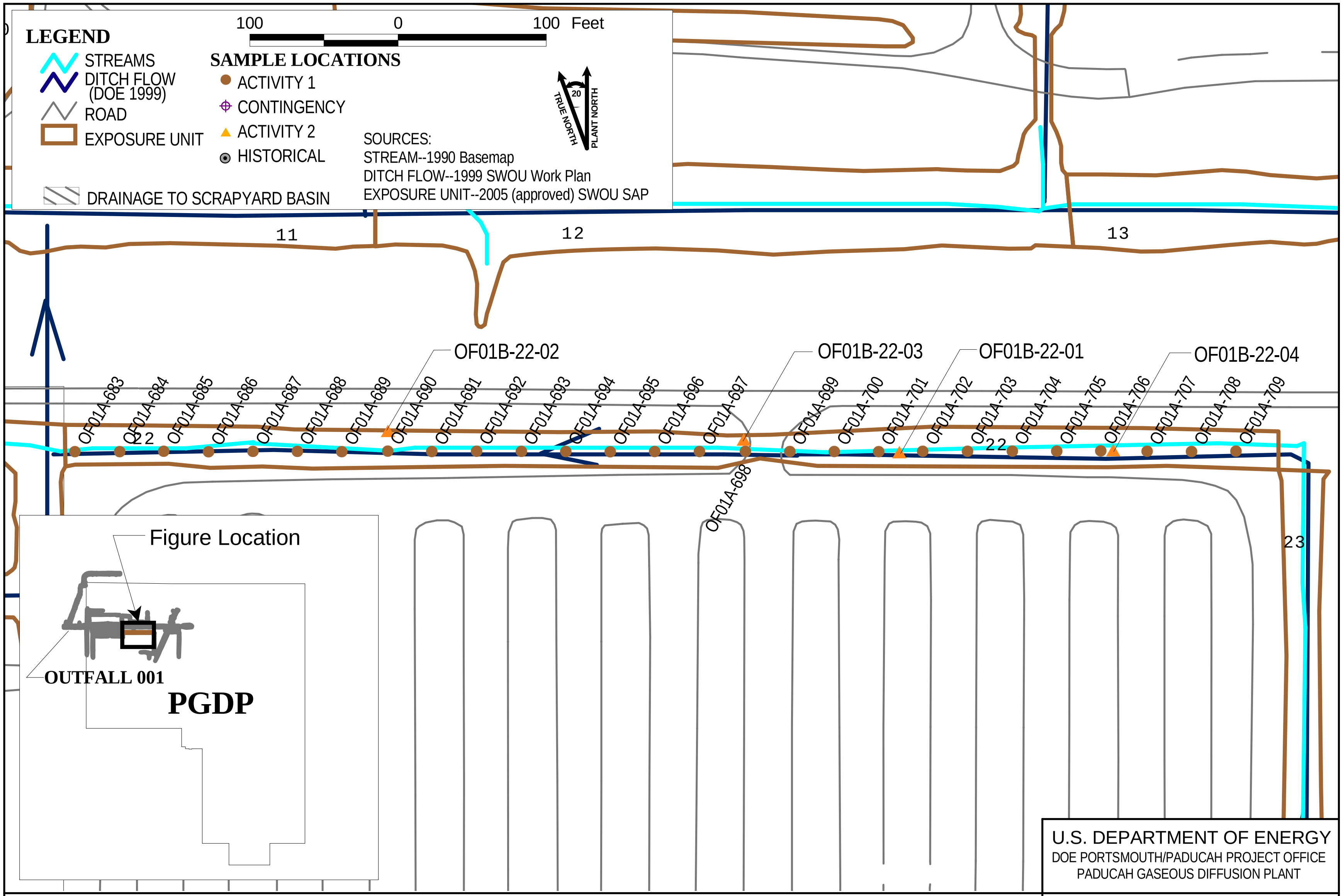

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Figure 4.56. Outfall 001 EU 22 - Locations of RI and Historical Samples

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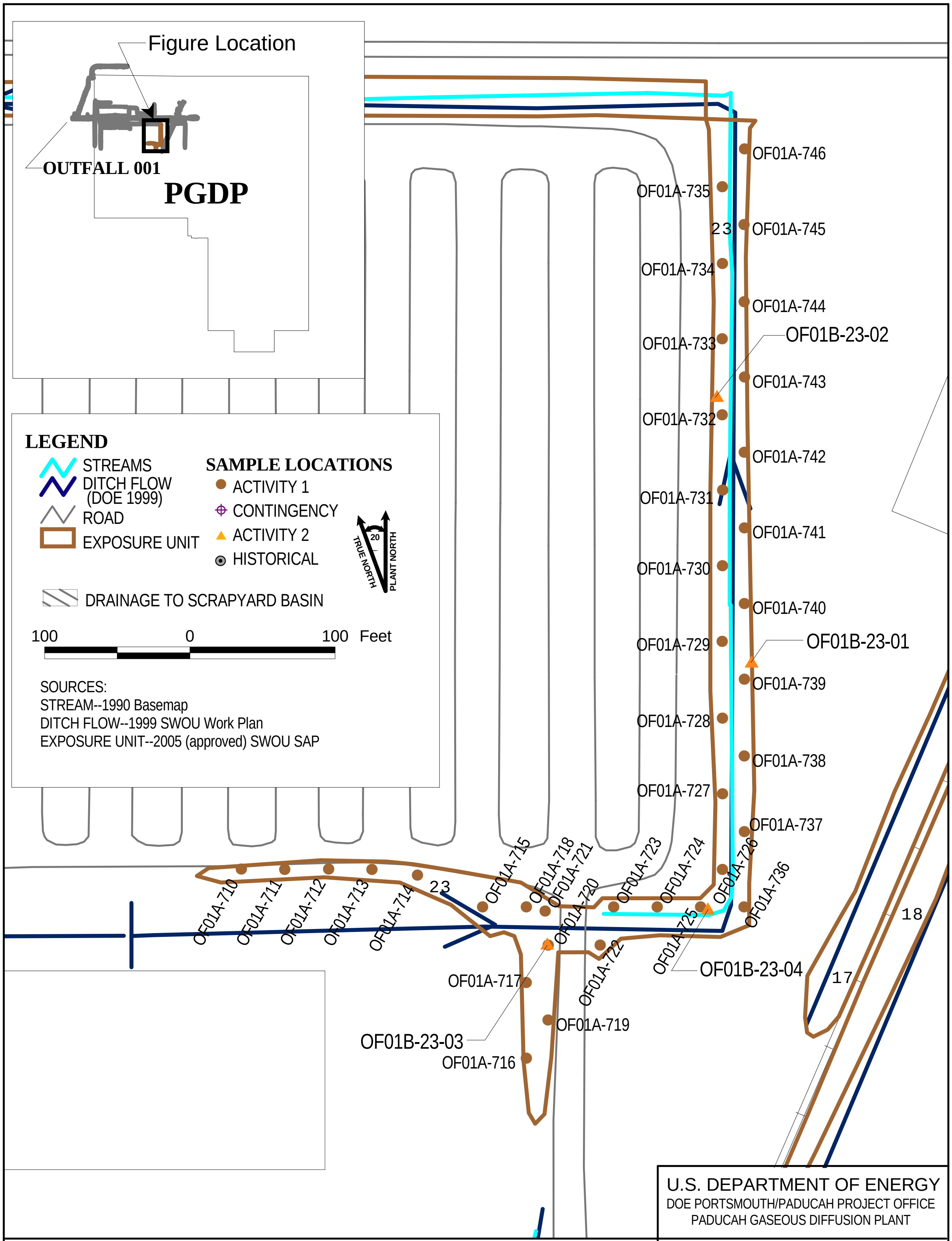

SOURCES:
STREAM--1990 Basemap
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EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.57. Outfall 001 EU 23 - Locations of RI and Historical Samples

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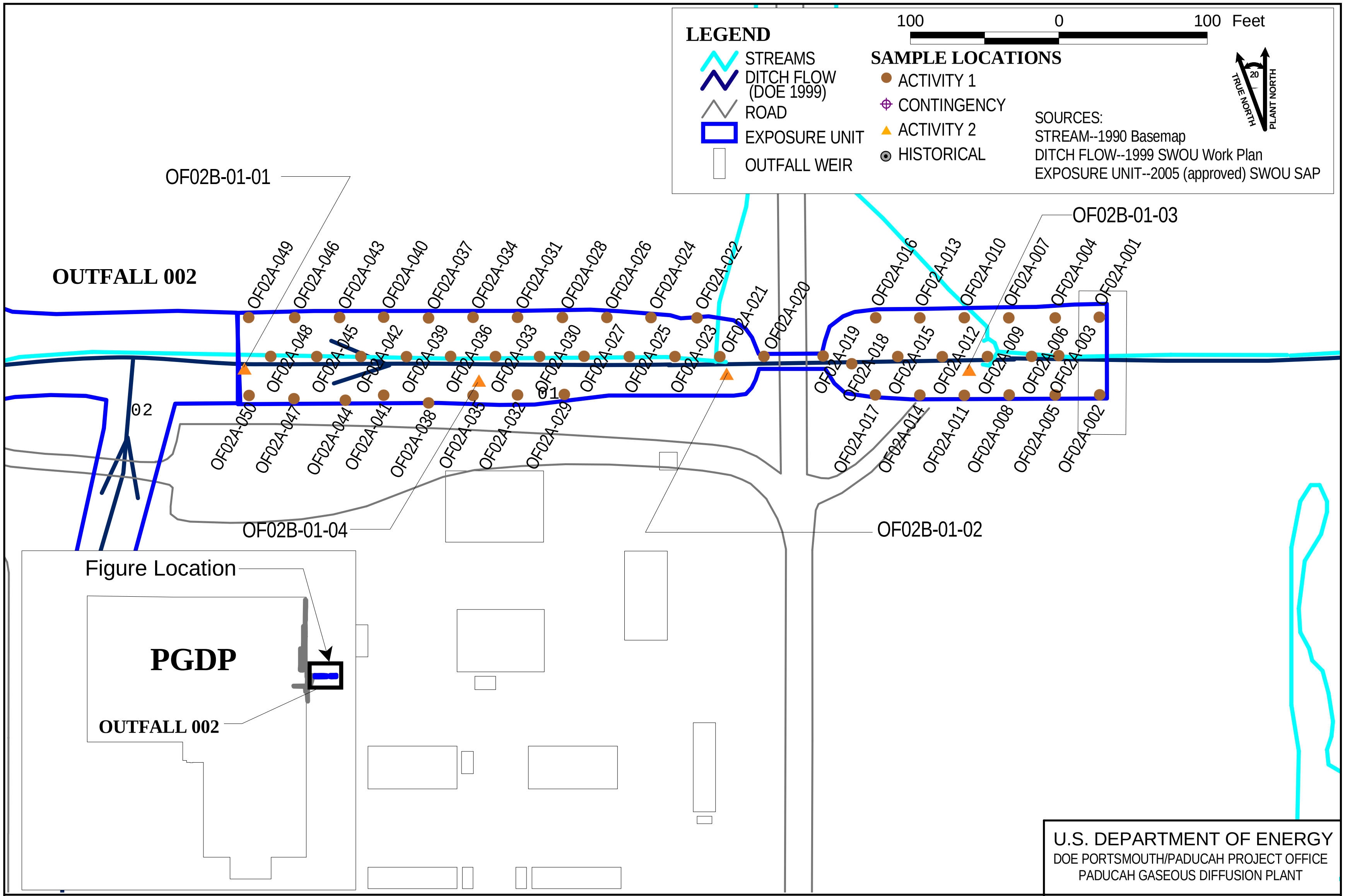

Figure 4.58. Outfall 002 EU 01 - Locations of RI and Historical Samples

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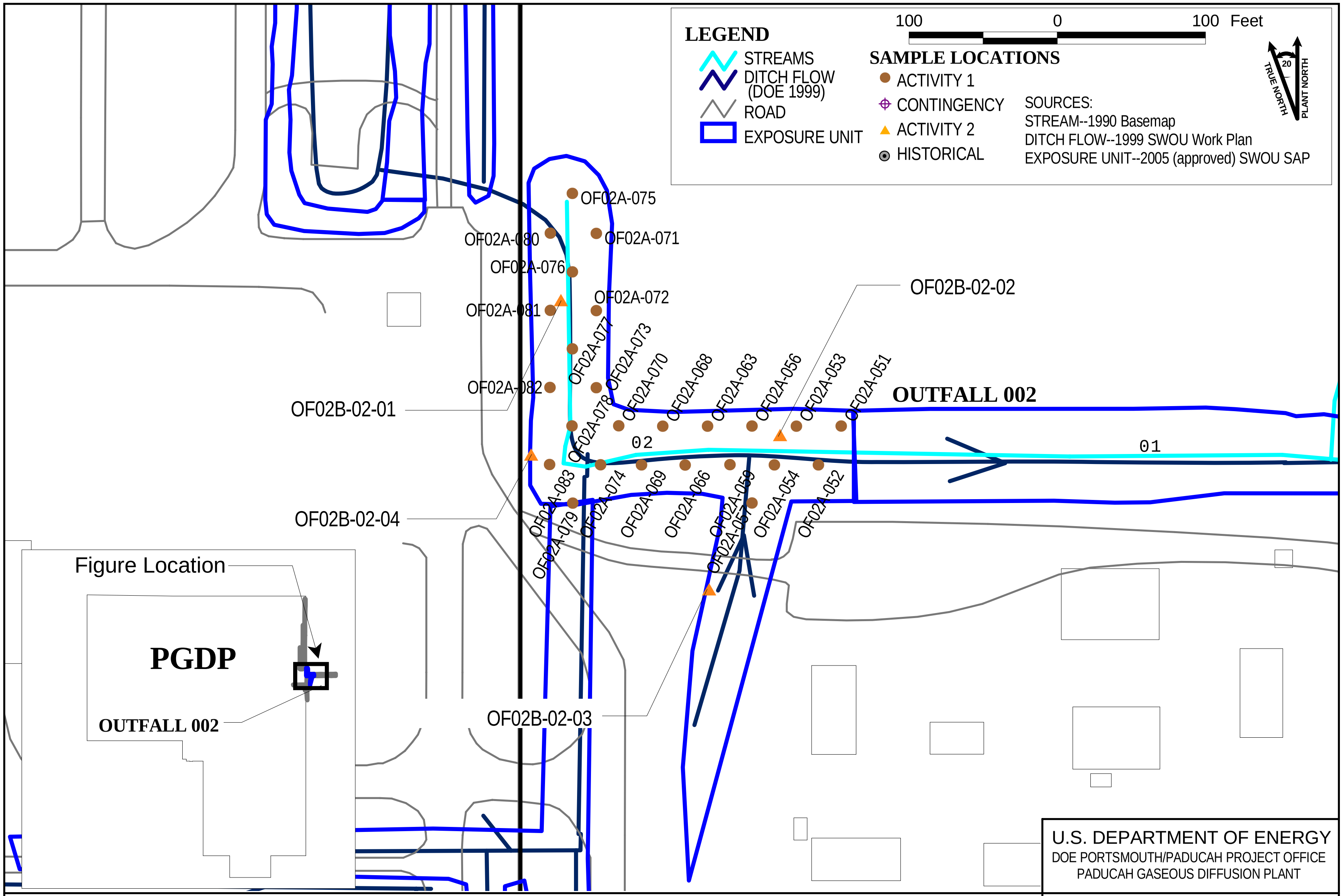

Figure 4.59. Outfall 002 EU 02 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF02R2.apr
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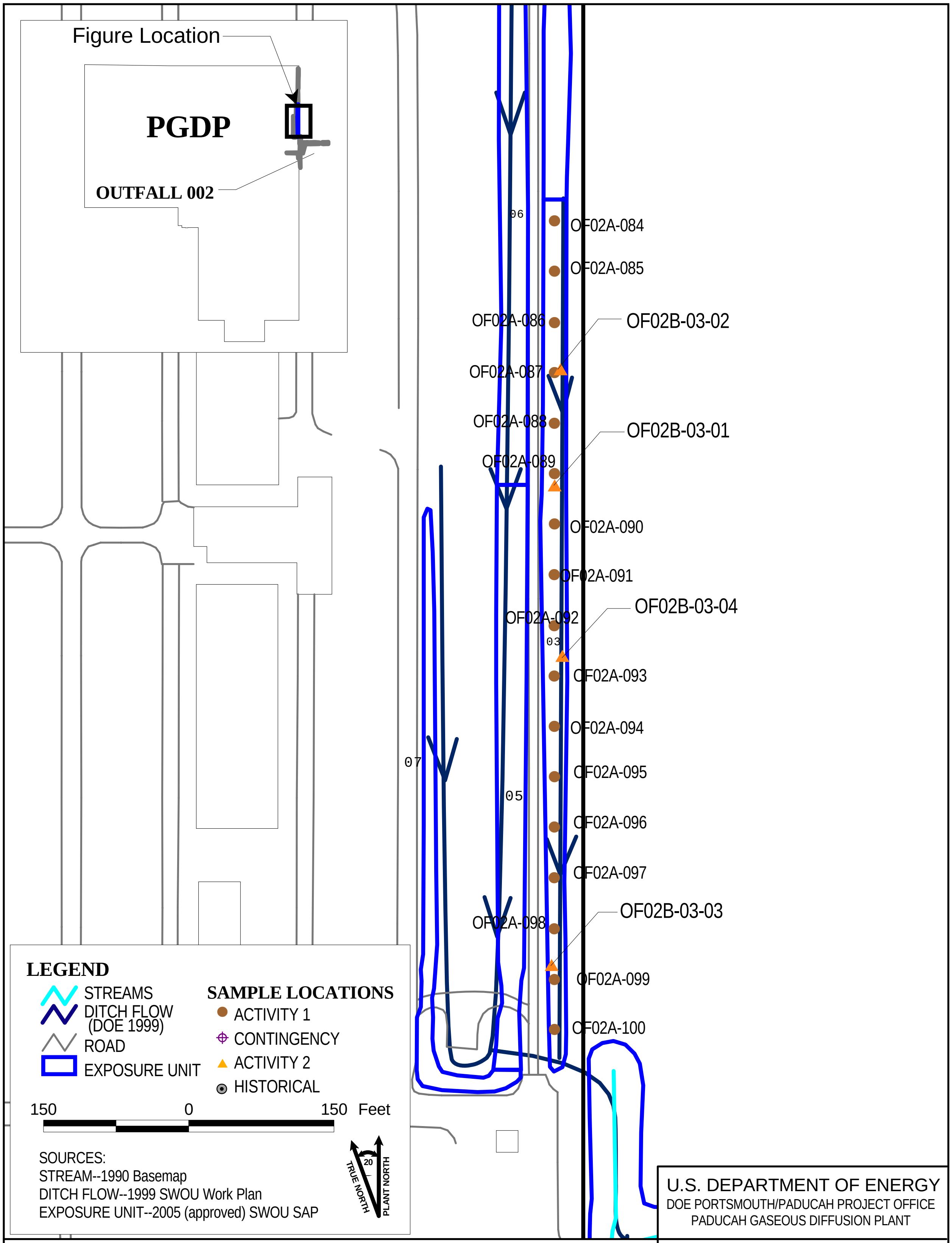

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Figure 4.60. Outfall 002 EU 03 - Locations of RI and Historical Samples

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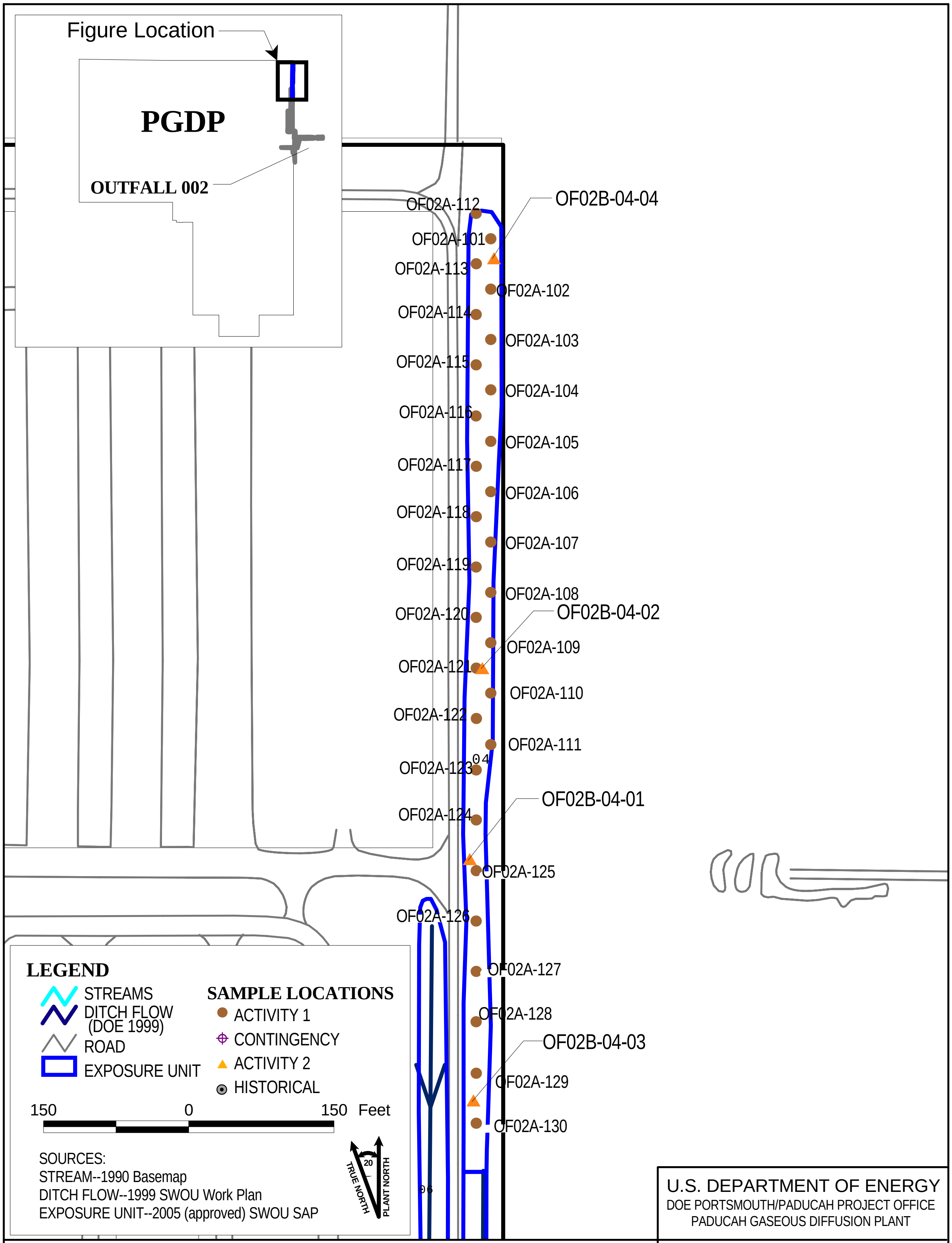

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Figure 4.61. Outfall 002 EU 04 - Locations of RI and Historical Samples

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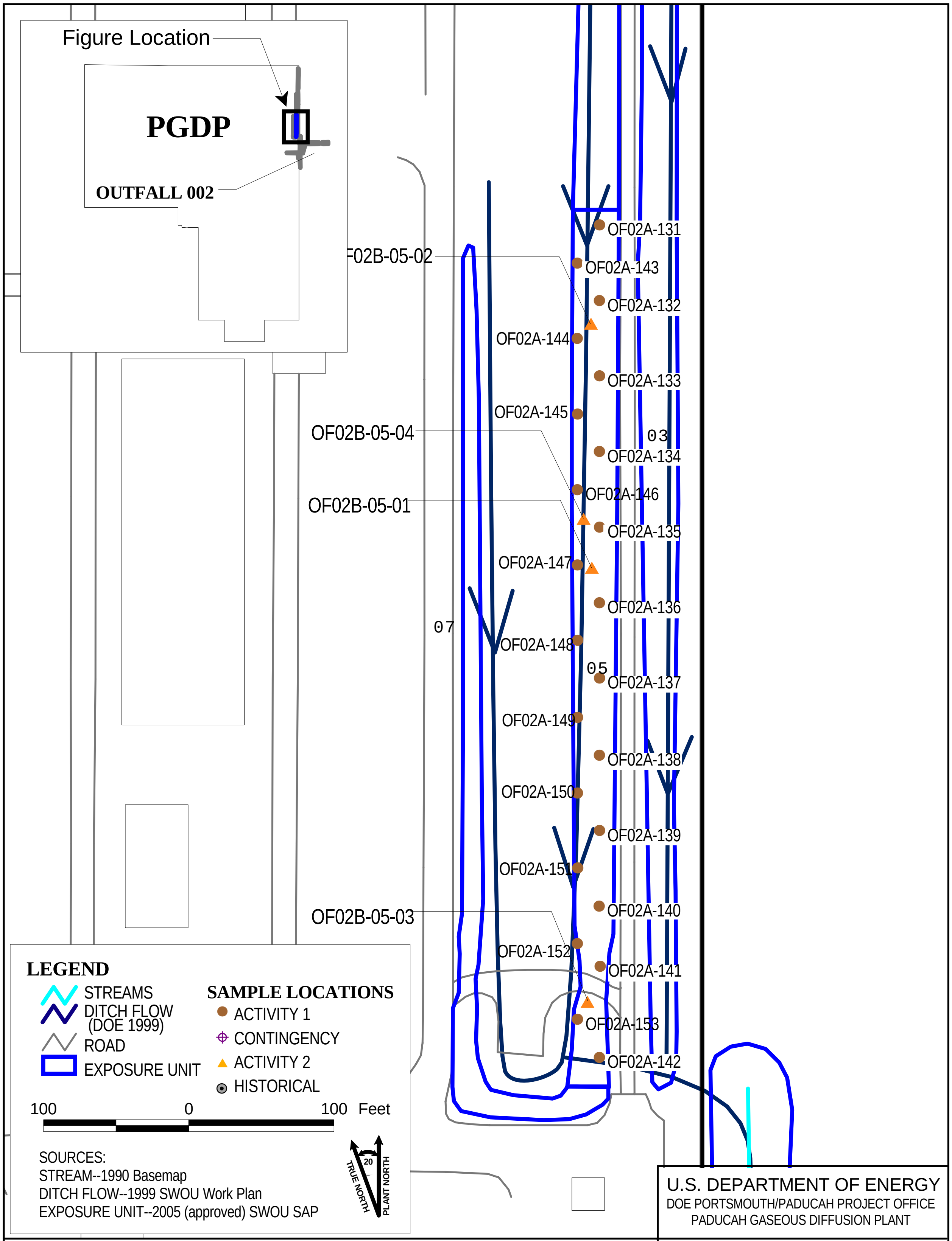
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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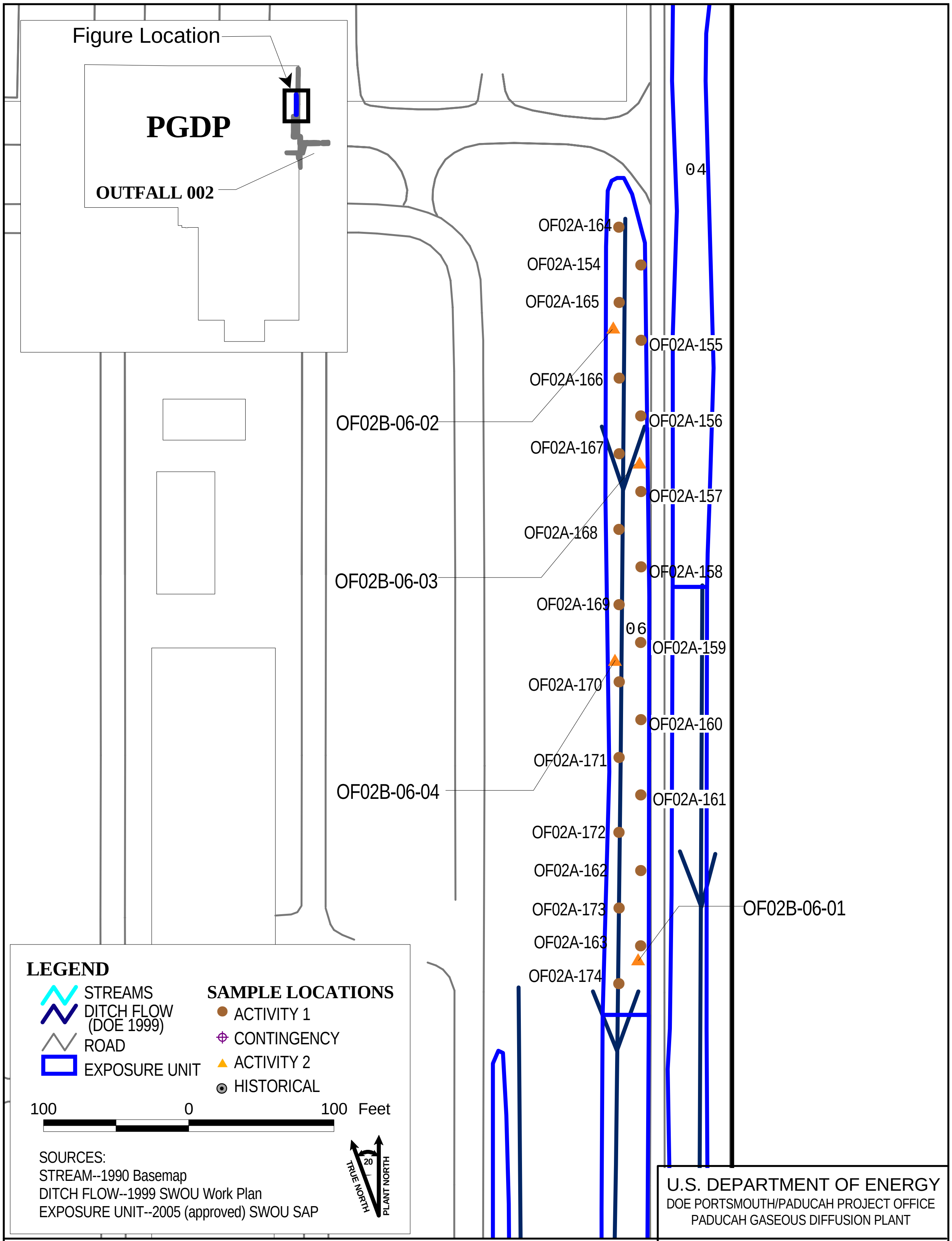
Figure 4.62. Outfall 002 EU 05 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF02R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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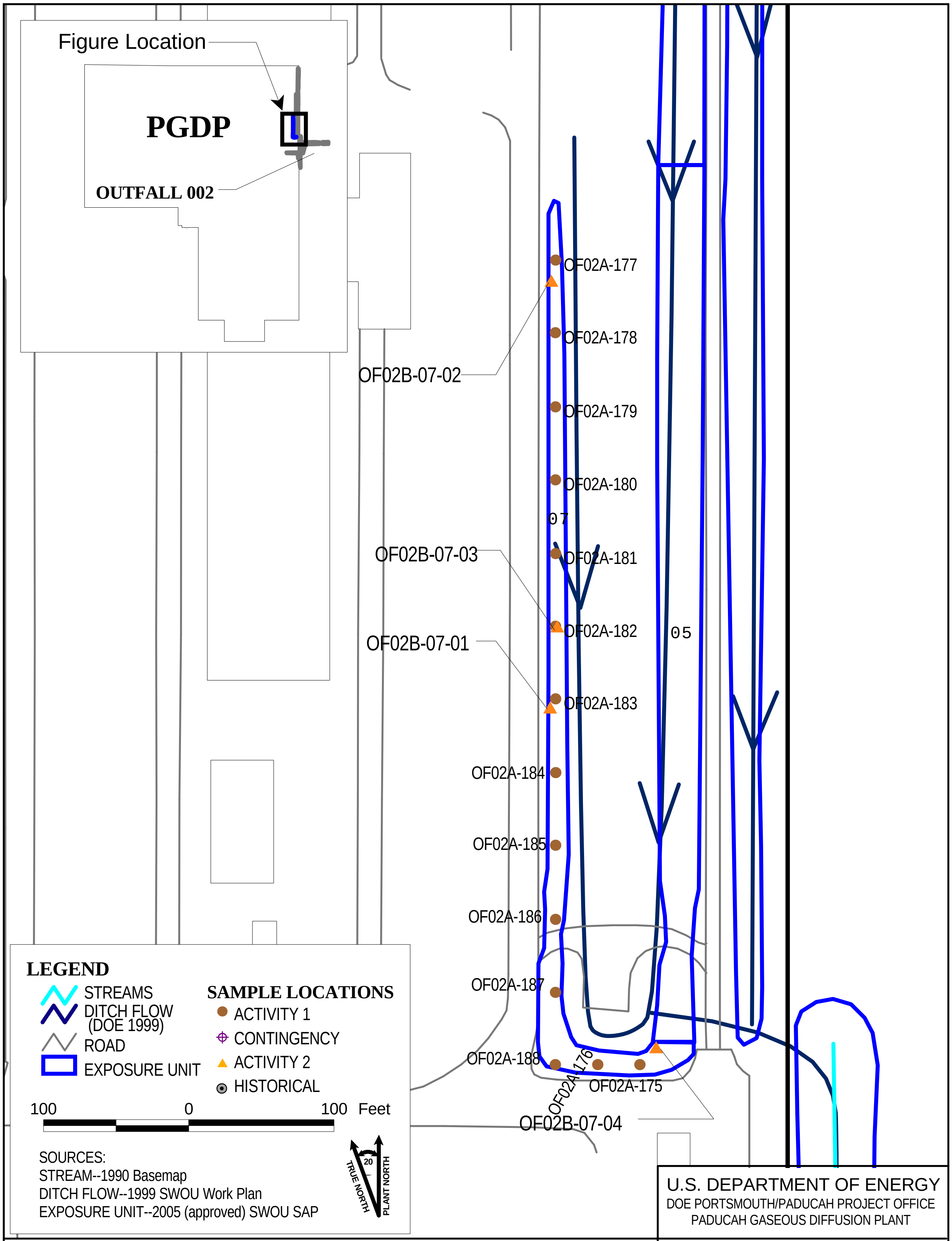
Figure 4.63. Outfall 002 EU 06 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF02R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.64. Outfall 002 EU 07 - Locations of RI and Historical Samples

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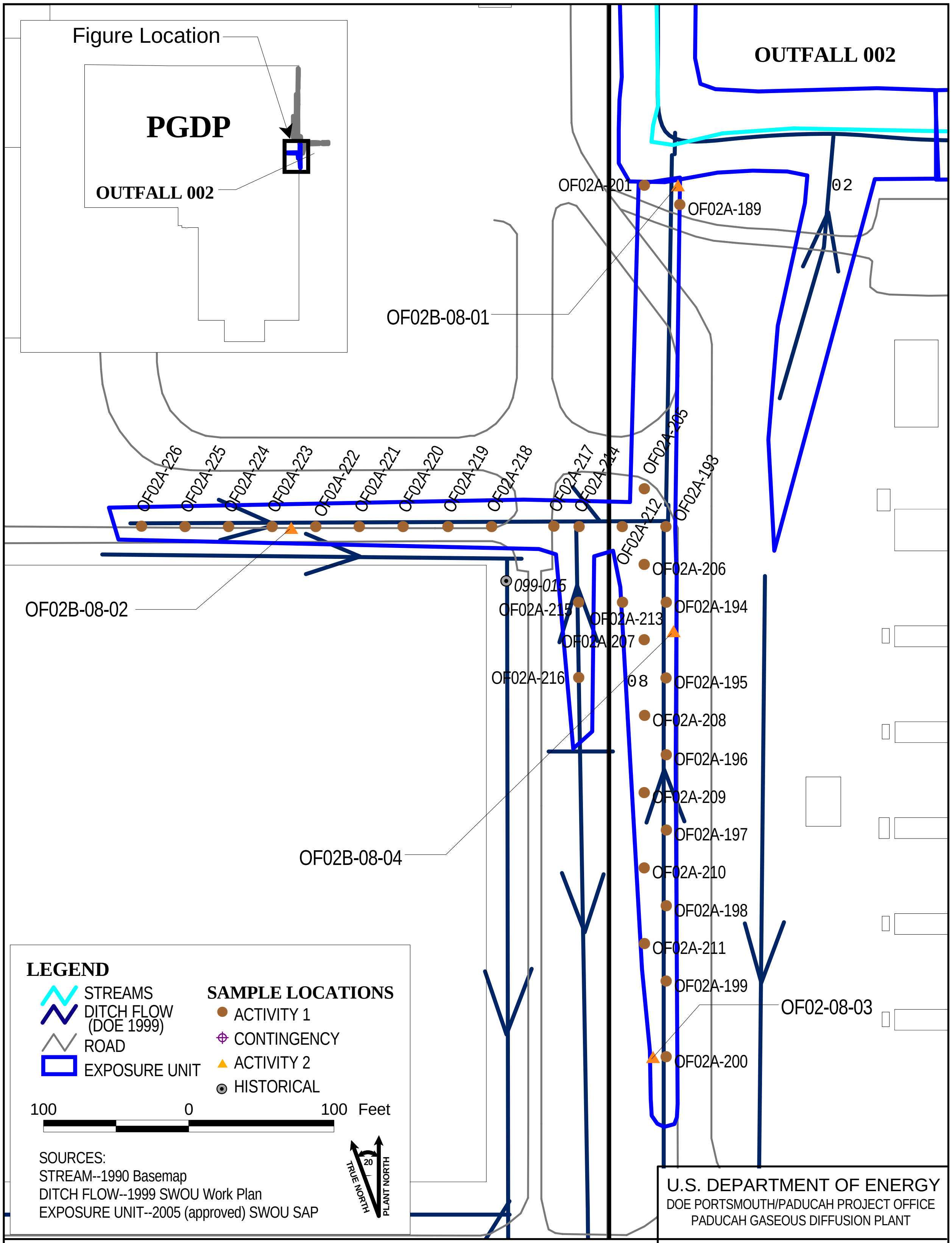

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Figure 4.65. Outfall 002 EU 08 - Locations of RI and Historical Samples

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DATE 03-12-07

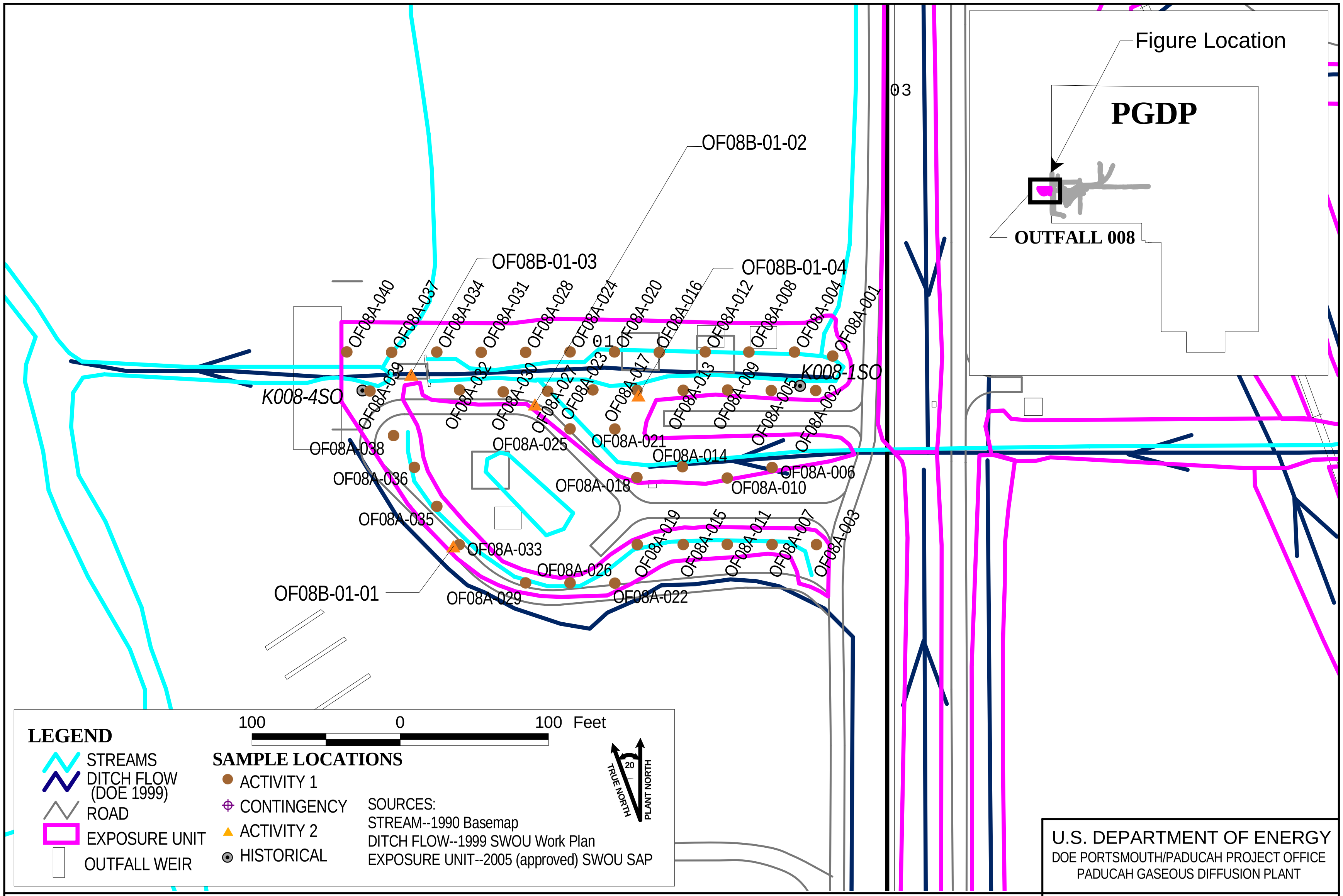

Figure 4.66. Outfall 008 EU 01 - Locations of RI and Historical Samples

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Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

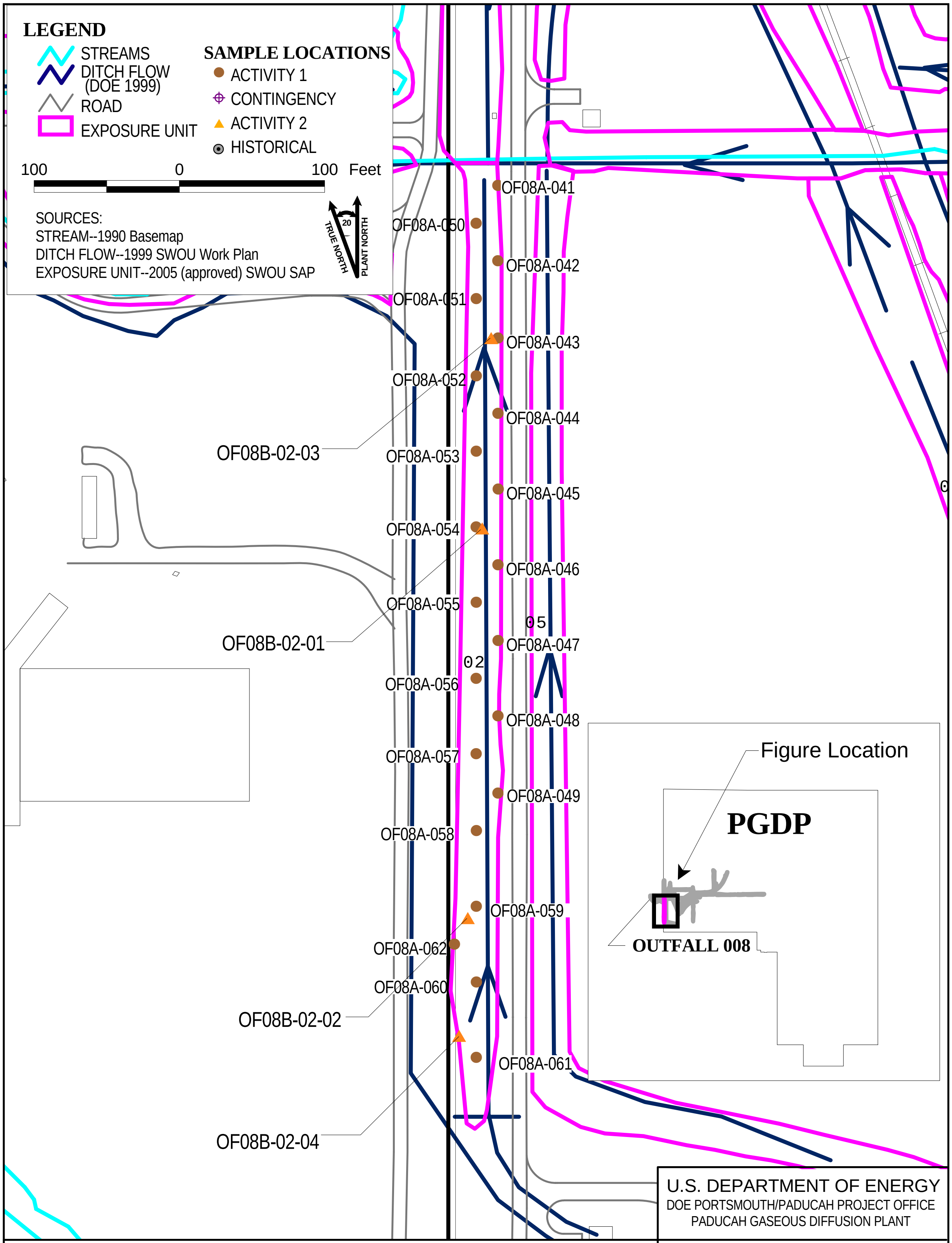

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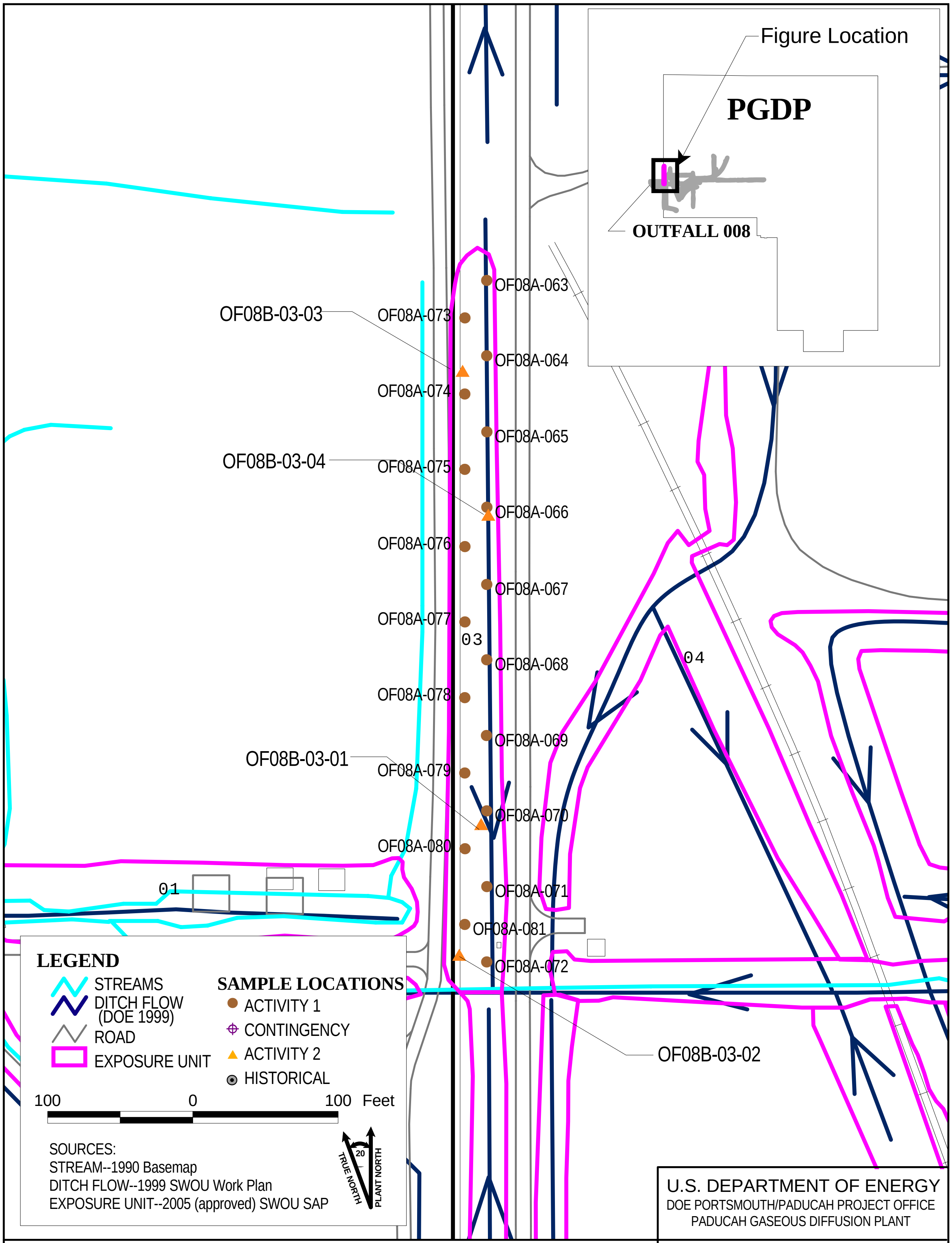
Figure 4.67. Outfall 008 EU 02 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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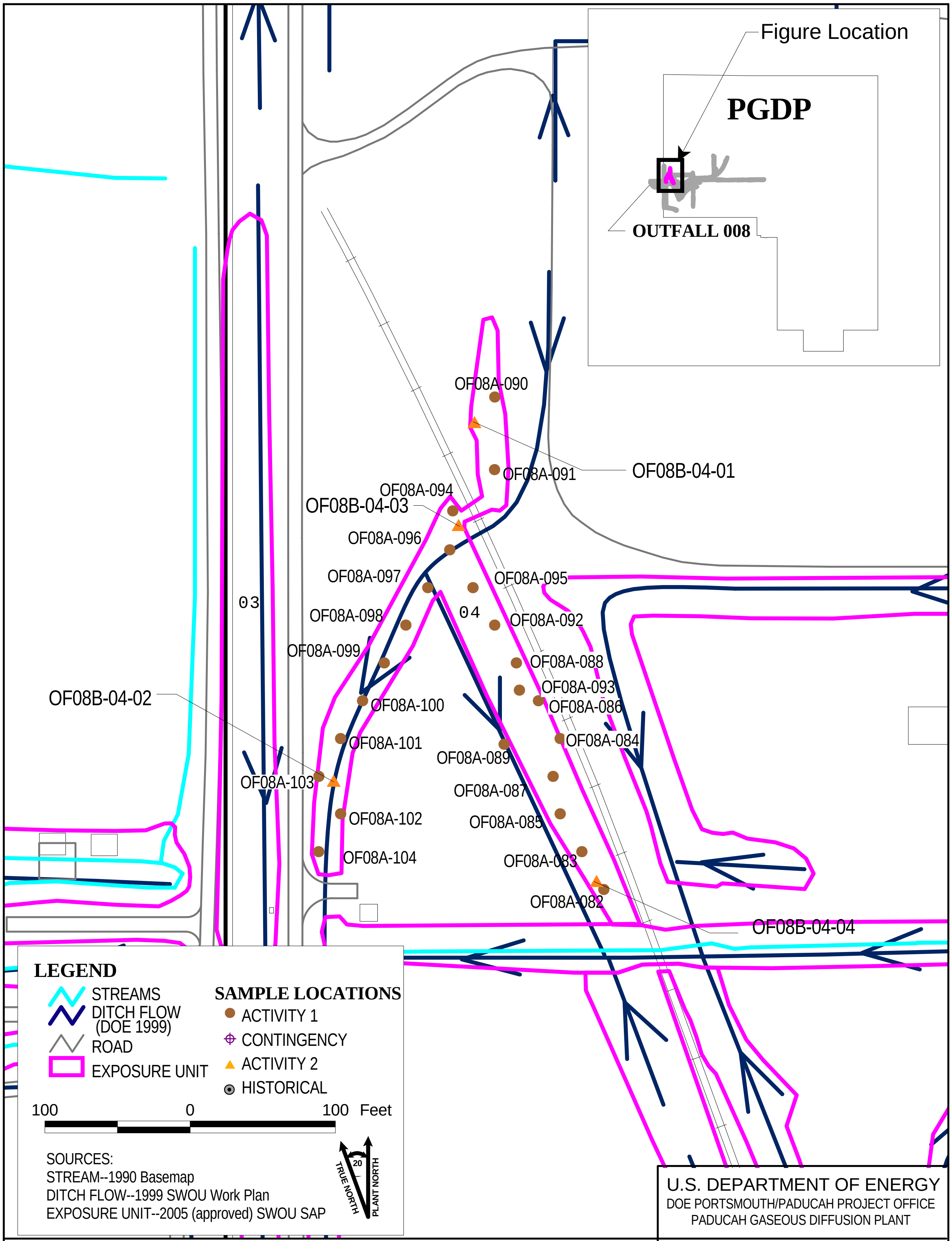
Figure 4.68. Outfall 008 EU 03 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

DOCUMENT No. DOE/LX/07-0001



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.69. Outfall 008 EU 04 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

DOCUMENT No. DOE/LX/07-0001

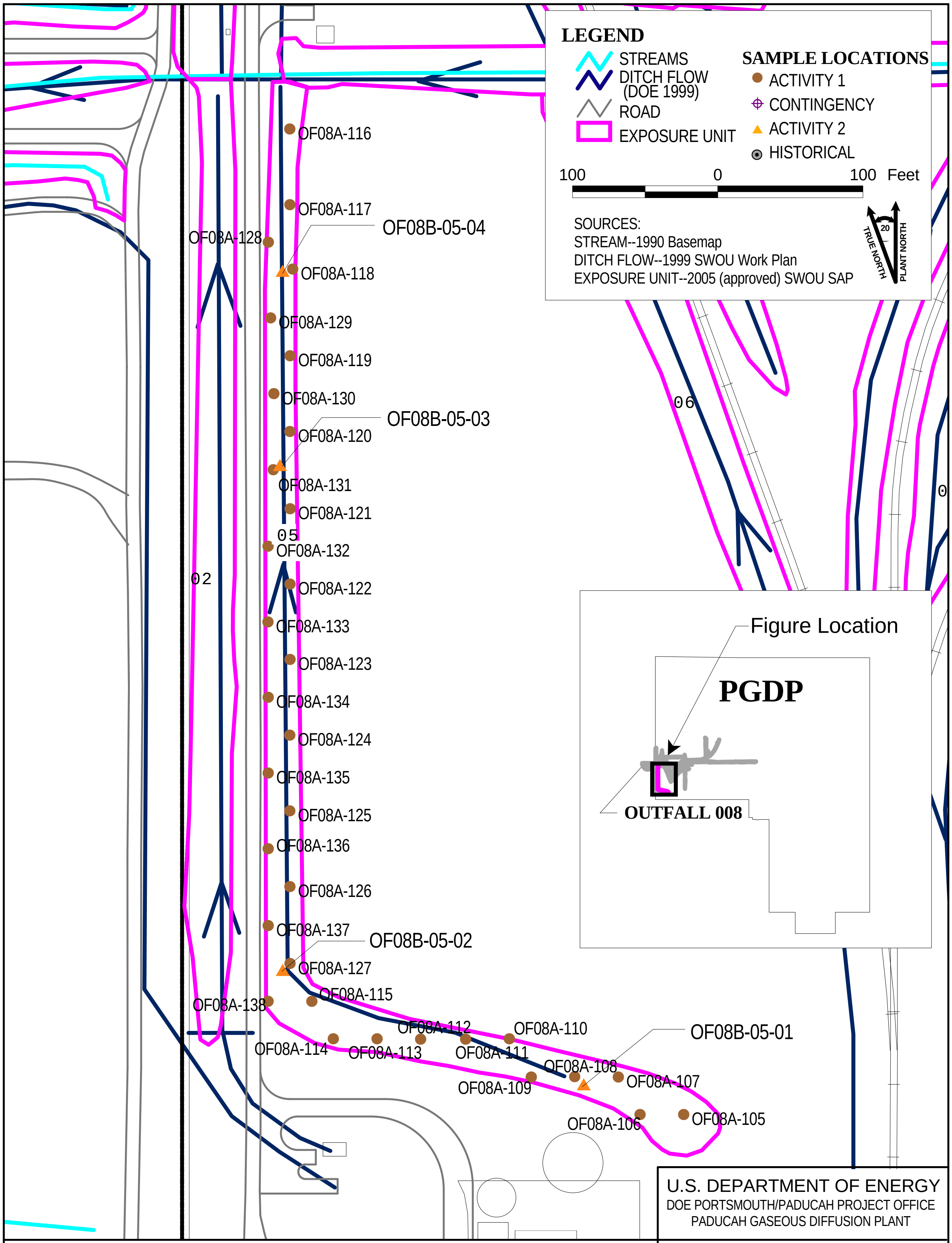

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Figure 4.70. Outfall 008 EU 05 - Locations of RI and Historical Samples

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DATE 03-12-07

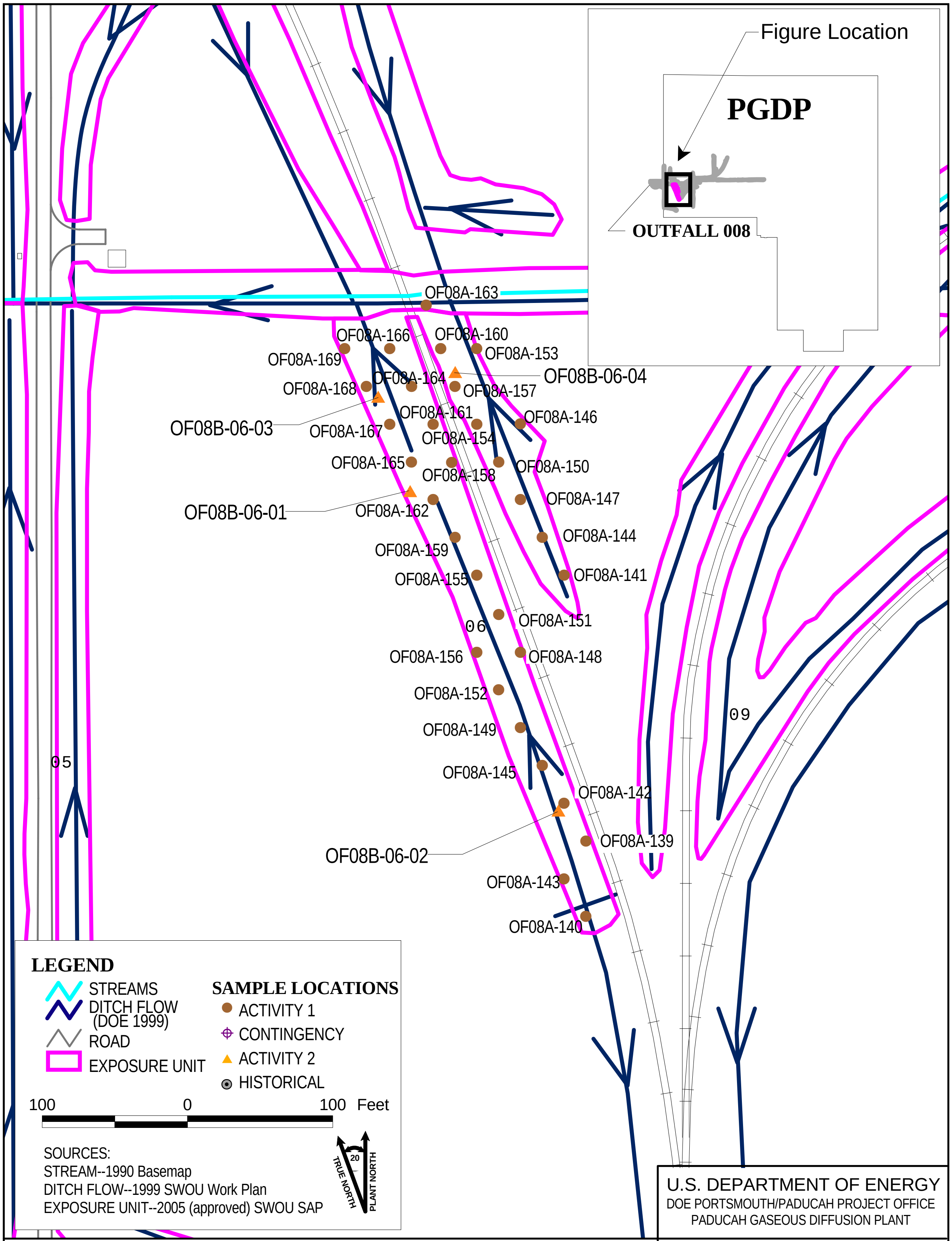

Figure 4.71. Outfall 008 EU 06 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

DOCUMENT No. DOE/LX/07-0001

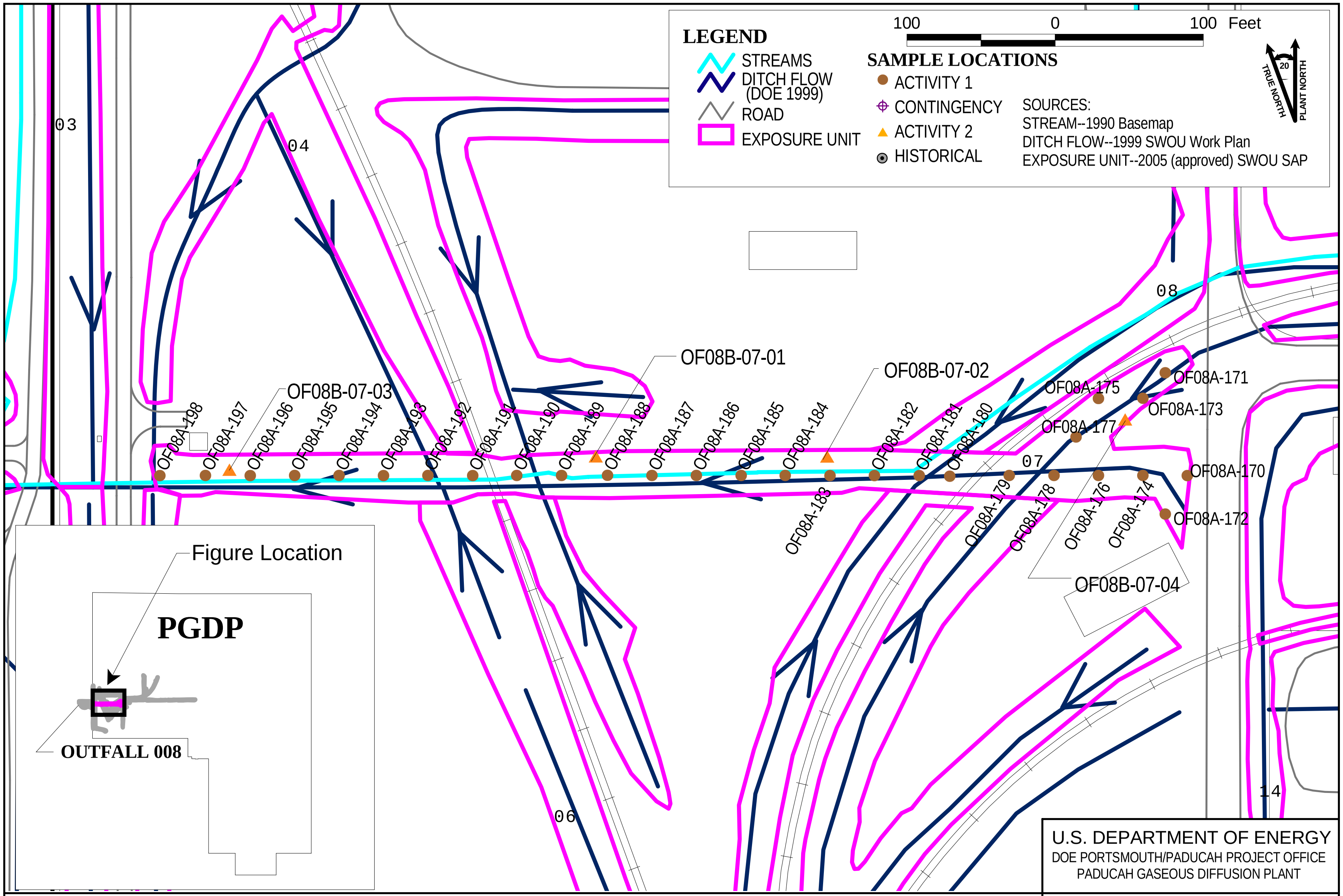

Figure 4.72. Outfall 008 EU 07 - Locations of RI and Historical Samples

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DATE 03-12-07

DOCUMENT No. DOE/LX/07-0001

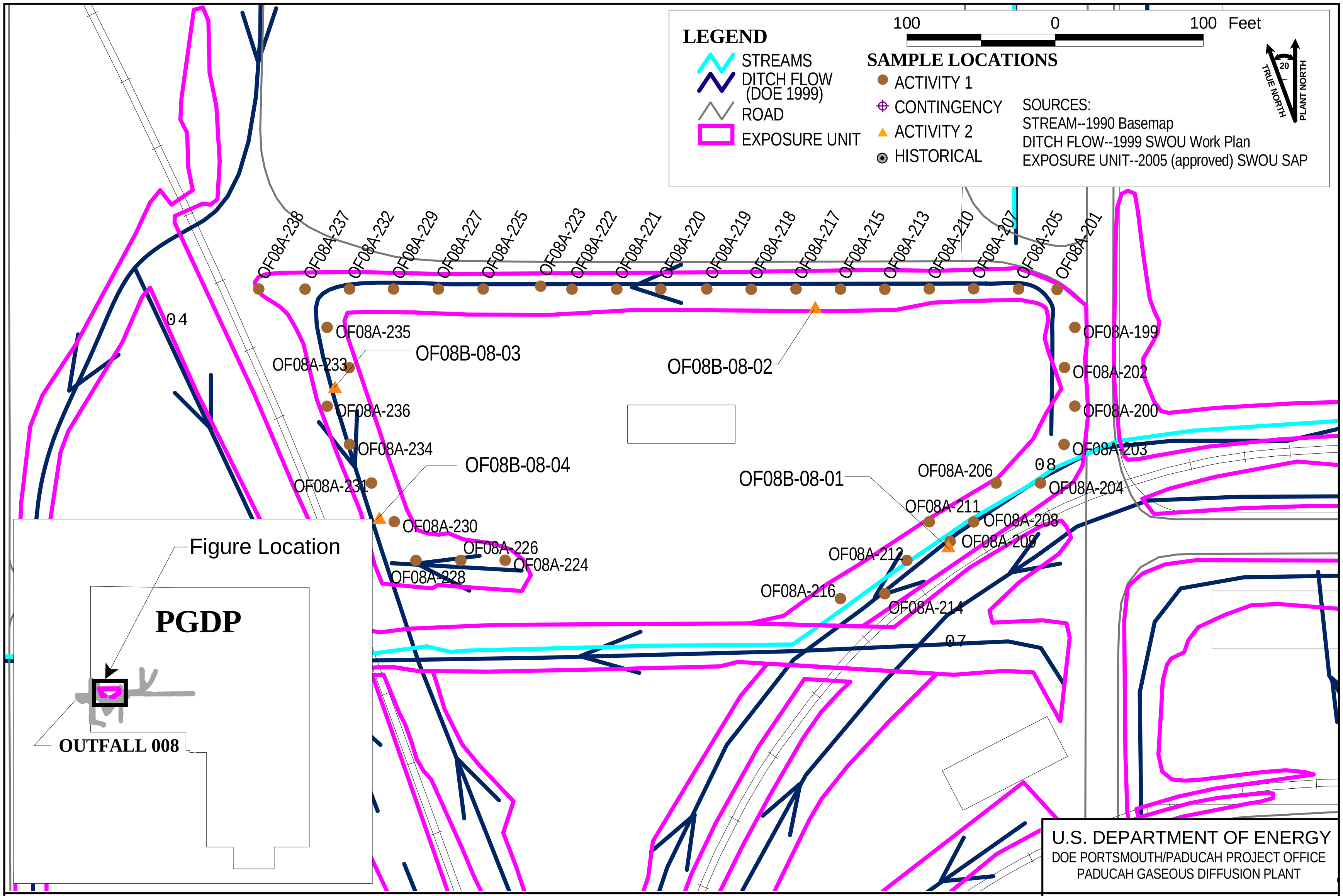

Figure 4.73. Outfall 008 EU 08 - Locations of RI and Historical Samples

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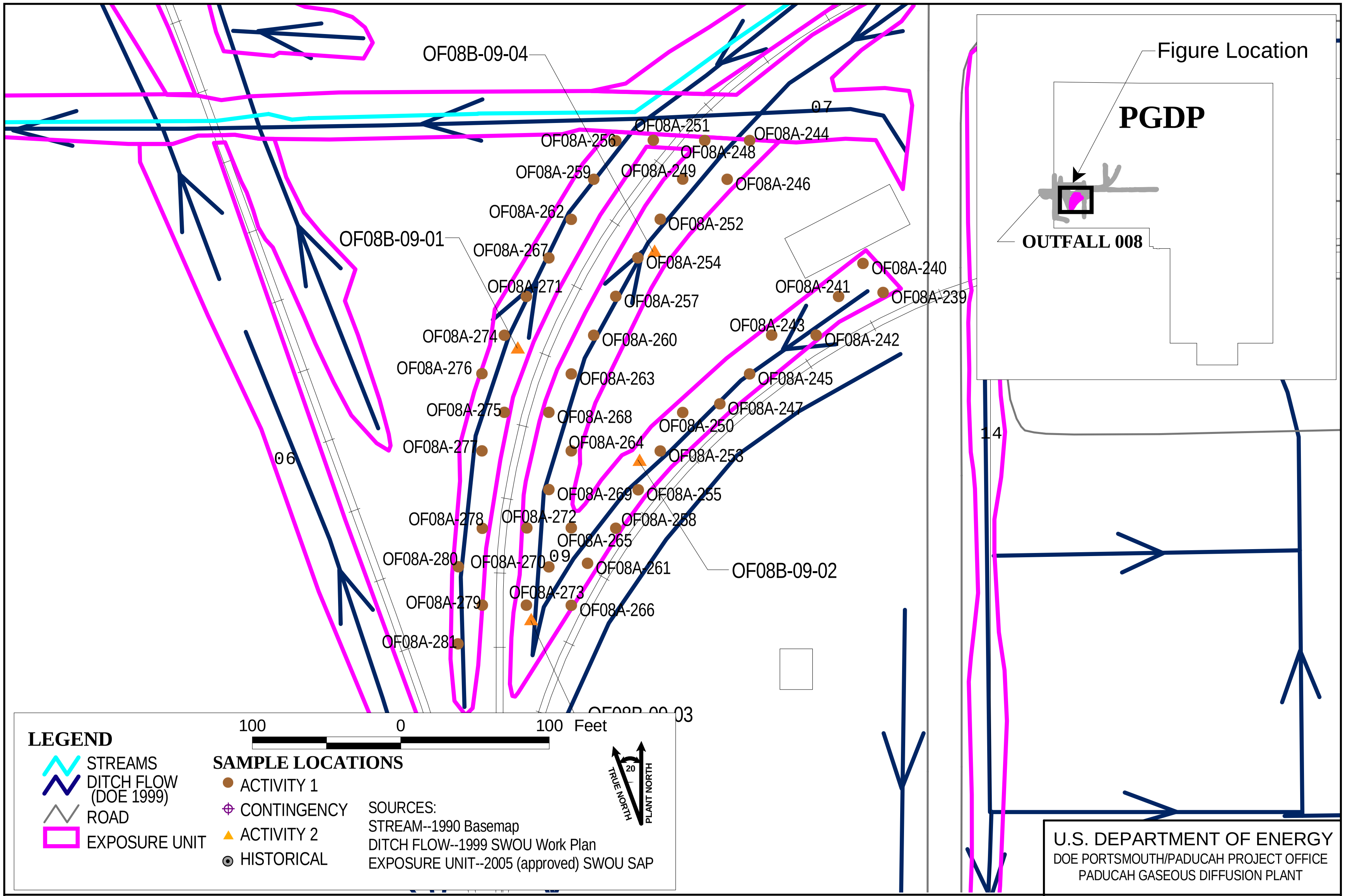

SOURCES:
STREAM--1990 Basemap
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Figure 4.74. Outfall 008 EU 09 - Locations of RI and Historical Samples

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Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

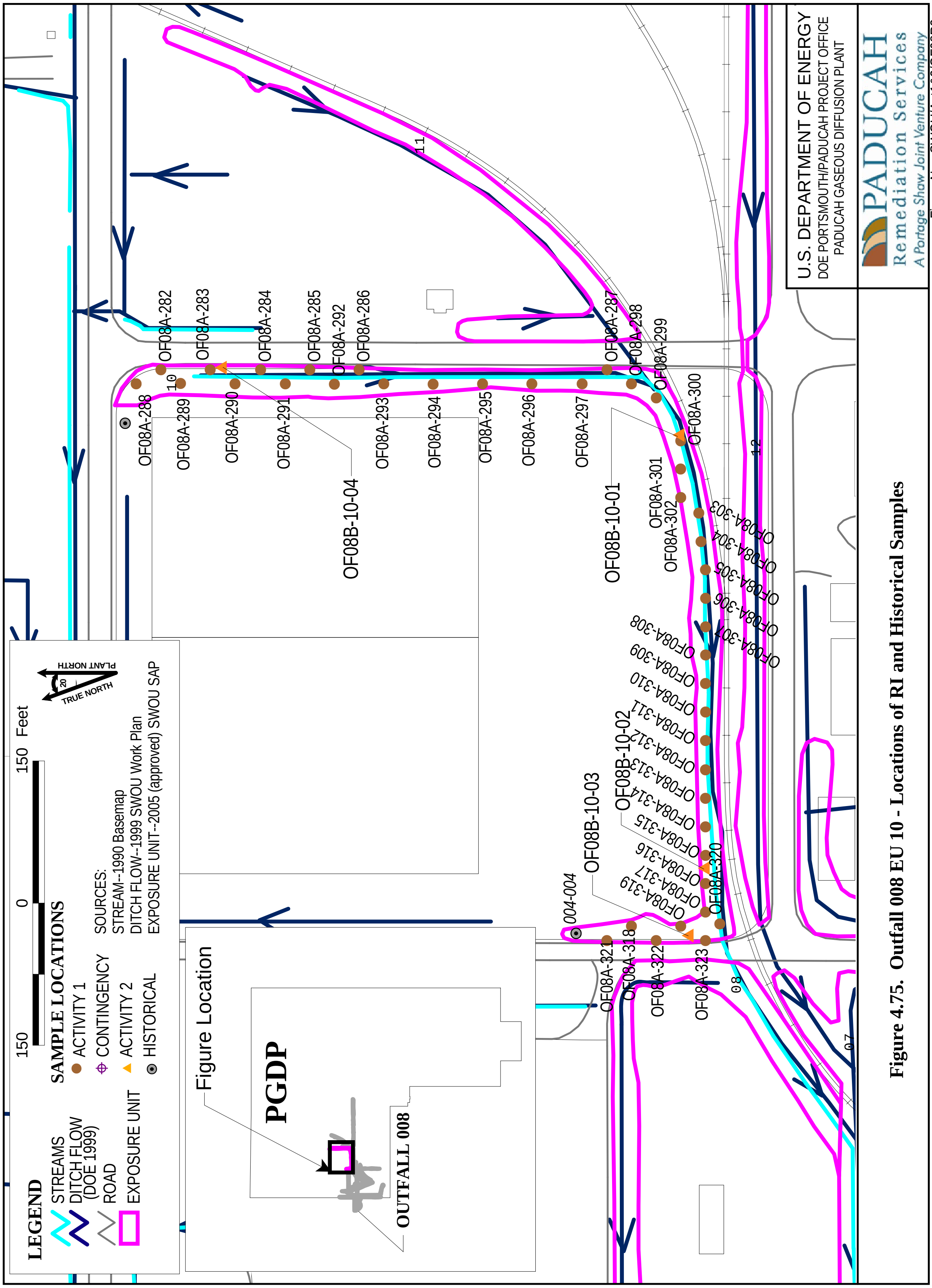

Figure 4.75. Outfall 008 EU 10 - Locations of RI and Historical Samples

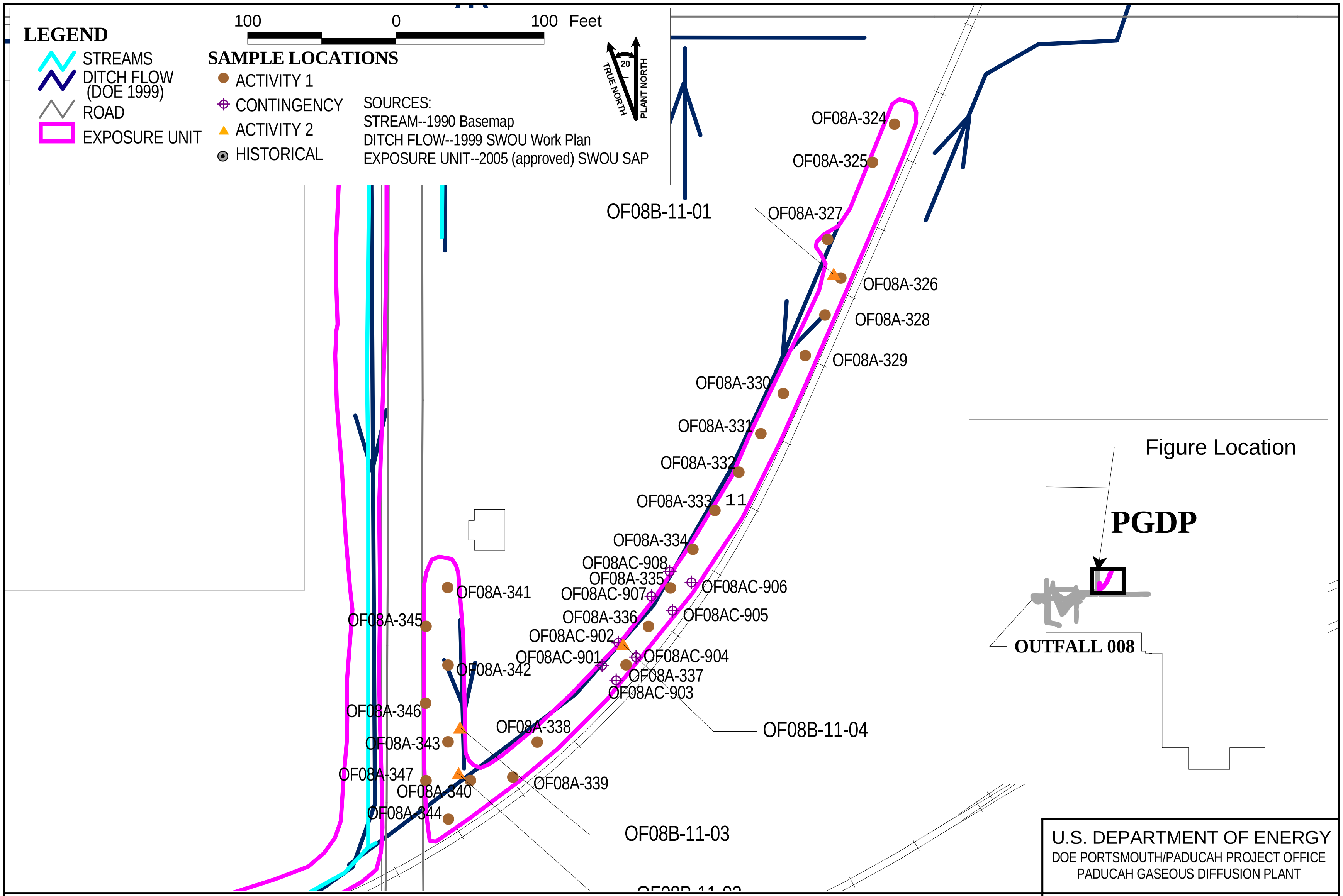

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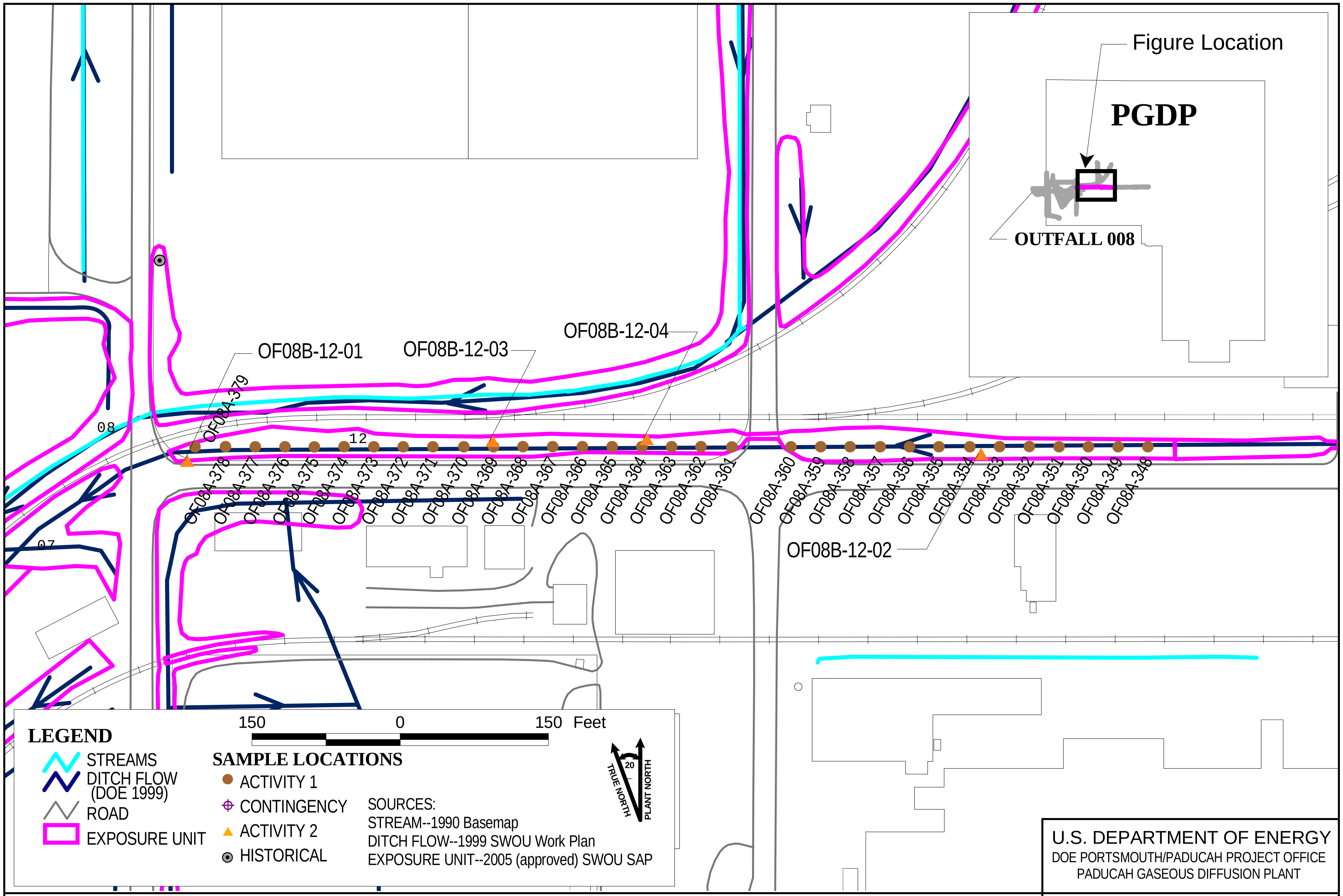
Figure 4.76. Outfall 008 EU 11 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.77. Outfall 008 EU 12 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

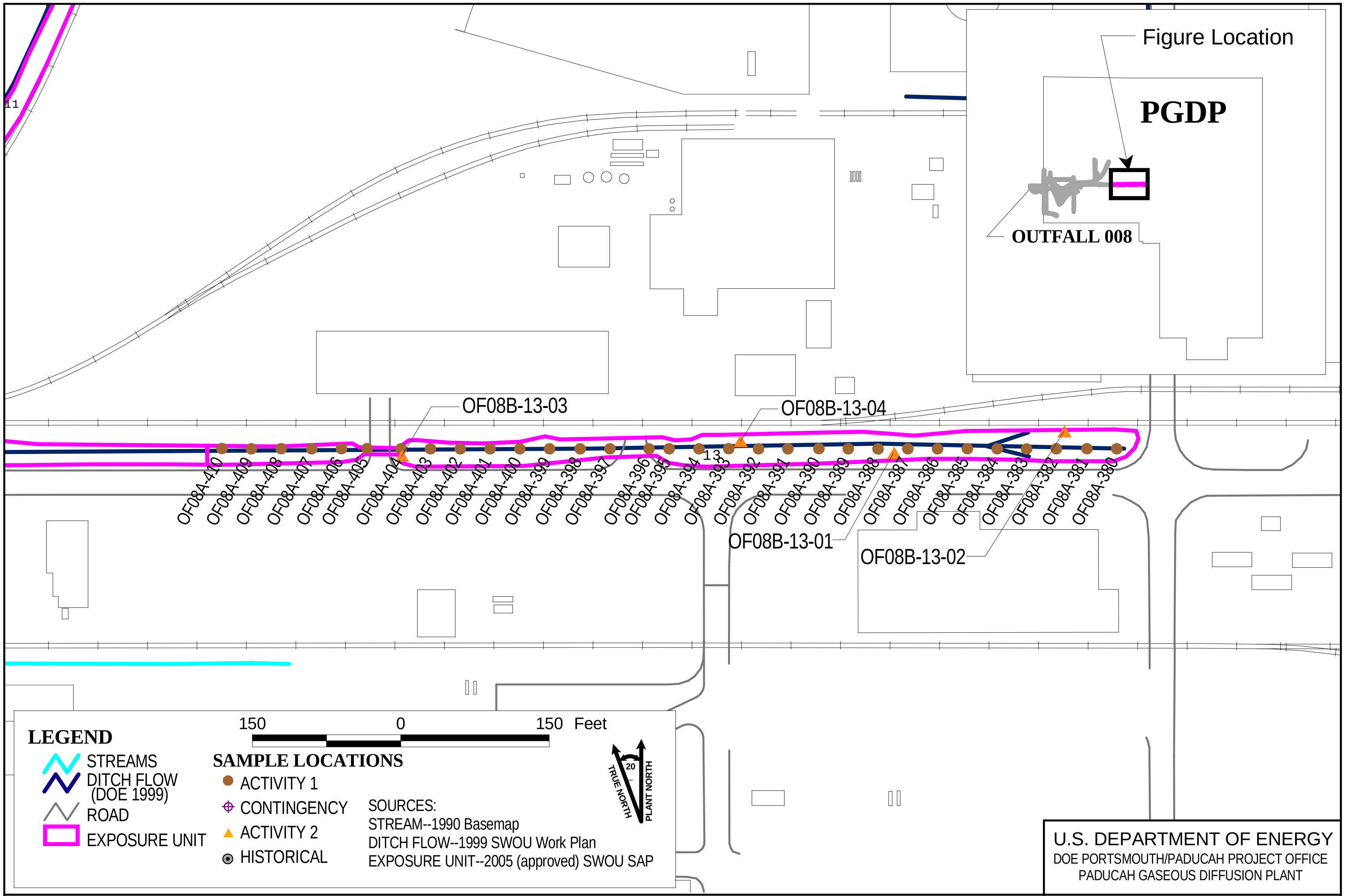

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Figure 4.78. Outfall 008 EU 13 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

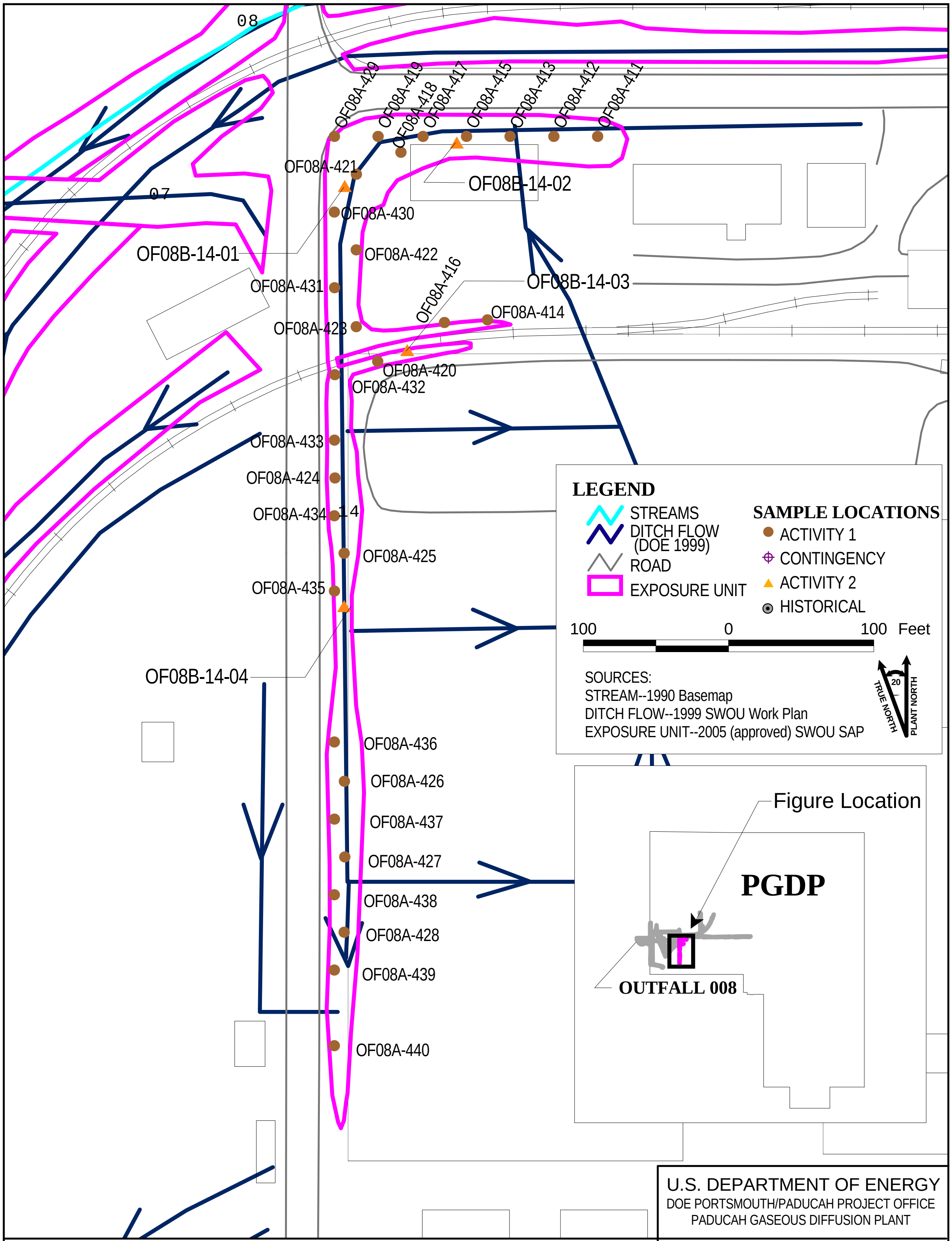

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Figure 4.79. Outfall 008 EU 14 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF08R2.apr
DATE 03-12-07

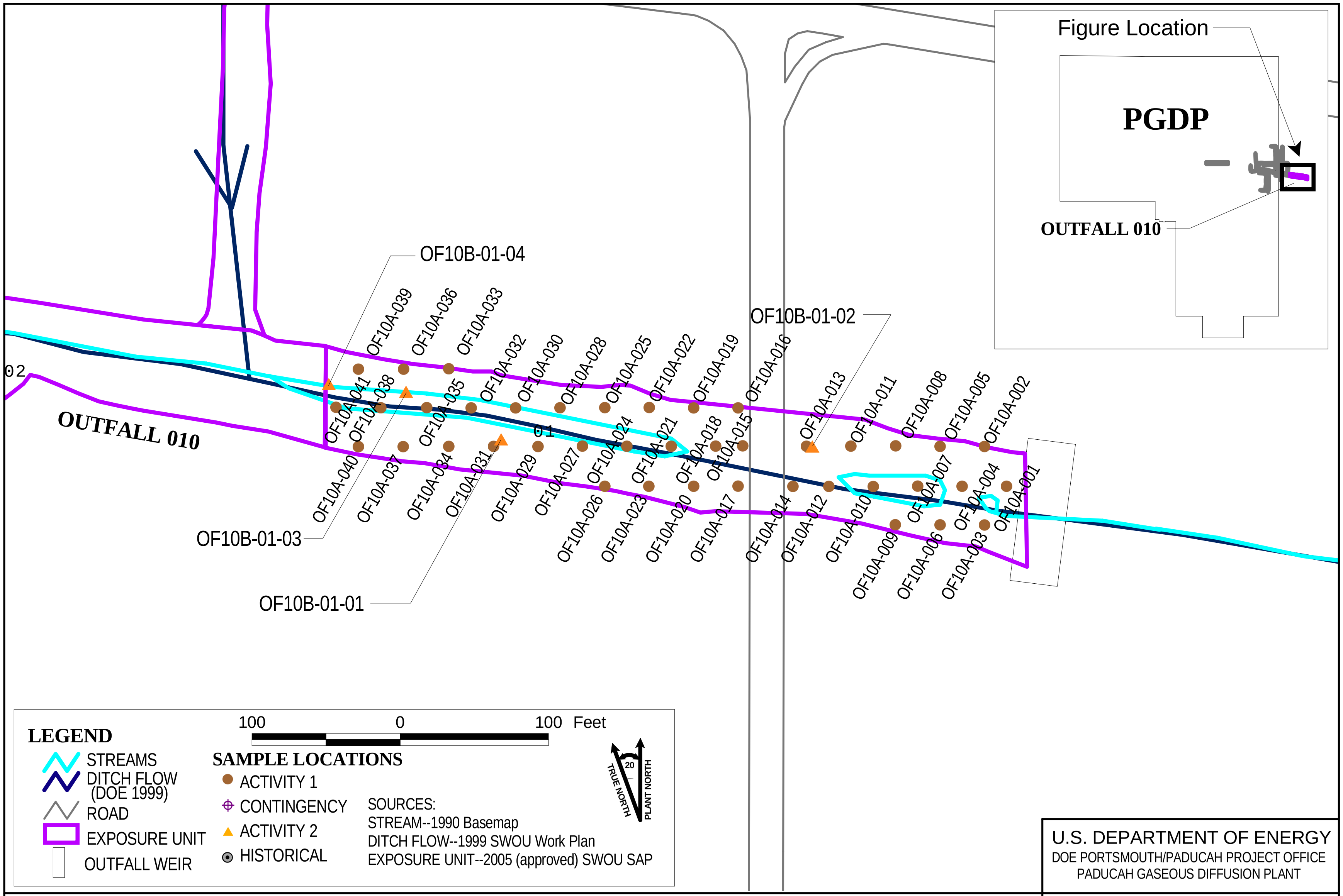

Figure 4.80. Outfall 010 EU 01 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

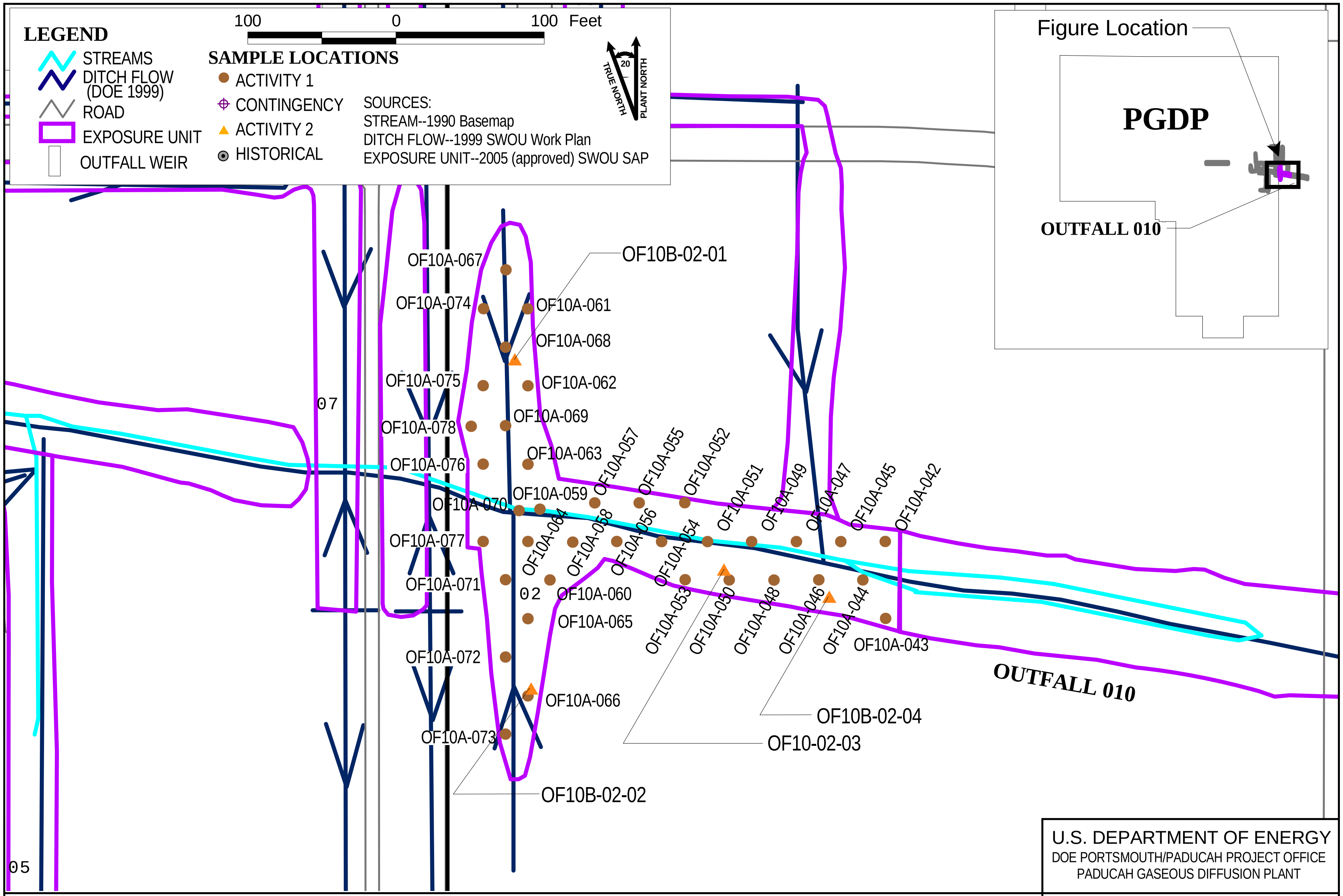

Figure 4.81. Outfall 010 EU 02 - Locations of RI and Historical Samples

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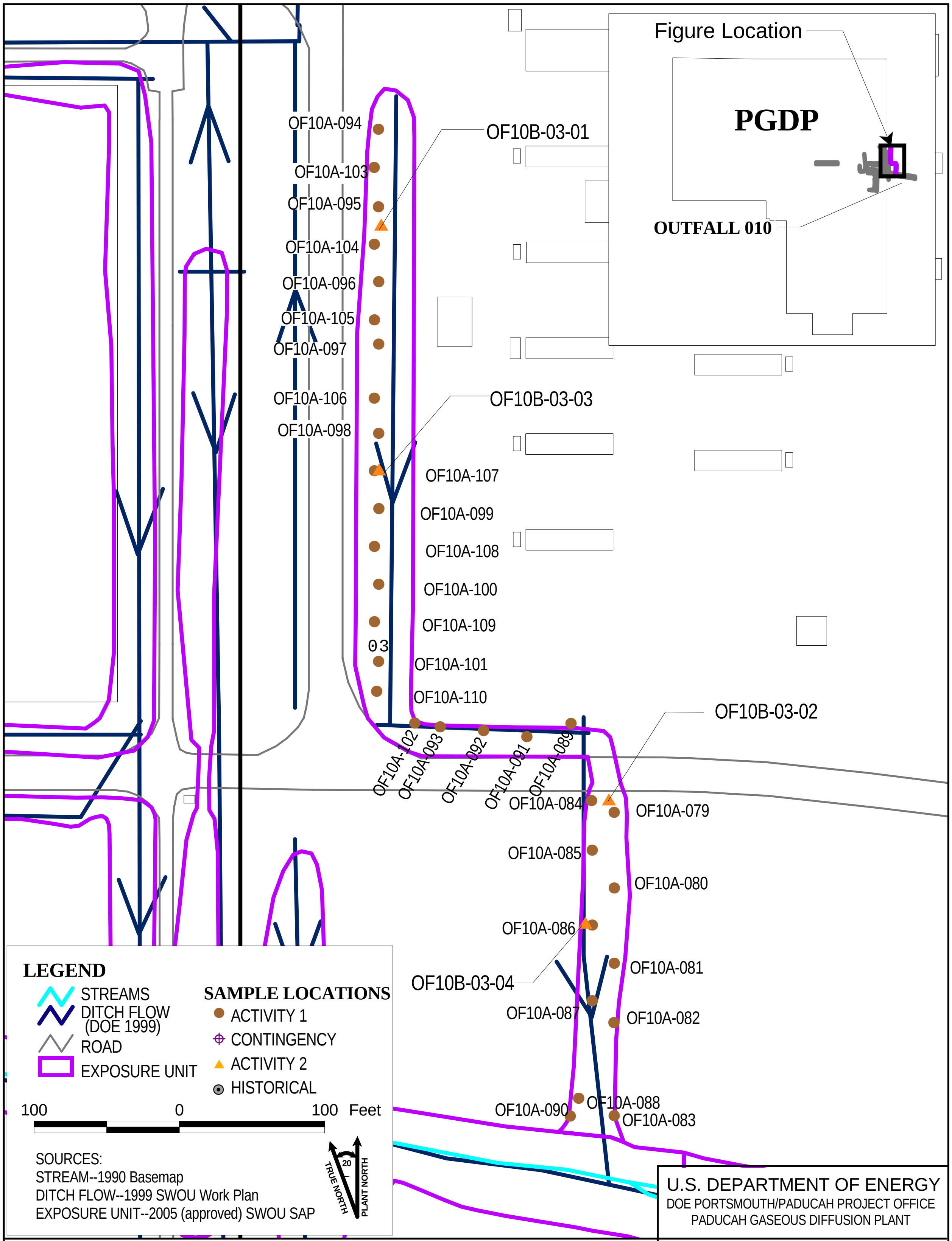
Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.82. Outfall 010 EU 03 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

DOCUMENT NO. DOE/LX/07-0001

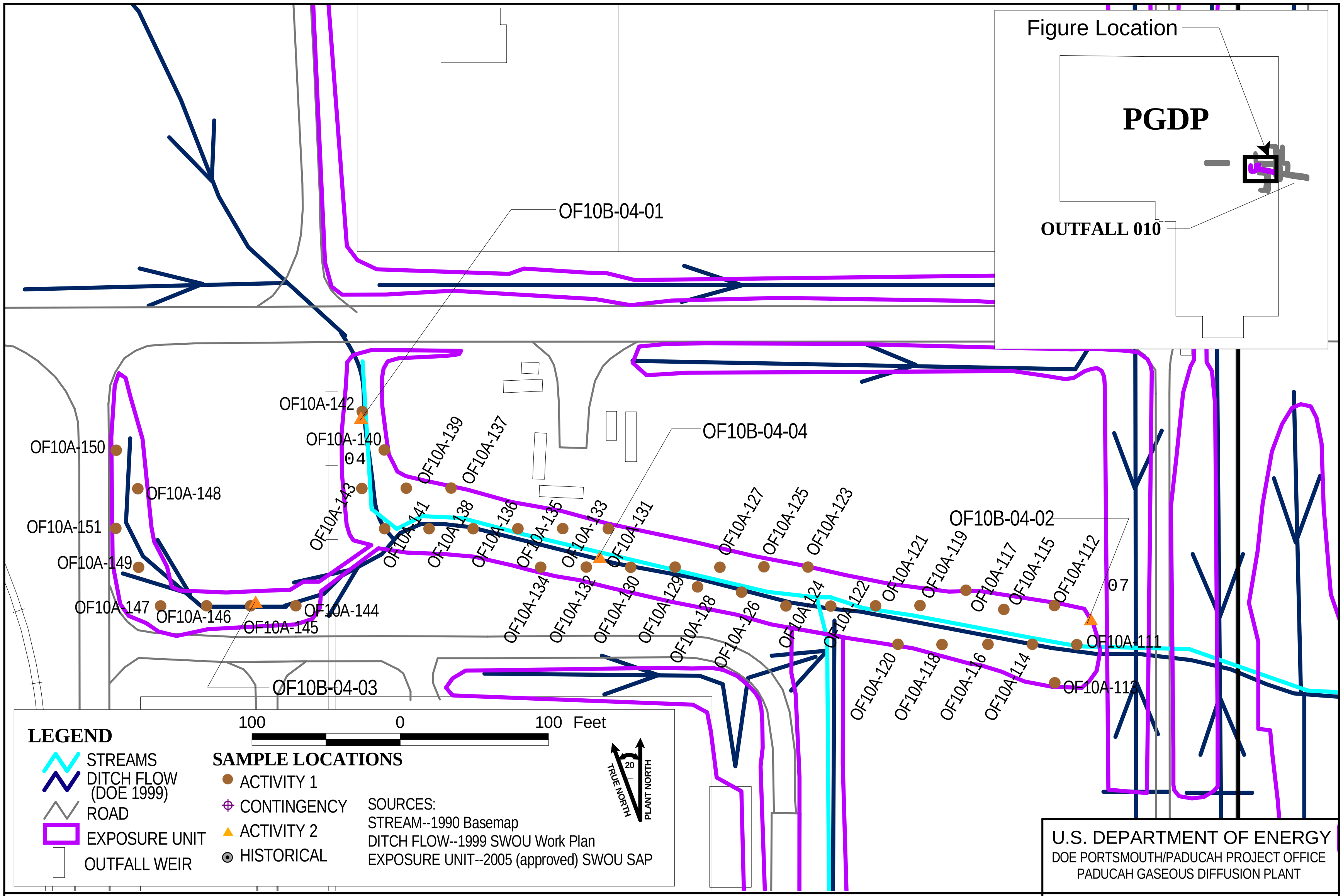

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Figure 4.83. Outfall 010 EU 04 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

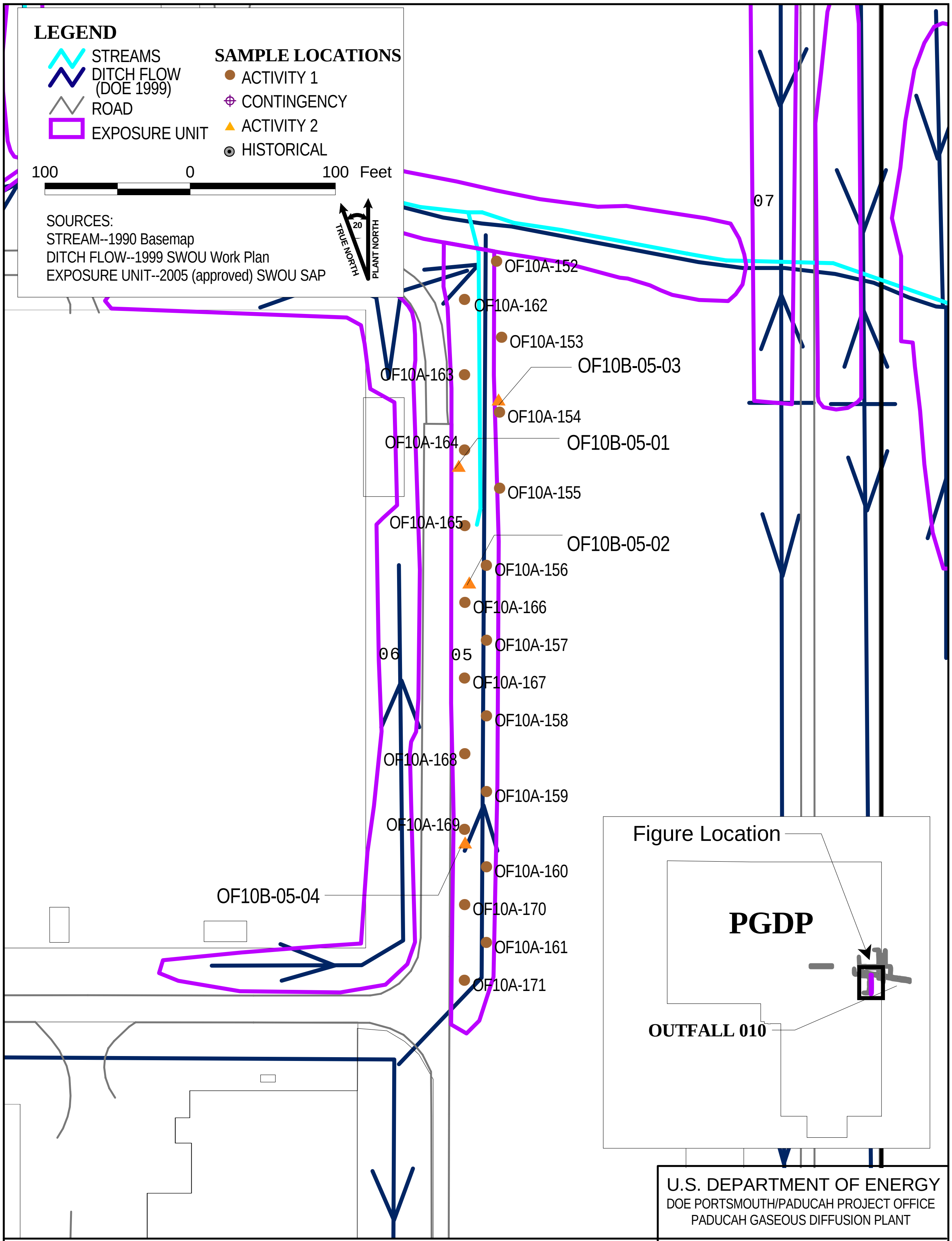

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Figure 4.84. Outfall 010 EU 05 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

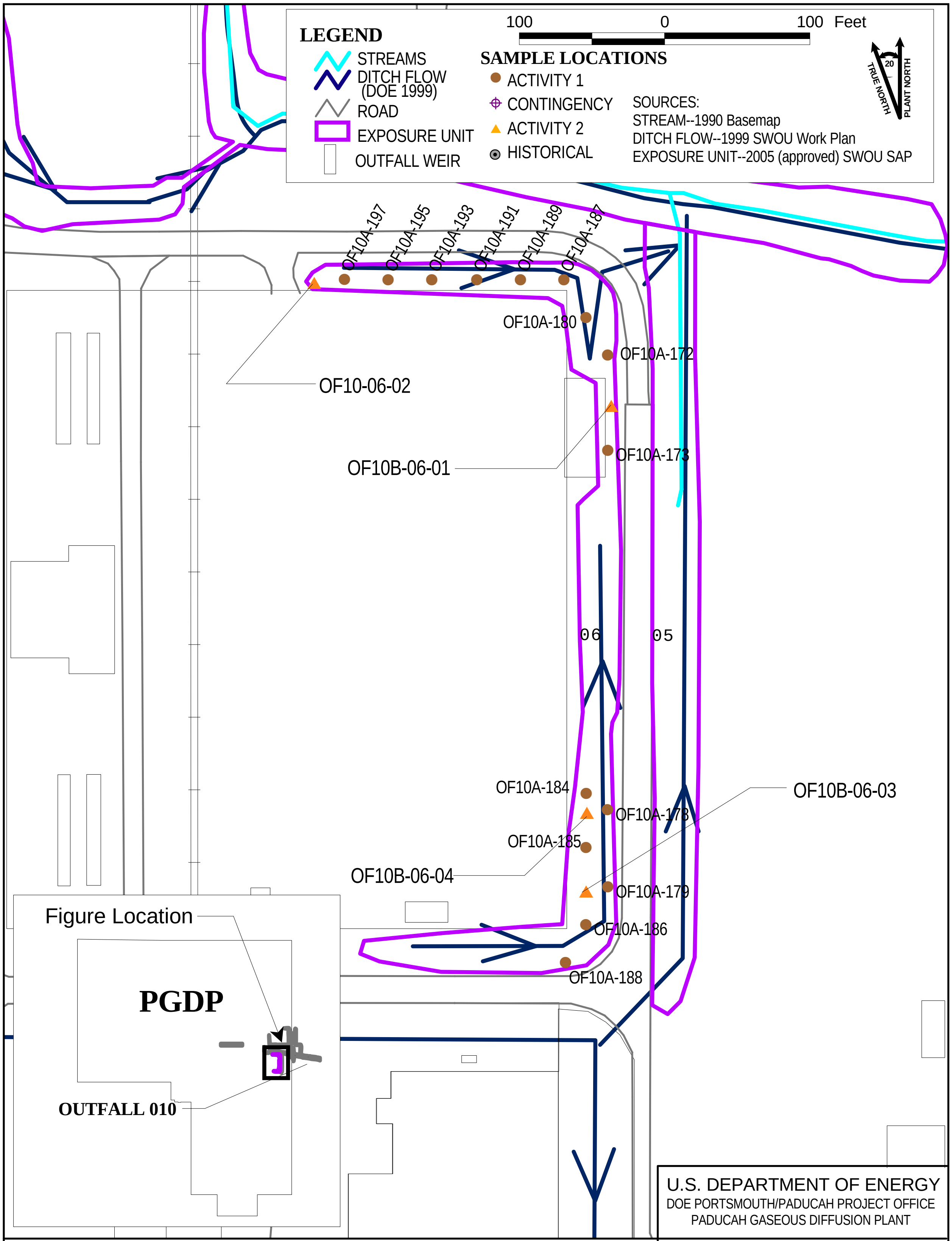

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Figure 4.85. Outfall 010 EU 06 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
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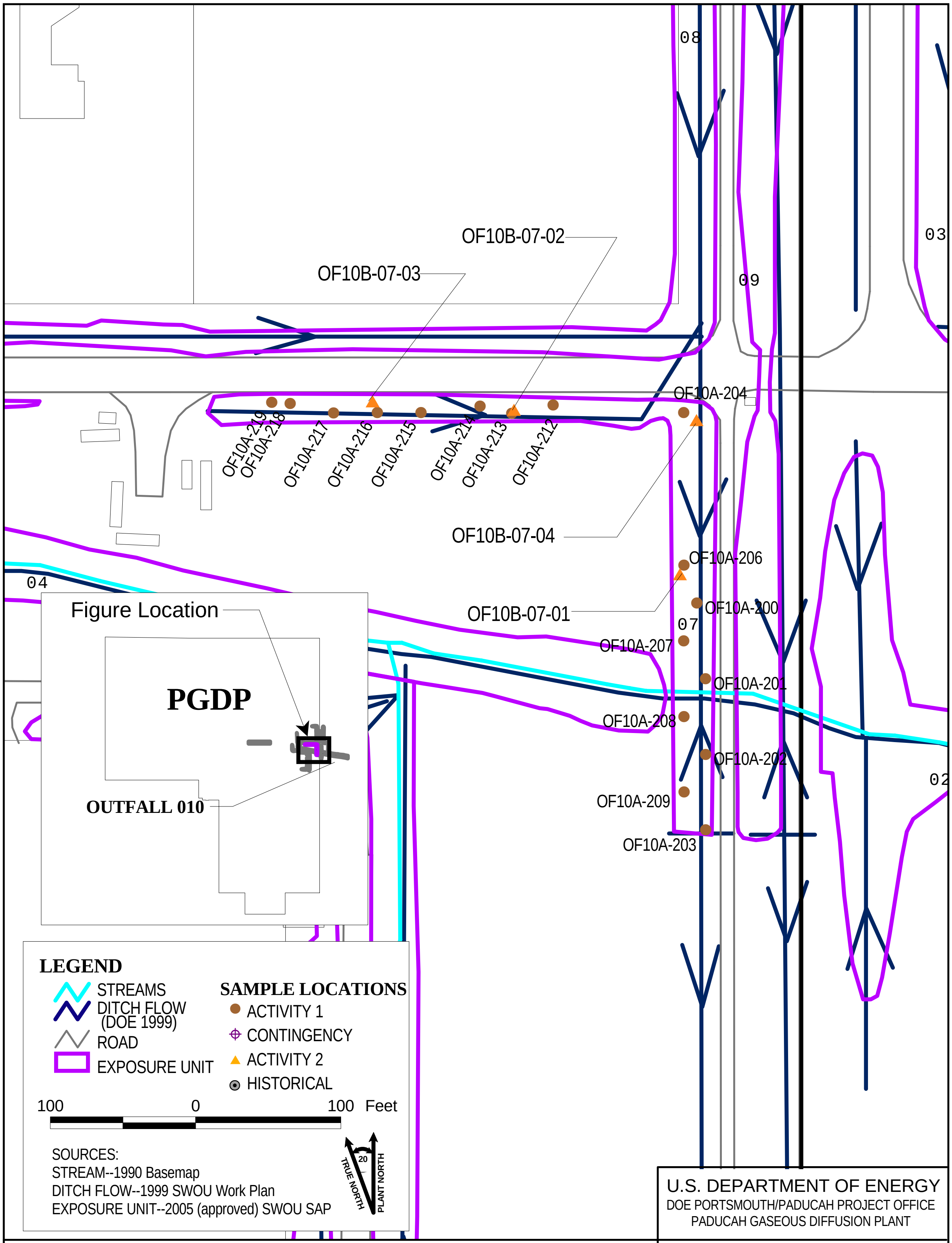

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.86. Outfall 010 EU 07 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

DOCUMENT NO. DOE/LX/07-0001

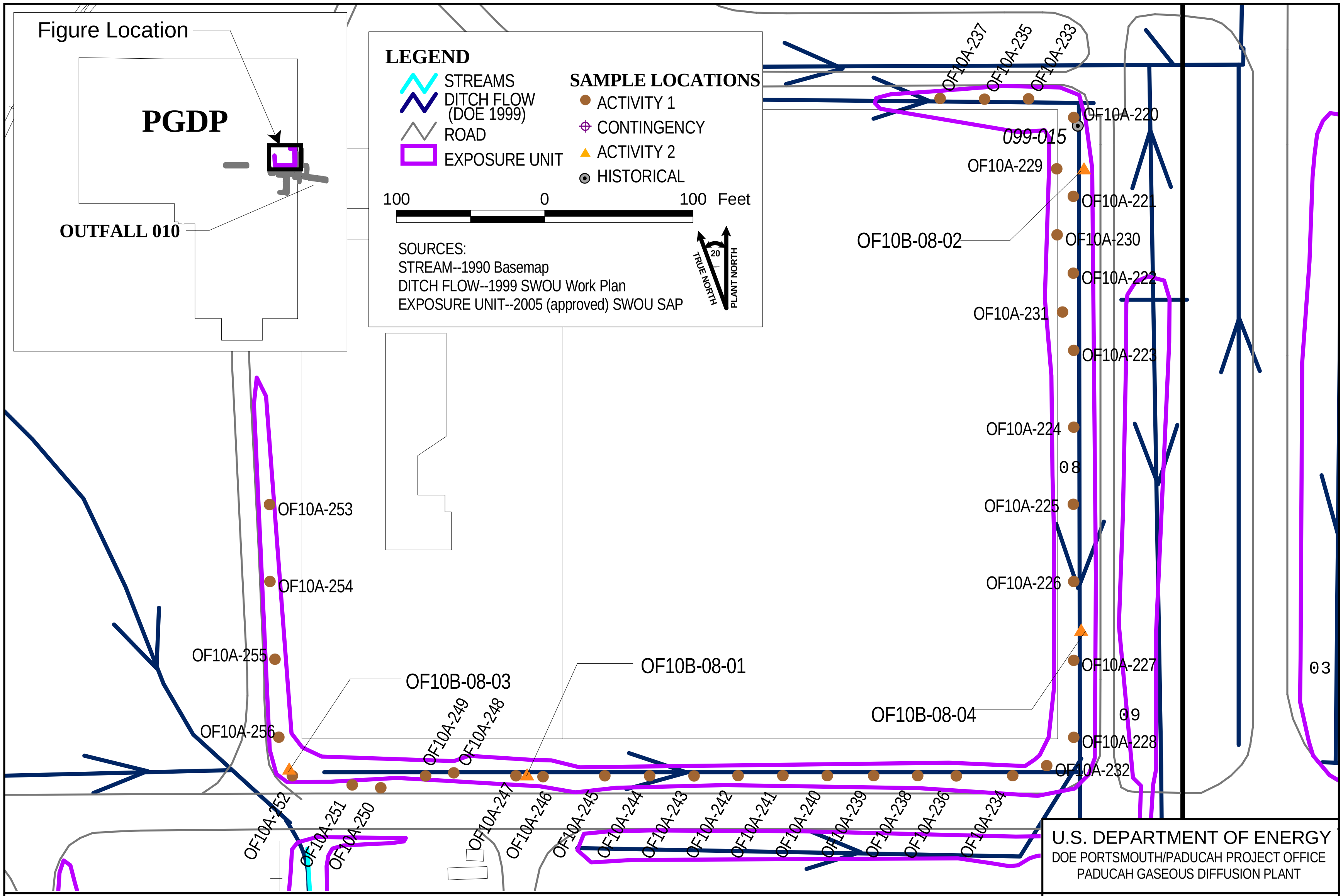

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Figure 4.87. Outfall 010 EU 08 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

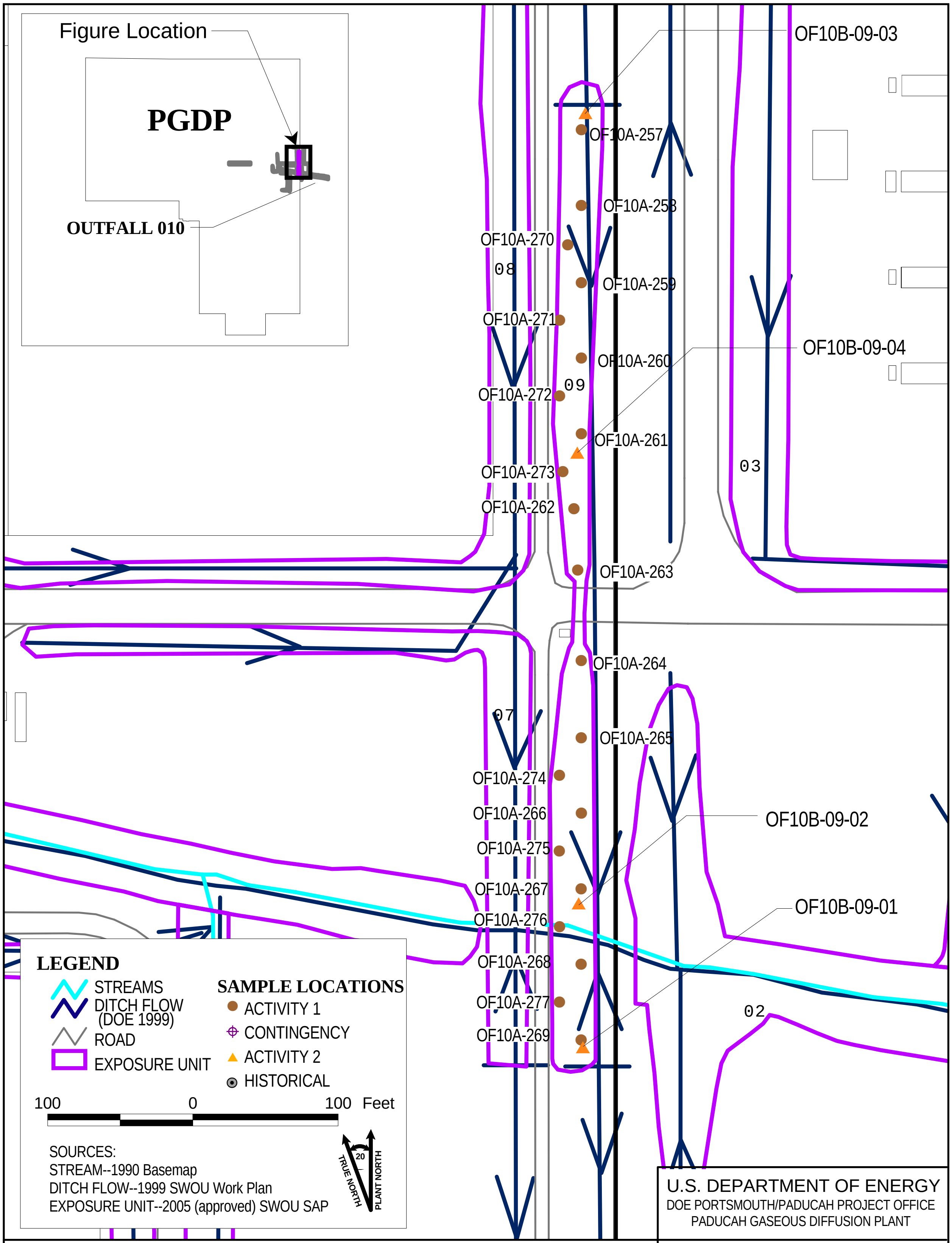

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Figure 4.88. Outfall 010 EU 09 - Locations of RI and Historical Samples

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Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

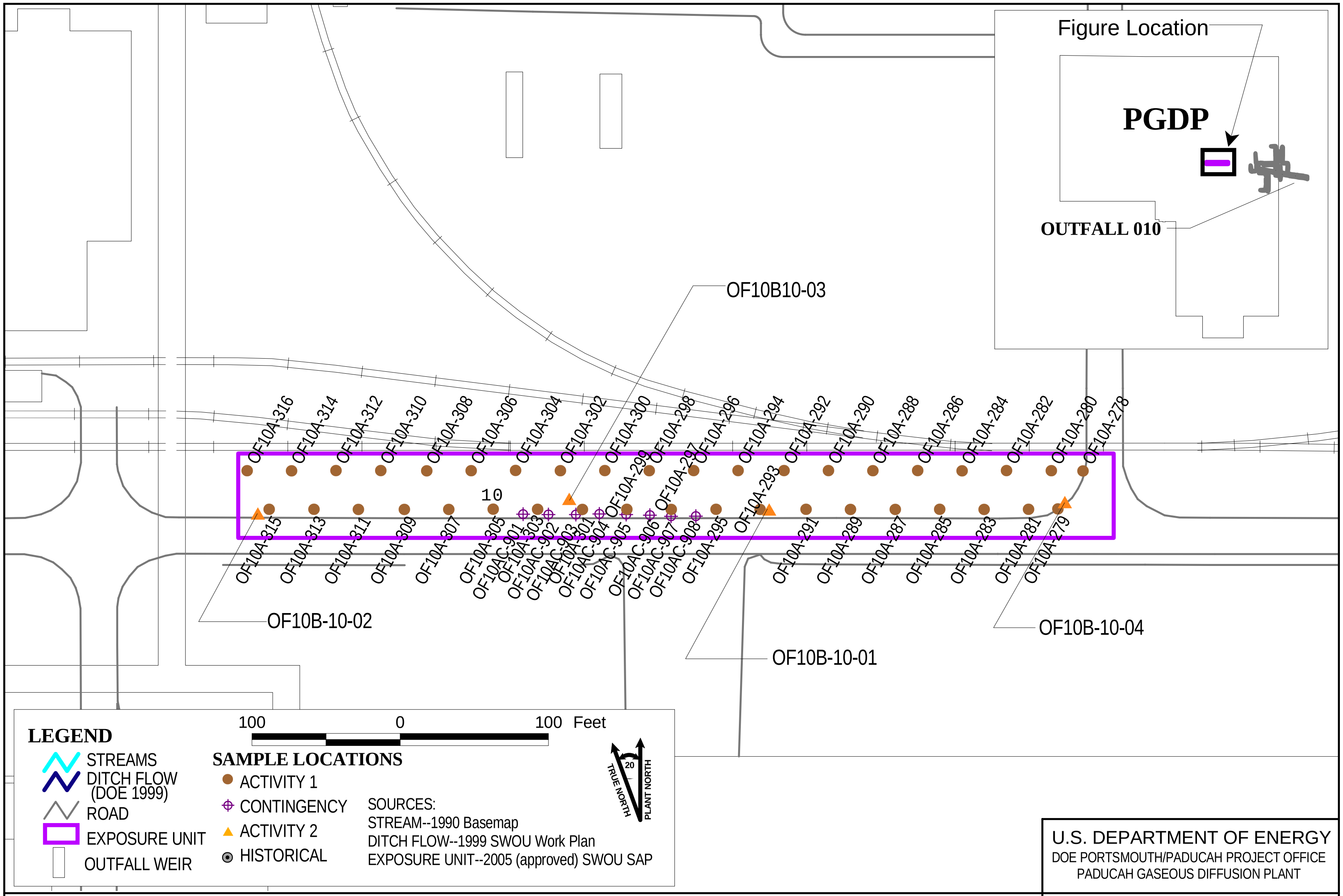

Figure 4.89. Outfall 010 EU 10 - Locations of RI and Historical Samples

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Figure No. SWOU/Act1&2/OF10R2.apr
DATE 03-12-07

DOCUMENT NO. DOE/LX/07-0001

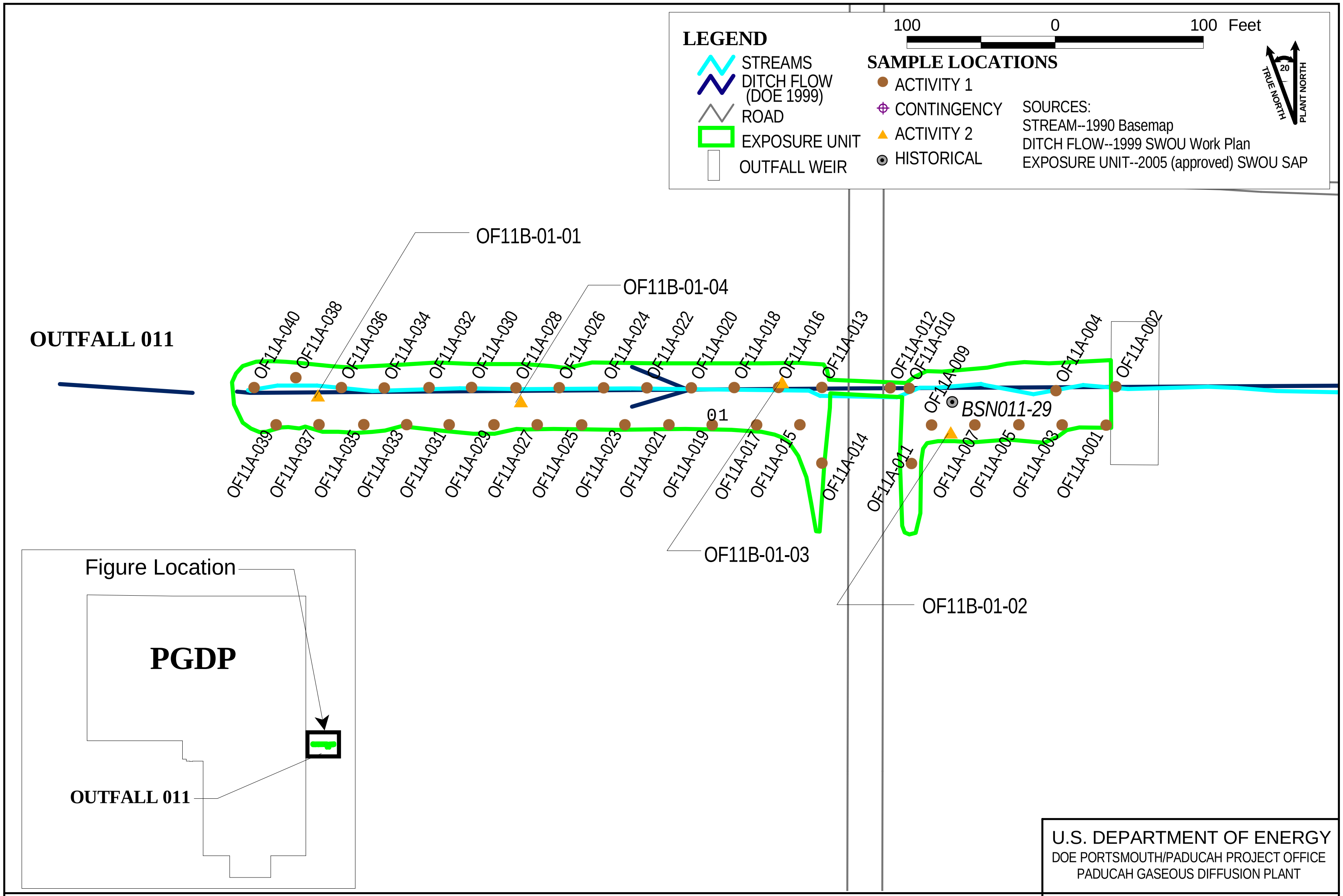

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Figure 4.90. Outfall 011 EU 01 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF11R2.apr
DATE 03-12-07

DOCUMENT NO. DOE/LX/07-0001

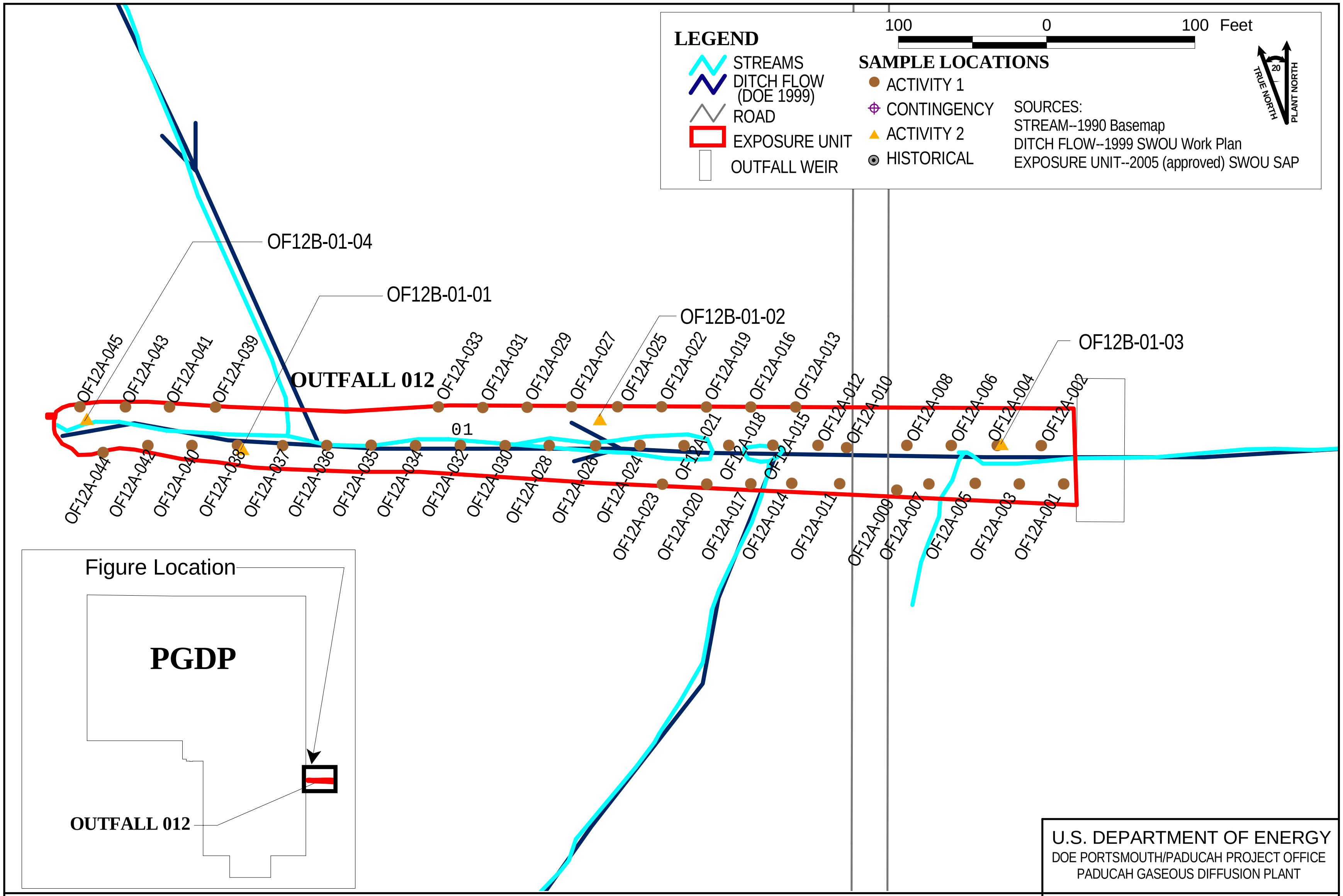

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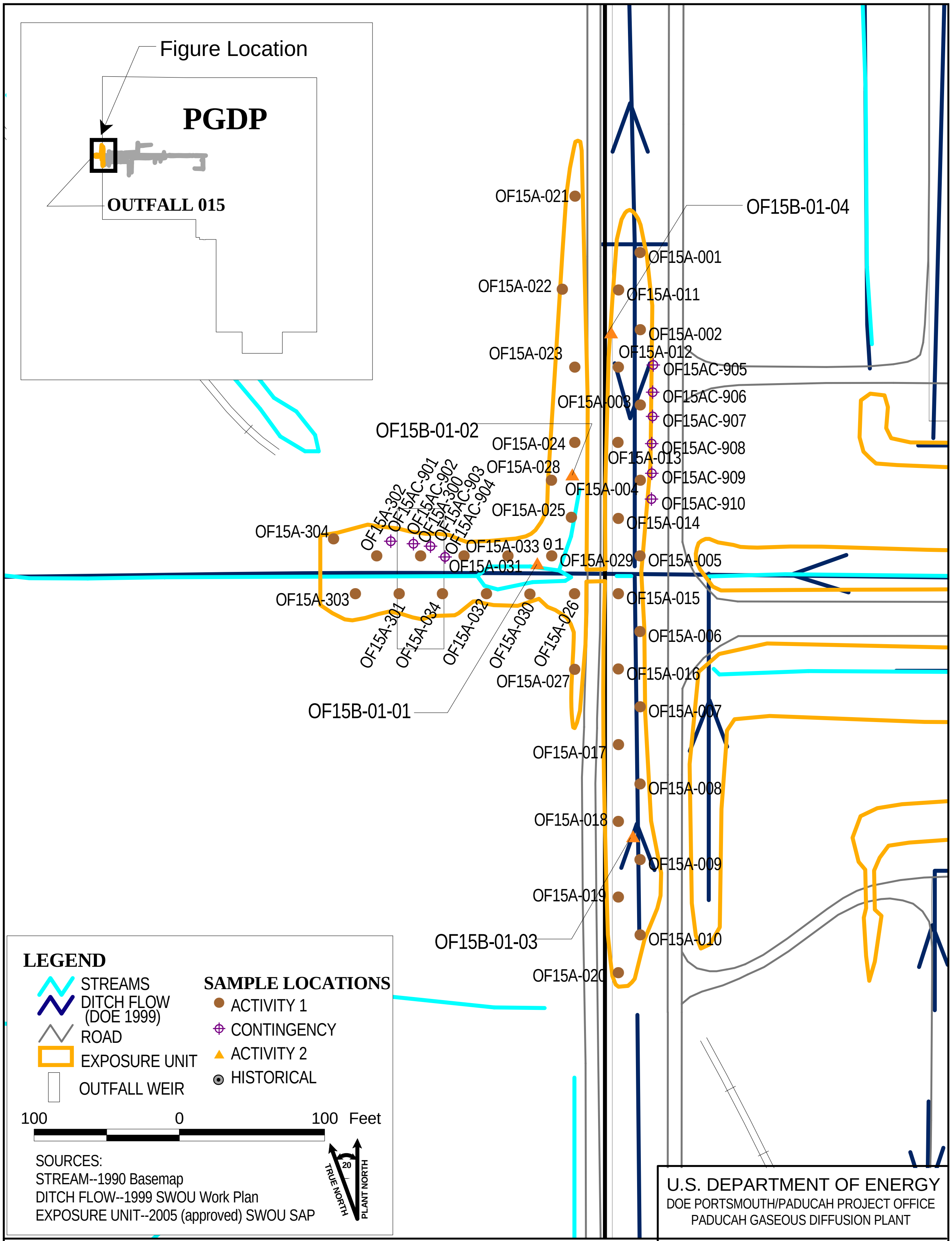
Figure 4.91. Outfall 012 EU 01 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF12R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.92. Outfall 015 EU 01 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF15R2.apr
DATE 03-12-07

DOCUMENT NO. DOE/LX/07-0001

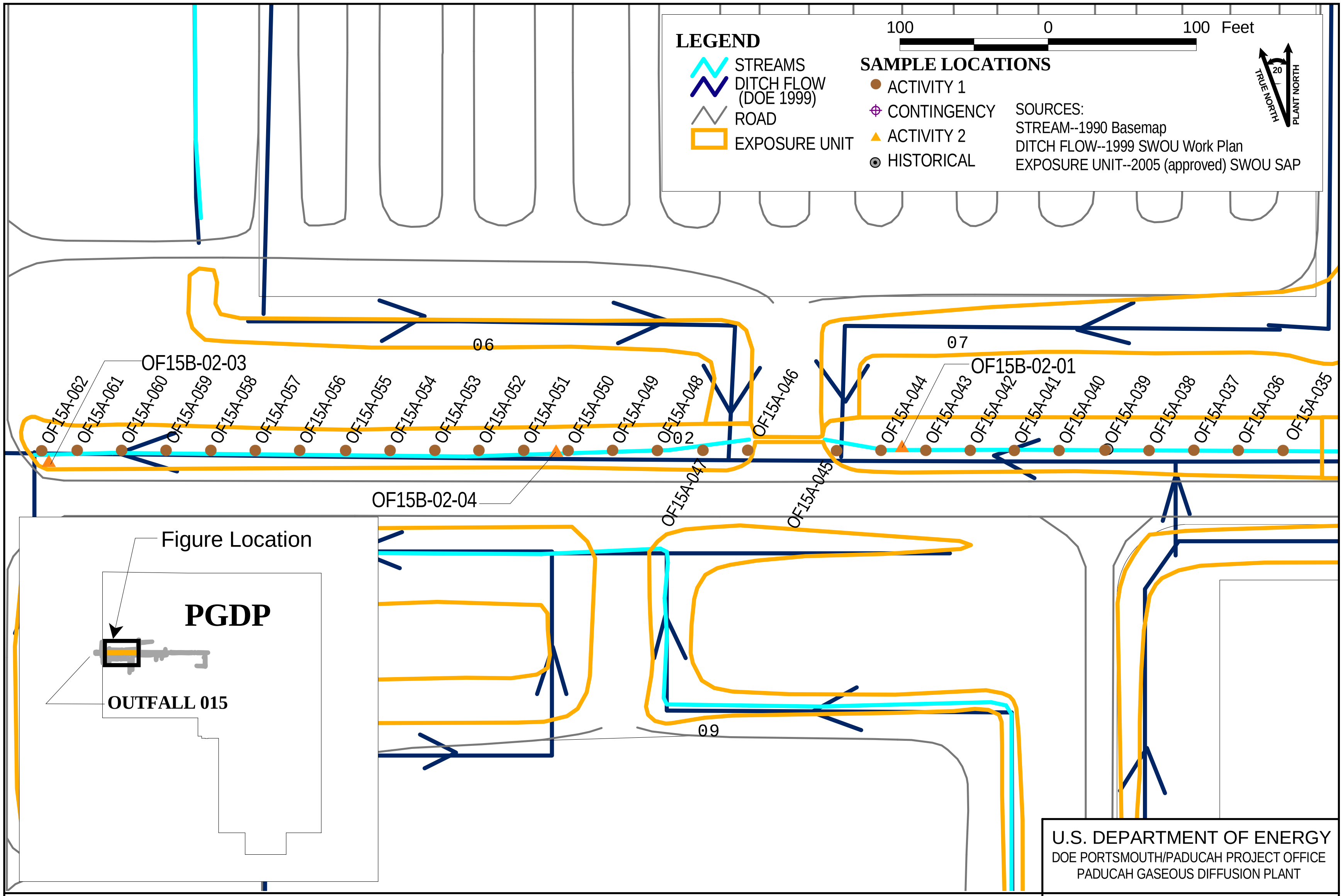

Figure 4.93. Outfall 015 EU 02 - Locations of RI and Historical Samples

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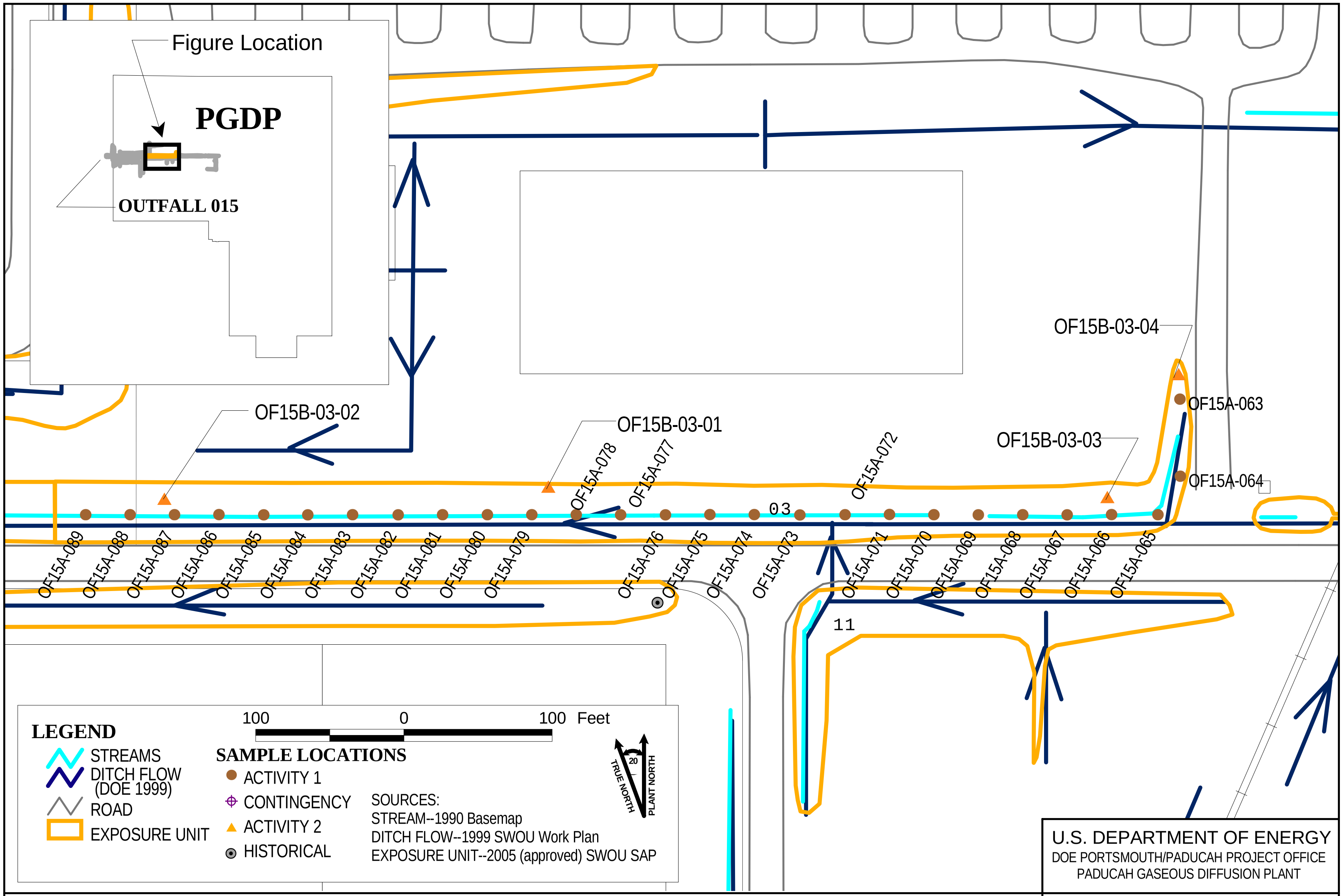

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.94. Outfall 015 EU 03 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF15R2.apr
DATE 03-12-07

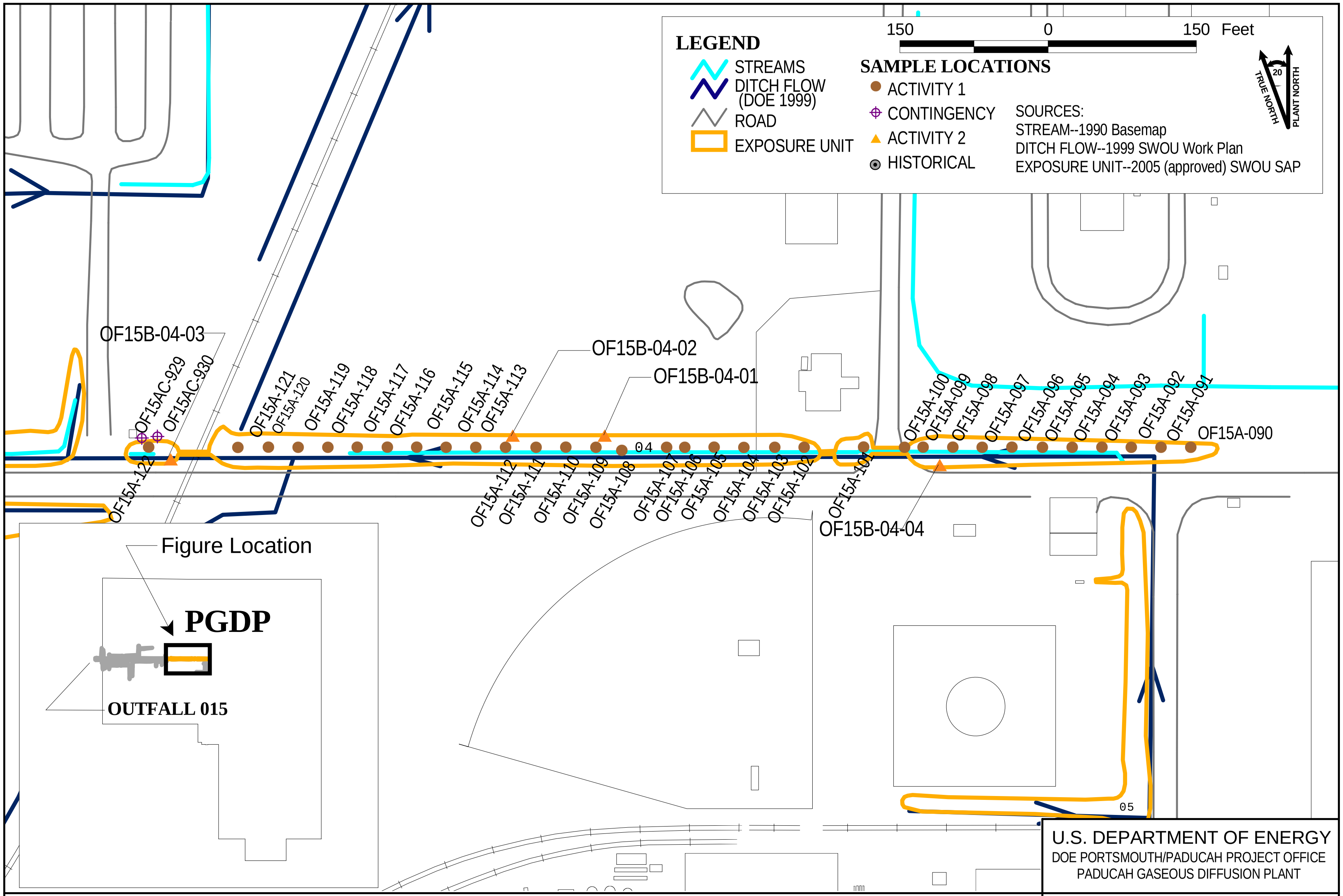
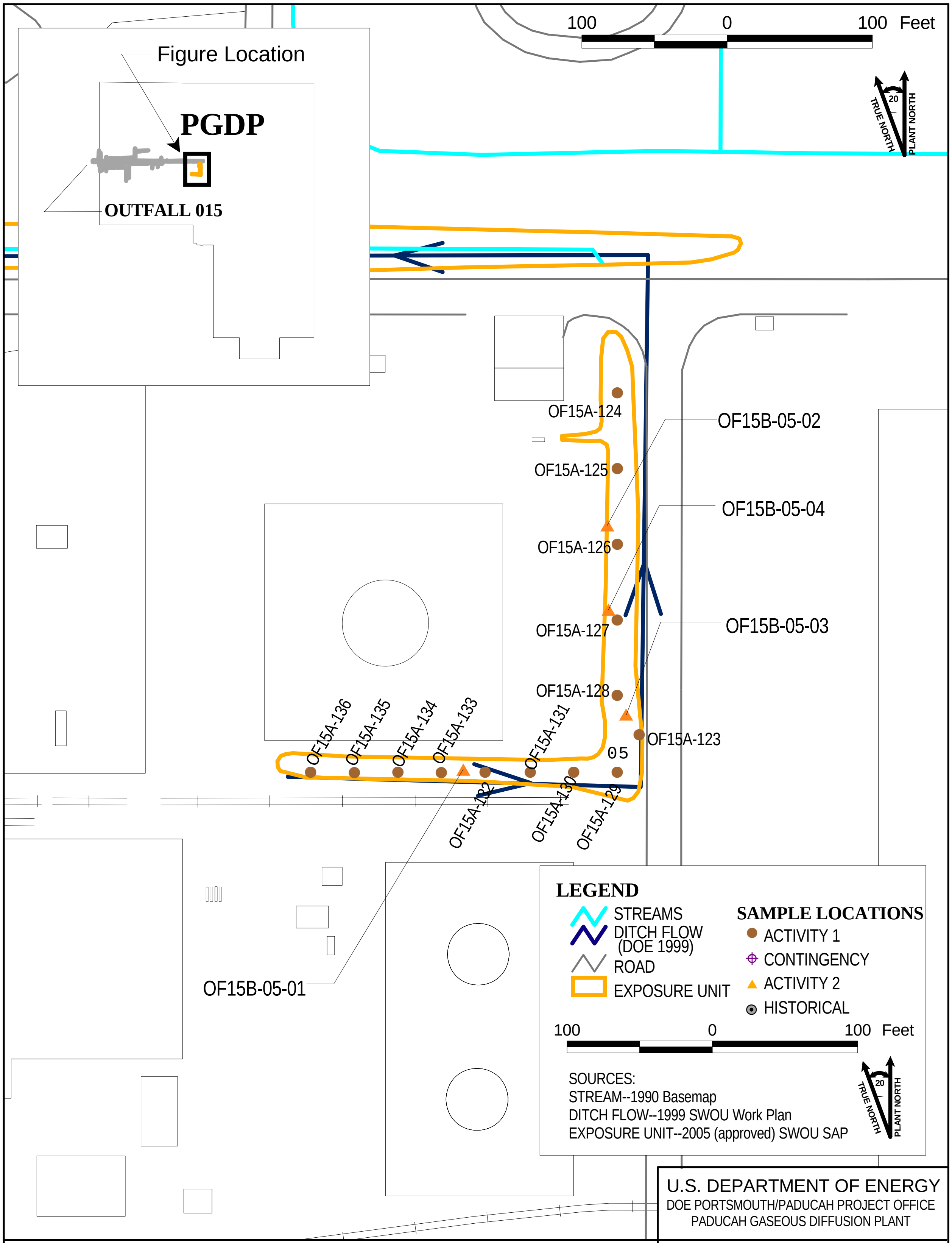


Figure 4.95. Outfall 015 EU 04 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF15R2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.96. Outfall 015 EU 05 - Locations of RI and Historical Samples

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DATE 03-12-07

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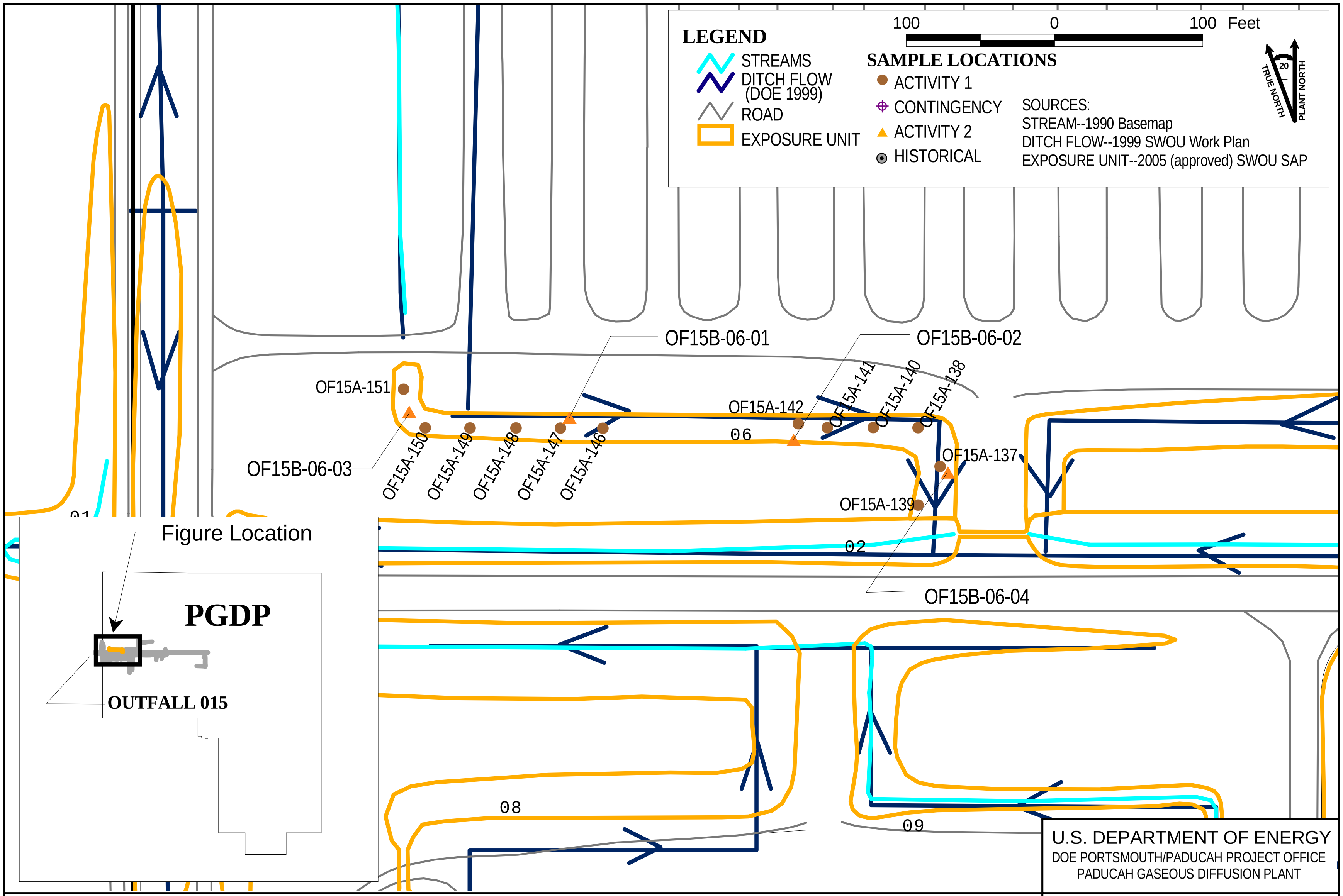

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Figure 4.97. Outfall 015 EU 06 - Locations of RI and Historical Samples

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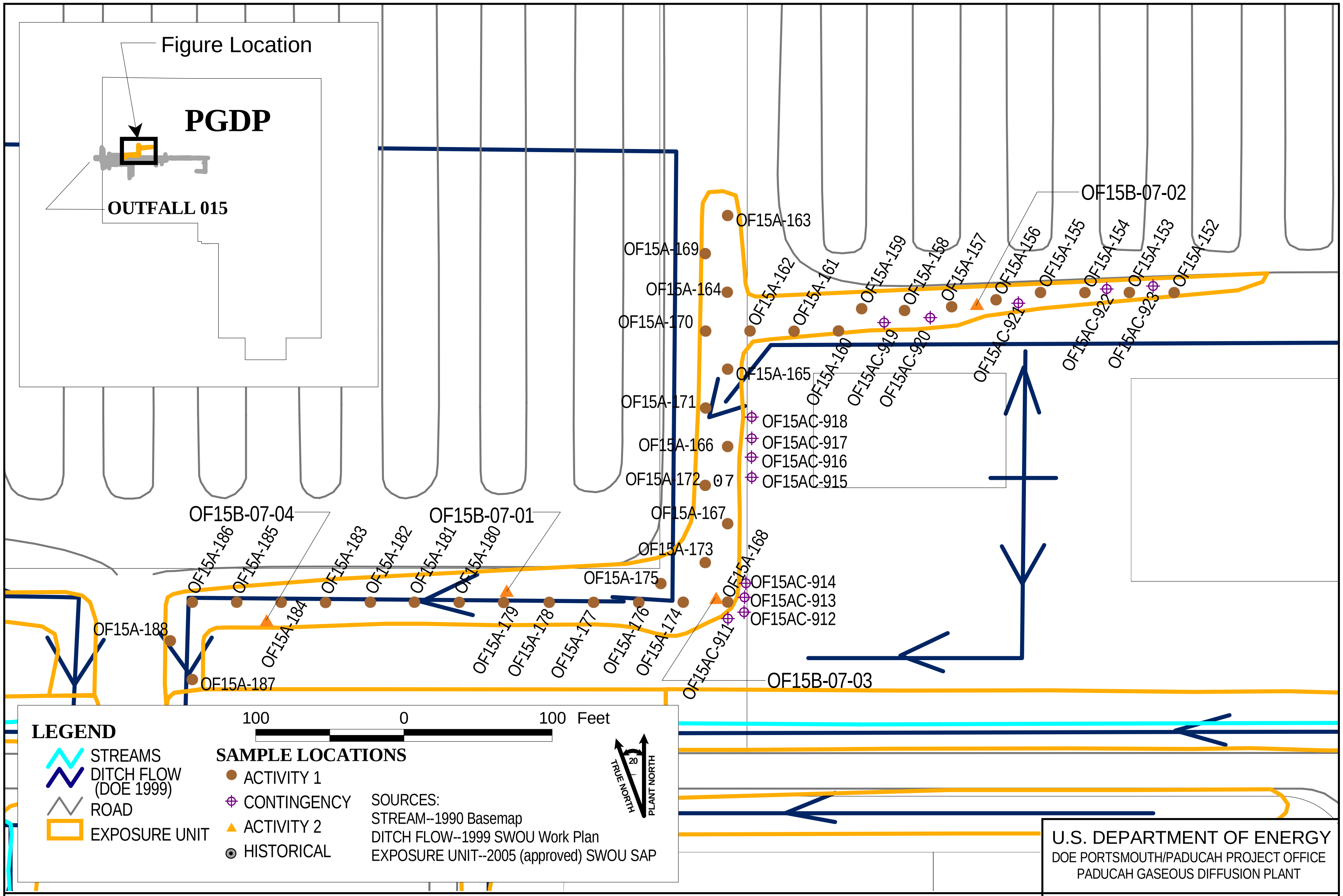

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

Figure 4.98. Outfall 015 EU 07 - Locations of RI and Historical Samples

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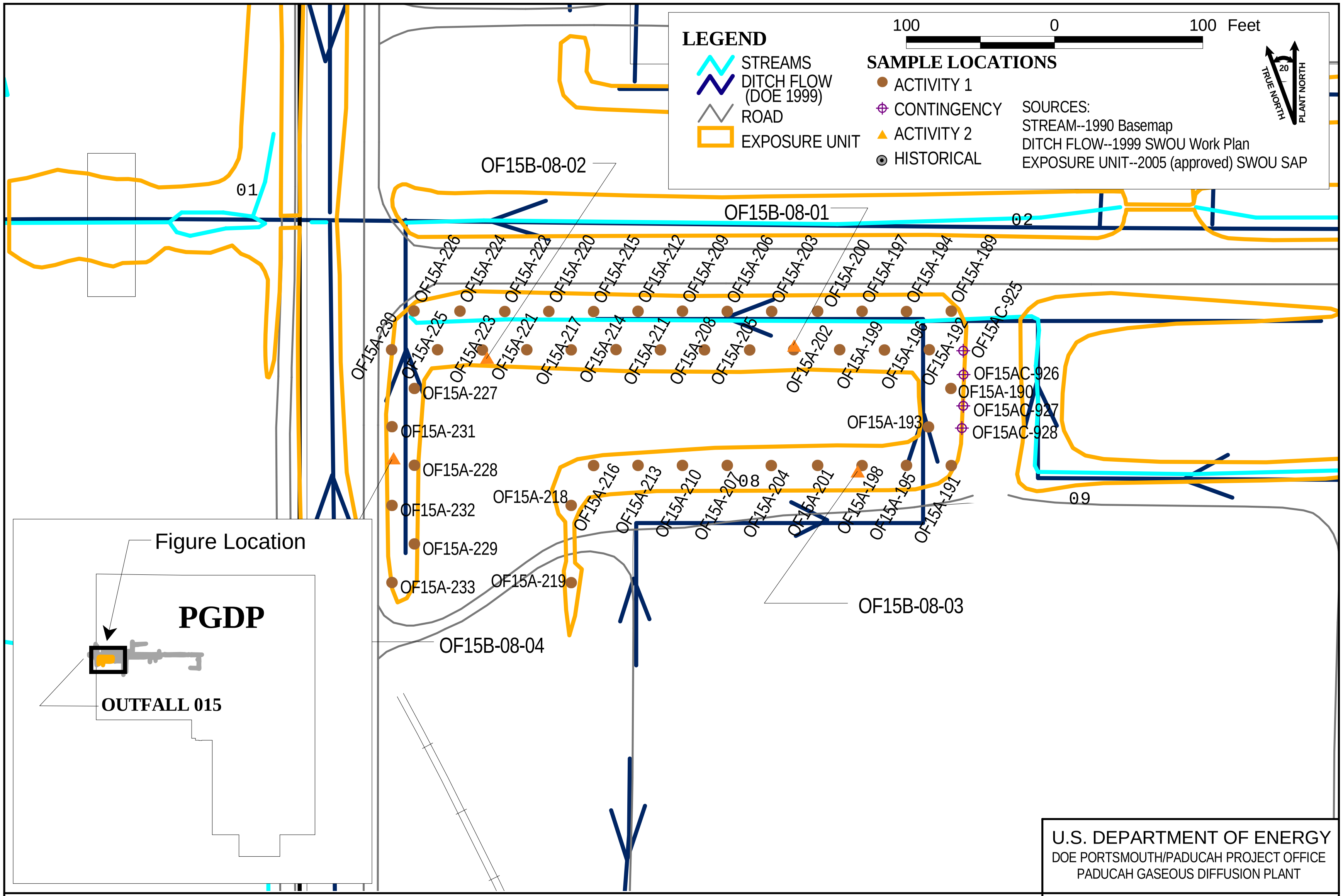

Figure 4.99. Outfall 015 EU 08 - Locations of RI and Historical Samples

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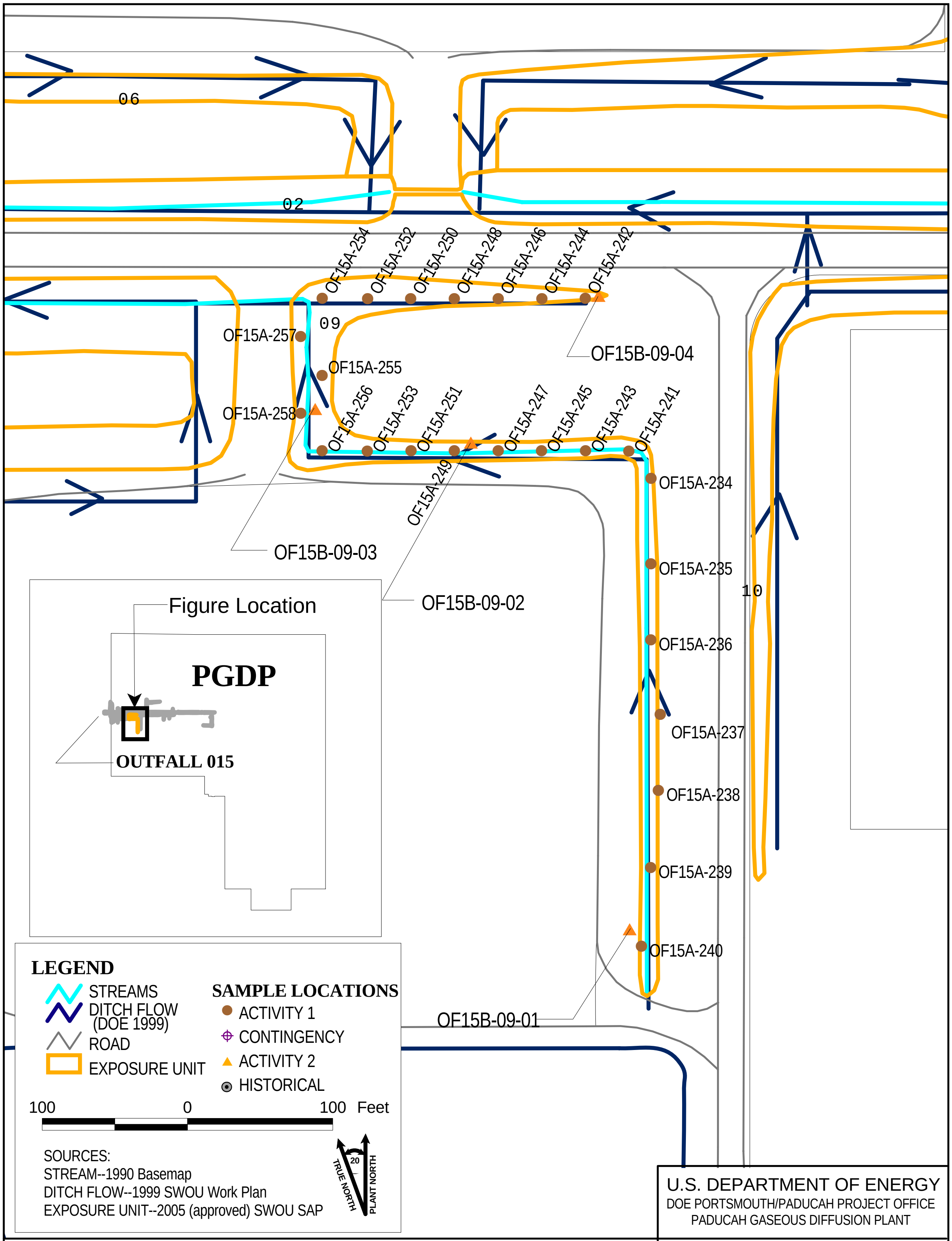

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.100. Outfall 015 EU 09 - Locations of RI and Historical Samples

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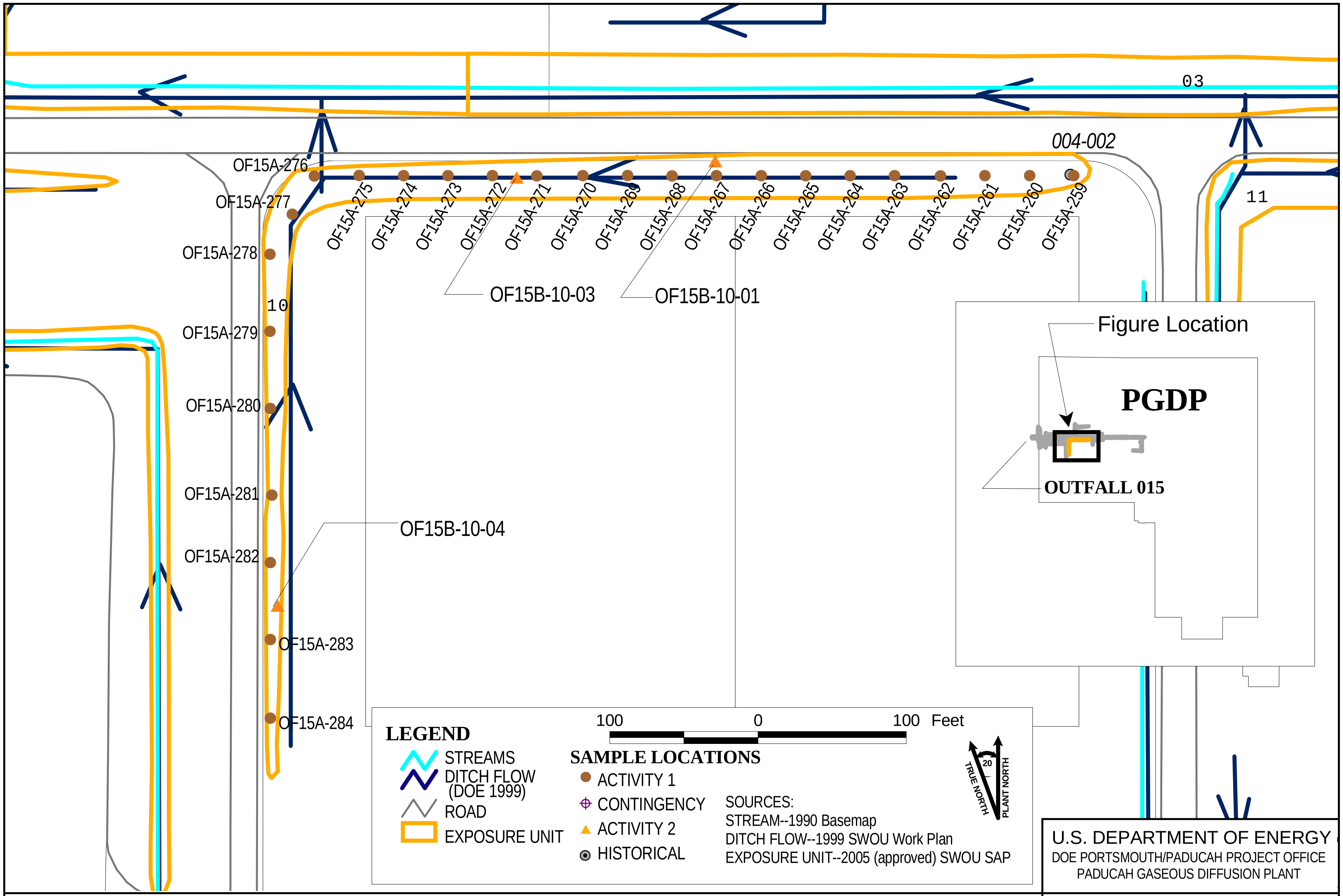

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.101. Outfall 015 EU 10 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF15R2.apr
DATE 03-12-07

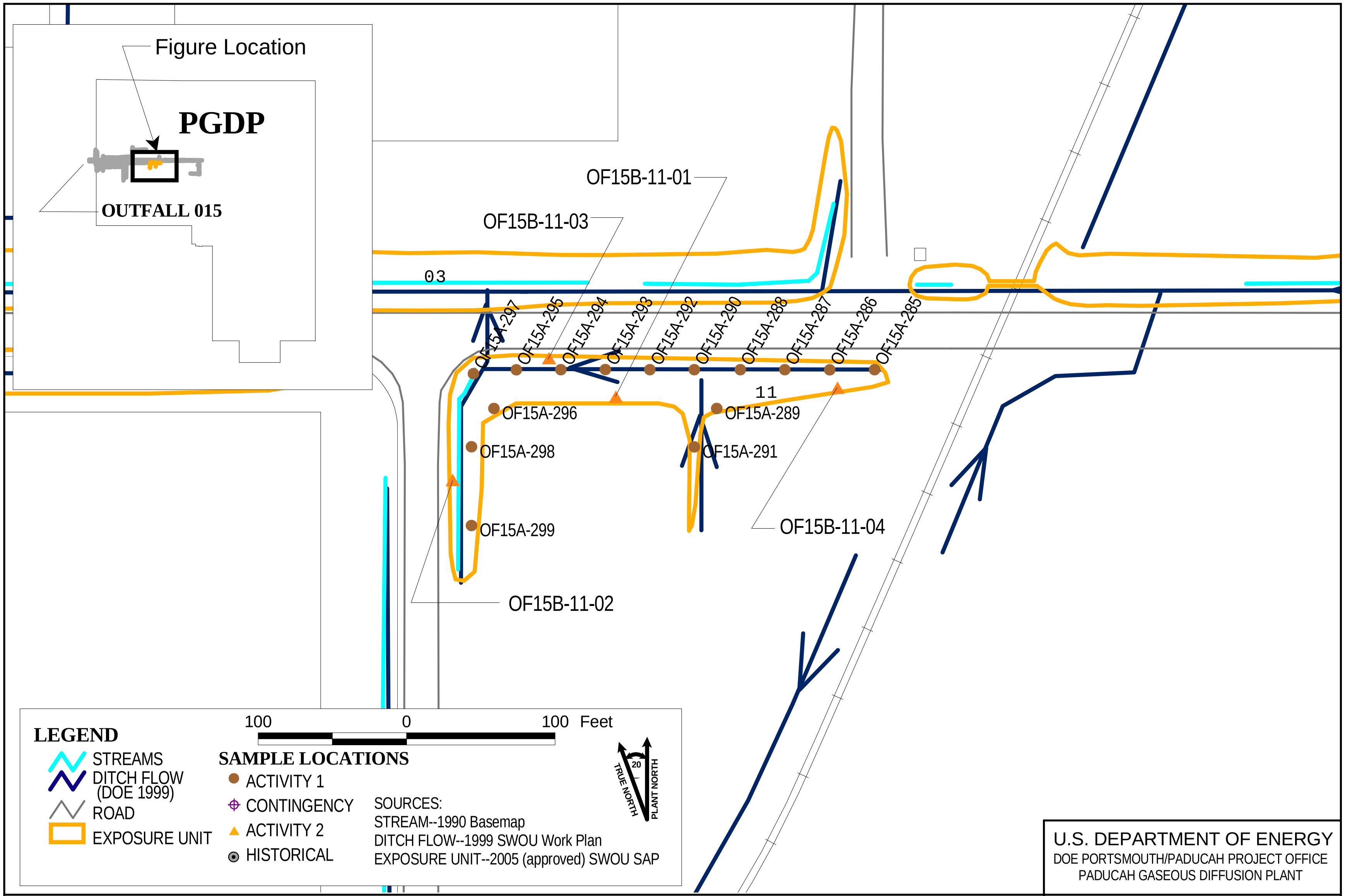

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Figure 4.102. Outfall 015 EU 11 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/OF15R2.apr
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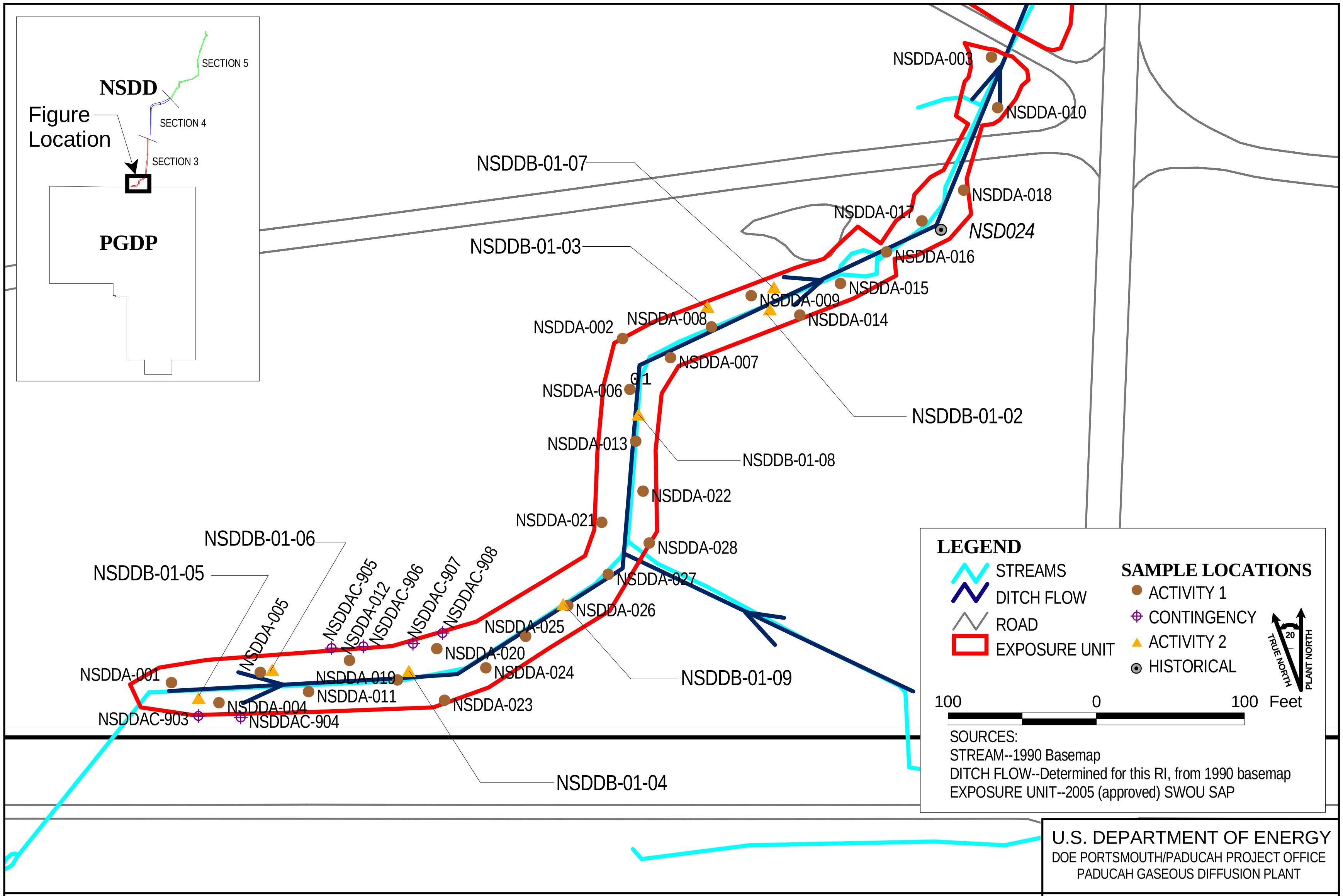

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
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Figure 4.103. NSDD Section 3 EU 01 - Locations of RI and Historical Samples

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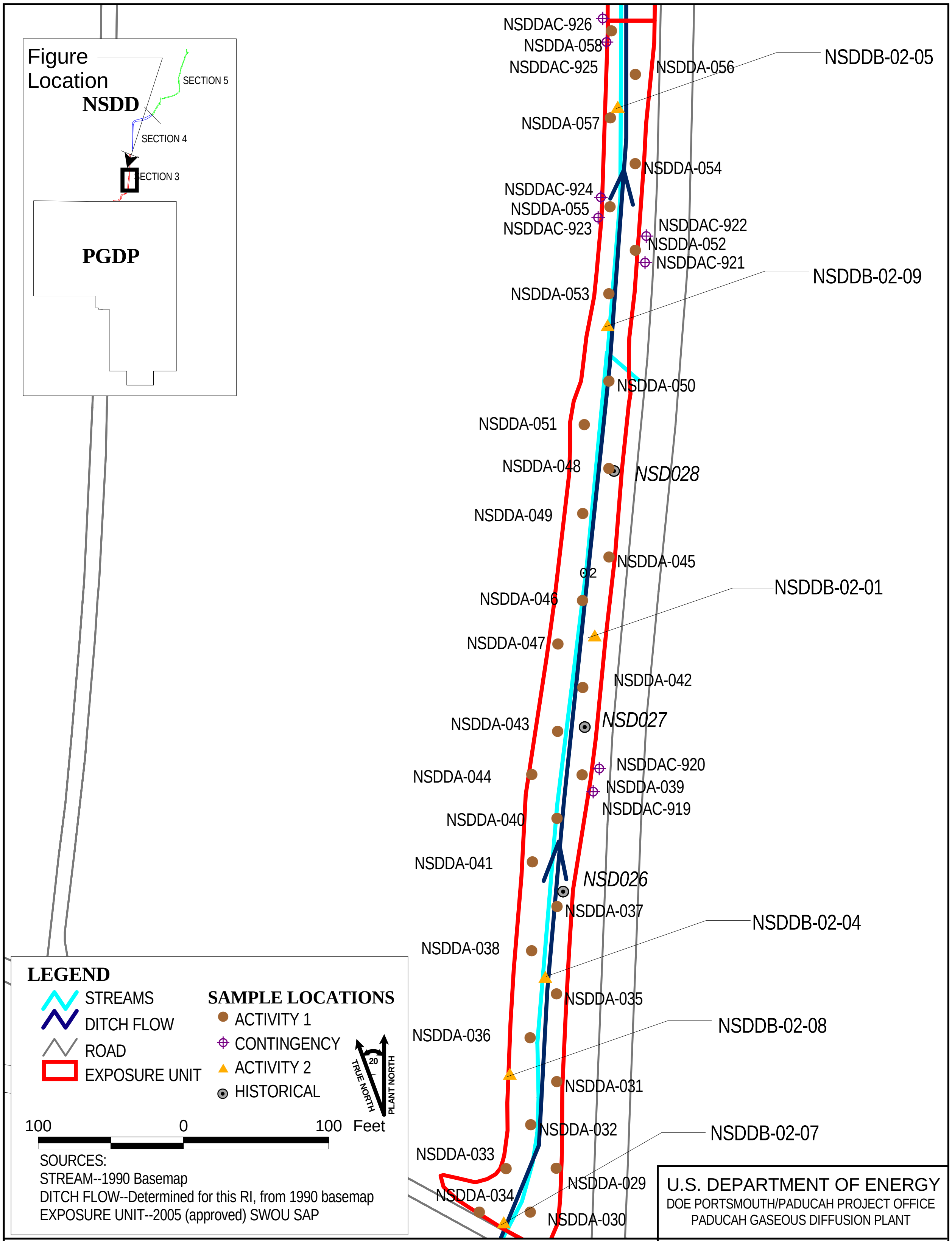

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

Figure 4.104. NSDD Section 3 EU 02 - Locations of RI and Historical Samples

Figure No. SWOU/Act1&2/NSDDR2.apr
DATE 03-12-07

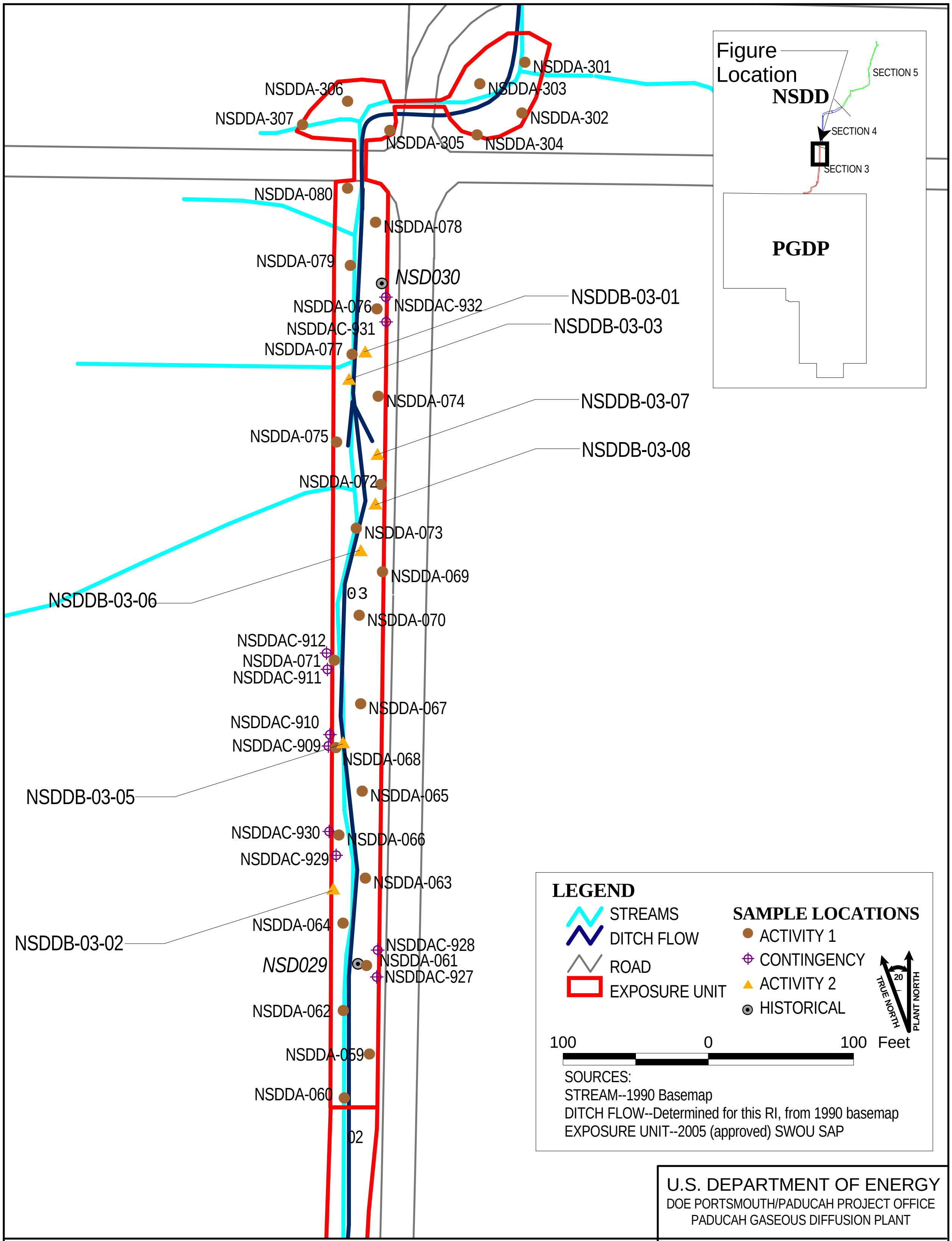

Figure 4.105. NSDD Section 3 EU 03 - Locations of RI and Historical Samples

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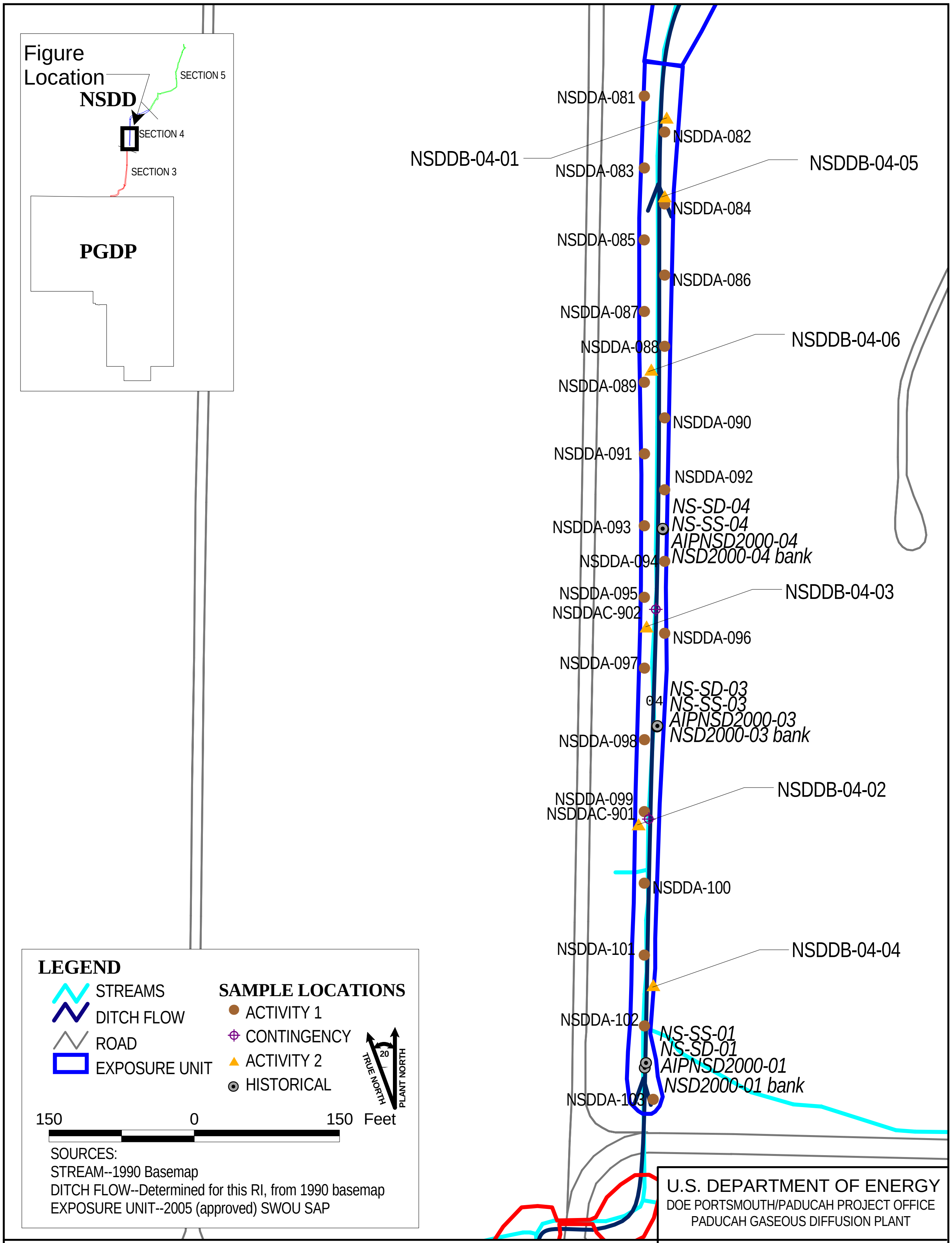

Figure 4.106. NSDD Section 4 EU 04 - Locations of RI and Historical Samples

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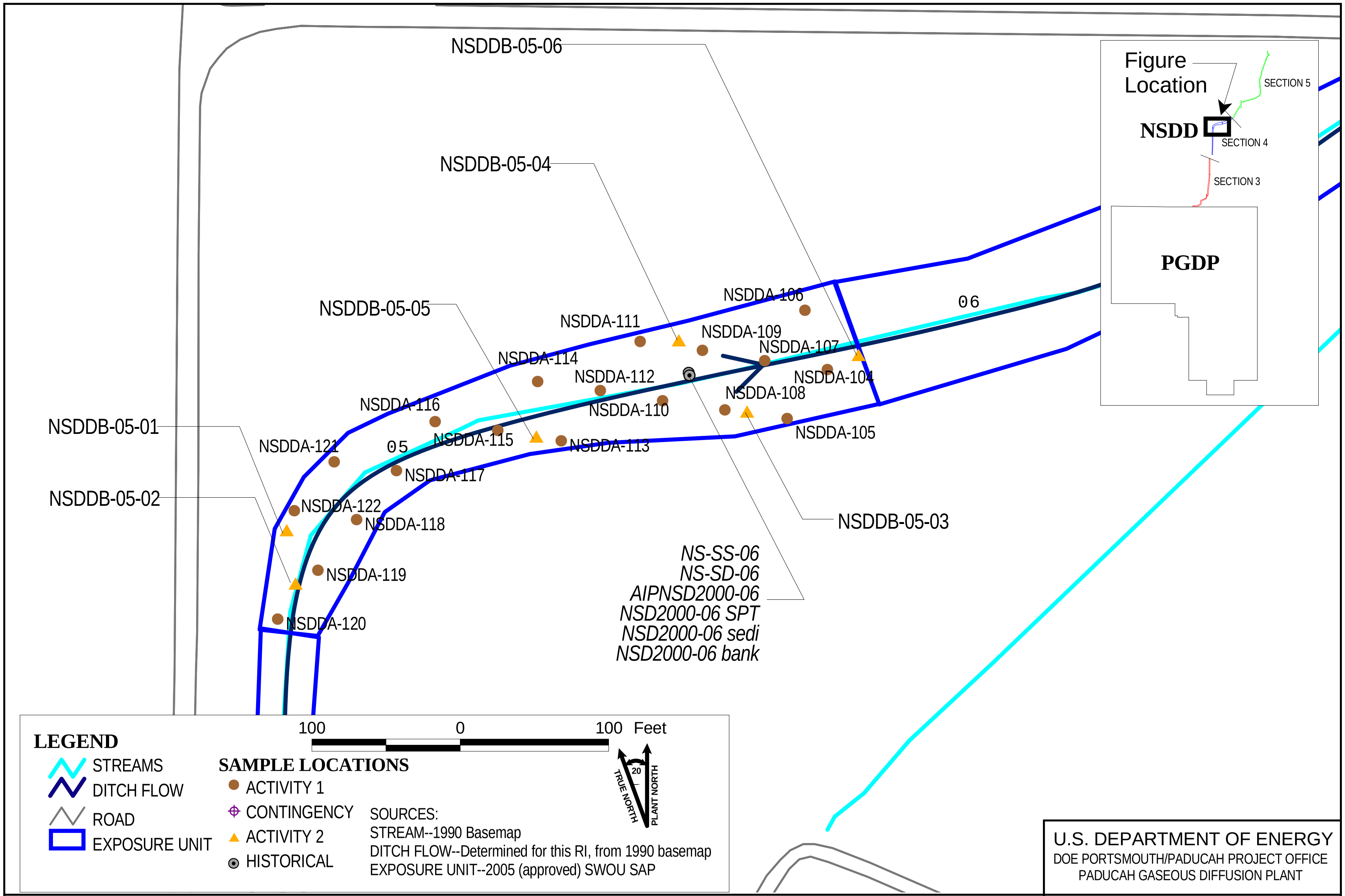

Figure 4.107. NSDD Section 4 EU 05 - Locations of RI and Historical Samples

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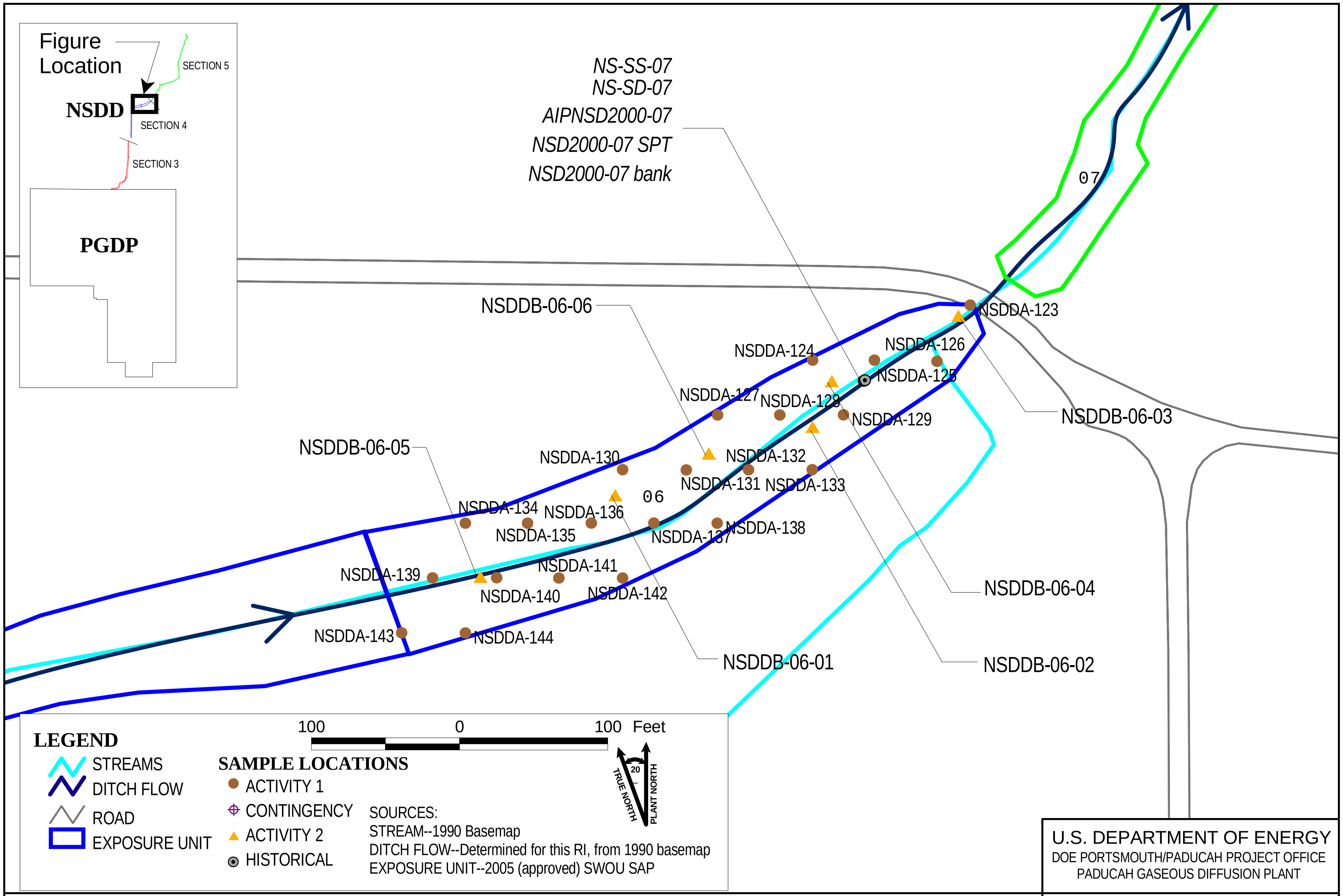

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Figure 4.108. NSDD Section 4 EU 06 - Locations of RI and Historical Samples

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DATE 03-12-07

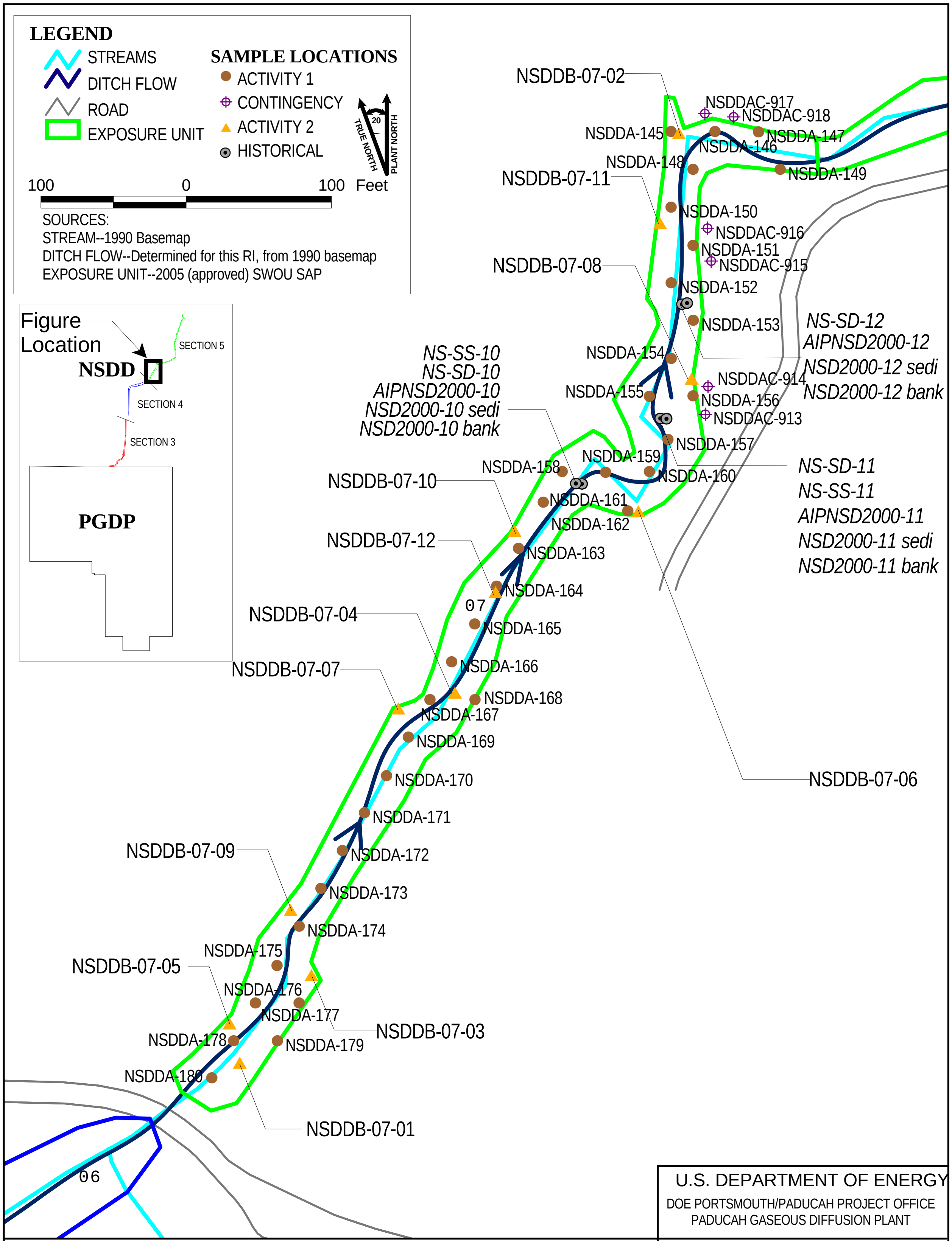

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Figure 4.109. NSDD Section 5 EU 07 - Locations of RI and Historical Samples

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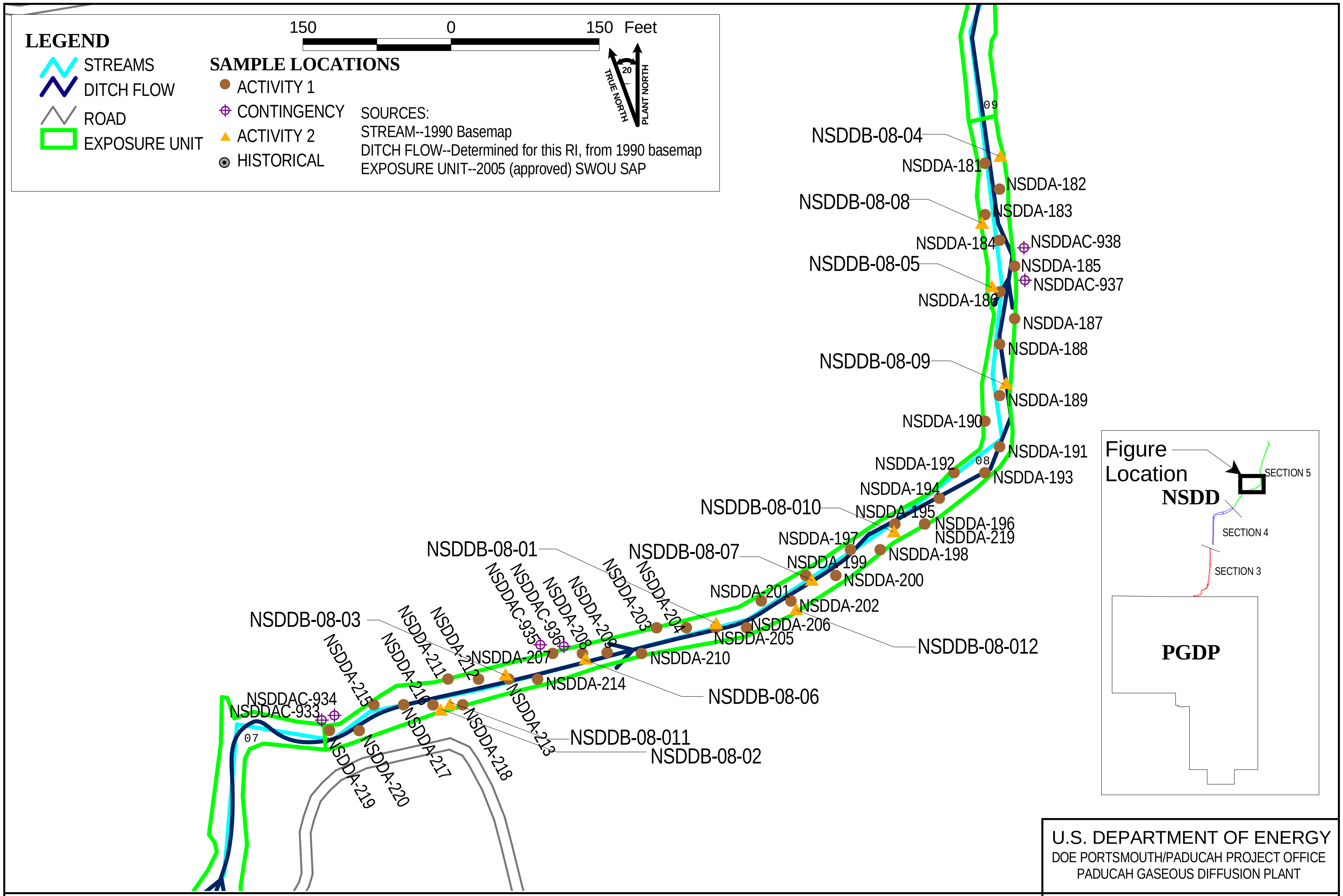

Figure 4.110. NSDD Section 5 EU 08 - Locations of RI and Historical Samples

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Figure No. SWOU/Act1&2/NSDDR2.apr
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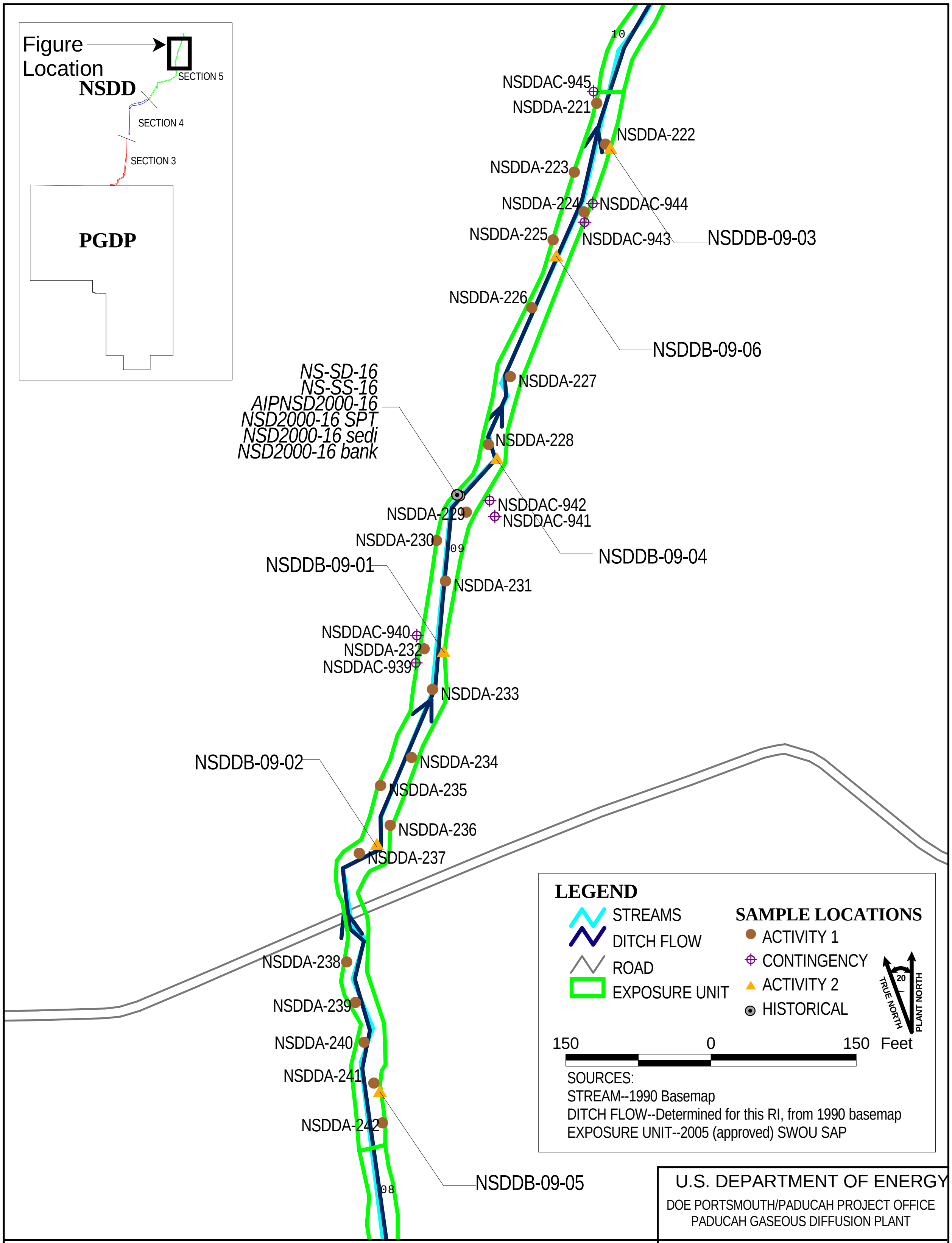

SOURCES:
STREAM--1990 Basemap
DITCH FLOW--Determined for this RI, from 1990 basemap
EXPOSURE UNIT--2005 (approved) SWOU SAP

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Figure 4.111. NSDD Section 5 EU 09 - Locations of RI and Historical Samples

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DATE 03-12-07

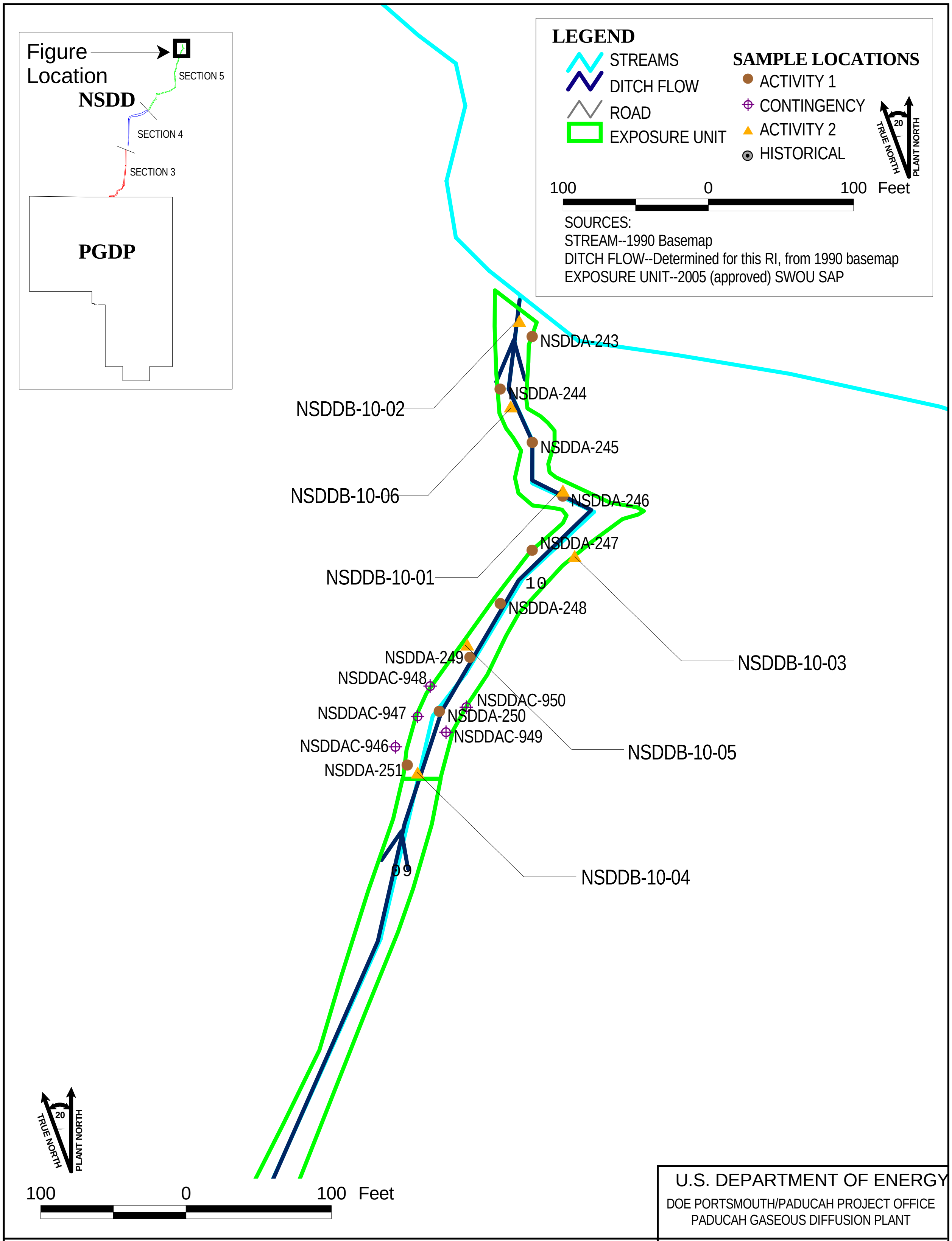

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Figure 4.112. NSDD Section 5 EU 10 - Locations of RI and Historical Samples

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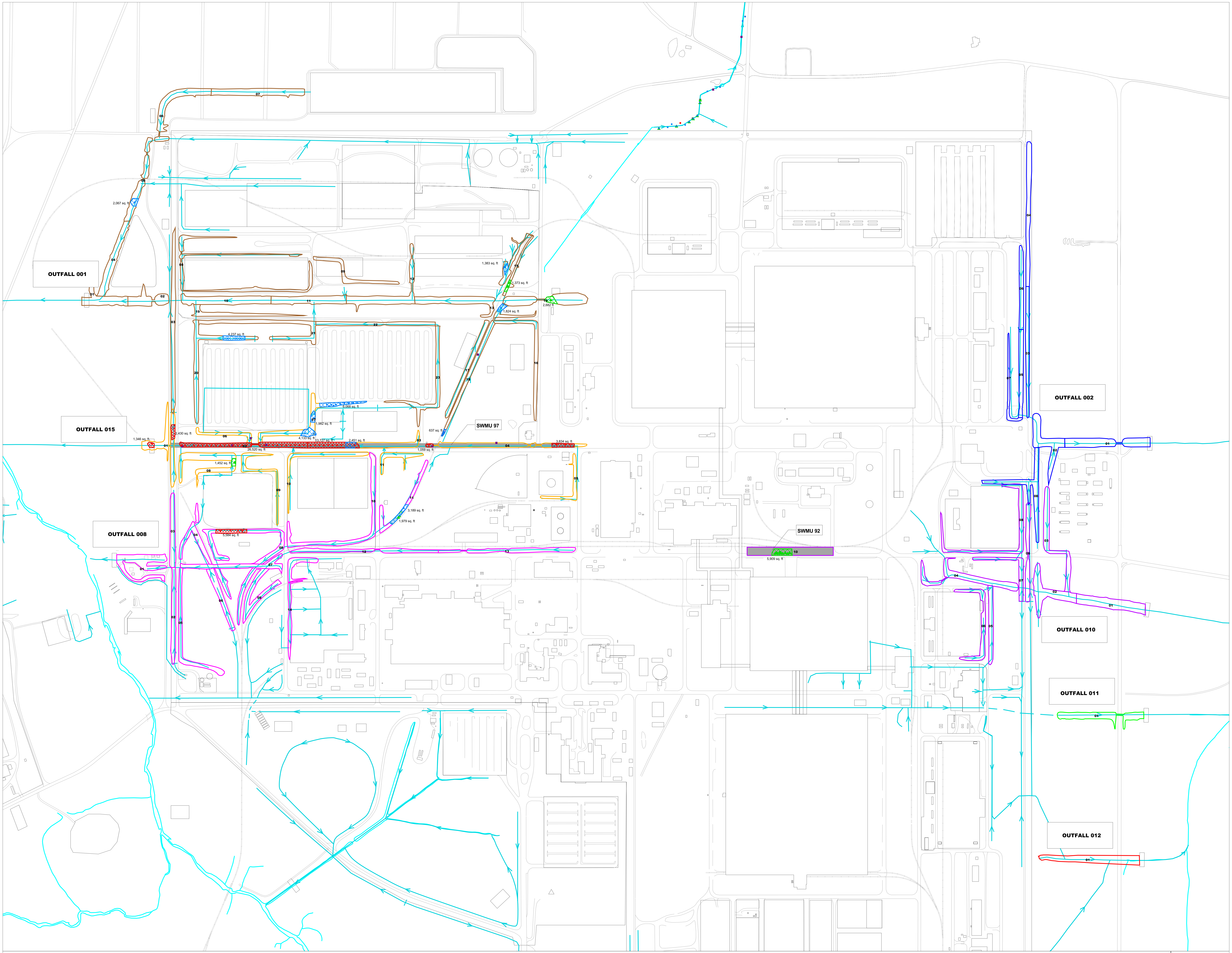
Figure No. SWOU/Act1&2/NSDDR2.apr
DATE 03-12-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
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Plate 1. Outfall EUs.

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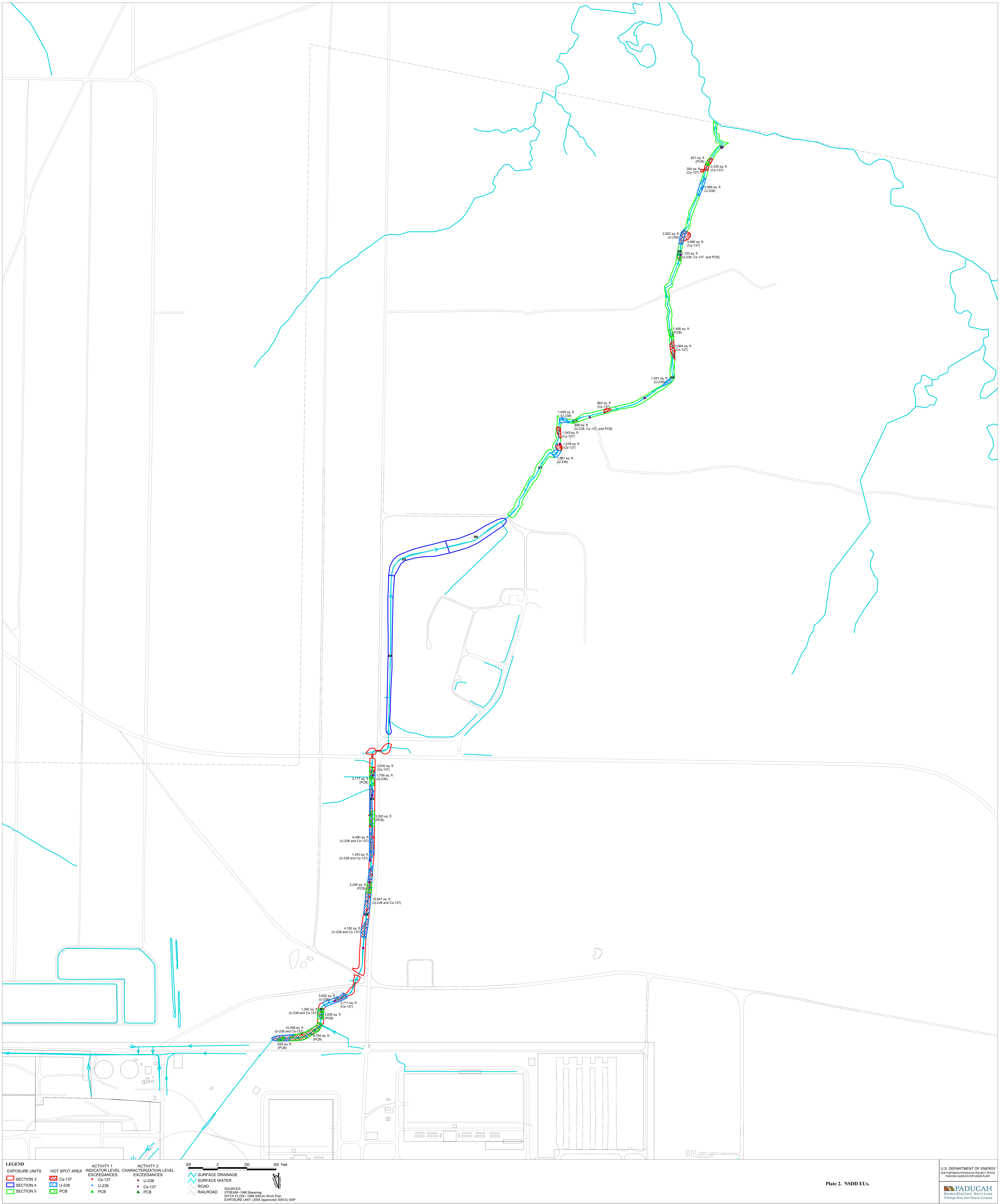
Figure No. \SWOU\PlatesR2.apr
DATE 04-11-07



SOURCES:
STREAM--1990 Basemap
DITCH FLOW--1999 SWOU Work Plan
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Plate 2. NSDD EUs.

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Figure No. \SWOU\PlatesR2.apr
DATE 04-11-07

5. CONTAMINANT FATE AND TRANSPORT

Fate and transport modeling is used to evaluate potential future impacts to human health and the environment. The potential migration pathways and mechanisms for transport of chemical and radiological substances found in surface soils and sediments at PGDP are evaluated by mathematical models. This SI uses the Modified Universal Soil Loss Equation (MUSLE) (Mills et al. 1982) and the Storm Water Management Model (SWMM) (Huber and Dickinson 1988) to predict likely future contaminant concentrations within the outfalls (just before mixing in the creeks) and within the creeks (at the point where each of the outfalls discharges to the surrounding creeks) and at the creek integrator points located downgradient of all outfalls.[1] Use of these models is consistent with the tiered approach of the groundwater/surface water modeling matrix presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001).

This chapter presents the principles of contaminant fate and transport modeling along with the results of modeling activities. Section 5.1 summarizes the development of the conceptual site models (CSMs) for contaminant sources and potential routes of surface water migration. Section 5.2 discusses the persistence of contaminants in the environment and important contaminant physical and chemical properties. Section 5.3 reviews modeling of soil erosion and partitioning of the COPCs between soil and water in surface runoff and the receiving water bodies. Section 5.4 presents the results of modeling contaminant migration for Total PCBs and uranium-238 and summarizes the primary model uncertainties.

5.1 CONCEPTUAL SITE MODEL

The CSM is a statement of known site conditions that serves as the framework for quantitative modeling. Site conditions described by the CSM include waste source information, the geologic and hydrologic settings, a listing of the COPCs at the site, and the current spatial distribution of the chemicals. This information is combined to identify the likely chemical migration pathways at PGDP. The details of the CSM have been presented in Sections 3 and 4. A summary of the salient model elements follows.

5.1.1 Contaminant Sources

The initial step in the SI used risk assessment results for direct contact with contaminated sediment to identify the contaminants that might pose the greatest risk through migration to off-site locations. This step identified antimony, iron, uranium, Total PCBs, Total PAHs, and uranium-238 as preliminary COPCs. The SI selected EUs with one or more of the indicator chemicals (uranium-238, cesium-137, and Total PCBs) at concentrations above the indicator levels (see Section 4.2.1.1 for a discussion of indicator chemicals and indicator levels used for the SWOU SI) as contaminant sources, in addition to the outfalls in general, for fate and transport modeling. The derived contaminant source units are as follows:

- Outfall 001 – The SWOU includes 23 EUs within this outfall (SWMU 69) and its associated internal ditches. Of these 23 EUs, only EU 05, EU 14, EU 15, EU 16, EU 18, and EU 20 were contaminant sources.

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[1] Sections 3, 4, and 5 of the NSDD were not included as part of the SWMM modeling per the established DQOs found in the SWOU SAP. Since Sections 3, 4, and 5 of the NSDD are located outside the industrialized area of the PGDP where direct contact with contaminated sediment by recreational receptors is possible, project scoping determined that direct contact was the driving factor and that the consideration of contaminant migration would not apply to those portions of the NSDD.

- Outfall 008 – There are 14 EUs within this outfall (SWMU 63) and its associated internal ditches. Of these 14 EUs, only EU 08 and EU 11 were found to be significantly contaminated.

- Outfall 010 – Only one of the 10 EUs present in this outfall (EU 10/SWMU 66) and its associated internal ditches and area (SWMU 92) was contaminated.

- Outfall 015 – There are 11 EUs within this outfall (SWMU 68) and its associated internal ditches and areas (SWMU 97). Of these 11 EUs, only EU 01, EU 02, EU 03, EU 04, EU 07, and EU 08 were contaminant sources.

Outfalls 002, 011, and 012 did not have any EUs that were identified as sources of the indicator contaminants.

5.1.2 Surface Water Migration Routes

This section presents potential routes of surface water migration. Figure 5.1 shows the general surface drainage patterns of PGDP. Man-made or altered drainage ways within and surrounding PGDP receive and transmit surface waters to off-site receiving streams.

In general, surface water flows from areas at PGDP to either Bayou Creek or Little Bayou Creek. Bayou Creek is a perennial stream that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River, and extends along the western boundary of the plant. Little Bayou Creek, also a perennial stream, originates within the WKWMA, and flows northward near the east boundary of the plant to join Bayou Creek near the Ohio River. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River. Drainage areas for both creeks are generally rural; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and the TVA Shawnee Steam Plant. A major portion of the flow in both creeks north of PGDP is effluent water from the plant discharged through KPDES-permitted outfalls.

5.2 CONTAMINANT PERSISTENCE

Fate and transport of metals, radionuclides, and organic compounds are functions of site characteristics and the physical and chemical interactions between the contaminants and the environmental media with which they come into contact. The physical and chemical properties of a contaminant that influences these interactions include, but are not limited to, the contaminant's solubility in water, the contaminant's tendency to transform or degrade, usually described by a half-life or an environmental half-life in a given medium, and the contaminant's chemical affinity for solids or organic matter, usually described by a partitioning coefficient (K_d, K_{oc}, or K_{ow}). These properties and their effects on the behavior of inorganic compounds, radionuclides, and organic compounds at PGDP are described below.

5.2.1 Inorganics

Inorganic chemicals released to unsaturated soil, including surface soil, will be dissolved in soil moisture or adsorbed onto soil particles. Dissolved inorganic analytes detected at PGDP include metals and cyanide. These dissolved metals are subject to movement with surface water and soil water. Metals, unlike organic compounds, cannot be degraded; however, the migration of metals can be attenuated by retardation reactions such as adsorption, surface complexation, and ion exchange reactions with the soils they come into contact. Such reactions are affected by pH, redox conditions, and the type and amount of

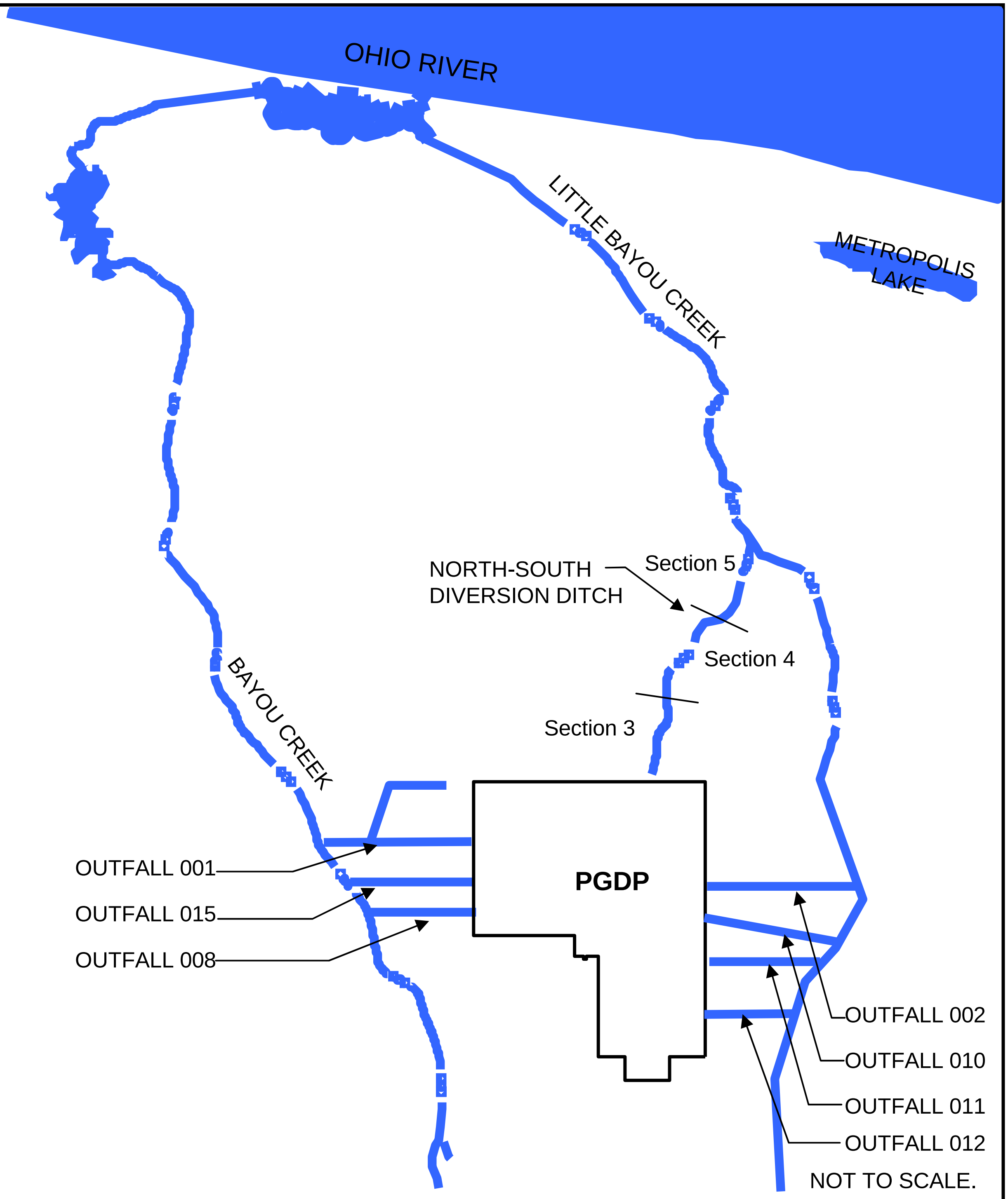

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Figure 5.1. SWOU Discharge into the Receiving Creeks

organic matter, clay, and hydrous oxides present. These reactions typically are reversible, resulting in dynamic metals' solubility in immature or poorly developed soils. Such transformations can reduce the metals' toxicities and/or affect their mobilities by governing the way in which they react with soil particles or other solid surfaces by ion exchange, adsorption, precipitation, or complexation.

Contaminant persistence is a function of physical, chemical, and biological processes that affect the chemical as it moves through air, soil, and water. Some inorganic contaminants may undergo chemical species transformation after being released to the environment. An important example of one such transformation is the change of the charge state from chromium^{+6} to chromium^{+3}. Organometallic compounds can undergo a variety of chemical reactions that may transform one compound into another, change the physical state of the compound, or cause a compound to combine with other chemicals; however, the metallic portion of the organometallic compounds will change only oxidation states. With the exception of changing oxidation states or possibly exchanging metallic species, inorganic contaminants are much more stable than organic contaminants.

The mobility of metals is directly related to their solubility in water or other fluids and to pH and redox conditions. In the absence of fluids to mobilize and transport metals, virtually no transport is possible. Even if fluids are present, metals will be significantly mobilized only under favorable pH and redox conditions. Movement of metals also is controlled by the solubility (pH and redox dependent) and adsorption of the metal. With the exception of barium, selenium, and hexavalent chromium, the solubility of other metals of concern is inversely proportional to pH. The presence of iron, manganese, aluminum oxides, carbonates, hydroxides, and organic materials, may cause metals to precipitate or be adsorbed onto soil particles.

5.2.2 Radionuclides

Radionuclides comprise a special case of inorganic species. Radioactive nuclides undergo spontaneous transformations that involve the emission of particles and radiant energy. Resulting decay products either may be radioactive themselves, in which case they too will undergo decay, or they may be stable nuclides. The decay process can occur by various spontaneous mechanisms. Two of the more important decay modes are alpha decay and beta decay, with the latter differentiated into negatron and positron decay. Like inorganic and organic chemical species, which do not undergo nuclear transformations, the persistence of radionuclide contaminants at PGDP is related largely to their geochemical mobility in the environment.

Natural uranium consists of three primary isotopes: uranium-238, uranium-235, and uranium-234. The natural abundance of these isotopes, as well as the abundance of these isotopes in enriched (typical power reactor enrichment) and depleted uranium, is listed in Table 5.1. The decay products of uranium isotopes also are radioactive and form decay chains. The primary isotopes of uranium are all long-lived alpha emitters.

Table 5.1. Typical Isotopic Abundance (Grams of Isotope per 100 g of Natural Uranium)

Isotope	Natural uranium	Typical commercial feed enrichment	Depleted uranium
Uranium-238	99.2739	97.01	99.75
Uranium-235	0.7204	2.96	0.25
Uranium-234	0.0057	0.03	0.0005

Since DOE facilities do not routinely process uranium ore concentrates, the only nonuranium members of the decay chains that will be present in virgin feed materials are those that have grown in since the chemical extraction of the uranium. The nuclides that occur in sufficient abundance to have an impact on radiological controls are thorium-234, protactinium-234, and thorium-231. The long half-life of thorium-230 in the uranium-238 chain and the protactinium-231 in the uranium-235 chain effectively prevents the accumulation of significant quantities of other decay products. Still, some thorium-230 and radium-226 may be found in the process waste water of some facilities. Several other radionuclides are sitewide COPCs at PGDP [e.g., americium-241, cobalt-60, plutonium-238, plutonium-239, cesium-137, neptunium-237, strontium-90, as identified in the Methods Document (DOE 2001)].

5.2.3 Organic Compounds

The organic constituents detected at PGDP include volatile organic compounds (VOCs), SVOAs, and pesticides/PCBs. These contaminants may be degraded in the environment by various processes, including hydrolysis, oxidation/reduction, photolysis, or biodegradation. Degradation may reduce the toxicity of chemicals, or as in the case of TCE, may result in more toxic decay products.

Half-life is the time necessary for half of the chemical concentration to react. Environmental half-lives of organic compounds in various media can vary from minutes to years, depending on chemical and environmental conditions. Measurements of half-lives for the organic compounds of interest are not available for this site; however, they can be estimated based on data summarized in the *Handbook of Environmental Degradation Rates* (Howard et al. 1991). Biodegradation rates were not used in modeling for this SI.

The mobility of an organic compound is affected by its volatility, its partitioning behavior between solids and water, water solubility, and concentration. A compound's Henry's Law constant value (K_H) is a measure of the ratio of the compound's vapor pressure to its aqueous solubility. The K_H value can be used to make general predictions about the compound's tendency to volatilize from water. Substances with K_H values less than 10^{-7} atm/m^3/mol generally will volatilize slowly, while compounds with K_H greater than 10^{-3} atm/m^3/mol will volatilize rapidly (Lyman et al. 1982). Vapor pressure is a measure of the pressure at which a compound, as a solid or a liquid, is in equilibrium with its vapor. The value can be used to determine the extent to which a compound would travel in air, as well as the rate of volatilization from soils and surface water. In general, compounds with vapor pressures lower than 10^{-7} mm mercury will not be present in the atmosphere or soil air in significant amounts, while compounds with vapor pressures higher than 10^{-2} mm mercury will exist primarily in the air (Dragun 1988). Unless the soil is saturated, VOCs will exist primarily in the atmosphere and soil air. Pesticides, PCBs, and other SVOAs will exist in the air, water, and soil.

In soil systems, the principal type of diffusion is from a region of high concentration to a region of low concentration (Dragun 1988). Diffusion occurs most readily in gases, to a lesser extent in liquids, and least in solids. Rate of diffusion is proportional to the concentration gradient of a substance, increases with temperature, and is related inversely to density and pressure. The air diffusion coefficient is a measure of the rate of spontaneous mixing, presented in units of cm^2/s, of one substance with another when in contact or separated by a permeable membrane (Sax and Lewis 1987).

Water solubility and the tendency to adsorb to particles or organic matter can correlate with retardation in water transport. The adsorption coefficient/distribution coefficient (K_d) of an organic compound is related to the organic carbon-based water partition coefficient (K_{oc}) by

$$K_d = (f_{oc})(K_{oc})$$

where

f_{oc} = soil organic carbon content as mass fraction.

Chemical-specific K_{oc} values may be obtained from the literature or may be calculated using empirical formulas relating the octanol-water partitioning coefficient (K_{ow}) to the K_{oc}. The K_{ow} is the ratio of a contaminant's concentrations in a system containing water and octanol. K_{ow} is used to estimate the tendency for a chemical to partition between environmental phases of different polarity. Organic compounds with log K_{ow} values less than 1 are highly hydrophilic, while organic compounds with log K_{ow} values exceeding 4 are nearly insoluble in water and will partition to soil particles. Most of the detected SVOAs and pesticides have log K_{ow} values less than 4, indicating preferential partitioning to soil. The formula used most commonly (Mills et al. 1985) to relate K_{ow} to K_{oc} is given by

$$K_{oc} = (0.63)(K_{ow}).$$

The water solubility of a compound is a measure of the saturated concentration of the compound in water at a given temperature and pressure. The tendency for a compound to be transported by water is directly related to its solubility and inversely related to both its tendency to adsorb to soil and to volatilize from water (OGE 1988). Compounds with high water solubilities tend to desorb from soils and sediments, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a compound varies with temperature, pH, and the presence of other dissolved constituents (including organic carbon and humic acids). Chemicals with relatively high water solubilities and low adsorption coefficients (e.g., acetone, methyl ethyl ketone, methylene chloride) are expected to remain primarily as dissolved phases and be transported at the same rate as the water flow. Chemicals with lower water solubilities and higher adsorption coefficients (e.g., pesticides and PCBs) are expected to remain primarily adsorbed to the surface of the soils and their transportation with the surface water would be limited.

PCBs are characterized by low water solubility, low volatility, high affinity for organic matter, and high resistance to chemical or biological degradation. Due to the low solubility and the tendency to adsorb to soils, PCBs on the surface generally do not result in significant groundwater contamination. In water, absorption of PCBs to sediment and other organic matter is the major fate. Because PCB concentrations are higher in sediment and suspended matter than in the associated water column, aquatic sediments act as an "environmental sink" from which PCBs may be redistributed throughout the environment unless buried. Significant leaching of PCBs should not be expected in most situations because of their low water solubility; however, PCBs may become mobile if attached with an organic solvent.

PAHs are common components of the incomplete burning of various fuels, asphalt, coal tar, hydrocarbons. PAHs routinely can be found in vehicle exhausts. These compounds show low mobility in groundwater and collect in sediments due to adsorption and the general low mobility and volatility of the compounds. PAHs typically metabolize in animals and do not significantly bioconcentrate. PAHs are volatile and the major environmental fate process is volatilization from soil.

5.3 SURFACE SOIL EROSION AND CONTAMINANT PARTITION MODELING

As precipitation falls on the surface of the soil, the energy of the impact dislodges soil particles that then can be transported in the runoff flowing from an area. The contaminants sorbed to these soil particles are, therefore, also transported in the runoff. In addition, the runoff water is contaminated by contact with the soil and transports contaminants in a dissolved phase. The relative concentration of contaminant attached to soil particles and dissolved in the runoff water is determined by the partition coefficient, K_d.

The modeling approach for this SI follows that outlined in the Superfund Exposure Assessment Manual (EPA 1988). MUSLE was used to predict erosion from a typical site using the 30-year, 24-hour storm for Paducah, KY. Additional contaminant partitioning and loading models determined contaminant partitioning between soil and water in the runoff flow. These partitioning models provided an estimate of the contaminant concentration dissolved in the runoff water and adsorbed to the soil that is carried with the runoff and deposited in the sediment of the ditches and creeks. Because internal plant ditches are grass-lined and the outfalls are grass-lined or otherwise stabilized, the contaminants are not likely to be transported attached to suspended soil particles within the ditches and outfalls; therefore, the results of the sediment transport modeling presented in this SI are expected to be overly conservative.

The dissolved contaminant concentration in the receiving stream was estimated by a simple dilution model using runoff concentration, runoff volume, and stream flow. Appendix C presents detailed discussion on surface soil erosion and contaminant partitioning modeling, the input parameters for the MUSLE model, and model calculations.

As an initial screening step, this SI compared the predicted dissolved concentrations of each of the COPCs, in the surface water runoff in the outfalls and mixed in the receiving streams (i.e., Bayou Creek and Little Bayou Creek), and the predicted adsorbed soil concentration (that is carried with the runoff and deposited in the sediments of the ditches and creeks) to the following risk-based screening criteria:

- Industrial worker no action level
- Child recreational no action level
- Industrial worker action level
- Child recreational action level

These screening levels are the most stringent criteria for the risk exposure scenarios applicable to the SWOU. Note that in the case of uranium-238, the risk comparison uses a screening value related to a wading scenario for the Little Bayou Creek Outfalls (002, 010, 011, 012) and a screening value related to a swimming scenario for the Bayou Creek Outfalls (001, 008, 015). (Little Bayou Creek flow is insufficient to support swimming while Bayou Creek flow may support either wading or swimming.) The uranium-238 screening level for the swimming scenario is more stringent because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure, due to the shielding provided by water. The swimming scenario includes both dermal exposure and exposure by consumption.

Table 5.2 summarizes the screening criteria that were exceeded for modeled surface water concentrations of Total PAHs and uranium metal. **No other modeled COPC concentration in surface water exceeded a screening level.** Tables 5.3 through 5.6 present the modeling results for surface water.

Table 5.2. Summary of Surface Water Exceedances of Screening Criteria (Based on MUSLE)

COPCs Exceeding a Screening Level	**Screening Level**	**Location COPCs Exceeding a Screening Level**	
		Outfalls	Bayou and Little Bayou Creeks
		Source of COPCs Exceeding Screening Level	
Total PAHs	Industrial Worker No Action	All outfalls	Outfalls 001 and 011 only
	Child Recreational No Action	All outfalls	Outfalls 001, 010, and 011 only
	Child Recreational Action	Outfall 011 only	None
Uranium metal	Industrial Worker No Action	Outfall 011 only	None
	Child Recreational No Action	Outfalls 011 and 015 only	None

Table 5.3. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	1.40E-03	7.31E-03	No	4.41E-03	No
Outfall_1	METAL	Iron	3.15E-01	4.11E+01	No	1.38E+01	No
Outfall_1	METAL	Uranium	3.03E-02	4.66E-01	No	4.64E-02	No
Outfall_1	PPCB	TOTAL PCB	6.16E-06	1.65E-04	No	1.12E-04	No
Outfall_1	RADS	Uranium-238	1.47E+01	N/A	No	4.91E+01	No
Outfall_1	**SVOA**	**TOTAL PAHs**	**9.10E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_10	METAL	Antimony	1.40E-03	7.31E-03	No	3.12E-03	No
Outfall_10	METAL	Iron	3.08E-01	4.11E+01	No	1.75E+01	No
Outfall_10	METAL	Uranium	2.12E-02	4.66E-01	No	1.99E-01	No
Outfall_10	PPCB	TOTAL PCB	5.92E-05	1.65E-04	No	9.61E-05	No
Outfall_10	RADS	Uranium-238	7.67E+00	N/A	No	4.91E+01	No
Outfall_10	**SVOA**	**TOTAL PAHs**	**1.84E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_11	METAL	Antimony	1.45E-03	7.31E-03	No	3.12E-03	No
Outfall_11	METAL	Iron	3.95E-01	4.11E+01	No	1.75E+01	No
Outfall_11	**METAL**	**Uranium**	**5.47E-01**	**4.66E-01**	**Yes**	**1.99E-01**	**Yes**
Outfall_11	PPCB	TOTAL PCB	1.70E-05	1.65E-04	No	9.61E-05	No
Outfall_11	RADS	Uranium-238	3.83E+01	N/A	No	4.91E+01	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**6.86E-05**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_12	METAL	Antimony	1.43E-03	7.31E-03	No	3.12E-03	No
Outfall_12	METAL	Iron	3.35E-01	4.11E+01	No	1.75E+01	No
Outfall_12	METAL	Uranium	9.66E-03	4.66E-01	No	1.99E-01	No
Outfall_12	PPCB	TOTAL PCB	5.58E-06	1.65E-04	No	9.61E-05	No
Outfall_12	RADS	Uranium-238	2.29E+00	N/A	No	4.91E+01	No
Outfall_12	**SVOA**	**TOTAL PAHs**	**1.73E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_15	METAL	Antimony	1.43E-03	7.31E-03	No	4.41E-03	No
Outfall_15	METAL	Iron	2.65E-01	4.11E+01	No	1.38E+01	No
Outfall_15	**METAL**	**Uranium**	**1.18E-01**	4.66E-01	No	**4.64E-02**	**Yes**
Outfall_15	PPCB	TOTAL PCB	7.39E-06	1.65E-04	No	1.12E-04	No
Outfall_15	RADS	Uranium-238	3.62E+01	N/A	No	4.91E+01	No
Outfall_15	**SVOA**	**TOTAL PAHs**	**1.20E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_2	METAL	Antimony	1.39E-03	7.31E-03	No	3.12E-03	No

Table 5.3. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	2.56E-01	4.11E+01	No	1.75E+01	No
Outfall_2	METAL	Uranium	4.36E-03	4.66E-01	No	1.99E-01	No
Outfall_2	PPCB	TOTAL PCB	1.49E-06	1.65E-04	No	9.61E-05	No
Outfall_2	RADS	Uranium-238	2.35E+00	N/A	No	4.91E+01	No
Outfall_2	**SVOA**	**TOTAL PAHs**	**1.18E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_8	METAL	Antimony	1.42E-03	7.31E-03	No	4.41E-03	No
Outfall_8	METAL	Iron	2.88E-01	4.11E+01	No	1.38E+01	No
Outfall_8	METAL	Uranium	1.79E-02	4.66E-01	No	4.64E-02	No
Outfall_8	PPCB	TOTAL PCB	3.09E-06	1.65E-04	No	1.12E-04	No
Outfall_8	RADS	Uranium-238	8.83E+00	N/A	No	4.91E+01	No
Outfall_8	**SVOA**	**TOTAL PAHs**	**1.24E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**

[a] The value is based on "low risk no action level" for total PCB; the "lowest risk no action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 no action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk no action level"; the "lowest risk no action level" for wading = 5.49E-04; for swimming = 6.38E-04.

Table 5.4. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	1.40E-03	2.19E-01	No	1.32E-01	No
Outfall_1	METAL	Iron	3.15E-01	1.23E+03	No	4.15E+02	No
Outfall_1	METAL	Uranium	3.03E-02	1.40E+01	No	1.39E+00	No
Outfall_1	PPCB	TOTAL PCB	6.16E-06	1.65E-02	No	1.12E-02	No
Outfall_1	RADS	Uranium-238	1.47E+01	N/A	No	4.91E+03	No
Outfall_1	SVOA	TOTAL PAHs	9.10E-06	9.06E-05	No	6.20E-05	No
Outfall_10	METAL	Antimony	1.40E-03	2.19E-01	No	9.36E-02	No
Outfall_10	METAL	Iron	3.08E-01	1.23E+03	No	5.26E+02	No
Outfall_10	METAL	Uranium	2.12E-02	1.40E+01	No	5.96E+00	No
Outfall_10	PPCB	TOTAL PCB	5.92E-05	1.65E-02	No	9.61E-03	No
Outfall_10	RADS	Uranium-238	7.67E+00	N/A	No	4.91E+03	No
Outfall_10	SVOA	TOTAL PAHs	1.84E-06	9.06E-05	No	5.29E-05	No
Outfall_11	METAL	Antimony	1.45E-03	2.19E-01	No	9.36E-02	No
Outfall_11	METAL	Iron	3.95E-01	1.23E+03	No	5.26E+02	No
Outfall_11	METAL	Uranium	5.47E-01	1.40E+01	No	5.96E+00	No
Outfall_11	PPCB	TOTAL PCB	1.70E-05	1.65E-02	No	9.61E-03	No
Outfall_11	RADS	Uranium-238	3.83E+01	N/A	No	4.91E+03	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**6.86E-05**	9.06E-05	No	**5.29E-05**	**Yes**
Outfall_12	METAL	Antimony	1.43E-03	2.19E-01	No	9.36E-02	No
Outfall_12	METAL	Iron	3.35E-01	1.23E+03	No	5.26E+02	No
Outfall_12	METAL	Uranium	9.66E-03	1.40E+01	No	5.96E+00	No
Outfall_12	PPCB	TOTAL PCB	5.58E-06	1.65E-02	No	9.61E-03	No
Outfall_12	RADS	Uranium-238	2.29E+00	N/A	No	4.91E+03	No
Outfall_12	SVOA	TOTAL PAHs	1.73E-06	9.06E-05	No	5.29E-05	No
Outfall_15	METAL	Antimony	1.43E-03	2.19E-01	No	1.32E-01	No
Outfall_15	METAL	Iron	2.65E-01	1.23E+03	No	4.15E+02	No
Outfall_15	METAL	Uranium	1.18E-01	1.40E+01	No	1.39E+00	No
Outfall_15	PPCB	TOTAL PCB	7.39E-06	1.65E-02	No	1.12E-02	No
Outfall_15	RADS	Uranium-238	3.62E+01	N/A	No	4.91E+03	No
Outfall_15	SVOA	TOTAL PAHs	1.20E-06	9.06E-05	No	6.20E-05	No
Outfall_2	METAL	Antimony	1.39E-03	2.19E-01	No	9.36E-02	No

Table 5.4. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	2.56E-01	1.23E+03	No	5.26E+02	No
Outfall_2	METAL	Uranium	4.36E-03	1.40E+01	No	5.96E+00	No
Outfall_2	PPCB	TOTAL PCB	1.49E-06	1.65E-02	No	9.61E-03	No
Outfall_2	RADS	Uranium-238	2.35E+00	N/A	No	4.91E+03	No
Outfall_2	SVOA	TOTAL PAHs	1.18E-06	9.06E-05	No	5.29E-05	No
Outfall_8	METAL	Antimony	1.42E-03	2.19E-01	No	1.32E-01	No
Outfall_8	METAL	Iron	2.88E-01	1.23E+03	No	4.15E+02	No
Outfall_8	METAL	Uranium	1.79E-02	1.40E+01	No	1.39E+00	No
Outfall_8	PPCB	TOTAL PCB	3.09E-06	1.65E-02	No	1.12E-02	No
Outfall_8	RADS	Uranium-238	8.83E+00	N/A	No	4.91E+03	No
Outfall_8	SVOA	TOTAL PAHs	1.24E-06	9.06E-05	No	6.20E-05	No

[a] The value is based on "low risk action level" for total PCB; the "lowest risk action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk action level"; the "lowest risk action level" for wading = 5.49E-02; for swimming = 6.38E-02.

Table 5.5. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	2.73E-04	7.31E-03	No	4.41E-03	No
Outfall_1	METAL	Iron	6.16E-02	4.11E+01	No	1.38E+01	No
Outfall_1	METAL	Uranium	5.93E-03	4.66E-01	No	4.64E-02	No
Outfall_1	PPCB	TOTAL PCB	1.20E-06	1.65E-04	No	1.12E-04	No
Outfall_1	RADS	Uranium-238	2.87E+00	N/A	No	4.91E+01	No
Outfall_1	**SVOA**	**TOTAL PAHs**	**1.78E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_10	METAL	Antimony	6.90E-04	7.31E-03	No	3.12E-03	No
Outfall_10	METAL	Iron	1.52E-01	4.11E+01	No	1.75E+01	No
Outfall_10	METAL	Uranium	1.04E-02	4.66E-01	No	1.99E-01	No
Outfall_10	PPCB	TOTAL PCB	2.92E-05	1.65E-04	No	9.61E-05	No
Outfall_10	RADS	Uranium-238	3.78E+00	N/A	No	4.91E+01	No
Outfall_10	**SVOA**	**TOTAL PAHs**	**9.05E-07**	9.06E-07	Yes	**5.29E-07**	**Yes**
Outfall_11	METAL	Antimony	9.76E-05	7.31E-03	No	3.12E-03	No
Outfall_11	METAL	Iron	2.66E-02	4.11E+01	No	1.75E+01	No
Outfall_11	METAL	Uranium	3.69E-02	4.66E-01	No	1.99E-01	No
Outfall_11	PPCB	TOTAL PCB	1.15E-06	1.65E-04	No	9.61E-05	No
Outfall_11	RADS	Uranium-238	2.58E+00	N/A	No	4.91E+01	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**4.62E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_12	METAL	Antimony	1.91E-04	7.31E-03	No	3.12E-03	No
Outfall_12	METAL	Iron	4.48E-02	4.11E+01	No	1.75E+01	No
Outfall_12	METAL	Uranium	1.29E-03	4.66E-01	No	1.99E-01	No
Outfall_12	PPCB	TOTAL PCB	7.47E-07	1.65E-04	No	9.61E-05	No
Outfall_12	RADS	Uranium-238	3.06E-01	N/A	No	4.91E+01	No
Outfall_12	SVOA	TOTAL PAHs	2.32E-07	9.06E-07	No	5.29E-07	No
Outfall_15	METAL	Antimony	1.16E-04	7.31E-03	No	4.41E-03	No
Outfall_15	METAL	Iron	2.15E-02	4.11E+01	No	1.38E+01	No
Outfall_15	METAL	Uranium	9.58E-03	4.66E-01	No	4.64E-02	No
Outfall_15	PPCB	TOTAL PCB	6.01E-07	1.65E-04	No	1.12E-04	No
Outfall_15	RADS	Uranium-238	2.94E+00	N/A	No	4.91E+01	No
Outfall_15	SVOA	TOTAL PAHs	9.74E-08	9.06E-07	No	6.20E-07	No
Outfall_2	METAL	Antimony	3.36E-04	7.31E-03	No	3.12E-03	No

Table 5.5. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	6.20E-02	4.11E+01	No	1.75E+01	No
Outfall_2	METAL	Uranium	1.05E-03	4.66E-01	No	1.99E-01	No
Outfall_2	PPCB	TOTAL PCB	3.60E-07	1.65E-04	No	9.61E-05	No
Outfall_2	RADS	Uranium-238	5.70E-01	N/A	No	4.91E+01	No
Outfall_2	SVOA	TOTAL PAHs	2.85E-07	9.06E-07	No	5.29E-07	No
Outfall_8	METAL	Antimony	1.68E-04	7.31E-03	No	4.41E-03	No
Outfall_8	METAL	Iron	3.41E-02	4.11E+01	No	1.38E+01	No
Outfall_8	METAL	Uranium	2.12E-03	4.66E-01	No	4.64E-02	No
Outfall_8	PPCB	TOTAL PCB	3.66E-07	1.65E-04	No	1.12E-04	No
Outfall_8	RADS	Uranium-238	1.05E+00	N/A	No	4.91E+01	No
Outfall_8	SVOA	TOTAL PAHs	1.47E-07	9.06E-07	No	6.20E-07	No

[a] The value is based on "low risk no action level" for total PCB; the "lowest risk no action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 no action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk no action level"; the "lowest risk no action level" for wading = 5.49E-04; for swimming = 6.38E-04.

Table 5.6. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	2.73E-04	2.19E-01	No	1.32E-01	No
Outfall_1	METAL	Iron	6.16E-02	1.23E+03	No	4.15E+02	No
Outfall_1	METAL	Uranium	5.93E-03	1.40E+01	No	1.39E+00	No
Outfall_1	PPCB	TOTAL PCB	1.20E-06	1.65E-02	No	1.12E-02	No
Outfall_1	RADS	Uranium-238	2.87E+00	N/A	No	4.91E+03	No
Outfall_1	SVOA	TOTAL PAHs	1.78E-06	9.06E-05	No	6.20E-05	No
Outfall_10	METAL	Antimony	6.90E-04	2.19E-01	No	9.36E-02	No
Outfall_10	METAL	Iron	1.52E-01	1.23E+03	No	5.26E+02	No
Outfall_10	METAL	Uranium	1.04E-02	1.40E+01	No	5.96E+00	No
Outfall_10	PPCB	TOTAL PCB	2.92E-05	1.65E-02	No	9.61E-03	No
Outfall_10	RADS	Uranium-238	3.78E+00	N/A	No	4.91E+03	No
Outfall_10	SVOA	TOTAL PAHs	9.05E-07	9.06E-05	No	5.29E-05	No
Outfall_11	METAL	Antimony	9.76E-05	2.19E-01	No	9.36E-02	No
Outfall_11	METAL	Iron	2.66E-02	1.23E+03	No	5.26E+02	No
Outfall_11	METAL	Uranium	3.69E-02	1.40E+01	No	5.96E+00	No
Outfall_11	PPCB	TOTAL PCB	1.15E-06	1.65E-02	No	9.61E-03	No
Outfall_11	RADS	Uranium-238	2.58E+00	N/A	No	4.91E+03	No
Outfall_11	SVOA	TOTAL PAHs	4.62E-06	9.06E-05	No	5.29E-05	No
Outfall_12	METAL	Antimony	1.91E-04	2.19E-01	No	9.36E-02	No
Outfall_12	METAL	Iron	4.48E-02	1.23E+03	No	5.26E+02	No
Outfall_12	METAL	Uranium	1.29E-03	1.40E+01	No	5.96E+00	No
Outfall_12	PPCB	TOTAL PCB	7.47E-07	1.65E-02	No	9.61E-03	No
Outfall_12	RADS	Uranium-238	3.06E-01	N/A	No	4.91E+03	No
Outfall_12	SVOA	TOTAL PAHs	2.32E-07	9.06E-07	No	5.29E-05	No
Outfall_15	METAL	Antimony	1.16E-04	2.19E-01	No	1.32E-01	No
Outfall_15	METAL	Iron	2.15E-02	1.23E+03	No	4.15E+02	No
Outfall_15	METAL	Uranium	9.58E-03	1.40E+01	No	1.39E+00	No
Outfall_15	PPCB	TOTAL PCB	6.01E-07	1.65E-02	No	1.12E-02	No
Outfall_15	RADS	Uranium-238	2.94E+00	N/A	No	4.91E+03	No
Outfall_15	SVOA	TOTAL PAHs	9.74E-08	9.06E-05	No	6.20E-05	No
Outfall_2	METAL	Antimony	3.36E-04	2.19E-01	No	9.36E-02	No

Table 5.6. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	6.20E-02	1.23E+03	No	5.26E+02	No
Outfall_2	METAL	Uranium	1.05E-03	1.40E+01	No	5.96E+00	No
Outfall_2	PPCB	TOTAL PCB	3.60E-07	1.65E-02	No	9.61E-03	No
Outfall_2	RADS	Uranium-238	5.70E-01	N/A	No	4.91E+03	No
Outfall_2	SVOA	TOTAL PAHs	2.85E-07	9.06E-07	No	5.29E-05	No
Outfall_8	METAL	Antimony	1.68E-04	2.19E-01	No	1.32E-01	No
Outfall_8	METAL	Iron	3.41E-02	1.23E+03	No	4.15E+02	No
Outfall_8	METAL	Uranium	2.12E-03	1.40E+01	No	1.39E+00	No
Outfall_8	PPCB	TOTAL PCB	3.66E-07	1.65E-02	No	1.12E-02	No
Outfall_8	RADS	Uranium-238	1.05E+00	N/A	No	4.91E+03	No
Outfall_8	SVOA	TOTAL PAHs	1.47E-07	9.06E-05	No	6.20E-05	No

[a] The value is based on "low risk action level" for total PCB; the "lowest risk action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk action level"; the "lowest risk action level" for wading = 5.49E-02; for swimming = 6.38E-02.

Table 5.7 summarizes the the screening criteria that were exceeded for modeled sediment concentrations of the COPCs. Tables 5.8 and 5.9 present the modeling results for sediment. These results indicate that Total PAHs, PCBs, antimony, and uranaium metals will exceed their respective sediment “No Ation” screening levels in nearly all the outfalls, and only Total PAHs will exceed its sediment “Action” screening level in Outfall 011. As mentioned earlier, the sediment transport results presented represent highly conservative values.

5.4 CONTAMINANT MIGRATION

This section includes details of contaminant migration and the SWMM modeling methods and results.

5.4.1 Factors Affecting Contaminant Migration

As discussed above, contaminants in surface soils are released to the surrounding environment through dissolution by rainwater and mass movement by soil erosion. These contaminants enter the plant drainage ditches and are transported in surface water as dissolved chemical species. The on-site ditches direct surface water runoff and plant discharges to off-site receiving streams.

5.4.2 Modeling Methods and Results

5.4.2.1 Surface water flow and contaminant transport modeling

Contaminants in surface soils can be released from source areas and transported to surface water via precipitation runoff. Contaminants that are sorbed onto surface soils can be released by desorption in surface runoff or captured with particulate matter by sheet erosion during a storm event. When it rains, some amount of the rainwater may stay in the soil, some may infiltrate through the soil column, and some may move as surface runoff. The proportions of these depend on the soil type, the soil cover, the amount of moisture already present in the soil, the intensity and duration of rainfall, and the slope length and steepness.

5.4.2.2 Modeling approach

Watersheds (drainage areas) in and around the site and surface water integrator points (Figure 5.2) delineate the domain of the SWMM for the SWOU SI. Topographic variations within the domain further discretized watersheds and streams. In the SWMM model, these subunits are referred to as subwatersheds and pipes, respectively. Characteristics of the subwatersheds and pipes were estimated using topographic contours and soil properties.

Three USGS stations with flow measurements provided the basis for calibration of the flow model. These stations are located on Bayou Creek near Heath, Bayou Creek near Grahamville, and Little Bayou Creek near Grahamville. The site-specific data included flow rates at the stations and measurements of rainfall on the site over the April–September period of 2001.

Sources and concentrations of each contaminant were identified in each subwatershed, and a source term for the contaminants was developed for each subwatershed to support the transport model. The transport model for the contaminant was calibrated to its observed concentration in surface water.

Annual rainfall for calendar year (CY) 2000 was similar to the 30-year average annual rainfall for the site; therefore, rainfall for CY 2000 was selected as the rainfall input for the model. The daily rainfall for this year was repeated 30 times to create the rainfall for a 30-year period. The model was run to

Table 5.7. Summary of Sediment Exceedances of Screening Criteria (Based on MUSLE)

COPCs Exceeding a Screening Level	Screening Level	Source of COPCs Exceeding Screening Level
Total PAHs	Industrial Worker No Action	All outfalls
	Child Recreational No Action	All outfalls
	Industrial Worker Action	Outfall 011 only
	Child Recreational Action	Outfall 011 only
Total PCB	Industrial Worker No Action	All but Outfall 002
	Child Recreational No Action	All outfalls
	Industrial Worker Action	None
	Child Recreational Action	None
Antimony	Industrial Worker No Action	All outfalls
	Child Recreational No Action	All outfalls
	Industrial Worker Action	None
	Child Recreational Action	None
Uranium	Industrial Worker No Action	Outfalls 011 and 015
	Child Recreational No Action	Outfalls 001, 008, 010, 011 and 015
	Industrial Worker Action	None
	Child Recreational Action	None
Uranium-238	Industrial Worker No Action	Outfalls 001, 008, 010, and 011
	Child Recreational No Action	Outfalls 001, 008, 010, and 012
	Industrial Worker Action	None
	Child Recreational Action	None

Table 5.8. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_1	METAL	Antimony	9.36E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_1	METAL	Iron	1.13E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_1	METAL	Uranium	2.03E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_1	PPCB	TOTAL PCB	7.99E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_1	RADS	Uranium-238	9.83E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_1	SVOA	TOTAL PAHs	3.70E+00	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_10	METAL	Antimony	9.38E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_10	METAL	Iron	1.10E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_10	METAL	Uranium	1.42E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_10	PPCB	TOTAL PCB	7.68E+00	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_10	RADS	Uranium-238	5.14E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_10	SVOA	TOTAL PAHs	7.47E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_11	METAL	Antimony	9.71E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_11	METAL	Iron	1.41E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_11	METAL	Uranium	3.67E+02	4.90E+00	Yes	6.50E+01	Yes	8.69E+00	Yes
Outfall_11	PPCB	TOTAL PCB	2.21E+00	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_11	RADS	Uranium-238	2.57E+01	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_11	SVOA	TOTAL PAHs	2.79E+01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_12	METAL	Antimony	9.57E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_12	METAL	Iron	1.20E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_12	METAL	Uranium	6.47E+00	4.90E+00	Yes	6.50E+01	No	8.69E+00	No
Outfall_12	PPCB	TOTAL PCB	7.24E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_12	RADS	Uranium-238	1.53E+00	1.20E+00	Yes	1.71	No	3.64E+00	No
Outfall_12	SVOA	TOTAL PAHs	7.04E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_15	METAL	Antimony	9.55E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_15	METAL	Iron	9.47E+03	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_15	METAL	Uranium	7.89E+01	4.90E+00	Yes	6.50E+01	Yes	8.69E+00	Yes
Outfall_15	PPCB	TOTAL PCB	9.59E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_15	RADS	Uranium-238	2.43E+01	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_15	SVOA	TOTAL PAHs	4.87E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_2	METAL	Antimony	9.29E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes

Table 5.8. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_2	METAL	Iron	9.16E+03	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_2	METAL	Uranium	2.92E+00	4.90E+00	No	6.50E+01	NA	8.69E+00	NA
Outfall_2	PPCB	TOTAL PCB	1.93E-01	NA	Yes	1.99E-01	No	1.27E-01	Yes
Outfall_2	RADS	Uranium-238	1.58E+00	1.20E+00	Yes	1.71	No	3.64E+00	No
Outfall_2	SVOA	TOTAL PAHs	4.80E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_8	METAL	Antimony	9.49E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_8	METAL	Iron	1.03E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_8	METAL	Uranium	1.20E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_8	PPCB	TOTAL PCB	4.01E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_8	RADS	Uranium-238	5.92E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_8	SVOA	TOTAL PAHs	5.04E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes

[a] Highlighted cell indicates predicted concentration exceeds no action level based on Hazard Index of 0.1

[b] Highlighted cell indicates predicted sediment concentration exceeds no action level based on ELCR of 1E-6

NA = not applicable as the predicted concentration is below background level.

Table 5.9. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Backgrounds	Industrial Worker Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_1	METAL	Antimony	9.36E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_1	METAL	Iron	1.13E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_1	METAL	Uranium	2.03E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_1	PPCB	TOTAL PCB	7.99E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_1	RADS	Uranium-238	9.83E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_1	SVOA	TOTAL PAHs	3.70E+00	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_10	METAL	Antimony	9.38E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_10	METAL	Iron	1.10E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_10	METAL	Uranium	1.42E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_10	PPCB	TOTAL PCB	7.68E+00	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_10	RADS	Uranium-238	5.14E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_10	SVOA	TOTAL PAHs	7.47E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_11	METAL	Antimony	9.71E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_11	METAL	Iron	1.41E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_11	METAL	Uranium	3.67E+02	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_11	PPCB	TOTAL PCB	2.21E+00	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_11	RADS	Uranium-238	2.57E+01	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_11	SVOA	TOTAL PAHs	2.79E+01	NA	Yes	1.46E+01	Yes	1.46E+01	Yes
Outfall_12	METAL	Antimony	9.57E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_12	METAL	Iron	1.20E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_12	METAL	Uranium	6.47E+00	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_12	PPCB	TOTAL PCB	7.24E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_12	RADS	Uranium-238	1.53E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_12	SVOA	TOTAL PAHs	7.04E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_15	METAL	Antimony	9.55E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_15	METAL	Iron	9.47E+03	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_15	METAL	Uranium	7.89E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_15	PPCB	TOTAL PCB	9.59E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_15	RADS	Uranium-238	2.43E+01	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_15	SVOA	TOTAL PAHs	4.87E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_2	METAL	Antimony	9.29E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No

Table 5.9. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Backgrounds	Industrial Worker Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_2	METAL	Iron	9.16E+03	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_2	METAL	Uranium	2.92E+00	4.90E+00	No	1.77E+04	NA	1.48E+03	NA
Outfall_2	PPCB	TOTAL PCB	1.93E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_2	RADS	Uranium-238	1.58E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_2	SVOA	TOTAL PAHs	4.80E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_8	METAL	Antimony	9.49E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_8	METAL	Iron	1.03E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_8	METAL	Uranium	1.20E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_8	PPCB	TOTAL PCB	4.01E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_8	RADS	Uranium-238	5.92E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_8	SVOA	TOTAL PAHs	5.04E-01	NA	Yes	1.46E+01	No	1.46E+01	No

[a] Highlighted cell indicates predicted sediment concentration exceeds action level based on ELCR of 1E-04

NA = Not applicable as the predicted concentration is below background level.

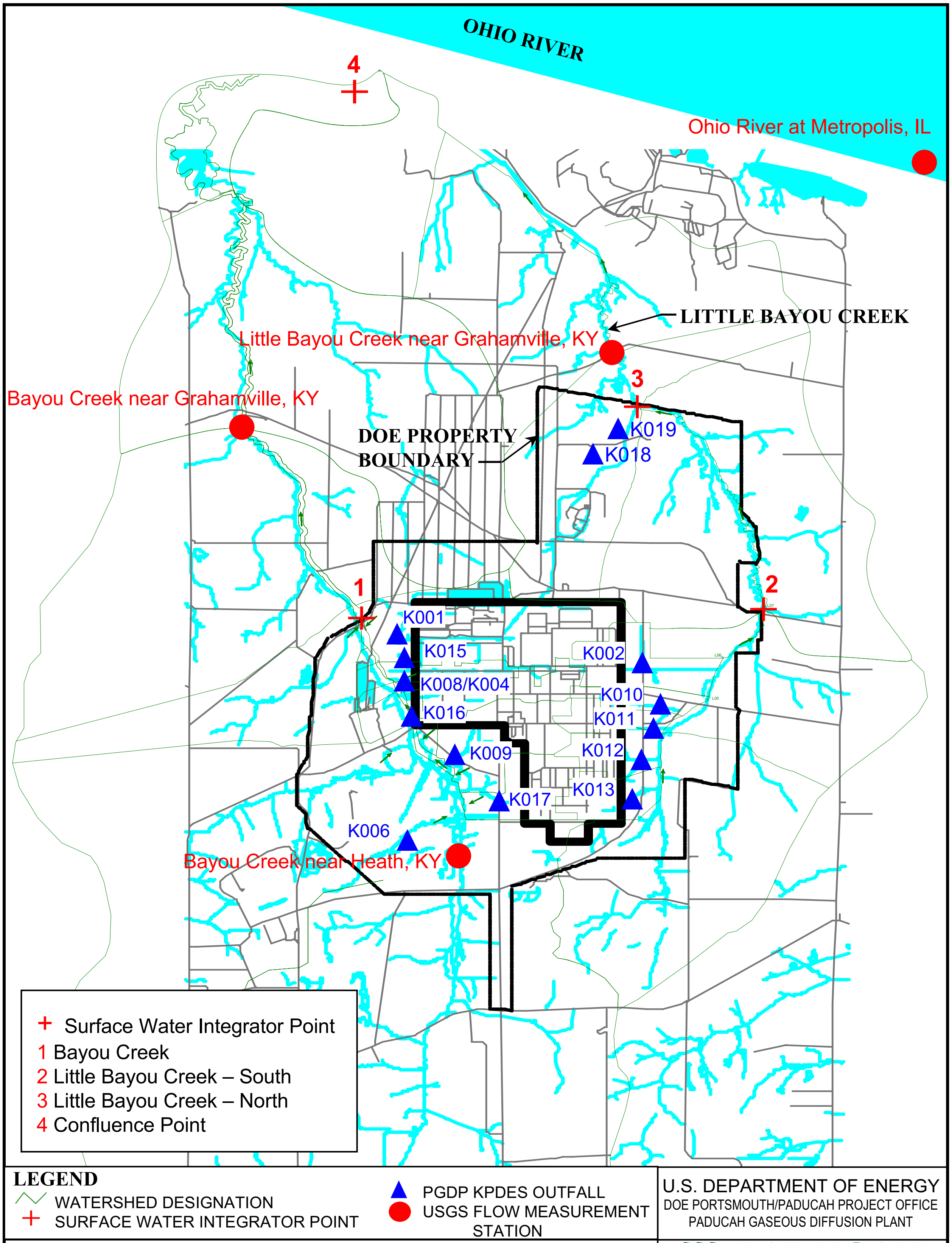

Figure 5.2. General Surface Drainage from the PGDP

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simulate the concentrations of the contaminants in the surface water runoff within the outfalls (just before mixing in the creeks) and in the combined flow within the creeks at the outfall discharge points and at the downgradient integrator points over 30 years.

5.4.2.3 Discretization

The SWOU SWMM discretizes the sitewide model into 50 subwatersheds. Of these, 26 subwatersheds are associated with Bayou Creek and 24 are associated with Little Bayou Creek.

The watersheds were modeled as pipes and inlets (Figure 5.3). The portion of a creek between two inlets is called a pipe. Of these, one inlet is an upstream inlet, and the other inlet is a downstream inlet. Surface water flows through the pipe from the upstream inlet to the downstream inlet.

Subwatersheds discharging to pipes were named considering their upstream inlets and their geographic locations around the creek. The subwatersheds discharging to inlets were named considering the inlets only. In general, inlets were associated with outfall locations based on proximity (Figure 5.3).

In the model, Bayou Creek consists of 15 inlets (nodes, junctions, or manholes) and 14 pipes (segments, gutters, links, channels, and streams). The inlets were named B01–B11, OF_01, OF_08, OF_15, and C01. Little Bayou Creek is modeled as 15 inlets and 14 pipes. The Little Bayou Creek inlets were named L01-L10, OF_02, OF_10, OF_11, OF_12, and C01. It should be noted that the contaminant transport analysis for the SWOU is limited only to the outfalls (e.g., OF_01, OF_08, OF_15, OF_02, OF_10, OF_11, and OF_12) and the immediate downgradient integrator points (B09 and L07). As shown in Figure 5.3, C01 is the confluence point for the runoff from Bayou Creek and Little Bayou Creek, and L08 is the integrator point for Little Bayou Creek south of the NSDD. These integrator points were not used in this analysis since these points are not within the scope of the SWOU (On-site). They are shown on the figure since they are critical integrator points that may be used in future modeling analysis.

5.4.2.4 SWMM description

SWMM is a mathematical model for simulating flow and contaminant transport in a watershed and its drainage channels. The model was developed by EPA (Huber and Dickinson 1988) and is widely recognized and accepted for simulating runoff quantity and quality due to rainfall. The model simulates time-varying hydrologic conditions, rainfall excess for runoff, infiltration, runoff flows, and movement of contaminants for a specified rainfall period. SWMM is an overland and pipe flow routing model that generates both hydrographs and pollutographs based on the hydrologic and contaminant transport characteristics. Single-event and continuous simulation can be performed for almost all components of the rainfall, runoff, and quality cycles for a watershed. The model is organized into blocks for simulating various hydrologic processes. Overland flow and contaminant transport are computed by the Runoff Block. SWMM simulates all aspects of the hydrologic and quality cycles, including rainfall, snowmelt, surface and subsurface runoff, and flow routing through a drainage network.

The conceptual surface water flow model was used as a basis to form the initial SWMM numerical model for the site. This model was refined using site hydrologic data (i.e., rainfall); site physical characteristics (soil, topography); surface water drainage patterns; and contaminant concentration data from the field. Data gaps were known to exist, so steps were taken to reduce the uncertainty in the characterization of site conditions. The goal was to develop the CSM for numerical simulation with a realistic evaluation of site hydrologic conditions.

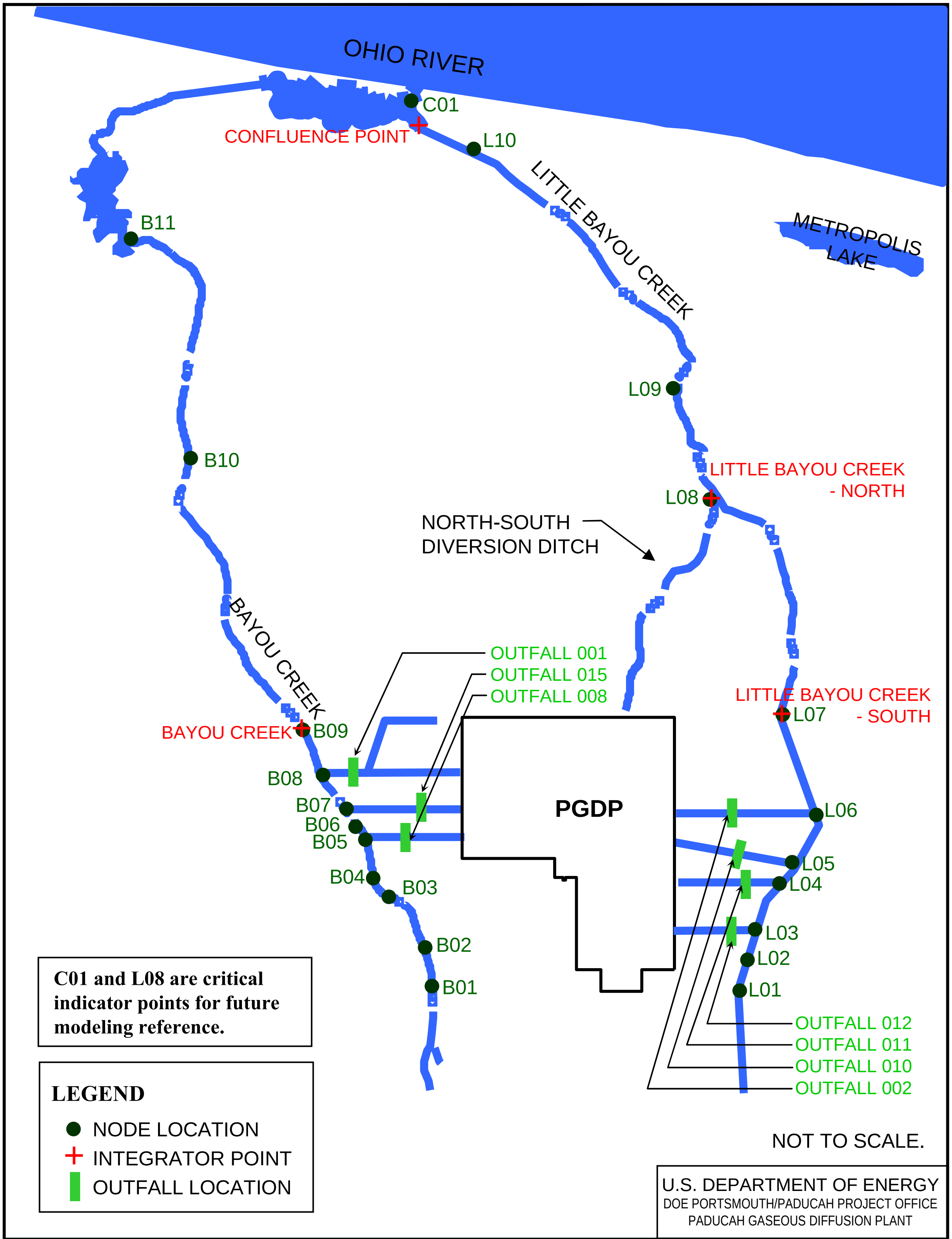

Figure 5.3. SWOU Modeling Node, Integrator, and Outfall Locations

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5.4.2.5 SWMM input parameters

Precipitation and Evaporation. The CY 2000 rainfall record was used for all simulations. Total rainfall for 2000 was 123.2 cm (48.5 inches), which is comparable to the annual average rainfall for Paducah, KY. Evaporation rates were estimated for each month based on the soil parameters and climatological data. A uniform evaporation rate of 0.1 inch/day was selected for modeling based on the estimate that was developed from the HELP model simulation results for the PGDP site. The practice of using uniform evapotranspiration over the period of simulation is very common and is not very sensitive with respect to the modeling (Hubber and Dickerson 1988).

Subwatershed. Parameters required for each subwatershed included the following:

- Total area

- Width for overland flow to pipe

- Slope

- Percent impervious area (area covered by compacted soils and paved and covered surfaces that prevent infiltration)

- Manning’s roughness coefficient (a measure of resistance to overland flow) for pervious and impervious areas

- Infiltration constants

- Depression storage (water from precipitation that collects in puddles at the land surface) for pervious and impervious areas

The model computes the runoff from each subwatershed based on the above data. Thereafter, the model routes the runoff through the drainage network.

Drainage network. Parameters required for the drainage network included the following:

- Pipe type (circular, trapezoidal, or other)
- Pipe length
- Pipe width (or diameter)
- Slope
- Manning’s roughness coefficient
- Water depths under initial and full flow conditions

Contaminant. Parameters required for each contaminant included the following:

- Initial loading in each subwatershed

- Washoff coefficient (measure of rate at which a pollutant is washed off of a specific land type during a rain event)

The parameters used in SWMM modeling are presented in Appendix C.

5.4.2.6 Source term derivation

The initial step in developing source terms for fate and transport modeling was a comparison of risk assessment results against screening levels for direct contact with contaminated sediment to identify contaminants that might pose the greatest risk through migration to offsite locations. This evaluation determined that antimony, iron, uranium, Total PCBs, Total PAHs, and uranium-238 required further assessment. The MUSLE model was used to further assess the potential impact of these contaminants on runoff water quality. Of the MUSLE model results, Total PAHs and uranium metal were the only contaminants to exceed screening levels.

Evaluation of the MUSLE results with respect to the SI DQOs identified the need for SWMM modeling of Total PCBs and uranium-238 to verify the MUSLE results. The ubiquitous nature of PAHs across the site and the strong recontamination potential during routine road usage, road repair, fuel usage, and roofing activities make selection of PAHs for further assessment inconsistent with the primary goal of the SWOU, which is to identify potential "hot spots" that can be addressed as part of an "early action"; therefore, Total PAHs was excluded from further transport simulation. SWMM modeling was not performed for uranium metal because the results for this contaminant indicated a hazard index below 1.

The SWMM model required that potential "hot spot" areas for Total PCBs and uranium-238 be developed for each EU. Next, the EUs potentially contributing to surface water contamination were assigned to the outfalls to which they drain by geographic information system analysis of the watershed map shown in Figure 5.2. Finally, source terms for Total PCBs and uranium-238 were developed for the EUs that potentially contribute to surface water contamination. The total area of the potential "hot spots" in the subwatershed determined the effective area for the SWMM model. A depth of 0.3 m (1 ft) and an appropriate bulk density were considered for the surface soil and multiplied by the effective area to estimate an effective mass for the soil contained within the effective area. The product of the mean concentrations of the contaminants in the subwatersheds and the effective mass of the soil determined the source term for the contaminants.

5.4.2.7 Modeling assumptions

The SWMM simulations incorporated the following assumptions for the SWOU flow and transport modeling:

- The rainfall of 2000 represents rainfall for a typical year.

- Depression storage equals to zero for all areas.

- Overland flow from an outfall subwatershed goes to an inlet node. The inlet node is connected to an upstream/downstream node in a stream through a 0.3-m (1-ft) long imaginary pipe.

- Subwatershed characteristics like area, slope, and perviousness were estimated from USGS drainage maps and Geographic Information System (GIS) digitized maps.

- Horton parameters (measures of the infiltration capacity of a soil) used were minimum infiltration (0.284 in/hr), maximum infiltration (2.84 inch/hr), and decay (0.00125 inch/sec). The infiltration rates were adjusted during calibration. The resulting infiltration rates were larger than the few observed rates at the site, but were consistent with expectations because water balances for PGDP have shown a large loss of surface water to groundwater.

- Manning's roughness coefficient equals 0.015 for impervious areas and 0.15 for pervious areas.

- Bayou Creek and Little Bayou Creek were approximated as parabolic streams (i.e., streams with a bowl shaped cross section). Required model parameters, like depth and width of the streams, were taken from the nearest transect developed using field information.

- Manning's roughness coefficient for all stream sections was 0.13.

- Overland flow after a rainfall event transported a contaminant from the subwatersheds to the creeks and then to the integrator points.

5.4.2.8 Model calibration

Contaminant transport through the surface water pathway is dominated by the site topography and site hydrologic characteristics. The SWMM model was used to simulate the concentrations of the contaminants based on the computed surface runoff. Washoff of the contaminants due to surface runoff was computed based on the loading concentrations representing the site surface soil concentrations.

In the model, the contaminants migrate due to routing of flows in the ditches and streams. The computational algorithm for the transport of contaminants in the SWMM model depends on washoff and runoff parameters. Uncertainties in simulation results associated with these parameters were minimized by calibrating the model with observed concentrations in the outfalls.

Calibration consisted of a trial and error approach that minimized the differences between measured and computed concentrations by changing the washoff and runoff parameters. The calibration achieved an agreeable match between observed and computed concentrations of contaminants. Table C2.7 of Appendix C presents the final calibration results for transport analysis.

5.4.2.9 SWMM modeling results

Table 5.10 presents the results of contaminant fate and transport modeling through the surface water pathway for Total PCBs and uranium-238. The table includes predicted average and maximum concentrations of the contaminants in the surface water runoff in the outfalls (just before mixing in the creeks) as well as in the creeks adjacent to the outfall discharge points and at the integrator points for Bayou Creek (B09) and Little Bayou Creek (L07). These integrator points represent the first integrator point immediately downgradient of all source areas (outfalls) in each of the two creeks. The predicted contaminant concentrations were compared to no action screening levels. These screening levels are not based on site-specific exposure scenarios and should not be considered cleanup goals for the SWOU.

As can be seen in Table 5.10, both the average and the maximum concentrations of Total PCBs exceed the child recreational and industrial worker no action screening levels for surface water within the outfalls (just before mixing in the creeks), but Total PCBs concentrations within the creeks and at the creek integrator points do not exceed these no action screening levels.[1] For uranium-238, the only exceedance of the modeled concentrations is within Outfall 001 (just before mixing in the creeks) for the no action child recreational screening level. As with Total PCBs, uranium-238 concentrations within the creeks and at creek integrator points did not exceed these no action screening levels. It should be noted

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[1] The cancer risk for the child recreational scenario is less than 1 x 10^{-5}. Moreover, the no action child recreational screening level is based on a 40-year exposure of 140 days/year, which is unlikely to occur along the outfall ditches or at the discharge points to the creeks; therefore, actual risks likely would be much lower than those calculated using the child recreational scenario.

that the results are based on a 30-year simulation period starting from the present. These predicted results were compared against the concentrations of radionuclides identified by ISCO continuous surface water samplers (UK 2007) from PGDP outfalls and creeks. The data indicate that the predicted results compared favorably to the ISCO continous monitoring data. For example, the six-year average concentrations of uranium-238 for surface water samples collected from ISCO samplers at Outfalls 001 (ISCO A) and 008 (ISCO F) are 2.77 pCi/L and 1.42 pCi/L, respectively; the SWMM-predicted 30-year average concentrations at Outfall 001 and Outfall 008 are 10.6 pCi/L and 1.94 pCi/L, respectively.

Table 5.10. SWMM Modeled Contaminant Concentrations of PGDP Surface Water COPCs (Total PCBs and Uranium-238) at Multiple Receptor Locations

Action level	Total PCBs	Uranium-238
Industrial Worker (Action)	1.65E-02 mg/L	N/A
Industrial Worker (No Action)	1.65E-04 mg/L	N/A
Child Recreational (Action)	1.12E-02 / 9.61E-03 mg/L	4.91E+03 pCi/L
Child Recreational (No Action)	1.12E-04 / 9.61E-05 mg/L	4.91E+01 pCi/L

	SWMM Predicted Surface Water Concentrations[2]			
	Total PCBs		Uranium-238	
Receptor Location[1]	Average (mg/L)	Maximum (mg/L)	Average (pCi/L)	Maximum (pCi/L)
Outfall 001	**1.18E-04**	**5.27E-04**	1.06E+01	**5.15E+01**
Outfall 008	**1.84E-04**	**8.11E-04**	1.94E+00	9.26E+00
Outfall 010	**4.21E-04**	**1.70E-03**	0.00E+00	0.00E+00
Outfall 015	**1.58E-04**	**6.68E-04**	4.07E+00	1.73E+01
B09 (IP for Bayou Creek)	8.50E-06	1.46E-05	4.40E-02	8.18E-01
B06 (from OF 008)	4.80E-07	1.98E-05	5.06E-03	2.27E-01
L05 (from OF 010)	2.16E-06	1.91E-05	0.00E+00	0.00E+00
B07 (from OF 015)	5.57E-07	4.13E-05	7.70E-03	7.13E-01
L07 (IP for Little Bayou Creek)	1.37E-06	7.93E-06	0.00E+00	0.00E+00

[1] Outfall concentrations are at the pipe, and creek concentrations are immediately downgradient of the outfalls.

[2] Predicted concentrations are based on 30-year simulations.

IP = Integrator Point.

OF = Outfall.

L04, L05, and L07 are discharge points in Little Bayou Creek.

B06, B07, and B09 are discharge points in Bayou Creek.

Bolded values represent exceedance of one or more of no action level values.

5.4.2.10 Uncertainties and Model Parameter Sensitivity Analysis

The primary uncertainties associated with the fate and transport modeling are the simplifying assumptions concerning the hydrogeology, soil properties and geochemistry, distribution coefficients (e.g., washoff coefficients) of contaminants in soils within the contaminant migration pathways, and the contaminant source terms, as well as contaminant contribution from groundwater/surface water interaction. In the following section, a brief discussion is presented on the surface water modeling uncertainties.

The assumptions for surface water modeling already have been presented earlier in the text. In general, the watershed and the streams were discretized into subwatersheds and pipes, and homogeneous properties for the hydrogeology and contaminants in a subwatershed or a pipe were assumed; therefore, significant uncertainties were introduced through the assumptions of watershed, stream, and contaminant characteristics. The watershed was discretized into subwatersheds using topographic contours available for the site. The streams were discretized using the resulting subwatershed, and their properties were set considering a few transects developed using field data. The loading from discrete sources in a subwatershed was idealized as a uniform loading rate from the entire subwatershed. In short, the modeling remained limited by data availability and may have contributed to uncertainty in the simulation results.

The assumptions related washoff of a contaminant from the surface of the subwatershed to the overland flow using an empirical method. The parameters of the method are difficult to estimate and may have contributed to uncertainty in the simulation results. In addition, the assumptions considered contaminant transport as advection caused by overland flow and exclude the impacts of molecular diffusion and/or mechanical dispersion on the transport, as well as the interaction between multiple constituents present in the system. These assumptions, however, are expected not to dominate the transport caused by overland flow, and their exclusion is not expected to contribute significantly to the uncertainty in the simulation results. The use of 30-year average rainfall represented by calendar year 2002 also may have introduced some uncertainty in the modeling results; however, for the average condition, this uncertainty is expected to be negligible.

The assumption of average COPC concentration to be the representative EPC for an EU may produce some uncertainties in the modeling results. However, as compared to the upper 95% confidence limit of the mean, the average concentration is expected to produce more reasonable results. It should be noted that the use of the average concentration is consistent with the SWOU SAP (page 6-4) (DOE 2005a) and the Risk Methods Document (DOE 2001).

Due to the sediment transport mechanism discussed earlier in this chapter, there could be some uncertainty due to the use of historical sediment data. Because sediments are mobile and subject to redistribution by suspended sediment load transport, historical concentrations in contaminated sediment may be subject to change over time due to additional sedimentation (from erosion) and redistribution of existing sediments. Due to the vegetative cover present at this site, this uncertainty may be very limited.

The ubiquitous nature of PAHs at the site and the strong recontamination potential during routine road usage, road repair, fuel usage, and roofing activities made selection of PAHs inconsistent with the primary goal of the SWOU, which is to identify “hot spots” that can be addressed as part of an “early action”; therefore, the analyte group “Total PAHs” was excluded from transport analysis using SWMM. However, it should be noted that since EU specific data was available for conservative transport modeling, total PAHs were evaluated as part of the MUSLE model. Results of the MUSLE model identified PAHs as a potential concern for contaminant transport.

The sensitivity of the SWMM configuration to various input parameters was evaluated by selecting sensitive model parameters and varying the values through a range. Parameters that did not produce significant changes in model results, such as subbasin slopes and maximum infiltration rates, were not further evaluated. Parameters producing significant changes in model results included subbasin impermeability and the minimum infiltration rate. The likely ranges of these parameter values were modeled and the resulting contaminant concentrations at the outfall locations were predicted. The results are summarized in Appendix C.

Strong vertical (downward) hydraulic gradients predominate in the industrial area of the PGDP, typically limiting the area that contributes groundwater infiltration to ditches and creeks to the immediate vicinity of the waterways (PRS 2007). Prolonged periods of rainfall will saturate the shallow soils and will raise the water table, resulting in throughflow over much greater distances to the ditches and creeks. As a result, during these periods of prolonged rainfall, increased groundwater discharge to ditches and creeks will occur over an estimated period of 1-2 days before normal throughflow of groundwater to surface water resumes. Greater contaminant levels and heightened risk may be present temporarily in the ditches and streams. The typical impact of these events will be manifested in the sediment contamination as characterized by the SWOU SI.

Limited areas of discharge and interaction between contaminated groundwater and surface water are present both within and near PGDP. Discharges of contaminated groundwater to surface water occur at seeps in Little Bayou Creek at the Ohio River. The groundwater in these seeps contains contaminants associated with the Northwest Plume (i.e., TCE and technetium-99). Within the PGDP industrial area (but outside the limited or fenced area), at a location adjacent to Bayou Creek near the C-746-K Landfill, there are contaminated groundwater seeps that contain metals, volatile organic compounds, and radionuclides. Consistent with the approved SWOU work plan, the modeling completed as part of the SWOU SI/BRA report did not include any risk posed by contaminants from these seep locations.

A limited stretch of Outfall 011 is the only location within the PGDP industrial area where contaminated groundwater and surface water are known to interact. At this location, the *Final Site Evaluation Report for the Outfall 010, 011, and 012 Areas* (DOE 1995) documented the presence of a small TCE source near the Outfall 011 ditch. During periods of prolonged rainfall, the water table rises, resulting in discharge of contaminated groundwater to the surface waters of Outfall 011. Periods of groundwater discharge to Outfall 011 are transient. Additional information taken from *Final Site Evaluation Report for the Outfall 010, 011, and 012 Areas* (DOE 1995) is discussed in *Surface Water to Groundwater Interaction at the Paducah Gaseous Diffusion Plant* (PRS 2007).

6. BASELINE RISK ASSESSMENT

The BRA was prepared in two parts: the BHHRA (Appendix D) and the SERA (Appendix E). This section presents the results of the BHHRA and SERA conducted for the SWOU (On-Site) SI. In these assessments, information collected during the recently completed SI for the SWOU, historical data, and routine environmental monitoring data from the site were used to characterize the baseline risks posed to human health and the environment.

6.1 BHHRA

From the project data set, 36 COPCs were identified and carried through the BHHRA. The list of COPCs initially was narrowed and further refined by screening against residential no action levels and by eliminating chemicals considered human nutrients.

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

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

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

- Current/Future Industrial Worker
  - Incidental ingestion of soil/sediment
  - Dermal contact with soil/sediment
  - Inhalation of particulates emitted from soil/sediment
  - External exposure to ionizing radiation emitted from soil/sediment
  - Dermal contact with surface water

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

- Current/Future Recreational User
  - Incidental ingestion of soil/sediment
  - Dermal contact with soil/sediment
  - Inhalation of particulates emitted from soil/sediment
  - External exposure to ionizing radiation emitted from soil/sediment
  - Dermal contact with surface water
  - Ingestion of deer grazing on vegetation grown in contaminated soil/sediment
  - Ingestion of rabbit grazing on vegetation grown in contaminated soil/sediment
  - Ingestion of quail grazing on vegetation grown in contaminated soil/sediment

Table 6.1 presents a summary of human receptors by land use and exposure pathways. Important conclusions and observations of the BHHRA based on the analysis of exposures to the above receptors are presented in the following sections.

Table 6.2 presents the pathways of concern in the BHHRA. The pathways that either are highlighted in pink or are marked with an "X" are priority pathways that resulted in risks greater than the hazard limit of 1 or an ELCR greater than 1E-04.

Tables 6.3 and 6.4 summarize hazards and cancer risks for each exposure scenario at each EU. The results by exposure scenario are summarized in Subsections 6.1.1 through 6.1.3.

6.1.1 Current Industrial Workers

Soil hazards (total HIs) for the current industrial worker were at or below a cumulative hazard estimate of 1 for all contact exposures associated with soil/sediment and for surface water at all EUs. A cumulative ELCR greater than 1E-06 was estimated for all EUs, with a cumulative ELCR greater than 1E-04 estimated for two of the EUs for current industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the current industrial worker exceeded 1E-04 at Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot.

Table 6.1. Summary Exposure Routes Evaluated in the BHHRA

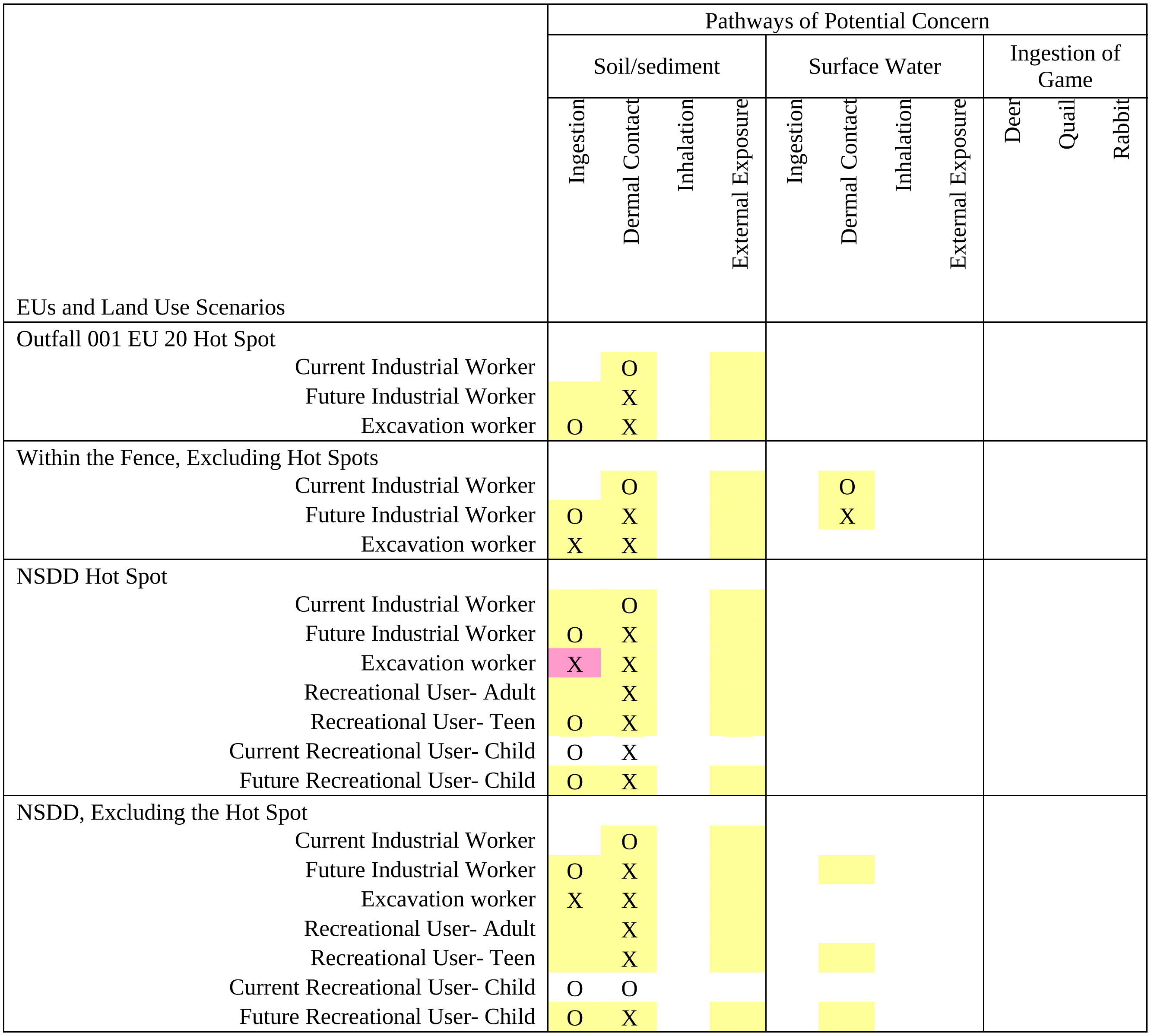
	Pathways of potential concern										
	Soil				Surface water				Ingestion of game		
EUs and land use scenarios	**Ingestion**	**Dermal contact**	**Inhalation**	**External exposure**	**Ingestion**	**Dermal contact**	**Inhalation**	**External exposure**	**Deer**	**Quail**	**Rabbit**
Outfall 008 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 010 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 011 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 015 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 13 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 14 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 15 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 16 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 18 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Outfall 001 EU 20 Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Within the Fence, Excluding Hot Spots											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
NSDD Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Future Recreational user–adult	X	X	X	X		X			X	X	X
Future Recreational user–teen	X	X	X	X		X			X	X	X
Current/Future Recreational user–child	X	X	X	X		X			X	X	X
NSDD, Excluding the Hot Spot											
Current/Future Industrial worker	X	X	X	X		X					
Excavation worker	X	X	X	X							
Future Recreational user–adult	X	X	X	X		X			X	X	X
Future Recreational user–teen	X	X	X	X		X			X	X	X
Current/Future Recreational user–child	X	X	X	X		X			X	X	X

X: Exposure route was evaluated quantitatively in the BHHRA.

Table 6.2. Summary of Pathways of Concern

	Pathways of Potential Concern										
	Soil/sediment				Surface Water				Ingestion of Game		
EUs and Land Use Scenarios	Ingestion	Dermal Contact	Inhalation	External Exposure	Ingestion	Dermal Contact	Inhalation	External Exposure	Deer	Quail	Rabbit
Outfall 008 Hot Spot											
Current Industrial Worker	🟨	O		🟨							
Future Industrial Worker	O	X		🟨							
Excavation worker	X	X		🟨							
Outfall 010 Hot Spot											
Current Industrial Worker		O									
Future Industrial Worker	O	X		🟨							
Excavation worker	X	X		🟨							
Outfall 011 Hot Spot											
Current Industrial Worker	🟨	O				O					
Future Industrial Worker	O	X		🟨		X					
Excavation worker	X	X		🟨							
Outfall 015 Hot Spot											
Current Industrial Worker		O		🟨							
Future Industrial Worker	O	X		🟨		O					
Excavation worker	X	X		🟨							
Outfall 001 EU 13 Hot Spot											
Current Industrial Worker		O									
Future Industrial Worker	O	X		🟨							
Excavation worker	X	X		🟨							
Outfall 001 EU 14 Hot Spot											
Current Industrial Worker	🟨	O				O					
Future Industrial Worker	O	X		🟨		X					
Excavation worker	X	X		🟨							
Outfall 001 EU 15 Hot Spot											
Current Industrial Worker	O	O									
Future Industrial Worker	O	X		🟨							
Excavation worker	X	X		🟨							
Outfall 001 EU 16 Hot Spot											
Current Industrial Worker		O									
Future Industrial Worker	O	X									
Excavation worker	X	X									
Outfall 001 EU 18 Hot Spot											
Current Industrial Worker		O		🟨							
Future Industrial Worker	O	X		🟨							
Excavation worker	X	X		🟨							

Table 6.2. Summary of Pathways of Concern (Continued)



EUs and Land Use Scenarios	Pathways of Potential Concern										
	Soil/sediment				Surface Water				Ingestion of Game		
	Ingestion	Dermal Contact	Inhalation	External Exposure	Ingestion	Dermal Contact	Inhalation	External Exposure	Deer	Quail	Rabbit
Outfall 001 EU 20 Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨	🟨 X		🟨							
Excavation worker	🟨 O	🟨 X		🟨							
Within the Fence, Excluding Hot Spots											
Current Industrial Worker		🟨 O		🟨		🟨 O					
Future Industrial Worker	🟨 O	🟨 X		🟨		🟨 X					
Excavation worker	🟨 X	🟨 X		🟨							
NSDD Hot Spot											
Current Industrial Worker	🟨	🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨							
Excavation worker	🟥 X	🟨 X		🟨							
Recreational User- Adult	🟨	🟨 X		🟨							
Recreational User- Teen	🟨 O	🟨 X		🟨							
Current Recreational User- Child	O	X									
Future Recreational User- Child	🟨 O	🟨 X		🟨							
NSDD, Excluding the Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨		🟨					
Excavation worker	🟨 X	🟨 X		🟨							
Recreational User- Adult	🟨	🟨 X		🟨							
Recreational User- Teen	🟨	🟨 X		🟨		🟨					
Current Recreational User- Child	O	O									
Future Recreational User- Child	🟨 O	🟨 X		🟨		🟨					

O: Indicates that HI is greater than 0.1 but less than 1.
X: Indicates that HI is greater than 1.
Yellow shading indicates an ELCR is between 1E-06 and 1E-04.
Pink shading indicates an ELCR greater than 1E-04.
Blank cells indicate no COPCs were selected or neither the HI nor ELCR risk limits were exceeded.
EU = exposure unit.
NSDD = North-South Diversion Ditch.

Table 6.3. Hazard Index Risk Summary

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001 EU 13 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	3.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	1.E+00	100%	
	Total Risk =	1.E+00		No
Outfall 001 EU 14 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Teen			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-01	83%	
	Surface Water	1.E-01	17%	
	Total Risk =	9.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	83%	
	Surface Water	3.E+00	17%	
	Total Risk =	2.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 001	Recreational Adult			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001 EU 15 Hot Spot (Cont.)	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	1.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+00		No
	Future Industrial Worker			
	Soil	3.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E+01		**Yes**
	Excavation Worker			
	Soil	3.E+01	100%	
	Total Risk =	3.E+01		**Yes**
Outfall 001 EU 16 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Future Recreational Child			
EU 16	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	7.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 001	Recreational Adult			
EU 18	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Current Industrial Worker			
EU 18	Soil	3.E-01	100%	
Hot Spot	Surface Water	NC	0%	
(Cont.)	**Total Risk =**	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	5.E+00	100%	
	Total Risk =	5.E+00		**Yes**
Outfall 001	Recreational Adult			
EU 20	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-01		No
	Future Industrial Worker			
	Soil	4.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	4.E+00		**Yes**

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001 EU 20 Hot Spot (Cont.)	Excavation Worker			
	Soil	3.E+00	100%	
	Total Risk =	3.E+00		**Yes**
Outfall 008 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	9.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	9.E-01		No
	Future Industrial Worker			
	Soil	2.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E+01		**Yes**
	Excavation Worker			
	Soil	2.E+01	100%	
	Total Risk =	2.E+01		**Yes**
Outfall 010 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 010 Hot Spot (Cont.)	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	6.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	6.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 011 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 011	Current Recreational Child			
Hot Spot	Sediment	NE	0%	
(Cont.)	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	6.E-01	61%	
	Surface Water	4.E-01	39%	
	Total Risk =	1.E+00		No
	Future Industrial Worker			
	Soil	1.E+01	96%	
	Surface Water	4.E-01	4%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 015	Recreational Adult			
Hot Spot	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 015 Hot Spot (Cont.)	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-01	95%	
	Surface Water	3.E-02	5%	
	Total Risk =	5.E-01		No
	Future Industrial Worker			
	Soil	9.E+00	95%	
	Surface Water	5.E-01	5%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Within the Fence, Excluding the Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Within the Fence, Excluding the Hot Spot (Cont.)	Current Industrial Worker			
	Soil	3.E-01	66%	
	Surface Water	1.E-01	34%	
	Total Risk =	4.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	66%	
	Surface Water	3.E+00	34%	
	Total Risk =	8.E+00		**Yes**
	Excavation Worker			
	Soil	5.E+00	100%	
	Total Risk =	5.E+00		**Yes**
NSDD Hot Spot	Recreational Adult			
	Sediment	2.E+00	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	2.E+00		**Yes**
	Recreational Teen			
	Sediment	1.E+01	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Current Recreational Child			
	Sediment	2.E+00	99%	
	Game	1.E-02	1%	
	Surface Water	NC	0%	
	Total Risk =	2.E+00		**Yes**
	Future Recreational Child			
	Sediment	2.E+01	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	2.E+01		**Yes**
	Current Industrial Worker			
	Soil	4.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	4.E-01		No
	Future Industrial Worker			
	Soil	8.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	8.E+00		**Yes**

Table 6.3. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD Hot Spot (Cont.)	Excavation Worker			
	Soil	9.E+00	100%	
	Total Risk =	9.E+00		**Yes**
NSDD, Excluding the Hot Spot	Recreational Adult			
	Sediment	2.E+00	99%	
	Game	1.E-02	1%	
	Surface Water	5.E-11	0%	
	Total Risk =	2.E+00		**Yes**
	Recreational Teen			
	Sediment	7.E+00	100%	
	Game	8.E-03	0%	
	Surface Water	2.E-10	0%	
	Total Risk =	7.E+00		**Yes**
	Current Recreational Child			
	Sediment	1.E+00	99%	
	Game	9.E-03	1%	
	Surface Water	3.E-11	0%	
	Total Risk =	1.E+00		No
	Future Recreational Child			
	Sediment	1.E+01	100%	
	Game	9.E-03	0%	
	Surface Water	3.E-10	0%	
	Total Risk =	1.E+01		**Yes**
	Current Industrial Worker			
	Soil	3.E-01	100%	
	Surface Water	6.E-12	0%	
	Total Risk =	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	1.E-10	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	2.E+00	100%	
	Total Risk =	2.E+00		**Yes**

NC: No COCs selected.

NE: Exposure to the media was not evaluated because the pathway is not complete. A fence surrounds the outfalls, precluding recreational exposure.

Table 6.4. Excess Lifetime Cancer Risk Summary

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Adult			
EU 13	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	8.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	8.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Teen			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-04	99%	
	Surface Water	3.E-06	1%	
	Total Risk =	5.E-04		**Yes**
	Future Industrial Worker			
	Soil	9.E-03	99%	
	Surface Water	5.E-05	1%	
	Total Risk =	9.E-03		**Yes**
	Excavation Worker			
	Soil	2.E-03	100%	
	Total Risk =	2.E-03		**Yes**
Outfall 001	Recreational Adult			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Current Recreational Child			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	3.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-05		**Yes**
	Future Industrial Worker			
	Soil	5.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-04		**Yes**
	Excavation Worker			
	Soil	6.E-04	100%	
	Total Risk =	6.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 16	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001				
EU 16	Future Industrial Worker			
Hot Spot	Soil	1.E-04	100%	
(Cont.)	Surface Water	NC	0%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 18	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Adult			
EU 20	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	9.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	9.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 008	Recreational Adult			
Hot Spot	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 008 Hot Spot (Cont.)	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	1.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-05		**Yes**
	Future Industrial Worker			
	Soil	3.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-04		**Yes**
	Excavation Worker			
	Soil	3.E-04	100%	
	Total Risk =	3.E-04		**Yes**
Outfall 010 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 010	Current Recreational Child			
Hot Spot	Sediment	NE	0%	
(Cont.)	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-05		**Yes**
	Future Industrial Worker			
	Soil	3.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-04		**Yes**
	Excavation Worker			
	Soil	3.E-04	100%	
	Total Risk =	3.E-04		**Yes**
Outfall 011	Recreational Adult			
Hot Spot	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-04	92%	
	Surface Water	1.E-05	8%	
	Total Risk =	2.E-04		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 011 Hot Spot (Cont.)	Future Industrial Worker			
	Soil	3.E-03	100%	
	Surface Water	1.E-05	0%	
	Total Risk =	3.E-03		**Yes**
	Excavation Worker			
	Soil	3.E-03	100%	
	Total Risk =	3.E-03		**Yes**
Outfall 015 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-06	93%	
	Surface Water	5.E-07	7%	
	Total Risk =	7.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	93%	
	Surface Water	9.E-06	7%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	2.E-04	100%	
	Total Risk =	2.E-04		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Within the Fence, Excluding the Hot Spots	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	70%	
	Surface Water	2.E-06	30%	
	Total Risk =	8.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	70%	
	Surface Water	4.E-05	30%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
NSDD Hot Spot	Recreational Adult			
	Sediment	5.E-05	99%	
	Game	3.E-07	1%	
	Surface Water	NC	0%	
	Total Risk =	5.E-05		**Yes**
	Recreational Teen			
	Sediment	7.E-05	100%	
	Game	1.E-07	0%	
	Surface Water	NC	0%	
	Total Risk =	7.E-05		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD Hot Spot (Cont.)	Future Recreational Child			
	Sediment	5.E-05	100%	
	Game	4.E-08	0%	
	Surface Water	NC	0%	
	Total Risk =	5.E-05		**Yes**
	Current Recreational Child			
	Sediment	1.E-06	96%	
	Game	4.E-08	4%	
	Surface Water	NC	0%	
	Total Risk =	1.E-06		No
	Current Industrial Worker			
	Soil	1.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-05		**Yes**
	Future Industrial Worker			
	Soil	2.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-04		**Yes**
	Excavation Worker			
	Soil	4.E-04	100%	
	Total Risk =	4.E-04		**Yes**
NSDD, Excluding the Hot Spot	Recreational Adult			
	Sediment	3.E-05	96%	
	Game	2.E-07	1%	
	Surface Water	9.E-07	3%	
	Total Risk =	3.E-05		**Yes**
	Recreational Teen			
	Sediment	6.E-05	97%	
	Game	8.E-08	0%	
	Surface Water	2.E-06	3%	
	Total Risk =	6.E-05		**Yes**
	Future Recreational Child			
	Sediment	4.E-05	97%	
	Game	4.E-08	0%	
	Surface Water	1.E-06	3%	
	Total Risk =	4.E-05		**Yes**

Table 6.4. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD, Excluding the Hot Spot (Cont.)	Current Recreational Child			
	Sediment	7.E-07	92%	
	Game	4.E-08	5%	
	Surface Water	2.E-08	3%	
	Total Risk =	8.E-07		No
	Current Industrial Worker			
	Soil	5.E-06	98%	
	Surface Water	1.E-07	2%	
	Total Risk =	6.E-06		**Yes**
	Future Industrial Worker			
	Soil	9.E-05	97%	
	Surface Water	2.E-06	3%	
	Total Risk =	9.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**

NC: No COCs selected.

NE: Exposure to the media was not evaluated because the pathway is not complete. A fence surrounds the outfalls, precluding recreational exposure.

The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

6.1.2 Future Industrial Worker

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

6.1.3 Excavation Worker

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

6.1.4 Current/Future Recreational User

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

HI estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were below a hazard of 1. ELCR estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were at or below 1E-06, with the exception of future teen dermal contact with surface water at the NSDD, Excluding the Hot Spot (Section 3, EU3: Section 4, all EUs; and Section 5, all EUs).

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

In summary, based on the estimated cancer and noncancer risks for each receptor, the following are the media of concern for each EU under current exposure scenarios conditions:

- Outfall 011 Hot Spot—Soil/Sediment
- Outfall 001 EU 14 Hot Spot—Soil/Sediment
- NSDD Hot Spot—Soil/Sediment

Based on the estimated cancer and noncancer risks for each receptor, the following are the media of concern for each EU under future exposure scenario conditions:

- Outfall 008 Hot Spot—Soil/Sediment
- Outfall 010 Hot Spot—Soil/Sediment
- Outfall 011 Hot Spot—Soil/Sediment
- Outfall 015 Hot Spot—Soil/Sediment
- Outfall 001 EU 13 Hot Spot—Soil/Sediment
- Outfall 001 EU 14 Hot Spot—Soil/Sediment and Surface Water
- Outfall 001 EU 15 Hot Spot—Soil/Sediment
- Outfall 001 EU 16 Hot Spot—Soil/Sediment
- Outfall 001 EU 18 Hot Spot—Soil/Sediment
- Outfall 001 EU 20 Hot Spot—Soil/Sediment
- Within the Fence, Excluding Hot Spots—Soil/Sediment and Surface Water
- NSDD Hot Spot—Soil/Sediment
- NSDD, Excluding the Hot Spot—Soil/Sediment and Surface Water

This information is taken from the risk summary tables (Appendix D) that present the cumulative hazard and risk values for each land use scenario, the COPCs, and the pathways of concern (POCs).

6.1.5 Observations from the BHHRA

Dermal contact with soil was a driving exposure route in previous BHHRAs at PGDP, with most of this risk arising from contact with metals in soil. This is a direct result of using dermal absorption factors (ABS values) that exceed GI absorption values and may be too conservative. In such circumstances, risk estimates from the dermal exposure route may be unrealistic and exceed the real risk posed by this route of exposure. Although chemical-specific ABS values were used when available, default ABS values were used for most chemicals, such as aluminum, because chemical-specific values are lacking. Chemical-specific ABS values were available for PCBs and employed in this BHHRA. Remedial decisions based on the dermal contact with soil exposure route should be considered carefully because of the uncertainty associated with risk from this exposure route.

Iron was identified as a priority COC at several EUs based on contact with soil/sediment for future exposure scenarios. Remedial decisions focused on iron may be inappropriate since iron likely is consistent with background values. All but one EPC for iron were below the background concentration of 28,000 mg/kg. The single exception is a case where the maximum detected concentration was used as the EPC due to a statistical instability in the H-statistic calculation. Additionally, the derived oral RfD for iron is very conservative, further overestimating iron risks.

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

The identification of Total PAHs as risk drivers in soil at several EUs for future industrial workers and excavation workers agrees with previous PGDP risk assessments; however, the significance of this finding should be considered along with the sources previously and currently identified as PGDP. Generally, before taking actions to address PAH contamination in soil at the EUs, it may be prudent to consider the widespread nature of PAH contamination at PGDP, the continuing sources of contamination (e.g., motorized vehicles, asphalt paving, etc.), and the level of PAH contamination at areas outside PGDP.

The use of KDEP default exposure assumptions contributes significantly to uncertainty in the BHHRA. Cancer risk and noncancer hazard estimates for current industrial workers and current recreational users (outside the security fence) are more appropriate receptors for those EUs relative to future risk estimates for industrial workers, excavation workers, and recreational users using default Methods Document exposure assumptions. Cancer risks and noncancer hazards for the current industrial worker were estimated based on a 14 day per year exposure frequency (Rudy Lee, e-mail to Jana White, May 18, 2006), making it more representative of possible future site risks that would be applicable to the narrow system of drainages ditches that makes up the SWOU. Future industrial workers spending 8 hours per day, 250 days per year for 25 years in one or more ditches is not realistic based on known site conditions. Similarly, the current recreational user visits the NSDD 10 days per year for one year in contrast to the future recreational user who spends 140 days per year for six years. Given the unattractiveness of the NSDD EUs that are essentially swales and ditches, the default exposure assumptions are not realistic for the site; therefore, the priority areas of concern are Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot based on current risk to industrial workers.

Finally, the risks to excavation workers likely are unrealistic given that if any excavation work were to be conducted within the SWOU, workers would be required to follow soil management plans and/or health and safety plans that would stipulate that proper personal protective equipment and clothing be used before coming in contact with soils/sediments.

If the final BHHRA risks are reevaluated considering key uncertainties and conservative assumptions described in the observations section, risks are considerably reduced as described below:

- Excess cancer risk greater than 1E-04 calculated for current industrial workers at two potential “hot spot” locations (Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot) was driven by dermal contact with PAHs in soil/sediment. If the risk due to PAHs is segregated from the total risk, then the total risk would decrease by approximately two orders of magnitude. Overall, all cancer risks would be within or below acceptable risk limits of 1E-06 to 1E-04. All calculated noncancer hazards met or were below the risk limit of 1.

- Excess cancer risk greater than 1E-04 calculated for future industrial workers using default exposure assumptions at six potential “hot spot” locations (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall EU 15 Hot Spot, and NSDD Hot Spot) was driven by dermal contact with PCBs and PAHs in five outfall potential “hot spot” locations and primarily by external exposure to radionuclides in the NSDD Hot Spot in soil/sediment. If the risk due to PAHs and PCB is segregated from the total risk, then the total risk at all EUs would be within or below acceptable risk limits of 1E-06 to 1E-04.

- Excess noncancer risk with hazards greater than 1 was calculated for all 13 EUs for the future industrial worker. Dermal contact with metals such as antimony, iron, and uranium, as well as dermal contact with PCBs in soil/sediment accounted for over 90% of the risk at each location. Assuming that dermal contact with metals is overestimated by a factor of 50 and PCB dermal risk is overestimated by a factor of 10, then excess risk is only found for two areas: Outfall 008 Hot Spot and Outfall 001 EU 15 Hot Spot based on ingestion and dermal contact with PCBs.

- Excess cancer risk greater than 1E-04 was calculated for excavation workers using default exposure assumptions at seven potential “hot spot” locations: five driven by dermal contact with PCBs and PAHs (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 15 Hot Spot) and two driven by ingestion of PCBs and radionuclides in soil/sediment (Outfall 015 Hot Spot, and NSDD Hot Spot). If the risk due to PAHs and PCB is segregated from the total risk, then the total risk at the five EUs would be within or below acceptable risk limits of 1E-06 to 1E-04. Excess cancer risk greater than 1E-04 would remain at the two EUs (Outfall 001 EU 15 Hot Spot, and NSDD Hot Spot) driven by ingestion of soil/sediment.

- Noncancer risk with hazards greater than 1 was calculated for 12 EUs (0utfall 001 EU 13 Hot Spot met the risk limit) for the excavation worker in contact with soil/sediment. Dermal contact with metals such as antimony, iron, and uranium, as well as dermal contact with PCBs in soil/sediment, accounted for greater than 50% of total risk in 12 of the 13 EUs. Assuming that dermal contact with metals is overestimated by a factor of 50 and PCB dermal risk is overestimated by a factor of 10, then excess risk is reduced to a hazard less than 1 at three locations (Outfall 001 EU 13 Hot Spot, Outfall 001 EU 18 Hot Spot, and Outfall 001 EU 20 Hot Spot). Hazards remain greater than 1 in remaining locations based primarily on ingestion of PCBs and/or uranium in soil/sediment.

- For a current child recreational scenario, all cancer risks were at or below the cancer risk limit of 1E-06. The noncancer hazard at the NSDD, Excluding the Hot Spot met the risk limit of 1. The noncancer hazard at the NSDD Hot Spot exceeded 1 based on dermal contact with metals and PCBs in soil/sediment. Assuming PCB dermal risk is overestimated by a factor of 10 and metals dermal risk is overestimated by a factor of 50, the NSDD Hot Spot hazard is well below the limit of 1.

- For future adult, teen, and child recreational users, all cancer risks were between 1E-06 and 1E-04. The noncancer hazards greater than 1 calculated at the NSDD Hot Spot and the NSDD, Excluding the Hot Spot was based on dermal contact with soil/sediment. Assuming PCB dermal risk is overestimated by a factor of 10 and metals dermal risk is overestimated by a factor of 50, the hazards at both NSDD locations are below the limit of 1.

6.2 SERA

As presented in the Paducah Ecological Risk Assessment (ERA) Guidance (DOE 2001), Steps 1 and 2 of the ERA process at PGDP constitute a SERA. Step 1 includes the problem formulation and effects evaluation, while Step 2 contains exposure estimate and risk calculations. The objective of this SERA is to identify, qualitatively and quantitatively, where appropriate, the potential current and future environmental risks associated with the site that would exist if no further remedial action is taken. Specifically, the DOE guidance states, “The purpose of the screening-level risk assessment is to evaluate whether existing data justify a decision that site contaminants do not pose a risk to ecological receptors, or whether additional evaluation is necessary” (DOE 2001). In accordance with guidance, conservative assumptions were used in this SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks.

Areas of contamination at PGDP were divided into six OUs for evaluation of remedial actions, including the SWOU. The SWOU includes source areas within PGDP that contain or contribute to surface water contamination. More than 3,000 samples were collected from the SWOU during historical sampling events and activities related to the SI. Soil, sediment, and surface water samples were collected from NSDD Sections 3, 4, and 5; Outfalls 001, 002, 008, 010, 012, and 015; and storm sewers C-333-A, C-337-A, C-340, C-535, and C-537 to evaluate the nature and extent of contamination to the SWOU related to historical and current site activities. Contaminants present in one or more media within the SWOU include metals, PCBs, radionuclides, SVOAs, VOAs, dioxins, and furans.

The outfalls associated with the SWOU receive drainage from numerous sources associated with activities occurring on the PGDP property, including roof and floor drains, ground surface runoff, treated wastewater effluent, and also storm water. Surface water discharges from Outfalls 001, 008, and 015 to Bayou Creek located west of the PGDP property and from Outfalls 002, 010, 011, and 012 to Little Bayou Creek located east of the PGDP property. Site-related contaminants in surface water or sediment may reach the receiving creeks via these discharge pathways. Site-related soil contaminants may reach the off-site creeks via erosion into the drainage ditches, storm sewers, and outfalls, especially during above normal precipitation events when water overflows the banks of the drainage ditches that lead from the outfalls to the creeks.

Per PGDP ERA guidance presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001) and other related guidance, conservative assumptions were used in the SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks. Screening of COPCs was completed primarily by a comparison of maximum detected concentrations or one-half the highest detection limits (for nondetect data) in surface water, sediment, and soil media to no further action screening levels. This screen provides risk estimates based on direct exposure (direct contact and ingestion) of aquatic and terrestrial biota to contaminated media. The screens were completed for the NSDD (Sections 3, 4, and 5) and the outfall drainage ditches. For screening of dioxins and furans detected in soil samples from Outfall 010, the toxicity equivalence factor (TEF)/toxicity equivalent (TEQ) approach (discussed in the SERA) was employed. Food web modeling was completed for Total PCBs in the NSDD and Outfall 001 to assess the bioaccumulation potential of these chemicals for a specific suite of mammalian and avian receptors including the soil-based receptors of short-tailed shrew, meadow vole, American kestrel, American woodcock, American robin, and bobwhite quail (northern bobwhite) and the sediment-water-based receptors of mink (aka American mink), little brown bat, marsh wren, and belted kingfisher.

In SERAs, assessment endpoints usually are considered to be protective against any adverse effects from site contamination for any ecological receptors at the site. Specific preliminary assessment endpoints for the PGDP SWOU included the protection of federal or state designated threatened or endangered flora and fauna species, soil-dwelling invertebrate communities, amphibian and reptile communities, plant communities, aquatic invertebrate and fish communities, bird communities, and mammal communities.

6.2.1 Comparisons of Site Data to No Further Action Screening Levels

The result of these comparisons is a list of area-specific and media-specific COPCs that are retained for subsequent investigations that may follow Steps 1 and 2 of the ERA process. These results are summarized below in Table 6.5 for each of the areas evaluated.

As shown in Table 6.5, the Steps 1 and 2 ecological screening of chemicals resulted in a large number of COPCs that were retained for further consideration in the ERA process. The results of the PCB food web modeling revealed significant risks to the soil-based receptors of short-tailed shrew (NSDD, Outfall 001); meadow vole (NSDD); American kestrel (NSDD); American woodcock (NSDD, Outfall 001); and American robin (NSDD, Outfall 001). The sediment-based receptors with modeled significant risk were mink (NSDD); little brown bat (NSDD, Outfall 001); marsh wren (NSDD, Outfall 001); and belted kingfisher (NSDD, Outfall 001).

6.2.2 Conclusions

The screening results and site information for a given unit are used at the Scientific/Management Decision Point (SMDP) 1 to support a decision whether to continue evaluating ecological risk. PGDP ERA guidance presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001), provides a path forward, following completion of the SERA. This guidance states the following:

> *If any constituents in an abiotic medium to which organisms are potentially exposed are at a concentration exceeding the PGDP NFA level or if there is not an NFA level for a constituent, then further evaluation of the potential for risk will be required. A decision not to take further action may be justified if no constituent exceeds the NFA level, the synergistic effects of COPCs are not known, and there are no critical data gaps.*

Based on this guidance, further evaluation of the potential for risk is required. This conclusion is based on significant and extensive exceedance of no further action levels at multiple locations and the lack of no further action levels for many constituents. If this further evaluation includes a BERA, it would include Steps 3–8 of the ERA process.

Table 6.5. Data Summary—Surface Water, Sediment, and Surface Soil—All Areas of the SWOU

		Number of COPCs					
Area	**Media**	**Dioxin/furan**	**Metal**	**Pesticide/PCB**	**Rad**	**SVOA**	**VOA**
NSDD	SW	1	28	10	9	57	17
	SED	—	26	10	4	17	—
	SS	—	27	10	2	34	21
Outfall 001	SW	1	28	10	9	44	18
	SED	—	25	10	5	139	4
	SS	—	26	9	28	54	22
Outfall 002	SW	—	18	—	4	—	1
	SED	—	21	9	4	17	—
	SS	—	—	—	28	—	—
Outfall 008	SW	—	17	9	4	—	1
	SED	—	27	10	4	63	25
	SS	—	26	10	28	—	—
Outfall 010	SW	—	19	—	6	—	13
	SED	—	26	10	4	139	4
	SS	17	26	9	2	54	7
Outfall 011	SW	—	22	9	4	38	3
	SED	—	24	10	30	137	4
	SS	—	24	9	—	49	2
Outfall 012	SW	—	9	—	4	—	1
	SED	—	20	9	4	139	4
	SS	—	—	—	—	—	—
Outfall 015	SW	1	22	10	6	31	10
	SED	—	25	9	4	64	25
	SS	—	—	—	—	—	—

Parameters with no value indicate that the chemical was not sampled for or the data did not meet the criteria for COPC selection.
SED = Sediment
SS = Surface soil
SW = Surface water

6.2.3 Observations from the SERA

The following are uncertainties associated with the SERA:

- Lack of screening benchmarks for constituents,
- Lack of analytical data for constituents,
- Future land use and future habitat types,
- Species present or might be present at the PGDP site,
- Use of maximum detected concentration as exposure concentration and no further action values as screening criteria,
- Subsurface soil exposures,
- No further action values for silver,
- Multiple contaminant exposures,

- Food web model, and
- Hardness-dependent metal no further action values.

When considering these uncertainties in combination, it is likely that risks to ecological receptors were overestimated in the SERA and that the list of COPCs would be shorter if all uncertainties could be addressed completely. However, further evaluation consistent with the BERA process would be necessary to identify more specifically the risks to ecological receptors at the PGDP site.

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7. SUMMARY AND CONCLUSIONS

This section presents the summary and conclusions of the SWOU (On-Site) SI and reviews the problem statements and principal study questions developed in the SWOU SAP. In addition, the decision rules presented in the SWOU SAP are reviewed. The conclusions presented are drawn from results from previous investigations and from Sections 3 through 6 of this SWOU (On-Site) SI Report.

7.1 SUMMARY

A summary of the nature and extent of contamination, fate and transport, BRA, and DQOs are detailed in the following sections.

7.1.1 Nature and Extent of Contamination

The SI sampling strategy was designed to determine the nature and extent of contamination. Activity 1 samples were collected to identify "hot spots"[1] by comparing measured results with pre-determined indicator levels; Activity 2 samples were collected to identify "hot spots" by comparing the samples to characterization levels and to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU. Contingency samples were collected to further delineate both the nature and extent of contamination. This section presents a summary of the all sampling performed during the SI.

7.1.1.1 NSDD and outfalls and associated internal ditches and areas sampling

A total of 258 Activity 1 samples and 32 QC samples were collected from Sections 3, 4, and 5 of the NSDD. Sixty-nine samples exceeded radionuclide indicator levels (48 samples were a combination of cesium-137 and uranium-238, 9 samples for uranium-238 only, and 12 for cesium-137 only), and 13 samples exceeded PCB indicator levels. A total of 2,076 Activity 1 samples and 230 QC samples was collected from the outfalls and their associated internal ditches and areas. Seventy samples exceeded radionuclide indicator levels (4 samples were a combination of cesium-137 and uranium-238, 19 samples were uranium-238 only, and 47 samples were cesium-137 only), and nine exceeded PCB indicator levels. A comparison of the Activity 1 sample results to the indicator levels resulted in the identification of the following potential "hot spots."

Activity 1 Hot Spots

Potential "hot spots" were identified from Activity 1 sample results exceeding radiological indicator levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 5 (EUs 07, 08, 09, and 10)
- Outfall 001 (EUs 05, 15, 16, 18, and 20)

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[1] A potential "hot spot" is characterized by an area in which one or more indicator chemicals exceeded an indicator level or one or more analytes exceeded an analyte's characterization level as established in the SAP. It should be noted that neither indicator nor characterization levels should be considered cleanup goals. Cleanup goals will be determined in the removal action evaluation process.

- Outfall 008 (EUs 08 and 11)
- Outfall 015 (EUs 01, 02, 03, 04, and 07)

Potential "hot spots" were identified from Activity 1 sample results exceeding PCB indicator levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 5 (EUs 08, 09, and 10)
- Outfall 001 (EUs 14 and 15)
- Outfall 008 (EU 11)
- Outfall 010 (EU 10)
- Outfall 015 (EU 08)

A total of 75 Activity 2 samples and 18 QC samples was collected from Sections 3, 4, and 5 of the NSDD. A total of 270 Activity 2 samples and 106 QC samples was collected from the outfalls and their associated internal ditches and areas. Activity 2 sample data were used to further characterize the nature and extent of the contamination in soil and sediment by comparing analytical results to risk-based characterization levels. Comparison of the Activity 2 sample results to the characterization levels resulted in the identification of the following potential "hot spots."

Activity 2 Hot Spots. Potential "hot spots" were identified from Activity 2 sample results exceeding radiological characterization levels at the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 5 (EUs 07, 08, 09, and 10)
- Outfall 001 (EU 18)
- Outfall 015 (EUs 02, 04, and 06)

Potential "hot spots" were identified from Activity 2 sample results exceeding PCB characterization levels at the following locations:

- NSDD Section 3 (EU 01)
- NSDD Section 5 (EU 08)
- Outfall 001 (EU 15)
- Outfall 010 (EU 10)

Potential "hot spots" were identified from Activity 2 sample results exceeding metals characterization levels at the following locations:

- NSDD Section 3 (EU 02)
- NSDD Section 4 (EU 06)
- NSDD Section 5 (EUs 07, 08, and 09)
- Outfall 001 (EUs 07, 15, 16, 19, and 21)
- Outfall 010 (EUs 06 and 10)
- Outfall 011 (EU 01)
- Outfall 015 (EUs 03, 07, and 10)

Potential "hot spots" were identified from Activity 2 sample results exceeding PAH characterization levels at the following locations:

- Outfall 001 (EUs 14 and 15)
- Outfall 008 (EU 13)
- Outfall 010 (EUs 04 and 10)
- Outfall 011 (EU 01)

Of the 50 contingency samples collected from Sections 3, 4, and 5 of the NSDD, eight had activity levels of uranium-238 or cesium-137 that exceeded indicator levels. None of these contingency samples exceeded the indicator level for PCBs.

Of the 54 contingency samples collected from internal ditches and areas associated with Outfalls 001, 008, 010, and 015, five showed uranium-238 and/or cesium-137 activity exceeding indicator levels. Six contingency samples and one duplicate sample showed elevated PCB concentrations in the outfalls. This was most notable in Outfall 010 EU 10 where all five of the contingency samples contained Total PCB concentrations in excess of 100 mg/kg each.

7.1.1.2 Storm sewer water sampling

In order to characterize potential releases at the storm sewer discharge points, which could result in unacceptable levels of risk to current and reasonably anticipated future receptors, a three-step sampling approach was planned at four storm sewers. Contaminant concentrations in water (i.e., PCBs, total uranium, and TCE) were compared against indicator levels (i.e., 0.5 µg/L, 30 µg/L, and 5 µg/L, respectively) to determine if releases were unacceptable.

Step 1 samples were collected twice a month for three months, resulting in the collection of 26 samples, including two duplicates. For all locations, except the C-340 storm sewers, all contaminant concentrations in Step 1 water samples were below indicator levels. For the C-340 storm sewer, one sample had a total uranium result (35.3 µg/L) greater than the indicator level. All results for Total PCBs, TCE, and all other total uranium results were less than their respective indicator levels.

Step 2 sampling was conducted at the C-340 storm sewer system due to the single total uranium analysis that exceeded the indicator level in the Step 1 sampling. No contaminants were detected at levels greater than the indicator values in any water sample collected during Step 2 activities. Step 3 sampling was not required.

7.1.2 Fate and Transport

Fate and transport modeling was used to estimate contaminant concentrations at selected points of exposure. The potential migration pathways and mechanisms for transport of chemical and radiological substances found in surface soils and sediments at PGDP were evaluated using the MUSLE (Mills et al. 1982) and the SWMM (Huber and Dickinson 1988). The points of exposure considered were within the outfalls (just before mixing in the creeks); within the creeks (at the point where each of the outfalls discharges to the surrounding creeks); and at the creek integrator points located downgradient of all outfalls. Use of these models was consistent with the tiered approach of the groundwater/surface water modeling matrix presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001). The predicted contaminant concentrations were compared to no action screening levels. These screening levels are not based on site-specific exposure scenarios and should not be considered cleanup goals for the SWOU.

The initial step of the fate and transport modeling considered the risk assessment results for direct contact with contaminated sediment and identified the contaminants that might pose the greatest risk through migration to off-site locations. This step identified antimony, iron, uranium, Total PCBs, Total

PAHs, and uranium-238 as preliminary COPCs. The SI selected EUs with one or more of the indicator chemicals (uranium-238, cesium-137, and Total PCBs) at concentrations above the indicator levels as contaminant sources, in addition to the outfalls in general, for fate and transport modeling.

Evaluation of the MUSLE results, with respect to the SI DQOs, identified the need for SWMM modeling of Total PCBs and uranium-238 to verify the MUSLE results. The ubiquitous nature of PAHs across the site and the strong recontamination potential during routine road usage, road repair, fuel usage, and roofing activities make selection of PAHs for further assessment inconsistent with the primary goal of the SWOU, which is to identify potential "hot spots" that can be addressed as part of an "early action"; therefore, Total PAHs was excluded from further transport simulation. In addition, SWMM modeling was not performed for uranium metal because the results for this contaminant indicated a hazard index below 1.

The SWMM model required that potential "hot spot" areas for Total PCBs and uranium-238 be developed for each EU. Next, the EUs potentially contributing to surface water contamination were assigned to the outfalls to which they drain by geographic information system analysis. Finally, source terms for Total PCBs and uranium-238 were developed for the EUs that potentially contribute to surface water contamination.

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

7.1.3 BRA

A BHHRA and SERA were included as part of the SI for the SWOU. The following sections include a summary of these tasks.

7.1.3.1 BHHRA

Human health risks were estimated for current industrial workers and current child recreational users using site-specific exposure assumptions. For the current exposure scenarios, soil hazards (total HIs) for the current industrial worker were below or met a cumulative hazard estimate of 1 for all contact exposures associated with soil/sediment and for surface water at all EUs. A cumulative ELCR greater than 1E-06 was estimated for all EUs with a cumulative ELCR greater than 1E-04 estimated for two of the EUs for current industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the current industrial worker exceeded 1E-06 at all EUs and 1E-04 at the Outfall 011 Hot Spot (EU 01) and Outfall 001 EU 14 Hot Spot. The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern is soil/sediment.

For the current child recreational scenario, the cumulative HI met the hazard limit of 1 and the ELCR was less than 1E-06 at the NSDD, Excluding the Hot Spot. The cumulative risk estimates included risks from direct contact with soil/sediment, dermal contact with surface water and ingestion of game. The cumulative hazard estimate for the current child recreational user was greater than 1 at the NSDD Hot Spot (Section 3 EUs 01 and 02). The excess risk was due to dermal contact with soil/sediment and the primary risk drivers were antimony and uranium. The ELCR for a current child recreational user scenario was estimated at 1E-06 at the NSDD Hot Spot (Section 3 EUs 01 and 02).

Human health risks also were calculated for future industrial workers and excavation workers using default KEPPC exposure assumptions. Cumulative HIs for the future industrial worker were greater than 1 for all EUs based on soil/sediment contact exposures. Cumulative hazard estimates greater than 1 were identified for two EUs [Outfall 001 EU 14 Hot Spot and Within the Fence, Excluding the Hot Spots] due to surface water exposures. A cumulative ELCR greater than 1E-06 was estimated for all EUs, with an ELCR greater than 1E-04 estimated for six of the EUs for future industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the future industrial worker exceeded 1E-04 at Outfall 008 Hot Spot (EUs 08 and 11), Outfall 010 Hot Spot (EU 10), Outfall 011 Hot Spot (EU 01), Outfall 001 EU 14 Hot Spot, Outfall 001 EU15 Hot Spot, and NSDD Hot Spot (Section 3 EUs 01 and 02). The major contaminants driving risk at all EUs was Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

A cumulative HI at or greater than 1 was estimated for each EU for excavation workers, with antimony, iron, uranium, and Total PCBs being the risk drivers and soil/sediment being the only medium of concern. A cumulative ELCR greater than 1E-06 was estimated at all EUs, with an ELCR greater than 1E-04 estimated for seven EUs [Outfall 008 Hot Spot (EUs 08 and 11), Outfall 010 Hot Spot (EU 10), Outfall 011 Hot Spot (EU 01), Outfall 015 Hot Spot (EUs 01, 02, 03, 04, 07 and 08), Outfall 001 EU 14 Hot Spot, Outfall 001 EU 15 Hot Spot, NSDD Hot Spot (Section 3 EUs 01 and 02)] based on direct contact exposures to soil/sediment. The major contaminants driving risk at all EUs are Total PCBs, Total PAHs (as BaPE), and thorium-230, and the driving medium of concern is soil/sediment.

Finally, human health risks were calculated for future recreational users at the NSDD using default exposure assumptions. HI estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were below a hazard of 1. ELCR estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were at or below 1E-06, with the exception of future teen dermal contact with surface water at the NSDD, Excluding the Hot Spot (Section 3, EU3: Section 4, all EUs; and Section 5, all EUs,). Direct contact with sediment resulted in hazard estimates greater than 1 for future recreational users (adult, teen, and child) under default exposure assumptions at both the NSDD Hot Spot and the NSDD, Excluding the Hot Spot. All ELCRs for direct contact with sediment for each receptor were greater than 1E-06, but below 1E-04. The major contributor to risks for future adults, teens, and children included antimony, iron, uranium, and Total PCBs at both NSDD EUs and PCBs at the NSDD Hot Spot (Section 3 EUs 01 and 02). The medium of concern was soil/sediment.

Several key uncertainties were discussed in the risk assessment that potentially overestimated human health risks to a significant degree such as unrealistic default exposure assumptions, the inclusion of contaminants that are present due to background sources, and overly conservative dermal absorption factors. If the final BHHRA risks are reevaluated adjusting for the key uncertainties, then risks are significantly reduced. Excess risk to current industrial workers at two potential “hot spot” locations (Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot) and current recreational users at the NSDD Hot Spot evaluated using site-specific exposure assumptions would be reduced below cancer and hazard risk limits. Risks to future receptors that were evaluated using default exposure assumptions would be reduced as well. Excess risks to future industrial workers would be reduced from 13 EU locations to two EU locations (Outfall 008 Hot Spot and Outfall 001 EU 15 Hot Spot). Excess risks to excavation workers would be reduced from 13 EU locations to 10 EU locations (Outfall 008 Hot Spot; Outfall 010 Hot Spot; Outfall 011 Hot Spot; Outfall 015 Hot Spot; Outfall 001 EU 14 Hot Spot; Outfall 001 EU 15 Hot Spot; Outfall 001 EU 16 Hot Spot; Within the Fence, Excluding the Hot Spots; NSDD Hot Spot and NSDD, Excluding the Hot Spot). Excess risks to future recreational users would be reduced below risk limits at the NSDD locations.

In summary, cancer risk and noncancer hazard estimates for current industrial workers and current recreational users (outside the security fence) are more appropriate receptors for this OU relative to future risk estimates for industrial workers, excavation workers, and recreational users using default Methods Document exposure assumptions. Cancer risks and noncancer hazards for the current industrial worker were estimated based on a 14-day per year exposure frequency, making it more representative of possible future site risks that would be applicable to the narrow system of drainages ditches that make up the SWOU. Future industrial workers spending 8 hours per day, 250 days per year for 25 years, as the Methods Document directs, in one or more ditches is not realistic. Similarly, the current recreational user visits the NSDD 10 days per year for one year in contrast to the future recreational user that spends 140 days per year for six years.

7.1.3.2 SERA

Steps 1 and 2 of the ERA process in the PGDP Risk Methods Document (DOE 2001) constitute a SERA, which is included as Appendix E to this report. The objective of the SERA was to identify, qualitatively and quantitatively, where appropriate, the potential environmental risks associated with the SWOU at the PGDP that would exist if no further remedial action is taken. The specific areas subject to the SERA were the NSDD (Sections 3, 4, and 5); the drainage ditches associated with Outfalls 001, 002, 008, 010, 011, 012, and 015; and the storm sewers associated with these outfalls, including the storm sewers to C-333-A, C-337-A, C-340, C-535, and C-537. This further included surface water discharges from Outfalls 001, 008, and 015 to Bayou Creek located west of the PGDP property and from Outfalls 002, 010, 011, and 012 to Little Bayou Creek located east of the PGDP property.

Conservative assumptions were used in the SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks. Screening of COPCs was completed primarily by a comparison of maximum detected concentrations or one-half the highest detection limits (for nondetect data) to no further action screening levels for surface water, sediment, and soil media in the NSDD (Sections 3, 4, and 5) and the outfall drainage ditches. For screening of dioxins and furans detected in soil samples from Outfall 010, the TEF/TEQ approach (discussed in the SERA) was employed. Food web modeling was completed for Total PCBs in the NSDD and Outfall 001 to assess the bioaccumulation potential of this chemical for a specific suite of mammalian and avian receptors. This screen provided risk estimates based on direct exposure (direct contact and ingestion) of aquatic and terrestrial biota to contaminated media.

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

7.1.4 Data Quality Objectives Assessment

The decision rules developed during the DQO process and presented in the SWOU SAP are addressed in this section. In addition, the decision rules that are specific for each area are summarized.

7.1.4.1 Decision Rules for Sections 3, 4, and 5 of the NSDD

Decision Rule 1:

If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then call the area sampled a potential "hot spot" and identify this area for possible action depending on the outcome of the BRA and decision-making process.

Of the 258 Activity 1 samples (non-QC) collected at Sections 3, 4, and 5 of the NSDD, 69 samples exceeded radionuclide indicator levels (48 samples were a combination of cesium-137 and uranium-238, 9 samples for uranium-238 only, and 12 for cesium-137 only) and 13 samples exceeded PCB indicator levels. These specific samples with their corresponding analytical results are presented in Section 4 Tables 4.3 and 4.4. The sample locations are shown on Figures 4.1 through 4.7. These areas have been identified as potential "hot spots" in this SWOU SI/BRA report.

Total potential "hot spot" areas were calculated using geographical computer modeling for each section of the NSDD. These potential "hot spot" areas, as compared to the various source areas and the total area investigated, are presented below.

NSDD Section	Estimated Total Potential Hot Spot Area (Acres)	Total Section Area (Acres)
Section 3	1.2	1.9
Section 4	0	2.1
Section 5	0.6	2.4

Decision Rule 2:

If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then sample site extending 35 ft away from ditch to determine if source of the "hot spot" contamination is in the associated area; identify areas exceeding indicator levels for possible action depending on the outcome of the BRA and decision-making process.

For those areas identified as potential "hot spots" during Activity 1 sampling, additional soil/sediment samples were collected in accordance with the SWOU SAP to better define the aereal extent of potential "hot spots" and to aid in determining where contaminant sources were located.

Of the 50 contingency samples collected in the NSDD, eight contingency samples exceeded radionuclide indicator levels. None of the contingency samples exceeded PCB indicator levels. These specific samples with their corresponding analytical results are presented in Section 4 Tables 4.3 and 4.4. The sample locations are shown on Figures 4.1 through 4.7.

As defined in the SAP, Activity 1 contingency samples were collected from an area adjacent to the potential "hot spot" from a 35 by 35 ft area (1,225 ft^2). Since eight contingency samples exceeded radionuclide indicator levels, the total additional area of the NSDD identified by contingency sampling as potential "hot spots" was 9,800 ft^2 (0.2 acres).

Decision Rule 3:

If the average concentration (average defined as the 95% UCL on the mean of sample results) of a contaminant within an EU exceeds its characterization level, then identify the EU as possibly requiring action, pending the outcome of the BRA and the decision-making process.

The risk-based characterization levels developed specifically for the NSDD EUs are presented in Appendix C of the SWOU SAP, including the specific criteria used to develop them (see Table 7.1).

The following COPCs exceeded risk-based characterization levels in the NSDD Hot Spot (Section 3 EU 01 and EU 02):

- Antimony
- Total PCBs
- Total PAHs
- Cesium-137
- Neptunium-237
- Thorium-228
- Thorium-230
- Uranium-238

The following COPCs exceeded risk-based characterization levels in the NSDD, Excluding the Hot Spot (Section 3 EU 03, Section 4 All EUs, and Section 5 All EUs):

- Total PAHs

Table 7.1 presents a comparison of NSDD soil/sediment EPCs to NSDD risk-based characterization levels.

Decision Rule 4:
If the cumulative cancer risk to human health from contamination within an EU exceeds $1x10^{-6}$ or if the cumulative hazard index for effects on human health from contamination within an EU exceeds 1, then declare site "of concern" and identify the EU as possibly requiring action pending the outcome of the decision-making process.

As presented in the SWOU BHHRA, the following EUs exceeded a cumulative $1x10^{-6}$ cancer risk level and/or a cumulative HI of 1 based on a future (default) recreational user scenario, indicating that it is a site of concern and will be considered for further remedial action:

- NSDD Hot Spot (Section 3 EU 01 and EU 02)
- NSDD, Excluding the Hot Spot (Section 3 EU 03; Section 4, all EUs; and Section 5, all EUs)

Decision Rule 5:
If the average of contaminant concentrations within the EU exceeds WAC for characteristic or listed-hazardous waste or for Toxic Substances Control Act (TSCA) waste, then declare the waste from the EU as potentially hazardous pending further characterization.

Based on arsenic, chromium, lead, and selenium exceedances of the WAC in the NSDD Hot Spot, future waste generated in this area potentially may be hazardous. Arsenic, chromium, lead, and selenium also exceed the WAC in the NSDD, Excluding the Hot Spot, along with cadmium. These exceedances indicate that future waste generated in this area also may be potentially hazardous. Further evaluation of metals data, coupled with additional characterization in both of these areas, likely is warranted.

Table 7.1. Comparison of NSDD Soil/Sediment EPCs to NSDD Risk-Based Characterization Levels

COPC	Characterization Levels (1)	NSDD Hot Spot (Section 3 EU 01 and EU 02)		NSDD, Excluding the Hot Spot (Section 3 EU 03, Section 4 All EUs, and Section 5 All EUs)	
Inorganic Chemicals	**NSDD**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Aluminum	NA	8095	8395	6425	6639
Antimony	11	**14**	**17**	10	11
Arsenic	7.9	5.8	5.4	6.0	6.0
Barium	NA	78	74	66	69
Beryllium	26	0.65	0.52	0.58	0.59
Cadmium	591	ND	ND	2.1	2.0
Chromium	9890	85	59	39	40
Copper	13700	123	52	35	35
Iron	57400	11177	11937	9331	9302
Lead	50	21	21	21	21
Manganese	1260	417	358	456	447
Mercury	27	0.60	0.42	0.11	0.13
Molybdenum	2310	8.3	8.3	4.6	4.6
Nickel	6710	94	65	16	18
Selenium	2640	20	20	22	27
Silver	1140	3.4	3.4	2.9	3.1
Uranium	562	328	328	164	234
Vanadium	92	20	24	17	18
Zinc	75700	102	75	38	39
Organic Compounds					
Fluoranthene	6130	0.68	0.68	2.2	2.2
Pyrene	4600	0.56	0.53	1.4	1.3
Total PCBs	1.38	**2.7**	**2.7**	1.1	1.1
Total PAHs	0.147	**1.0**	**0.66**	**1.2**	**1.2**
Radionuclides					
Americium-241	43	4.4	3.7	0.48	0.45
Cesium-137	0.794	**4.2**	**3.7**	0.76	0.73
Cobalt-60	0.163	ND	ND	ND	ND
Neptunium-237	2.5	**5.3**	**5.3**	0.28	0.33
Plutonium-239/240	80	21	21	4.8	4.6
Technetium-99	2600	596	240	32	34
Thorium-228	1.6	**2.0**	1.1	0.47	0.49
Thorium-230	105	**497**	**497**	67	70
Thorium-232	94	2.4	1.4	0.56	0.58
Uranium-234	138	29	14	3.0	2.8
Uranium-235	3.6	NA	NA	NA	NA
Uranium-238	15	**26**	11	4.3	4.1

(1) Characterization levels from Appendix C of the Paducah Gaseous Diffusion Plant *Sampling and Analysis Plan.*

NA= Not analyzed. ND = Not detected.

Units for metals and organic compounds are mg/kg.

Units for radionuclides are pCi/g.

Bold underlined values exceed risk-based characterization levels.

Further, it should be noted that the WAC for inorganic analytes is based on toxicity characteristic leaching procedure (TCLP) criteria, whereas the compared analyses are total inorganic analytes. This comparison is very conservative. A general rule for comparing total metal concentrations to TCLP criteria is to divide the total value by a factor of 20 and compare it to the TCLP action limit. Further characterization of the waste, performing TCLP analysis directly on select samples, and a waste determination are required before final disposition of the waste occurs. This will ensure proper classification of the waste stream(s) as a listed, characteristic, or TSCA waste. Table 7.2 (a and b) presents a comparison of WAC values to outfall and NSDD EPCs.

Decision Rule 6:
If the median of contaminant concentrations from samples from Sections 3, 4, and 5 of the NSDD exceed authorized limits for the C-746-U Landfill, then either develop plans for alternative disposition of any waste generated or consider refining the authorized limits calculations, as appropriate, prior to any waste disposition.

Median concentrations of plutonium-239/240 and thorium-230 exceeded the authorized limits for the C-746-U Landfill in the NSDD Hot Spot surface soil; therefore, it is necessary either to develop plans for alternative disposition of any waste that may be generated associated with surface soil of the NSDD Hot Spot or to refine the authorized limits calculations prior to any waste disposition. There were no exceedances of the authorized limits for the C-746-U Landfill in the NSDD, Excluding the Hot Spot.

Table 7.3 (a and d) presents median soil/sediment concentrations in the outfalls and NSDD compared to authorized limits for the C-746-U Landfill. It should be noted that although limits for the landfill were provided for plutonium-238, total alpha, and total beta/gamma, these analyses were not performed for the SWOU SI; therefore, no results are presented in the table for these radionuclides. WAC and authorized limit exceedances are underlined in the tables.

7.1.4.2 Decision Rules for Internal Ditches and Areas Associated with Outfalls 001, 002, 008, 010, 011, 012, and 015

Decision Rule 1:
If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then call the area sampled a potential "hot spot" and identify this area for possible action depending on the outcome of the BRA and decision-making process.

Of the 2,076 Activity 1 samples (non-QC) collected at the outfalls and their associated internal ditches and areas, 70 samples exceeded radionuclide indicator levels (4 samples were a combination of cesium-137 and uranium-238, 19 samples were uranium-238 only, and 47 samples were cesium-137 only) and 9 samples exceeded PCB indicator levels. These specific samples with their corresponding analytical results are presented in Tables 4.7 and 4.8. The sample locations are shown on Figures 4.8 through 4.22. These areas have been identified as potential "hot spots" in the SWOU SI/BRA report.

Total potential "hot spot" areas were calculated using geographical computer modeling for each outfall and associated internal ditches and areas. These potential "hot spot" areas, as compared to the various source areas and the total area investigated, are presented below.

Outfall Ditch and Areas	Estimated Total Potential Hot Spot Area (Acres)	Total Section Area (Acres)
Outfall 001	0.3	13.8
Outfall 002	0	4.2
Outfall 008	0.3	7.8
Outfall 010	0.1	5.8
Outfall 011	0	0.6
Outfall 012	0	0.8
Outfall 015	1.4	5.5

Decision Rule 2:

If indicator chemicals are detected at concentrations greater than their indicator levels during Activity 1, then sample site extending 35 ft away from ditch to determine if source of the "hot spot" contamination is in the associated area; identify areas exceeding indicator levels for possible action depending on the outcome of the BRA and decision-making process.

For those areas identified as potential "hot spots" during Activity 1 sampling, additional soil/sediment samples were collected in accordance with the SWOU SAP to better define the aereal extent of potential "hot spots" and to aid in determining where contaminant sources are located.

Of the 54 contingency samples collected at the outfalls, five contingency sample analyses exceeded radionuclide indicator levels. There also were six contingency sample analyses that exceeded PCB indicator levels. These specific samples with their corresponding analytical results are presented in Tables 4.7 and 4.8. The sample locations are shown on Figures 4.6 through 4.18.

As defined in the SAP, Activity 1 contingency samples were collected from an area adjacent to the potential "hot spot" from a 35 by 35 ft area (1,225 ft^2). Since five contingency samples exceeded radionuclide indicator levels and six samples exceeded PCB indicator levels, the total additional area of the outfalls and their associated internal ditches and areas identified by contingency sampling as potential "hot spots" was 13,475 ft^2 (0.3 acres).

Decision Rule 3:

If the average concentration (average defined as the upper 95% confidence limit on the mean of sample results) of a contaminant within an EU exceeds its characterization level, then identify the EU as possibly requiring action pending the outcome of the BRA and the decision-making process.

The risk-based characterization levels developed specifically for outfall EUs are presented in Appendix C of the SWOU SAP. Specific criteria used to develop the characterization levels are discussed in the Section C3.3 of the SAP. Three EUs did not have any COPCs exceeding risk-based characterization levels (Outfall 001 EU 13 Hot Spot, Outfall 001 EU 20 Hot Spot, and the area Within the Fence, Excluding Hot Spots). Each of the remaining eight EUs had at least one COPC exceeding a risk-based characterization level.

Table 7.2a. Comparison of Outfalls 001 and 008 EPCs to WAC

COPC	Waste Acceptance Criteria	Outfall 001 EU 13 Hot Spot		Outfall 001 EU 14 Hot Spot		Outfall 001 EU 15 Hot Spot		Outfall 001 EU 16 Hot Spot		Outfall 001 EU 18 Hot Spot		Outfall 001 EU 20 Hot Spot		Outfall 008 Hot Spot	
		Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Inorganic Chemicals															
Aluminum	NL	8880	8880	8163	7542	7490	7490	8190	8190	11500	11500	9040	9040	9113	9113
Antimony	NL	9.86	9.86	15	19	9.79	9.79	9.62	9.62	9.93	9.93	9.74	9.74	9.7	9.7
Arsenic	5.0	5.17	5.17	5.0	5.3	9.55	9.55	10.7	10.7	4.68	4.68	6.84	6.84	5.7	5.7
Barium	100	91.4	91.4	87	91	48.4	48.4	71	71	61.4	61.4	69.2	69.2	73	73
Beryllium	NL	0.493	0.493	0.48	0.49	ND	ND	0.663	0.663	0.604	0.604	ND	ND	0.53	0.53
Cadmium	1.0	ND	ND	1.9	2.0	2.8	2.8	19.3	19.3	ND	ND	ND	ND	ND	ND
Chromium	5.0	43.5	43.5	71	77	72.7	72.7	23.5	23.5	21.6	21.6	11.4	11.4	14	14
Copper	NL	12.9	12.9	43	44	47.7	47.7	13.9	13.9	49	49	ND	ND	18	18
Iron	NL	15200	15200	11527	11667	11700	11700	182000	182000	15700	15700	11200	11200	12418	12418
Lead	5.0	21.9	21.9	23	22	64.6	64.6	21.1	21.1	ND	ND	ND	ND	22	22
Manganese	NL	788	788	339	354	342	342	1540	1540	847	847	471	471	469	469
Mercury	0.20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.10	0.10
Molybdenum	NL	ND	ND	4.68	4.7	23.9	23.9	ND	ND	21	21	ND	ND	8.2	8.2
Nickel	NL	12.7	12.7	16	19	520	520	10.3	10.3	182	182	7.24	7.24	17	17
Selenium	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	5.0	2.47	2.47	2.4	2.5	2.45	2.45	2.41	2.41	2.48	2.48	2.44	2.44	2.4	2.4
Uranium	NL	48.5	48.5	7.8	7.8	642	642	14.3	14.3	90.8	90.8	19.4	19.4	96	96
Vanadium	NL	16.5	16.5	19	21	15.6	15.6	25.3	25.3	22.7	22.7	19.6	19.6	21	21
Zinc	NL	112	112	155	165	1370	1370	67.8	67.8	86.7	86.7	29.7	29.7	50	50
Organic Compounds															
Fluoranthene	NL	0.49	0.49	200	200	7.6	7.6	1.1	1.1	0.5	0.5	0.49	0.49	0.58	0.58
Pyrene	NL	0.49	0.49	46	46	5.6	5.6	1.2	1.2	0.5	0.5	0.49	0.49	0.50	0.50
Total PCBs	49	3.3	3.3	22	22	52	52	1.8	1.8	1.5	1.5	0.71	0.71	32	32
Total PAHs	NL	1.1	1.1	184	184	5.2	5.2	1.4	1.4	1.1	1.1	1.1	1.1	1.2	1.2
Radionuclides															
Americium-241	NL	ND	ND	ND	ND	0.127	0.127	ND	ND	0.521	0.521	0.061	0.061	1.0	1.0
Cesium-137	NL	0.301	0.301	0.12	0.094	0.681	0.681	0.175	0.175	9.38	9.38	0.282	0.282	0.55	0.55
Cobalt-60	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Neptunium-237	NL	0.60	0.60	0.068	0.059	0.335	0.335	0.0697	0.0697	2.88	2.88	0.521	0.521	0.66	0.66
Plutonium-239/240	NL	0.0699	0.0699	0.079	0.079	0.625	0.625	0.0565	0.0565	3.62	3.62	0.404	0.404	9.1	9.1
Technetium-99	NL	10.3	10.3	4.7	4.3	36.5	36.5	6.12	6.12	229	229	6.22	6.22	7.4	7.4
Thorium-228	NL	0.347	0.347	0.39	0.44	0.324	0.324	ND	ND	0.353	0.353	0.632	0.632	0.59	0.59
Thorium-230	NL	2.98	2.98	1.8	2.6	4.32	4.32	0.658	0.658	12.2	12.2	4.33	4.33	84	84

Table 7.2a. Comparison of Outfalls 001 and 008 EPCs to WAC (Continued)

COPC	Waste Acceptance Criteria	Outfall 001 EU 13 Hot Spot		Outfall 001 EU 14 Hot Spot		Outfall 001 EU 15 Hot Spot		Outfall 001 EU 16 Hot Spot		Outfall 001 EU 18 Hot Spot		Outfall 001 EU 20 Hot Spot		Outfall 008 Hot Spot	
		Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Radionuclides															
Thorium-232	NL	0.448	0.448	0.44	0.47	0.349	0.349	0.196	0.196	0.392	0.392	0.664	0.664	0.67	0.67
Uranium-234	NL	4.4	4.4	2.0	2.4	11.4	11.4	0.725	0.725	2.51	2.51	3.72	3.72	3.1	3.1
Uranium-235	NL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238	NL	16.3	16.3	2.6	2.2	11.5	11.5	1.96	1.96	12.9	12.9	4.29	4.29	4.6	4.6

Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Underlined values exceed WAC.

COPC = chemical of potential concern.

EPC = exposure point concentration.

NA: Not analyzed.

ND: Not detected.

NL: Not listed.

WAC = waste acceptance criteria.

Table 7.2b. Comparison of Outfalls 010, 011, and 015 and NSDD EPCs to WAC

COPC	Waste Acceptance Criteria	Outfall 010 Hot Spot		Outfall 011 Hot Spot		Outfall 015 Hot Spot		Within the Fence, Excluding the Hot Spots		NSDD Hot Spot		NSDD, Excluding the Hot Spot	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Inorganic Chemicals													
Aluminum	NL	12900	12900	10378	10378	6720	6720	7170	7170	8095	8395	6425	6639
Antimony	NL	9.67	9.67	17	17	11	11	11	11	14	17	10	11
Arsenic	5.0	12.6	12.6	13	13	10	10	6.0	6.0	5.8	5.4	6.0	6.0
Barium	100	95.1	95.1	92	92	77	77	70	70	78	74	66	69
Beryllium	NL	0.48	0.48	0.96	0.96	0.57	0.57	0.52	0.52	0.65	0.52	0.58	0.59
Cadmium	1.0	ND	ND	2.8	2.8	2.1	2.1	3.6	3.6	ND	ND	2.1	2.0
Chromium	5.0	23.3	23.3	149	149	23	23	17	17	85	59	39	40
Copper	NL	18.3	18.3	202	202	20	20	11	11	123	52	35	35
Iron	NL	15600	15600	23320	23320	14665	14665	10720	10720	11177	11937	9331	9302
Lead	5.0	75.2	75.2	52	52	45	45	21	21	21	21	21	21
Manganese	NL	323	323	595	595	530	530	345	345	417	358	456	447
Mercury	0.20	0.31	0.31	0.17	0.17	0.16	0.16	0.11	0.11	0.60	0.42	0.11	0.13
Molybdenum	NL	13.9	13.9	7.3	7.3	5.5	5.5	6.3	6.3	8.3	8.3	4.6	4.6
Nickel	NL	21.8	21.8	14	14	29	29	9.9	9.9	94	65	16	18
Selenium	1.0	ND	ND	ND	ND	ND	ND	20	20	20	20	22	27
Silver	5.0	2.42	2.42	2.5	2.5	2.6	2.6	2.6	2.6	3.4	3.4	2.9	3.1
Uranium	NL	26.4	26.4	439	439	920	920	208	208	328	328	164	234
Vanadium	NL	27.8	27.8	42	42	19	19	18	18	20	24	17	18
Zinc	NL	252	252	764	764	114	114	72	72	102	75	38	39
Organic Chemicals													
Fluoranthene	NL	5.1	5.1	43	43	0.68	0.68	0.73	0.73	0.68	0.68	2.2	2.2
Pyrene	NL	3.5	3.5	130	130	0.63	0.63	0.68	0.68	0.56	0.53	1.4	1.3
Total PCBs	49	19	19	7.6	7.6	1.1	1.1	0.63	0.63	2.7	2.7	1.1	1.1
Total PAHs	NL	3.1	3.1	58	58	1.1	1.1	1.0	1.0	1.0	0.66	1.2	1.2
Radionuclides													
Americium-241	NL	ND	ND	ND	ND	0.56	0.56	0.20	0.25	4.4	3.7	0.48	0.45
Cesium-137	NL	0.726	0.726	0.54	0.54	31	31	0.43	0.45	4.2	3.7	0.76	0.73
Cobalt-60	NL	ND	ND	ND	ND	0.18	0.18	0.14	0.15	ND	ND	ND	ND
Neptunium-237	NL	0.0636	0.0636	ND	ND	0.42	0.42	0.065	0.11	5.3	5.3	0.28	0.33
Plutonium-239/240	NL	0.109	0.109	0.046	0.046	27	27	0.050	0.056	21	21	4.8	4.6

Table 7.2b. Comparison of Outfalls 010, 011, and 015 and NSDD EPCs to WAC (Continued)

COPC	Waste Acceptance Criteria	Outfall 010 Hot Spot		Outfall 011 Hot Spot		Outfall 015 Hot Spot		Within the Fence, Excluding the Hot Spots		NSDD Hot Spot		NSDD, Excluding the Hot Spot	
		Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Radionuclides													
Technetium-99	NL	8.44	8.44	7.5	7.5	21	21	5.9	5.9	596	240	32	34
Thorium-228	NL	0.328	0.328	0.48	0.48	0.51	0.51	0.32	0.32	2.0	1.1	0.47	0.49
Thorium-230	NL	0.821	0.821	1.1	1.1	16	16	0.77	0.77	497	497	67	70
Thorium-232	NL	0.271	0.271	0.50	0.50	0.55	0.55	0.33	0.33	2.4	1.4	0.56	0.58
Uranium-234	NL	7.42	7.42	3.1	3.1	6.1	6.1	1.4	1.4	29	14	3.0	2.8
Uranium-235	NL	NA	NA	NA	NA	NA	NA	5.9	5.9	NA	NA	NA	NA
Uranium-238	NL	8.81	8.81	17	17	33	33	3.7	3.8	26	11	4.3	4.1

Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Underlined values exceed WAC.

COPC = chemical of potential concern.

EPC = exposure point concentration.

NA: Not analyzed.

ND: Not detected.

NL: Not listed.

WAC = waste acceptance criteria.

Table 7.3a. Median Soil/Sediment Concentrations in the Outfalls 008, 010, 011, and 015 Compared to Authorized Limits for the C-746-U Landfill

COPCs	Authorized Limits for the C-746-U Landfill	Outfall 008 Hot Spot		Outfall 010 Hot Spot		Outfall 011 Hot Spot		Outfall 015 Hot Spot	
		Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Inorganic Chemicals									
Uranium	150	6.92	6.92	12.95	12.95	100	100	26.9	26.9
Radionuclides									
Americium-241	3	0.05015	0.05015	0.045	0.045	0.03	0.03	0.03	0.03
Cesium-137	3	0.3665	0.3665	0.2895	0.2895	0.1	0.1	0.78	0.78
Neptunium-237	3	0.035	0.035	0.04595	0.04595	0.03	0.03	0.04	0.04
Plutonium-238	3	NS	NS	NS	NS	NS	NS	NS	NS
Plutonium-239/240	3	0.147	0.147	0.04625	0.04625	0.02	0.02	0.0719	0.0719
Technetium-99	500	4.28	4.28	7.115	7.115	4.31	4.31	5.275	5.275
Thorium-230	15 *	1.2765	1.2765	0.4485	0.4485	0.383	0.383	1.53	1.53
Thorium-232	15 *	0.525	0.525	0.1855	0.1855	0.347	0.347	0.362	0.362
Total alpha	100000	NS	NS	NS	NS	NS	NS	NS	NS
Total beta/gamma	6000	NS	NS	NS	NS	NS	NS	NS	NS

*: Authorized limit is based on the sum of thorium-230 and thorium-232.
Units for inorganic chemicals are mg/kg. Units for radionuclides are pCi/g. Total alpha and total beta/gamma units are dpm/100 cm^2.
Underlined values exceed authorized limits for the C-746-U Landfill.
COPC = chemical of potential concern
NS: Not selected as a COPC
NSDD = North South Diversion Ditch

Table 7.3b. Median Soil/Sediment Concentrations in Outfall 001 EUs 13, 14, and 15 Compared to Authorized Limits for the C-746-U Landfill

COPCs	Authorized Limits for the C-746-U Landfill	Outfall 001 EU 13 Hot Spot		Outfall 001 EU 14 Hot Spot		Outfall 001 EU 15 Hot Spot	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Inorganic Chemicals							
Uranium	150	4.09	4.09	4.52	4.52	38.2	38.2
Radionuclides							
Americium-241	3	0.05	0.05	0.05	0.05	0.0722	0.0722
Cesium-137	3	0.1485	0.1485	0.08995	0.066	0.197	0.197
Neptunium-237	3	0.03785	0.03785	0.0363	0.0389	0.0751	0.0751
Plutonium-238	3	NS	NS	NS	NS	NS	NS
Plutonium-239/240	3	0.0216	0.0216	0.015	0.02	0.477	0.477
Technetium-99	500	5.475	5.475	3.27	3.27	23.8	23.8
Thorium-230	15 *	0.4725	0.4725	0.465	0.643	1.59	1.59
Thorium-232	15 *	0.3255	0.3255	0.338	0.461	0.198	0.198
Total alpha	100000	NS	NS	NS	NS	NS	NS
Total beta/gamma	6000	NS	NS	NS	NS	NS	NS

* Authorized limit is based on the sum of thorium-230 and thorium-232.
Units for inorganic chemicals are mg/kg. Units for radionuclides are pCi/g. Total alpha and total beta/gamma units are dpm/100 cm^2.
Underlined values exceed authorized limits for the C-746-U Landfill.
COPC = chemical of potential concern.
NS: Not selected as a COPC.
NSDD = North South Diversion Ditch.

Table 7.3c. Median Soil/Sediment Concentrations in Outfall 001 EUs 16, 18, and 20 Compared to Authorized Limits for the C-746-U Landfill

COPCs	Authorized Limits for the C-746-U Landfill	Outfall 001 EU 16 Hot Spot		Outfall 001 EU 18 Hot Spot		Outfall 001 EU 20 Hot Spot	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Inorganic Chemicals							
Uranium	150	26.9	4.52	79.4	79.4	10.43	10.43
Radionuclides							
Americium-241	3	0.03	0.05	0.184	0.184	0.03	0.03
Cesium-137	3	0.1485	0.1485	4.99	4.99	0.1555	0.1555
Neptunium-237	3	0.03785	0.03785	1.12	1.12	0.035	0.035
Plutonium-238	3	NS	NS	NS	NS	NS	NS
Plutonium-239/240	3	0.0216	0.0216	1.75	1.75	0.03965	0.03965
Technetium-99	500	5.275	5.275	53.6	53.6	3.19	3.19
Thorium-230	15 *	0.4725	0.4725	4.33	4.33	0.823	0.823
Thorium-232	15 *	0.347	0.347	0.196	0.196	0.5395	0.5395
Total alpha	100000	NS	NS	NS	NS	NS	NS
Total beta/gamma	6000	NS	NS	NS	NS	NS	NS

* Authorized limit is based on the sum of thorium-230 and thorium-232.
Units for inorganic chemicals are mg/kg. Units for radionuclides are pCi/g. Total alpha and total beta/gamma units are dpm/100 cm^2.
Underlined values exceed authorized limits for the C-746-U Landfill.
COPC = chemical of potential concern.
NS: Not selected as a COPC.
NSDD = North South Diversion Ditch.

Table 7.3d. Median Soil/Sediment Concentrations in the NSDD Compared to Authorized Limits for the C-746-U Landfill

COPCs	Authorized Limits for the C-746-U Landfill	Within the Fence, Excluding Hot Spots		NSDD Hot Spot		NSDD, Excluding the Hot Spot	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Inorganic Chemicals							
Uranium	150	3.905	3.905	45.4	100	5.345	5.135
Radionuclides							
Americium-241	3	0.03	0.03	0.823	0.114	0.0827	0.0744
Cesium-137	3	0.186	0.188	0.777	0.4375	0.201	0.2115
Neptunium-237	3	0.03	0.03	1.0555	0.654	0.06195	0.05475
Plutonium-238	3	NS	NS	NS	NS	NS	NS
Plutonium-239/240	3	0.02	0.02	3.78	0.2195	0.2855	0.2755
Technetium-99	500	3.7	3.7	49.55	14.6	11	9.845
Thorium-230	15 *	0.3825	0.3825	69.5	6.225	4.76	4.305
Thorium-232	15 *	0.313	0.313	1.035	0.425	0.3625	0.3585
Total alpha	100000	NS	NS	NS	NS	NS	NS
Total beta/gamma	6000	NS	NS	NS	NS	NS	NS

* Authorized limit is based on the sum of thorium-230 and thorium-232.

NS: Not selected as a COPC.

Units for inorganic chemicals are mg/kg. Units for radionuclides are pCi/g. Total alpha and total beta/gamma units are dpm/100 cm^2.

Underlined values exceed authorized limits for the C-746-U Landfill.

COPC = chemical of potential concern.

NSDD = North South Diversion Ditch.

The following COPCs exceeded risk-based characterization levels in the Outfall 001 EU 14 Hot Spot:

- Antimony
- Total PCBs
- Total PAHs

The following COPCs exceeded risk-based characterization levels in the Outfall 001 EU 15 Hot Spot:

- Lead
- Uranium
- Total PCBs
- Total PAHs

The following COPCs exceeded risk-based characterization levels in the Outfall 001 EU 16 Hot Spot:

- Iron
- Manganese

The following COPC exceeded risk-based characterization levels in the Outfall 001 EU 18 Hot Spot:

- Cesium-137

The following COPC exceeded risk-based characterization levels in the Outfall 008 Hot Spot (EU 08 and EU 11):

- Total PCBs

The following COPCs exceeded risk-based characterization levels in the Outfall 010 Hot Spot (EU 10):

- Total PAHs
- Lead

The following COPCs exceeded risk-based characterization levels in the Outfall 011 Hot Spot (EU 01):

- Antimony
- Lead
- Total PAHs

The following COPC exceeded risk-based characterization levels in the Outfall 015 Hot Spot (EU 01, EU 02, EU 03, EU 04, EU 07, and EU 08):

- Uranium

Table 7.4 (a and b) presents a comparison of Outfall soil/sediment EPCs to Outfall risk-based characterization levels.

<u>Decision Rule 4:</u>

If the cumulative cancer risk to human health from contamination within an EU exceeds $1x10^{-6}$ *or if the cumulative HI for effects on human health from contamination within an EU exceeds 1, then declare site "of concern" and identify the EU as possibly requiring action, pending the outcome of the decision-making process.*

As presented in the SWOU BHHRA, each of the 11 EUs exceeded a cumulative $1x10^{-6}$ cancer risk level and/or a cumulative HI of 1 based on a future (default) industrial worker scenario, indicating that it is a site of concern and will be considered for further remedial action. Even the three EUs that did not have COPCs exceeding risk-based characterization levels had cumulative quantitative risk exceedances. The EUs with cumulative risk exceedances are listed below:

- Outfall 008 Hot Spot (EU 08, EU 11)
- Outfall 010 Hot Spot (EU 10)
- Outfall 011 Hot Spot (EU 01)
- Outfall 015 Hot Spot (EU 01, EU 02, EU 03, EU 04, EU 07, and EU 08)
- Outfall 001 EU 13 Hot Spot
- Outfall 001 EU 14 Hot Spot
- Outfall 001 EU 15 Hot Spot
- Outfall 001 EU 16 Hot Spot
- Outfall 001 EU 18 Hot Spot
- Outfall 001 EU 20 Hot Spot
- Within the Fence, Excluding Hot Spots

<u>Decision Rule 5:</u>
If the average of contaminant concentrations within the EU exceeds WAC for characteristic or listed-hazardous waste or for TSCA waste, then declare the waste from the EU as potentially hazardous pending further characterization.

Based on arsenic, chromium, and lead exceedances of WAC in Outfall 008 Hot Spot, Outfall 011 Hot Spot, Outfall 015 Hot Spot, and Outfall 001 EU 13 Hot Spot, future waste generated in these areas potentially may be hazardous. Arsenic, chromium, and lead also exceeded WAC in Outfall 001 EU 14 Hot Spot and Outfall 001 EU 16 Hot Spot, along with cadmium, which indicates that future waste generated in these areas potentially may be hazardous. Exceedances of WAC also were identified in Outfall 010 Hot Spot (arsenic, chromium, lead, and mercury); Outfall 001 EU 15 Hot Spot (arsenic, cadmium, chromium, lead, and Total PCBs); Outfall 001 EU 16 Hot Spot (chromium); Outfall 001 EU 20 Hot Spot (arsenic and chromium); and Within the Fence, Excluding Hot Spots (arsenic, chromium, lead and selenium). Further evaluation of metals data, coupled with additional characterization in both of these areas, likely is warranted.

Further, it should be noted that the WAC for inorganic analytes is based on TCLP criteria, whereas the compared analyses are total inorganic analytes. Further characterization of the waste, performing TCLP analysis directly on select samples and a waste determination, would be required before final disposition of the waste occurs. This will ensure proper classification of the waste stream(s) as a listed, characteristic, or TSCA waste. Table 7.2 (a and b) presents a comparison of WAC values to Outfall and NSDD EPCs.

<u>Decision Rule 6:</u>
If the median of contaminant concentrations of samples from the Outfalls 001, 002, 008, 010, 011, 012, and 015, their associated internal ditches, and associated areas exceed authorized limits for the C-746-U Landfill, then either develop plans for alternative disposition of any waste generated or consider refining the authorized limits calculations, as appropriate, prior to any waste disposition.

Table 7.4a. Comparison of Outfall 001 Soil/Sediment EPCs to Outfall Risk-Based Characterization Levels

COPC	**Characterization Levels (1)**	**Outfall 001 EU 13 Hot Spot**		**Outfall 001 EU 14 Hot Spot**		**Outfall 001 EU 15 Hot Spot**		**Outfall 001 EU 16 Hot Spot**		**Outfall 001 EU 18 Hot Spot**		**Outfall 001 EU 20 Hot Spot**	
Inorganic Chemicals	**OUTFALLS**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Aluminum	NA	8880	8880	8163	7542	7490	7490	8190	8190	11500	11500	9040	9040
Antimony	11	9.86	9.86	**15**	**19**	9.79	9.79	9.62	9.62	9.93	9.93	9.74	9.74
Arsenic	52	5.17	5.17	5.0	5.3	9.55	9.55	10.7	10.7	4.68	4.68	6.84	6.84
Barium	NA	91.4	91.4	87	91	48.4	48.4	71	71	61.4	61.4	69.2	69.2
Beryllium	29	0.493	0.493	0.48	0.49	ND	ND	0.663	0.663	0.604	0.604	ND	ND
Cadmium	639	ND	ND	1.9	2.0	2.8	2.8	19.3	19.3	ND	ND	ND	ND
Chromium	10700	43.5	43.5	71	77	72.7	72.7	23.5	23.5	21.6	21.6	11.4	11.4
Copper	14800	12.9	12.9	43	44	47.7	47.7	13.9	13.9	49	49	ND	ND
Iron	62000	15200	15200	11527	11667	11700	11700	**182000**	**182000**	15700	15700	11200	11200
Lead	50	21.9	21.9	23	22	**64.6**	**64.6**	21.1	21.1	ND	ND	ND	ND
Manganese	1360	788	788	339	354	342	342	**1540**	**1540**	847	847	471	471
Mercury	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	2490	ND	ND	4.68	4.7	23.9	23.9	ND	ND	21	21	ND	ND
Nickel	7250	12.7	12.7	16	19	520	520	10.3	10.3	182	182	7.24	7.24
Selenium	2850	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	1230	2.47	2.47	2.4	2.5	2.45	2.45	2.41	2.41	2.48	2.48	2.44	2.44
Uranium	607	48.5	48.5	7.8	7.8	**642**	**642**	14.3	14.3	90.8	90.8	19.4	19.4
Vanadium	100	16.5	16.5	19	21	15.6	15.6	25.3	25.3	22.7	22.7	19.6	19.6
Zinc	81800	112	112	155	165	1370	1370	67.8	67.8	86.7	86.7	29.7	29.7
Organic Compounds													
Fluoranthene	6620	0.49	0.49	200	200	7.6	7.6	1.1	1.1	0.5	0.5	0.49	0.49
Pyrene	4960	0.49	0.49	46	46	5.6	5.6	1.2	1.2	0.5	0.5	0.49	0.49
Total PCBs	20	3.3	3.3	**22**	**22**	**52**	**52**	1.8	1.8	1.5	1.5	0.71	0.71
Total PAHs	2.1	1.1	1.1	**184**	**184**	**5.2**	**5.2**	1.4	1.4	1.1	1.1	1.1	1.1
Radionuclides													
Americium-241	467	ND	ND	ND	ND	0.127	0.127	ND	ND	0.521	0.521	0.061	0.061
Cesium-137	8.6	0.301	0.301	0.12	0.094	0.681	0.681	0.175	0.175	**9.38**	**9.38**	0.282	0.282
Cobalt-60	1.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Neptunium-237	27	0.60	0.60	0.068	0.059	0.335	0.335	0.0697	0.0697	2.88	2.88	0.521	0.521
Plutonium-239/240	563	0.0699	0.0699	0.079	0.079	0.625	0.625	0.0565	0.0565	3.62	3.62	0.404	0.404

Table 7.4a. Comparison of Outfall 001 Soil/Sediment EPCs to Outfall Risk-Based Characterization Levels (Continued)

COPC	Characterization Levels (1)	Outfall 001 EU 13 Hot Spot		Outfall 001 EU 14 Hot Spot		Outfall 001 EU 15 Hot Spot		Outfall 001 EU 16 Hot Spot		Outfall 001 EU 18 Hot Spot		Outfall 001 EU 20 Hot Spot	
Radionuclides	**OUTFALLS**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Technetium-99	36200	10.3	10.3	4.7	4.3	36.5	36.5	6.12	6.12	229	229	6.22	6.22
Thorium-228	2.8	0.347	0.347	0.39	0.44	0.324	0.324	ND	ND	0.353	0.353	0.632	0.632
Thorium-230	1490	2.98	2.98	1.8	2.6	4.32	4.32	0.658	0.658	12.2	12.2	4.33	4.33
Thorium-232	725	0.448	0.448	0.44	0.47	0.349	0.349	0.196	0.196	0.392	0.392	0.664	0.664
Uranium-234	1980	4.4	4.4	2.0	2.4	11.4	11.4	0.725	0.725	2.51	2.51	3.72	3.72
Uranium-235	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238	171	16.3	16.3	2.6	2.2	11.5	11.5	1.96	1.96	12.9	12.9	4.29	4.29

(1) Characterization levels from Appendix C of the SWOU *Sampling and Analysis Plan*.

Bolded underlined values exceed risk-based characterization levels.

Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

COPC = chemical of potential concern.

EPC = exposure point concentration.

EU = exposure unit.

NA: Not analyzed.

ND: Not detected.

Table 7.4b. Comparison of Outfalls 008, 010, 011, and 015 Soil/Sediment EPCs to Outfall Risk-Based Characterization Levels

COPC	Characterization Levels (1)	Outfall 008 Hot Spot (EU 08 and EU 11)		Outfall 010 Hot Spot (EU 10)		Outfall 011 Hot Spot (EU 01)		Outfall 015 Hot Spot (EU 01, EU 02, EU 03, EU 04, EU 07, EU 08)		Within the Fence, Excluding the Hot Spots	
Inorganic Chemicals	**OUTFALLS**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Aluminum	NA	9113	9113	12900	12900	10378	10378	6720	6720	7170	7170
Antimony	11	9.7	9.7	9.67	9.67	**17**	**17**	11	11	11	11
Arsenic	52	5.7	5.7	12.6	12.6	13	13	10	10	6.0	6.0
Barium	NA	73	73	95.1	95.1	92	92	77	77	70	70
Beryllium	29	0.53	0.53	0.48	0.48	0.96	0.96	0.57	0.57	0.52	0.52
Cadmium	639	ND	ND	ND	ND	2.8	2.8	2.1	2.1	3.6	3.6
Chromium	10700	14	14	23.3	23.3	149	149	23	23	17	17
Copper	14800	18	18	18.3	18.3	202	202	20	20	11	11
Iron	62000	12418	12418	15600	15600	23320	23320	14665	14665	10720	10720
Lead	50	22	22	**75.2**	**75.2**	**52**	**52**	45	45	21	21
Manganese	1360	469	469	323	323	595	595	530	530	345	345
Mercury	30	0.10	0.10	0.31	0.31	0.17	0.17	0.16	0.16	0.11	0.11
Molybdenum	2490	8.2	8.2	13.9	13.9	7.3	7.3	5.5	5.5	6.3	6.3
Nickel	7250	17	17	21.8	21.8	14	14	29	29	9.9	9.9
Selenium	2850	ND	ND	ND	ND	ND	ND	ND	ND	20	20
Silver	1230	2.4	2.4	2.42	2.42	2.5	2.5	2.6	2.6	2.6	2.6
Uranium	607	96	96	26.4	26.4	439	439	**920**	**920**	208	208
Vanadium	100	21	21	27.8	27.8	42	42	19	19	18	18
Zinc	81800	50	50	252	252	764	764	114	114	72	72
Organic Compounds											
Fluoranthene	6620	0.58	0.58	5.1	5.1	43	43	0.68	0.68	0.73	0.73
Pyrene	4960	0.50	0.50	3.5	3.5	130	130	0.63	0.63	0.68	0.68
Total PCBs	20	**32**	**32**	19	19	7.6	7.6	1.1	1.1	0.63	0.63
Total PAHs	2.1	1.2	1.2	**3.1**	**3.1**	**58**	**58**	1.1	1.1	1.0	1.0
Radionuclides											
Americium-241	467	1.0	1.0	ND	ND	ND	ND	0.56	0.56	0.20	0.25
Cesium-137	8.6	0.55	0.55	0.726	0.726	0.54	0.54	31	31	0.43	0.45
Cobalt-60	1.8	ND	ND	ND	ND	ND	ND	0.18	0.18	0.14	0.15
Neptunium-237	27	0.66	0.66	0.0636	0.0636	ND	ND	0.42	0.42	0.065	0.11
Plutonium-239/240	563	9.1	9.1	0.109	0.109	0.046	0.046	27	27	0.050	0.056

Table 7.4b. Comparison of Outfalls 008, 010, 011, and 015 Soil/Sediment EPCs to Outfall Risk-Based Characterization Levels (Continued)

COPC	Characterization Levels (1)	Outfall 008 Hot Spot (EU 08 and EU 11)		Outfall 010 Hot Spot (EU 10)		Outfall 011 Hot Spot (EU 01)		Outfall 015 Hot Spot (EU 01, EU 02, EU 03, EU 04, EU 07, EU 08)		Within the Fence, Excluding the Hot Spots	
Radionuclides	**OUTFALLS**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Technetium-99	36200	7.4	7.4	8.44	8.44	7.5	7.5	21	21	5.9	5.9
Thorium-228	2.8	0.59	0.59	0.328	0.328	0.48	0.48	0.51	0.51	0.32	0.32
Thorium-230	1490	84	84	0.821	0.821	1.1	1.1	16	16	0.77	0.77
Thorium-232	725	0.67	0.67	0.271	0.271	0.50	0.50	0.55	0.55	0.33	0.33
Uranium-234	1980	3.1	3.1	7.42	7.42	3.1	3.1	6.1	6.1	1.4	1.4
Uranium-235	40	NA	NA	NA	NA	NA	NA	NA	NA	5.9	5.9
Uranium-238	171	4.6	4.6	8.81	8.81	17	17	33	33	3.7	3.8

(1) Characterization levels from Appendix C of the SWOU *Sampling and Analysis Plan*.

Bolded underlined values exceed risk-based characterization levels.

Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

COPC = chemical of potential concern.

EPC = exposure point concentration.

EU = exposure unit

NA: Not analyzed.

ND: Not detected.

Median concentrations of cesium-137 exceeded the authorized limits for the C-746-U Landfill in the Outfall 010 Hot Spot; therefore, it is necessary either to develop plans for alternative disposition of any waste generated or to refine the authorized limits calculations prior to any waste disposition. There were no exceedances of the authorized limits for the C-746-U Landfill in any of the other outfalls.

Table 7.3 (a–d) presents median soil/sediment concentrations in the outfalls and NSDD compared to authorized limits for the C-746-U Landfill. It should be noted that although limits for the landfill were provided for plutonium-238, total alpha, and total beta/gamma, these analyses were not performed for the SWOU SI. To ensure proper waste disposition, additional characterization of waste streams may be necessary for these radionuclides. Because they were not evaluated, no results are presented in the table for these radionuclides. WAC and authorized limit exceedances are underlined in the tables.

Decision Rule 7:
If modeling performed as part of the baseline human health risk assessment for the ditches associated with Outfalls 001, 002, 008, 010, 011, 012, or 015 or if modeling performed as part of analyses subsequent to any response actions (including a no further action decision) indicates that contaminants migrating from ditches may be impacting human health or the environment at downgradient locations, then evaluate measures to mitigate these impacts, including the evaluation of the potential effectiveness of sediment control basins.

Fate and transport modeling was used to estimate contaminant concentrations at selected points of exposure. The potential migration pathways and mechanisms for transport of chemical and radiological substances found in surface soils and sediments at PGDP were evaluated using the MUSLE (Mills et al. 1982) and the SWMM (Huber and Dickinson 1988). The points of exposure considered were within the outfalls (just before mixing in the creeks); within the creeks (at the point where each of the outfalls discharges to the surrounding creeks); and at the creek integrator points located downgradient of all outfalls.

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

7.1.4.3 Decision Rules for Storm Sewers Associated with C-333-A, C-337-A, C-340, C-535, and C-537

Decision Rule 1:
If sampling over multiple flow rates at locations where the storm sewer discharges to ditches determines concentrations of PCBs and uranium are in excess of indicator levels for water, then relocate samplers to upgradient locations to delimit the source area(s).

For all locations, except the C-340 storm sewer, all contaminant concentrations in Step 1 water samples were below indicator levels. For the C-340 storm sewer, one sample collected during one sampling event exceeded the uranium indicator level. An assessment of the data concluded that the noted uranium result is not statistically different from previous analyses from this location. Further, the mean concentration was determined to be well below the indicator level. Tables 4.12 to 4.14 present the analytical results of the Step 1 C-340 storm sewer sampling.

Decision Rule 2:
If sampling over multiple flow rates at upgradient locations determines concentrations of PCBs and uranium are in excess of indicator levels for water, then identify source areas.

Step 2 sampling was conducted at eight locations upgradient of the C-340 discharge every other week during a six-week period. Three sample sets were collected during the sampling event. Concentrations of Total PCBs, TCE, and total uranium all were below the indicator levels. Tables 4.15 to 4.17 present the analytical results of the Step 2 C-340 storm sewer sampling. Figure 4.23 shows the locations of Step 2 samples.

Decision Rule 3:
Once source areas are identified, collect soil samples from suspected source areas. If concentrations of PCBs and uranium are in excess of indicator levels for soil, then identify the nature and extent of the source term for use in later decision documents.

Based on an absence of contamination detected in the water samples (except one Step 1 sample), a decision was made not to collect soil samples. Section A.9 of the Technical Memorandum (Appendix A) provides a technical and statistical justification supporting this decision.

Decision Rule 4:
If the average of contaminant concentrations within the source area exceeds waste acceptance criteria for characteristic or listed hazardous waste or for TSCA waste, then declare any waste from the source as potentially hazardous pending further characterization.

Based on the results of the SI, the sewer systems are not assumed to be a source of potentially hazardous waste.

Decision Rule 5:
If the median of contaminant concentrations within the source area exceeds authorized limits for the C-746-U Landfill, then either develop plans for alternative disposition of any waste generated or consider refining the authorized limits calculations, as appropriate, prior to any waste disposition.

Based on the results of the SI, the sewer systems are not assumed to be a source of waste to be disposed of in the C-746-U Landfill.

Decision Rule 6:
If modeling performed as part of the BHHRA for the storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 or if modeling performed as part of analyses subsequent to any response actions (including a no further action decision) indicates that contaminants migrating from storm sewers may be impacting human health or the environment at downgradient locations, then evaluate measures to mitigate these impacts, including the evaluation of the potential effectiveness of sediment control basins.

Based on the results of the SI, the sewer systems are not assumed to be a source of contamination in the outfalls and their internal ditches and areas.

7.2 CONCLUSIONS

7.2.1 Data Limitations and Recommendations for Future Work

Historical data representative of current site conditions that meet the requirements of the Risk Methods Document as well as the extensive data collected during the field investigation described in the SAP were utilized in support of this SI/BRA. The following summarizes the dataset:

- The datasets were determined to be complete, meeting all DQOs,
- Datasets were evaluated for adequacy and were determined to meet project goals,
- Some datasets were qualified (i.e., low bias for PCB); analysis of the qualified datasets indicated that the data were useable but that the low bias should be considered when making decisions for areas where results are close to the removal action level,
- The datasets were verified, validated, and assessed; the data were determined acceptable for use in decision making, and
- Existing, historical datasets were analyzed for usability and met the criteria established in the Risk Methods Document.

Potential source areas, as determined by the analytical results, were examined, and potential site-related contaminants were identified. In particular, Outfall 010, EU 10 (SWMU 92) was identified as an area that contained PCB concentrations significant enough to warrant installation of institutional controls (Appendix A, Section A.12). This area will require continuing inspection and maintenance of postings as necessary.

Fate and transport modeling was used to evaluate potential migration pathways and mechanisms for transport of chemical and radiological substances found in surface soils and sediments. No predicted concentrations within the creeks exceeded a risk-based no action screening criteria. These results are consistent with recent KPDES outfall monitoring data, and monitoring will continue in the future.

No data gaps likely to affect the conclusions of the BHHRA were identified during the evaluation of the data set for the SWOU; therefore, no additional data appear critical for support of BHHRA and remedial activities for the site.

The SERA indicated that further evaluation of the potential for risk was required. This conclusion was based on significant and extensive exceedance of no further action levels at multiple locations and the lack of no further action levels for many constituents. If this further evaluation includes a BERA, it would include Steps 3-8 of the ERA process.

7.2.2 Recommended Remedial Action Objectives

For the SWOU, a phased approach is being utilized to meet the remedial action objective (RAO) goals for protecting human health and the environment (EPA 1998b; EPA 2005). This phased approach implements a series of steps that meet the following short-term protection goals, intermediate performance goals, and long-term, final cleanup goals:

(1) Control sources early; focus resources at facilities that warrant attention in the near term, prioritizing actions within facilities to address the greatest risks first.

(2) Minimize human exposure to contaminants, maximizing the effectiveness of institutional controls.

(3) Control further migration of contaminated sediment.

(4) Reduce risk from highly contaminated sediment hot spots.

(5) Make progress toward the ultimate goal of protecting recreational users and industrial workers from exposure to contaminated surface water and sediment.

Based upon the decision rules, RAO #3 and RAO #4 apply to this SI and any subsequent removal action. In addition RAO #2 also was applied during this SI when Outfall 010, EU 10 (SWMU 92) was identified and institutional controls were put in place as a result of the high concentrations of PCBs detected in the soil/sediment samples collected during the SI.

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APPENDIX A

SURFACE WATER OPERABLE UNIT SITE INVESTIGATION

TECHNICAL MEMORANDUM FOR FIELD ACTIVITIES

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CONTENTS

FIGURES

TABLES

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ACRONYMS

BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CSOU	Comprehensive Site-Wide Operable Unit
DOE	U.S. Department of Energy
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ES&H	environment, safety, and health
EU	exposure unit
GPS	global positioning system
NSDD	North-South Diversion Ditch
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
QC	quality control
RCRA	Resource, Conservation, and Recovery Act
SAP	sampling and analysis plan
SI	site investigation
SMP	Site Management Plan
SWMU	solid waste management unit
SWOU	surface water operable unit
TCA	trichloroethane
TCE	trichloroethene
TSCA	Toxic Substances Control Act
VOC	volatile organic compound

A.1 INTRODUCTION

The purpose of this memorandum is to provide certain technical details regarding field activities pertaining to the Surface Water Operable Unit (SWOU) Site Investigation (SI). A brief summary of project objectives is provided below; a more thorough discussion is contained in the body of the report.

The SWOU is one of six operable units located within the Paducah Gaseous Diffusion Plant (PGDP). The SWOU consists of source units that contain suspected surface water contamination or potentially contribute to surface water contamination. These source units include Sections 3, 4, and 5 of the North-South Diversion Ditch (NSDD); outfall ditches; impoundment ponds; and Little Bayou and Bayou Creeks. The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky have agreed that preventing off-site migration of contaminants is the highest sitewide priority for nonemergency cleanup activities at PGDP.

Cleanup activities for the SWOU have been planned as a series of prioritized response actions. The first response action is an SI of specific solid waste management units (SWMUs) within the SWOU. The following SWMUs were investigated as part of this SI:

- SWMU 58 – Sections 3, 4, and 5 of the NSDD
- SWMU 60 – Outfall 002
- SWMU 61 – Outfall 013
- SWMU 62 – Outfall 009
- SWMU 63 – Outfall 008
- SWMU 66 – Outfall 010
- SWMU 67 – Outfall 011
- SWMU 68 – Outfall 015
- SWMU 69 – Outfall 001
- SWMU 92 – Polychlorinated Biphenyl (PCB) Spill
- SWMU 97 – C-601 Diesel Spill
- SWMU 102 – Plant Storm Sewers
- SWMU 168 – Outfall 012
- SWMU 526 – Internal Plant Ditches

It should be noted that SWMU 61 (Outfall 013) and SWMU 62 (Outfall 009) were evaluated during development of the Sampling Analysis Plan (SAP). An assessment of the outfalls, which included a review of historical data, indicated that SWMU 61 and SWMU 62 did not require an early action, and further assessment of SWMU 61 and SWMU 62 would be addressed during the Comprehensive Site-Wide Operable Unit (CSOU). SWMU 92 (PCB spill) was addressed as part of Outfall 008 and Outfall 010. SWMU 97 (C-601Diesel spill) was addressed as part of Outfall 015.

The SI was designed to focus on those areas within the SWOU that have the greatest potential for surface water discharge of contaminants to the creeks surrounding the industrialized portion of PGDP. As defined in the Site Management Plan (SMP), the SWOU (On-Site) SI/ Baseline Risk Analysis (BRA) addresses NSDD Sections 3, 4, and 5; PGDP Outfalls 001 (those portions not addressed by the C-613 Sedimentation Basin), 002, 008, 010, 011, 012 (those portions downgradient of the storm sewer discharge point), and 015, associated internal ditches and areas (including SWMU 92 and SWMU 97); and PGDP storm water sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537.The SI had the following three specific objectives:

- Provide data that can be used to identify areas of elevated contaminant concentrations (i.e., identify "hot spots") in surface soil and sediment along the outfalls and their associated internal ditches and areas and within Sections 3, 4, and 5 of the NSDD and to identify the extent of contamination in these areas. For the storm sewers, provide data that can be used to determine if a particular storm sewer system is releasing contamination and target a portion of the storm sewer that is the suspected source of contamination.

- Provide data that can be used to characterize contamination in soil and sediment found in the outfalls and their associated internal ditches and areas and within Sections 3, 4, and 5 of the NSDD.

- Utilize data collected to meet the first two objectives and information from other projects (e.g., sampling results from routine surface water monitoring) to determine the potential for migration of contamination through the outfalls, from their associated internal ditches and areas, and from the storm water sewers. [The potential for migration was determined using modeling procedures outlined in the PGDP Risk Methods Document (DOE 2001).]

The following table presents various procedures and work instructions that were used to successfully and correctly complete the fieldwork conducted as part of This SWOU SI.

Table A.1. Procedures and Work Instructions Used in This Site Investigation of the SWOU

Management and Use of Procedures, Work Instructions, and Operator Aids
Document Control
Records Management
Quality Assured Data
Development, Completion, and Control of Data Forms and Logbooks
Sample Chain-of-Custody
Sample Tracking and Handling Guidance
Collection of Field Quality Control Samples
Equipment Cleaning and Decontamination
Temperature Control for Sample Storage
Work Instruction for SWOU SI Sediment/Soil Sampling

Subjects addressed in this technical memorandum include the following:

- Sampling strategy and procedures;
- Surveying;
- Decontamination;
- Waste management;
- Environment, safety, and health;
- Field documentation;
- Justification to support a decision not to implement Step 3 sampling for the C-340 storm sewer system;
- Deviations from planned sample quantities;
- Deviations from planned sample locations; and
- PCBs detected in SWMU 92 [Outfall Ditch 010, Exposure Unit (EU) 10].

A.2 SAMPLING STRATEGY

The field sampling strategies for soil and sediment of the NSDD and outfalls and internal ditches and for water discharging from the storm sewers are described below.

A.2.1 NSDD AND OUTFALL SAMPLING

Sampling of Sections 3, 4, and 5 of the NSDD and the outfalls and their associated internal ditches was completed using the following two activities.

Activity 1

The purpose of Activity 1 sampling (grab samples) was to identify the presence of indicator chemicals above indicator levels ("hot spots") and to identify the extent of contamination in surface soil and sediment. The general premise of this activity was that if an indicator chemical was present above its indicator level, then either the indicator chemical or one or more co-contaminants were present at a concentration greater than their characterization level.

The indicator chemicals used for Sections 3, 4, and 5 of the NSDD and their indicator levels are listed below.

- ^{238}U – 10 pCi/g
- ^{137}Cs – 1 pCi/g
- Total PCBs – 1 mg/kg

The indicator chemicals that were used for the outfalls and their associated internal ditches and areas, and their indicator levels, are listed below.

- ^{238}U – 100 pCi/g
- ^{137}Cs – 10 pCi/g
- Total PCBs – 20 mg/kg

A "hot spot" was characterized by comparing a sample's detected analyte concentrations against the indicator levels. In locations where potential "hot spots" were identified, as part of Activity 1 sampling,(Sections 3, 4, and 5 of the NSDD and the internal ditch or area associated with the outfalls), there were provisions in the SAP for collecting contingency samples from the area immediately adjacent to the location containing the potential "hot spot" identified from Activity 1 results. The contingency samples were collected under the following conditions:

- Sampling at the planned location fails (e.g., sample is rendered unusable while in the field by bottle breakage, equipment failure, etc.). (Note: "Failure" in this context does not indicate an exceedance of an indicator level.)

- A potential "hot spot" is identified at the edge of an internal ditch or area associated with the outfalls or at the edge of Sections 3, 4, or 5 of the NSDD.

- During field activities, an area with obvious staining was discovered, but a sample from this area was not part of the previously determined sampling plan and the Prime Subcontractor Project Manager determined the location required sampling.

When conducting the contingency sampling related to the potential "hot spots," the size of the adjacent areas sampled was limited to a 35 ft x 35 ft area (1,225 ft^2). Within each area, two Activity 1 contingency samples were collected.

Activity 2

Activity 2 grab samples were collected and sent to a fixed-base laboratory for analyses of a suite of analytes that included bulk inorganic chemicals, trichloroethene (TCE); 1,1,1-trichloroethane (TCA); polycyclic aromatic hydrocarbons; PCBs; and radionuclides. Analysis for TCE and 1,1,1–TCA was performed for only Activity 2 samples collected from the outfalls and their ditches and associated areas. As specified in the SAP,[1] samples collected from NSDD Sections 3, 4, and 5 were not analyzed for TCE and 1,1,1-TCA because they were not expected to be present, based on previous sampling results. The purpose of this activity was that the results obtained would be used to characterize the average contaminant concentrations within the individual EU. These results were to be used to complete the baseline human health and screening-level ecological risk assessments.

Contingency Activity 2 samples were collected under the following conditions:

- Sampling at a planned location failed (e.g., sample is rendered unusable while in the field by bottle breakage, equipment failure, etc.), which resulted in collection of a "replacement" sample.

- During sampling at a planned location, the extent (depth) of nonnative sediments was found to extend beyond 2 ft below ground surface, which resulted in collection of "depth" samples to determine the extent of contamination based upon field observation.

- During field activities, a unique area was discovered (e.g., stained area, area to which effluent is discharged) that did not contain a planned sample location, which resulted in collection of "biased/ judgmental" samples based upon direction from project management.

A.2.2 STORM SEWER WATER SAMPLING

Sampling of water associated with PGDP storm sewer outfalls and storm sewer systems related to buildings C-333-A, C-337-A, C-340, C-535, and C-537 was completed using the three steps described in the SAP and summarized below:

- Step 1: Collection of water samples at the point where the water within the storm sewer discharges to an outfall ditch. Analyses of these samples were used to verify contaminant release.

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[1] Analyses for TCE and 1,1,1-TCA were performed on Activity 2 samples collected from the outfalls and their ditches and associated areas only. Analyses of these analytes were not performed for samples from Sections 3, 4, and 5 of the NSDD because they were not expected to be present, based on previous sampling results. Additionally, the cover letter for comments on the D1 revision of the SAP from the Commonwealth of Kentucky Environmental and Public Protection Cabinet, dated July 14, 2004, states that information presented in the sampling plan "adequately supports removal of SWMU 58 (Sections 3, 4, & 5 of the NSDD) from the 'Suspected Listed Wastes SWMUs' at the site," making sampling for TCE and 1,1,1-TCA for waste characterization unnecessary.

- Step 2: Collection of water samples within the storm sewer systems at locations upgradient from the systems' discharge points. Analyses of these samples were used to assist with the identification of the source location(s). Upgradient water samples were located where the water flow converged.

- Step 3: Collection of soil samples, using direct-push technology, from source areas suspected to lie along the storm sewer lines. This sampling was planned to characterize the nature and extent of any contamination that may be affecting contaminant concentrations in storm water effluents. This step was not implemented (see Section A.9 of this technical memorandum regarding the justification).

Step 1

Step 1 of the storm sewer investigation involved collection of water samples using autosamplers at the point where the water within the storm sewer systems discharged to an outfall ditch. This sampling was used to verify contaminant release. Step 1 sampling was completed by collecting two samples per month, for three months, from each designated Step 1 sampling location (i.e., six samples were collected per location). Samples were collected with an autosampler, and attempts were made to ensure that the autosampling, which lasted one week per sampling event, occurred over periods that were representative of "dry" and "wet" conditions. The indicator levels for the water samples collected were as follows:

- Total PCBs – 0.5 µg/L
- TCE – 5 µg/L
- Total uranium – 30 µg/L (20 pCi/L)

All 24 water samples planned in the SAP were collected during Step 1. Potential exceedances of indicator levels were identified at only one location.

Step 2

Step 2 of the storm sewer investigation involved collection of water samples using autosamplers at locations within the storm sewer system, that were upgradient from the systems' discharge points, which had exceedances identified during Step 1. Samples were collected at locations where water flow converged within the storm sewer system. Step 2 sampling was completed by collecting a sample every two weeks, for six weeks, from each designated Step 2 sampling location (i.e., three samples per location). Samples were collected with an autosampler, and each sampling event lasted one week. The indicator levels for the water samples collected were as follows:

- Total PCBs – 0.5 µg/L
- TCE – 5 µg/L
- Total uranium – 30 µg/L (20 pCi/L)

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A.3 SURVEYING

A Commonwealth of Kentucky registered surveyor used the predetermined sample location coordinates to establish soil/sediment sample locations before sample collection. The sample coordinates were provided in Appendix H of the SAP. Each location was designated with a flagged stake and labeled with the corresponding sample identification number. Surveying methods included either a global positioning system (GPS) or a total station instrument (theodolite and electronic distance meter) to establish the final coordinates and elevations of the sample locations. These instruments were calibrated in accordance with the manufacturer's instructions.

Quality control (QC) requirements for surveying included the following:

- Maintaining complete, accurate logs of survey work and redlining as-built drawings during the progression of work;

- Accurately and neatly recording changes that were made in the work or additional information that was uncovered in the course of work;

- Establishing the sample locations in the field within ±1.0 ft horizontal accuracy of the coordinates and determining the sample location elevation;

- Legibly recording survey field notes on standardized (4 in. × 7¼ in.) permanent-bound, hard back, transit field logbooks that included the title of the project, name of the survey company, initials of the survey party, and date of the survey; and

- Verifying the locations of survey control points and the accuracy of the survey by comparing the results to known control points.

Not all predetermined locations were suitable for sample collection. As a result, the field teams collecting samples were required to adjust collection locations. The following criteria were established for the relocation of soil/sediment samples:

- If an obstruction, such as a log, rock, etc., precluded the collection of a sample at a predetermined sample location, the location was moved by as much as 15 ft from the proposed location and the new location's coordinates and elevation were obtained. The new location was selected based on similar features (e.g., center of a ditch, along slope, etc.) as that of the predetermined location.

- If the area clearly did not contain adequate soil/sediment for sample collection and a more representative sample area was located within 15 ft, then the sample location was relocated as described above.

- If relocation was greater than 15 ft, the field manager obtained concurrence from DOE's prime contractor prior to relocation.

The above criteria were not specified in the SAP; however, use of these criteria was consistent with selection of location for contingency samples in the SAP and best management practices for environmental projects.

The registered surveyor submitted the following deliverables:

- A copy of reduced field notes, calculated coordinates, elevations, and quantity calculations;
- A certification of survey accuracy as well as quantity calculations by the surveyor or engineer; and
- An electronic file of the survey data.

A.4 SAMPLING PROCEDURES

During the sampling event, three types of samples—soil/sediment, storm water, and field QC—were collected and submitted for analysis. Sampling teams varied between two and four members as well as an environment, safety, and health (ES&H) representative. Prior to initiation of field sampling, sample team members completed general and project-specific training.

Samples were collected, stored, and shipped according to pre-established QC protocols and approved project procedures, which were consistent with EPA Region 4 sampling methodologies. Sample container, preservation, and holding time requirements were in accordance with the EPA Engineering Support Branch Standard Operating Procedures.

Samples collected for this project were assigned unique sample identifiers that were recorded on the sample labels and chain-of-custody forms. Labels were directly affixed to the sample containers and included the following:

- Project number,
- Unique sample number,
- Sample location,
- Sample media,
- Analysis to be performed,
- Sampling date and time,
- Person collecting the sample, and
- Preservation method.

Proper personal protective equipment (PPE) was worn during sampling. PPE consisted of, in part, company-issued clothing, waterproof hip boots, safety glasses, and latex gloves. PPE was modified, if required, when sampling in radiological contamination areas.

A.4.1 SOIL/SEDIMENT SAMPLES

Activity 1 samples were collected using pre-cleaned Nyglass® hand trowels. Samples that were under water were collected using a clean, stainless steel core sampler. Samples were collected no deeper than 6 in. into the sediment/soil and included as few inclusions of sand, rock, or gravel as possible. Samples were decanted of as much liquid as possible while filling the sample containers. The Nyglass® hand trowels were used only once and disposed of. The stainless steel core samplers were properly decontaminated after each use.

Activity 2 samples, which were not under water or where the sediment/soil sample depth was no greater than 6 in., were collected using pre-cleaned, stainless steel trowels. Samples that were under water or where the sediment/soil thickness was greater than 6 in. were collected using pre-cleaned, stainless steel core samplers. Samples were collected with as few inclusions of sand, rock, or gravel as possible, and were decanted of as much liquid as possible, while filling the sample containers. The sample for volatile organic compound (VOC) analysis (Note: VOCs were not collected at NSDD Sections 3, 4, and 5.) was collected first at each location and placed in the sample container such that no headspace remained in the container. The stainless steel trowels and core samplers were properly decontaminated after each use.

A total of 2,714 Activity 1 samples, including the associated contingency and QC samples, was collected during the investigation. This total included 2,334 primary samples, 118 contingency samples, 130 duplicate samples, and 132 other QC samples. In addition, a total of 470 Activity 2 samples, including the associated contingency and QC samples, was collected. This total included 345 primary samples, 1 contingency sample, 31 duplicate samples, and 93 other QC samples.

A.4.2 STORM SEWER WATER SAMPLES

Storm sewer water samples were collected using autosamplers and operated in accordance with the manufacturer's instructions for this equipment. Autosamplers were programmed to collect storm sewer water flow at 1 ounce (30 mL) per hour for seven days, providing a one-week sample.

The autosamplers were insulated and iced daily so that the sample was maintained at a temperature of <4°C during the one-week collection period. Thermometers were kept in the autosamplers, and the temperatures were recorded at selected intervals during the sampling period. A rain gauge was attached to one of the autosamplers, which also was monitored. Rain volumes were recorded during the sampling periods.

Teflon tubing was used to direct the sample from the sample source to the autosamplers. The vertical distance between the level of the sample source and the autosamplers' pump was less than 26 ft.

The samples were collected using the following procedure. Carboys (sample collection containers) were removed from the bottom of the autosamplers. Water from the carboys was poured into clean beakers (one beaker dedicated to each sampling location). Water samples first were collected for VOC analysis at each location and placed in the appropriate sample containers, ensuring no air bubbles were present. The remaining sample containers then were filled in an order of convenience to the samplers.

After the sample containers were filled, the empty carboy was cleaned and reinstalled in the autosampler. The autosampler then was reprogrammed for the next sampling period.

Step 1 water samples were collected at four storm sewers where the water from the selected storm sewer systems discharged into outfall ditches. Sampling was conducted by collecting two samples per month for three months from each sampling location (i.e., six samples were collected at each location). Samples were collected in the attempt to represent periods of "dry" and "wet" conditions. A total of 24 Step 1 samples was collected.

One Step 1 sample from the C-340 area exceeded the indicator level for total uranium. In accordance with the SAP, the investigation then proceeded to Step 2 for that area.

Step 2 water samples were collected at eight locations within the C-340 storm sewer system. These locations were hydraulically upgradient from the storm sewer system outfall where water flow converged within the storm sewer system. Step 2 samples were collected using the same protocols described previously in this section.

Water samples for Step 2 were collected every two weeks for six weeks from each designated sampling location (i.e., three samples per Step 2 location). Similar to the Step 1 samples, Step 2 samples were collected by the autosamplers during a one week period.

A total of 50 storm sewer water samples (24 Step 1, 23 Step 2 and 3 duplicates), with associated QC samples, was collected during the investigation.

A.4.3 FIELD QC SAMPLES

To meet the data quality objectives and increase the credibility of the data for the project, the following QC sample types were obtained during sample collection:

- Trip Blanks—Trip blanks were used to detect cross contamination by VOCs during sample shipping and handling. Trip blanks were prepared before sampling and consisted of Type II water, or other similar characteristic water, in VOC bottles. Trip blanks accompanied each rigid container (i.e., ice chest) shipped to the laboratory containing samples for VOC analysis. Trip blanks were analyzed for VOCs only.

- Field Blanks—Field blanks served as a check for potential airborne environmental contamination at the sample site. Distilled, deionized water was transported to each sampling site, opened in the field, transferred into each type of sample bottle, and returned to the laboratory for analysis of all parameters associated with that sampling event. It was acceptable for field blanks to be filled in the field support area or sample staging area, transported to the field, and then opened. Field blanks also were used as a reagent blank, as needed. Field blanks were collected at a frequency of one in 20 samples (5%) for each sample matrix.

- Field Duplicate Samples—Field duplicate samples determined the sampling variance. One duplicate for every ten samples (10%), per matrix, was analyzed for the same set of analytical parameters as the sample it duplicated.

- Equipment Blanks or Rinsate Samples—Equipment blanks consisted of deionized water passed through or over decontaminated sampling equipment. Equipment blanks were used as a measure of the decontamination process effectiveness and were analyzed for the same parameters as the samples collected with the equipment. Equipment blanks were used as reagent blanks, as needed. Equipment blanks were required only when nondisposable equipment was being used. Equipment blanks were collected at a frequency of one for every 20 samples (5%).

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A.5 FIELD DECONTAMINATION

The field decontamination followed procedures that had been approved by DOE’s prime contractor, Procedure ”Equipment Cleaning and Decontamination.” This procedure, as applied during the sampling, is summarized as follows:

- Field personnel were required to wear protective clothing and safety equipment as specified in the project-specific health and safety plan.
- Cleaning activities took place over a plastic tub used for collection of the decontamination water; a plastic sheet underlined the tub.
- Equipment was first cleaned with tap water and nonphosphate detergent, using a brush if necessary, to remove particulate matter and surface films.
- The equipment was then rinsed thoroughly with tap water, followed by an analyte-free water rinse, an isopropyl alcohol rinse, and then a final analyte-free water rinse.
- If the sample equipment was used to collect samples with potential metals concentrations, a nitric acid rinse was also applied.
- Cleaned sample equipment was allowed to air dry.
- Cleaned equipment was handled only by personnel wearing clean latex gloves to prevent recontamination.
- If cleaned sampling equipment was not reused immediately, it was wrapped in aluminum foil (shiny side out), sealed in plastic, and labeled with the date cleaned.
- Decontamination water was transferred to a storage tank in the waste storage area.

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A.6 WASTE MANAGEMENT

A project-specific waste management plan was included in the approved SAP and was used to provide written procedures regarding waste management. A variety of wastes were generated during the field investigation, including sample residuals and associated waste derived from sample collection. This waste was stored and disposed of in accordance with applicable state and federal requirements. The waste was not manifested when moved from the field to a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste storage area. The storage area complied with the substantive requirements of the Resource, Conservation, and Recovery Act (RCRA) 90-Day Accumulation Areas. Disposal of the waste awaited final characterization.

PPE was considered to fall into the same waste classification as the environmental media with which it came into contact. PPE, plastic, and disposable sampling tools were segregated by classification, collected in clear plastic bags, and labeled appropriately.

Decontamination water, that included small quantities of soil sediments/mud, was generated from cleaning the sampling equipment. The water was collected, stored in a polyethylene tank, and discharged to the Kentucky Pollutant Discharge Elimination System Outfall 001 upon approval by the DOE Prime Contractor after review of analyses of waste characterization samples.

Solid waste was containerized in U.S. Department of Transportation 1A2 drums, or approved equivalent, that were lined with a minimum 12-mil (0.47244-in.) thick plastic liner. Prior to disposal, drums were inspected for the presence of any free liquid, if free liquid was present approved absorbent was added. Nonhazardous waste that met the waste acceptance criteria was disposed of in C-746-U Landfill. Approximately 5-gal of PCB-contaminated waste was transferred to interim waste storage for off-site disposal.

Clean trash (i.e., trash that was not chemically or radiologically contaminated) was segregated according to established guidelines and then disposed of once it was approved for off-site disposal. Examples of clean trash are office paper, aluminum cans, packaging materials, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items.

Waste generated during sampling activities was tracked using a system capable of maintaining an up-to-date inventory of waste. To prevent inappropriate disposal of waste, the tracking system documented generation data and information necessary to determine the amount of contamination present in the waste, if any, so that proper disposal methods could be used.

Based on sample analyses, existing data, or process knowledge, the waste was classified into one of the following categories:

- PCB waste
- Low-level waste
- Nonhazardous waste

Waste minimization requirements were implemented, as appropriate, and included those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, 435.1; and the DOE Prime contractor's requirements. Requirements specified in the waste management plan regarding waste generation, waste tracking, waste reduction techniques, and the waste reduction program, in general, also were implemented.

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A.7 ENVIRONMENT, SAFETY, AND HEALTH

The project was executed using the ES&H plan from a subcontractor to the DOE Prime Contractor. The ES&H plan established specific applicable standards and practices used during the investigation to protect the safety and health of workers, the public, and the environment. The ES&H plan outlined directly, or by reference, federal and state standards, pertinent consensus standards, and applicable contract requirements. The ES&H plan was implemented in accordance with 29 *Code of Federal Regulations* (CFR) 1910.120, Hazardous Waste Operations and Emergency Response. Additional health and safety requirements were incorporated into the ES&H plan for the various field activities, through preparation of project-specific activity hazard analyses.

The field sampling team held daily safety meetings at the beginning of each shift and at the end of each shift. This approach allowed review of the planned daily activities prior to execution. The potential hazards were identified and discussed with the entire field team. In addition, a review of the day's activities was conducted at the end of each day, whereby, worker feedback and recommendations were documented and incorporated into subsequent work activities.

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A.8 FIELDWORK DOCUMENTATION

Field documentation was maintained in various formats, including field logbooks, sample labels, and data forms. Documentation, as it related to the development, completion, and control of data forms and logbooks, followed DOE prime contractor-approved procedures. The purpose of this procedure was to establish criteria and guidelines for content and control of data forms and logbooks and to provide guidelines for accurate and complete documentation of activities. This procedure, as applied during sampling, is summarized as follows:

- Forms were controlled and identified through a procedure, work instruction, or operator aid.

- Forms contained an identifying number on the bottom left-hand corner of the form, which consisted of the procedure number, the procedure/form revision number, initials of the form name, and the date the form was developed/revised.

- Forms included a date and the signature of the person recording the information.

- Logbook pages were bound, prenumbered, and waterproof (i.e., water repellent pages).

- A project logbook inventory was maintained.

- The following information was recorded on the outside of the front cover of each logbook using indelible ink:

    - project name and number,
    - unique logbook name and number,
    - document control number,
    - activity or site name,
    - start date of the logbook, and
    - completion date of the logbook (when completed).

- Logbooks were stored in a secured area when not in use.

- Photocopies of all logbooks, field data sheets, and chain-of-custody forms were made periodically and placed in the project file.

- Corrections to the logbooks and data forms were made by striking through the error with a single line that did not obliterate the original entry. Corrections were initialed and dated.

- Dates and times were recorded using the format “mm/dd/yy” for the date and “24-hour clock” to record the time.

- Blank lines and sections were prohibited. Information was entered on every line/section, or a diagonal line was drawn through an unused line/section, dated, and initialed.

Quality assurance personnel conducted periodic reviews of the data forms and logbooks (including data forms placed in the logbooks) prepared by field personnel to verify the following:

- Accuracy of entries;
- Legibility and clarity of entries;
- Completeness, to ensure that at least the minimum required information was recorded;
- Consistency of information recorded;
- Signature and date of entries by the designated team member; and
- Compliance to the requirements in the aforementioned procedure.

A.9 JUSTIFICATION TO SUPPORT A DECISION NOT TO IMPLEMENT STEP 3 SAMPLING FOR C-340 STORM SEWER SYSTEM

A.9.1 PURPOSE STATEMENT

This technical memorandum provides statistical analysis to support a decision not to implement Step 3 sampling along the C-340 storm sewer. For an additional discussion of planned storm sewer sampling, please see section 5.4.3 and C.4 of the SAP (DOE 2005).

A.9.2 DISCUSSION OF STEP 1 AND STEP 2 SAMPLING

As discussed in the SAP, storm sewer sampling was performed to determine if releases at the discharge points could result in unacceptable levels of risk to current and reasonably anticipated future receptors. In order to characterize these potential releases, an incremental three-step sampling approach was planned. These steps were as follows:

- Step 1: Sampling of water at storm sewer discharge points, with comparison of contaminant concentrations in water (i.e., total PCBs, total uranium, and TCE) against indicator levels (i.e., 0.5, 30, and 5 µg/L, respectively) to determine if releases are unacceptable.

- Step 2: Sampling of water at upgradient locations along storm sewers, and comparison of contaminant concentrations in water against indicator levels to identify stretches along the storm sewers that may be sources of total PCBs, total uranium, and TCE.

- Step 3: Sampling of soil along storm sewers, at areas identified as potential sources by either Step 1 or Step 2 sampling, and comparison of contaminant concentrations in soil against indicator levels to confirm source identification.

As discussed in the SI report, Step 1 samples were collected twice a month for three months (July, August, and September 2005) during SAP implementation. This sampling resulted in the collection of 26 samples, including 2 duplicates.

For all locations, except the C-340 storm sewers, all contaminant concentrations in Step 1 water samples were below indicator levels. For the C-340 storm sewer, one sample, collected on July 19, 2005, had a total uranium result (35.3 µg/L) greater than the indicator level. All results for total PCBs, TCE, and all other total uranium results were less than their respective indicator levels. Tables A.2, A.3, and A.4 present the results from the Step 1 C-340 storm sewer sampling.

Based on the results of Step 1 sampling, only the C-340 storm sewer sampling proceeded to Step 2. Consistent with the SAP, the Step 2 sampling was conducted at eight locations, every other week, over six weeks (October and November 2005). A total of three samples were collected from each Step 2 sample location, except for W340-07, which did not yield a sample during the first sampling event due to the absence of water. Figure A.1 shows the locations where the C-340 storm sewer was sampled. Tables A.5, A.6, and A.7 present the results from the Step 2 C-340 storm sewer sampling,

Table A.2. Total PCB Analysis for Step 1 of the C-340 Storm Sewer

(PCB Indicator Level = 0.5µg/L)

Date collected	Chemical	Results
07-19-2005	PCB, total	ND
08-02-2005	PCB, total	ND
08-23-2005	PCB, total	ND
08-31-2005	PCB, total	ND
09-21-2005	PCB, total	ND
09-29-2005	PCB, total	ND

ND – Nondetect

Table A.3. TCE Analysis for Step 1 of the C-340 Storm Sewer

(TCE Indicator Level = 5µg/L)

Date collected	Chemical	Results
07-19-2005	Trichloroethene	ND
08-02-2005	Trichloroethene	ND
08-23-2005	Trichloroethene	ND
08-31-2005	Trichloroethene	ND
09-21-2005	Trichloroethene	ND
09-29-2005	Trichloroethene	ND

ND – Nondetect

Table A.4. Total Uranium Analysis for Step 1 of the C-340 Storm Sewer

(Total Uranium Indicator Level = 30 µg/L)

Date collected	Chemical	Results (µg/L)	Rad error
07-19-2005	Total uranium mass	35.3	18.4
08-02-2005	Total uranium mass	ND at 5.5	5.94
08-23-2005	Total uranium mass	13.4	7.3
08-31-2005	Total uranium mass	19.1	NA
09-21-2005	Total uranium mass	15.9	11.5
09-21-2005	Total uranium mass	ND at 14 (duplicate)	21.5
09-29-2005	Total uranium mass	22.7	11

ND – Nondetect
NA – Not available due to analytical method utilized

Table A.5. Total PCB Analysis for Step 2 of the C-340 Storm Sewer

(PCB Indicator Level = 0.5µg/L)

Location	Date collected	Chemical	Results
W340-02	10-07-2005	PCB, total	ND
W340-02	10-21-2005	PCB, total	ND
W340-02	11-04-2005	PCB, total	ND
W340-03	10-07-2005	PCB, total	ND
W340-03	10-21-2005	PCB, total	ND
W340-03	11-04-2005	PCB, total	ND
W340-04	10-07-2005	PCB, total	ND
W340-04	10-21-2005	PCB, total	ND
W340-04	11-04-2005	PCB, total	ND
W340-05	10-07-2005	PCB, total	ND
W340-05 (Duplicate)	10-07-2005	PCB, total	ND
W340-05	10-21-2005	PCB, total	ND
W340-05	11-04-2005	PCB, total	Not enough volume
W340-06	10-07-2005	PCB, total	ND
W340-06	10-21-2005	PCB, total	ND
W340-06	11-04-2005	PCB, total	ND
W340-07	10-07-2005	Dry – no sample	
W340-07	10-21-2005	PCB, total	ND
W340-07	11-04-2005	PCB, total	ND
W340-08	10-07-2005	PCB, total	ND
W340-08	10-21-2005	PCB, total	ND
W340-08	11-04-2005	PCB, total	ND
W340-09	10-07-2005	PCB, total	ND
W340-09	10-21-2005	PCB, total	ND
W340-09	11-04-2005	PCB, total	ND

ND – Nondetect

Table A.6. TCE Analysis for Step 2 of the C-340 Storm Sewer

(TCE Indicator Level = 5μg/L)

Location	Date collected	Chemical	Results
W340-02	10-07-2005	Trichloroethene	ND
W340-02	10-21-2005	Trichloroethene	ND
W340-02	11-04-2005	Trichloroethene	ND
W340-03	10-07-2005	Trichloroethene	ND
W340-03	10-21-2005	Trichloroethene	ND
W340-03	11-04-2005	Trichloroethene	ND
W340-04	10-07-2005	Trichloroethene	ND
W340-04	10-21-2005	Trichloroethene	ND
W340-04	11-04-2005	Trichloroethene	ND
W340-05	10-07-2005	Trichloroethene	ND
W340-05 (Duplicate)	10-07-2005	Trichloroethene	ND
W340-05	10-21-2005	Trichloroethene	ND
W340-05	11-04-2005	Trichloroethene	ND
W340-06	10-07-2005	Trichloroethene	ND
W340-06	10-21-2005	Trichloroethene	ND
W340-06	11-04-2005	Trichloroethene	ND
W340-07	10-07-2005	Dry—no sample	
W340-07	10-21-2005	Trichloroethene	ND
W340-07	11-04-2005	Trichloroethene	ND
W340-08	10-07-2005	Trichloroethene	ND
W340-08	10-21-2005	Trichloroethene	ND
W340-08	11-04-2005	Trichloroethene	ND
W340-09	10-07-2005	Trichloroethene	ND
W340-09	10-21-2005	Trichloroethene	ND
W340-09	11-04-2005	Trichloroethene	ND

ND – Nondetect

Table A.7. Total Uranium Analysis for Step 2 of the C-340 Storm Sewer

(Total Uranium Indicator Level = 30 µg/L)

Location	Date Collected	Chemical	Results (µg/L)	Rad error
W340-02	10/7/2005	Total uranium mass	ND at 9.98	19.5
W340-02	10/21/2005	Total uranium mass	ND at 6.22	6.67
W340-02	11/4/2005	Total uranium mass	ND at 1.77	2.66
W340-03	10/7/2005	Total uranium mass	10.2	7.4
W340-03	10/21/2005	Total uranium mass	ND at 11.9	17.5
W340-03	11/4/2005	Total uranium mass	ND at 0.199	0.504
W340-04	10/7/2005	Total uranium mass	ND at 1.09	1.6
W340-04	10/21/2005	Total uranium mass	ND at 0.198	0.317
W340-04	11/4/2005	Total uranium mass	ND at 0.0305	0.0852
W340-05	10/7/2005	Total uranium mass	ND at 0.672	1.44
W340-05 (Duplicate)	10/7/2005	Total uranium mass	ND at 0.516	0.53
W340-05	10/21/2005	Total uranium mass	ND at 0.0774	0.192
W340-05	11/4/2005	Total uranium mass	ND at 0.148	0.161
W340-06	10/7/2005	Total uranium mass	13.9	10.5
W340-06	10/21/2005	Total uranium mass	ND at 7.93	7.66
W340-06	11/4/2005	Total uranium mass	ND at 2.54	3.8
W340-07	10/7/2005	Dry – no sample		
W340-07	10/21/2005	Total uranium mass	ND at 0.101	0.234
W340-07	11/4/2005	Total uranium mass	ND at 0.127	0.214
W340-08	10/7/2005	Total uranium mass	14.3	7.59
W340-08	10/21/2005	Total uranium mass	ND at 0.386	0.652
W340-08	11/4/2005	Total uranium mass	ND at 0.283	0.62
W340-09	10/7/2005	Total uranium mass	24.4	11
W340-09	10/21/2005	Total uranium mass	ND at 1.98	3.02
W340-09	11/4/2005	Total uranium mass	ND at 2.57	5.36

ND – Nondetect

As indicated by the results presented in Tables A.5 and A.6, neither Total PCBs nor TCE was detected in a Step 2 sample. In addition, two of the three Step 2 sampling events (October 21, 2005 and November 4, 2005) showed no detectable total uranium. The samples collected on October 7, 2005, had detectable uranium in four of eight samples collected; however, all results were below the indicator level for total uranium. The locations with detectable total uranium are depicted in Figure A.1.

A.9.3 JUSTIFICATION TO SUPPORT A DECISION NOT TO IMPLEMENT STEP 3 SAMPLING

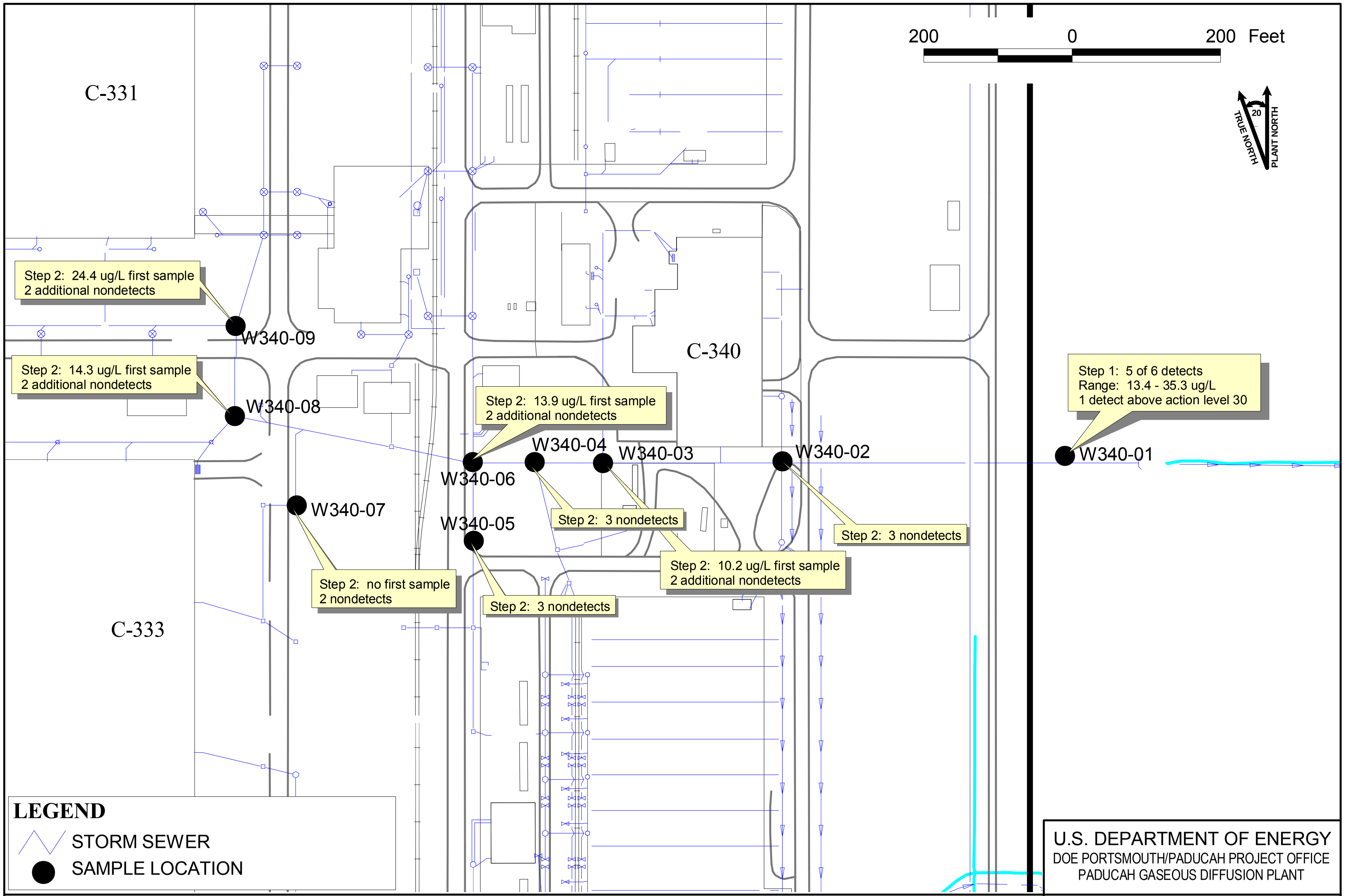
The results from the Step 2 sampling at C-340 indicate that Step 3 sampling is not required at any of the locations upgradient to W340-02. However, additional data evaluation was conducted to determine if Step 3 sampling was necessary between sampling locations W340-01 and W340-02. This section of the Technical Memorandum presents the Data Quality Assessment (DQA) that provides justification for not implementing Step 3 sampling at the discharge location (W340-01) and the first upgradient location (W340-02).

DQA is the scientific and statistical evaluation of data to determine if data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use. A DQA analysis was conducted for the C-340 storm sewer to evaluate the data set and determine if the data set is usable for decision making. DQA is built on a fundamental premise: data quality, as a concept, is meaningful only when it relates to the intended use of the data.

The six primary samples (and one duplicate sample) collected from the C-340 discharge during the Step 1 sampling events showed total uranium at an average concentration below the 30 µg/L indicator level. These samples were collected over a three month period, in both dry and wet conditions. The sampling indicated an average release of 15.5 µg/L for total uranium over a three month period (based on Step 1 sample results). The maximum concentration of 35.3 µg/L slightly exceeded the indicator level of 30 µg/L. Based upon a summary of the statistics (Table A.8) for the data sets from both Step 1 and Step 2 and the scatter chart below (Figure A.2), the DQA demonstrates that the 35.3 µg/L is an anomalous event.

Table A.8. Step 1 and Step 2 Total Uranium Data Summary Statistics for the C-340 Storm Sewer

Summary statistics	Step 1	Step 2
Average (µg/L)	15.5	3.10
Maximum (µg/L)	35.3	24.4
Minimum (µg/L)	0.86	0.35
Median (µg/L)	15.90	0.62
Mode	N/A	0.70
Range (µg/L)	35.3 to 0.86	24.4 to 0.35
Standard deviation (µg/L)	12.17	6.16
Variance	148	38.0
N (count)	7	24
Number detects	5	4
Coefficient of variation (CV=S/X)	0.78793305	1.985903489



Step 1: 5 of 6 detects
Range: 13.4 - 35.3 ug/L
1 detect above action level 30

Step 2: 3 nondetects

Step 2: 10.2 ug/L first sample
2 additional nondetects

Step 2: 3 nondetects

Step 2: 13.9 ug/L first sample
2 additional nondetects

Step 2: 3 nondetects

Step 2: no first sample
2 nondetects

Step 2: 14.3 ug/L first sample
2 additional nondetects

Step 2: 24.4 ug/L first sample
2 additional nondetects

Figure A.1. Uranium Analysis for Step 2 of the C-340 Storm Sewer

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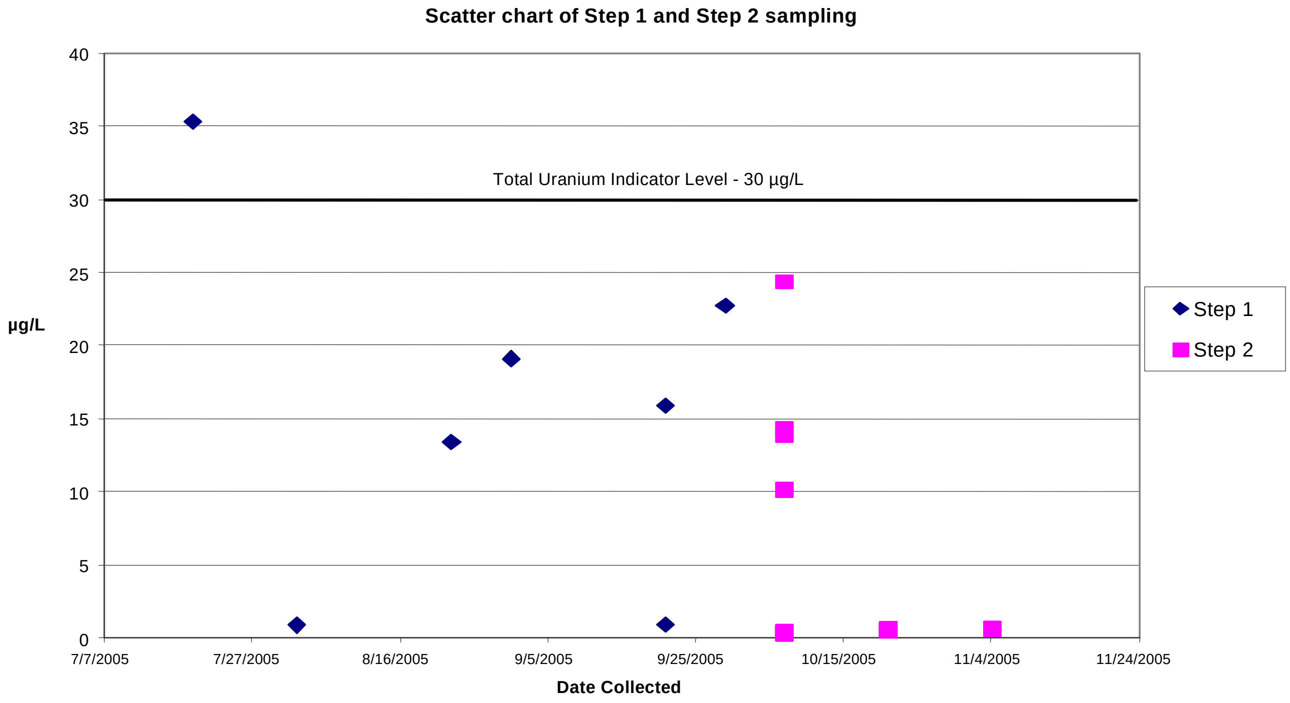

Figure A.2. Scatter Chart of Step 1 and Step 2 Total Uranium Results for the C-340 Storm Sewer

Additionally, the range of error for the radiological analyses was evaluated for the data set. The range of error, as presented in Figure A.3, demonstrates that the 35.3 µg/L result is not statistically different from the reference value of 30 µg/L due to the limitations of scientific instrumentation. Given the range of error for this data point, the actual result could have been lower than the 30 µg/L indicator

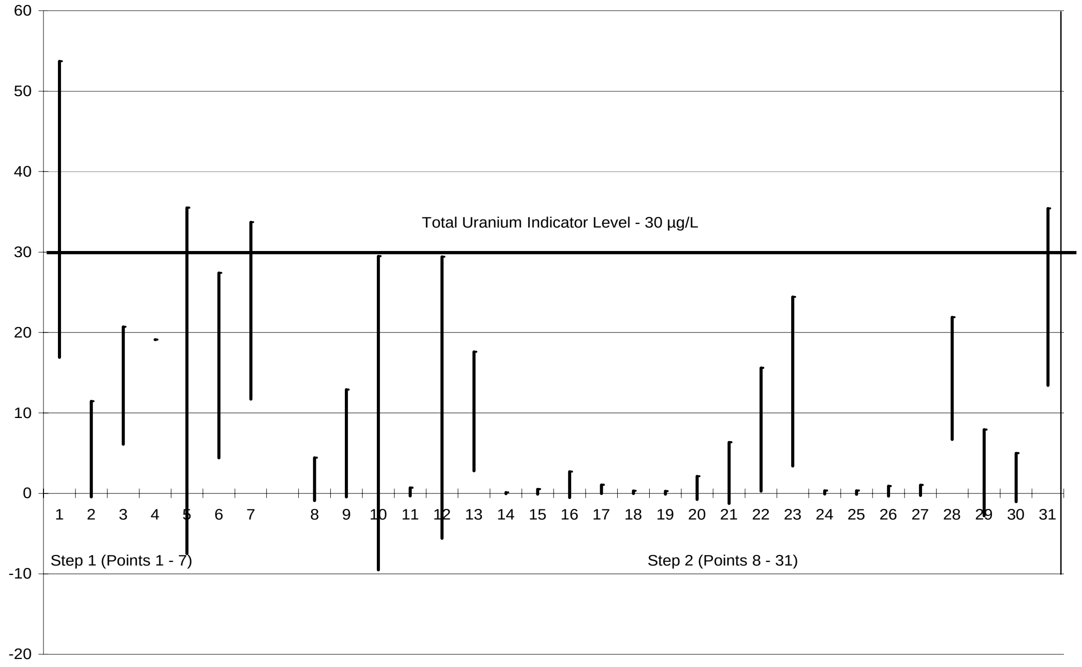

Figure A.3. Step 1 and Step 2 Total Uranium Results (Including Radiological Error) for C-340 Storm Sewer

level. As noted in Figure A.3, three other data points could have been above the indicator level given the error factor added to the result reported by the laboratory.

The overall average of 15.5 µg/L, with the statistically generated radiological error of 6.8 µg/L for the Step 1 samples, provides a maximum average value of 22.3 µg/L, which is lower than the 30 µg/L indicator level. Based upon this information, Step 3 should not be implemented for the C-340 storm sewer.

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A.10 DEVIATION FROM PLANNED SAMPLE QUANTITY

A.10.1 INTRODUCTION

The SWOU SAP included a total quantity of 2,375 Activity 1 samples that was planned to be collected (258 planned samples for Sections 3, 4, and 5 of the NSDD and 2,117 planned samples for the Outfall ditches). During the implementation of the SAP, the actual quantity of Activity 1 samples collected was 2,334. This section presents a summary of where and why 41 of the planned samples could not be collected.

The SAP also included the collection of 344 Activity 2 samples (75 from NSDD Section 3, 4, and 5 and 269 from the Outfall ditches). All of the planned Activity 2 samples were collected during SAP implementation.

A.10.2 DISCUSSION OF ACTIVITY 1 SAMPLE QUANTITY DEVIATION

The SWOU SAP (Appendix H) included the survey coordinates for all Activity 1 and 2 samples that were planned to be collected. During the surveying and locating of these samples, some Activity 1 samples could not be sampled due to the site conditions. Some of the sample locations were offset from the locations included in Appendix H of the SAP. This deviation is discussed in Section A.11 of this technical memorandum.

The SAP had planned that 2,375 samples would be collected from the NSDD and Outfall ditches as presented in Table A.9 below. As shown in Table A.9, not all of the planned samples were collected from the plant ditches leading to Outfalls 001, 002, 010, 011, and 015. The following details why these samples were not collected. Figures A.4 to A.11 show where these samples were located within each ditch.

Table A.9 Activity 1 Sample Summary

Location	Planned Quantity	Actual Quantity Collected	Percent Sampled
NSDD Section 3	87	87	100%
NSDD Section 4	64	64	100%
NSDD Section 5	107	107	100%
Outfall 001	746	***740***	***99%***
Outfall 002	226	***212***	***94%***
Outfall 008	440	440	100%
Outfall 010	316	***300***	***95%***
Outfall 011	40	***38***	***95%***
Outfall 012	45	45	100%
Outfall 015	304	***301***	***99%***
TOTALS	**2,375**	***2,334***	***98%***

Note: Bold italic font indicates a deviation from the planned sample quantity.

Outfall 001 (6 not collected)

A total of six planned samples was not collected from the ditches leading to Outfall 001 from EU 4 and EU 12.

- EU 4 (5 samples)—Samples could not be collected at five locations in EU 4 due to the placement of riprap along the bank of the ditch. The samples that were not collected included OF01A-092, 093, 096, 101, and 105. EU 4 is a north-south ditch located outside of the plant security fence and drains into Outfall 001 just upstream of the discharge point of this outfall. (See Figure A.4).

- EU 12 (1 sample)—A sample was not collected at 1 location in EU12 due to the sample being located in a DMSA. Sample number OF01A-367 was not collected from this EU. EU 12 is located inside the security fence and south of C-746-B. (See Figure A.5).

Outfall 002 (14 not collected)

A total of 14 planned samples was not collected from the ditches leading to Outfall 002 from EU 2 and EU 8.

- EU 2 (8 samples)—Samples could not be collected at eight locations in EU2 due to construction activities on the northwest side of the C-755 trailer area. The construction eliminated the ditch, which was replaced by the installation of culverts and an asphalt parking lot. The samples that were not collected included OF02A-055, 058, 060, 061, 062, 064, 065, and 067. (See Figure A.6).

- EU 8 (6 samples)—Samples could not be collected at six locations in EU 8 due to construction activities on the west side of the C-755 trailer area. The construction eliminated the ditch, which was replaced by the installation of culverts and an asphalt road. The samples that were not collected included OF02A-190, 191, 192, 202, 203, and 204. (See Figure A.7.)

Outfall 010 (16 not collected)

A total of 16 planned Activity 1 samples was not collected from the ditches leading to Outfall 010 from EU 6 and EU 7.

- EU 6 (11 samples)—Samples could not be collected at 11 locations in EU 6 due to construction activities for the expansion of a transformer yard that included the installation of culverts and placement of geotextile fabric covered with gravel. Samples that could not be collected included OF10A-174, 175, 176, 177, 181, 182, 183, 190, 192, 194, and 196. This ditch is located inside the plant security fence and on the west side of the C-531-2 switch yard. (See Figure A.8).

- EU 7 (5 samples)—Samples could not be collected at five locations in EU7 due to construction activities for the installation of additional security features at Post 48. The construction eliminated this ditch and included the installation of culverts and placement of gravel. Samples that could not be collected included OF10A-198, 199, 205, 210, and 211. EU 7 is located inside the security fence and just south of Post 48. (See Figure A.9.)

<u>Outfall 011 (2 not collected)</u>

A total of two planned Activity 1 samples was not collected from EU 1 in the ditch draining into Outfall 011.

- EU 1 (2 samples)—Samples could not be collected at two locations in EU1 due to the placement of riprap along the bank of the ditch. The samples that were not collected included OF11A-006 and 008. This EU is located outside of the security fence and is in the segment of the ditch west of Dykes Road just upstream of the discharge point. (See Figure A.10).

<u>Outfall 015 (3 not collected)</u>

A total of three samples could not be collected from EU6 in the ditch draining into Outfall 015.

- EU 6 (3 samples)—Samples could not be collected at three locations in EU 6 due to construction activities for expansion of a cylinder yard that included the installation of culverts and placement of gravel. The samples that could not be collected included OF15A-143, 144, and 145. This EU is located inside the security fence and on the southwest corner of the C-745-B cylinder yard. (See Figure A.11.)

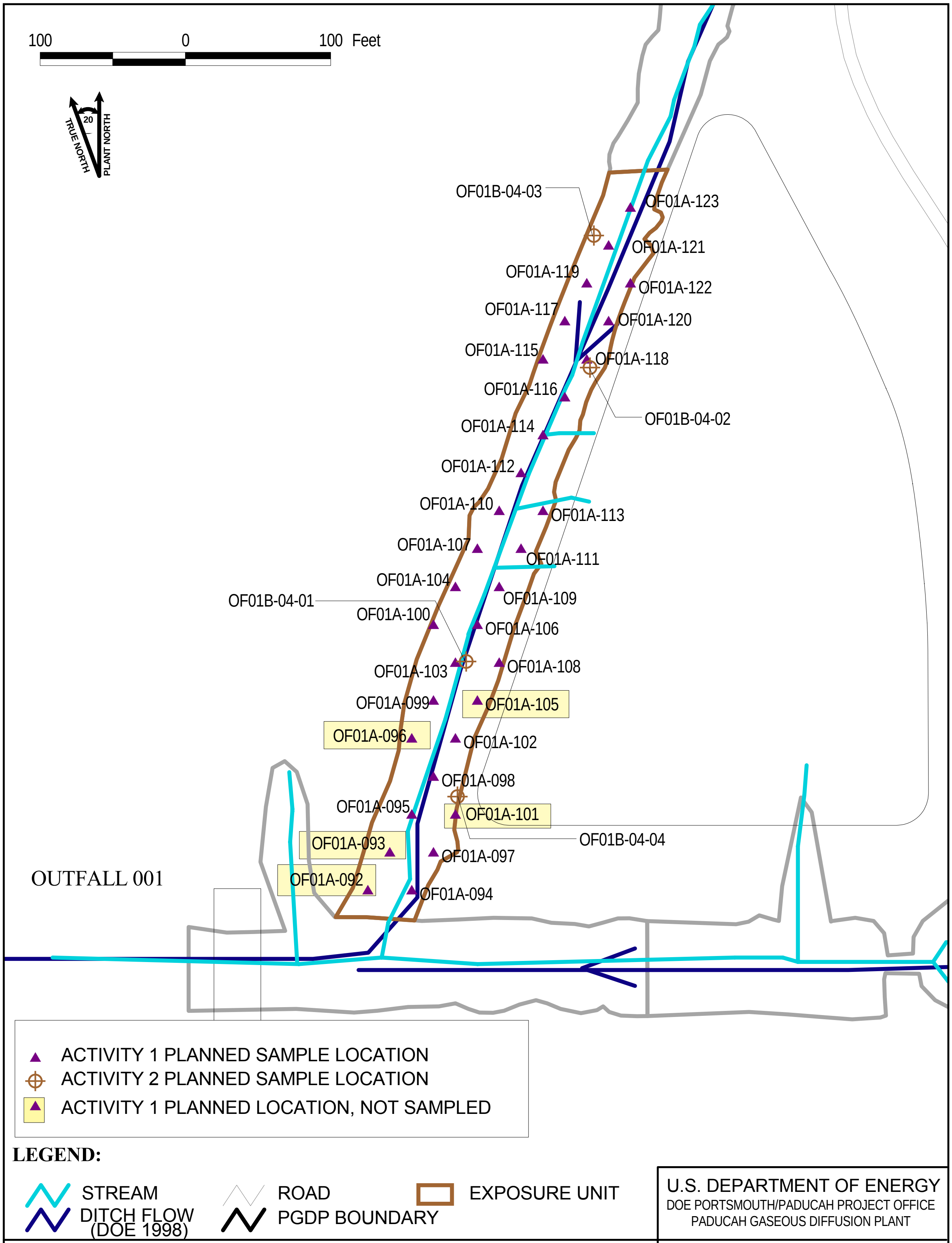

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Figure A.4. Outfall 001 EU 04 Activity 1 Locations Not Sampled

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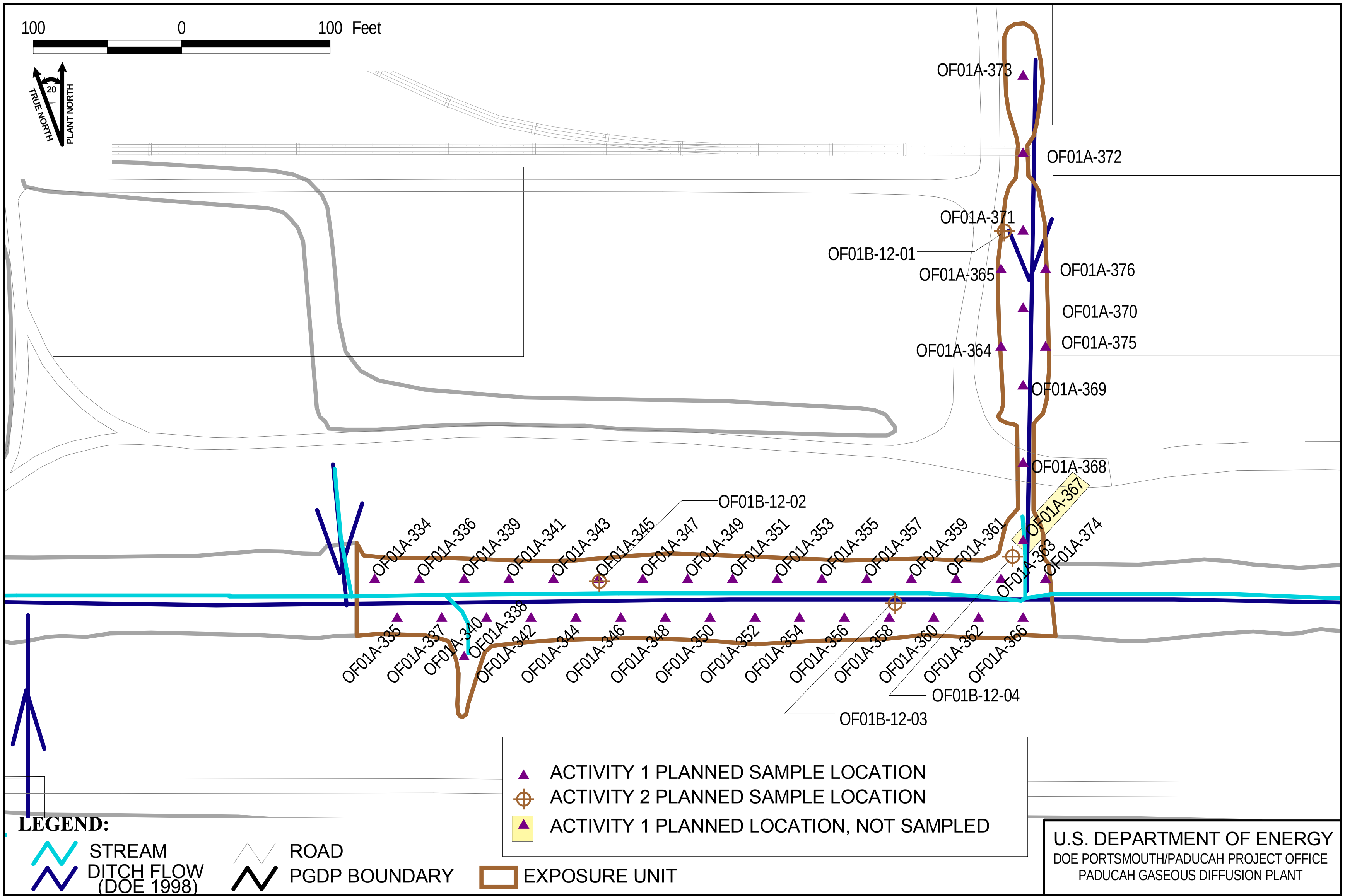

Figure A.5. Outfall 001 EU 12 Activity 1 Locations Not Sampled

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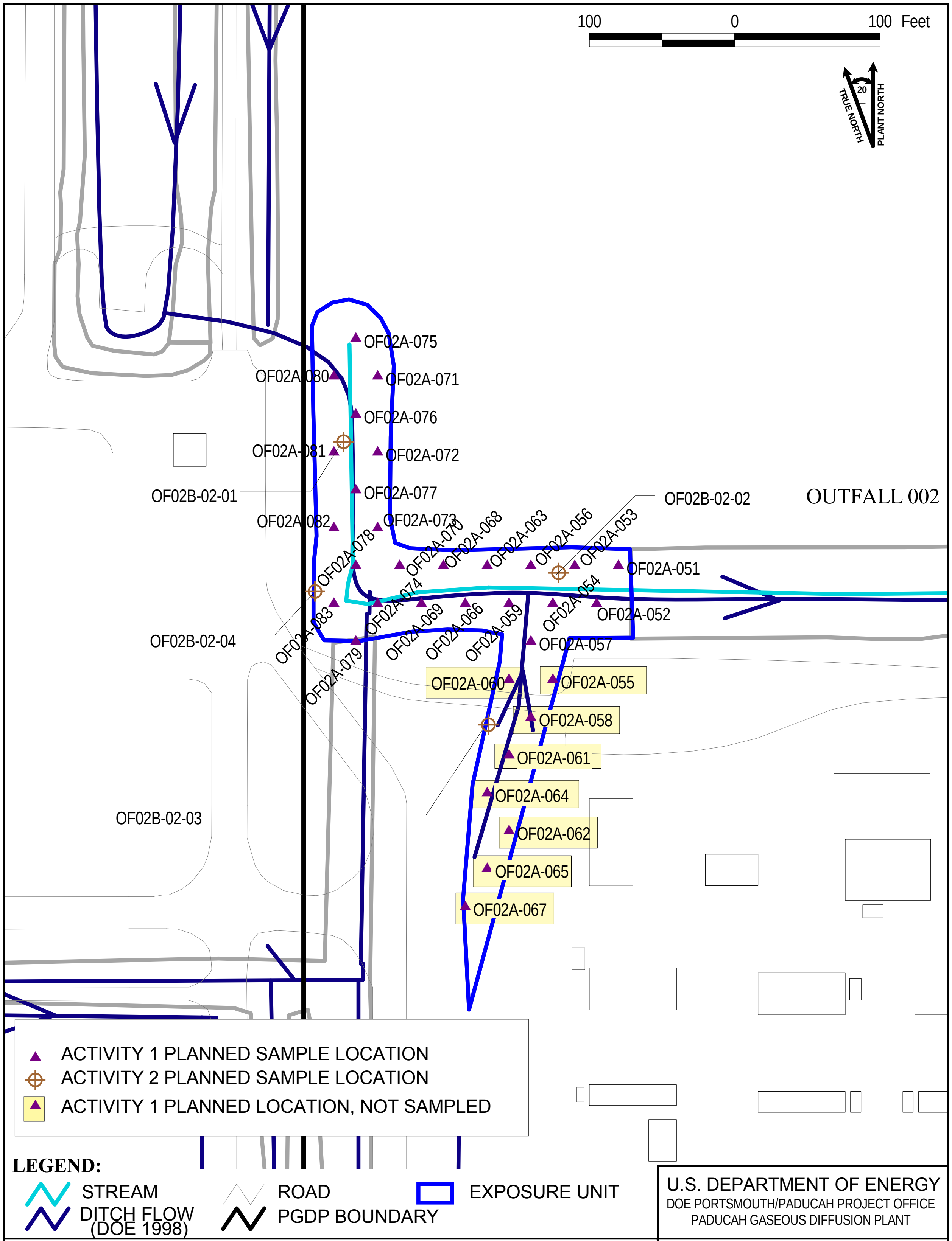

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Figure A.6. Outfall 002 EU 02 Activity 1 Locations Not Sampled

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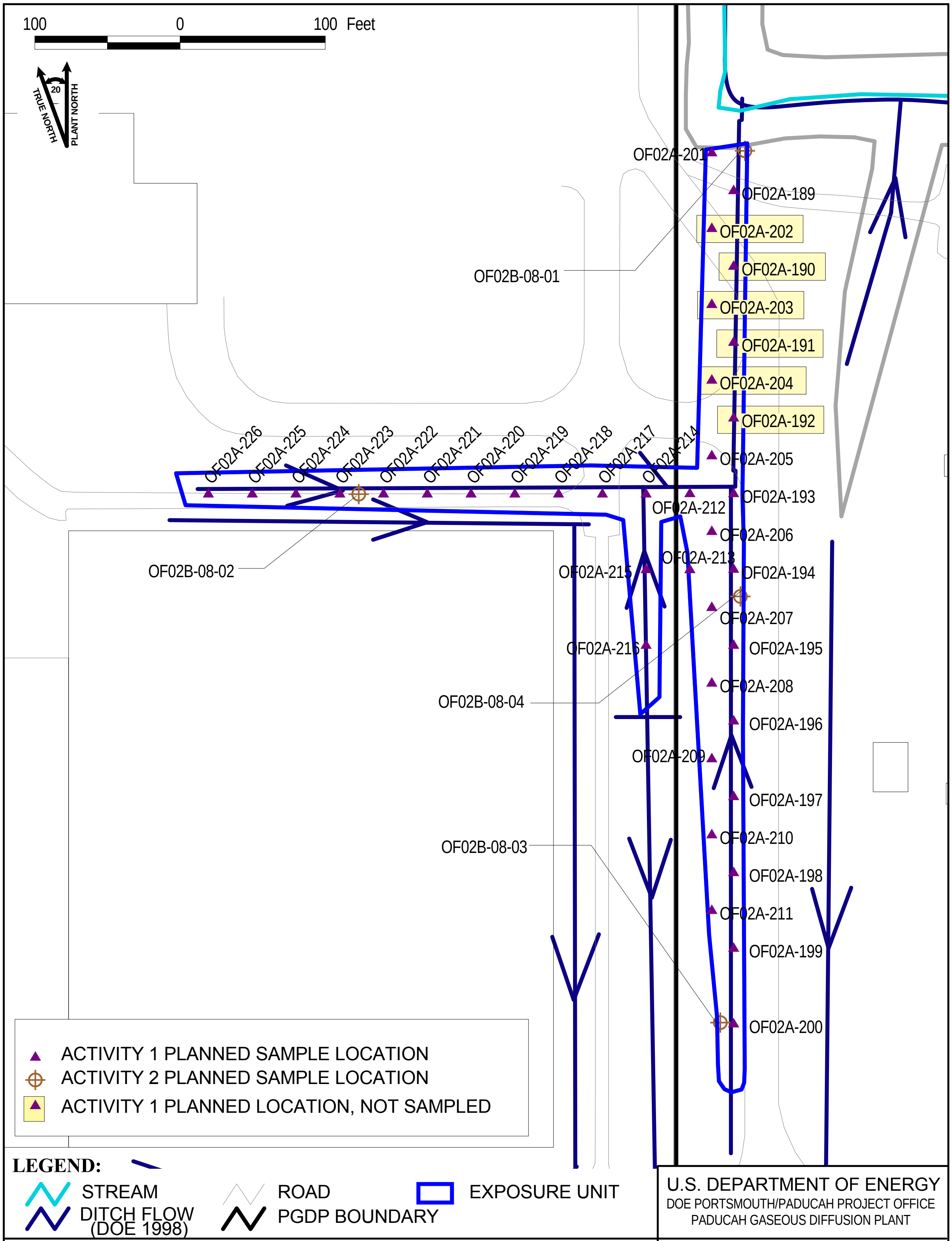

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Figure A.7. Outfall 002 EU 08 Activity 1 Locations Not Sampled

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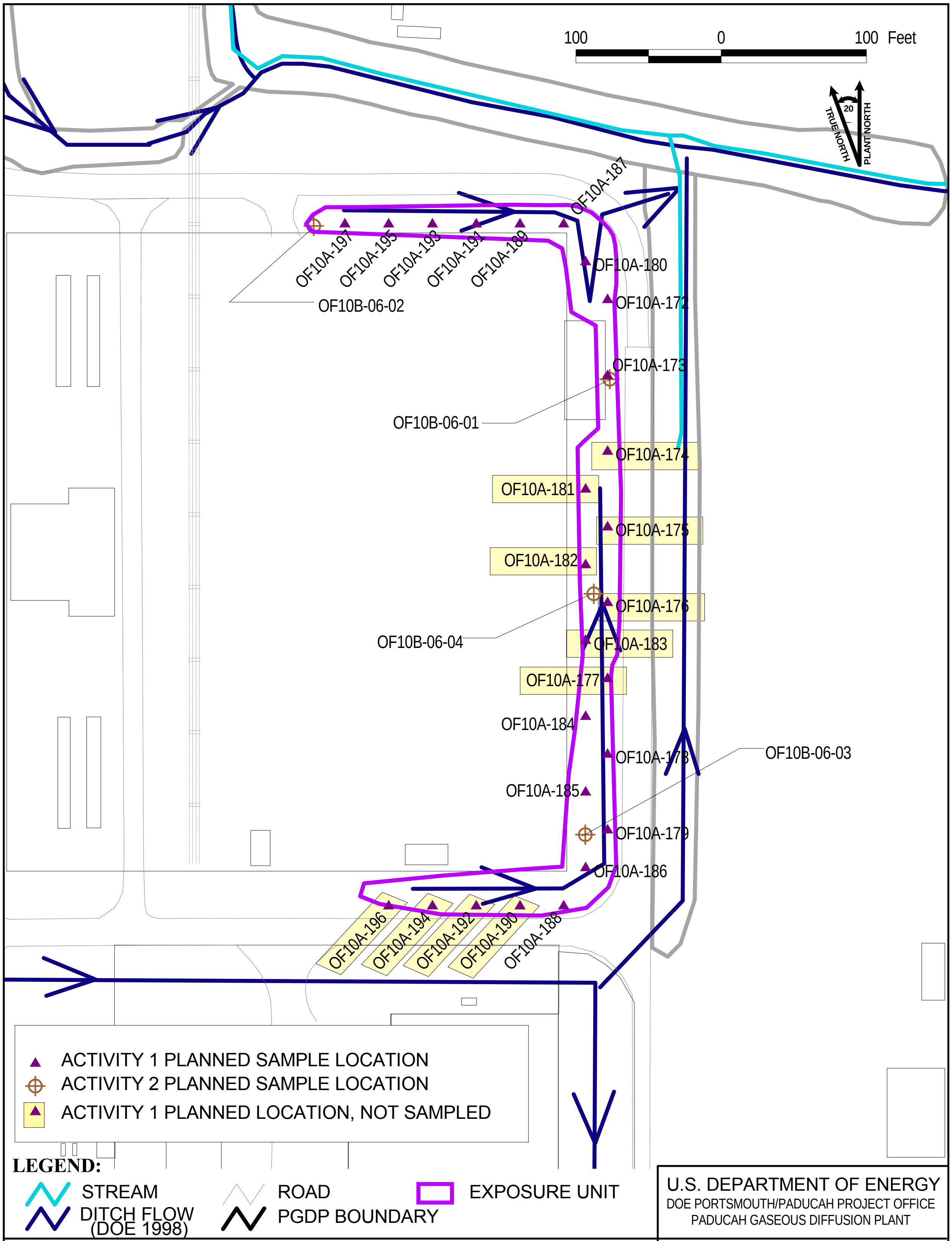

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Figure A.8. Outfall 010 EU 06 Activity 1 Locations Not Sampled

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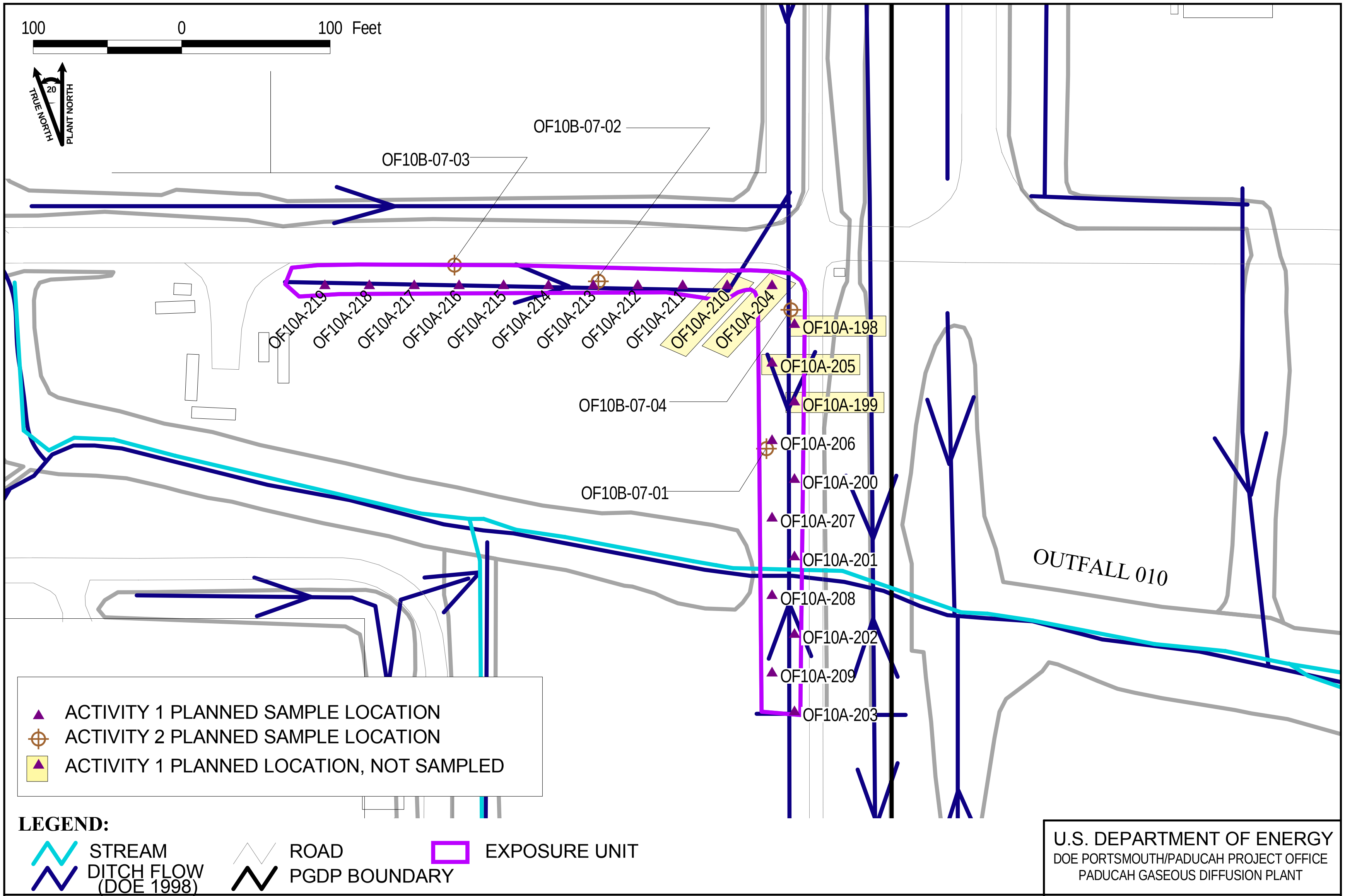

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Figure A.9. Outfall 010 EU 07 Activity 1 Locations Not Sampled

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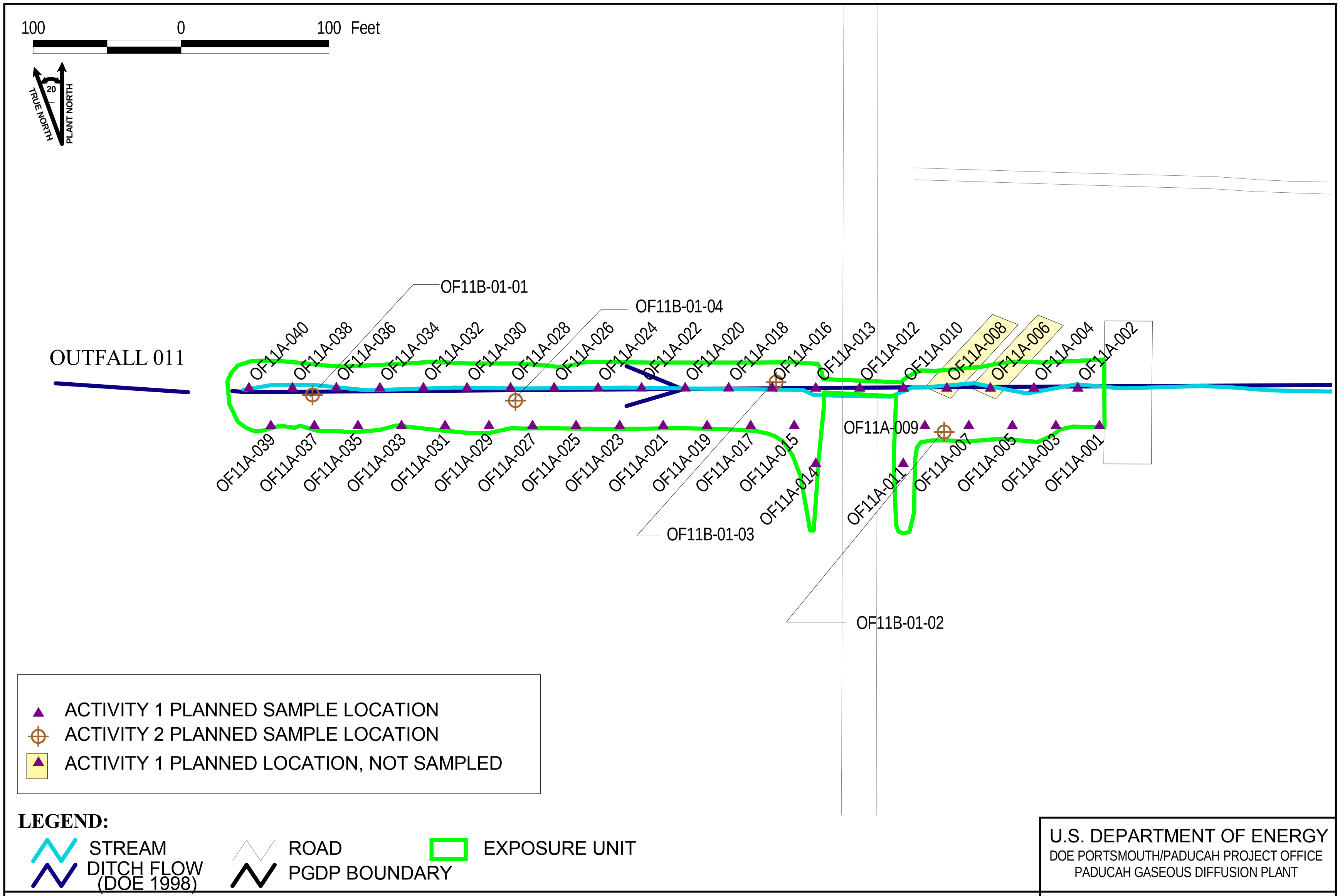

Figure A.10. Outfall 011 EU 01 Activity 1 Locations Not Sampled

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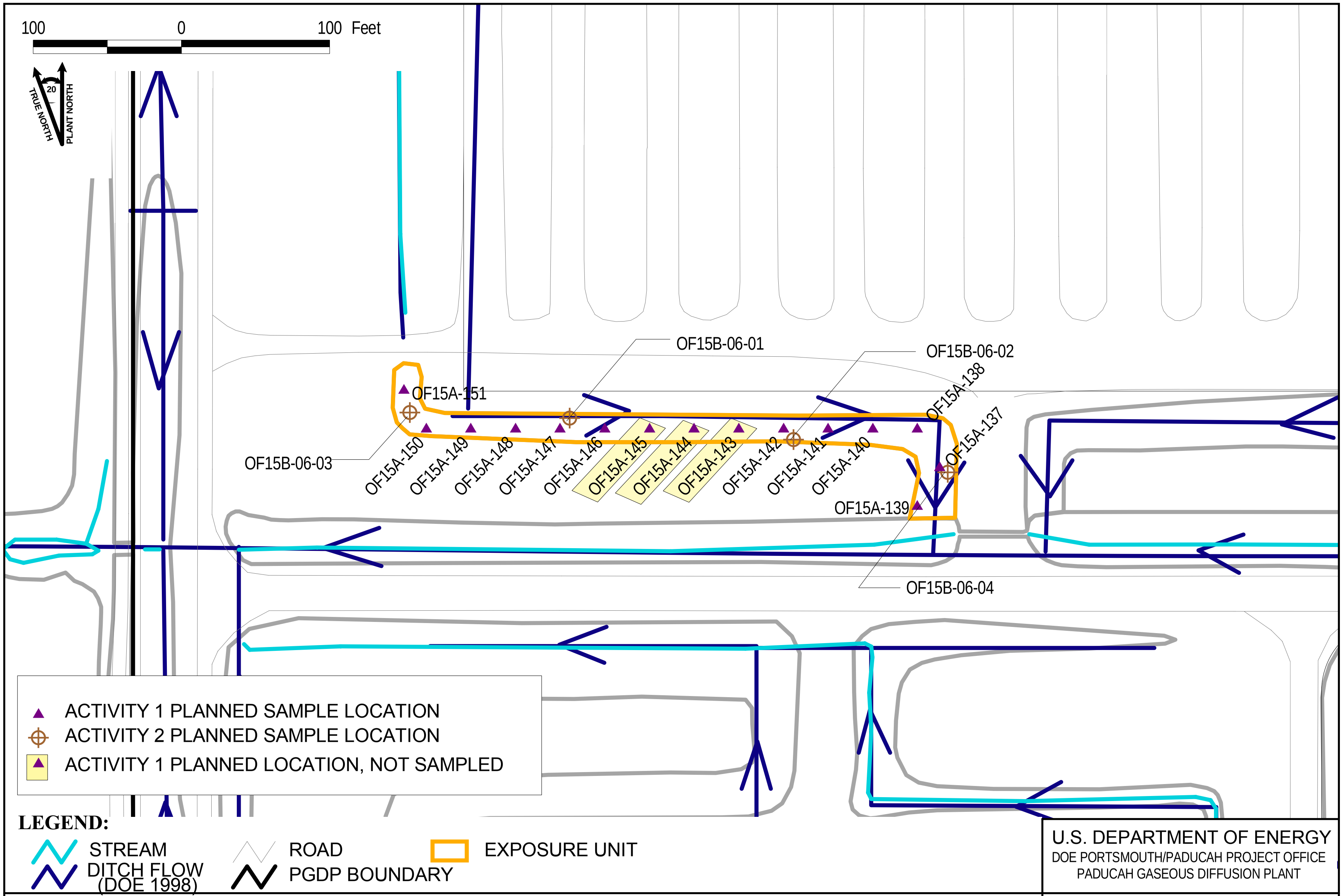

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Figure A.11. Outfall 015 EU 06 Activity 1 Locations Not Sampled

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A.11 DEVIATION FROM PLANNED SAMPLE LOCATIONS

A.11.1 INTRODUCTION

Appendix H of the SWOU SAP provided survey coordinates for each Activity 1 and Activity 2 sample location. This data was used to locate the samples in the field using either GPS or conventional survey methods. GPS could not be used at all sample locations due to the dense trees/wooded areas at some sample locations. This section presents a summary of the locations that were not placed at the coordinate locations that were provided in Appendix H of the SAP.

A.11.2 DISCUSSION OF DEVIATION FROM SAP COORDINATE LOCATIONS

The SWOU SAP (Appendix H) included the survey coordinates for all Activity 1 and Activity 2 samples that were planned to be collected. As discussed in Section A.3, during the surveying and locating of the sample locations, there were some Activity 1 and Activity 2 samples that could not be located at the planned coordinates due to the obstructions in the ditch. Obstructions included fallen trees, tree stumps, large rocks, concrete rubble/debris, and access issues due to vegetation in areas that could not be accessed by the brush clearing equipment. When obstructions or conditions prevented location of a sample at the planned location, the samples were offset and relocated when possible. This section presents a summary of the samples that were relocated and provides the distance that the sample was offset from the coordinates provided in Appendix H of the SAP.

NSDD Sample Locations

Six Activity 1 sample locations and one Activity 2 sample location were relocated (offset) from the Appendix H coordinates. All of the offsets were less than 10 ft from the original “x” or “y” coordinate and most were less than 5 ft from the original location. See Table A.10 for the NSDD samples that were offset and the distance from the original location.

Table A.10 NSDD Relocated Samples

				SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
Sample Location	Sample Type	NSDD Section	EU	X Coord	Y Coord	X Coord	Y Coord	
NSDDA-016	A1	3	1	-3507	1378	-3504.1081	1378.55689	2.9
NSDDA-103	A1	4	4	-3214	3179	-3204.881	3176.806	9.4
NSDDA-126	A1	4	6	-2440	4598	-2441.188	4597.146	1.5
NSDDA-157	A1	5	7	-2058	5107	-2060.2031	5103.01028	4.6
NSDDA-161	A1	5	7	-2148	5054	-2146.0016	5060.03785	6.4
NSDDA-209	A1	5	8	-1667	5383	-1671.9539	5383.98587	5.1
NSDDB-06-03	A2	4	6	-2422	4626	-2426.762	4628.00162	5.2

A1 = Activity 1 Sample
A2 = Activity 2 Sample

Outfall Ditch Sample Locations

A total of 81 Activity 1 sample locations and 24 Activity 2 sample location was relocated (offset) from the Appendix H coordinates. All of the offsets were less than 25 ft from the original "x" or "y" coordinate and most were less than 10 ft from the original location. See Tables A.11 to A.17 for the Outfall ditch samples that were offset and their distance from the original location.

Table A.11 Outfall Ditch 001 Relocated Samples

			SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
Sample Location	Sample Type	EU	X Coord	Y Coord	X Coord	Y Coord	
OF01A-047	A1	2	-7443	-112	-7448.614	-111.202	5.7
OF01A-077	A1	3	-7280	-235	-7279.341	-209.711	25.3
OF01A-095	A1	4	-7753	-3	-7744.508	-2.095	8.5
OF01A-097	A1	4	-7738	-29	-7752.326	-29.636	14.3
OF01A-099	A1	4	-7738	75	-7723.192	75.798	14.8
OF01A-108	A1	4	-7693	101	-7692.1248	101.8703	1.2
OF01A-140	A1	5	-7482	726	-7485.1369	722.154	5.0
OF01A-248	A1	9	-6100	45	-6113.755	43.055	13.9
OF01A-355	A1	12	-5781	-89	-5777.579	-91.885	4.5
OF01A-368	A1	12	-5646	-11	-5647.982	-32.749	21.8
OF01A-393	A1	13	-5370	-89	-5363.293	-89.551	6.7
OF01A-414	A1	13	-5099	-89	-5101.925	-90.305	3.2
OF01A-432	A1	14	-4724	-100	-4731.992	-100.815	8.0
OF01A-459	A1	15	-5009	-33	-5005.163	-43.726	11.4
OF01A-467	A1	15	-4979	71	-4985.287	72.885	6.6
OF01A-471	A1	15	-4963	149	-4956.788	147.345	6.4
OF01A-475	A1	15	-4918	123	-4922.801	125.413	5.4
OF01A-484	A1	16	-5080	-233	-5077.946	-220.572	12.6
OF01A-488	A1	16	-5035	-259	-5041.184	-252.436	9.0
OF01A-492	A1	16	-5005	-259	-4992.817	-258.245	12.2
OF01A-524	A1	17	-5398	-901	-5402.336	-899.217	4.7
OF01A-528	A1	17	-5353	-771	-5343.295	-755.361	18.4
OF01A-531	A1	17	-5308	-692	-5312.517	-689.969	5.0
OF01A-537	A1	17	-5232	-510	-5233.838	-508.934	2.1
OF01A-539	A1	17	-5217	-484	-5221.786	-481.418	5.4
OF01A-545	A1	17	-5142	-301	-5144.125	-300.199	2.3
OF01A-547	A1	17	-5127	-275	-5131.134	-271.227	5.6
OF01A-548	A1	18	-5434	-1013	-5429.501	-1014.587	4.8
OF01A-554	A1	18	-5344	-804	-5339.145	-807.397	5.9
OF01A-555	A1	18	-5329	-778	-5317.393	-761.714	20.0
OF01A-560	A1	18	-5254	-648	-5258.675	-646.483	4.9
OF01A-577	A1	19	-7119	-183	-7137.48	-181.955	18.5
OF01A-578	A1	19	-7104	-209	-7105.746	-216.234	7.4
OF01A-721	A1	23	-5579	-821	-5595.999	-823.851	17.2
OF01B-01-04	A2	1	-7845	-5	-7835.183	-8.789	10.5
OF01B-03-04	A2	3	-7281	-253	-7283.277	-263.181	10.4
OF01B-04-04	A2	4	-7721	9	-7739.917	6.977	19.0
OF01B-05-01	A2	5	-7595	451	-7593.8079	453.5481	2.8
OF01B-12-04	A2	12	-5653	-74	-5646.493	-87.891	15.3

Table A.11 Outfall Ditch 001 Relocated Samples (Continued)

Sample Location	Sample Type	EU	SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
			X Coord	Y Coord	X Coord	Y Coord	
OF01B-15-04	A2	15	-4994	-2	-4990.593	-2.739	3.5
OF01B-17-04	A2	17	-5360	-754	-5352.841	-752.766	7.3
OF01B-18-01	A2	18	-5198	-474	-5194.128	-475.368	4.1
OF01B-18-02	A2	18	-5109	-263	-5102.176	-265.656	7.3
OF01B-18-04	A2	18	-5361	-848	-5357.32	-849.594	4.0
OF01B-23-03	A2	23	-5578	-847	-5594.676	-846.016	16.7

A1 = Activity 1 Sample; A2 = Activity 2 Sample

Table A.12 Outfall Ditch 002 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
			X Coord	Y Coord	X Coord	Y Coord	
OF02A-018	A1	1	-760	-1079	-760.877	-1083.996	5.1
OF02A-044	A1	1	-1106	-1105	-1101.8787	-1108.5408	5.4
OF02A-189	A1	8	-1360	-1141	-1350.592	-1128.254	15.8

A1 = Activity 1 Sample

Table A.13 Outfall Ditch 008 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
			X Coord	Y Coord	X Coord	Y Coord	
OF08A-001	A1	1	-7332	-1866	-7335.9815	-1868.83912	4.9
OF08A-038	A1	1	-7633	-1918	-7632.246	-1922.429	4.5
OF08A-089	A1	4	-7099	-1783	-7107.497	-1786.89	9.3
OF08A-093	A1	4	-7114	-1757	-7097.029	-1749.679	18.5
OF08A-094	A1	4	-7129	-1627	-7142.849	-1626.309	13.9
OF08A-118	A1	5	-7225	-2072	-7223.075	-2064.403	7.8
OF08A-163	A1	6	-6998	-1939	-6987.826	-1935.154	10.9
OF08A-209	A1	8	-6611	-1866	-6611.93	-1853.226	12.8
OF08A-223	A1	8	-6897	-1683	-6887.971	-1681.067	9.2
OF08A-239	A1	9	-6550	-2047	-6550.887	-2044.267	2.9
OF08A-247	A1	9	-6656	-2125	-6661.04	-2119.294	7.6
OF08A-261	A1	9	-6746	-2229	-6749.962	-2226.685	4.6
OF08A-303	A1	10	-6047	-1768	-6048.465	-1760.985	7.2
OF08A-320	A1	10	-6484	-1794	-6481.656	-1783.132	11.1
OF08A-328	A1	11	-5595	-1344	-5596.894	-1342.934	2.2
OF08A-339	A1	11	-5806	-1657	-5807.312	-1654.687	2.7
OF08A-414	A1	14	-6382	-2012	-6382.66	-2007.253	4.8
OF08B-03-03	A2	3	-7299	-1505	-7292.7	-1506.121	6.4
OF08B-05-04	A2	5	-7227	-2073	-7230.172	-2065.523	8.1
OF08B-08-01	A2	8	-6611	-1868	-6613.264	-1856.276	11.9

A1 = Activity 1 Sample; A2 = Activity 2 Sample

Table A.14 Outfall Ditch 010 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
			X Coord	Y Coord	X Coord	Y Coord	
OF10A-059	A1	2	-1330	-2093	-1336.816	-2097.26	8.0
OF10A-070	A1	2	-1360	-2093	-1350.809	-2098.219	10.6
OF10A-088	A1	3	-1157	-2059	-1166.458	-2073.96	17.7
OF10A-097	A1	3	-1292	-1564	-1303.986	-1554.83	15.1
OF10A-102	A1	3	-1292	-1825	-1279.147	-1815.741	15.8
OF10A-110	A1	3	-1307	-1799	-1305.328	-1793.708	5.5
OF10A-115	A1	4	-1553	-2040	-1557.242	-2042.415	4.9
OF10A-214	A1	7	-1630	-1876	-1620.163	-1871.449	10.8
OF10A-219	A1	7	-1781	-1876	-1763.492	-1868.861	18.9
OF10A-229	A1	8	-1488	-1408	-1484.384	-1416.509	9.2
OF10A-232	A1	8	-1488	-1826	-1491.165	-1819.132	7.6
OF10A-246	A1	8	-1819	-1826	-1830.824	-1826.634	11.8
OF10A-248	A1	8	-1880	-1826	-1891.06	-1824.103	11.2
OF10A-251	A1	8	-1970	-1826	-1959.34	-1832.272	12.4
OF10A-255	A1	8	-2015	-1748	-2011.674	-1747.393	3.4
OF10A-263	A1	9	-1423	-1835	-1425.43	-1824.844	10.4
OF10B-03-02	A2	3	-1149	-1864	-1145.755	-1868.128	5.3
OF10B-05-01	A2	5	-1683	-2208	-1690.188	-2208.658	7.2
OF10B-06-01	A2	6	-1725	-2202	-1723.616	-2180.745	21.3
OF10B-06-04	A2	6	-1736	-2350	-1740.374	-2460.958	111.0
OF10B-07-04	A2	7	-1467	-1893	-1471.421	-1880.958	12.8
OF10B-08-01	A2	8	-1845	-1818	-1841.606	-1824.838	7.6
OF10B-09-03	A2	9	-1413	-1511	-1420.231	-1510.326	7.3
OF10B-10-04	A2	10	-2778	-1837	-2792.782	-1826.971	17.9

A1 = Activity 1 Sample; A2 = Activity 2 Sample

Table A.15 Outfall Ditch 011 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H		Actual Location		Change from Appendix H Location in Total Feet
			X Coord	Y Coord	X Coord	Y Coord	
OF11A-002	A1	1	-651	-2942	-629.73059	-2941.28639	21.3
OF11A-004	A1	1	-681	-2942	-670.1057	-2944.03356	11.1

A1 = Activity 1 Sample

Table A.16 Outfall Ditch 012 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H X Coord	SAP Appendix H Y Coord	Actual Location X Coord	Actual Location Y Coord	Change from Appendix H Location in Total Feet
OF12A-009	A1	1	-791	-3958	-782.53828	-3962.11113	9.4
OF12A-010	A1	1	-806	-3932	-816.57717	-3933.47491	10.7

A1 = Activity 1 Sample

Table A.17 Outfall Ditch 015 Relocated Samples

Sample Location	Sample Type	EU	SAP Appendix H X Coord	SAP Appendix H Y Coord	Actual Location X Coord	Actual Location Y Coord	Change from Appendix H Location in Total Feet
OF15A-022	A1	1	-7320	-903	-7328.518	-902.304	8.5
OF15A-108	A1	4	-5046	-1092	-5049.368	-1095.153	4.6
OF15A-142	A1	6	-6861	-1018	-6850.582	-1015.122	10.8
OF15A-237	A1	9	-6566	-1450	-6559.455	-1449.397	6.6
OF15A-240	A1	9	-6566	-1607	-6572.395	-1609.037	6.7
OF15A-281	A1	10	-6493	-1366	-6491.806	-1372.602	6.7
OF15A-297	A1	11	-5846	-1156	-5844.774	-1158.612	2.9
OF15B-02-03	A2	2	-7225	-1103	-7218.258	-1103.965	6.8
OF15B-09-01	A2	9	-6571	-1594	-6580.632	-1597.242	10.2

A1 = Activity 1 Sample; A2 = Activity 2 Sample

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A.12 PCBs DETECTED IN SOIL FROM SWMU 92

A.12.1 INTRODUCTION

Soil samples collected during the SWOU SI detected elevated concentrations of PCBs in a section of a ditch that leads to Outfall 010. The section of the ditch where the samples were located is within EU 10, as identified in the SWOU SI Sampling Plan.

This area (EU 10) is within the area identified as SWMU 92 (Fill area for dirt from the C-420 PCB spill site). Samples collected during an investigation of this area in December 1993 detected PCB concentrations ranging from 4.6 ppm to 253 ppm from intervals between 1 and 18 in. below surface.

The purpose of this paper is to provide a summary of the results detected during the SWOU Site Investigation and identify recommended actions.

A.12.2 SUMMARY OF SOIL SAMPLING

Shallow soil samples were collected from a ditch that drains to Outfall 010 as a part of conducting the SWOU SI. Laboratory analysis of seven of these samples detected Total PCB concentrations ranging from 102 ppm to 609 ppm. These samples were collected from a section of the ditch inside the DOE security fence, north of building C-331, on the north side of Tennessee Avenue. Refer to Figure A.12 for a site map of this area. The samples collected during the SWOU SI were taken from a depth of approximately 4 in. below ground surface. The topography is relatively flat with a low gradient flowing west to east, eventually draining into Outfall 010.

As shown on Figure A.13, the seven samples were collected from consecutive sampling locations and represent a distance, from west to east, of approximately 100 ft. The elevated PCBs (i.e., 100 ppm or more) are limited to this area, as samples located to the east, west, and north had PCB detections ranging from 1 ppm to 11 ppm. Analytical data including data qualifiers from all of the samples collected from this section of the ditch are presented in Table A.18.

A.12.3 TSCA CONSIDERATIONS

For the purpose of risk screening, TSCA regulation (40 CFR § 761.61) states the following:

> *(B) Low occupancy area. (1) The cleanup level for bulk PCB remediation waste in low occupancy areas is ≤ 25 ppm. (2) Bulk PCB remediation wastes may remain at a cleanup site at concentrations >25 ppm and ≤50 ppm if the site is secured by a fence and marked with a sign including the* M_L *mark. (3) Bulk PCB remediation wastes may remain at a cleanup site at concentrations>25 ppm and ≤100 ppm if the site is covered with a cap meeting the requirements of paragraphs (a) (7) and (a) (*) of this sections.*

The SWOU SI sampling that identified the PCB concentrations was collected only in the shallow subsurface (0-6 in. interval); therefore, the vertical extent is unknown. Based on the 1993 sampling, PCBs were detected to a depth of 18 in. TSCA regulations do allow PCBs to remain in place under certain circumstances. If removal is chosen, the following waste volume calculations are estimated for a range of depths, since the depth is unknown. The length and width of the excavation are based on the nearest adjacent sampling points that are below 25 ppm. This results with an area for potential removal of 150 ft long by 50 ft wide.

<u>Estimated Soil Removal Quantities (in place)</u>

(1) 150 ft x 50 ft x 2 ft = 15,000 ft^3/ 27 = 556 cy^3
(2) 150 ft x 50 ft x 3 ft = 22,500 ft^3/ 27 = 833 cy^3
(3) 150 ft x 50 ft x 4 ft = 30,000 ft^3/ 27 = 1,111 cy^3

An expansion value would need to be applied to the in-place volumes to account for the disturbance due to the excavation. For the type of soil typically present at the site, an expansion value of 20% to 30% would be appropriate to be applied to the in-place volumes.

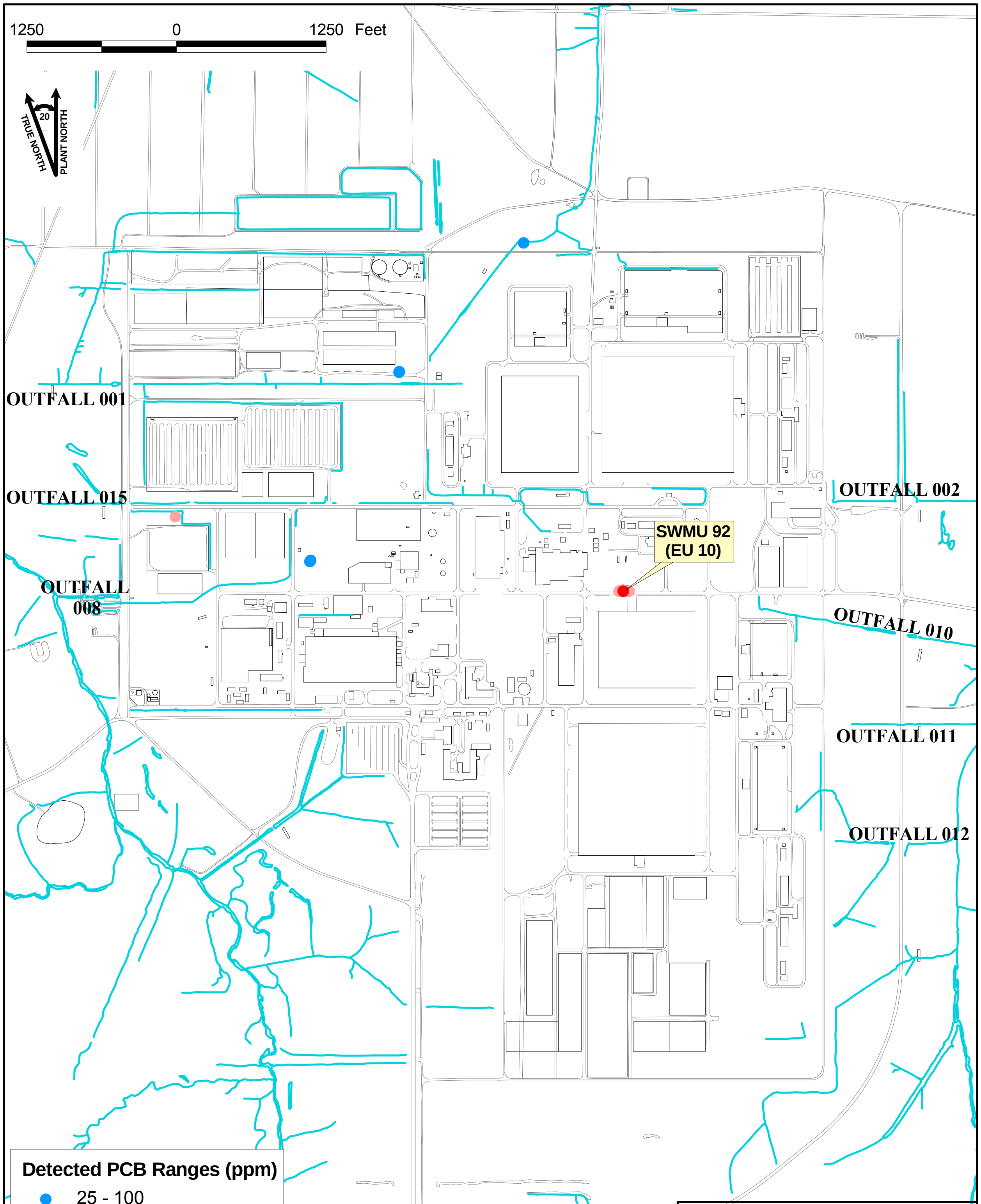
A.12.4 RECOMMENDED ACTIONS

Currently, there are no activities being conducted in this area but routine mowing by the Infrastructure Subcontractor occurs approximately once a month during the mowing season.

There is potential for site workers and personnel performing mowing activities to be exposed to PCB concentrations detected in the section of the Outfall 010 ditch are noted above. It is recommended that the area with the elevated PCB concentrations immediately be protected from entry of personnel by placing roping and installing PCB warning signs. Additionally, all other subcontractors at the site should be notified of the contaminant concentrations detected in this area.

A.12.5 FOLLOW-UP ACTIONS

Fence posts were installed around the PCB area in SWMU 92 (Outfall Ditch 010, EU10) and roping was secured to the posts. PCB warning signs then were attached to the roping and/or fence posts. United States Enrichment Corporation and DOE prime contractors were notified of the newly posted area. These actions were completed in mid-March 2006 in accordance with the preceding recommended actions section.



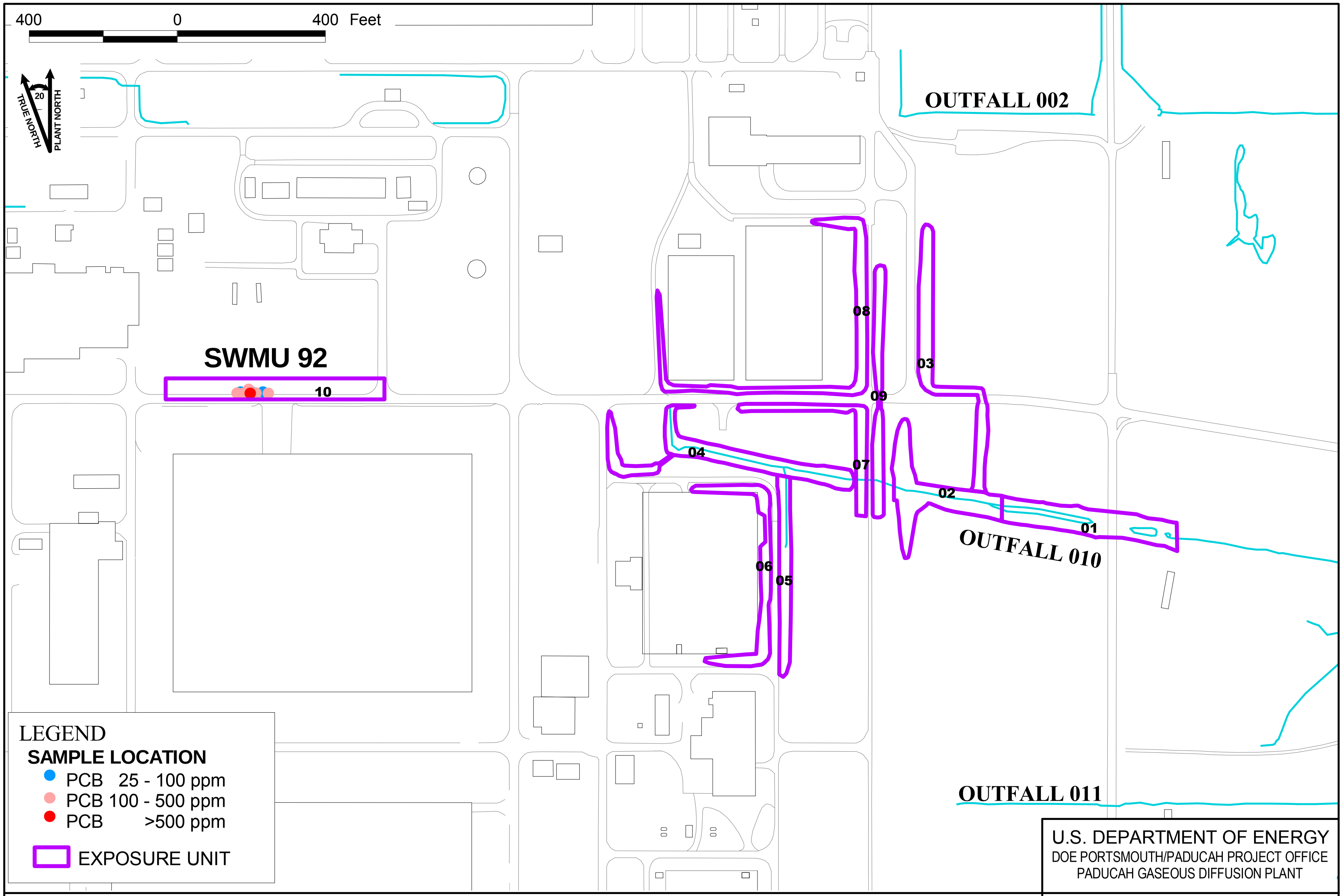
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure A.12. PGDP Site Map of SWOU RI PCB Detections

PADUCAH
Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\SWMU92.apr
DATE 08-25-06

DOCUMENT No. DOE/LX/07-0001



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PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH
Remediation Services
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Figure A.13. PCB Sample Locations Oufall 010 EU 10 and SWMU 92

Figure No. \SWOU\010-SWMU92.apr
DATE 08-25-06

Table A.18. Soil PCB Analytical Data for Outfall Ditch 010, EU 10, SWMU 92

PROJ_SAMPLE_ID	CHEMICAL_NAME	RESULTS	RSLTQUAL	DETECT_LIMIT	UNITS
OF10AC-903	Polychlorinated biphenyl	609000	DEXY	3250	ug/kg
OF10AC-902	Polychlorinated biphenyl	489000	DEXY	3250	ug/kg
OF10AC-904	Polychlorinated biphenyl	380000	DEY	3250	ug/kg
OF10AC-901D	Polychlorinated biphenyl	278000	DEY	3250	ug/kg
OF10AC-901	Polychlorinated biphenyl	244000	DEY	3250	ug/kg
OF10AC-906	Polychlorinated biphenyl	103000	DY	3250	ug/kg
OF10B-10-03	Polychlorinated biphenyl	102000	EXY	130	ug/kg
OF10A-301	Polychlorinated biphenyl	90100	E	130	ug/kg
OF10A-299	Polychlorinated biphenyl	61800	E	120	ug/kg
OF10A-303	Polychlorinated biphenyl	60200	E	120	ug/kg
OF10A-297	Polychlorinated biphenyl	24200	E	130	ug/kg
OF10AC-907	Polychlorinated biphenyl	16000	EY	130	ug/kg
OF10AC-905	Polychlorinated biphenyl	12500	EXY	130	ug/kg
OF10A-305	Polychlorinated biphenyl	11000	E	130	ug/kg
OF10A-300	Polychlorinated biphenyl	7590	E	120	ug/kg
OF10A-304	Polychlorinated biphenyl	6840	E	130	ug/kg
OF10A-286	Polychlorinated biphenyl	6500	EX	120	ug/kg
OF10A-309	Polychlorinated biphenyl	6130	E	120	ug/kg
OF10A-311	Polychlorinated biphenyl	4760	E	120	ug/kg
OF10A-302	Polychlorinated biphenyl	3750	E	120	ug/kg
OF10A-313	Polychlorinated biphenyl	3480	E	130	ug/kg
OF10A-298	Polychlorinated biphenyl	3430	E	130	ug/kg
OF10B-10-01	Polychlorinated biphenyl	3360	E	130	ug/kg
OF10A-287	Polychlorinated biphenyl	2810	E	120	ug/kg
OF10A-307	Polychlorinated biphenyl	2720	E	130	ug/kg
OF10A-292	Polychlorinated biphenyl	2340	E	120	ug/kg
OF10A-296	Polychlorinated biphenyl	2140	E	130	ug/kg
OF10A-296D	Polychlorinated biphenyl	2130	E	120	ug/kg
OF10A-291	Polychlorinated biphenyl	1980	E	130	ug/kg
OF10A-294	Polychlorinated biphenyl	1540	E	120	ug/kg
OF10A-293	Polychlorinated biphenyl	1460	E	130	ug/kg
OF10A-289	Polychlorinated biphenyl	1340	E	130	ug/kg
OF10B-10-04	Polychlorinated biphenyl	1260	E	130	ug/kg
OF10A-308	Polychlorinated biphenyl	1230	E	120	ug/kg
OF10A-310	Polychlorinated biphenyl	1140	E	130	ug/kg
OF10A-306	Polychlorinated biphenyl	1050	E	130	ug/kg
OF10A-315	Polychlorinated biphenyl	910	E	130	ug/kg
OF10B-10-02	Polychlorinated biphenyl	810	EY	120	ug/kg
OF10A-285	Polychlorinated biphenyl	710	E	120	ug/kg
OF10A-288	Polychlorinated biphenyl	640		130	ug/kg
OF10A-295	Polychlorinated biphenyl	500		130	ug/kg
OF10A-290	Polychlorinated biphenyl	480		120	ug/kg
OF10AC-908	Polychlorinated biphenyl	430	Y	130	ug/kg
OF10A-284	Polychlorinated biphenyl	350		130	ug/kg
OF10A-312	Polychlorinated biphenyl	350		130	ug/kg
OF10A-316	Polychlorinated biphenyl	320		120	ug/kg
OF10A-279	Polychlorinated biphenyl	280	Y	120	ug/kg
OF10A-281	Polychlorinated biphenyl	230		120	ug/kg
OF10A-278D	Polychlorinated biphenyl	200		130	ug/kg
OF10A-283	Polychlorinated biphenyl	190		130	ug/kg
OF10A-280	Polychlorinated biphenyl	180		120	ug/kg
OF10A-314	Polychlorinated biphenyl	150		130	ug/kg
OF10A-282	Polychlorinated biphenyl	130	UY	130	ug/kg
OF10A-278	Polychlorinated biphenyl	130	Y	130	ug/kg

Result Code Qualifiers

D	Compounds identified in an analysis at a secondary dilution factor.
E	Result exceeds calibration range. (GC/MS flag)
X	Other specific flags and footnotes may be required to properly define the results.
Y	MS,MSD recovery and/or RPD failed acceptance criteria.
U	Compound analyzed for but not detected at or below the lowest concentration reported.

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APPENDIX B

ANALYTICAL DATA AND QA/QC EVALUATION RESULTS

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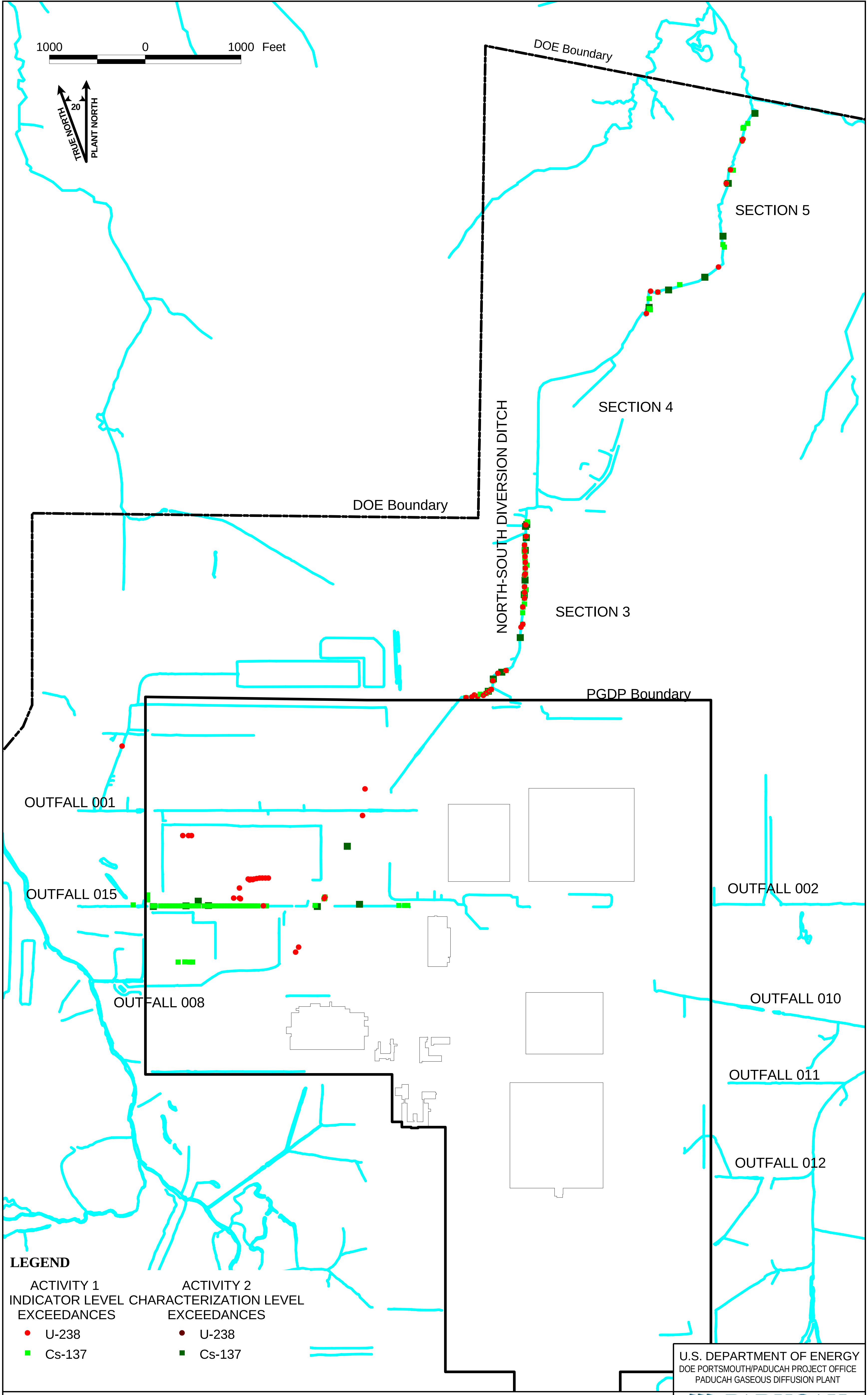
APPENDIX B

ANALYTICAL DATA, QA/QC RESULTS



PADUCAH Remediation Services
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Figure B.1. Activities 1 and 2 Indicator Level Radiological Hot Spots

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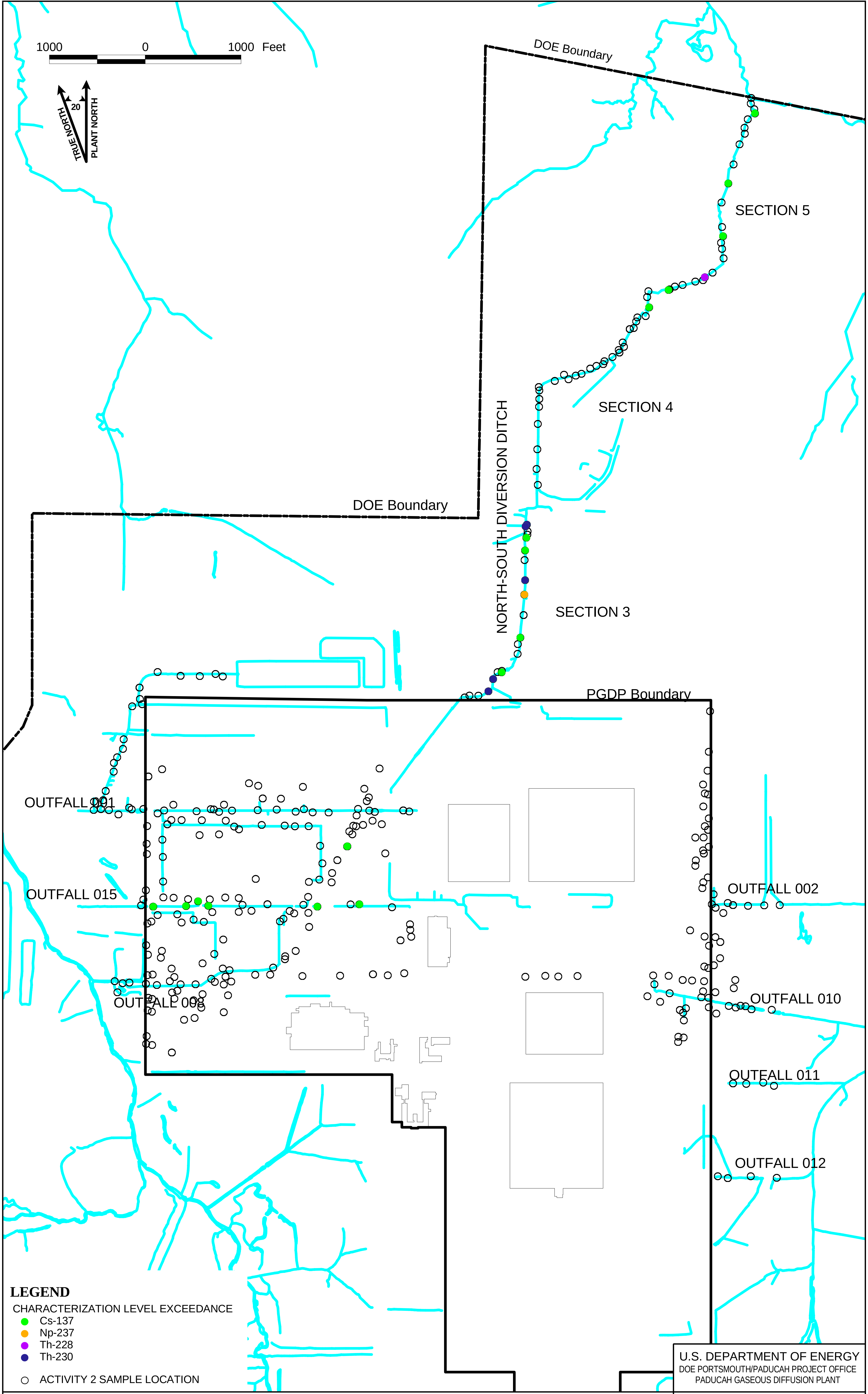

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
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Figure B.2. Activity 2 Characterization Level Radiological Hot Spots

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APPENDIX C

SURFACE SOIL EROSION, CONTAMINANT PARTITIONING MODELING, AND FATE AND TRANSPORT MODELING

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CONTENTS

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TABLES

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FIGURES

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ACRONYMS

COPC	chemical of potential concern
EPA	U.S. Environmental Protection Agency
EU	exposure unit
HELP	Hydrologic Evaluation of Landfill Performance
Kd	adsorption/distribution coefficient
MUSLE	Modified Universal Soil Loss Equation
NOAA	National Oceanic and Atmospheric Administration
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
SCS	storm water collection system
SI	site investigation
SWMM	Storm Water Management Model
SWOU	Surface Water Operable Unit
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation

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C1. SURFACE SOIL EROSION AND CONTAMINANT PARTITIONING MODELING

C1.1 INTRODUCTION

As precipitation falls on the surface of the soil, the energy of the impact dislodges soil particles that then can be transported in the runoff flowing from an area. The contaminants adsorbed to these soil particles, therefore, also are transported in the runoff. In addition, the runoff water is contaminated by contact with the soil and transports contaminants in a dissolved phase. The relative concentration of a contaminant attached to soil particles and dissolved in water is measured by the adsorption/distribution coefficient (K_d). The less soluble a contaminant is in water, the more likely it will be adsorbed to soil particles. Because the water solubility of different types of contaminants vary widely, transport in runoff in both phases will be taken into account. The following analysis yields estimates of runoff and the total erosion of sediments from identified contaminated source areas. These results are used to compute both the total mass and concentration of a contaminant in the dissolved and adsorbed phases leaving the source area.

Modeling the transport of soil by runoff requires characterization of the contaminants in the initial soil or waste source term. Sample results of the Surface Water Operable Unit (SWOU) Site Investigation (SI) provide the characterization of the source terms for this model. The U.S. Environmental Protection Agency (EPA) *Superfund Exposure Assessment Manual* (EPA 1988) includes two models to quantify the migration of contaminated soils to stream sediment by erosion and runoff, the Universal Soil Loss Equation (USLE) and the Modified Universal Soil Loss Equation (MUSLE). These models calculate the total mass of soil transported annually (USLE) or for a single rainfall event (MUSLE). The USLE model uses an area-dependent method to determine runoff, while MUSLE calculates rainfall-specific runoff volume and flow rate characteristics; therefore, MUSLE is expected to produce more conservative results and is the model that was chosen for the analysis presented in this study. Additional contaminant partitioning and loading models are used to describe contaminant distribution between soil and water in the runoff. These partitioning models provide an estimate of the contaminant concentration dissolved in runoff and adsorbed to the soil that is carried with the runoff and deposited in the sediments of the ditches and creeks (Haith 1980; Mills et al. 1982).

A measure of the volume of runoff also is required to determine the amount that stream flow may be increased by a runoff event and to estimate the amount of dissolved contaminant added to the stream. Depth of runoff is calculated as a function of the depth of rainfall and a soil water retention factor. The dissolved contaminant concentration in the receiving stream is estimated by a simple dilution model using runoff concentration, runoff volume, and stream flow. Following sections present model calculations, model input parameters, and results.

C1.2 CALCULATION OF SOIL LOSS FROM RUNOFF

Soil loss for the single rainfall event is estimated using MUSLE by the following equation:

$$Y(S)_E = (CF)[(Vr)(q_p)]^{0.56}(K_e)(LS)(C)(P)$$

where

$Y(S)_E$ = sediment yield/soil loss in runoff (metric tons/storm event)
CF = conversion factor (11.8 for metric units)
Vr = volume of runoff (m^3)

q_p = peak runoff flow rate (m^3/s)
K_e = soil erodibility factor (metric tons/ha/Rr)
Rr = rainfall and runoff erosion potential factor (unitless)
LS = topographic factor derived from slope length factor (L) and slope steepness factor (S) (unitless) =
L = slope-length factor (m)
S = slope-steepness (%)

C = cover factor (unitless; 1.0 for bare ground)
P = erosion control practice factor (unitless; 1.0 for areas where erosion-control measures are not in place)

Intermediate parameters Vr and q_p are calculated as follows:

$$Vr = (100)(A)(Qr)$$
$$Qr = (Rt - 0.2S_w)^2/(Rt + 0.8S_w)$$
$$S_w = (1000/CN)-25.4$$
$$q_p = 0.028(A)(Rt)(Qr)/[(Tr)(Rt-0.2S_w)]$$

$$LS = (L/72.6)^{NN}(65s^2 + 450s + 650)/(s^2 + 10{,}000)$$

where
A = contaminated area (hectares)[1]
Qr = depth of runoff (cm)
Rt = total storm rainfall (cm)
S_w = soil water retention factor (cm)
CN = storm water collection system (SCS) runoff curve number (unitless)
Tr = rainfall duration (hours)

NN = exponent (unitless, see Table C1.3)

C1.3 CALCULATION OF CONTAMINANT PARTITIONING AND LOADING

The following partitioning model provided the estimate of the contaminant concentrations dissolved in water:

$$Ms = [1/(1 + K_d.\rho/Oc)](Ci)(\rho)(A)(d)(CF)$$
and
$$Ss = [1/(1 + Oc/(K_d.\rho))](Ci)(\rho)(A)(d)(CF)$$

where
Ms = available quantity of dissolved contaminant (portion to water) (g)
Ss = available quantity of sorbed contaminant (portion adsorbed to soil) (g)
K_d = adsorption/distribution coefficient (cm^3/g or L/kg)
ρ = soil bulk density (g/cm^3)
Oc = available water capacity in top cm of soil (unitless)
Ci = concentration of contaminant in surface soil (mg/kg)

---

[1] Specific areas are defined as units of ft^2 in the report. For reference, 1 hectare = 107,556 ft^2.

d = depth of soil affected by rainfall (assumed = 1 cm)
CF = conversion factor, 100 (kg/mg * cm^2/ha)

Modeling of contaminant partitioning and loading also required the following:

The mass of dissolved contaminant from the source area is $PQi = (Qr/Rt)(Ms)$

and

the mass of adsorbed contaminant from the source area is $PXi = Y(S)_E /(\rho.CF)(Ss)$

where,

PQi = dissolved substance available per event (g); and

PXi = sorbed substance available per event (g).

The contaminant concentration of the sediment in the runoff effluent $Cs = PXi/Y(S)_E$

where, Cs = concentration of contaminant in the sediment (mg/kg, or pCi/g).

The contaminant concentration in the runoff effluent is $Ce = PQi/Vr$

where, Ce = concentration of contaminant in runoff (g/m^3, mg/L, or pCi/L).

The average effluent flow rate is $Qe = Vr/Tr$.

The contaminant concentration in the receiving water body downstream is calculated as follows:

$$Cw = (Ce)(Qe)/(Qt + Qe)$$

where,
Cw = Concentration of contaminant in surface water downstream (mg/L)
Qe = Runoff flow rate (m^3/hr)
Qt = Flow rate of receiving water body downstream (flow in the creek) (m^3/hr)

Note: Measured flow rate of the receiving water body downstream was not available for this analysis; therefore, SWMM developed flow in the creek that represents (Qt + Qe) was used.

or for annual inputs:

$$Cw = (PQi)(N)/Qta$$

where,
N = Number of rainfall events per year
Qta = Average yearly flow of receiving water body (m^3/yr).

C1.4 CALCULATION OF TOTAL LOADINGS

The effect of runoff from several source areas simultaneously entering the receiving water body (as expected in a storm event) can be estimated by summing the constituent loadings from each source area:

$$Cw = [(\Sigma PQi)/Tr]/[Qt + (\Sigma Vr)/Tr]$$

where PQi and Vr are summed for all sites contributing to the receiving stream.

C1.5 MODEL PARAMETERS AND RESULTS

Where they were available, parameters used in the MUSLE model were selected from findings of previous investigations that were representative of the site. When selecting a literature-based parameter, a conservative approach always was utilized. Tables and figures are presented at the end of the section. Tables C1.1 through C1.6 present the model parameters. Figures C1.1 through C1.15 depict the delineation of potential "hot spot" areas for model input. The results are documented in Table C1.7. Tables C1.8 through C1.11 show the comparison of model results with surface water action and no action screening levels for the industrial worker and child recreational user. Table C1.12 shows the comparison of predicted sediment concentrations in the runoff with sediment no action screening levels, and Table C1.13 shows the comparison of predicted sediment concentrations in the runoff with sediment action screening levels. The industrial worker and child recreational user risk scenarios are the most conservative of the risk scenarios applicable to the outfalls and associated ditches and areas.

C1.6 ASSUMPTIONS

The identification of contaminated areas required multiple steps. First, the COPCs for modeling were reduced from a list of preliminary COPCs by performing surface soil erosion (MUSLE) and contaminant partitioning modeling and comparing the results with multiple action levels. As defined by this step, the COPCs were Total PCBs, Total PAHs, and uranium-238. The ubiquitous nature of PAHs at the site and the strong recontamination potential during routine road usage, road repair, fuel usage, and roofing activities make selection of PAHs inconsistent with the primary goal of the SWOU, which is to identify "hot spots" that can be addressed as part of an "early action"; therefore, the analyte group Total PAHs was excluded from further transport simulation. Storm Water Management Model (SWMM) modeling was not performed for uranium metal because the results for this contaminant indicated a hazard index below 1. Second, potential "hot spot" areas for Total PCBs and uranium-238 were developed for each EU. The potential "hot spots" were defined as the areas of sample locations with contaminants above the contaminant-specific indicator level (see Section 2.1 for a definition of indicator levels), extending to the closest clean sample location, and limited within the boundaries of the EU (which was typically defined as the area within the banks of the ditches and streams).

Additional assumptions in this analysis included the following:

- Constituents adsorbed to soils in runoff remain adsorbed in the stream sediments;
- Constituents dissolved in runoff remained in the water column in the receiving stream;

- Inputs from individual source areas could be summed to obtain site-wide inputs to receiving streams;
- Interaction between multiple COPCs are not considered; and
- PAHs were considered for MUSLE analysis, but were not carried through for further analysis using SWMM.

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Table C1.1 Parameters Used in Surface Soil Erosion and Contaminant Partitioning Modeling

Parameter Symbol	Parameter Description	Units	Value[a]	Source/Reference[b]
A	Contaminated area	hectares	outfall-specific	
C	Cover factor	unitless	0.035	Literature-based (EPA 1988) default value
Ce	Concentration of contaminant in runoff water	mg/L or pCi/L	outfall-specific	calculated
Ci	Concentration of contaminant in surface soil	mg/kg	outfall-specific	analytical data (outfall-specific)
CN	SCS runoff curve number	unitless	82	site-specific
Cw	Concentration of contaminant in stream water	mg/L or pCi/L	outfall-specific	calculated
d	Depth of soil affected by rainfall	cm	1	EPA 1988
K_e	Soil erodibility factor	metric tons/ha(/unit Rr)	0.28	DOE 1998
Kd	adsorption/distribution coefficient	cm^3/g or L/kg	chemical-specific	calculated and literature based
LS[c]	Topographic factor derived from slope length factor (L) and slope steepness factor (S) (unitless)	unitless	outfall-specific	calculated
Ms	Available quantity of dissolved contaminant	g	outfall-specific	calculated
NN	Slope constant	unitless	outfall-specific	Ontario Ministry of Agriculture, Food, and Rural Affairs 2000
Oc	Available water capacity in top cm of soil	unitless	0.3	site-specific
P	Erosion control practice factor	unitless	1	conservative assumption
q_p	Peak runoff flow rate	m^3/s	outfall-specific	calculated
Qr	Depth of runoff	cm	storm-specific	calculated
Qt	Flow in the creek	m^3/hr	outfall-specific	SWMM modeling results
Rr	Rainfall and runoff erosion potential factor	unitless	100	conservative assumption
Rt	Depth of rainfall	cm	13.4	30-year 24-hr storm at PGDP[d]
L[c]	Slope length	m	outfall-specific	estimated from source sites
S[c]	Slope steepness	%	outfall-specific	estimated from source sites
Sw	Soil water retention factor	cm	outfall-specific	calculated
Tr	rainfall duration	hours	24	selected for this analysis
Vr	Volume of runoff	m^3	outfall-specific	calculated
$Y(S)_E$	Soil loss in runoff	metric tons/event	outfall-specific	calculated
ρ	Soil bulk density	g/cm^3	1.8	site-specific

[a] Site-specific and chemical-specific values are presented in separate tables in this appendix.

[b] Calculated and literature-based values are presented in separate tables in this appendix.

[c] Parameters "LS" is a function of parameter "L" and "S" (see Section C1.2) as a unitless value.

[d] The 30-year 24-hour storm rainfall total was derived from the site Hydrologic Evaluation of Landfill Performance (HELP) model.

Table C1.2. Outfall and Storm Specific Parameters for a 30-Year 24-Hour Storm

		Lookup	Measured	Measured	Constant	Lookup	Calculated	Default
Storm Type	**EU**	**Contaminated area (A)** **(ha)**	**Slope steepness (SS)** **(%)**	**Slope length (SL)** **(m)**	**Metric conversion constant (CC)** **(unitless)**	**Slope constant (NN)** **(unitless)**	**Length/slope factor (LS)** **(unitless)**	**Rainfall erosion runoff potential factor (Rr)** **(unitless)**
30-yr 24-hr storm (13.5cm)	Outfall_1	5.56	25.94	3.46	22.1	0.5	2.235	100
30-yr 24-hr storm (13.5cm)	Outfall_2	1.72	15	5	22.1	0.5	1.056	100
30-yr 24-hr storm (13.5cm)	Outfall_8	3.14	16	5.65	22.1	0.5	1.248	100
30-yr 24-hr storm (13.5cm)	Outfall_10	2.33	4	8	22.1	0.4	0.234	100
30-yr 24-hr storm (13.5cm)	Outfall_11	0.25	15	5	22.1	0.5	1.056	100
30-yr 24-hr storm (13.5cm)	Outfall_12	0.31	15	5	22.1	0.5	1.056	100
30-yr 24-hr storm (13.5cm)	Outfall_15	2.25	27.25	6.825	22.1	0.5	3.426	100

		Default	Default	Default	Assumed	Calculated	Measured	Measured
Storm Type	**EU**	**Soil Erodibility Factor (K)** **(metric tons/ha)**	**Cover Factor (C)** **(unitless)**	**Erosion Control Practice Factor (P)** **(unitless)**	**SCS Curve Number (CN)** **(unitless)**	**Soil Water Retention Factor (Sw)** **(cm)**	**Total Rainfall (Rt)** **(cm)**	**Total Rainfall Duration (Tr)** **(hours)**
30-yr 24-hr storm (13.5cm)	Outfall_1	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_2	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_8	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_10	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_11	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_12	0.28	0.035	1	82	5.58	13.4	24
30-yr 24-hr storm (13.5cm)	Outfall_15	0.28	0.035	1	82	5.58	13.4	24

		Calculated	Calculated	Calculated
Storm Type	**EU**	**Depth of Runoff (Qr)** **(cm)**	**Volume of Runoff (Vr)** **(m3)**	**Peak Runoff Flow Rate (qp)** **(m3/s)**
30-yr 24-hr storm (13.5cm)	Outfall_1	8.450	4699.8	0.0598
30-yr 24-hr storm (13.5cm)	Outfall_2	8.450	1449.9	0.0185
30-yr 24-hr storm (13.5cm)	Outfall_8	8.450	2653.9	0.0338
30-yr 24-hr storm (13.5cm)	Outfall_10	8.450	1969.8	0.0251
30-yr 24-hr storm (13.5cm)	Outfall_11	8.450	210.4	0.0027
30-yr 24-hr storm (13.5cm)	Outfall_12	8.450	265.7	0.0034
30-yr 24-hr storm (13.5cm)	Outfall_15	8.450	1899.2	0.0242

Table C1.3. Slope Constant (NN Value) Lookup Table

Slope (%)	NN value (unitless)
0	0.2
0.99	0.2
1	0.3
2.99	0.3
3	0.4
4.99	0.4
≥5	0.5

Slope constant (NN) is used as part of calculating the length-slope factor (LS) and can be found at http://www.omafra.gov.on.ca/english/engineer/facts/00-001.htm.

Table C1.4. MUSLE Single Event Soil Loss Calculation for a 30-Year 24-Hour Storm

Storm Type	Location	Soil Erodibility Factor (K_e) (metric tons/ha)	Cover Factor (C) (unitless)	Erosion Control Practice Factor (P) (unitless)	Length/Slope Factor (LS) (unitless)	Depth of Runoff (Qr) (cm)	Volume of Runoff (Vr) (m^3)	Peak Runoff Flow Rate (q_p) (m^3/s)	Metric Conversion Factor (CF) (unitless)	Single Event Soil Loss $Y(S)_E$ (metric tons)
30-yr 24-hr storm (13.5cm)	Outfall_1	0.28	0.035	1	2.24	8.450	4699.8	0.060	11.8	6.078
30-yr 24-hr storm (13.5cm)	Outfall_2	0.28	0.035	1	1.06	8.450	1449.9	0.018	11.8	0.769
30-yr 24-hr storm (13.5cm)	Outfall_8	0.28	0.035	1	1.25	8.450	2653.9	0.034	11.8	1.790
30-yr 24-hr storm (13.5cm)	Outfall_10	0.28	0.035	1	0.23	8.450	1969.8	0.025	11.8	0.241
30-yr 24-hr storm (13.5cm)	Outfall_11	0.28	0.035	1	1.06	8.450	210.4	0.003	11.8	0.089
30-yr 24-hr storm (13.5cm)	Outfall_12	0.28	0.035	1	1.06	8.450	265.7	0.003	11.8	0.115
30-yr 24-hr storm (13.5cm)	Outfall_15	0.28	0.035	1	3.43	8.450	1899.2	0.024	11.8	3.377

Table C1.5. MUSLE Contaminant Partitioning and Loading for a 30-Year 24-Hour Storm

Location	Analysis	Chemical	Source Concentration[1]	Units	Converted Concentration (Ci) (mg/kg)	Adsorption/ Distribution Coefficient[2] (Kd) (L/kg)	Soil Bulk Density ρ (g/cm^3)	Water Capacity in Topsoil (Oc) (unitless)	Depth of Affected Soil (d) (cm)	Conversion Factor (kg-cm^2/mg-ha)
Outfall_1	METAL	Antimony	9.37E+00	mg/kg	9.37E+00	150	1.8	0.3	1	100
Outfall_1	METAL	Iron	1.13E+04	mg/kg	1.13E+04	800	1.8	0.3	1	100
Outfall_1	METAL	Uranium	2.06E+01	mg/kg	2.06E+01	15	1.8	0.3	1	100
Outfall_1	PPCB	TOTAL PCB	7.99E+02	ug/kg	7.99E-01	2904.6	1.8	0.3	1	100
Outfall_1	RADS	Uranium-238	9.94E+00	pCi/g	2.98E+01	15	1.8	0.3	1	100
Outfall_1	SVOA	TOTAL PAHs	3.70E+03	ug/kg	3.70E+00	9108.6	1.8	0.3	1	100
Outfall_10	METAL	Antimony	9.39E+00	mg/kg	9.39E+00	150	1.8	0.3	1	100
Outfall_10	METAL	Iron	1.10E+04	mg/kg	1.10E+04	800	1.8	0.3	1	100
Outfall_10	METAL	Uranium	1.43E+01	mg/kg	1.43E+01	15	1.8	0.3	1	100
Outfall_10	PPCB	TOTAL PCB	7.68E+03	ug/kg	7.68E+00	2904.6	1.8	0.3	1	100
Outfall_10	RADS	Uranium-238	5.20E+00	pCi/g	1.56E+01	15	1.8	0.3	1	100
Outfall_10	SVOA	TOTAL PAHs	7.47E+02	ug/kg	7.47E-01	9108.6	1.8	0.3	1	100
Outfall_11	METAL	Antimony	9.72E+00	mg/kg	9.72E+00	150	1.8	0.3	1	100
Outfall_11	METAL	Iron	1.41E+04	mg/kg	1.41E+04	800	1.8	0.3	1	100
Outfall_11	METAL	Uranium	3.71E+02	mg/kg	3.71E+02	15	1.8	0.3	1	100
Outfall_11	PPCB	TOTAL PCB	2.21E+03	ug/kg	2.21E+00	2904.6	1.8	0.3	1	100
Outfall_11	RADS	Uranium-238	2.60E+01	pCi/g	7.79E+01	15	1.8	0.3	1	100
Outfall_11	SVOA	TOTAL PAHs	2.79E+04	ug/kg	2.79E+01	9108.6	1.8	0.3	1	100
Outfall_12	METAL	Antimony	9.58E+00	mg/kg	9.58E+00	150	1.8	0.3	1	100
Outfall_12	METAL	Iron	1.20E+04	mg/kg	1.20E+04	800	1.8	0.3	1	100
Outfall_12	METAL	Uranium	6.54E+00	mg/kg	6.54E+00	15	1.8	0.3	1	100
Outfall_12	PPCB	TOTAL PCB	7.24E+02	ug/kg	7.24E-01	2904.6	1.8	0.3	1	100
Outfall_12	RADS	Uranium-238	1.55E+00	pCi/g	4.65E+00	15	1.8	0.3	1	100
Outfall_12	SVOA	TOTAL PAHs	7.04E+02	ug/kg	7.04E-01	9108.6	1.8	0.3	1	100
Outfall_15	METAL	Antimony	9.56E+00	mg/kg	9.56E+00	150	1.8	0.3	1	100
Outfall_15	METAL	Iron	9.47E+03	mg/kg	9.47E+03	800	1.8	0.3	1	100
Outfall_15	METAL	Uranium	7.98E+01	mg/kg	7.98E+01	15	1.8	0.3	1	100
Outfall_15	PPCB	TOTAL PCB	9.59E+02	ug/kg	9.59E-01	2904.6	1.8	0.3	1	100
Outfall_15	RADS	Uranium-238	2.45E+01	pCi/g	7.36E+01	15	1.8	0.3	1	100
Outfall_15	SVOA	TOTAL PAHs	4.87E+02	ug/kg	4.87E-01	9108.6	1.8	0.3	1	100
Outfall_2	METAL	Antimony	9.31E+00	mg/kg	9.31E+00	150	1.8	0.3	1	100
Outfall_2	METAL	Iron	9.16E+03	mg/kg	9.16E+03	800	1.8	0.3	1	100
Outfall_2	METAL	Uranium	2.95E+00	mg/kg	2.95E+00	15	1.8	0.3	1	100
Outfall_2	PPCB	TOTAL PCB	1.93E+02	ug/kg	1.93E-01	2904.6	1.8	0.3	1	100
Outfall_2	RADS	Uranium-238	1.60E+00	pCi/g	4.79E+00	15	1.8	0.3	1	100
Outfall_2	SVOA	TOTAL PAHs	4.80E+02	ug/kg	4.80E-01	9108.6	1.8	0.3	1	100
Outfall_8	METAL	Antimony	9.50E+00	mg/kg	9.50E+00	150	1.8	0.3	1	100
Outfall_8	METAL	Iron	1.03E+04	mg/kg	1.03E+04	800	1.8	0.3	1	100
Outfall_8	METAL	Uranium	1.21E+01	mg/kg	1.21E+01	15	1.8	0.3	1	100
Outfall_8	PPCB	TOTAL PCB	4.01E+02	ug/kg	4.01E-01	2904.6	1.8	0.3	1	100
Outfall_8	RADS	Uranium-238	5.98E+00	pCi/g	1.80E+01	15	1.8	0.3	1	100
Outfall_8	SVOA	TOTAL PAHs	5.04E+02	ug/kg	5.04E-01	9108.6	1.8	0.3	1	100

[1] Values for Source Concentration and Contaminated Area are site-specific measurements.

[2] See Table C1.6 for source of adsorption/distribution coefficients.

Table C1.5. MUSLE Contaminant Partitioning and Loading for a 30-Year 24-Hour Storm (Continued)

Contaminated Area[1] (A) (ha)	Sorbed Contaminant Mass (Ss) (g)	Dissolved Contaminant Mass (Ms) (g)	Single Event Soil Loss Y(S)$_E$ (metric tons)	Sorbed Contaminant Mass per Event (PXi) (g)	Dissolved Contaminant Mass per Event (PQi) (g)	Depth of Runoff (Qr) (cm)	Runoff Volume (Vr) (m^3)	Flow in the Creek (Qt)[3] (m^3)	Runoff Sediment Concentration (Cs) (mg/kg or pCi/g)	Runoff Concentration (Ce) (mg/L or pCi/L)	Creek Concentration (Cw) (mg/L or pCi/L)
5.562	9.37E+03	1.04E+01	6.078	5.69E+01	6.57E+00	8.450	4699.774	24049.8	9.36E+00	1.40E-03	2.73E-04
5.562	1.13E+07	2.35E+03	6.078	6.85E+04	1.48E+03	8.450	4699.774	24049.8	1.13E+04	3.15E-01	6.16E-02
5.562	2.03E+04	2.26E+02	6.078	1.24E+02	1.43E+02	8.450	4699.774	24049.8	2.03E+01	3.03E-02	5.93E-03
5.562	8.00E+02	4.59E-02	6.078	4.86E+00	2.90E-02	8.450	4699.774	24049.8	7.99E-01	6.16E-06	1.20E-06
5.562	2.95E+04	3.28E+02	6.078	1.79E+02	2.07E+02	8.450	4699.774	24049.8	9.83E+00	1.47E+01	2.87E+00
5.562	3.71E+03	6.78E-02	6.078	2.25E+01	4.28E-02	8.450	4699.774	24049.8	3.70E+00	9.10E-06	1.78E-06
2.331	3.93E+03	4.37E+00	0.241	2.26E+00	2.76E+00	8.450	1969.753	3997.7	9.38E+00	1.40E-03	6.90E-04
2.331	4.62E+06	9.63E+02	0.241	2.65E+03	6.07E+02	8.450	1969.753	3997.7	1.10E+04	3.08E-01	1.52E-01
2.331	5.95E+03	6.61E+01	0.241	3.41E+00	4.17E+01	8.450	1969.753	3997.7	1.42E+01	2.12E-02	1.04E-02
2.331	3.22E+03	1.85E-01	0.241	1.85E+00	1.17E-01	8.450	1969.753	3997.7	7.68E+00	5.92E-05	2.92E-05
2.331	6.47E+03	7.19E+01	0.241	3.71E+00	4.53E+01	8.450	1969.753	3997.7	5.14E+00	7.67E+00	3.78E+00
2.331	3.14E+02	5.74E-03	0.241	1.80E-01	3.62E-03	8.450	1969.753	3997.7	7.47E-01	1.84E-06	9.05E-07
0.249	4.35E+02	4.83E-01	0.089	8.60E-01	3.05E-01	8.450	210.366	3121.8	9.71E+00	1.45E-03	9.76E-05
0.249	6.32E+05	1.32E+02	0.089	1.25E+03	8.30E+01	8.450	210.366	3121.8	1.41E+04	3.95E-01	2.66E-02
0.249	1.64E+04	1.83E+02	0.089	3.25E+01	1.15E+02	8.450	210.366	3121.8	3.67E+02	5.47E-01	3.69E-02
0.249	9.89E+01	5.67E-03	0.089	1.95E-01	3.58E-03	8.450	210.366	3121.8	2.21E+00	1.70E-05	1.15E-06
0.249	3.45E+03	3.84E+01	0.089	6.83E+00	2.42E+01	8.450	210.366	3121.8	2.57E+01	3.83E+01	2.58E+00
0.249	1.25E+03	2.29E-02	0.089	2.47E+00	1.44E-02	8.450	210.366	3121.8	2.79E+01	6.86E-05	4.62E-06
0.314	5.42E+02	6.02E-01	0.115	1.10E+00	3.80E-01	8.450	265.711	1985.6	9.57E+00	1.43E-03	1.91E-04
0.314	6.78E+05	1.41E+02	0.115	1.38E+03	8.91E+01	8.450	265.711	1985.6	1.20E+04	3.35E-01	4.48E-02
0.314	3.66E+02	4.07E+00	0.115	7.44E-01	2.57E+00	8.450	265.711	1985.6	6.47E+00	9.66E-03	1.29E-03
0.314	4.10E+01	2.35E-03	0.115	8.33E-02	1.48E-03	8.450	265.711	1985.6	7.24E-01	5.58E-06	7.47E-07
0.314	2.61E+02	2.90E+00	0.115	5.30E-01	1.83E+00	8.450	265.711	1985.6	1.53E+00	2.29E+00	3.06E-01
0.314	3.99E+01	7.29E-04	0.115	8.10E-02	4.60E-04	8.450	265.711	1985.6	7.04E-01	1.73E-06	2.32E-07
2.248	3.86E+03	4.29E+00	3.377	3.23E+01	2.71E+00	8.450	1899.160	23364.8	9.55E+00	1.43E-03	1.16E-04
2.248	3.83E+06	7.98E+02	3.377	3.20E+04	5.03E+02	8.450	1899.160	23364.8	9.47E+03	2.65E-01	2.15E-02
2.248	3.19E+04	3.55E+02	3.377	2.67E+02	2.24E+02	8.450	1899.160	23364.8	7.89E+01	1.18E-01	9.58E-03
2.248	3.88E+02	2.23E-02	3.377	3.24E+00	1.40E-02	8.450	1899.160	23364.8	9.59E-01	7.39E-06	6.01E-07
2.248	2.94E+04	3.27E+02	3.377	2.46E+02	2.06E+02	8.450	1899.160	23364.8	2.43E+01	3.62E+01	2.94E+00
2.248	1.97E+02	3.61E-03	3.377	1.65E+00	2.28E-03	8.450	1899.160	23364.8	4.87E-01	1.20E-06	9.74E-08
1.716	2.87E+03	3.19E+00	0.769	7.15E+00	2.01E+00	8.450	1449.865	5994.1	9.29E+00	1.39E-03	3.36E-04
1.716	2.83E+06	5.89E+02	0.769	7.05E+03	3.72E+02	8.450	1449.865	5994.1	9.16E+03	2.56E-01	6.20E-02
1.716	9.02E+02	1.00E+01	0.769	2.25E+00	6.32E+00	8.450	1449.865	5994.1	2.92E+00	4.36E-03	1.05E-03
1.716	5.97E+01	3.42E-03	0.769	1.49E-01	2.16E-03	8.450	1449.865	5994.1	1.93E-01	1.49E-06	3.60E-07
1.716	1.46E+03	1.62E+01	0.769	3.64E+00	1.02E+01	8.450	1449.865	5994.1	1.58E+00	2.35E+00	5.70E-01
1.716	1.48E+02	2.71E-03	0.769	3.69E-01	1.71E-03	8.450	1449.865	5994.1	4.80E-01	1.18E-06	2.85E-07
3.141	5.36E+03	5.96E+00	1.790	1.70E+01	3.76E+00	8.450	2653.918	22386.2	9.49E+00	1.42E-03	1.68E-04
3.141	5.82E+06	1.21E+03	1.790	1.84E+04	7.64E+02	8.450	2653.918	22386.2	1.03E+04	2.88E-01	3.41E-02
3.141	6.76E+03	7.51E+01	1.790	2.14E+01	4.74E+01	8.450	2653.918	22386.2	1.20E+01	1.79E-02	2.12E-03
3.141	2.27E+02	1.30E-02	1.790	7.17E-01	8.20E-03	8.450	2653.918	22386.2	4.01E-01	3.09E-06	3.66E-07
3.141	1.00E+04	1.12E+02	1.790	3.18E+01	7.03E+01	8.450	2653.918	22386.2	5.92E+00	8.83E+00	1.05E+00
3.141	2.85E+02	5.22E-03	1.790	9.02E-01	3.29E-03	8.450	2653.918	22386.2	5.04E-01	1.24E-06	1.47E-07

[1] Values for Source Concentration and Contaminated Area are site-specific measurements.

[2] See Table C1.6 for source of adsorption/distribution coefficients.

[3] Qt values listed represent the sum of the runoff flow rate and the flow rate of the receiving water body downstream.

Table C1.6. Soil-Water Adsorption/Distribution Coefficients (Kd)

Chemical Name	K_d (L/kg)	Reference
Antimony	150	Sheppard & Thibault 1990
Iron	800	Sheppard & Thibault 1990
TOTAL PAHs	9108.6	Calculated using Koc and foc
TOTAL PCB	2904.6	Calculated using Koc and foc
Uranium	15	Sheppard & Thibault 1990
Uranium-238	15	Sheppard & Thibault 1990

K_d = Koc*foc, where foc = 0.0094

K_{oc} for PAH = 969000 (EPA 1996)
K_{oc} for PCB = 309000[1] (EPA 1996); However, it should be noted that the significantly varies between PCB congeners.

EPA 1996. Soil Screening Guidance: *Technical Background Document, Office of Emergency and Remedial Response, Washington, DC. EPA /540/R-95/129*

Sheppard, M.I. and Thibault, D.H., *Default Soil Solid/Liquid Partition Coefficients for Four Major Soil Types: A Compendium, Health Physics, vol. 59, No.4, pp. 471-482, 1991*

Table C1.7. Summary of Observed and Calculated COPC Concentrations at SWOU, PGDP for a 30-Year 24-Hour Storm

Location	Analysis	Chemical	Source Concentration	Units	Converted Concentration (Ci) (mg/kg)	Runoff Sediment Concentration (Cs) (mg/L or pCi/L)	Runoff Concentration (Ce) (mg/L or pCi/L)	Creek Concentration (Cw) (mg/L or pCi/L)
Outfall_1	METAL	Antimony	9.37E+00	mg/kg	9.37E+00	9.36E+00	1.40E-03	2.73E-04
Outfall_1	METAL	Iron	1.13E+04	mg/kg	1.13E+04	1.13E+04	3.15E-01	6.16E-02
Outfall_1	METAL	Uranium	2.06E+01	mg/kg	2.06E+01	2.03E+01	3.03E-02	5.93E-03
Outfall_1	PPCB	TOTAL PCB	7.99E+02	ug/kg	7.99E-01	7.99E-01	6.16E-06	1.20E-06
Outfall_1	RADS	Uranium-238	9.94E+00	pCi/g	2.98E+01	9.83E+00	1.47E+01	2.87E+00
Outfall_1	SVOA	TOTAL PAHs	3.70E+03	ug/kg	3.70E+00	3.70E+00	9.10E-06	1.78E-06
Outfall_10	METAL	Antimony	9.39E+00	mg/kg	9.39E+00	9.38E+00	1.40E-03	6.90E-04
Outfall_10	METAL	Iron	1.10E+04	mg/kg	1.10E+04	1.10E+04	3.08E-01	1.52E-01
Outfall_10	METAL	Uranium	1.43E+01	mg/kg	1.43E+01	1.42E+01	2.12E-02	1.04E-02
Outfall_10	PPCB	TOTAL PCB	7.68E+03	ug/kg	7.68E+00	7.68E+00	5.92E-05	2.92E-05
Outfall_10	RADS	Uranium-238	5.20E+00	pCi/g	1.56E+01	5.14E+00	7.67E+00	3.78E+00
Outfall_10	SVOA	TOTAL PAHs	7.47E+02	ug/kg	7.47E-01	7.47E-01	1.84E-06	9.05E-07
Outfall_11	METAL	Antimony	9.72E+00	mg/kg	9.72E+00	9.71E+00	1.45E-03	9.76E-05
Outfall_11	METAL	Iron	1.41E+04	mg/kg	1.41E+04	1.41E+04	3.95E-01	2.66E-02
Outfall_11	METAL	Uranium	3.71E+02	mg/kg	3.71E+02	3.67E+02	5.47E-01	3.69E-02
Outfall_11	PPCB	TOTAL PCB	2.21E+03	ug/kg	2.21E+00	2.21E+00	1.70E-05	1.15E-06
Outfall_11	RADS	Uranium-238	2.60E+01	pCi/g	7.79E+01	2.57E+01	3.83E+01	2.58E+00
Outfall_11	SVOA	TOTAL PAHs	2.79E+04	ug/kg	2.79E+01	2.79E+01	6.86E-05	4.62E-06
Outfall_12	METAL	Antimony	9.58E+00	mg/kg	9.58E+00	9.57E+00	1.43E-03	1.91E-04
Outfall_12	METAL	Iron	1.20E+04	mg/kg	1.20E+04	1.20E+04	3.35E-01	4.48E-02
Outfall_12	METAL	Uranium	6.54E+00	mg/kg	6.54E+00	6.47E+00	9.66E-03	1.29E-03
Outfall_12	PPCB	TOTAL PCB	7.24E+02	ug/kg	7.24E-01	7.24E-01	5.58E-06	7.47E-07
Outfall_12	RADS	Uranium-238	1.55E+00	pCi/g	4.65E+00	1.53E+00	2.29E+00	3.06E-01
Outfall_12	SVOA	TOTAL PAHs	7.04E+02	ug/kg	7.04E-01	7.04E-01	1.73E-06	2.32E-07
Outfall_15	METAL	Antimony	9.56E+00	mg/kg	9.56E+00	9.55E+00	1.43E-03	1.16E-04
Outfall_15	METAL	Iron	9.47E+03	mg/kg	9.47E+03	9.47E+03	2.65E-01	2.15E-02
Outfall_15	METAL	Uranium	7.98E+01	mg/kg	7.98E+01	7.89E+01	1.18E-01	9.58E-03
Outfall_15	PPCB	TOTAL PCB	9.59E+02	ug/kg	9.59E-01	9.59E-01	7.39E-06	6.01E-07
Outfall_15	RADS	Uranium-238	2.45E+01	pCi/g	7.36E+01	2.43E+01	3.62E+01	2.94E+00
Outfall_15	SVOA	TOTAL PAHs	4.87E+02	ug/kg	4.87E-01	4.87E-01	1.20E-06	9.74E-08
Outfall_2	METAL	Antimony	9.31E+00	mg/kg	9.31E+00	9.29E+00	1.39E-03	3.36E-04
Outfall_2	METAL	Iron	9.16E+03	mg/kg	9.16E+03	9.16E+03	2.56E-01	6.20E-02
Outfall_2	METAL	Uranium	2.95E+00	mg/kg	2.95E+00	2.92E+00	4.36E-03	1.05E-03
Outfall_2	PPCB	TOTAL PCB	1.93E+02	ug/kg	1.93E-01	1.93E-01	1.49E-06	3.60E-07
Outfall_2	RADS	Uranium-238	1.60E+00	pCi/g	4.79E+00	1.58E+00	2.35E+00	5.70E-01
Outfall_2	SVOA	TOTAL PAHs	4.80E+02	ug/kg	4.80E-01	4.80E-01	1.18E-06	2.85E-07
Outfall_8	METAL	Antimony	9.50E+00	mg/kg	9.50E+00	9.49E+00	1.42E-03	1.68E-04
Outfall_8	METAL	Iron	1.03E+04	mg/kg	1.03E+04	1.03E+04	2.88E-01	3.41E-02
Outfall_8	METAL	Uranium	1.21E+01	mg/kg	1.21E+01	1.20E+01	1.79E-02	2.12E-03
Outfall_8	PPCB	TOTAL PCB	4.01E+02	ug/kg	4.01E-01	4.01E-01	3.09E-06	3.66E-07
Outfall_8	RADS	Uranium-238	5.98E+00	pCi/g	1.80E+01	5.92E+00	8.83E+00	1.05E+00
Outfall_8	SVOA	TOTAL PAHs	5.04E+02	ug/kg	5.04E-01	5.04E-01	1.24E-06	1.47E-07

Table C1.8. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	1.40E-03	7.31E-03	No	4.41E-03	No
Outfall_1	METAL	Iron	3.15E-01	4.11E+01	No	1.38E+01	No
Outfall_1	METAL	Uranium	3.03E-02	4.66E-01	No	4.64E-02	No
Outfall_1	PPCB	TOTAL PCB	6.16E-06	1.65E-04	No	1.12E-04	No
Outfall_1	RADS	Uranium-238	1.47E+01	N/A	No	4.91E+01	No
Outfall_1	**SVOA**	**TOTAL PAHs**	**9.10E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_10	METAL	Antimony	1.40E-03	7.31E-03	No	3.12E-03	No
Outfall_10	METAL	Iron	3.08E-01	4.11E+01	No	1.75E+01	No
Outfall_10	METAL	Uranium	2.12E-02	4.66E-01	No	1.99E-01	No
Outfall_10	PPCB	TOTAL PCB	5.92E-05	1.65E-04	No	9.61E-05	No
Outfall_10	RADS	Uranium-238	7.67E+00	N/A	No	4.91E+01	No
Outfall_10	**SVOA**	**TOTAL PAHs**	**1.84E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_11	METAL	Antimony	1.45E-03	7.31E-03	No	3.12E-03	No
Outfall_11	METAL	Iron	3.95E-01	4.11E+01	No	1.75E+01	No
Outfall_11	**METAL**	**Uranium**	**5.47E-01**	**4.66E-01**	**Yes**	**1.99E-01**	**Yes**
Outfall_11	PPCB	TOTAL PCB	1.70E-05	1.65E-04	No	9.61E-05	No
Outfall_11	RADS	Uranium-238	3.83E+01	N/A	No	4.91E+01	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**6.86E-05**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_12	METAL	Antimony	1.43E-03	7.31E-03	No	3.12E-03	No
Outfall_12	METAL	Iron	3.35E-01	4.11E+01	No	1.75E+01	No
Outfall_12	METAL	Uranium	9.66E-03	4.66E-01	No	1.99E-01	No
Outfall_12	PPCB	TOTAL PCB	5.58E-06	1.65E-04	No	9.61E-05	No
Outfall_12	RADS	Uranium-238	2.29E+00	N/A	No	4.91E+01	No
Outfall_12	**SVOA**	**TOTAL PAHs**	**1.73E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_15	METAL	Antimony	1.43E-03	7.31E-03	No	4.41E-03	No
Outfall_15	METAL	Iron	2.65E-01	4.11E+01	No	1.38E+01	No
Outfall_15	**METAL**	**Uranium**	**1.18E-01**	4.66E-01	No	**4.64E-02**	**Yes**
Outfall_15	PPCB	TOTAL PCB	7.39E-06	1.65E-04	No	1.12E-04	No
Outfall_15	RADS	Uranium-238	3.62E+01	N/A	No	4.91E+01	No
Outfall_15	**SVOA**	**TOTAL PAHs**	**1.20E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_2	METAL	Antimony	1.39E-03	7.31E-03	No	3.12E-03	No

Table C1.8. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	2.56E-01	4.11E+01	No	1.75E+01	No
Outfall_2	METAL	Uranium	4.36E-03	4.66E-01	No	1.99E-01	No
Outfall_2	PPCB	TOTAL PCB	1.49E-06	1.65E-04	No	9.61E-05	No
Outfall_2	RADS	Uranium-238	2.35E+00	N/A	No	4.91E+01	No
Outfall_2	**SVOA**	**TOTAL PAHs**	**1.18E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_8	METAL	Antimony	1.42E-03	7.31E-03	No	4.41E-03	No
Outfall_8	METAL	Iron	2.88E-01	4.11E+01	No	1.38E+01	No
Outfall_8	METAL	Uranium	1.79E-02	4.66E-01	No	4.64E-02	No
Outfall_8	PPCB	TOTAL PCB	3.09E-06	1.65E-04	No	1.12E-04	No
Outfall_8	RADS	Uranium-238	8.83E+00	N/A	No	4.91E+01	No
Outfall_8	**SVOA**	**TOTAL PAHs**	**1.24E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**

[a] The value is based on "low risk no action level" for total PCB; the "lowest risk no action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 no action level is for swimming only. U-238+ decay products no action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk no action level"; the "lowest risk no action level" for wading = 5.49E-04; for swimming = 6.38E-04.

Table C1.9. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	1.40E-03	2.19E-01	No	1.32E-01	No
Outfall_1	METAL	Iron	3.15E-01	1.23E+03	No	4.15E+02	No
Outfall_1	METAL	Uranium	3.03E-02	1.40E+01	No	1.39E+00	No
Outfall_1	PPCB	TOTAL PCB	6.16E-06	1.65E-02	No	1.12E-02	No
Outfall_1	RADS	Uranium-238	1.47E+01	N/A	No	4.91E+03	No
Outfall_1	SVOA	TOTAL PAHs	9.10E-06	9.06E-05	No	6.20E-05	No
Outfall_10	METAL	Antimony	1.40E-03	2.19E-01	No	9.36E-02	No
Outfall_10	METAL	Iron	3.08E-01	1.23E+03	No	5.26E+02	No
Outfall_10	METAL	Uranium	2.12E-02	1.40E+01	No	5.96E+00	No
Outfall_10	PPCB	TOTAL PCB	5.92E-05	1.65E-02	No	9.61E-03	No
Outfall_10	RADS	Uranium-238	7.67E+00	N/A	No	4.91E+03	No
Outfall_10	SVOA	TOTAL PAHs	1.84E-06	9.06E-05	No	5.29E-05	No
Outfall_11	METAL	Antimony	1.45E-03	2.19E-01	No	9.36E-02	No
Outfall_11	METAL	Iron	3.95E-01	1.23E+03	No	5.26E+02	No
Outfall_11	METAL	Uranium	5.47E-01	1.40E+01	No	5.96E+00	No
Outfall_11	PPCB	TOTAL PCB	1.70E-05	1.65E-02	No	9.61E-03	No
Outfall_11	RADS	Uranium-238	3.83E+01	N/A	No	4.91E+03	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**6.86E-05**	9.06E-05	No	**5.29E-05**	**Yes**
Outfall_12	METAL	Antimony	1.43E-03	2.19E-01	No	9.36E-02	No
Outfall_12	METAL	Iron	3.35E-01	1.23E+03	No	5.26E+02	No
Outfall_12	METAL	Uranium	9.66E-03	1.40E+01	No	5.96E+00	No
Outfall_12	PPCB	TOTAL PCB	5.58E-06	1.65E-02	No	9.61E-03	No
Outfall_12	RADS	Uranium-238	2.29E+00	N/A	No	4.91E+03	No
Outfall_12	SVOA	TOTAL PAHs	1.73E-06	9.06E-05	No	5.29E-05	No
Outfall_15	METAL	Antimony	1.43E-03	2.19E-01	No	1.32E-01	No
Outfall_15	METAL	Iron	2.65E-01	1.23E+03	No	4.15E+02	No
Outfall_15	METAL	Uranium	1.18E-01	1.40E+01	No	1.39E+00	No
Outfall_15	PPCB	TOTAL PCB	7.39E-06	1.65E-02	No	1.12E-02	No
Outfall_15	RADS	Uranium-238	3.62E+01	N/A	No	4.91E+03	No
Outfall_15	SVOA	TOTAL PAHs	1.20E-06	9.06E-05	No	6.20E-05	No
Outfall_2	METAL	Antimony	1.39E-03	2.19E-01	No	9.36E-02	No

Table C1.9. Summary of Predicted Concentrations in Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Runoff (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	2.56E-01	1.23E+03	No	5.26E+02	No
Outfall_2	METAL	Uranium	4.36E-03	1.40E+01	No	5.96E+00	No
Outfall_2	PPCB	TOTAL PCB	1.49E-06	1.65E-02	No	9.61E-03	No
Outfall_2	RADS	Uranium-238	2.35E+00	N/A	No	4.91E+03	No
Outfall_2	SVOA	TOTAL PAHs	1.18E-06	9.06E-05	No	5.29E-05	No
Outfall_8	METAL	Antimony	1.42E-03	2.19E-01	No	1.32E-01	No
Outfall_8	METAL	Iron	2.88E-01	1.23E+03	No	4.15E+02	No
Outfall_8	METAL	Uranium	1.79E-02	1.40E+01	No	1.39E+00	No
Outfall_8	PPCB	TOTAL PCB	3.09E-06	1.65E-02	No	1.12E-02	No
Outfall_8	RADS	Uranium-238	8.83E+00	N/A	No	4.91E+03	No
Outfall_8	SVOA	TOTAL PAHs	1.24E-06	9.06E-05	No	6.20E-05	No

[a] The value is based on "low risk action level" for total PCB; the "lowest risk action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk action level"; the "lowest risk action level" for wading = 5.49E-02; for swimming = 6.38E-02.

Table C1.10. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	2.73E-04	7.31E-03	No	4.41E-03	No
Outfall_1	METAL	Iron	6.16E-02	4.11E+01	No	1.38E+01	No
Outfall_1	METAL	Uranium	5.93E-03	4.66E-01	No	4.64E-02	No
Outfall_1	PPCB	TOTAL PCB	1.20E-06	1.65E-04	No	1.12E-04	No
Outfall_1	RADS	Uranium-238	2.87E+00	N/A	No	4.91E+01	No
Outfall_1	**SVOA**	**TOTAL PAHs**	**1.78E-06**	**9.06E-07**	**Yes**	**6.20E-07**	**Yes**
Outfall_10	METAL	Antimony	6.90E-04	7.31E-03	No	3.12E-03	No
Outfall_10	METAL	Iron	1.52E-01	4.11E+01	No	1.75E+01	No
Outfall_10	METAL	Uranium	1.04E-02	4.66E-01	No	1.99E-01	No
Outfall_10	PPCB	TOTAL PCB	2.92E-05	1.65E-04	No	9.61E-05	No
Outfall_10	RADS	Uranium-238	3.78E+00	N/A	No	4.91E+01	No
Outfall_10	**SVOA**	**TOTAL PAHs**	**9.05E-07**	9.06E-07	Yes	**5.29E-07**	**Yes**
Outfall_11	METAL	Antimony	9.76E-05	7.31E-03	No	3.12E-03	No
Outfall_11	METAL	Iron	2.66E-02	4.11E+01	No	1.75E+01	No
Outfall_11	METAL	Uranium	3.69E-02	4.66E-01	No	1.99E-01	No
Outfall_11	PPCB	TOTAL PCB	1.15E-06	1.65E-04	No	9.61E-05	No
Outfall_11	RADS	Uranium-238	2.58E+00	N/A	No	4.91E+01	No
Outfall_11	**SVOA**	**TOTAL PAHs**	**4.62E-06**	**9.06E-07**	**Yes**	**5.29E-07**	**Yes**
Outfall_12	METAL	Antimony	1.91E-04	7.31E-03	No	3.12E-03	No
Outfall_12	METAL	Iron	4.48E-02	4.11E+01	No	1.75E+01	No
Outfall_12	METAL	Uranium	1.29E-03	4.66E-01	No	1.99E-01	No
Outfall_12	PPCB	TOTAL PCB	7.47E-07	1.65E-04	No	9.61E-05	No
Outfall_12	RADS	Uranium-238	3.06E-01	N/A	No	4.91E+01	No
Outfall_12	SVOA	TOTAL PAHs	2.32E-07	9.06E-07	No	5.29E-07	No
Outfall_15	METAL	Antimony	1.16E-04	7.31E-03	No	4.41E-03	No
Outfall_15	METAL	Iron	2.15E-02	4.11E+01	No	1.38E+01	No
Outfall_15	METAL	Uranium	9.58E-03	4.66E-01	No	4.64E-02	No
Outfall_15	PPCB	TOTAL PCB	6.01E-07	1.65E-04	No	1.12E-04	No
Outfall_15	RADS	Uranium-238	2.94E+00	N/A	No	4.91E+01	No
Outfall_15	SVOA	TOTAL PAHs	9.74E-08	9.06E-07	No	6.20E-07	No
Outfall_2	METAL	Antimony	3.36E-04	7.31E-03	No	3.12E-03	No

Table C1.10. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker No Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational No Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	6.20E-02	4.11E+01	No	1.75E+01	No
Outfall_2	METAL	Uranium	1.05E-03	4.66E-01	No	1.99E-01	No
Outfall_2	PPCB	TOTAL PCB	3.60E-07	1.65E-04	No	9.61E-05	No
Outfall_2	RADS	Uranium-238	5.70E-01	N/A	No	4.91E+01	No
Outfall_2	SVOA	TOTAL PAHs	2.85E-07	9.06E-07	No	5.29E-07	No
Outfall_8	METAL	Antimony	1.68E-04	7.31E-03	No	4.41E-03	No
Outfall_8	METAL	Iron	3.41E-02	4.11E+01	No	1.38E+01	No
Outfall_8	METAL	Uranium	2.12E-03	4.66E-01	No	4.64E-02	No
Outfall_8	PPCB	TOTAL PCB	3.66E-07	1.65E-04	No	1.12E-04	No
Outfall_8	RADS	Uranium-238	1.05E+00	N/A	No	4.91E+01	No
Outfall_8	SVOA	TOTAL PAHs	1.47E-07	9.06E-07	No	6.20E-07	No

[a] The value is based on "low risk no action level" for Total PCB; the "lowest risk no action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 no action level is for swimming only. U-238+ decay products no action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk no action level"; the "lowest risk no action level" for wading = 5.49E-04; for swimming = 6.38E-04.

Table C1.11. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_1	METAL	Antimony	2.73E-04	2.19E-01	No	1.32E-01	No
Outfall_1	METAL	Iron	6.16E-02	1.23E+03	No	4.15E+02	No
Outfall_1	METAL	Uranium	5.93E-03	1.40E+01	No	1.39E+00	No
Outfall_1	PPCB	TOTAL PCB	1.20E-06	1.65E-02	No	1.12E-02	No
Outfall_1	RADS	Uranium-238	2.87E+00	N/A	No	4.91E+03	No
Outfall_1	SVOA	TOTAL PAHs	1.78E-06	9.06E-05	No	6.20E-05	No
Outfall_10	METAL	Antimony	6.90E-04	2.19E-01	No	9.36E-02	No
Outfall_10	METAL	Iron	1.52E-01	1.23E+03	No	5.26E+02	No
Outfall_10	METAL	Uranium	1.04E-02	1.40E+01	No	5.96E+00	No
Outfall_10	PPCB	TOTAL PCB	2.92E-05	1.65E-02	No	9.61E-03	No
Outfall_10	RADS	Uranium-238	3.78E+00	N/A	No	4.91E+03	No
Outfall_10	SVOA	TOTAL PAHs	9.05E-07	9.06E-05	No	5.29E-05	No
Outfall_11	METAL	Antimony	9.76E-05	2.19E-01	No	9.36E-02	No
Outfall_11	METAL	Iron	2.66E-02	1.23E+03	No	5.26E+02	No
Outfall_11	METAL	Uranium	3.69E-02	1.40E+01	No	5.96E+00	No
Outfall_11	PPCB	TOTAL PCB	1.15E-06	1.65E-02	No	9.61E-03	No
Outfall_11	RADS	Uranium-238	2.58E+00	N/A	No	4.91E+03	No
Outfall_11	SVOA	TOTAL PAHs	4.62E-06	9.06E-05	No	5.29E-05	No
Outfall_12	METAL	Antimony	1.91E-04	2.19E-01	No	9.36E-02	No
Outfall_12	METAL	Iron	4.48E-02	1.23E+03	No	5.26E+02	No
Outfall_12	METAL	Uranium	1.29E-03	1.40E+01	No	5.96E+00	No
Outfall_12	PPCB	TOTAL PCB	7.47E-07	1.65E-02	No	9.61E-03	No
Outfall_12	RADS	Uranium-238	3.06E-01	N/A	No	4.91E+03	No
Outfall_12	SVOA	TOTAL PAHs	2.32E-07	9.06E-07	No	5.29E-05	No
Outfall_15	METAL	Antimony	1.16E-04	2.19E-01	No	1.32E-01	No
Outfall_15	METAL	Iron	2.15E-02	1.23E+03	No	4.15E+02	No
Outfall_15	METAL	Uranium	9.58E-03	1.40E+01	No	1.39E+00	No
Outfall_15	PPCB	TOTAL PCB	6.01E-07	1.65E-02	No	1.12E-02	No
Outfall_15	RADS	Uranium-238	2.94E+00	N/A	No	4.91E+03	No
Outfall_15	SVOA	TOTAL PAHs	9.74E-08	9.06E-05	No	6.20E-05	No
Outfall_2	METAL	Antimony	3.36E-04	2.19E-01	No	9.36E-02	No

Table C1.11. Summary of Predicted Concentrations in Creek Water Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Creek (mg/L or pCi/L)	Industrial Worker Action Level[a] (mg/L or pCi/L)	Exceeds Criteria?	Child Recreational Action Level[b,c] (mg/L or pCi/L)	Exceeds Criteria?
Outfall_2	METAL	Iron	6.20E-02	1.23E+03	No	5.26E+02	No
Outfall_2	METAL	Uranium	1.05E-03	1.40E+01	No	5.96E+00	No
Outfall_2	PPCB	TOTAL PCB	3.60E-07	1.65E-02	No	9.61E-03	No
Outfall_2	RADS	Uranium-238	5.70E-01	N/A	No	4.91E+03	No
Outfall_2	SVOA	TOTAL PAHs	2.85E-07	9.06E-07	No	5.29E-05	No
Outfall_8	METAL	Antimony	1.68E-04	2.19E-01	No	1.32E-01	No
Outfall_8	METAL	Iron	3.41E-02	1.23E+03	No	4.15E+02	No
Outfall_8	METAL	Uranium	2.12E-03	1.40E+01	No	1.39E+00	No
Outfall_8	PPCB	TOTAL PCB	3.66E-07	1.65E-02	No	1.12E-02	No
Outfall_8	RADS	Uranium-238	1.05E+00	N/A	No	4.91E+03	No
Outfall_8	SVOA	TOTAL PAHs	1.47E-07	9.06E-05	No	6.20E-05	No

[a] The value is based on "low risk action level" for Total PCB; the "lowest risk action level" = 9.40E-04.

[b] Value is for wading in Little Bayou Creek Outfalls (002, 010, 011, 012) and for swimming in Bayou Creek Outfalls (001, 008, 015); U-238 action level is for swimming only. U-238+ decay products action level for wading is not applicable because the wading scenario includes only dermal exposure and radioisotopes are not expected to have an effect through dermal exposure due to the shielding provided by water.

[c] The Total PCB value is based on "low risk action level"; the "lowest risk action level" for wading = 5.49E-02; for swimming = 6.38E-02.

Table C1.12. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against No Action Levels)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_1	METAL	Antimony	9.36E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_1	METAL	Iron	1.13E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_1	METAL	Uranium	2.03E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_1	PPCB	TOTAL PCB	7.99E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_1	RADS	Uranium-238	9.83E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_1	SVOA	TOTAL PAHs	3.70E+00	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_10	METAL	Antimony	9.38E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_10	METAL	Iron	1.10E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_10	METAL	Uranium	1.42E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_10	PPCB	TOTAL PCB	7.68E+00	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_10	RADS	Uranium-238	5.14E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_10	SVOA	TOTAL PAHs	7.47E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_11	METAL	Antimony	9.71E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_11	METAL	Iron	1.41E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_11	METAL	Uranium	3.67E+02	4.90E+00	Yes	6.50E+01	Yes	8.69E+00	Yes
Outfall_11	PPCB	TOTAL PCB	2.21E+00	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_11	RADS	Uranium-238	2.57E+01	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_11	SVOA	TOTAL PAHs	2.79E+01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_12	METAL	Antimony	9.57E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_12	METAL	Iron	1.20E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_12	METAL	Uranium	6.47E+00	4.90E+00	Yes	6.50E+01	No	8.69E+00	No
Outfall_12	PPCB	TOTAL PCB	7.24E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_12	RADS	Uranium-238	1.53E+00	1.20E+00	Yes	1.71	No	3.64E+00	No
Outfall_12	SVOA	TOTAL PAHs	7.04E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_15	METAL	Antimony	9.55E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_15	METAL	Iron	9.47E+03	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_15	METAL	Uranium	7.89E+01	4.90E+00	Yes	6.50E+01	Yes	8.69E+00	Yes
Outfall_15	PPCB	TOTAL PCB	9.59E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_15	RADS	Uranium-238	2.43E+01	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_15	SVOA	TOTAL PAHs	4.87E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_2	METAL	Antimony	9.29E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes

Table C1.12. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against No Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational No Action Level[a,b] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_2	METAL	Iron	9.16E+03	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_2	METAL	Uranium	2.92E+00	4.90E+00	No	6.50E+01	NA	8.69E+00	NA
Outfall_2	PPCB	TOTAL PCB	1.93E-01	NA	Yes	1.99E-01	No	1.27E-01	Yes
Outfall_2	RADS	Uranium-238	1.58E+00	1.20E+00	Yes	1.71	No	3.64E+00	No
Outfall_2	SVOA	TOTAL PAHs	4.80E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes
Outfall_8	METAL	Antimony	9.49E+00	2.10E-01	Yes	3.79E-01	Yes	1.61E-01	Yes
Outfall_8	METAL	Iron	1.03E+04	2.80E+04	No	2.07E+03	NA	8.83E+02	NA
Outfall_8	METAL	Uranium	1.20E+01	4.90E+00	Yes	6.50E+01	No	8.69E+00	Yes
Outfall_8	PPCB	TOTAL PCB	4.01E-01	NA	Yes	1.99E-01	Yes	1.27E-01	Yes
Outfall_8	RADS	Uranium-238	5.92E+00	1.20E+00	Yes	1.71	Yes	3.64E+00	Yes
Outfall_8	SVOA	TOTAL PAHs	5.04E-01	NA	Yes	2.12E-02	Yes	1.33E-02	Yes

[a] Highlighted cell indicates predicted concentration exceeds no action level based on Hazard Index of 0.1

[b] Highlighted cell indicates predicted sediment concentration exceeds no action level based on ELCR of 1E-6

NA = not applicable as the predicted concentration is below background level.

Table C1.13. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against Action Levels)

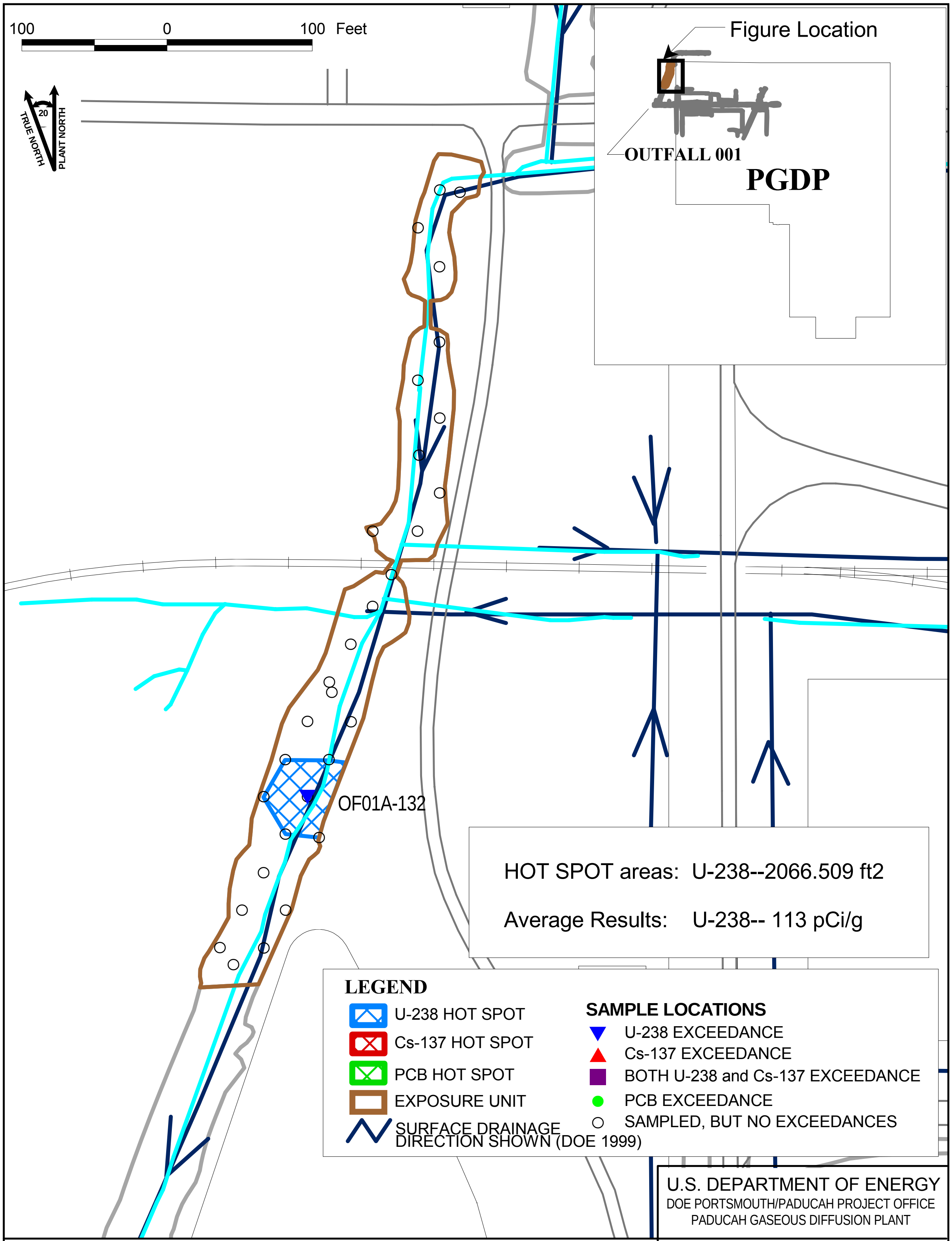
Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_1	METAL	Antimony	9.36E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_1	METAL	Iron	1.13E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_1	METAL	Uranium	2.03E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_1	PPCB	TOTAL PCB	7.99E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_1	RADS	Uranium-238	9.83E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_1	SVOA	TOTAL PAHs	3.70E+00	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_10	METAL	Antimony	9.38E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_10	METAL	Iron	1.10E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_10	METAL	Uranium	1.42E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_10	PPCB	TOTAL PCB	7.68E+00	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_10	RADS	Uranium-238	5.14E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_10	SVOA	TOTAL PAHs	7.47E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_11	METAL	Antimony	9.71E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_11	METAL	Iron	1.41E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_11	METAL	Uranium	3.67E+02	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_11	PPCB	TOTAL PCB	2.21E+00	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_11	RADS	Uranium-238	2.57E+01	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_11	SVOA	TOTAL PAHs	2.79E+01	NA	Yes	1.46E+01	Yes	1.46E+01	Yes
Outfall_12	METAL	Antimony	9.57E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_12	METAL	Iron	1.20E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_12	METAL	Uranium	6.47E+00	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_12	PPCB	TOTAL PCB	7.24E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_12	RADS	Uranium-238	1.53E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_12	SVOA	TOTAL PAHs	7.04E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_15	METAL	Antimony	9.55E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_15	METAL	Iron	9.47E+03	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_15	METAL	Uranium	7.89E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_15	PPCB	TOTAL PCB	9.59E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_15	RADS	Uranium-238	2.43E+01	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_15	SVOA	TOTAL PAHs	4.87E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_2	METAL	Antimony	9.29E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No

Table C1.13. Summary of Predicted Concentrations of Sediment in the Surface Water Runoff Based on Erosion Modeling Using MUSLE for a 30-Year 24-Hour Storm. (Comparison Against Action Levels) (Continued)

Location	Analysis Type	Constituents	Predicted Conc. in Sediment (mg/kg or pCi/g)	Background Sediment (mg/kg or pCi/g)	Exceeds Background	Industrial Worker Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?	Child Recreational Action Level[a] (mg/kg or pCi/g)	Exceeds Criteria?
Outfall_2	METAL	Iron	9.16E+03	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_2	METAL	Uranium TOTAL	2.92E+00	4.90E+00	No	1.77E+04	NA	1.48E+03	NA
Outfall_2	PPCB	PCB	1.93E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_2	RADS	Uranium-238 TOTAL	1.58E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_2	SVOA	PAHs	4.80E-01	NA	Yes	1.46E+01	No	1.46E+01	No
Outfall_8	METAL	Antimony	9.49E+00	2.10E-01	Yes	4.63E+02	No	1.99E+02	No
Outfall_8	METAL	Iron	1.03E+04	2.80E+04	No	1.00E+05	NA	1.00E+05	NA
Outfall_8	METAL	Uranium TOTAL	1.20E+01	4.90E+00	Yes	1.77E+04	No	1.48E+03	No
Outfall_8	PPCB	PCB	4.01E-01	NA	Yes	2.83E+01	No	2.83E+01	No
Outfall_8	RADS	Uranium-238 TOTAL	5.92E+00	1.20E+00	Yes	171	No	3.64E+02	No
Outfall_8	SVOA	PAHs	5.04E-01	NA	Yes	1.46E+01	No	1.46E+01	No

[a] Highlighted cell color indicates predicted sediment concentration exceeds action level based on ELCR of 1E-04

NA = Not applicable as the predicted concentration is below background level.



HOT SPOT areas: U-238--2066.509 ft2

Average Results: U-238-- 113 pCi/g

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Figure C1.1. Outfall 001 EU 05 - Hot Spot for EUs

Figure No. \SWOU\hotspot.apr
DATE 09-26-06

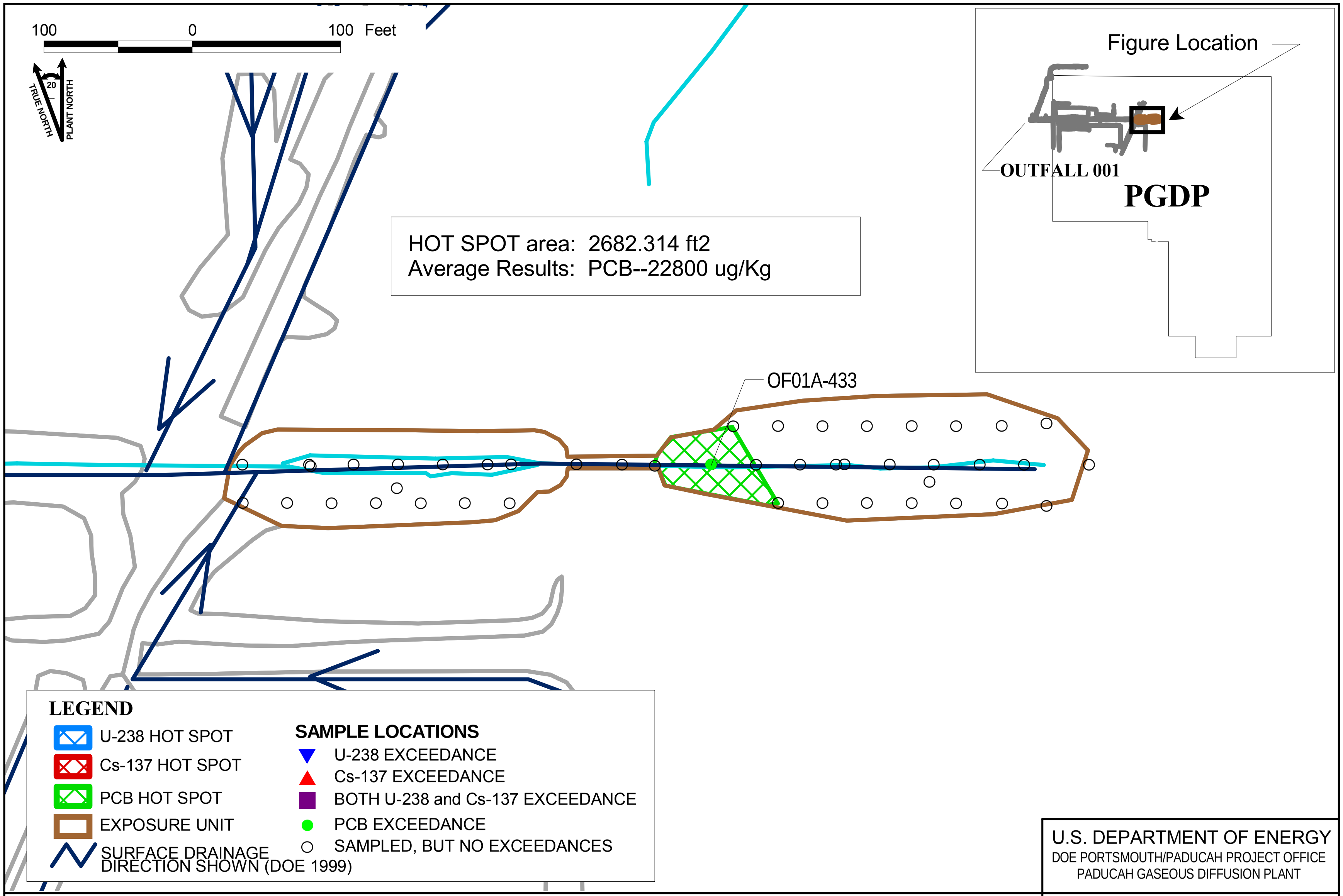

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Figure C1.2. Outfall 001 EU 14 - Hot Spot for EUs

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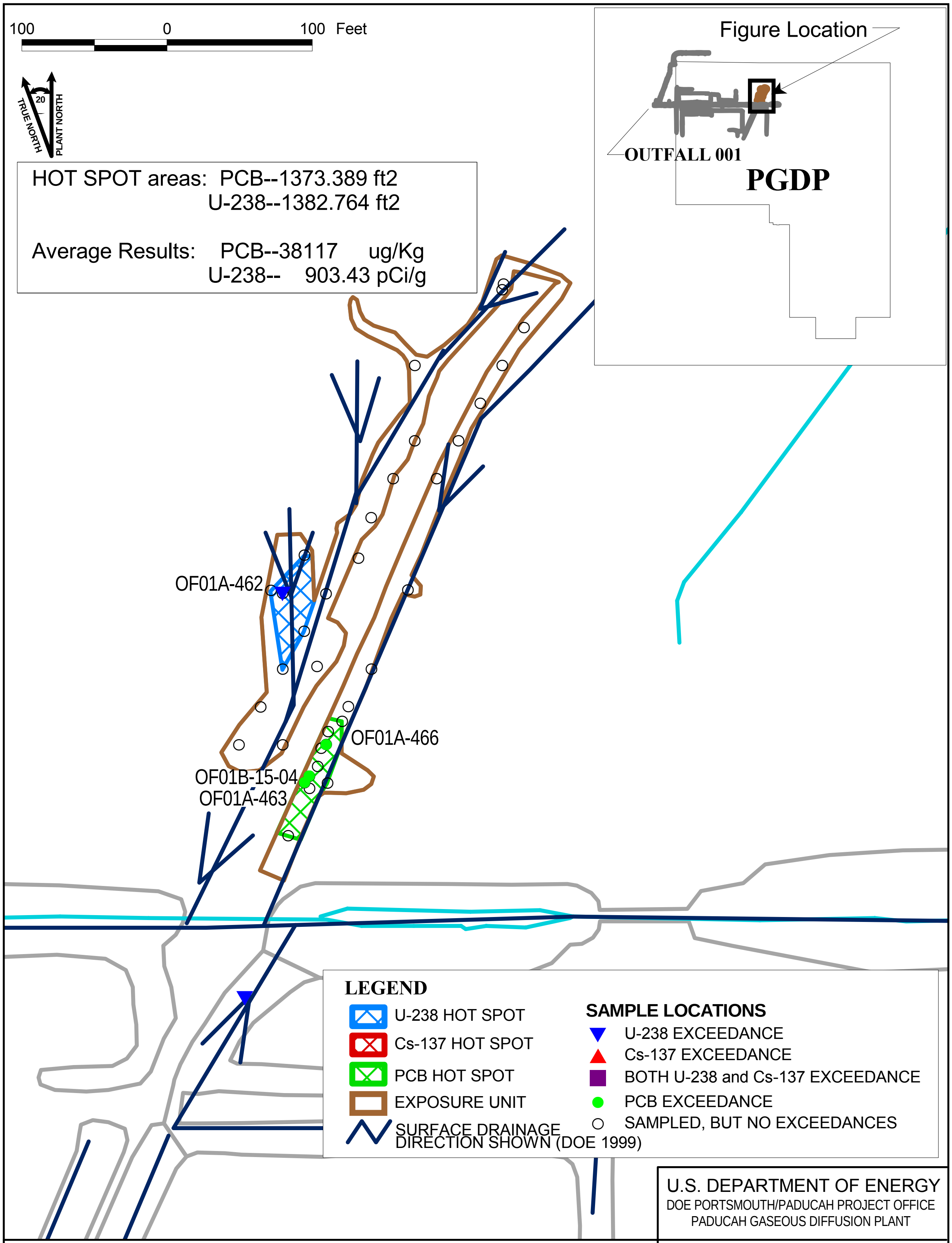
DATE 09-26-06



HOT SPOT areas: PCB--1373.389 ft2
U-238--1382.764 ft2

Average Results: PCB--38117 ug/Kg
U-238-- 903.43 pCi/g

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Figure C1.3. Outfall 001 EU 15 - Hot Spot for EUs

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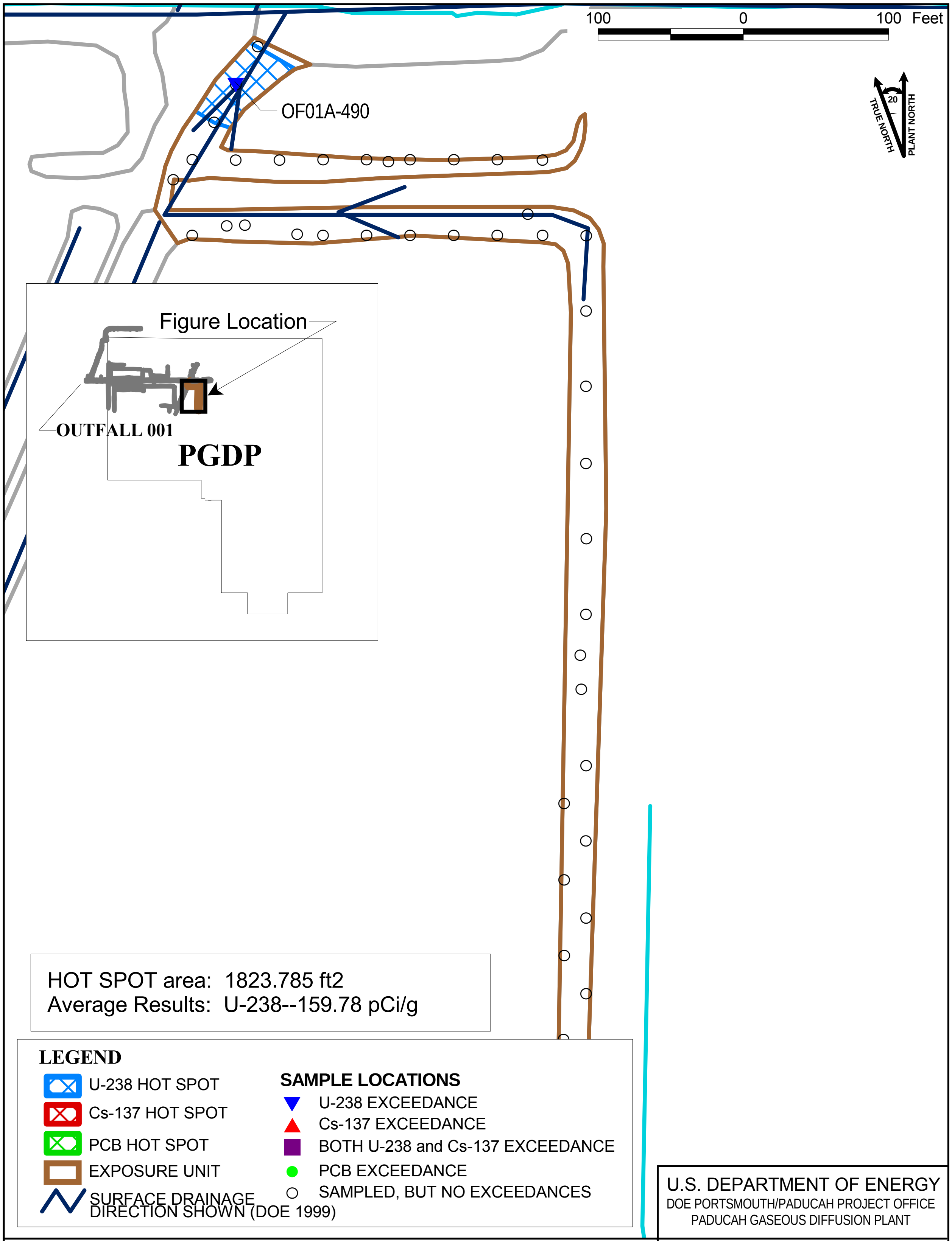

HOT SPOT area: 1823.785 ft2
Average Results: U-238--159.78 pCi/g

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Figure C1.4. Outfall 001 EU 16 - Hot Spot for EUs

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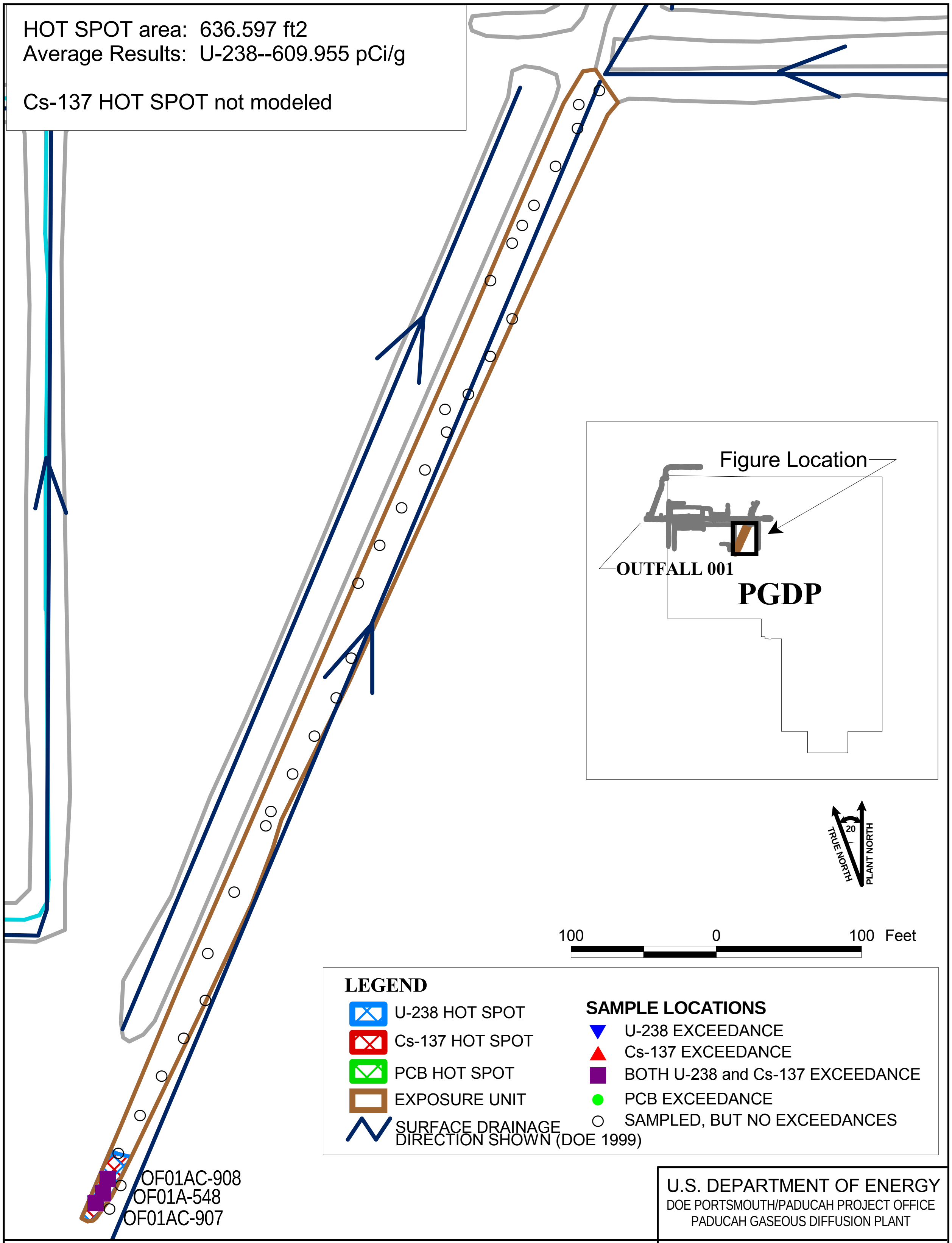

HOT SPOT area: 636.597 ft2
Average Results: U-238--609.955 pCi/g

Cs-137 HOT SPOT not modeled

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Figure C1.5. Outfall 001 EU 18 - Hot Spot for EUs

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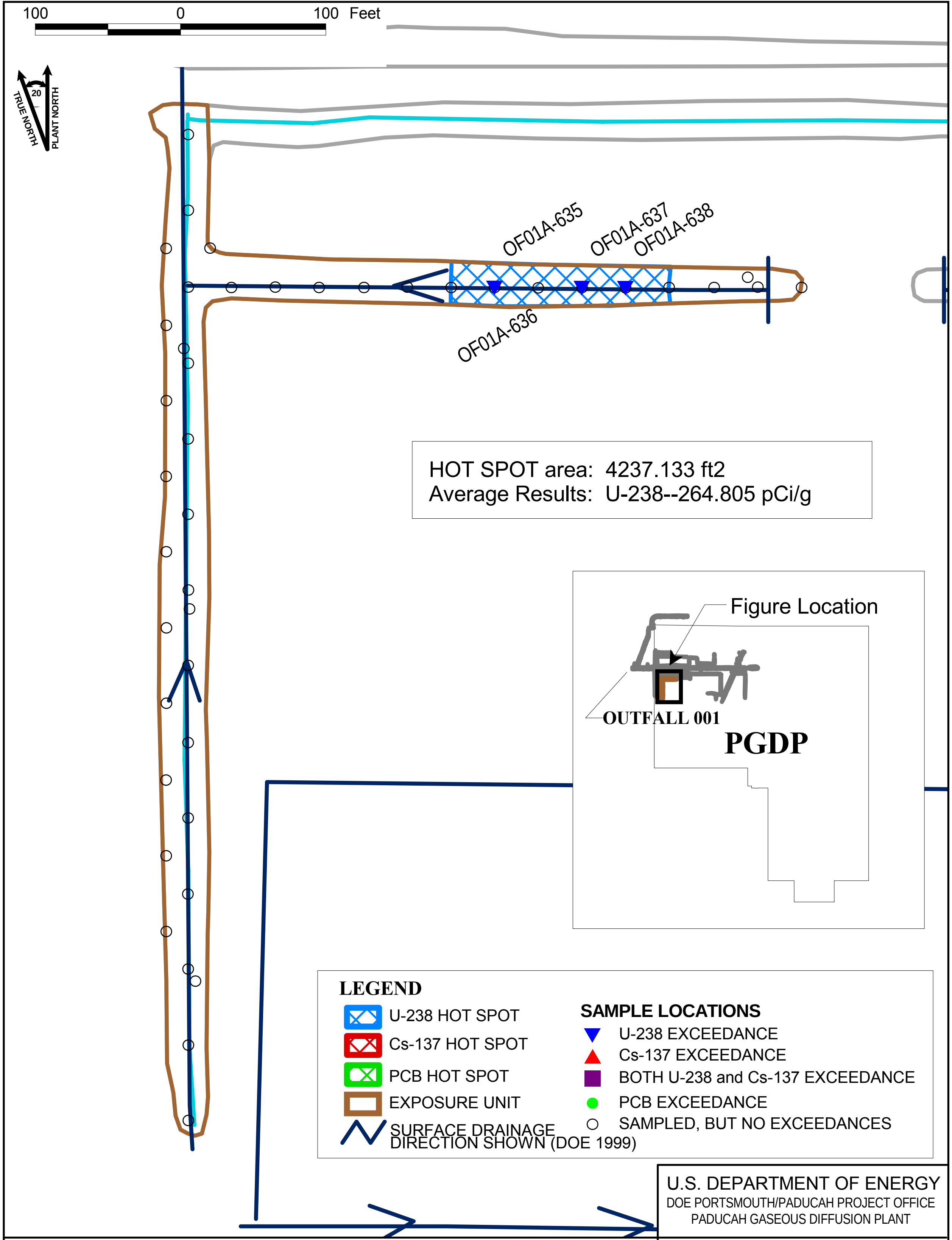

HOT SPOT area: 4237.133 ft2
Average Results: U-238--264.805 pCi/g

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Figure C1.6. Outfall 001 EU 20 - Hot Spot for EUs

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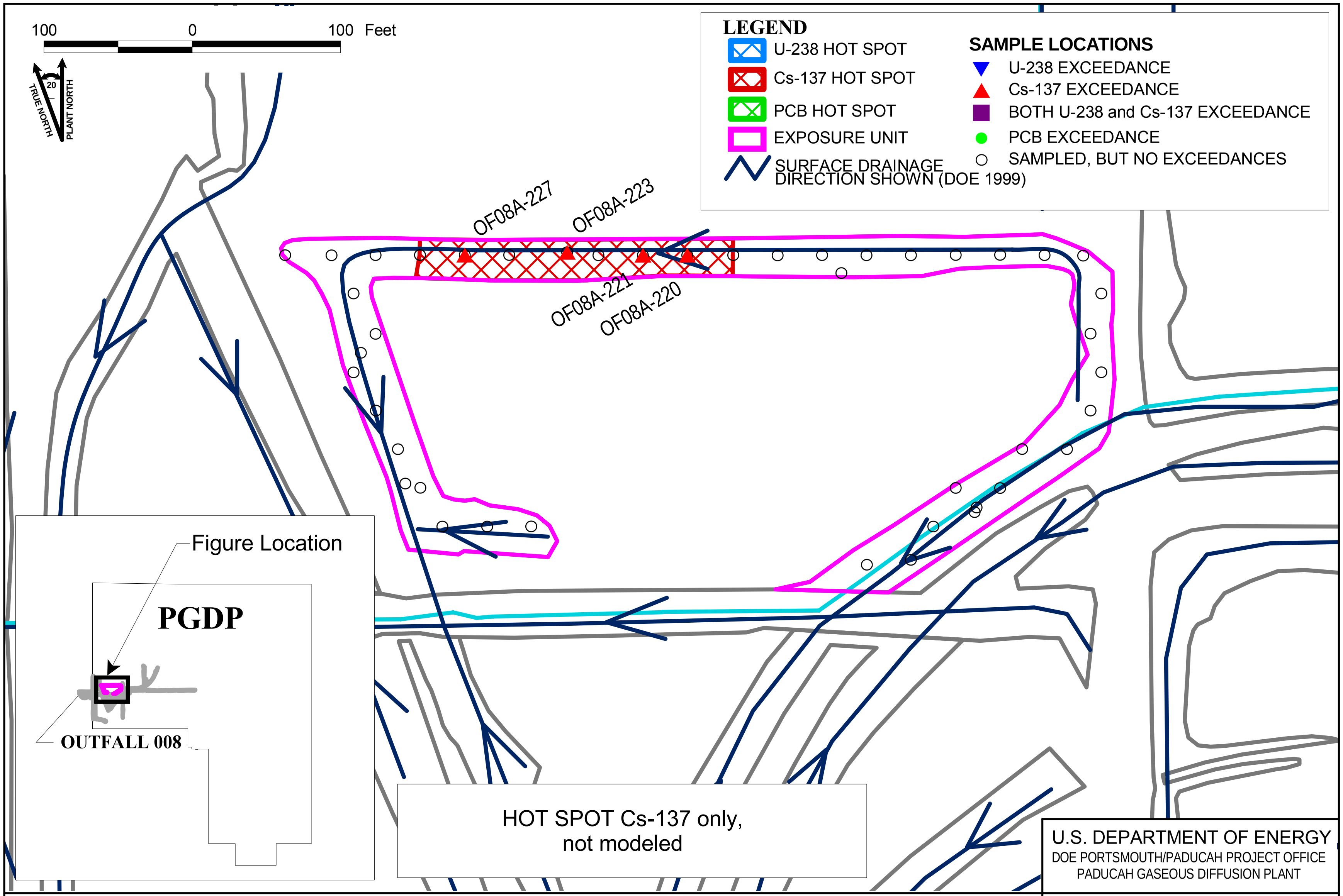

Figure C1.7. Outfall 008 EU 08 - Hot Spot for EUs

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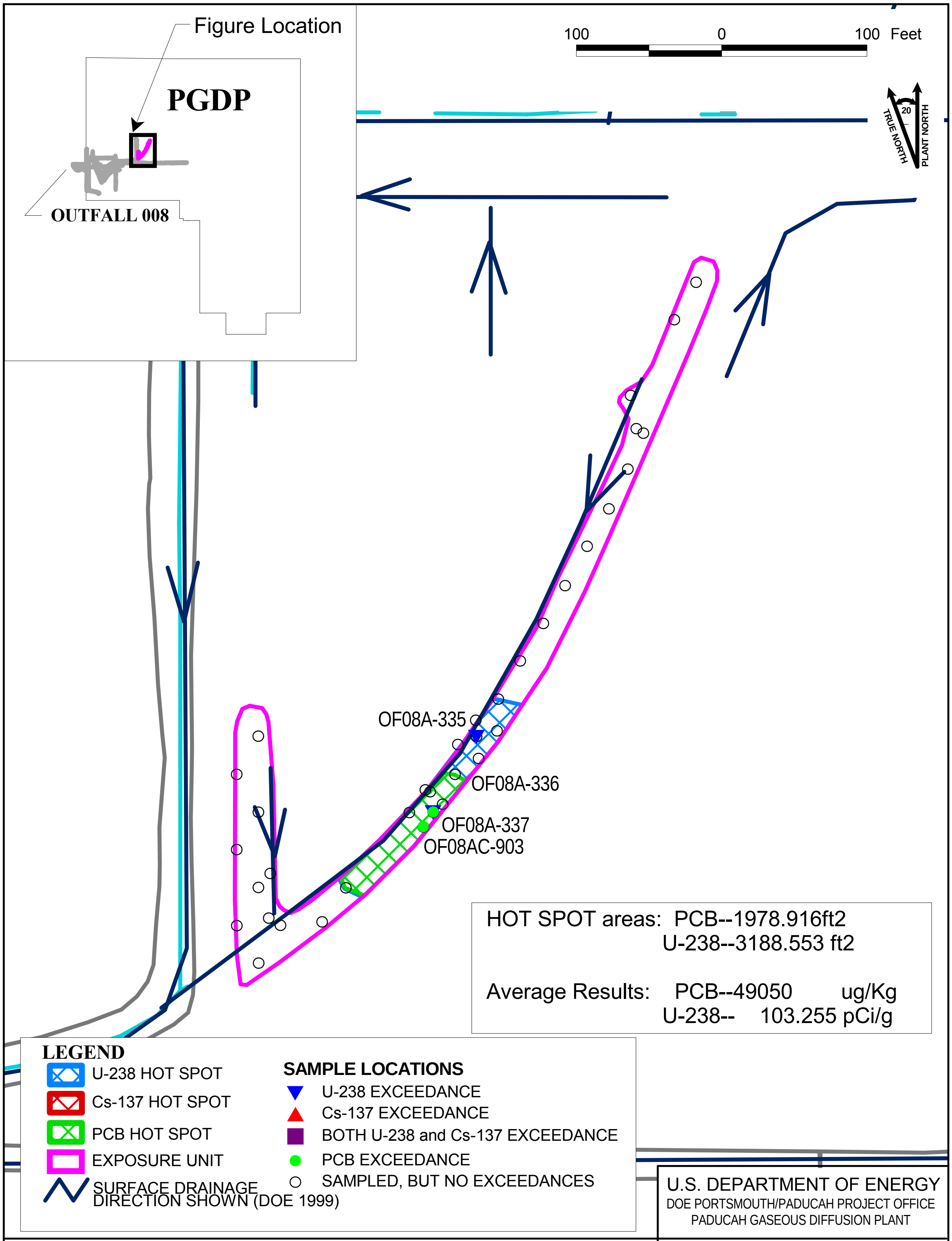

HOT SPOT areas: PCB--1978.916ft2
U-238--3188.553 ft2

Average Results: PCB--49050 ug/Kg
U-238-- 103.255 pCi/g

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Figure C1.8. Outfall 008 EU 11 - Hot Spot for EUs

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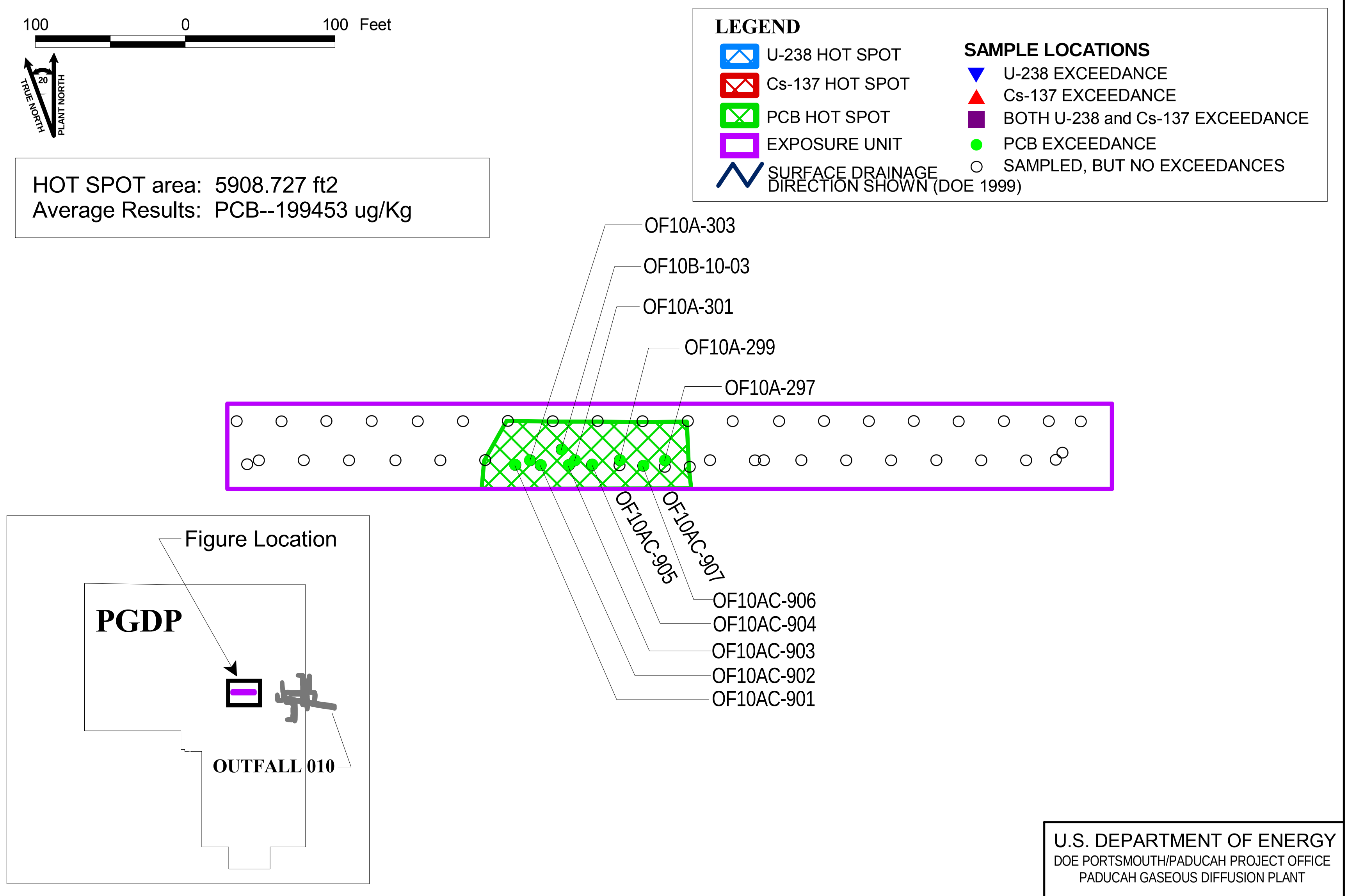

HOT SPOT area: 5908.727 ft2
Average Results: PCB--199453 ug/Kg

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Figure C1.9. Outfall 010 EU 10 - Hot Spot for EUs

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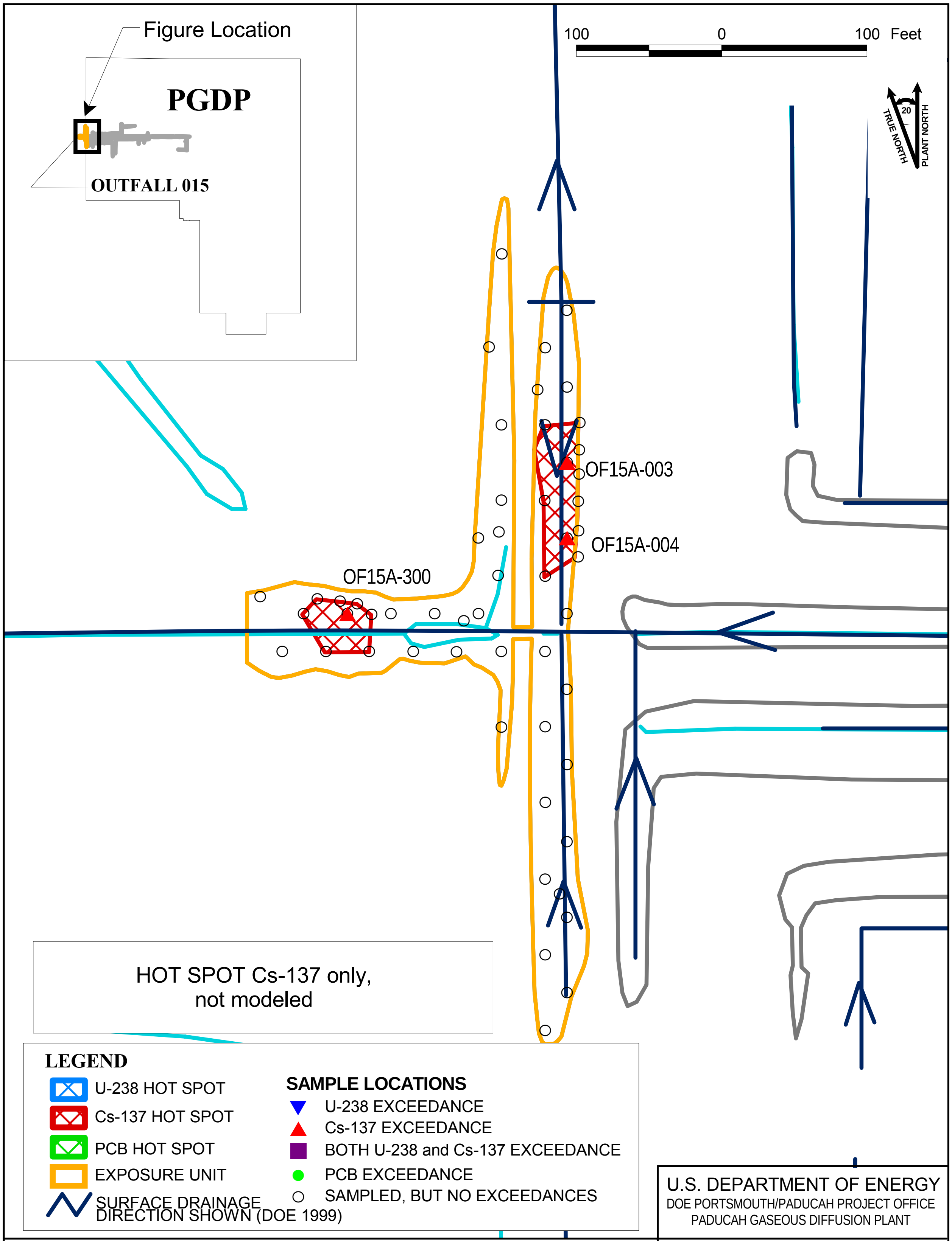

HOT SPOT Cs-137 only,
not modeled

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Figure C1.10. Outfall 015 EU 01 - Hot Spot for EUs

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DOCUMENT No. DOE/LX/07-0001

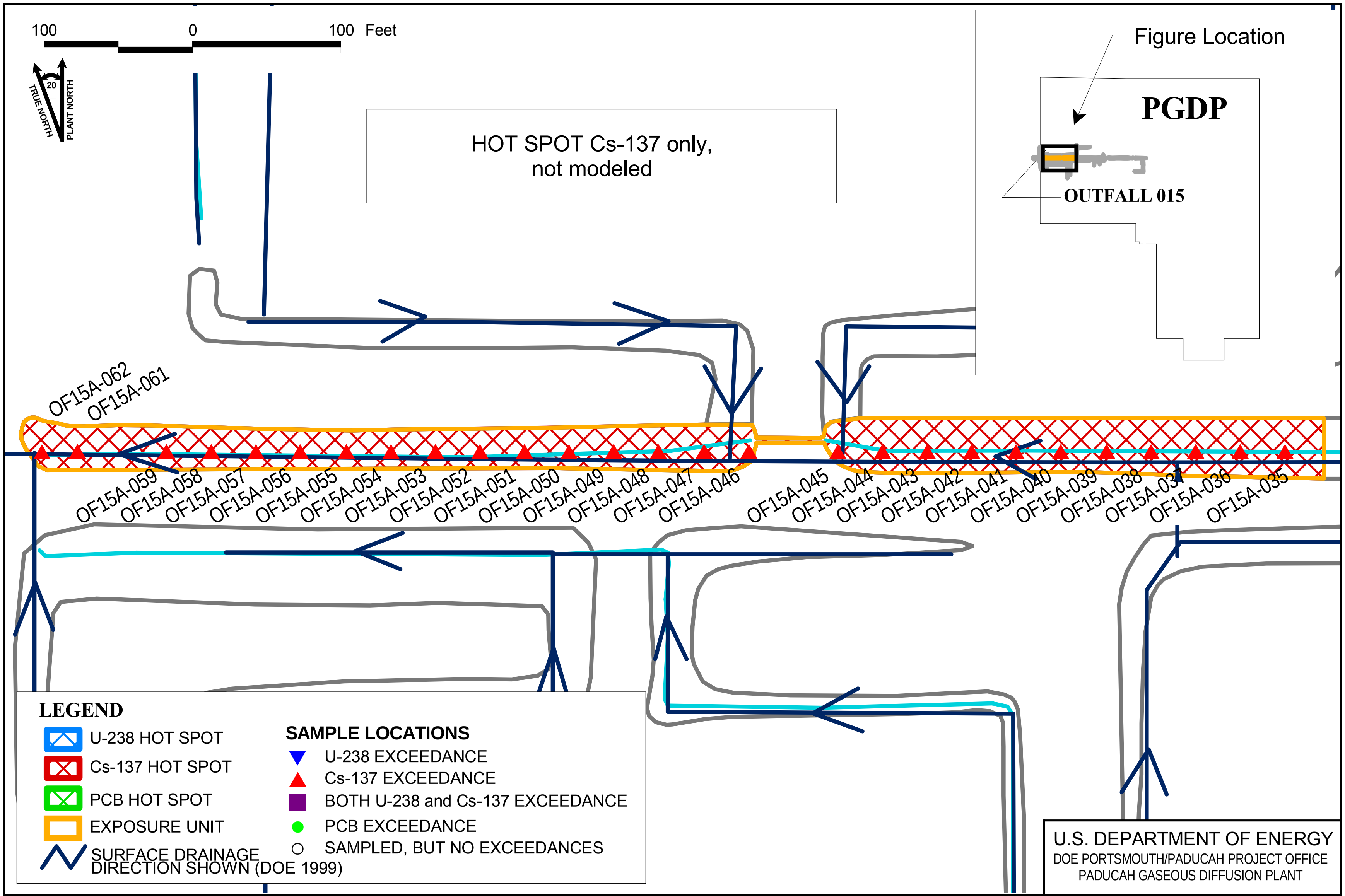

Figure C1.11. Outfall 015 EU 02 - Hot Spot for EUs

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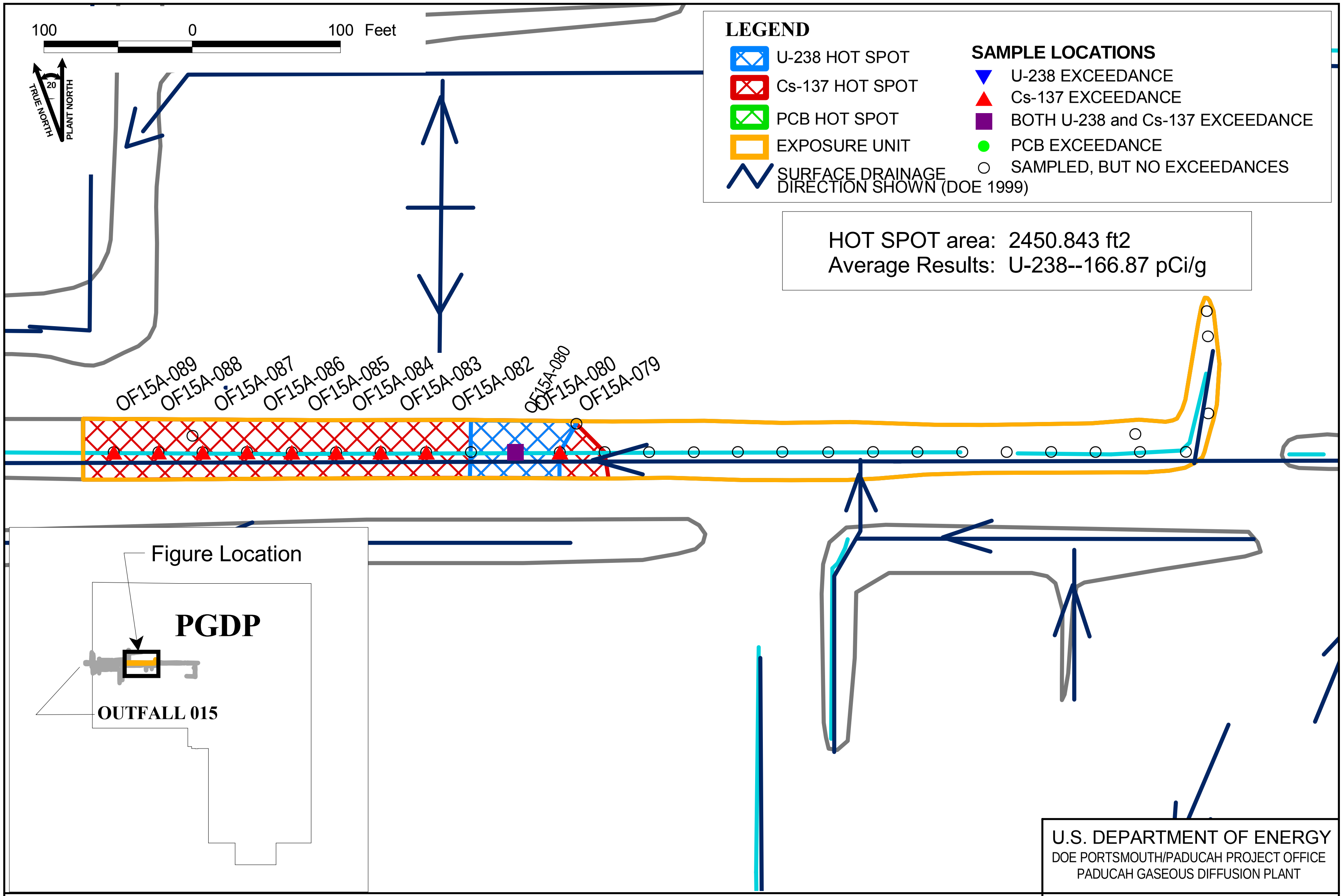

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Figure C1.12. Outfall 015 EU 03 - Hot Spot for EUs

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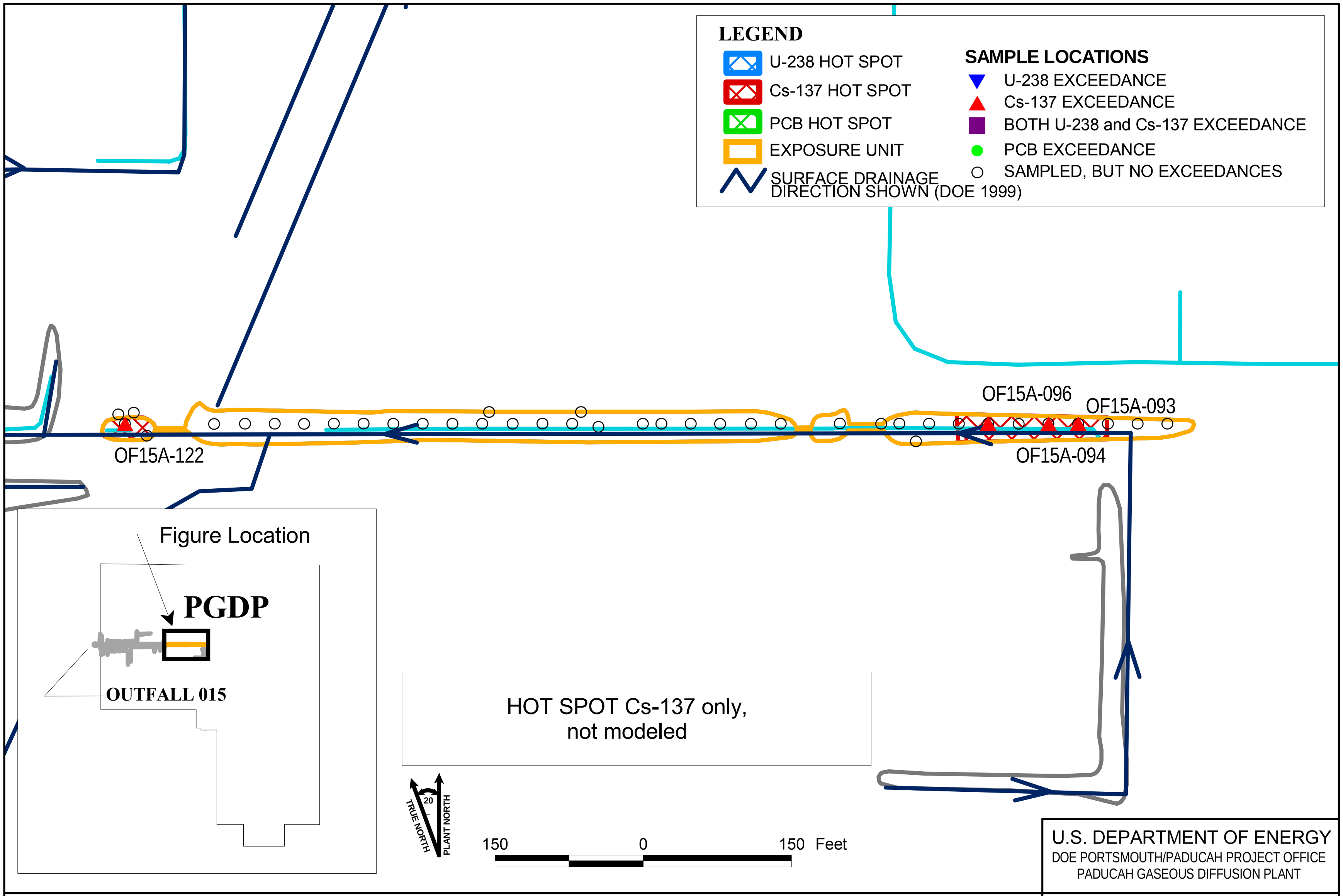

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Figure C1.13. Outfall 015 EU 04 - Hot Spot for EUs

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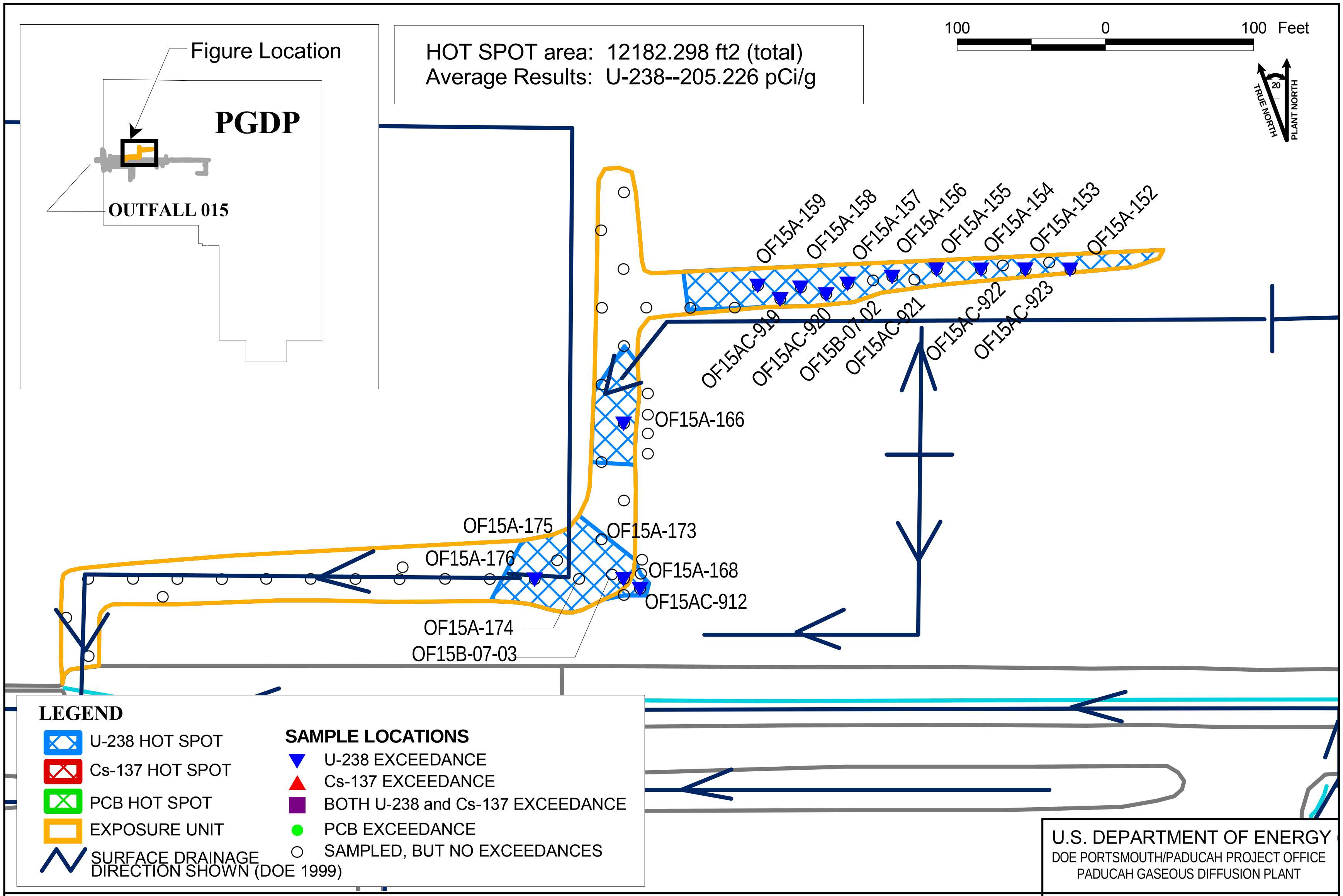

Figure C1.14. Outfall 015 EU 07 - Hot Spot for EUs

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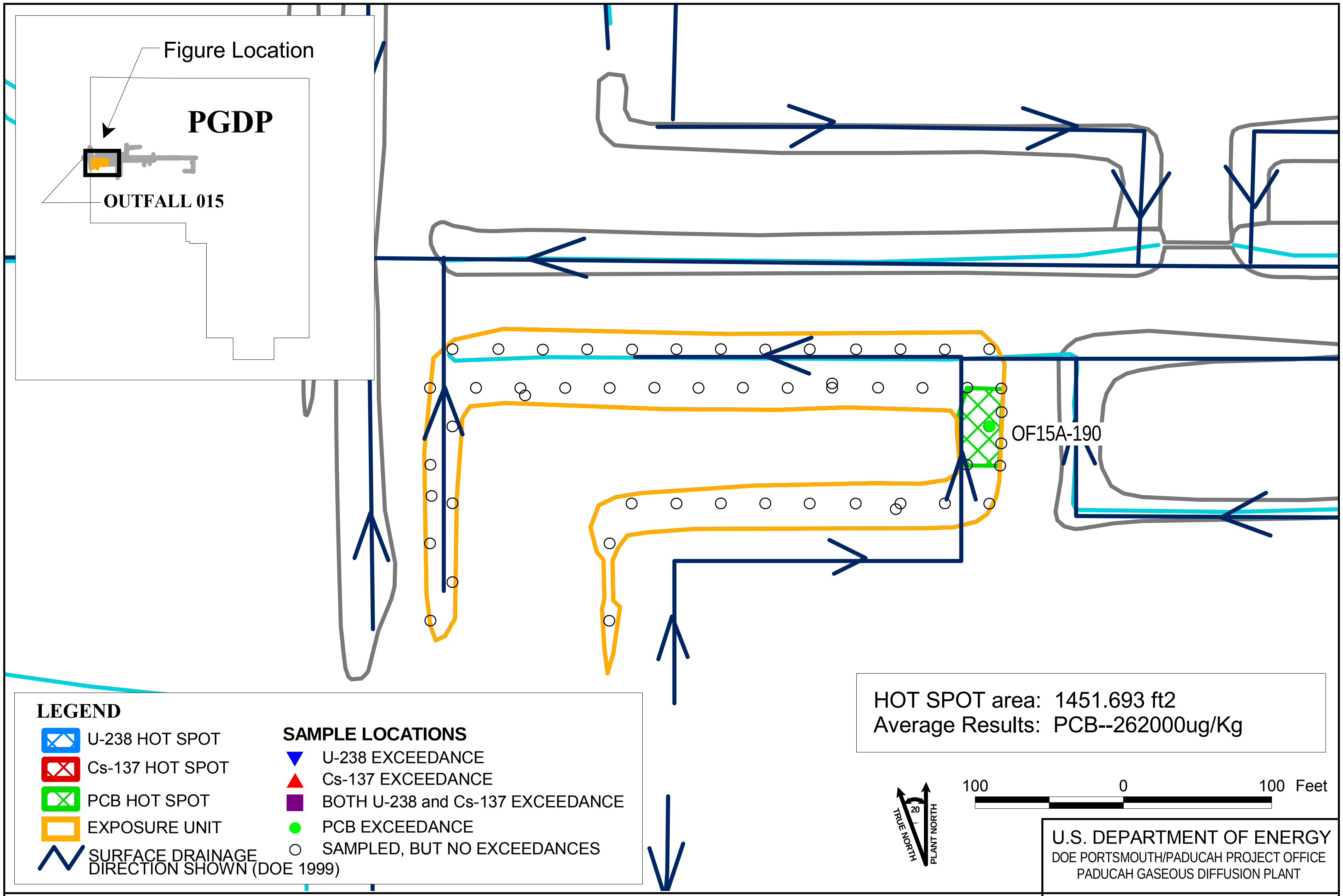

Figure C1.15. Outfall 015 EU 08 - Hot Spot for EUs

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C.2 FATE AND TRANSPORT MODELING

C.2.1 INTRODUCTION

This SI used the SWMM (Huber and Dickinson 1988) to simulate surface water flow (Figures C2.1 and C2.2) and contaminant transport due to rainfall (Figures C2.3 to C2.4) for the Paducah Gaseous Diffusion Plant (PGDP). SWMM is able to simulate time-varying hydrologic conditions (wet and dry periods) over a watershed (Figure C2.5) and contaminant transport through the watershed with proven efficiency and robustness. Moreover, SWMM is the recommended surface water model for the site as specified in the PGDP Methods Document (DOE 2001).

The PGDP SWMM is based on existing site data (Tables C2.1 to C2.7) including the following: hydrologic data (rainfall), drainage patterns (watershed-stream network), physical characteristics (soil and topography), and surface soil and sediment contamination. Section 5 of the main text discusses the conceptual site model, SWMM development, modeling results, model limitations and assumptions, and model uncertainties. This appendix presents the input parameters, model calibration, parameter sensitivity analysis, and summary results related to surface water modeling using SWMM. Tables C2.1 through C2.10 document the input parameters and calibration and sensitivity results. Model results are presented in Table C2.11. The outputs from the SWMM runs are too voluminous for hard copy format and, therefore, are provided in electronic format on a compact disk as an attachment to this appendix.

C.2.2 PARAMETER SENSITIVITY AND TRANSPORT MODEL CALIBRATION

The sensitivity of the SWMM model to various input parameters was evaluated by selecting sensitive model parameters and varying the values through a range. Parameters that did not produce significant changes in model results, such as subbasin slopes and maximum infiltration rates, were not evaluated further. Parameters producing significant changes in model results included subbasin impermeability and the minimum infiltration rate.

Table C2.9 presents the sensitivity analysis of impermeability and minimum infiltration rate. The sensitivity analysis consisted of varying the values for impermeability or minimum infiltration rate and comparing the resulting modeled polychlorinated biphenyl (PCB) concentrations in the outfalls (over a 30-year simulation period) with the long-term averages of observed concentrations. Impermeability was varied from 0% to 100%; results indicated the model was sensitive to this parameter throughout the range. The modeled PCB concentration based on 25% impermeability was consistent with the measured concentration; 25% impermeability was selected as the base case for the minimum infiltration runs.

The minimum infiltration rate was varied by multiplying the base value of 0.1 inch/hr, by 0.5, 2, 5, and 10. Results for the minimum infiltration rate values above 0.1 inch/hr were identical, indicating a low sensitivity to higher values for the given model configuration. The results of the model sensitivity evaluation were used to calibrate the model and generate final estimated outfall concentrations presented in Table C2.10.

C2.3 REFERENCES

DOE 2001. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D2.

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

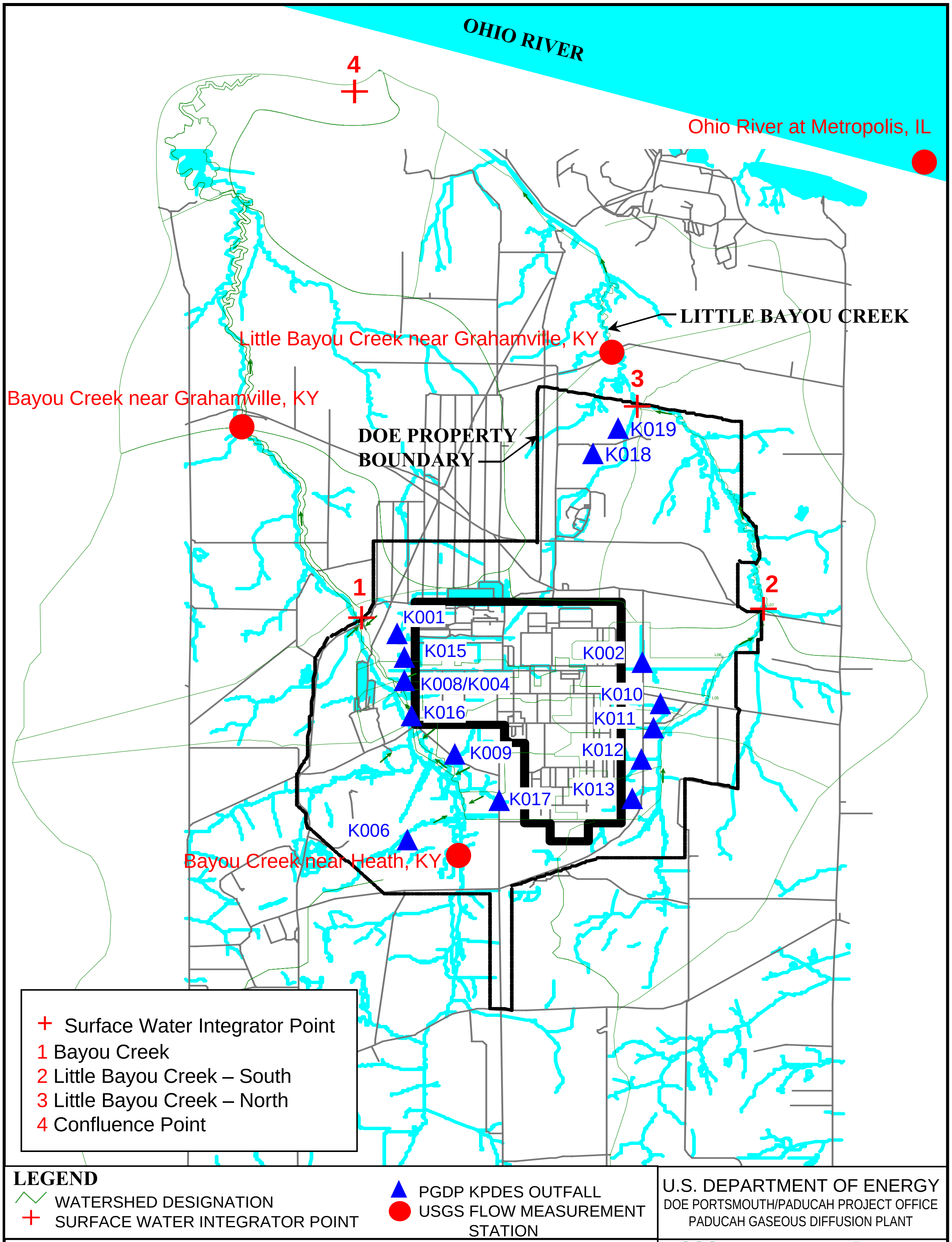

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Figure C2.1. Model Domain with Watershed-Stream Discretization

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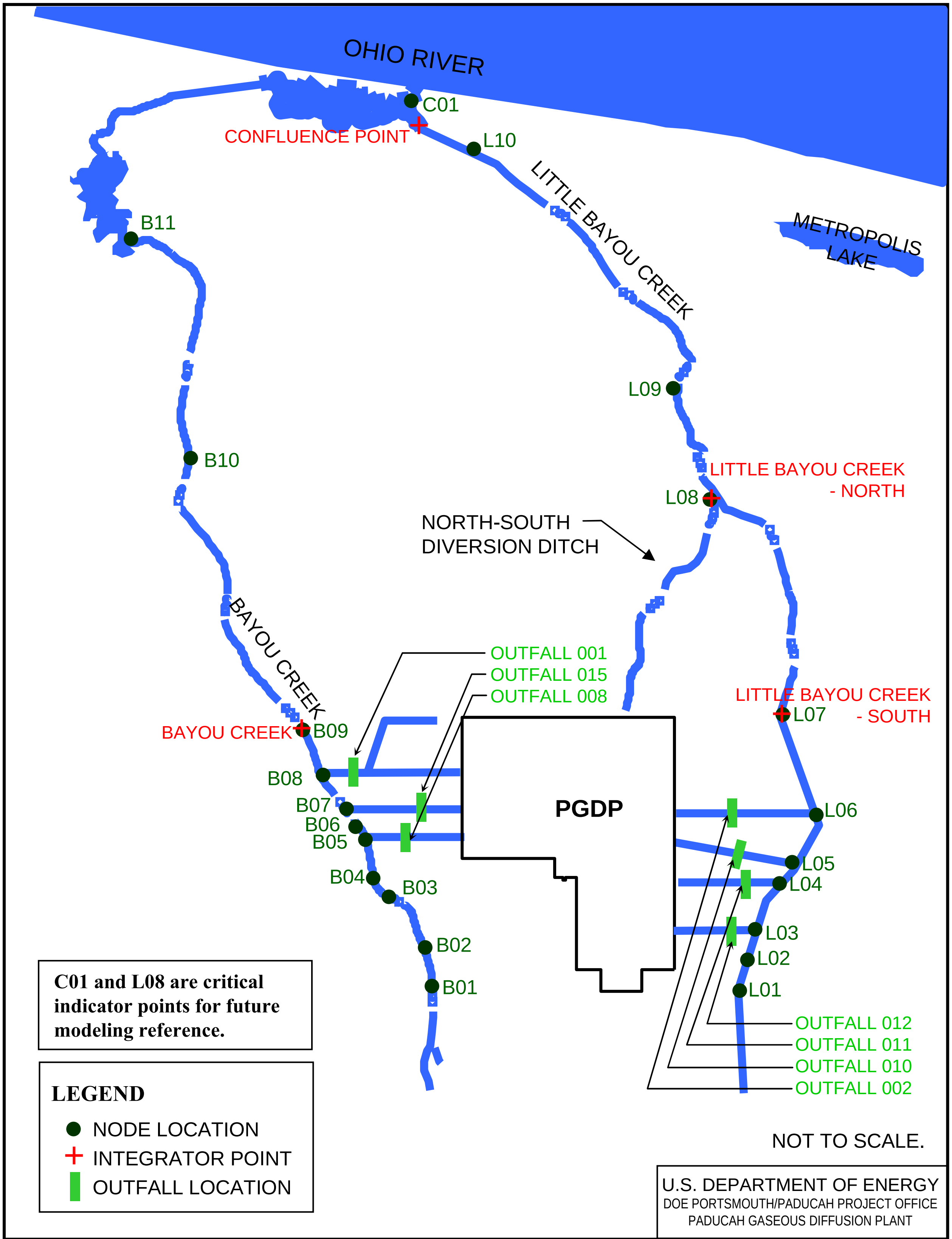

C01 and L08 are critical indicator points for future modeling reference.

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Figure C2.2. SWOU Modeling Node, Integrator, and Outfall Locations

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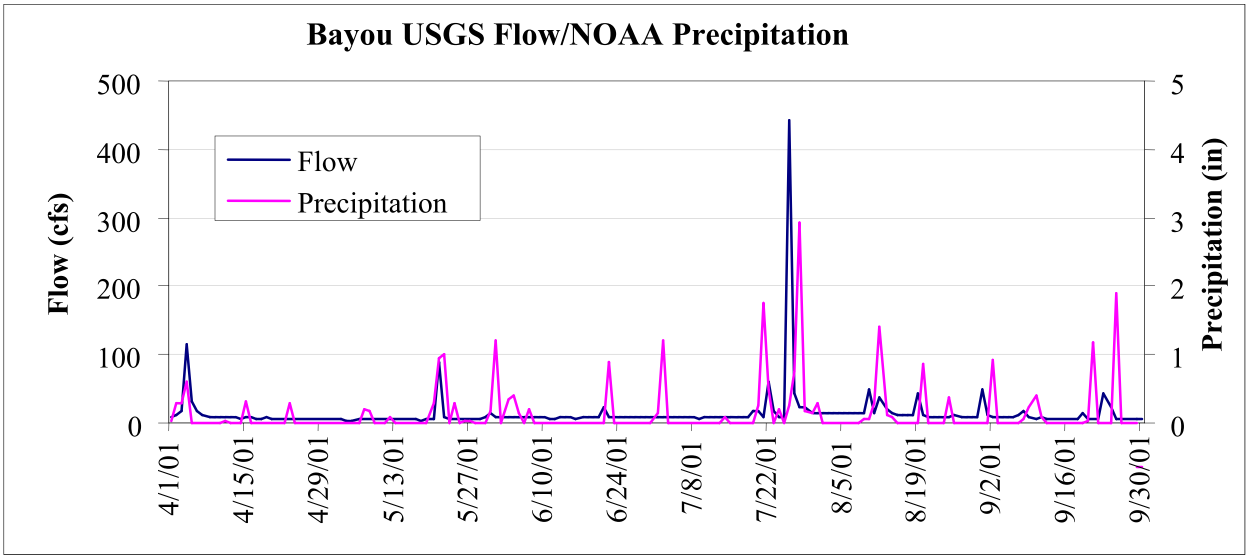
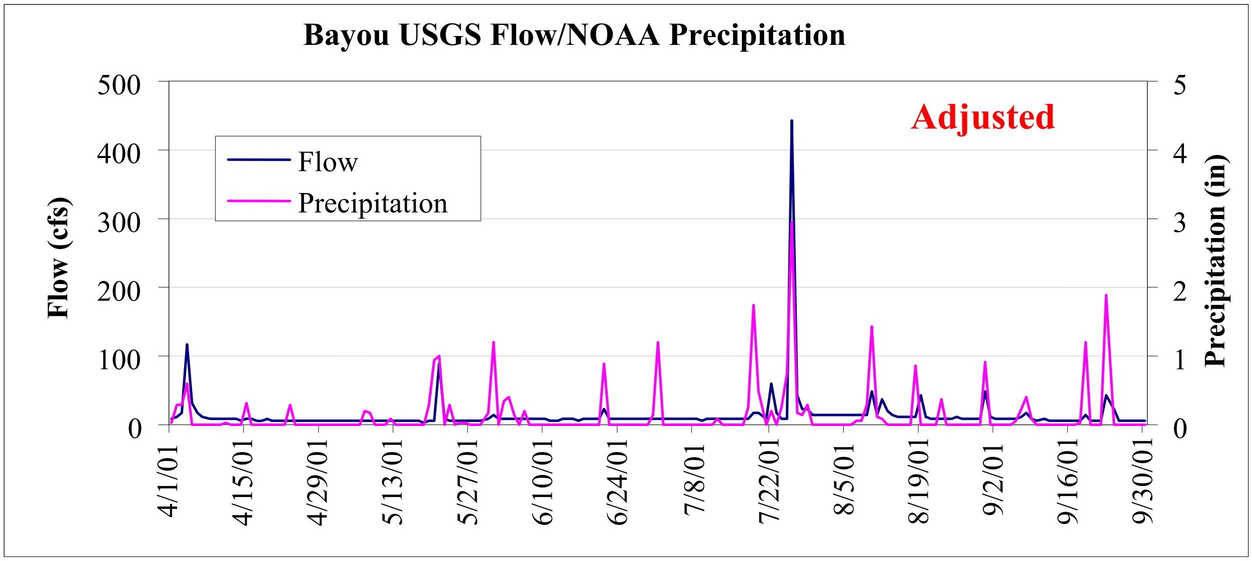
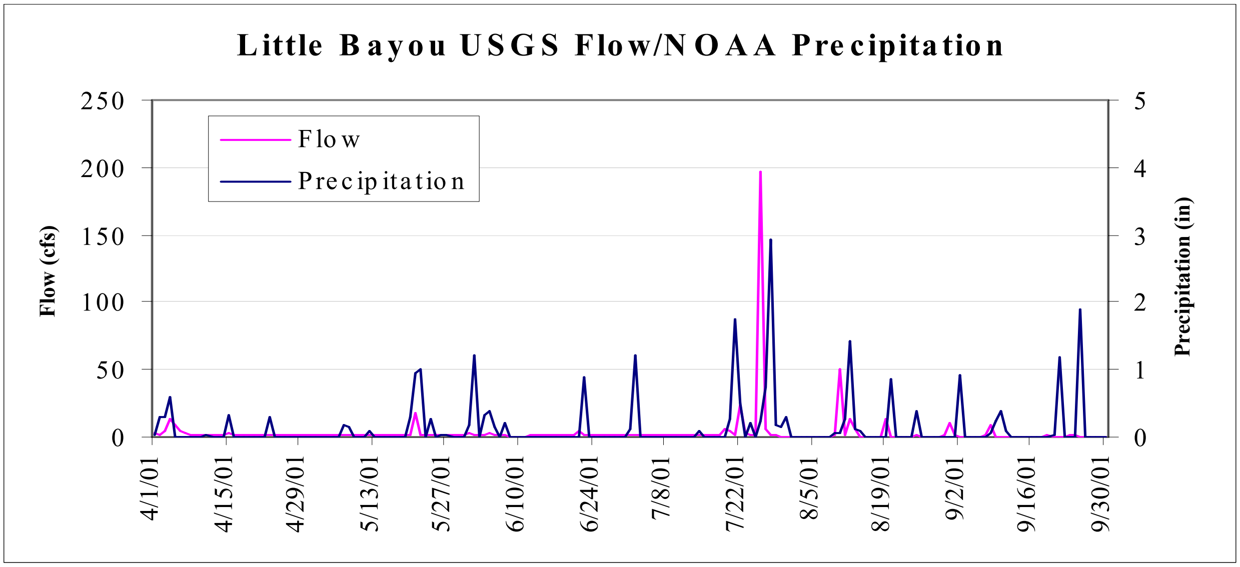


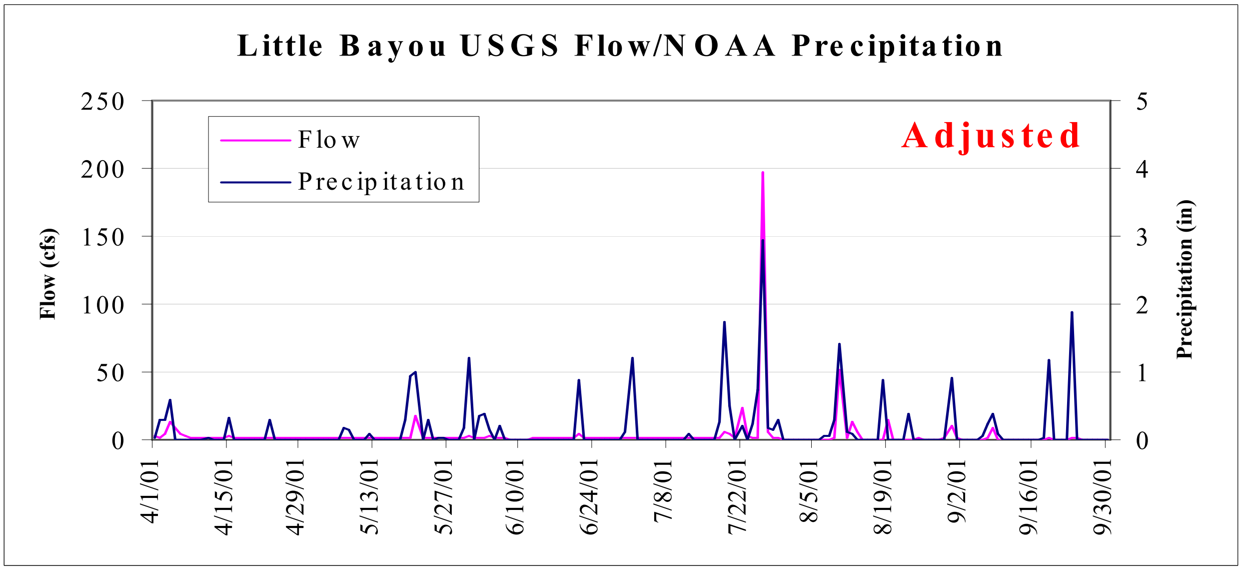


USGS = U.S. Geological Survey
NOAA = National Oceanic and Atmospheric Administration

It should be noted here that the peaks of flow always should follow the peaks of precipitation; however, the flow data for Bayou Creek from USGS showed the opposite relationship. Therefore, to account for this discrepancy, the time of precipitation was adjusted by re-positioning them one day ahead as shown in the "adjusted" figure.

Figure C2.3. Discharge and Precipitation Data for Bayou Creek





USGS = U.S. Geological Survey
NOAA = National Oceanic and Atmospheric Administration

It should be noted here that the peaks of flow always should follow the peaks of precipitation; however, the flow data for Little Bayou Creek from USGS showed the opposite relationship. Therefore, to account for this discrepancy, the time of precipitation was adjusted by re-positioning them one day ahead as shown in the "adjusted" figure.

Figure C2.4. Discharge and Precipitation Data for Little Bayou Creek

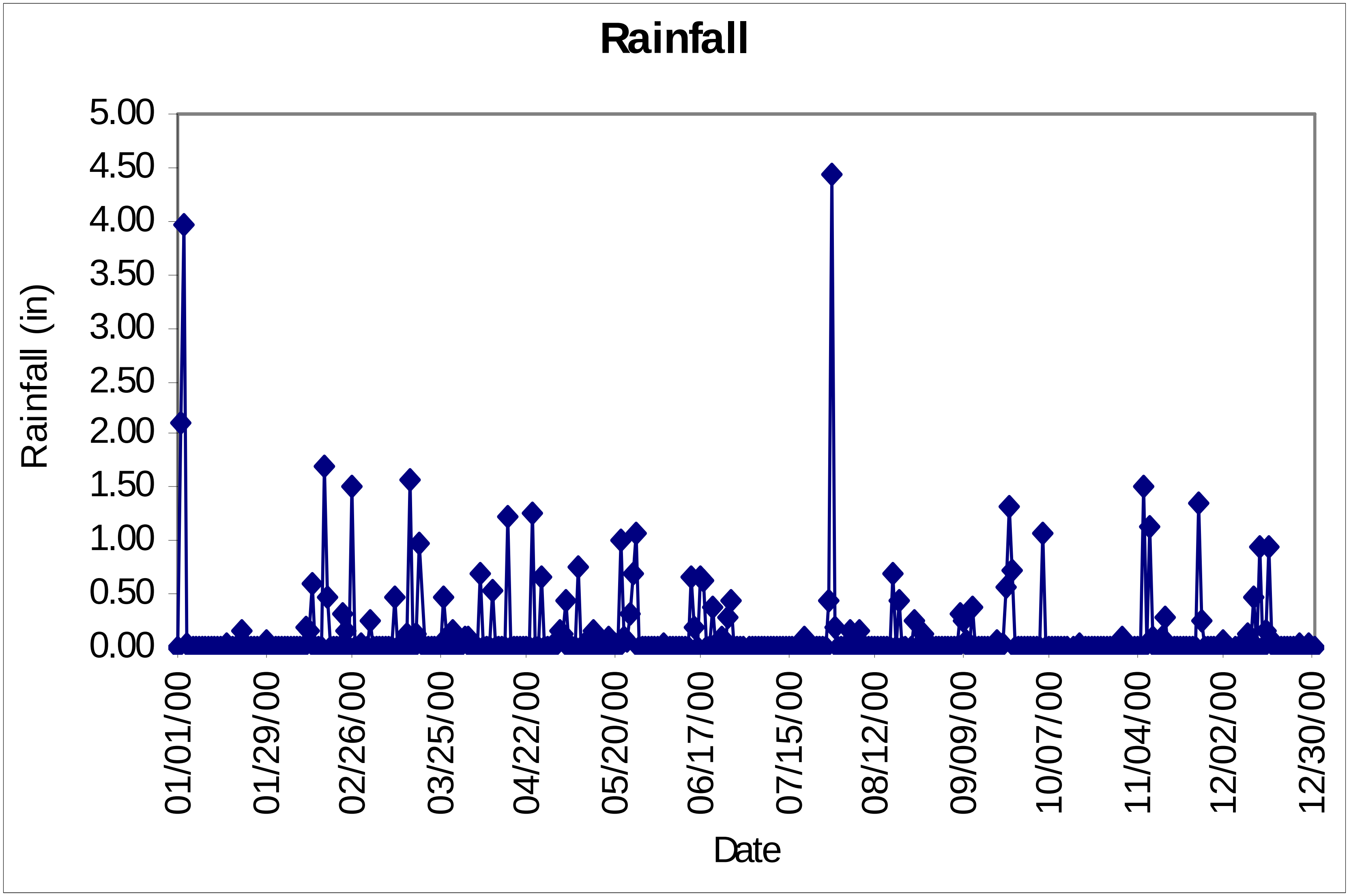


Figure C2.5. Precipitation in Calendar Year 2000 Used as Representative Rainfall for Contaminant Transport Modeling

Table C2.1. Evapotranspiration
(Calendar Year 2000)

Month	Evapotranspiration (in./day)
Jan	0.10
Feb	0.10
Mar	0.10
Apr	0.10
May	0.10
Jun	0.10
Jul	0.10
Aug	0.10
Sep	0.10
Oct	0.10
Nov	0.10
Dec	0.10

Table C2.2. Pipe (Stream) Properties

NAMEG	NGTO	NP	GWIDTH (ft)	GLEN (ft)	G3 (ft/ft)	GS1 (ft/ft)	GS2 (ft/ft)	G6	DFULL (ft)	GDEPTH (ft)
'B01'	'B02'	4	19.0	960.0	0.0001000	0	0	0.1300	7.0	3.5
'B02'	'B03'	4	19.0	1764.0	0.0028345	0	0	0.1300	7.0	3.5
'B03'	'B04'	4	19.0	1455.0	0.0034364	0	0	0.1300	7.0	3.5
'B04'	'B05'	4	19.0	1105.0	0.0001000	0	0	0.1300	7.0	3.5
'B05'	'B06'	4	19.0	326.0	0.0153374	0	0	0.1300	7.0	3.5
'B06'	'B07'	4	19.0	832.0	0.0001000	0	0	0.1300	7.0	3.5
'B07'	'B08'	4	19.0	544.0	0.0001000	0	0	0.1300	7.0	3.5
'B08'	'B09'	4	19.0	1473.0	0.0067889	0	0	0.1300	7.0	3.5
'B09'	'B10'	4	25.0	9600.0	0.0015625	0	0	0.1300	10.0	5.0
'B10'	'B11'	4	25.0	9600.0	0.0015625	0	0	0.1300	10.0	5.0
'B11'	'C01'	4	40.0	11031.0	0.0001000	0	0	0.1300	10.0	5.0
'B02A'	'B02'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B03A'	'B03'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B04A'	'B04'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B05A'	'B05'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B06A'	'B06'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B07A'	'B07'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B09A'	'B09'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B02B'	'B02'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B03B'	'B03'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B04B'	'B04'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B05B'	'B05'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B06B'	'B06'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B07B'	'B07'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'B09B'	'B09'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'OF_01'	'B09'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'OF_08'	'B06'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'OF_15'	'B07'	3	19.0	1.0	0.0010000	0	0	0.1300	7.0	3.5
'L01'	'L02'	4	175.0	1110.0	0.0001000	0	0	0.1300	10.0	0.0

Table C2.2. Pipe (Stream) Properties (Continued)

NAMEG	NGTO	NP	GWIDTH (ft)	GLEN (ft)	G3 (ft/ft)	GS1 (ft/ft)	GS2 (ft/ft)	G6	DFULL (ft)	GDEPTH (ft)
'L02'	'L03'	4	175.0	1072.0	0.0001000	0	0	0.1300	10.0	0.0
'L03'	'L04'	4	175.0	867.0	0.0115340	0	0	0.1300	10.0	0.0
'L04'	'L05'	4	175.0	925.0	0.0001000	0	0	0.1300	10.0	0.0
'L05'	'L06'	4	45.0	1462.0	0.0001000	0	0	0.1300	6.0	0.0
'L06'	'L07'	4	45.0	2328.0	0.0042955	0	0	0.1300	6.0	0.0
'L07'	'L08'	4	35.0	13080.0	0.0001000	0	0	0.1300	10.0	0.0
'L08'	'L09'	4	50.0	420.0	0.0119048	0	0	0.1300	6.0	0.0
'L09'	'L10'	4	50.0	920.0	0.0163043	0	0	0.1300	6.0	0.0
'L10'	'C01'	4	80.0	3430.0	0.0001000	0	0	0.1300	8.0	0.0
'L02A'	'L02'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L03A'	'L03'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L04A'	'L04'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L05A'	'L05'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L06A'	'L06'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L02B'	'L02'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L03B'	'L03'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L04B'	'L04'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L05B'	'L05'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L06B'	'L06'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'OF_02'	'L06'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'OF_10'	'L05'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'OF_11'	'L04'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'OF_12'	'L03'	3	30.0	1.0	0.0010000	0	0	0.1300	10.0	0.0
'L01'	'L02'	4	175.0	1110.0	0.0001000	0	0	0.1300	10.0	0.0

NAMEG: Channel/pipe number or name.
NGTO: Channel/pipe or inlet number or name for drainage.
NPG=NP: Type of channel or pipe.
1 = for trapezoidal channel
2 = for circular pipe
3 = for dummy channel/pipe, inflow
4 = for parabolic channel
5 = for trapezoidal channel with weir or orifice (follow with G2 data group)
6 = for circular pipe with weir or orifice
6 = for circular pipe with weir or orifice (follow with G2 data group)
7 = for parabolic channel with weir or orifice (follow with G2 data group)

The following parameters are not used if NP = 3:

GWIDTH: Bottom width of trapezoidal channel, diameter of pipe, or top width of parabolic channel
GLEN: Length of channel/pipe
G3: Invert slope
GS1: Left-hand side slope
GS2: Right-hand side slope
G6: Manning’s roughness coefficient
DFULL: Depth of channel when full (N.R. if NP equals 2, 3, or 6)
GDEPTH: Starting depth of pipe/channel

Table C2.3. Subwatershed Properties

JK	NAMEW	NGTO	WW(1)[a] (ft)	WAREA[a] (ac)	WW(3) (%)	WSLOPE (ft/ft)	WW(5)	WW(6)	WSTORE1 (in)	WSTORE2 (in)	WLMAX (in/hr)	WLMIN (in/hr)	DECAY (/sec)
Subcatchments draining to Bayou Creek													
1	'B01E'	'B02B'	800.0	121.00	95.00	0.0018100	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B02E'	'B03B'	1600.0	155.00	95.00	0.0054000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B03E'	'B04B'	1600.0	22.00	90.00	0.0070000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B04E'	'B05B'	1200.0	12.00	99.00	0.0090000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B05E'	'B06B'	200.0	95.00	95.00	0.0050000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B06E'	'B07B'	800.0	60.00	95.00	0.0040000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B08E'	'B09B'	2400.0	430.00	98.00	0.0010000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B01S'	'B01'	6400.0	4337.00	5.00	0.0100000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B01W'	'B02A'	800.0	684.00	5.00	0.0190000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B02W'	'B03A'	1600.0	331.00	5.00	0.0160000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B03W'	'B04A'	1600.0	762.00	5.00	0.0123000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B04W'	'B05A'	1200.0	60.00	5.00	0.0070000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B05W'	'B06A'	200.0	12.00	5.00	0.0043000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B06W'	'B07A'	400.0	35.00	5.00	0.0088000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B07W'	'B08'	400.0	12.00	5.00	0.0042000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B08W'	'B09A'	1600.0	453.00	5.00	0.0100000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B09E'	'B10'	7600.0	221.00	5.00	0.0030000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B09W'	'B10'	8000.0	1324.00	5.00	0.0120000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B10E'	'B11'	7600.0	298.00	5.00	0.0030000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B10W'	'B11'	8000.0	453.00	5.00	0.0120000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B10I'	'B11'	4800.0	938.00	5.00	0.0034000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'B11S'	'C01'	8000.0	276.00	5.00	0.0060000	0.0150	0.1500	0.0000	0.0000	1.0000	0.0180	0.0013
1	'EUS_01'	'OF_01'	**42600.0**	13.76	25.00	0.2500000	0.0150	0.1500	0.0000	0.0000	2.0000	0.0050	0.0013
1	'EUS_08'	'OF_08'	**26000.0**	7.77	25.00	0.1600000	0.0150	0.1500	0.0000	0.0000	2.0000	0.0050	0.0013
1	'EUS_15'	'OF_15'	**19400.0**	5.60	25.00	0.2700000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013

Table C2.3. Subwatershed Properties (Continued)

JK	NAMEW	NGTO	WW(1)[a] (ft)	WAREA[a] (ac)	WW(3) (%)	WSLOPE (ft/ft)	WW(5)	WW(6)	WSTORE1 (in)	WSTORE2 (in)	WLMAX (in/hr)	WLMIN (in/hr)	DECAY (1/sec)
Subcatchments draining to Little Bayou Creek													
1	'L01W'	'L02A'	800.0	107.00	100.00	0.0030000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L02W'	'L03A'	1000.0	94.92	100.00	0.0030000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L03W'	'L04A'	800.0	71.74	100.00	0.0010000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L04W'	'L05A'	800.0	47.46	100.00	0.0010000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L05W'	'L06A'	1600.0	132.00	95.00	0.0010000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L01S'	'L01'	4800.0	618.00	5.00	0.0090000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L01E'	'L02B'	800.0	176.00	5.00	0.0020000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L02E'	'L03B'	1000.0	121.00	5.00	0.0020000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L03E'	'L04B'	800.0	121.00	5.00	0.0040000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L04E'	'L05B'	800.0	107.00	5.00	0.0080000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L05E'	'L06B'	1000.0	83.00	5.00	0.0050000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L06E'	'L07'	2000.0	221.00	5.00	0.0030000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L06W'	'L07'	1000.0	60.00	5.00	0.0090000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L07E'	'L08'	8000.0	806.00	5.00	0.0030000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L07W'	'L08'	8000.0	464.00	5.00	0.0050000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L08E'	'L09'	1600.0	143.00	5.00	0.0200000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L09E'	'L10'	5600.0	364.00	5.00	0.0200000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L08W'	'L09'	1600.0	453.00	5.00	0.0070000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L09W'	'L10'	9600.0	684.00	5.00	0.0070000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'L10S'	'C01'	4800.0	640.00	5.00	0.0050000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'EUS_02'	'OF_02'	**10800.0**	3.60	0.00	0.2500000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'EUS_10'	'OF_10'	**15600.0**	5.80	0.00	0.0040000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1100	0.0013
1	'EUS_11'	'OF_11'	**1560.0**	0.60	0.00	0.2500000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013
1	'EUS_12'	'OF_12'	**1520.0**	0.65	0.00	0.4000000	0.0150	0.1500	0.0000	0.0000	2.0000	0.1000	0.0013

JK: Hyetograph number
NAMEW: Subcatchment number or name
NGTO: Channel/pipe or inlet (junction/node/manhole) number for drainage
WW(1): Width of subcatchment, ft
WAREA: Area of subcatchment, acres
WW(3): Percent imperviousness of subcatchment
WSLOPE*: Ground slope, ft/ft (dimensionless)
WW(5): Impervious area Manning's roughness
WW(6): Pervious area Manning's roughness
WSTORE1: Impervious area depression storage, inch
WSTORE2: Pervious area depression storage, inch

Horton equation
WLMAX: Maximum initial infiltration rate, inch/hr
WLMIN: Minimum (asymptotic) infiltration rate, inch/hr
DECAY: Decay rate of infiltration in Horton's equation, 1/sec

[a] Measurements of width of subcatchment and area of subcatchment are derived from site-specific topographic maps.

Table C2.4. Calibration Results for Flow Model

USGS Station	Node	Flow Minimum (cfs)	Flow Mean (cfs)	Flow Maximum (cfs)	Flow Total (cf)
Observed					
Bayou Creek near Grahamville, KY	B10	4.20	14.01	443.00	2.19E+08
Little Bayou Creek near Grahamville, KY	L09	0.33	3.06	197.00	4.77E+07
Simulated					
Bayou Creek near Grahamville, KY	B10	0.00	14.86	281.06	2.31E+08
Little Bayou Creek near Grahamville, KY	L09	0.00	3.40	101.97	5.29E+07

cf = cubic feet
cfs = cubic feet per second

Table C2.5. K_{oc}, K_d, and RCOEF for the Two Primary COPCs Selected for Surface Water Modeling

COPC	[1]K_{oc} (L/kg)	[1]K_d (L/kg)	[2]RCOEF (/in)
Organics			
Total PCBs	3.09E+05	2.90E+03	1.71E-01
Radionuclides			
Uranium-238+D		1.50E+01	5.82E-01

Selected
foc = 0.0094, Δz = 0.1 cm, F = 100, and ρb = 1.2 kg/L
RCOEFF = F/(Kd*Δz*ρb)
foc = fraction organic carbon
Δz = thickness
F = proportionality constant
ρb = bulk density of soil
K_{oc} = organic carbon partition coefficient
K_d = soil-water adsorption/distribution coefficient
RCOEF = washoff coefficient
COPC = contaminants of potential concern
[1] Reference for the Kd is provided in Appendix C1, Table C1.6.
[2] The washoff coefficient RCOEFF (which is a function of Kd) was developed through transport calibration.
Note: SWMM modeling was performed for Total PCBs and Uranium-238+D to verify the MUSLE results. (See main text, Section 5.4.2.6, of the SI/BRA.)

Table C2.6. Area, Volume, and Mass of Soil in EU Hot Spots for Surface Water Modeling

Draining Outfall	Area[1] (acre)	Volume (ft^3)	Mass (kg)
Total PCBs			
Outfall 001	0.094	2.05E+03	6.96E+04
Outfall 002	na	na	na
Outfall 008	0.045	9.80E+02	3.33E+04
Outfall 010	0.136	2.96E+03	1.01E+05
Outfall 011	na	na	na
Outfall 012	na	na	na
Outfall 015	0.033	7.19E+02	2.44E+04
Uranium-238			
Outfall 001	0.233	5.07E+03	1.72E+05
Outfall 002	na	na	na
Outfall 008	0.073	1.59E+03	5.40E+04
Outfall 010	na	na	na
Outfall 011	na	na	na
Outfall 012	na	na	na
Outfall 015	0.336	7.32E+03	2.49E+05

[1] Refer to Section C1.6 for a description of the process of defining "hot spots". Section 4.2.2.1 of the main text documents the EUs containing "hot spots". Figures C1.1 through C1.15 show the areas of the "hot spots". Note that the area of the "hot spots" on Figures C1.1 through C1.15 are given in units of ft^2 and in Table C2.6 are given in units of acre. 1 acre = 43, 560 ft^2.

Selected
D = 0.5 ft (the depth available for erosion) and ρb = 1.2 kg/L
Mass = Volume*ρb*28.32 L/ft^3
Volume = Area*D*43,560 ft^2
D = depth
ρb = bulk density of soil
na = no source "hot spots" identified
EU = exposure unit

Table C2.7. Mean Concentration and Load of COPCs at the EU Hot Spots Selected for Surface Water Modeling

EU Hotspot Drainage	COPC	Area Weighted Mean Concentration for All Hot Spots (mg/kg or pCi/g)	Load (mg or pCi)
Outfall 001	Total PCBs	27.9	1.94E+06
Outfall 001	Uranium-238+D	323.7	5.58E+10
Outfall 002	Total PCBs	na	na
Outfall 002	Uranium-238+D	na	na
Outfall 008	Total PCBs	49.0	1.65E+06
Outfall 008	Uranium-238+D	103.3	5.59E+09
Outfall 010	Total PCBs	199.5	2.00E+07
Outfall 010	Uranium-238+D	na	na
Outfall 011	Total PCBs	na	na
Outfall 011	Uranium-238+D	na	na
Outfall 012	Total PCBs	na	na
Outfall 012	Uranium-238+D	na	na
Outfall 015	Total PCBs	262.0	6.46E+06
Outfall 015	Uranium-238+D	198.8	4.94E+10

COPC = chemical of potential concern
EU = exposure unit
na = no EU “hot spots” identified

Table C2.8. EU Hot Spot-Creek Connection

EU Hot Spot Outfall	SWMM Discharge Node
Outfall 001	B09
Outfall 008	B06
Outfall 010	L05
Outfall 015	B07

EU = exposure unit
SWMM = Storm Water Management Model

Table C2.9 SWMM Modeling Parameters Sensitivity Analysis

Impermeability	**=**	**0%**	**25%**	**50%**	**75%**	**100%**
Location	Target Conc. (mg/l)	Run A1	Baseline Model	Run A2	Run A3	Run A4
OF_001	1.80E-04	3.47E-05	2.94E-05	4.92E-05	8.23E-05	1.32E-04
OF_002	1.86E-04	NA	NA	NA	NA	NA
OF_008	2.29E-04	3.69E-05	3.22E-05	5.34E-05	8.92E-05	1.43E-04
OF_010	3.60E-04	5.86E-04	5.87E-04	9.89E-04	1.70E-03	2.74E-03
OF_011	2.27E-04	NA	NA	NA	NA	NA
OF_012	1.80E-03	NA	NA	NA	NA	NA
OF_015	1.70E-04	1.90E-04	1.57E-04	2.63E-04	4.40E-04	7.06E-04

Minimum Inf. Rate Multiplier	**=**	**0.5**	**1.0**	**2.0**	**5.0**	**10.0**
Location	Target Conc. (mg/l)	Run B1	Baseline Model	Run B2	Run B3	Run B4
OF_001	1.80E-04	1.08E-04	2.94E-05	1.00E-06	1.00E-06	1.00E-06
OF_002	1.86E-04	NA	NA	NA	NA	NA
OF_008	2.29E-04	1.18E-04	3.22E-05	9.12E-07	9.12E-07	9.12E-07
OF_010	3.60E-04	2.05E-03	5.87E-04	2.05E-06	2.05E-06	2.05E-06
OF_011	2.27E-04	NA	NA	NA	NA	NA
OF_012	1.80E-03	NA	NA	NA	NA	NA
OF_015	1.70E-04	5.79E-04	1.57E-04	6.25E-06	6.25E-06	6.25E-06

Table C2.10. Transport Calibration Results

Final Calibration - Run C1	Observed PCB Concentration In Surface Water	Impermeability	Min. Inf. Rate Multiplier	SWMM Predicted PCB Concentration
Location	**(mg/L)**	**(%)**	**(unitless)**	**(mg/L)**
OF_001	1.80E-04	25%	0.05	1.70E-04
OF_002	1.86E-04	NA	NA	NA
OF_008	2.29E-04	25%	0.05	1.84E-04
OF_010	3.60E-04	25%	1.10	4.20E-04
OF_011	2.27E-04	NA	NA	NA
OF_012	1.80E-03	NA	NA	NA
OF_015	1.70E-04	25%	1.00	1.57E-04

	Observed U-238 Concentration In Surface Water	Impermeability	Min. Inf. Rate Multiplier	SWMM Predicted U-238 Concentration
Location	**(pCi/L)**	**(%)**	**(unitless)**	**(pCi/L)**
OF_001	6.57E+00	25%	0.05	3.30E+00
OF_002	8.70E-01	NA	NA	NA
OF_008	3.82E+01	25%	0.05	6.16E-01
OF_010	2.04E+01	25%	1.10	NA
OF_011	1.80E+02	NA	NA	NA
OF_012	3.87E+01	NA	NA	NA
OF_015	6.93E+01	25%	1.00	1.21E+00

Table C2.11. SWMM Modeled Contaminant Concentration of PGDP Surface Water COPCs (Total PCBs and Uranium-238) at Multiple Receptor Locations

Action level	**Total PCBs**	**Uranium-238**
Industrial Worker (Action)	1.65E-02 mg/L	N/A
Industrial Worker (No Action)	1.65E-04 mg/L	N/A
Child Recreational (Action)	1.12E-02 / 9.61E-03 mg/L[1]	4.91E+03 pCi/L
Child Recreational (No Action)	1.12E-04 / 9.61E-05 mg/L[1]	4.91E+01 pCi/L

	SWMM Predicted Surface Water Concentrations[3]			
	Total PCBs		**Uranium-238**	
Receptor Location[2]	**Average (mg/L)**	**Maximum (mg/L)**	**Average (pCi/L)**	**Maximum (pCi/L)**
Outfall 001	**1.18E-04**	**5.27E-04**	1.06E+01	**5.15E+01**
Outfall 008	**1.84E-04**	**8.11E-04**	1.94E+00	9.26E+00
Outfall 010	**4.21E-04**	**1.70E-03**	0.00E+00	0.00E+00
Outfall 015	**1.58E-04**	**6.68E-04**	4.07E+00	1.73E+01
B09 (IP for Bayou Creek)	8.50E-06	1.46E-05	4.40E-02	8.18E-01
B06 (from OF 8)	4.80E-07	1.98E-05	5.06E-03	2.27E-01
L05 (from OF 10)	2.16E-06	1.91E-05	0.00E+00	0.00E+00
B07 (from OF 15)	5.57E-07	4.13E-05	7.70E-03	7.13E-01
L07 (IP for Little Bayou Creek)	1.37E-06	7.93E-06	0.00E+00	0.00E+00

[1] Multiple screening levels are used to reflect a wading risk scenario for Little Bayou Creek (east side of PGDP) and a swimming risk scenario for Bayou Creek (west side of PGDP). Little Bayou Creek has relatively little flow and offers minimal opportunity for swimming. Bayou Creek has greater flow and opportunity for swimming, which poses a greater risk (consumption in addition to dermal contact) in the child recreation scenario.

[2] Outfall concentrations are at the pipe and creek concentrations are immediately downgradient of the outfalls.

[3] Predicted concentrations are based on 30-year simulations.

L04, L05, and L07 are discharge points in Little Bayou Creek.

B06, B07, and B09 are discharge points in Bayou Creek.

Bolded values represent exceedance of one or more of no action screening levels.

IP = Integrator Point.

OF = Outfall.

ATTACHMENT

STORM WATER MANAGEMENT MODEL OUTPUTS

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CD:

APPENDIX C

STORM WATER MANAGEMENT MODEL OUTPUTS

APPENDIX D

BASELINE HUMAN HEALTH RISK ASSESSMENT

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CONTENTS

FIGURES

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TABLES

ACRONYMS

AF	GI absorption fraction
ALAD	aminolevulinic acid dehydratase
AOC	area of concern
As	inorganic arsenic
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BaP	benzo(a)pyrene
BaPE	BaP equivalent
bgs	below ground surface
BHHRA	baseline human health risk assessment
BKSF	Biokinetic Slope Factor
BRHS	British Regional Heart Study
BJC	Bechtel Jacobs Company LLC
CDI	chronic daily intake
CFR	*Code of Federal Regulations*
CNS	central nervous system
COC	contaminant of concern
COPC	chemical of potential concern
Cr	chromium
CSM	conceptual site model
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EU	exposure unit
GI	gastrointestinal
GSD	geometric standard deviation
HEAST	Health Effects Assessment Summary Table
HI	hazard index
HQ	hazard quotient
IBTL	Industrial Biotest Laboratories
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
IEUBK	Integrated Exposure Uptake Biokinetic
IQ	intelligence quotient
IRIS	Integrated Risk Information System
ISOCS	In-Situ Object Counting System
KDFWR	Kentucky Department of Fish and Wildlife Resources
KEPPC	Kentucky Environmental and Public Protection Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
LET	linear energy transfer
LOAEL	lowest observed adverse effect level
mgd	million gallons per day
MOC	media of concern
NDMA	n-nitrosodimethylamine

NEA/OECD	Nuclear Energy Agency/Organization of Economic Cooperation and Development
NHANES III	National Health and Nutrition Evaluation Survey III
NOAEL	no observed adverse effect level
NRC	Nuclear Regulatory Commission
NRCC	National Research Council of Canada
NSDD	North-South Diversion Ditch
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PpB	baseline blood lead concentration
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen ion concentration
ppm	part per million
POC	pathway of concern
PROV	provisional
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RBC	risk-based concentration
RBF	relative bioavailability factor
RDA	recommended daily allowance
RfC	reference concentration
RfD	oral reference dose
RGO	remedial goal option
RI	remedial investigation
RME	reasonable maximum exposure
SADA	Spatial Analysis and Decision Assistance
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
Sb	antimony
SF	slope factor
SI	site investigation
SQL	sample quantitation limit
SWMU	solid waste management unit
SWOU	surface water operable unit
TARA	Toxicology and Risk Analysis
^{99}Tc	technetium-99
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TEF	toxicity equivalence factor
TWA	time-weighted average
UCL	upper confidence limit
UF_6	uranium hexafluoride
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	waste area grouping
WHO	World Health Organization
WKWMA	West Kentucky Wildlife Management Area

D.1 RESULTS OF PREVIOUS STUDIES

Human health risk assessments have been completed in the North-South Diversion Ditch (NSDD) Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 that are useful in understanding the risks to human health posed by exposure to contaminants present at or in the vicinity of the Surface Water Operable Unit (SWOU) (On-Site) at the Paducah Gaseous Diffusion Plant (PGDP). For the NSDD, a Screening-Level Human Health Risk Assessment (SHHRA) and a Screening Ecological Risk Assessment (SERA) were performed in support of the Record of Decision (ROD) for NSDD (DOE 2002), and the SHHRA was performed to support discussions with the regulatory agencies in 2003 (DOE 2003a). For the outfalls, an SHHRA and SERA were performed in support of the Sitewide Sediment Controls (SWSC) Project and an SHHRA was performed in support of a discussion with the regulatory agencies (DOE 2003b). In addition, a Baseline Human Health Risk Assessment (BHHRA) and SERA were completed for solid waste management unit (SWMU) 97 as part of the site evaluation report for waste area grouping (WAG) 15 (DOE 1996). These risk assessments have been summarized in Appendix B of the approved Sampling and Analysis Plan (SAP). Appendix B of the SAP is included in this document as Attachment D1a.

D.2. IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section describes the processes used to identify chemicals of potential concern (COPCs) for the SWOU. Specifically, the sources of data, the procedures used to screen the data, and the methods used to derive representative concentrations in environmental media and biota under current and future conditions are presented. Additionally, this section describes additional site characterization data used in the exposure assessment presented in Section D.3.

A list of COPCs for the SWOU was identified prior to sampling and analysis, based on investigations of other portions of the PGDP property (DOE 2005). Table 5.1 of the approved SAP was the starting point for the COPC selection process. The COPC selection process used all historical and current data within an Area of Concern (AOC) to identify any chemicals present in the SWOU, but not associated with past or current plant operations that could contribute to risks or hazards at the site. Several such chemicals were identified and are discussed qualitatively in Section D.6, Uncertainty in the Risk Assessment. Note that regulatory agency approval of the SAP and the COPCs selected therein documents regulatory approval of this deviation from the COPC selection process outlined in the Risk Methods document (DOE 2001).

D.2.1 SOURCES OF DATA

Data used in the BHHRA were taken from the following sources: (1) SWOU storm sewer data; (2) SWOU outfall and associated internal ditch Activity 1 [polychlorinated biphenyl (PCB) data only] and Activity 2 data; (3) SWOU NSDD Section 3, 4, and 5 Activity 1 (PCB data only) and Activity 2 data; (4) SWOU replacement samples data; (5) historical data [Oak Ridge Environmental Information System (OREIS); see SWOU SAP, Appendix C.6], and (6) OREIS environmental monitoring data. The SWOU storm sewer data incorporated in the BHHRA included surface water from four Step 1 locations and eight upgradient Step 2 locations at C-340 storm sewers and internal plant ditches. SWOU outfall Activity 1 PCB data and Activity 2 data included soil/sediment samples collected from 0 to 1 ft below ground surface (bgs) from Outfalls 001, 002, 008, 010, 011, 012, and 015. SWOU NSDD Sections 3, 4, and 5 Activity 1 PCB data and Activity 2 data included soil/sediment samples collected from 0 to 1 ft bgs. SWOU replacement samples were documented in Appendix H of the SWOU SAP and included existing soil and sediment data from samples near a planned ditch sample location. Historical data samples were documented in the SWOU SAP, Appendix C.6, and included useable data that met the sample collection data requirements and also included soil and sediment that was collected at various depths. Environmental monitoring data included data in OREIS from 1999 to 2005 that was collected near the plant site. Analytical results are used in the BHHRA to estimate exposure point concentrations (EPCs) that human receptors may be exposed to via ingestion, dermal contact, inhalation, or external exposure (for radionuclides), as well as to estimate contaminant concentrations in game.

The data sets presented in the site investigation (SI) and the BHHRA may differ in minor details due to different assessment methodologies (e.g., spatial versus statistical).

D.2.2 GENERAL DATA EVALUATION CONSIDERATIONS

Data were evaluated to ensure sufficient quality for use in the BHHRA. A general description of this evaluation is provided in this section. A graphical presentation of this evaluation is shown in Figure D.1.

Data evaluation was performed in eight steps:

(1) **Evaluation of sampling**—Data were examined to ensure that sampling methods were adequate for determining the nature and extent of contamination. Specific details of the sampling methods used and the equipment employed to collect samples are described in Section 5 of the SWOU SAP (DOE 2005) and Chapter 2 of Volume 1 of this report. Sample collection followed approved work plans and can be accepted as adequate for site characterization for risk assessment.

(2) **Evaluation of analytical methods**—These methods, as described in Section 5 of the SWOU SAP (DOE 2005), are adequate for the risk assessment.

(3) **Evaluation of sample quantitation limits (SQLs)**—The SQLs for each analyte and sample were examined to determine if these limits were below the concentration or activity at which the analyte may pose a risk or hazard to human health or the environment. If the maximum SQL for an analyte across all samples within a medium was greater than the concentration or activity that may pose a threat to human health or the environment and that analyte was not detected in any sample, the data for that analyte were deemed of insufficient quality and only a qualitative assessment for that analyte is presented in this assessment.

(4) **Evaluation of data qualifiers and codes**—The data used in the risk assessment were validated following accepted validation guidance commonly used at the PGDP. Data not rejected during the validation process are appropriate for use in the BHHRA.

(5) **Elimination of chemicals not detected**—For each sample, any analyte not detected in at least one media group using an appropriate SQL was eliminated from the data set.

(6) **Examination of toxicity of detected analytes**—Chemicals with maximum detections less than residential no action levels were eliminated as COPCs for the risk assessment. Human health no action levels based on residential exposure were derived according to equations in the Methods Document (DOE 2001, Appendix A, Tables A.10–A.36) using the most recent toxicity values available (DOE 2006a, http://risk.lsd.ornl.gov/).

(7) **Comparison of maximum analyte concentrations and activities detected in site samples to analyte concentrations and activities detected in background samples**—Background concentrations for soil were taken from *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1997). Chemicals retained in Step 6 above, but with concentrations within the background range, can be eliminated from further consideration; however, none of the chemicals examined in the COPC selection process fell into this category.

(8) **Essential human nutrients**—As provided for in the Methods Document (DOE 2001), four analytes—calcium, magnesium, potassium, and sodium—were on this list of COPCs from the SAP and were eliminated as COPCs.

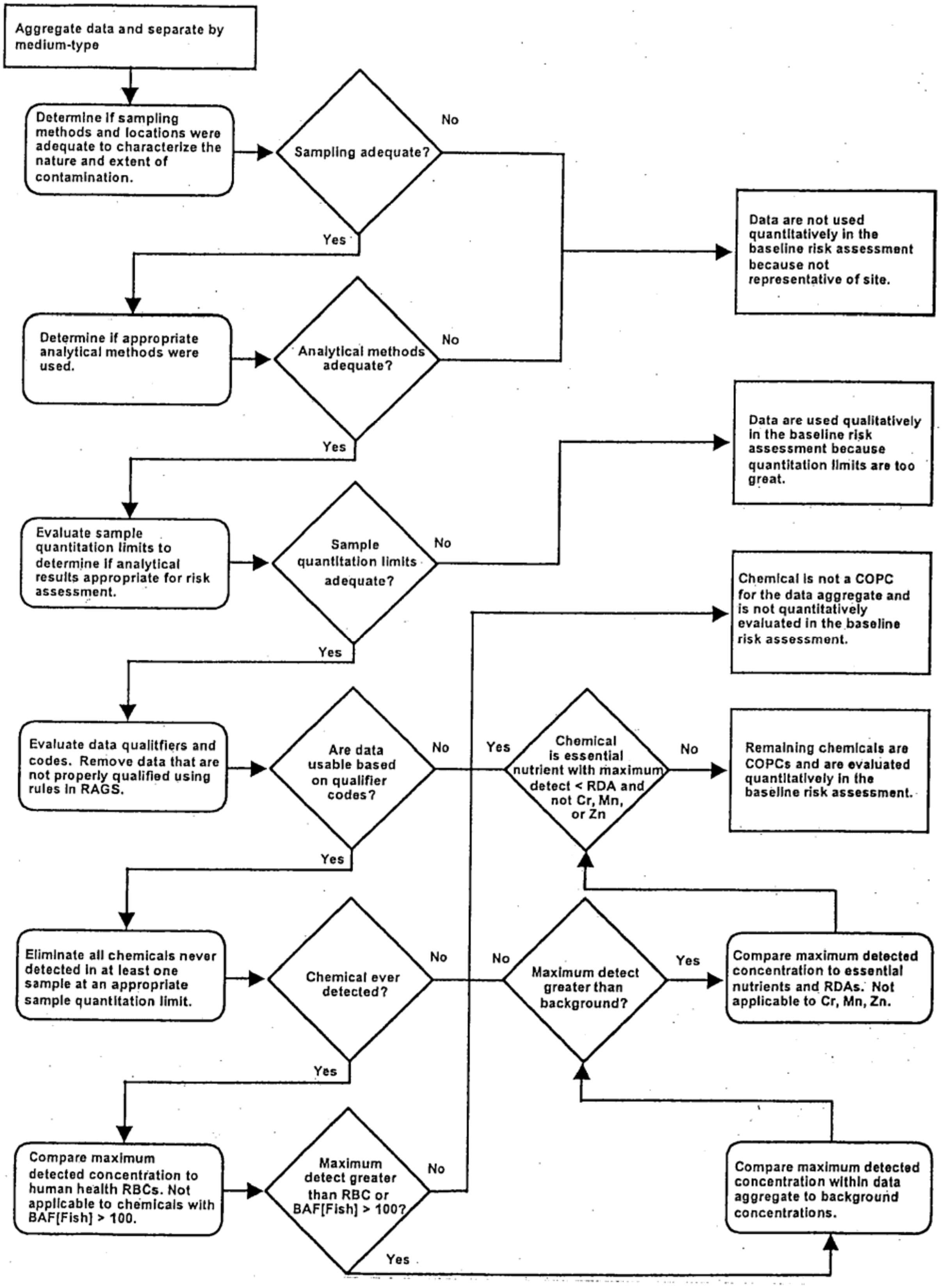

Figure D.1. Data Evaluation Steps

Note again that COPCs were selected based on Table 5.1 of the approved SAP for the AOC. Additional discussion of chemicals not on this list is provided in Section D.6, Uncertainty in the Risk Assessment.

D.2.3 RISK ASSESSMENT-SPECIFIC DATA EVALUATION

Specific processes used to evaluate data and calculate exposure concentrations under both current and future conditions are described in this section. Section D.2.3.1 summarizes the evaluation performed to determine representative concentrations of COPCs under current/future conditions.

D.2.3.1 Current/Future Conditions

The specific processes used to evaluate data and calculate exposure concentrations under current/future conditions are described in this section. A statistical summary of data used in the BHHRA is presented in Attachment D1b to this appendix.

D.2.3.1.1 Data consolidation

The project Microsoft Access database was queried for samples collected from soil, sediment, and surface water. Soil and sediment data then were grouped together because the environmental setting prevents differentiation of most sample locations. The SWOU consists solely of drainage ditches that are intermittently wet. Soil and sediment designations, therefore, are interchangeable depending upon whether water is present in the drainages. Further, soil samples (less numerous) typically were collected close to the locations of sediment samples. Receptors active in these areas are highly unlikely to be exposed to only one or the other medium. Finally, because soil samples are much less numerous by themselves, they are not representative of the entire ditch network within the SWOU. Thus, the most reasonable approach to risk assessment for this operable unit (OU) is to combine soil and sediment into a single data set and assess exposures to combined soil/sediment. For the remainder of this report, the solid medium at the site is referred to as "soil/sediment."

Grouped data were made ready for use in the human health risk evaluation through the following manipulations.

- **Units of measure were converted to units used in exposure calculations**—All chemical concentrations were converted to units of mg/kg or mg/L, and all radionuclide activities were converted to units of pCi/g or pCi/L.

- **Toxicity Equivalents were calculated for Total Polycyclic Aromatic Hydrocarbons (PAHs) [as benzo(a)pyrene equivalents (BaPEs)]**—In accordance with U.S. Environmental Protection Agency (EPA) Region 4 guidance (EPA 1995) and the Methods Document (DOE 2001), risk assessment for carcinogenic PAHs was performed using BaPEs. Toxicity equivalence factors (TEFs) used for this conversion are provided in Section D.4. TEFs are based on the potency of each PAH relative to benzo(a)pyrene. The concentration of each individual carcinogenic PAH for which a TEF exists was multiplied by its TEF to yield a BaPE. Subsequently, all TEFs were summed for each sample to yield estimates of total BaPEs by sampling location.

- **Total PCBs**—For PCBs, the maximum detected concentrations of individual Aroclors were summed by sample to yield estimated Total PCB concentrations.

If any individual carcinogenic PAH or Aroclor was detected within the SWOU, in either soil/sediment or surface water, the assessment assumed that these chemicals could be present in all locations. For PAHs, results for nondetect samples were set equal to the lowest reporting limit (SQL) by sample. For example, if the lowest reporting limit for any of the carcinogenic PAH was 50 ug/kg, total BaPE for that sample was set equal to 50. For PCBs, only 23 out of nearly 3,000 sample results were nondetect for all Aroclor mixtures. These samples were found scattered among the various exposure units (EUs) defined in the SAP. Samples with detections were considered representative for PCB, and these 23 sample results were not incorporated into the calculation of EPCs. This approach results in estimates of BaPEs and Total PCBs that are likely to be biased high. This bias is further discussed in Section 6, Uncertainty in the Risk Assessment.

D.2.3.1.2 Summary statistics

Summary statistics were calculated for all of the data after consolidation. Included in the summaries (see Attachment D1b, Tables D1b.1 and D1b.2 for data summaries of soil/sediment and surface water, respectively) are analyte name, frequency of detection, range of detected values, range of nondetected values (i.e., the range of the SQLs used in samples in which the analyte was not detected), arithmetic mean of the detected concentrations, and units of measure for the analyte.

D.2.3.1.3 No action level screen

Maximum detected concentrations of each analyte in soil/sediment then were compared to the lesser of the lifetime excess cancer-based and child hazard-based no action values for that analyte (Attachment D1b, Table D1b.1). Any chemical present at a maximum concentration less than its residential no action level was eliminated as a COPC for the SWOU. Results of this screening step provided a list of COPCs from Activity 1 and Activity 2 samples from the SWOU.

In the risk assessment, emphasis is placed on recreational and industrial exposure scenarios, since current or potential future exposures in drainage features likely will be limited to people visiting the site occasionally on a recreational basis or for a short-term construction project.

D.2.3.1.4 Identification of COPCs

As previously indicated, COPCs were identified based on previous investigations at PGDP (DOE 2005). Screening of maximum concentrations of chemicals against the lesser of the lifetime excess cancer-based and child hazard-based no action values identified 36 chemicals as COPCs for the SWOU as listed in Table D.1. All of the COPCs identified in Table D.1, therefore, were retained for risk assessment.

Several chemicals on the initial list of possible soil/sediment COPCs were eliminated from further consideration. These chemicals are 1,1,1-trichloroethane; acenaphthene; acenaphthylene; anthracene; benzo(g,h,i)perylene; cobalt; fluoranthene; fluorene; naphthalene; phenanthrene; plutonium-238; thallium; and trichloroethene. Maximum detected concentrations of these chemicals did not exceed the lesser of the lifetime excess cancer-based and child hazard-based no action values. Additionally, calcium, magnesium, potassium, and sodium were eliminated as COPCs because they are essential nutrients.

A few chemicals that may have been selected as COPCs, but were not included in Table 5.1 of the approved SAP, were identified as part of a more complete COPC screening process. This screening was

Table D.1. Comparison of Detected Analytes in Soil/Sediment to the Lesser of Lifetime Excess Cancer-Based and Child Hazard-Based No Action Levels

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
1,1,1-Trichloroethane	mg/kg	104/334	0.01	2.32E+01	No/A
1,1,2,2-Tetrachloroethane	mg/kg	2/40	0.01	1.45E-01	No/A
1,1,2-Trichloroethane	mg/kg	2/40	0.01	3.45E-01	No/A
1,1-biphenyl	mg/kg	0/29	0.13	3.50E+01	No/A.B
1,1-Dichloroethane	mg/kg	2/40	0.01	2.29E+01	No/A
1,1-Dichloroethene	mg/kg	1/42	0.508	2.76E-02	No/B
1,2,3,4,6,7,8-Heptachlorodibenzofuran	mg/kg	2/2	6.37E-05	1.49E-04	No/E
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	mg/kg	2/2	4.50E-04	1.49E--04	No/F
1,2,3,4,7,8,9-Heptachlorodibenzofuran	mg/kg	2/2	5.90E-06	1.49E-04	No/E
1,2,3,4,7,8-Hexachlorodibenzofuran	mg/kg	2/2	8.56E-06	1.49E-05	No/E
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	2/2	6.60E-06	1.49E-05	No/E
1,2,3,6,7,8-Hexachlorodibenzofuran	mg/kg	2/2	4.39E-06	1.49E-05	No/E
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	2/2	1.82E-05	1.49E-05	No/E
1,2,3,7,8,9-Hexachlorodibenzofuran	mg/kg	1/2	3.04E-06	1.49E-05	No/E
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	mg/kg	2/2	9.43E-06	1.49E-05	No/E
1,2,3,7,8-Pentachlorodibenzofuran	mg/kg	1/2	1.61E-06	2.98E-05	No/E
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	mg/kg	0/2	1.22E-06	2.98E-06	No/E
1,2,4-Trichlorobenzene	mg/kg	5/89	0.5	1.22E+01	No/A,B
1,2-Dichlorobenzene	mg/kg	5/89	0.5	4.00E+01	No/A,B
1,2-Dichloroethane	mg/kg	2/40	0.01	1.52E-01	No/A,B
1,2-Dichloropropane	mg/kg	2/40	0.01	1.80E-01	No/A,B
1,2-Dimethylbenzene	mg/kg	2/40	0.01	NL	No/A,B
1,2-Diphenylhydrazine	mg/kg	4/29	0.5	1.17E-01	No/E
1,3-Dichlorobenzene	mg/kg	5/89	0.5	9.97E-01	No/A
1,4-Dichlorobenzene	mg/kg	5/89	0.5	1.36E+00	No/A
2,3,4,6,7,8-Hexachlorodibenzofuran	mg/kg	1/2	3.04E-06	NL	No/E
2,3,4,7,8-Pentachlorodibenzofuran	mg/kg	2/2	1.44E-05	2.99E-05	No/A
2,3,7,8-Tetrachlorodibenzofuran	mg/kg	2/2	1.20E-05	1.49E-05	No/A
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	0/2	1.22E-06	1.49E-06	No/F
2,4,5-Trichlorophenol	mg/kg	5/89	0.5	1.60E+02	No/A
2,4,6-Trichlorophenol	mg/kg	5/89	0.5	8.51E+00	No/A
2,4'-DDD	mg/kg	0/29	0.012	1.13E+00	No/A,B
2,4'-DDE	mg/kg	2/29	0.015	7.94E-01	No/A
2,4'-DDT	mg/kg	0/29	0.012	7.94E-01	No/A,B
2,4-Dichlorophenol	mg/kg	5/89	0.5	6.93E+00	No/A
2,4-Dimethylphenol	mg/kg	6/89	0.5	3.20E+01	No/A
2,4-Dinitrophenol	mg/kg	4/74	0.5	5.28E+00	No/A
2,4-Dinitrotoluene	mg/kg	4/89	0.5	2.09E-01	No/A,B
2,6,10,14-Tetramethylhexadecane	mg/kg	1/29	0.75	NL	No/B
2,6,10,14-Tetramethylpentadecane	mg/kg	1/29	0.78	NL	No/B
2,6-Dichlorophenol	mg/kg	4/29	0.5	NL	No/B
2,6-Dimethylnaphthalene	mg/kg	1/29	0.13	NL	No/B
2,6-Dinitrotoluene	mg/kg	4/89	0.5	2.09E-01	No/B
2-Butanone	mg/kg	0/40	0.01	1.53E+02	No/A,B
2-Chloronaphthalene	mg/kg	5/89	0.5	3.38E+01	No/A,B
2-Chlorophenol	mg/kg	5/89	0.5	2.81E+00	No/A,B
2-Hexanone	mg/kg	1/40	0.01	NS	No/B
2-Methyl-4,6-dinitrophenol	mg/kg	5/88	0.5	NL	No/E
2-Methylnaphthalene	mg/kg	4/97	0.65	NS	No/B
2-Methylphenol	mg/kg	5/89	0.5	NL	No/E
2-Nitrobenzenamine	mg/kg	5/89	0.5	NL	No/E

Table D.1 (Continued)

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
2-Nitrophenol	mg/kg	5/89	0.5	NL	No/E
3,3'-Dichlorobenzidine	mg/kg	8/88	0.5	2.08E-01	Yes
3-Nitrobenzenamine	mg/kg	6/89	0.5	NL	No
4,4'-DDD	mg/kg	4/29	0.062	1.13E+00	No/A
4,4'-DDE	mg/kg	4/29	0.062	7.94E-01	No/A
4,4'-DDT	mg/kg	2/29	0.062	7.94E-01	No/A
4-Bromophenyl phenyl ether	mg/kg	6/88	0.5	NL	No/E
4-Chloro-3-methylphenol	mg/kg	6/89	0.5	NL	No/E
4-Chlorobenzenamine	mg/kg	6/89	0.5	NL	No/E
4-Chlorophenyl phenyl ether	mg/kg	6/88	0.5	NL	No/E
4-Methyl-2-pentanone	mg/kg	2/40	0.01	NL	No/B
4-Methylphenol	mg/kg	4/75	0.5	NL	No/E
4-Nitrobenzenamine	mg/kg	6/89	0.5	NL	No/E
4-Nitrophenol	mg/kg	6/89	0.5	2.11E+01	No/A
Acenaphthene	mg/kg	166/472	9.4	4.90E+01	No/A,D
Acenaphthylene	mg/kg	156/472	1.5	NS	No/D
Acetone	mg/kg	2/35	0.01	5.34E+01	No/A
Actinium-228	pCi/g	4/4	1.066	NL	No/E
Activity of U-235	pCi/g	319/415	3.11		No/E
Aldrin	mg/kg	0/29	0.062	5.51E-03	No/B
alpha-BHC	mg/kg	0/29	0.062	4.37E-02	No/B
alpha-Chlordane	mg/kg	4/29	0.062	5.34E-01	No/A
Aluminum	mg/kg	513/514	15500	7.32E+02	Yes
Americium-241	pCi/g	141/533	15.24	8.36E-01	Yes
Aniline	mg/kg	5/29	0.5	1.12E+01	No/A
Anthracene	mg/kg	170/472	30	5.26E+02	No/A,D
Antimony	mg/kg	257/507	20	6.35E-02	Yes
Antimony-124	pCi/g	0/4	0.01308	5.34E-01	No/A,B
Antimony-125	pCi/g	0/4	0.03606	NL	No/B
Arsenic	mg/kg	236/507	57.1	1.32E-01	Yes
Azinphos-methyl	mg/kg	0/29	0.15	NL	No/B
Barium	mg/kg	507/507	319	3.70E+01	Yes
Barium-133	pCi/g	0/4	0.01087	NL	No/B
Barium-140	pCi/g	0/4	0.01611	NL	No/B
Benz(a)anthracene	mg/kg	192/472	51	6.70E-02	Yes
Benzene	mg/kg	2/40	0.01	3.27E-01	No/A,B
Benzenemethanol	mg/kg	4/29	0.94	NL	No/E
Benzidine	mg/kg	3/29	0.5	5.91E-04	No/E
Benzo(a)pyrene	mg/kg	189/472	130	6.70E-03	Yes
Benzo(b)fluoranthene	mg/kg	209/472	290	6.70E-02	Yes
Benzo(e)pyrene	mg/kg	22/29	1.5	NL	No/D
Benzo(ghi)perylene	mg/kg	182/471	42	NS	No/D
Benzo(k)fluoranthene	mg/kg	181/435	29	6.70E-01	Yes
Benzoic acid	mg/kg	3/29	0.51	1.06E+04	No/A
Beryllium	mg/kg	160/517	3.3	1.60E-01	Yes
Beta activity	pCi/g	458/471	2730		
beta-BHC	mg/kg	0/29	0.062	1.48E-01	No/B
Bis(2-chloroethoxy)methane	mg/kg	5/89	0.5	NS	No/E
Bis(2-chloroethyl) ether	mg/kg	6/88	0.5	2.90E-02	Yes
Bis(2-chloroisopropyl) ether	mg/kg	1/88	0.5	5.95E-01	No/A,B
Bis(2-ethylhexyl)phthalate	mg/kg	3/84	0.5	2.84E+00	No/A,B
Bismuth-211	pCi/g	4/4	2.377	NL	No/E

Table D.1 (Continued)

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
Bismuth-212	pCi/g	2/4	0.8068	NL	No/E
Bismuth-214	pCi/g	4/4	0.9238	NL	No/E
Boron	mg/kg	1/38	200	2.21E+02	No/A,B
Bromodichloromethane	mg/kg	1/40	0.01	3.90E-01	No/A,B
Bromoform	mg/kg	1/40	0.01	1.38E+01	No/A,B
Bromomethane	mg/kg	1/40	0.01	1.86E-01	No/A,B
Butyl benzyl phthalate	mg/kg	1/74	0.5	3.73E+02	No/A,B
Cadmium	mg/kg	42/507	19.3	2.64E+00	Yes
Cadmium, Dissolved	mg/kg	0/7	2	NL	No/B
Calcium	mg/kg	513/513	314000	NL	No/C
Carbazole	mg/kg	8/89	7.3	6.14E+00	Yes
Carbon disulfide	mg/kg	1/40	0.01	1.57E+01	No/A,B
Carbon tetrachloride	mg/kg	1/40	0.01	9.78E-02	No/A,B
Cerium-139	pCi/g	0/4	0.04875	NL	No/B
Cerium-141	pCi/g	0/4	0.6713	NL	No/B
Cerium-144	pCi/g	0/4	0.3684	NL	No/B
Cesium-134	pCi/g	4/43	0.0228	NL	No/E
Cesium-136	pCi/g	0/4	0.06062	NL	No/B
Cesium-137	pCi/g	378/499	181	1.28E-02	Yes
Chlordane	mg/kg	0/29	0.47	5.34E-01	No/A,B
Chlorobenzene	mg/kg	1/40	0.01	4.47E+00	No/A,B
Chloroethane	mg/kg	0/5	0.01	NL	No/B
Chloroform	mg/kg	0/5	0.01	1.82E-02	No/A,B
Chloromethane	mg/kg	0/5	0.01	8.84E-01	No/A,B
Chromium	mg/kg	509/510	473	6.05E+01	Yes
Chromium-51	pCi/g	0/4	0.03836	NL	No/B
Chrysene	mg/kg	202/472	41	6.70E+00	Yes
cis-1,2-Dichloroethene	mg/kg	0/7	0.508	1.98E+00	No/A,B
cis-1,3-Dichloropropene	mg/kg	0/5	0.01	2.52E-01	No/A,B
Cobalt	mg/kg	488/514	46.6	2.09E+02	No/A
Cobalt-56	pCi/g	0/4	0.01612	NL	No/B
Cobalt-57	pCi/g	0/4	0.007815	NL	No/B
Cobalt-58	pCi/g	0/4	0.009686	NL	No/B
Cobalt-60	pCi/g	29/496	4.6	2.63E-03	Yes
Copper	mg/kg	482/507	234	6.81E+01	Yes
Cyanide	mg/kg	0/20	1	1.26E+01	No/A,B
Decane	mg/kg	1/29	0.75	NL	No/B
delta-BHC	mg/kg	3/29	0.062	NS	No/E
Demeton	mg/kg	0/2	0.015	6.39E-02	No/A,B
Diazinon	mg/kg	0/29	0.015	1.44E+00	No/A,B,D
Dibenz(a,h)anthracene	mg/kg	168/437	14	6.70E-03	Yes
Dibenzofuran	mg/kg	8/52	1.65	2.93E+00	No/A
Dibenzothiophene C1	mg/kg	0/29	0.13	NL	No/B
Dibenzothiophene C2	mg/kg	3/29	0.16	NL	No/E
Dibromochloromethane	mg/kg	0/5	0.01	3.34E-01	No/A,B
Dichlorvos	mg/kg	3/29	0.031	3.23E-01	No/A
Dieldrin	mg/kg	1/29	0.062	5.85E-03	No/B
Diethyl phthalate	mg/kg	5/52	0.5	1.97E+03	No/A
Dimethoate	mg/kg	0/29	0.031	3.20E-01	No/A,B
Dimethyl phthalate	mg/kg	4/52	0.5	2.46E+04	No/A
Di-n-butyl phthalate	mg/kg	23/52	1.6	NL	No/E
Di-n-octylphthalate	mg/kg	5/89	0.5	NL	No/E

Table D.1 (Continued)

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
Docosane	mg/kg	15/29	0.43	NL	No/E
Dodecane	mg/kg	1/29	0.75	NL	No/B
Dotriacontane	mg/kg	18/29	0.43	NL	No/E
Eicosane	mg/kg	15/29	0.43	NL	No/E
Endosulfan I	mg/kg	1/29	0.062	9.59E+00	No/A,B
Endosulfan II	mg/kg	2/29	0.062	9.59E+00	No/A
Endosulfan sulfate	mg/kg	2/29	0.062	NL	No/E
Endrin	mg/kg	0/29	0.062	2.41E-02	No/B
Endrin aldehyde	mg/kg	0/29	0.062	NL	No/B
Ethion	mg/kg	0/29	0.015	7.99E-01	No/A,B
Ethylbenzene	mg/kg	2/40	0.01	6.01E+00	No/A,B
Europium-152	pCi/g	0/4	0.01944	NL	No/B
Europium-154	pCi/g	0/4	0.0173	NL	No/B
Europium-155	pCi/g	0/4	0.1216	NL	No/B
Famphur	mg/kg	0/29	0.06	NL	No/B
Fensulfothion	mg/kg	0/29	0.055	NL	No/B
Fenthion	mg/kg	0/29	0.015	NL	No/B
Fluoranthene	mg/kg	208/435	200	3.43E+01	Yes
Fluorene	mg/kg	166/472	7.6	5.01E+01	No/A,D
gamma-Chlordane	mg/kg	0/29	0.062	5.34E-01	No/A,B
Henicosane	mg/kg	16/29	0.43	NL	No/E
Heptachlor	mg/kg	0/29	0.062	2.79E-02	No/B
Heptachlor epoxide	mg/kg	0/29	0.24	1.38E-02	No/B
heptacosane	mg/kg	28/29	1.2	NL	No/E
Heptadecane	mg/kg	20/29	0.79	NL	No/E
Hexachlorobenzene	mg/kg	4/52	0.5	5.85E-02	No/E
Hexachlorobutadiene	mg/kg	4/52	0.5	3.20E-01	No/E
Hexachlorocyclopentadiene	mg/kg	9/89	0.5	9.59E+00	No/A
Hexachloroethane	mg/kg	4/89	0.5	1.60E+00	No/A,B
Hexacosane	mg/kg	20/29	0.43	NL	No/E
Hexadecane	mg/kg	14/29	0.43	NL	No/E
Indeno(1,2,3-cd)pyrene	mg/kg	186/472	54	6.70E-02	Yes
Iridium-192	pCi/g	0/4	0.01048	NL	No/B
Iron	mg/kg	507/507	182000	3.14E+02	Yes
Iron-59	pCi/g	0/4	0.02634	NL	No/B
Isophorone	mg/kg	5/89	0.5	9.85E+01	No/A
Lead	mg/kg	106/507	303	5.00E+01	Yes
Lead-210	pCi/g	1/4	2.923	5.00E+01	No/A
Lead-211	pCi/g	4/4	2.377	5.00E+01	No/A
Lead-212	pCi/g	4/4	0.9273	5.00E+01	No/A
Lead-214	pCi/g	4/4	0.8645	5.00E+01	No/A
Lindane	mg/kg	1/29	0.062	2.12E-01	No/A,B
Lithium	mg/kg	32/43	10	6.98E+01	No/A
m,p-Cresol	mg/kg	0/14	0.49	9.77E+00	No/A,B
m,p-Xylene	mg/kg	1/40	0.02	6.55E+02	No/A,B
Magnesium	mg/kg	514/514	28100	NS	No/C
Malathion	mg/kg	0/29	0.036	3.20E+01	No/A,B
Manganese	mg/kg	514/514	4470	7.46E+00	Yes
ManganesE-054	pCi/g	0/4	0.02954	NL	No/B
Mercury	mg/kg	79/517	3.28	1.58E-01	Yes
Mercury-203	pCi/g	0/4	0.01619	NL	No/B
Methoxychlor	mg/kg	0/29	0.12	7.99E+00	No/A,B

Table D.1 (Continued)

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
Methyl parathion	mg/kg	1/29	0.015	4E-01	No/A,B
Methylene chloride	mg/kg	11/40	0.017	3.92E+00	No/A
Mirex	mg/kg	0/29	0.062	5.20E-02	No/B
Mocap	mg/kg	1/29	0.015	NL	No/B
Molybdenum	mg/kg	115/408	26.4	1.09E+01	Yes
Naphthalene	mg/kg	156/472	2.8	3.47E+00	No/A
Neodymium-147	pCi/g	0/4	37.6	NL	No/B
Neptunium-237	pCi/g	169/483	12.8	4.05E-02	Yes
Neptunium-239	pCi/g	0/4	0.5308	NL	No/B
n-Hentriacontane	mg/kg	29/29	3.9	NL	No/E
Nickel	mg/kg	435/514	520	3.40E+01	Yes
Niobium-94	pCi/g	0/4	0.01088	NL	No/B
Niobium-95	pCi/g	0/4	1.424	NL	No/B
Nitrobenzene	mg/kg	5/89	0.5	4.92E-01	Yes
N-Nitrosodimethylamine	mg/kg	4/29	0.5	1.84E-03	No/E
N-Nitroso-di-n-propylamine	mg/kg	5/89	0.5	7.30E-03	Yes
N-Nitrosodiphenylamine	mg/kg	5/89	0.5	1.04E+01	No/A
n-Octacosane	mg/kg	23/29	0.43	NL	No/E
Nonacosane	mg/kg	29/29	3.6	NL	No/E
Nonadecane	mg/kg	14/29	0.49	NL	No/E
n-Pentacosane	mg/kg	25/29	0.33	NL	No/E
n-Tetracosane	mg/kg	15/29	0.43	NL	No/E
n-Triacontane	mg/kg	24/29	0.43	NL	No/E
n-Tricosane	mg/kg	22/29	0.43	NL	No/E
n-Tritriacontane	mg/kg	29/29	0.85	NL	No/E
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	2/2	0.0253	1.49E-03	No/F
Octachlorodibenzofuran	mg/kg	2/2	0.000175	1.49E-03	No/A
Octadecane	mg/kg	15/29	0.43	NL	No/E
Parathion	mg/kg	2/29	0.015	9.59E+00	No/A
Pentachlorophenol	mg/kg	7/89	0.5	6.46E-01	No/A
Pentadecane	mg/kg	14/29	0.48	NL	No/E
Perylene	mg/kg	18/29	0.46	NL	No/E
Phenanthrene	mg/kg	195/472	130	NS	No/D
Phenol	mg/kg	6/89	0.5	1.48E+03	No/A
Phorate	mg/kg	0/29	0.015	3.20E-01	No/A,B
Plutonium-238	pCi/g	24/449	1.257	2.27E+00	No/A
Plutonium-239	pCi/g	1/1	0.0275	2.22E+00	No/A
Plutonium-239/240	pCi/g	268/515	61.45	2.23E+00	Yes
Polychlorinated biphenyl	mg/kg	882/3061	609	5.74E-02	Yes
Potassium	mg/kg	467/476	2500	3.66E+01	Yes
Potassium-40	pCi/g	52/52	9.78	NL	No/E
Promethium-146	pCi/g	0/4	0.00838	NL	No/B
Protactinium-231	pCi/g	4/4	60.81	NL	No/E
Protactinium-233	pCi/g	1/4	0.07362	NL	No/E
Protactinium-234m	pCi/g	37/45	570	NL	No/E
Pyrene	mg/kg	209/472	130	2.57E+01	Yes
Pyridine	mg/kg	8/70	0.5	1.60E+00	No/A
Radium-223	pCi/g	1/4	0.321	NL	No/E
Radium-226	pCi/g	4/10	2.51	3.82E-03	No/E
Radium-228	pCi/g	4/4	1.127	NL	No/E
Radon-219	pCi/g	1/4	0.358	NL	No/E
Ruthenium-106	pCi/g	0/4	0.1103	NL	No/B

Table D.1 (Continued)

Chemical name	Units	Detections/number of samples	Maximum detected concentration	Lesser Residential NAL	Selected as a COPC?
Selenium	mg/kg	27/502	27.9	1.21E+01	Yes
Silicon	mg/kg	25/25	881	NL	No/E
Silver	mg/kg	217/514	20.4	6.12E+00	Yes
Silver-110m	pCi/g	0/4	0.01035	NL	No/B
Sodium	mg/kg	262/469	990	NS	No/C
Sodium-22	pCi/g	0/4	0.02953	NL	No/B
Strontium	mg/kg	5/5	234	8.01E+02	No/A
Strontium-90	pCi/g	0/4	0.15	NL	No/B
Styrene	mg/kg	2/40	0.01	1.28E+02	No/A,B
Technetium-99	pCi/g	356/531	2650	6.74E+01	Yes
Tetrachloroethene	mg/kg	2/40	0.01	1.17E+00	No/A,B
Tetradecane	mg/kg	9/29	0.49	NL	No/E
Tetratriacontane	mg/kg	5/29	0.75	NL	No/E
Thallium	mg/kg	16/507	20	NS	No/E
Thallium-208	pCi/g	4/4	0.387	NL	No/E
Thorium-227	pCi/g	0/4	0.1128	NL	No/B
Thorium-228	pCi/g	396/417	4.38	4.18E-03	Yes
Thorium-229	pCi/g	0/4	0.1915	NL	No/B
Thorium-230	pCi/g	443/468	497	2.85E+00	Yes
Thorium-232	pCi/g	412/417	5.07	2.61E+00	Yes
Thorium-234	pCi/g	42/46	312	NL	No/E
Tin	mg/kg	23/38	217	4.39E+02	No/A
Tin-113	pCi/g	0/4	0.01112	NL	No/B
Toluene	mg/kg	2/40	0.01	3.12E+01	No/A,B
Toxaphene	mg/kg	0/29	6.2	8.51E-02	No/B
trans-1,2-Dichloroethene	mg/kg	2/42	0.508	3.26E+00	No/A,B
trans-1,3-Dichloropropene	mg/kg	2/40	0.01	2.52E-01	No/A,B
Trichloroethene	mg/kg	79/336	0.508	7.41E-01	No/A
Tridecane	mg/kg	4/29	0.75	NL	No/E
Tritium	pCi/g	0/1	1.82	NL	No/B
Undecane	mg/kg	2/29	0.75	NL	No/E
Uranium	mg/kg	692/839	943	2.16E+00	Yes
Uranium	pCi/g	692/839	388	NL	No/E
Uranium-234	pCi/g	460/489	56.14	3.81E+00	Yes
Uranium-235	pCi/g	70/75	9.9	5.91E+02	No/A
Uranium-238	pCi/g	488/490	317	2.61E-01	Yes
Vanadium	mg/kg	507/507	104	5.62E-01	Yes
Vinyl chloride	mg/kg	0/7	0.508	4E-02	No/B
Yttrium-88	pCi/g	0/4	0.01817	NL	No/B
Zinc	mg/kg	479/507	1430	4.01E+02	Yes
Zinc-65	pCi/g	0/4	0.008704	NL	No/B
Zirconium-95	pCi/g	0/4	1.396	NS	No/B
Total PCBs	mg/kg	882/3061	609	1.64E+00	Yes

A: Not selected as a COPC because maximum detected concentration is below the lower residential NAL.
B: Not selected as a COPC because the chemical was detected in 5% or less of the samples.
C: Not selected as a COPC based on being an essential nutrient.
D: Not selected as a COPC because a Total PAH value was derived using EPA Region 4 Regulations and per the Methods Document.
E: Not selected as a COPC based on frequency of detection, available toxicity information or maximum detected concentrations.
F: Not selected as a COPC based on limited amount of data.

COPC – Chemical of potential concern.
mg/kg – Milligram per kilogram.
NAL – No action levels.
NL – Not listed.
NS – Not sampled.
pCi/g – Picocuries per gram.

Residential NAL: The residential NAL employed was the lesser of the lifetime excess cancer-based and child hazard-based no action values.

performed for the sake of completeness; none of these additional chemicals is anticipated to contribute noticeably to site-related risks. These chemicals are discussed further in the uncertainty section.

D.2.3.1.5 Revising SWMUs into EUs for BHHRA purposes

Three analytes, Total PCBs, cesium-137, and uranium-238, were identified as indicator chemicals during development of the co-contamination study in the SAP (DOE 2005). As discussed in the SAP, a spatial analysis of the distributions of concentrations or activities of these indicators was to be used to refine an initial list of EUs. EUs are areas within a site that, because of similar levels of contamination or because of expected human activity patterns, reasonably can be assessed using one EPC for each COPC. The software program Spatial Analysis and Decision Assistance (SADA) was used for this analysis.

Data sets available for the analysis using SADA were large. Over 2000 independent data points were available, which allowed high resolution in assessing contaminant distributions. It should be noted that the Activity 1 data for cesium-137 and uranium-238 were produced using an *In Situ* Object Counting System (ISOCS) unit, as opposed to a fixed-base laboratory; therefore, the data are considered screening level only (its intended purpose). Since screening level data were considered acceptable for use in identifying hot spots, Activity 1 data for cesium-137 and uranium-238 were employed in SADA. However, since these data did not meet data evaluation methods, they could not be used in the risk assessment.

SADA was used to plot data for Total PCBs, cesium-137, and uranium-238 separately. In each case, sampling locations were plotted and color-coded to appropriate no action levels for recreational users, industrial workers, and excavation workers (the "excavation worker" scenario includes both current and future exposures). In each case, concentrations or activities below the no action levels were colored blue. Values between the no action levels and ten times the no action levels were colored green. Values between ten and 100 times the no action levels were colored gold and those exceeding 100 times the no action levels were colored red. This color coding corresponds roughly to concentrations or activities associated with cancer risks below 10^{-6}, between 10^{-6} and 10^{-5}, between 10^{-5} and 10^{-4}, and above 10^{-4}, respectively. Results of the SADA analyses are presented as Figures D.2 through D.10. Figures 4.25 through 4.31 from Section 4 of the SI/BRA depict the nature and extent of total PCBs.

In many cases, some dots representing relatively high concentrations are difficult to see in these figures, because the large number of data points causes dots to overlap significantly. Thus, the spatial analysis was confirmed against the actual data sets to verify that all locations were captured in the redefining of the EUs.

In redefining EUs for the risk assessment, the following approach was used. Each of the EUs identified in the SAP (DOE 2005) that contained at least one sample with a yellow or red dot on the SADA plots was identified as a separate exposure area or was combined with other EUs to represent a single exposure area. These redefined exposure areas (the new EUs) were identified as potential “hot spots,” both in recognition of potentially greater risk associated with these areas and to use a terminology different from that used in the SAP. Data that were not grouped into redefined hot spots were divided into one of two datasets representing areas inside and outside of the security fence.

Through this analysis, the following refined exposure areas were identified:

- Outfall 001 EU 13 was retained as a separate potential “hot spot” as were Outfall 001 EU 14, Outfall 001 EU 15, Outfall 001 EU 16, Outfall 001 EU 18, Outfall 001 EU 20, Outfall 010 EU 10, and Outfall 011 EU 01;

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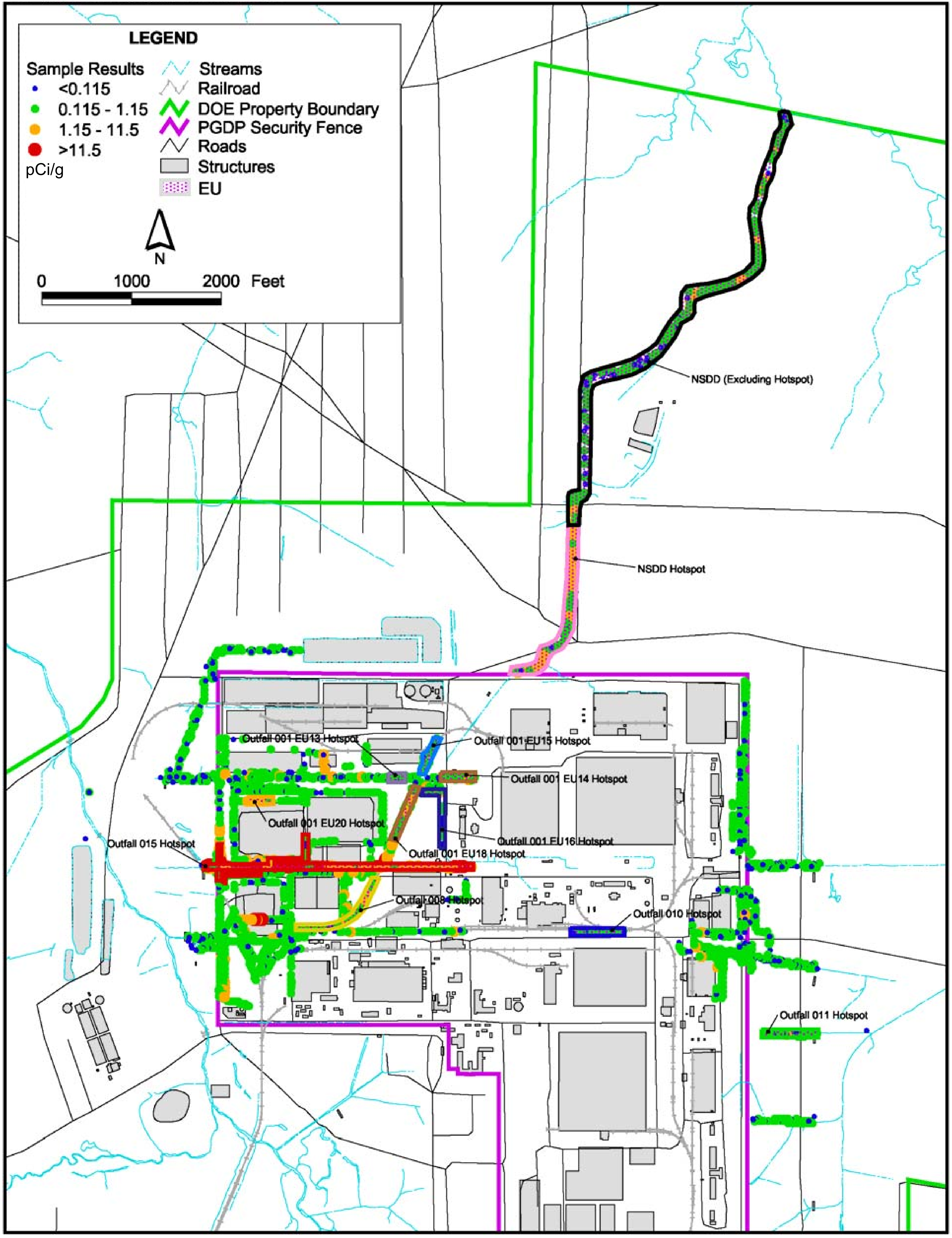

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Figure D.2. Cesium-137 in Sediment Excavation No Action Level

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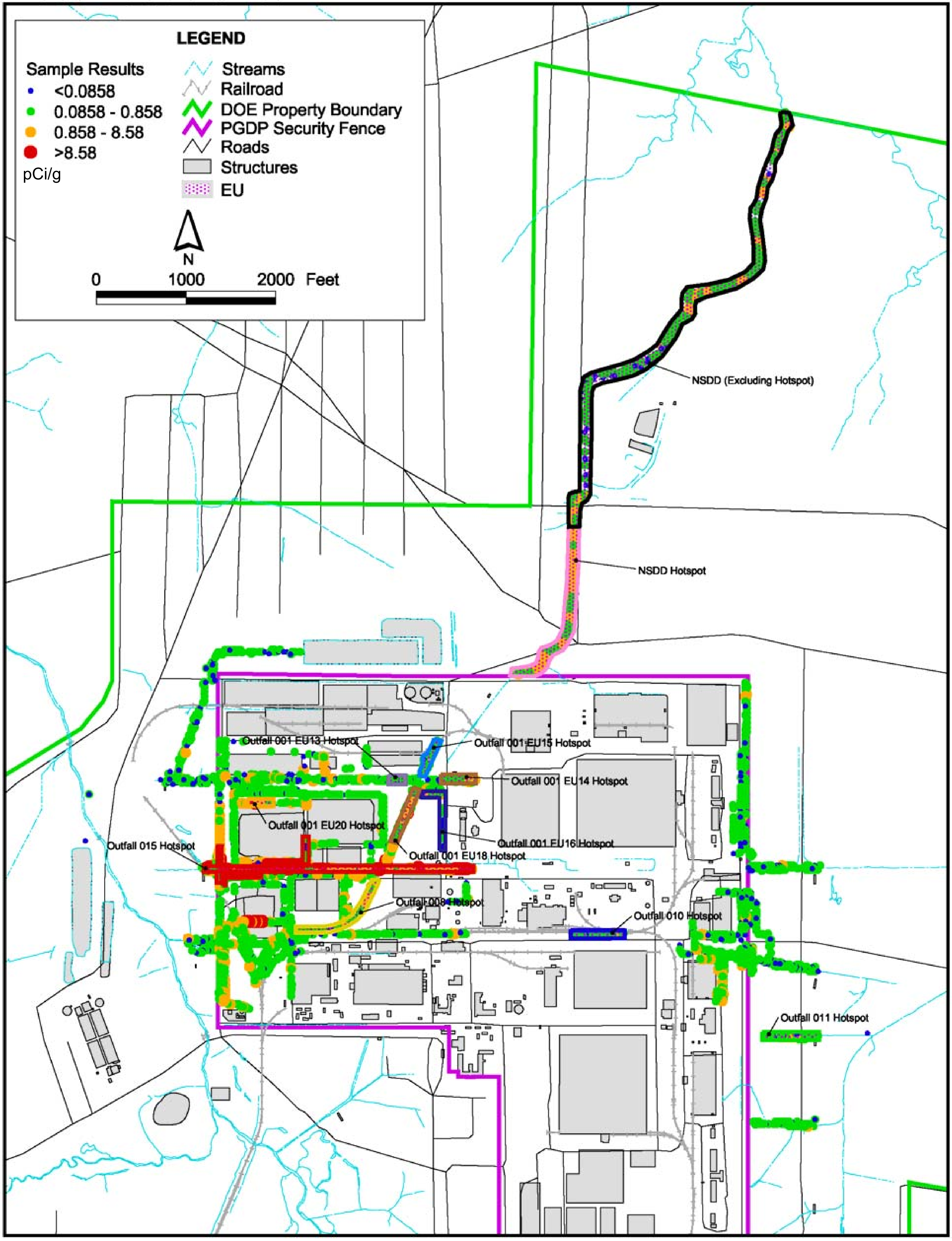

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Figure D.3. Cesium-137 in Sediment Industrial No Action Level

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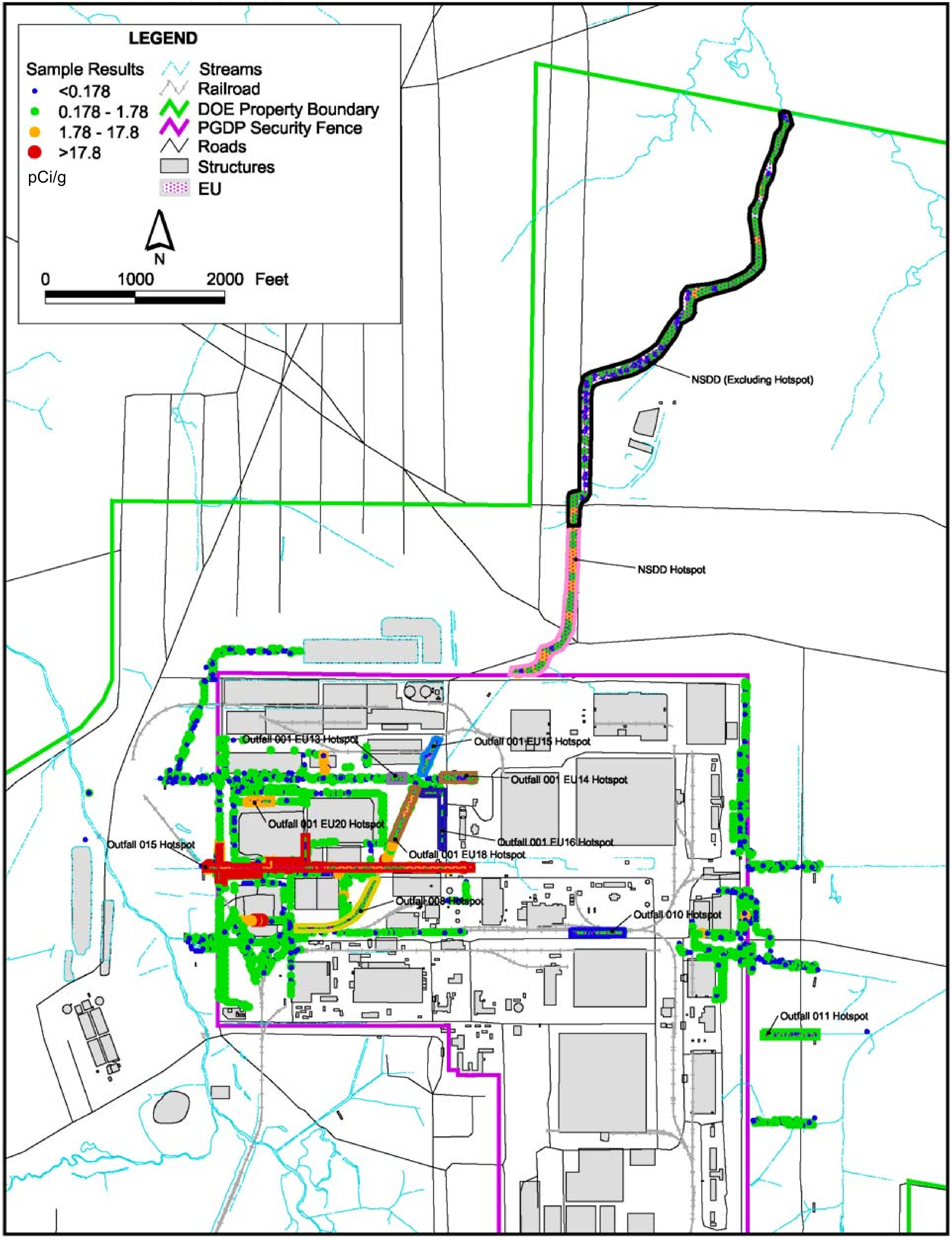

Figure D.4. Cesium-137 in Sediment Recreational No Action Level

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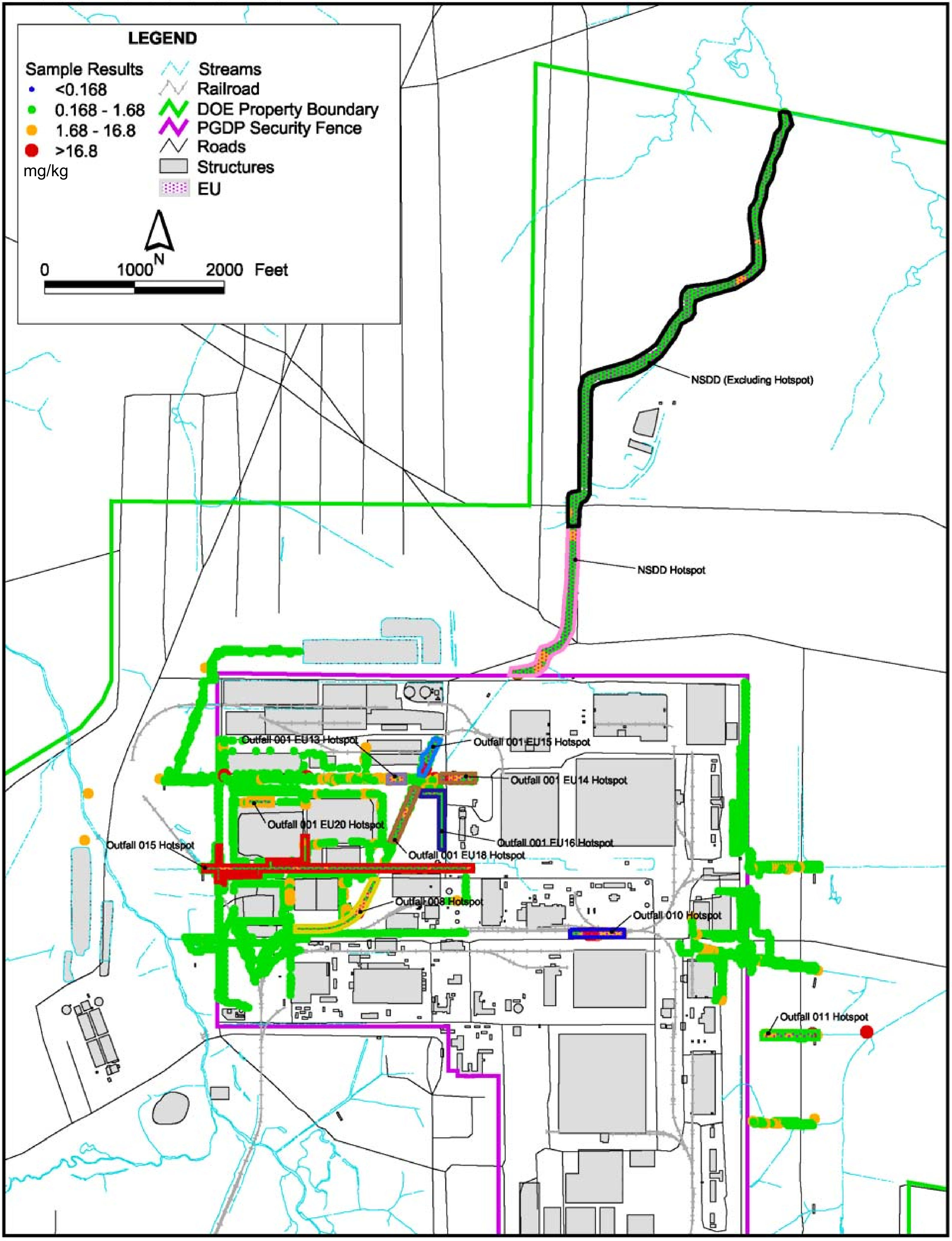

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Figure D.5. Total PCBs in Sediment Excavation No Action Level

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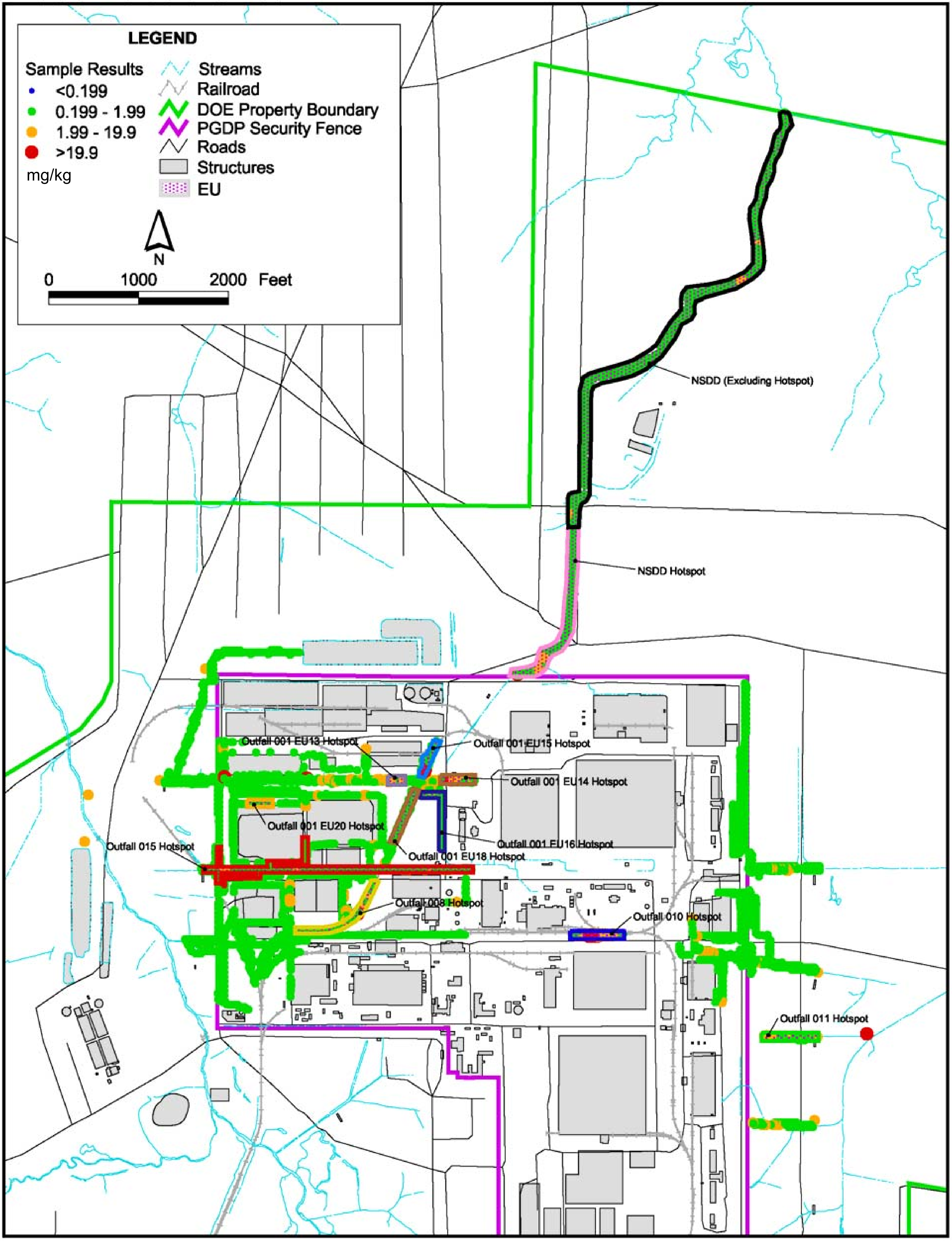

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Figure D.6. Total PCBs in Sediment Industrial No Action Level

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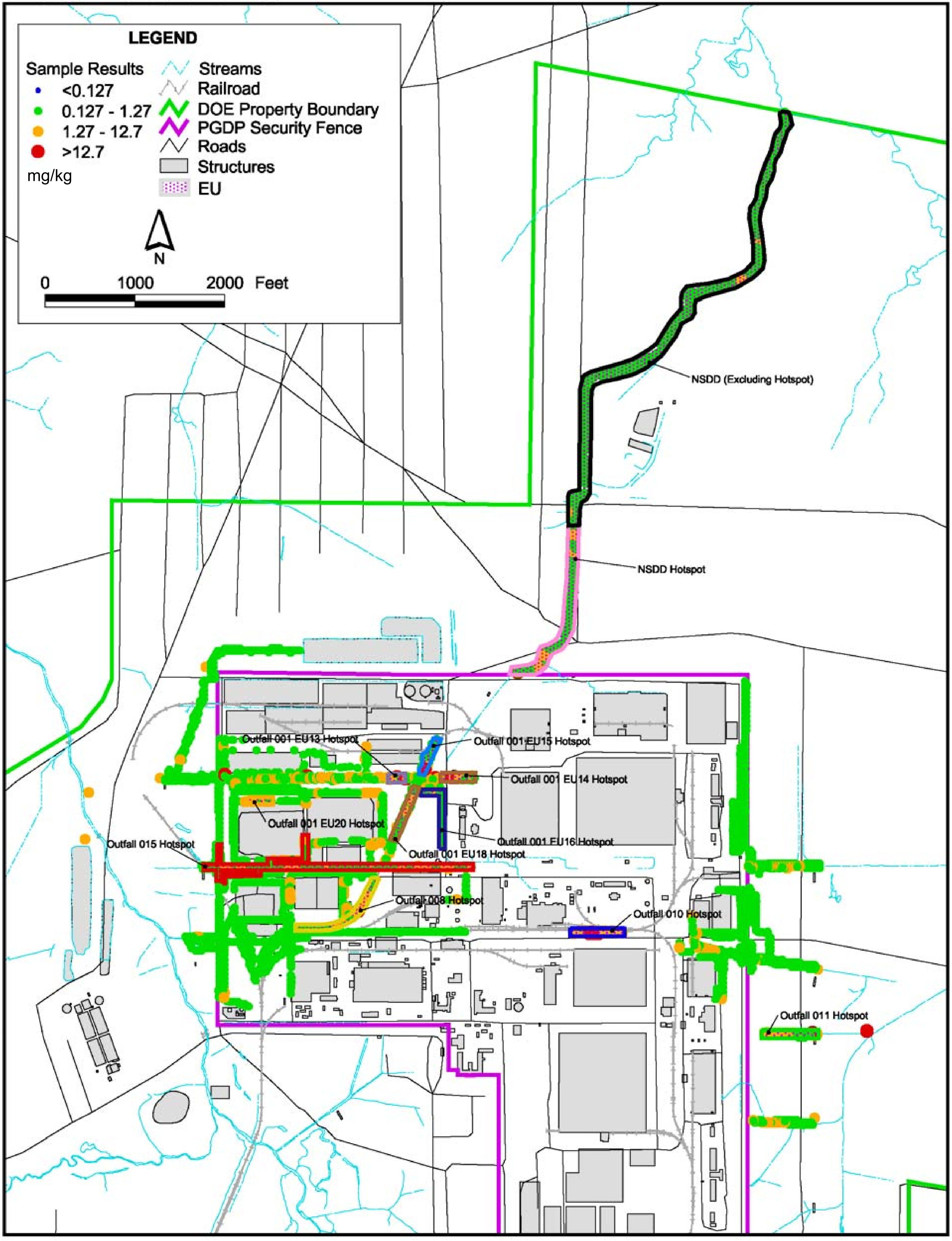

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Figure D.7. Total PCBs in Sediment Recreational No Action Level

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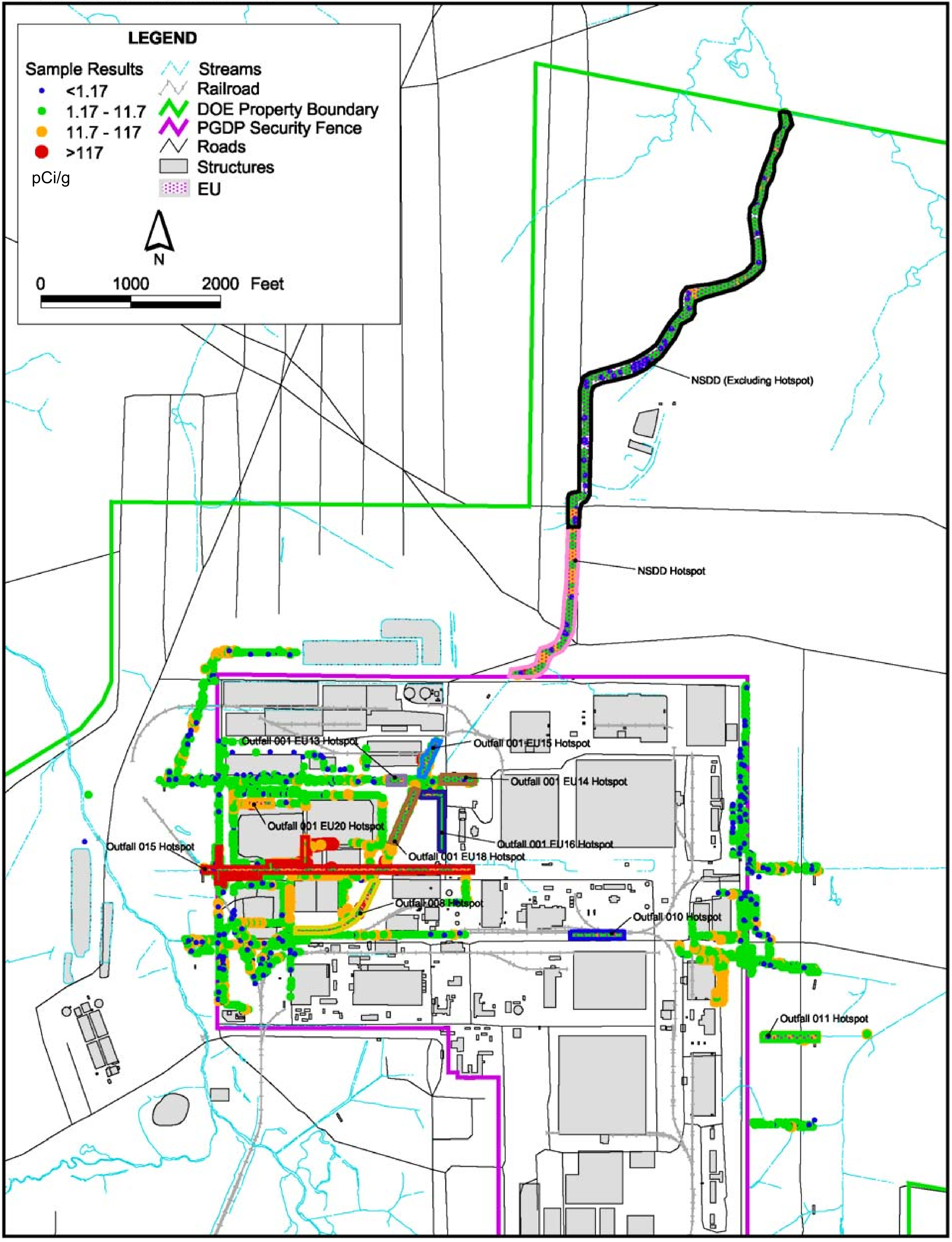

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Figure D.8. Uranium-238 in Sediment Excavation No Action Level

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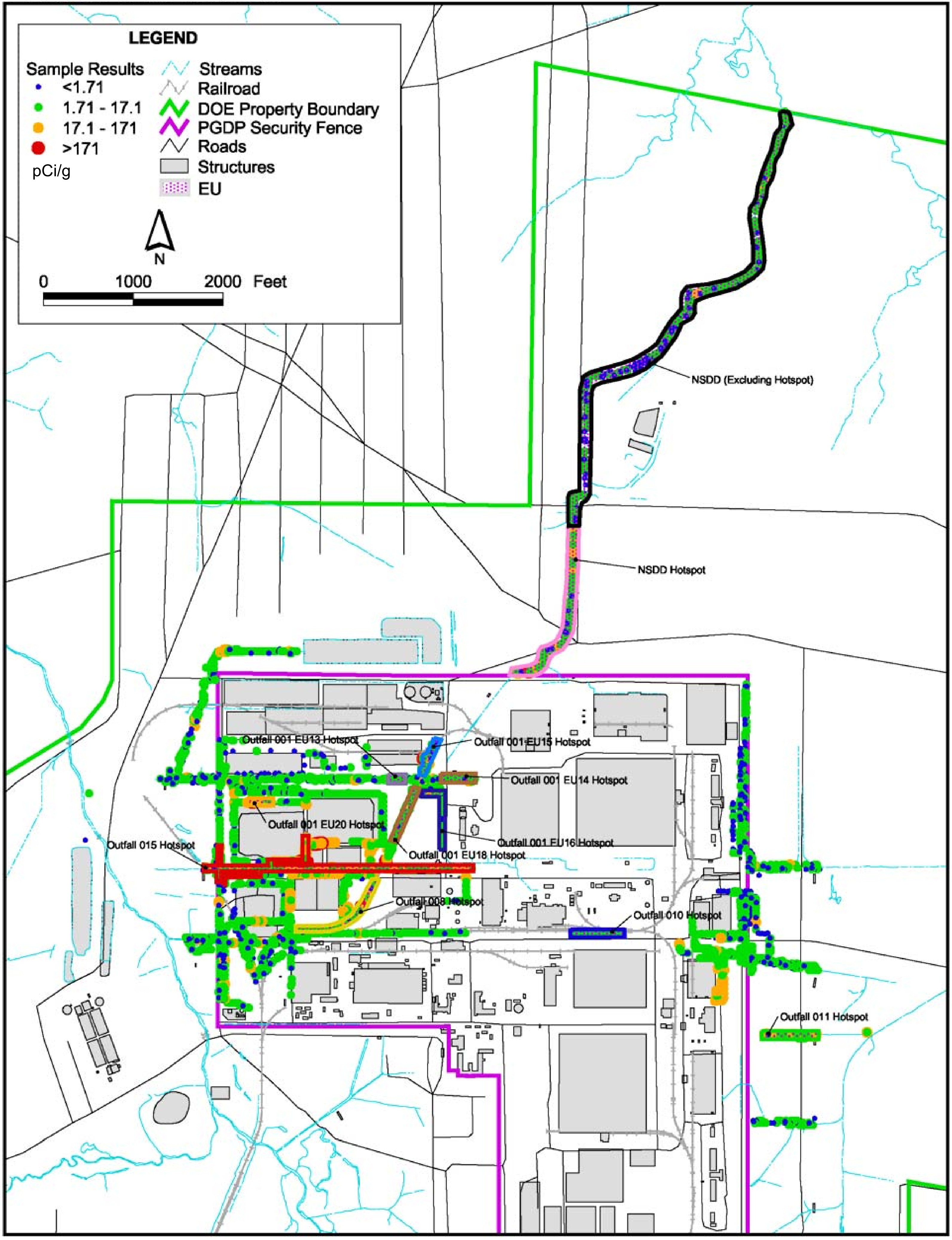

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Figure D.9. Uraniume-238 in Sediment Industrial No Action Level

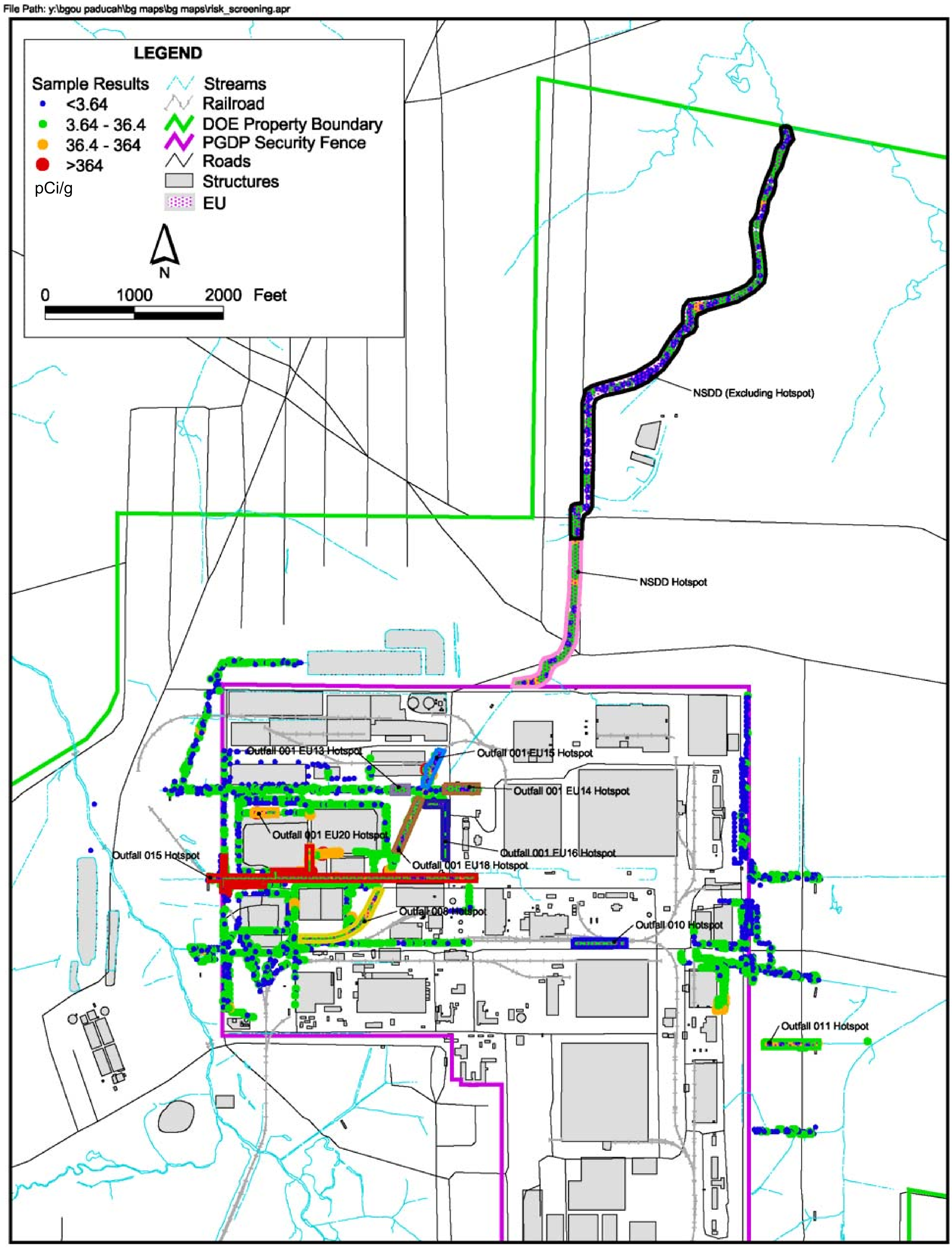

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Figure D.10. Uranium-238 in Sediment Recreational No Action Level

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- Outfall 008 EUs 08 and 11 were combined as a separate Outfall 008 Hot Spot;

- Outfall 015 EUs 01 through 04, 07, and 08 were combined as the Outfall 015 Hot Spot; and

- NSDD Section 3, EUs 01 and 02, were combined as the NSDD Hot Spot.

Data for the sampling locations that were not included in any of the above EUs and are located within the security fence were combined as a "within the fence, excluding Hot Spots" exposure area. Similar data from sampling locations outside the security fence were combined as "NSDD, Excluding the Hot Spot."

D.2.4 EVALUATION OF DATA FROM OTHER SOURCES

This section describes the results of the Kentucky Department of Fish and Wildlife Resources (KDFWR) information and site size information. This information was used to develop the exposure assessment in Section D.3.

D.2.4.1 KDFWR Information

During the development of the conceptual site model (CSM), presented in Section 3, it was determined that wildlife also may serve as an important exposure pathway to humans. To determine the level of importance of this pathway, requests were made for reports on deer, duck, geese, and turkey harvests in Ballard and McCracken Counties. Information on these game species was solicited because they are the most widely hunted animals in the area and require specific licenses and check-in procedures. Harvest information is provided in Chapter 3 of Appendix 5 of the Methods Document (DOE 2001).

D.2.4.2 SWMU Size Information

To calculate potential uptake of contaminants in soil/sediment into game animals (deer, rabbit, quail), the size of each EU is required (see Table D.2). These areas previously were estimated and are taken from the SAP (DOE 2005). This information was used in estimating COPC concentrations in game animals when assessing possible exposure of hunters. Methods used to integrate the size of the redefined EUs and their size is presented along with the exposure equations in Section D.3.

Table D.2. Summary of EU Area

Exposure unit	Area (acres)
NSDD Hot Spot	1.39
Outfall 001 EU 13 Hot Spot	0.69
Outfall 001 EU 14 Hot Spot	0.76
Outfall 001 EU 15 Hot Spot	0.41
Outfall 001 EU 16 Hot Spot	0.66
Outfall 001 EU 18 Hot Spot	0.46
Outfall 001 EU 20 Hot Spot	0.75
Outfall 008 Hot Spot	1.1
Outfall 010 Hot Spot	0.77
Outfall 011 Hot Spot	0.62
Outfall 015 Hot Spot	4.05
NSDD, Excluding the Hot Spot	5.02
Within the Fence, Excluding Hot Spots	28.24

NSDD = North-South Diversion Ditch
EU = exposure unit

D.2.5 SUMMARY OF COPCs

COPCs for the SWOU are listed in Table D.3. These chemicals are carried through the risk assessment in subsequent sections. This list of COPCs initially was narrowed to those chemicals listed in Table 5.1 of the SAP (DOE 2005). Subsequently, as provided for in the Methods Document (DOE 2001), essential nutrients were eliminated from the list of COPCs and residential no action levels were used to screen out those chemicals not detected at concentrations or activities that might pose a human health risk. Thirty-seven COPCs were identified in this process. These chemicals adequately define potential human health risks and hazards for the site. Cancer risks and/or noncancer hazards were estimated for each of these COPCs for all receptors in each of the refined EUs.

Several chemicals were detected in samples collected during the SWOU site characterization efforts, but were not included on the list of chemicals in the SAP. For the sake of completeness, these chemicals were subject to COPC screening also, and several chemicals could have been selected as COPCs by this process. Uncertainties in the risk assessment associated with the possible contribution of these chemicals to site-related risks are discussed in Section 6.

Table D.3. Summary of Approved SAP COPCs and Activity 1 and 2 COPCs Identified in the BHHRA

Approved SAP COPCs	Approved SAP COPCs not used in the BHHRA	Activity 1 and Activity 2 COPCs identified by the BHHRA but not used
Aluminum	1,1,1- Trichloroethane	3,3'-Dichlorobenzidine
Americium-241	Benzo(g,h,i)perylene	Bis(2-chloroethyl) ether
Antimony	Calcium*	Carbazole
Arsenic	Cobalt	Nitrobenzene
Barium	Fluorene	N-Nitroso-di-n-propylamine
Beryllium	Magnesium*	
Cadmium	Naphthalene	
Calcium	Phenanthrene	
Cesium-137	Plutonium-238	
Chromium	Sodium*	
Cobalt	Thallium	
Cobalt-60		
Copper		
Fluoranthene		
Iron		
Lead		
Magnesium		
Manganese		
Mercury		
Molybdenum		
Neptunium-237		
Nickel		
Potassium		
Plutonium-238		
Plutonium-239/240		
Pyrene		
Selenium		
Silver		
Sodium		
Total PCB		
Total PAH		
Technetium-99		
Thallium		
Thorium-228		
Thorium-230		
Thorium-232		
Uranium		
Uranium-234		
Uranium-238		
Vanadium		
Zinc		
Trichloroethene		
1,1,1- Trichloroethane		
Benzo(g,h,i)perylene		
Fluorene		
Naphthalene		
Phenanthrene		

*These were eliminated from the BHHRA based on being essential nutrients.
BHHRA – Baseline Human Health Risk Assessment.
COPC – Chemical of potential concern.
SAP – Sampling and Analysis Plan.
Total PAH – PAHs were totaled in accordance with EPA Region 4 guidance (EPA 1995) and the Methods Document (DOE 2001).
Total PCB – PCBs were totaled in accordance with the Methods Document (DOE 2001).

D.3. EXPOSURE ASSESSMENT

Exposure is the contact of an organism with a chemical or physical agent. The magnitude of exposure (i.e., dose) is determined by measuring or estimating the amount of an agent available at exchange boundaries (e.g., intestines, skin, and lung) during a specified period. Exposure assessment is a process that combines information about the exposure setting and human activities to develop CSMs for current and potential future conditions. This section introduces the general methods used in exposure assessment, applies these methods to the SWOU to develop a CSM, and presents assumptions and equations for calculating exposures (doses) for COPCs resulting from this application.

The first step in the exposure assessment is to characterize the exposure setting. This characterization includes describing physical characteristics of the SWOU and activities of human populations living, working, or recreating on or near the SWOU that may affect the extent of exposure. During this process, sensitive subpopulations that may be present currently or in the future at the SWOU, or that may be exposed to contamination migrating from the SWOU, also are considered to determine if the BHHRA should address these populations. Characterization of the exposure setting for the SWOU takes the form of a narrative on salient features of the OU and existing and future human land uses.

The second step in the exposure assessment is to identify exposure pathways. Exposure pathways are ways that a contaminant travels from its source to an individual. A complete exposure pathway includes all links between the source and the exposed population. It consists of a source of contamination, a mechanism of release to the environment, a means of transport of contaminants to a point where people might be exposed, and an exposure route (ingestion, inhalation, or dermal contact).

The third step in the exposure assessment is to calculate dose by quantifying the magnitude, frequency, and duration of exposure for the populations for exposure pathways identified in Step 2. This step involves estimating exposure or representative concentrations for COPCs and quantifying pathway-specific intakes.

All exposure estimates in this BHHRA are based on the concept of a reasonable maximum exposure (RME) that can be expected to occur under current or future site conditions. As defined in the *Risk Assessment Guidance for Superfund* (RAGS) (EPA 2001), an RME estimate is a conservative estimate of exposure that falls within the upper bound of the range of all possible exposure estimates. In situations where populations are exposed through multiple pathways, RME estimates are calculated for both individual and multiple pathways.

The focus of the exposure assessment for the SWOU at PGDP is to determine chronic intake or dose. A chronic exposure estimate is used because it allows for estimation of health consequences that result from long-term or unrestricted exposure to relatively low levels of contaminants observed in soil/sediment and surface water in the SWOU.

D.3.1 CHARACTERIZATION OF EXPOSURE SETTING

The first step in evaluating exposure is to characterize surface features, meteorology, geology, demography and land use, ecology, hydrology, and hydrogeology of the area inhabited by potential receptors. These aspects are fully discussed in Chapters D.1, D.2, and D.3 of this report. The following sections present physical descriptions of the SWMUs. Most of this information is from the SWOU SAP (DOE 2005).

D.3.1.1 Outfall 001

Outfall 001 has the largest watershed at PGDP and receives drainage from an area of about 203 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 001 drains the northwestern part of the plant and is approximately 20,420 ft in length, approximately 0.5 to 12 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951 and discharges directly to Bayou Creek. The reported monthly average flow through Outfall 001 into Bayou Creek is 2.79 million gallons per day (mgd). The Kentucky Pollutant Discharge Elimination System (KPDES) permit for Outfall 001 was issued to DOE in 1997.

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), 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), and the C-600 Steam Plant and supporting facilities. Runoff from the C-400, C-410, C-415, C-535, C-537, and settling pond areas drains to the NSDD detention basin, 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. Historically, Outfall 001 also has received runoff from scrap metal storage yards located in the northwestern portion (approximately 50.5 acres) of the Outfall 001 watershed. On August 28, 1995, a groundwater pump-and-treat system went on line near Outfall 001 and runs continuously. Groundwater is pumped from four groundwater extraction wells that are part of the Northwest Plume groundwater system and is treated for trichloroethene (TCE) and technetium-99 (^{99}Tc). Approximately 200 gal/min are extracted and treated. The treated groundwater then is discharged to Outfall 001 at an approximate rate of 200 gal/min. In 2002, a sediment basin was constructed to collect storm water discharge from the scrap metal storage yards. This storm water is discharged to Outfall 001 following analysis of and, if necessary, treatment for pH and total suspended solids (DOE 2005).

D.3.1.2 Outfall 002

Outfall 002 receives drainage from an area of approximately 55 acres, which includes the internal plant ditches that drain to it. The internal plant ditch system to Outfall 002 drains the northeastern part of the plant and is approximately 3150 ft in length, approximately 2 to 3 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. Flow through Outfall 002 is transferred by lift station to the C-617-B Treatment Lagoon and is treated for residual chlorine, pH, and excess temperature. The effluent then is discharged to the Outfall 010 ditch through Outfall 010 downstream of the Outfall 010 lift station and the C-337-A catch basin to Little Bayou Creek. In the event that a rainfall event exceeds the capacity of the lift station pumps, Outfall 002 may emit some flow directly to Little Bayou Creek. During these overflow events, the United States Enrichment Corporation (USEC) is required to measure and sample the flow. An average of these measurements during 2000 and 2001 indicates that Outfall 002 averages a discharge of 1.43 mgd during overflow events.

Releases from the internal plant ditches to Outfall 002 are characterized by historical information about the facilities that drain into the ditches and by samples associated with them. Facilities that drain into Outfall 002 include the C-360 Toll Transfer and Sampling Building, the C-637 buildings (i.e., C-637-1, -2A, -2B, -3, -4, -5, and -6), and the southeastern portion of C-337. The C-637 buildings and the southeastern portion of the C-337 Building drain to Outfall 002 via the storm sewer system; therefore, they will not contaminate the internal plant ditches to Outfall 002. The C-360 Toll Transfer and Sampling Building, however, discharges to Outfall 002 via internal plant ditches. Contamination from the C-360 Building may have been carried via surface water and sediment to Outfall 002 (DOE 2005).

D.3.1.3 Outfall 008

Outfall 008 receives drainage from an area of approximately 90.4 acres, which includes the internal plant ditches that drain to it. The internal plant ditch system to Outfall 008 drains the southwestern part of the plant and is approximately 12,215 ft in length, ranges from approximately 0.5 to 4 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow through Outfall 008 is 1.22 mgd. The KPDES permit for Outfall 008 is maintained by USEC.

Outfall 008 receives multiple waste streams from the southwest corner of the plant and discharges directly to Bayou Creek. These sources include storm water runoff from the surrounding area and flow from the wastewater treatment plant that discharge 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 Land Farm (SWMU 1), the C-745-A and C-746-H Cylinder Storage Yards, and the C-747 Burial Yard. Because these waste streams flow to the outfall through the internal plant ditches, contamination from these areas potentially could have been carried via surface water and sediment to the outfall.

D.3.1.4 Outfall 010

Outfall 010 is located on the east side of PGDP and receives drainage from an area of approximately 22 acres, including the internal plant ditches that drain into it. The internal plant ditch system to Outfall 010 drains the eastern part of PGDP and is approximately 7,400 ft in length, approximately 2 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow is 0.56 mgd. Outfall 010 is equipped with a containment dam that can be used, if necessary, during releases.

Facilities draining into the Outfall 010 drainage area include 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 may have been carried via surface water and sediments to Outfall 010 (DOE 2005). Flow from Outfall 010 is transferred to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. From this mixing chamber, the wastewater typically is discharged to the Outfall 010 ditch downstream of the lift station and eventually discharges to Little Bayou Creek.

D.3.1.5 Outfall 011

Outfall 011 is located on the east side of PGDP and receives drainage from an area of approximately 31 acres, including the area of the internal plant effluent ditches. The internal plant ditch system to Outfall 011 drains the eastern part of PGDP and is approximately 5,400 ft in length, approximately 2 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow for Outfall 011 is 0.34 mgd.

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 the C-540-A PCB Staging Area (SWMU 56) and the C-540 PCB Spill Site (SWMU 80) of WAG 23.

Under normal conditions, discharge from Outfall 011 is collected in a sump and pumped to the C-617-B Treatment Lagoon via a lift station and then is discharged to Little Bayou Creek via the Outfall 010 ditch, downstream of the lift station. 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 waste streams when Lift Station 011 is bypassed due to failures, maintenance, or excessive rainfall events that overwhelm existing discharge controls. During such bypass events, the water discharged through Outfall 011 flows directly to Little Bayou Creek. Maintenance activities, which occur on an as-needed basis, include cleaning the underflow weir that was installed in 1991 (DOE 2005).

D.3.1.6 Outfall 012

Outfall 012 lies on the east side of PGDP and receives drainage from an area of approximately 61 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 012 drains the east–central part of the plant and is approximately 3,200 ft in length, approximately 3 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The KPDES permit for Outfall 012 is maintained by USEC (DOE 2005). Specifically, under normal conditions, surface water discharges through Outfall 012 to a catchment and then to a lift station. The surface water then is discharged to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. Following treatment, the wastewater typically is discharged to the Outfall 010 ditch downstream of the Outfall 010 lift station, which flows to Little Bayou Creek.

Specific facilities contained in the Outfall 012 drainage area that drain via the internal plant ditches are the C-533-1 Switch House and appurtenant structures (C-533-3A, C-533-3B, C-533-3C, and C-533-3D Fire Valve Houses). A portion of the C-340 building also drains to Outfall 012 via the internal plant ditches. The C-333 Process Building and the C-633-1 Fire House and appurtenant structures drain to Outfall 012 through the storm sewer system (DOE 2005).

D.3.1.7 Outfall 015

Outfall 015, which discharges directly to Bayou Creek, lies on the west side of PGDP and receives drainage from an area of approximately 49 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 015 drains the west–central part of the plant and is approximately 10,665 ft in length, ranges from approximately 0.5 to 5 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow for Outfall 015 is 0.281 mgd. U.S. Department of Energy (DOE) is responsible for Outfall 015 under the KPDES permit.

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 (DOE 2005).

D.3.1.8 NSDD Sections 3, 4, 5

As described in the *Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (DOE 2005), the entire NSDD is located on property owned by DOE. For the purposes of response actions at PGDP, the NSDD has been divided into sections that are numbered south to north. Sections 1 and 2 (SWMU 59) are within the plant security-fenced area; Sections 3, 4, and 5 (SWMU 58) are outside the security-fenced area. The NSDD originates within the north-central portion of PGDP and discharges into Little Bayou Creek to the north of the plant. Little Bayou Creek originates within the West Kentucky Wildlife Management Area (WKWMA), south of PGDP, and flows northward to the Ohio River. Little Bayou Creek is intermittent in its upper reaches, becoming perennial downgradient of its confluence with Outfall 010, with a continuous flow outfall from PGDP. The confluence of Little Bayou Creek and Outfall 010 is upstream of the NSDD's confluence with Little Bayou Creek.

The portion of the NSDD within the security-fenced area (SWMU 59), which includes Sections 1 and 2, is approximately 2,600 ft long. This portion of the ditch varies in width from approximately 8 to 10 ft, and the depth ranges from approximately 0.5 to 5 ft. Inside the plant security fence, the ditch flows from Virginia Avenue north, beyond the C-616-C Lift Station, to the plant fence. Remediation of Sections 1 and 2, including excavation of soils to a depth of 4 ft bgs, was completed in 2004; therefore, this area was not evaluated in this BHHRA.

The portion of the NSDD outside the security-fenced area (SWMU 58), which includes Sections 3, 4, and 5, is approximately 8,400 ft long. This portion of the ditch varies in width from approximately 15 to 36 ft, and the depth ranges from approximately 5 to 15 ft. The banks of the NSDD outside of the security-fenced area generally are vegetated with grasses and brush, and trees line some sections of the bank. Approximately 3,000 ft of the NSDD (i.e., the portion nearest to Little Bayou Creek) fall within the 500-year floodplain of the Ohio River, and some portions of this segment fall within the 100-year floodplain of the Ohio River. Section 5 of the NSDD, downstream of the C-746-U Landfill access road, is a natural, relatively unmodified stream channel. Stream flow in this channel is intermittent in the southernmost reaches, but becomes perennial as it approaches Little Bayou Creek. Upstream of the C-746-U Landfill access road, the NSDD is channeled and bordered by mown grasses (Section 4), except for a short wooded segment immediately downstream of the security fence (Section 3). The NSDD outside of the security-fenced area is posted for radiological contamination [pursuant to 10 (*Code of Federal Regulations*) CFR 835 requirements].

Historically, the NSDD received wastewater from the C-400 Cleaning Building, coal pile runoff, and storm water. The primary functions of the C-400 Cleaning Building included cleaning, metal plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and uranium tetrafluoride (green salt) pulverization. Sources of storm water runoff to the ditch included a steam plant (C-600), process buildings (C-335 and C-337), a cooling tower (C-635), electrical switchyards (C-535 and C-537), a neutralizing pit (C-403), and a feed plant (C-410). As a consequence, the soil and sediment in the ditch have been contaminated. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed nearly filled the southern portion of Section 1 of the NSDD. This caused runoff from heavy rainfall events to overflow the ditch, primarily near 10th Street. In order to restore adequate flow, sediments periodically were dredged from the NSDD and the spoils were placed near the banks of the ditch.

In 2003 and 2004, the remediation of Sections 1 and 2 of the NSDD was accomplished by the excavation and disposal of all soil in those sections of the ditch to a depth of 4 ft bgs, and the excavated area was restored to grade with clay and/or soil. The distal end of Section 2 was plugged to prevent further discharge of any type of flow to downstream portions of the NSDD ditch. A surge basin was constructed surrounding the C-616-C Lift Station and all flow from Sections 1 and 2 of the NSDD, including effluent of the C-335 and C-337 Process Buildings and the C-535 and C-537 Switchyards that is transferred into the NSDD by the C-616-H Lift Station (Ditch 001 Lift Station), now is transmitted to the C-616-F Full Flow Lagoon (Appendix E, Figure E.5) for settlement of suspended solids prior to discharge through the KPDES.

D.3.2 DEMOGRAPHY AND LAND USE

As indicated in the physical descriptions presented, current land use of all SWOU EUs within the fence is industrial. Under current use, only plant workers and authorized visitors are allowed access to all EUs with the exception of the NSDD because of security arrangements. The northern portion of the NSDD is within the WKMA that can be used for recreational purposes. As discussed in the PGDP Site Management Plan (DOE 2006b), foreseeable future land use of the area is expected to be industrial as well; however, alternative uses in the future are possible as shown by the current use of the areas surrounding PGDP.

At present, recreational and residential land uses occur in areas surrounding PGDP. Recreational use occurs in the WKWMA. The WKWMA is used primarily for hunting and fishing, but other activities include horseback riding, field trials, hiking, and bird watching. An estimated 5000 fishermen visit the area annually, according to the KDFWR, which manages the WKWMA. Residential use near the plant generally is rural residential and includes agricultural activities; however, urban residential use occurs in the villages of Heath, Grahamville, and Kevil, which are within 3 miles of DOE property boundaries. The closest major urban area is the municipality of Paducah, Kentucky, which has a population of approximately 26,000 and is approximately ten miles from PGDP. Other municipalities in the region near PGDP are Cape Girardeau, Missouri, which is at least 40 miles west of the plant, and the cities of Metropolis and Joppa, Illinois, which are across the Ohio River from PGDP. According to 1990 census data, the total population within a 40-mile radius of the plant is approximately 500,000, with about 50,000 people living within ten miles. The population of McCracken County, in which PGDP is located, is an estimated 65,500 people.

In the area near PGDP, and in western Kentucky in general, the economy historically has been agriculturally based; however, industry has increased in recent years. PGDP is a major employer with approximately 1800 workers. Another major employer near PGDP is the Tennessee Valley Authority Shawnee Steam Plant that employs approximately 500 people.

D.3.2.1 Exposure Unit Information for Industrial Workers

During the development of the CSM, it was determined that the size of a site was directly proportional to the time a worker would be directly exposed to potentially contaminated soil/sediment at a site. To account for this, an EU was selected representing the reasonable area that an industrial worker would occupy in a day's time. This value was 0.5 acres, as presented in the report entitled, "Planning Issues for Superfund Site Remediation," contained in Appendix E of the Methods Document (DOE 2001).

D.3.2.2 Exposure Unit Information for Recreational Users

Recreational users were determined to be minimally exposed to the NSDD at PGDP. Section 5 of the NSDD is a natural, relatively unmodified stream channel. Stream flow in this channel is intermittent in the southern-most reaches, but becomes perennial as it approaches Little Bayou Creek. Section 4 of the NSDD is channeled and bordered by mown grasses. Section 3 of the NSDD is a short, wooded segment immediately downgradient of the security fence. Although a few fishermen do fish Little Bayou Creek, typically it is in a large beaver pond upstream of the PGDP outfalls. The fish population downstream of the outfalls is best characterized as being of minnow size and undesirable for fishing. Other potentially exposed users would be bow hunters and dog trainers who may cross the creek, but the exposures tend to be brief, or a large dirt-covered culvert is used to cross instead. Recreational users of Little Bayou Creek tend to be adults. Bayou Creek is used more frequently, with approximately 150 visitors per year. Approximately 90 percent of these visitors would be considered one-time users of the area, and no one person is expected to visit more than ten times per year. Recreational visitors to this area primarily are fishermen, although some using the WKWMA may be in the area for a brief amount of time to cross the creek at one of the bridges. Two-thirds of the visitors to Bayou Creek are expected to be adults with the remaining one-third being children. This information was determined from interviews with the KDFWR, as presented in the "Facsimile dated November 8, 1995, sent to Mr. Stephen Scott, FMSM Engineers, Inc., containing responses from Mr. Charles Logsdon, Kentucky Department of Fish and Wildlife, to the questionnaire dated October 26, 1995, sent to Mr. Charles Logsdon, Kentucky Department of Fish and Wildlife, by FMSM Engineers, Inc., regarding recreational use of Little and Big Bayou Creeks near PGDP" of Appendix E of the Methods Document (DOE 2001).

D.3.2.3 Wildlife Range Information

It was determined that the size of a site was directly proportional to the time a wildlife receptor would be exposed to potentially contaminated soil and vegetation at a site. The EU size for deer was based on the average home range of deer in the U.S., which is 494 acres. The means by which this value was determined is presented in the reports entitled, "Planning Issues for Superfund Site Remediation" and "Quantitative Decision Making in Superfund: A Data Quality Objectives Case Study" contained in Appendix E of the Methods Document (DOE 2001). The EU size for rabbit is 3.6 acres (EPA 1993). This value was based on the average home ranges of cottontail rabbits, male and female, in Wisconsin and Pennsylvania. The EU size for quail is 15.4 acres (EPA 1993). This value was based on the average home ranges for individual quail, male and female, and coveys in Iowa, Illinois, and Tennessee.

D.3.3 IDENTIFICATION OF EXPOSURE PATHWAYS

Exposure pathways describe how a contaminant travels from its source to an individual. A complete exposure pathway includes all links between the source and the exposed population. That is, a complete pathway consists of a source of release, a mechanism of release, a transport medium, a point of potential human contact, and an exposure route. The following discussions focus on points of potential human contact, types of receptors, and exposure routes.

D.3.3.1 Points of Human Contact—Land Use Considerations

The current land use for the SWOU is industrial and is expected to remain industrial in the foreseeable future. The plant is fenced and access is restricted to current workers, with the exception of the NSDD located outside of the fence. The NSDD is the only area considered potentially accessible to current and/or future recreational users.

Within the fenced plant, surface soil/sediment (0 to 1 ft bgs) within the drainages of the SWOU is accessible to current/future workers. If further expansion of the facility or other construction were to take place, or if repair or installation of utilities were necessary, excavation workers could come in contact with both surface and subsurface soil/sediment (0 to 6 ft bgs) within the fenced plant. Industrial workers also could visit these areas currently and in the future, although the areas do not appear to be particularly attractive for these receptors.

Outside the fenced plant within the NSDD, current/future recreational users potentially could come in contact with surface water and soil/sediment. Soil/sediment collected from within the top 0 to 1 ft bgs outside of the NSDD are considered accessible to recreational users, both during times when surface water is present (e.g. during wading) and when the drainage is dry. In addition to human receptors, game such as deer, quail, and rabbits may ingest plants that have taken up contaminants from NSDD soil/sediment. Recreational users that take and consume game from areas outside the security fence may ingest contaminants from game that feed in the NSDD area.

As discussed previously, residential use of the PGDP is not considered a foreseeable future use of the property; therefore, while a future residential homestead scenario was not assessed using the approach in the Methods Document (DOE 2001), since residential exposures reasonably cannot be anticipated for the SWOU, the recreational user is defined as a resident who routinely partakes in recreational activities in the areas where contamination is found. Furthermore, residential risks are assessed in a semiquantitative fashion using comparisons to residential no action levels. This evaluation is only provided for the sake of completeness, and its inclusion does not indicate that residential development of the NSDD is a foreseeable land use.

D.3.3.2 Potential Receptor Populations

Receptor populations, as indicated above, are industrial workers and child recreational users exposed to soil/sediment and surface water under current conditions, and industrial workers, excavation workers, and recreational users under potential future conditions. Within these broad categories, different age cohorts within the "recreational users" require consideration (Methods Document, DOE 2001). These age cohorts are based on a combination of likelihood and magnitude of possible exposure and on typical activity patterns. These cohorts include small children (age 1–7 years), teenagers (age 8–20 years), and adults (older than 21 years). The recreational user also may contain sensitive subpopulations such as pregnant women, young children (age 0–1 year), the elderly, and the infirm. In this assessment, exposures to these subpopulations are not quantified because much of the information needed is not available; however, these subpopulations are considered qualitatively in the uncertainty discussion included in this assessment. Also, as noted earlier, this assessment assumes that the recreational user is a rural resident who has continuous access to the study area. Recreational users not residing in the study area are not considered separately because nearby residents can be expected to access the site most often and, thereby, receive the highest exposures.

D.3.3.3 Delineation of Exposure Points and Pathways

Human health risks are assessed by determining exposure points and pathways. Exposure points are locations where human receptors can contact contaminated media (soil/sediment and surface water). Exposure pathways are the ways that human receptors contact contaminated media. The exposure pathways considered during the exposure assessment, per agreement with the regulatory agencies (DOE 2001), are described in the following paragraphs. These discussions also develop justifications for selecting exposure pathways for further quantitative evaluation.

- **Incidental ingestion of soil/sediment**—Industrial processes at the SWOU have released various contaminants to soils and sediments in the SWOU. Industrial workers may ingest soil/sediment while working outdoors or during break times. Excavation workers may ingest soil/sediment while digging building foundations, utility trenches, etc. Recreational users may ingest soil/sediment during recreational activities such as wading in the NSDD or hunting near the NSDD. Industrial workers, excavation workers, and recreational users are, therefore, potential receptors for this exposure route.

- **Dermal contact with soil/sediment**—Industrial processes at the SWOU have released various contaminants to soils and sediments in the SWOU. Industrial workers may get soil/sediment on their skin while working outdoors and excavation workers may get soil/sediment on their skin while digging. Recreational users may get soil/sediment on their skin during recreational activities. Industrial workers, excavation workers, and recreational users are potential receptors for this exposure route.

- **Inhalation of volatile compounds and particulates from soil/sediment**—Industrial processes at the SWOU have released various contaminants to soils and sediments in the SWOU. Some of these contaminants may be volatile and released to the air as vapors or particulates. Industrial workers may inhale these vapors or soil/sediment particulates while working outdoors and excavation workers may inhale these vapors or soil/sediment particulates while digging. Recreational users may inhale these vapors or soil/sediment particulates during recreational activities. Industrial workers, excavation workers, and recreational users, therefore, are potential receptors for this exposure route.

- **External exposure to ionizing radiation emitted by constituents in soil/sediment**—Industrial processes at the SWOU have released various contaminants to soils and sediments in the SWOU. Radionuclides present in contaminated soil/sediment undergo decay and emit ionizing radiation. Industrial workers may be exposed to ionizing radiation while working outdoors, excavation workers may be exposed to it while digging, and recreational users may be exposed to this ionizing radiation during recreational activities. Industrial workers, excavation workers, and recreational users, therefore, are potential receptors for this exposure route.

- **Incidental ingestion of surface water while wading in outfalls or NSDD**—Some contaminants released from past industrial processes are observed in surface water within the SWOU. Surface water inside the security fence is accessible to industrial workers or potentially to excavation workers, depending on the time of year. Theoretically, workers may ingest small amounts of surface water while working or spending break times outdoors and within the drainages. Outside the fenced area, surface water from the NSDD is accessible to recreational users. While not deep enough for swimming, wading is possible and recreational users may ingest small amounts of surface water during this activity. Industrial workers and recreational users, therefore, are potential receptors for this exposure route.

- **Dermal contact with surface water while wading in outfalls or NSDD**—Some contaminants released from past industrial processes are observed in surface water within the SWOU. Surface water inside the security fence is accessible to industrial workers or potentially to excavation workers, depending on the time of year. Theoretically, workers may come into dermal contact with surface water while working or spending break times outdoors and within the drainages. Outside the fenced area, surface water from the NSDD is accessible to recreational users. While not deep enough for swimming, wading is possible and recreational users would come into dermal contact with surface water during this activity. Industrial workers and recreational users, therefore, are potential receptors for this exposure route.

- **External exposure to ionizing radiation emitted by constituents in surface water while swimming or wading in outfalls or NSDD**—Some contaminants released from past industrial processes are observed in surface water within the SWOU. Surface water inside the security fence is accessible to industrial workers or potentially to excavation workers, depending on the time of year. Theoretically, workers may be exposed to ionizing radiation from radioactive contaminants in surface water while working or spending break times outdoors and within the drainages. Outside the fenced area, surface water from the NSDD is accessible to recreational users. While not deep enough for swimming, wading is possible and recreational users may be exposed to ionizing radiation from radioactive contaminants in surface water during this activity. Industrial workers and recreational users, therefore, are potential receptors for this exposure route.

- **Ingestion of fish taken from creeks and ponds**—Fish living in Bayou Creek or settling ponds may accumulate contaminants from surface water in their edible tissues. Although such bodies of water are not included in the SWOU study area, contaminants potentially may migrate from the SWOU to these areas. Recreational users and residents may catch and consume fish from the potentially impacted surface water bodies. Potential receptors for this route of exposure are recreational users.

- **Ingestion of vegetables and produce grown in contaminated soil**—As noted in Appendix E of the Methods Document (DOE 2001), crop farming and gardening are common activities near PGDP, and this land use pattern could be expanded to the SWOU area in the future if the industrial infrastructure were removed. Because of releases of chemical and radioactive contaminants to soil/sediment in the SWOU, plants raised in this soil may accumulate these contaminants. Finally, humans may consume contaminated produce. Potential receptors for this route of exposure are rural residents.

- **Ingestion of beef from cattle contaminated by consuming vegetation (pasture and concentrates) grown in contaminated soil and/or ingesting contaminated soil**—During interviews, agricultural extension agents for Ballard and McCracken Counties indicated that small-scale cow-calf operations are common in western Kentucky (see Appendix E of the Methods Document, DOE 2001). They further noted that slaughtering feeder cattle for home consumption is common. In the study area, such beef may be contaminated by incidental ingestion of soil while in the pasture or by ingestion of contaminated vegetation (pasture and concentrate). Residents may eat this beef. Potential receptors for this route of exposure, therefore, are rural residents.

- **Ingestion of dairy products (i.e., milk) from cows contaminated by consuming vegetation (pasture or concentrates) grown on contaminated soil and/or ingesting contaminated soil**—During interviews, agricultural extension agents for Ballard and McCracken Counties noted that dairy farming occurs in their counties (see Appendix E of the Methods Document, DOE 2001). Furthermore, the agents stated that these cattle are fed stored feed and are allowed to graze on pasture. As noted previously, the soil of the SWOU is contaminated, and the vegetation may become contaminated. Dairy cattle raised within the SWOU, if the industrial infrastructure were to be removed, may become contaminated through incidental ingestion of soil while in the pasture and ingestion of contaminated vegetation. Residents could in turn consume products made from milk from these cows. Potential receptors for this route of exposure, therefore, are rural residents.

- **Ingestion of pork from swine fed contaminated feed and water**—During interviews, agricultural extension agents for Ballard and McCracken Counties noted that both large commercial and small hog farms exist in their counties (see Appendix E of the Methods Document, DOE 2001). Furthermore, they indicated that swine on both types of farms were fed locally raised feed and, on the smaller farms, farmers consumed farm-raised pork. Swine raised on these farms may be contaminated through ingestion of contaminated feed and rural residents may eat this pork. Rural residents, therefore, are potential receptors for this pathway.

- **Ingestion of poultry from animals that have ingested contaminated water**—During interviews, agricultural extension agents for Ballard and McCracken Counties noted that commercial broiler production occurs in their counties, but not near PGDP (see Appendix E of the Methods

Document, DOE 2001). Home flocks for both meat and eggs were noted as being uncommon. Furthermore, they stated that broilers were fed purchased feed (not locally raised), that normal resident time in poultry houses was two months, and that commercial distribution of the product occurs. Thus, poultry is unlikely to become contaminated with site-related contaminants, and rural residents are potential, but unlikely, receptors.

- **Ingestion of game (i.e., deer, rabbits, and quail) contaminated by consuming contaminated vegetation or soil and ingestion of water**—As indicated in the Methods Document (DOE 2001), hunting of game is common around the study area. Potential game species include deer, rabbits, ducks, geese, quail, and wild turkey. Each of these species may be contaminated by ingestion of contaminated vegetation and/or soil/sediment. Potential receptors for this route of exposure are recreational users who take game from the areas near the NSDD.

Many potential exposure pathways are theoretically possible for the SWOU; however, not all of these routes are quantified in this assessment. As discussed below, several of these pathways are unlikely to be associated with significant exposure either currently or in the future. No quantitative estimates of exposure are developed for these pathways. Justification for this approach is provided below.

Pathways quantified are presented in Table D.4. Please note, soil and sediment are listed in this table as separate media to differentiate which calculation was employed when both soil and sediment calculations were available for a particular receptor. However, the combined soil/sediment EPCs were employed in the exposure calculations. The models and parameters used to quantify intakes of chemicals and radionuclides for the various exposure routes are presented in Attachment D2. Chemical-specific parameters used in these models, such as biouptake factors, are listed in Table D.5.

Table D.4. Summary of Exposure Routes Quantified in the BHHRA

Exposure route
Recreational user
Ingestion of sediment in study area (NSDD)
Dermal contact with sediment in study area (NSDD)
Inhalation of volatile compounds and particulates from sediment in study area (NSDD)
External exposure to ionizing radiation in sediment in study area (NSDD)
Dermal contact with surface water in study area (NSDD)
Ingestion of deer ranging in study area (NSDD)
Ingestion of rabbit ranging in study area (NSDD)
Ingestion of quail ranging in study area (NSDD)
Industrial worker
Dermal contact with surface water while working outdoors (SWOU outfalls)
Ingestion of surface soil (SWOU)
Dermal contact with surface soil (SWOU)
Inhalation of volatile compounds and particulates emitted from surface soil (SWOU)
External exposure to ionizing radiation emitted from surface soil (SWOU)
Excavation worker
Incidental ingestion of surface and subsurface soil (SWOU)
Dermal contact with surface and subsurface soil (SWOU)
Inhalation of volatile compounds and particulates emitted from surface and subsurface soil (SWOU)
External exposure to ionizing radiation emitted from surface and subsurface soil (SWOU)

BHHRA – Baseline human health risk assessment.
NSDD – North-south diversion ditch.
SWOU – Surface water operable unit.

Table D.5. Factors Used to Calculate Chronic Daily Intakes of COPCs

COPCs	Permeability constant (cm/hr)	Deer and rabbit biouptake factor (kg/kg)	Quail biouptake factor (kg/kg)	Worm biouptake factor (kg/kg)	Particulate emission factor (m^3/kg)
Inorganic chemicals (metals)					
Aluminum	1E-03	NA	1.50E-03	5.40E-02	3.21E+10
Antimony	1E-03	4E-05	4E-05	1E+00	3.21E+10
Arsenic	1E-03	NA	2E-03	1.50E-01	3.21E+10
Barium	1E-03	2E-04	9E-03	5.80E-02	3.21E+10
Beryllium	1E-03	NA	1E-03	6.30E-01	3.21E+10
Cadmium	1E-03	4E-04	8E-01	7.40E-01	3.21E+10
Chromium	1E-03	9E-03	9E-03	7.80E-02	3.21E+10
Copper	1E-03	9E-03	5E-01	NA	3.21E+10
Iron	1E-03	2E-02	1E+00	6.10E-02	3.21E+10
Lead	1E-04	4E-04	4E-04	7.20E-02	3.21E+10
Manganese	1E-03	5E-04	5E-02	6.40E-02	3.21E+10
Mercury	1E-03	NA	3E-02	NA	3.21E+10
Molybdenum		0.001	1E+00	NA	3.21E+10
Nickel	2E-04[1]	5E-03	NA	NA	3.21E+10
Selenium	1E-03	NA	9E+00	NA	3.21E+10
Silver	6E-04	3.-03	2.E+00	NA	3.21E+10
Uranium	1E-03	NA	NA	NA	3.21E+10
Vanadium	1E-03	NA	NA	NA	3.21E+10
Zinc	6E-04[1]	1E-01	7E+00	NA	3.21E+10
Organic compounds					
Fluoranthene	5.13E-01[1]	NA	NA	NA	3.21E+10
Pyrene	3.24E-01[1]	NA	NA	NA	3.21E+10
Total PCB	9.22E-01[1]	NA	NA	NA	3.21E+10
Total PAH	1.24E+00	NA	1.70E+00	5.40E-02	3.21E+10
Radionuclides					
Americium-241	NA	4E-05	6E-03	NA	3.21E+10
Cesium-137	NA	5E-02	1E+01	NA	3.21E+10
Cobalt-60	NA	1E-04	2E+00	NA	3.21E+10
Neptunium-237	NA	NA	NA	NA	3.21E+10
Plutonium-239/240	NA	1E-05	3E-03	2.50E+00	3.21E+10
Technetium-99	NA	NA	NA	NA	3.21E+10
Thorium-228	NA	NA	1E-04	1E+00	3.21E+10
Thorium-230	NA	NA	1E-04	1E+00	3.21E+10
Thorium-232	NA	NA	1E-04	1E+00	3.21E+10
Uranium-234	NA	3E-04	1E+00	9.20E-02	3.21E+10
Uranium-235	NA	3E-04	1E+00	9.20E-02	3.21E+10
Uranium-238	NA	3E-04	1E+00	9.20E-02	3.21E+10
Volatile organic compounds (VOCs)					
Trichloroethene	1.57E-02	NA	NA	NA	3.21E+10

COPC = chemical of potential concern.
cm/hr – Centimeters per hour.
kg/kg – Kilograms per kilogram.
m^3/kg – Cubic meters per kilogram.
NA – Not applicable.
PCB – Polychlorinated biphenyl.
PAH – Polycyclic aromatic hydrocarbon.
Total PAH – PAHs were totaled in accordance with EPA Region 4 guidance (EPA 1995) and the Methods Document (DOE 2001).
Total PCB – PCBs were totaled in accordance with Methods Document (DOE 2001).
[1] These values were obtained from ORNL Risk Assessment Information System (DOE 2006a).

D.3.3.4 Rationale for Elimination of Exposure Pathways

As indicated above, several potential pathways of exposure are not quantified in this assessment. Justification for elimination of these pathways from the quantitative assessment is provided below.

Three exposure pathways associated with contact to surface water in the outfalls and the NSDD were not quantitatively evaluated:

(1) Incidental ingestion of surface water while wading,
(2) External exposure to ionizing radiation emitted by constituents in surface water while wading, and
(3) Consumption of fish caught from drainages.

Ingestion of surface water was not quantitatively evaluated since it is not likely that the activity of wading in very shallow water would result in a significant exposure relative to ingestion. Typically, such incidental ingestion only is quantified when swimming is possible. Exposure to ionizing radiation emitted by surface water was not evaluated because water shields ionizing radiation. Consumption of fish was not evaluated because the drainages are small and, for the most part, are intermittent and do not support fish of a size and type that would be taken by anglers.

Six routes of exposure involving agricultural use of the land for future residential consumption were not evaluated in the BHHRA:

(1) Ingestion of vegetables,
(2) Ingestion of beef,
(3) Ingestion of dairy products,
(4) Ingestion of eggs,
(5) Ingestion of pork, and
(6) Ingestion of poultry.

The residential homestead scenario was not assessed in this BHHRA due to the site’s physical features that make residential development of surface water drainages unlikely. Additionally, if the plant ever were to be considered for future residential use, the process involved for removing the existing infrastructure would change all of the existing conditions and, therefore, an evaluation at this time cannot be reasonably performed. Finally, the drainage features are narrow and linear and would, even in the worst case, represent only a fraction of a residential yard. Residential exposures are assessed via the recreational use scenario.

The choice of receptors and pathways for the assessment is subject to some uncertainty. In particular, none of the receptors identified in the Methods Document (DOE 2001) fits the exposure setting for the SWOU very well. Workers are unlikely to spend any significant time in the drainage features for any activities, and recreational users have many more desirable recreational opportunities in the immediate area and are unlikely to spend significant time in the NSDD. These uncertainties are further discussed in Section 6.

D.3.3.5 Development of the Site Conceptual Model

Using the information in the previous sections, a CSM was developed for the SWOU. This CSM (Figure D.11) illustrates all sources, pathways of migration, and routes of potential exposure (exposure pathways) for potential receptors in the SWOU. The outfalls serve as the conduit for releasing contamination from the plant facility into the environment. Contaminated water discharges into the on-

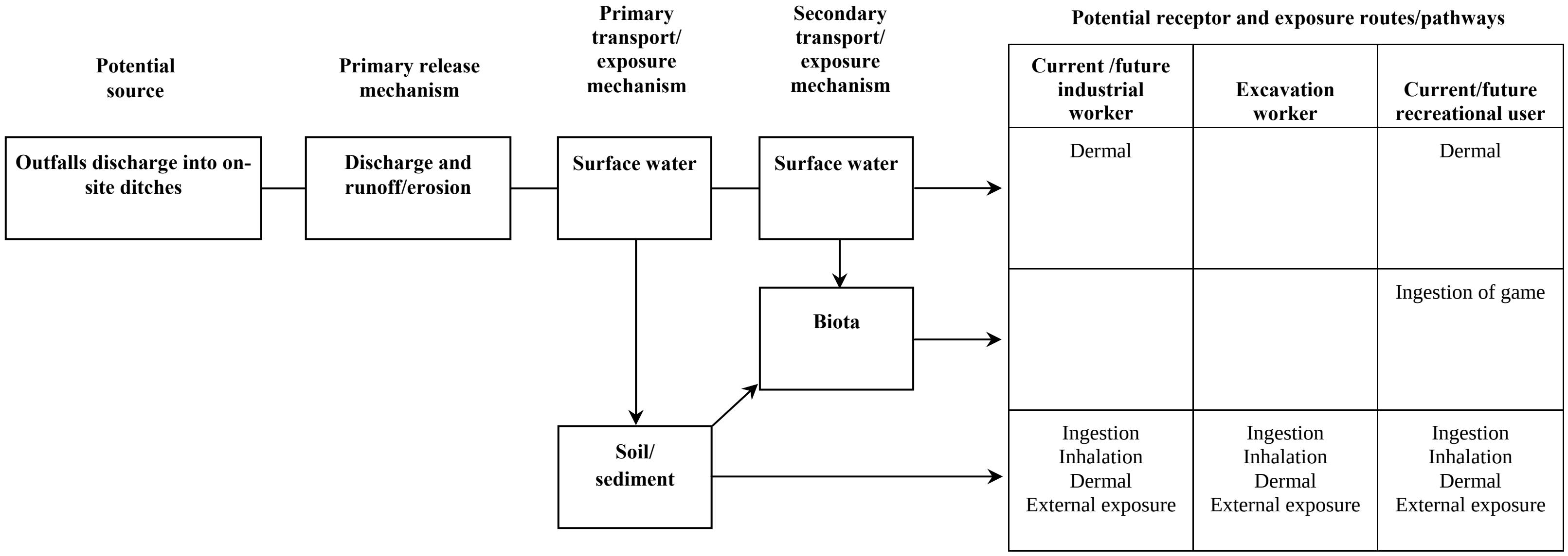

Figure D.11. Conceptual Site Exposure Model

site ditches where contaminants are released to the sediment. Surface water in the ditches periodically overflows and contaminates the soil and biota.

Table D.6 summarizes the routes of exposure that will be evaluated for each receptor in this characterization. Current and future industrial workers were evaluated for dermal contact with surface water in the outfalls and for exposures related to exposure to surface soil/sediment in the outfalls. The current industrial worker was assumed to be exposed to surface water 14 days per year (Rudy Lee, e-mail to Jana White, May 18, 2006), whereas the future industrial worker was assumed to be exposed to surface water 250 days per year. Excavation workers were evaluated for exposures related to surface soil/sediment and subsurface soils. Future recreational users were evaluated for dermal contact with surface water in the NSDD; for exposures related to soil/sediment; and for exposures related to ingestion of game, including consumption of deer, rabbits, and quail. The child recreational user also was evaluated using different assumptions for current and future soil/sediment and surface water exposures. Current child recreational users were assumed to visit the site 10 days over a one-year period for 4 hours per visit. Future child recreational users were assumed to visit the site 140 days per year for six years for 5 hours per visit. No site-specific changes were made to the ingestion of game pathway.

D.3.3.6 Calculation of Representative Concentrations of COPCs

Representative concentrations of COPCs in each medium, under current/future conditions for each of the redefined EUs, were estimated and used as input for calculating chronic daily intakes (CDIs). It should be noted that soil/sediment samples were segregated into surface (collected 0 to 1 ft bgs) and subsurface (1 to 6 ft bgs) groups. The shallower samples were used to assess most human receptors; however, subsurface soil samples were included in the evaluation of excavation workers because workers involved in excavation also might contact deeper soils. Representative concentrations for COPCs in surface soil/sediment, subsurface soil/sediment, and surface water are presented in Tables D.7 and D.8, respectively. ProUCL, a computer software program, was employed to calculate 95% upper confidence limits (UCLs) for each dataset, except as indicated below.

For all normally distributed data, the student t-statistic was identified as the EPC. For all other distributions, the H-statistic was employed as the EPC. However, if the representative concentration for a COPC within a medium was greater than the maximum detected concentration of the COPC in the medium, the lesser value was identified as the EPC. In addition, if the number of data points in the data set for a particular exposure area was five or less, the 95% UCL was not calculated and the maximum detected concentration was used as the EPC. Although it is a slight deviation from the Methods Document (DOE 2001) to check datasets with between five and ten samples for normality or lognormality, this was done for these datasets as a conservative data-specific measure. After determining whether the data were normally or lognormally distributed, the appropriate student t-statistic, H-statistic, or maximum detected concentration was employed. In deriving the 95% UCL concentrations, the quantitation limits for COPCs reported as nondetects were used in the calculations, with the exception of PAHs and PCBs. For these COPCs, see Section D.2.3.1 for the methods used to calculate concentrations for BaPEs and Total PCBs. EPC calculations are presented in Attachment D3.

Table D.6. Summary of Reasons for Selection or Dismissal of Exposure Routes for Quantitative Evaluation of SWOU Locations

Land use scenario	**Exposure route, medium, and exposure point**	**Route quantified**	**Reason for selection or dismissal**
Current/ future industrial worker	Ingestion of groundwater as drinking water	**No**	Groundwater not in use
	Inhalation of VOCs emitted during showering	**No**	Groundwater not in use
	Dermal contact with groundwater while showering	**No**	Groundwater not in use
	External exposure to radiation while showering	**No**	Groundwater not in use
	Inhalation of VOCs from groundwater irrigation	**No**	Groundwater not in use
	Ingestion of soil	Yes	Ingestion of soil may occur
	Dermal contact with soil	Yes	Dermal contact with soil may occur
	Inhalation of particulates emitted from soil	Yes	Inhalation of particulates and VOCs in soil may occur
	Inhalation of VOCs emitted from soil	**No**	No VOCs selected as COPCs
	External exposure to radiation emitted by soil	Yes	External radiation exposure may occur
	Ingestion of surface water in outfalls	**No**	Ingestion would be insignificant from wading activity
	Dermal contact with surface water in outfalls	Yes	Dermal contact with surface water may occur
	Incidental ingestion of sediment in outfalls	**No**	Evaluated as soil
	Dermal contact with sediment in outfalls	**No**	Evaluated as soil
	Inhalation of particulates and VOCs emitted from sediment	**No**	Evaluated as soil
	External exposure to radiation emitted in sediment in outfalls	**No**	Evaluated as soil
	Consumption of vegetables raised in contaminated soil	**No**	Site not suitable for agricultural development
	Consumption of vegetables irrigated with contaminated groundwater	**No**	Site not suitable for agricultural development
	Consumption of beef contaminated from ingesting biota or water	**No**	Site not suitable for agricultural development
	Consumption of dairy products contaminated from soil, biota or water	**No**	Site not suitable for agricultural development
	Consumption of pork contaminated from ingesting biota or water	**No**	Site not suitable for agricultural development
	Consumption of poultry contaminated from ingesting water	**No**	Site not suitable for agricultural development
	Consumption of game (deer, rabbits and quail)	**No**	Site is an enclosed industrial site
Excavation worker	Ingestion of groundwater as drinking water	**No**	Groundwater not in use
	Inhalation of VOCs emitted during showering	**No**	Groundwater not in use
	Dermal contact with groundwater while showering	**No**	Groundwater not in use
	External exposure to radiation while showering	**No**	Groundwater not in use
	Inhalation of VOCs from groundwater irrigation	**No**	Groundwater not in use
	Ingestion of soil	Yes	Ingestion of soil may occur
	Dermal contact with soil	Yes	Dermal contact with soil may occur
	Inhalation of particulates emitted from soil	Yes	Inhalation of particulates and VOCs in soil may occur
	Inhalation of VOCs emitted from soil	**No**	No VOCs selected as COPCs

Table D.6 (Continued)

Land use scenario	Exposure route, medium, and exposure point	Route quantified	Reason for selection or dismissal
Excavation worker (continued)	External exposure to radiation emitted by soil	Yes	External radiation exposure may occur
	Ingestion of surface water in outfalls	**No**	Contact restricted to soil only
	Dermal contact with surface water in outfalls	**No**	Contact restricted to soil only
	External exposure to radiation emitted in surface water in outfall	**No**	Contact restricted to soil only
	Incidental ingestion of sediment in outfalls	**No**	Contact restricted to soil only
	Dermal contact with sediment in outfalls	**No**	Contact restricted to soil only
	Inhalation of particulates and VOCs emitted from sediment	**No**	Contact restricted to soil only
	External exposure to radiation emitted in sediment in outfall	**No**	Contact restricted to soil only
	Consumption of fish from drainages	**No**	Drainages do not support fish of the size and type sought by anglers
	Consumption of vegetables raised in contaminated soil	**No**	Site not suitable for agricultural development
	Consumption of vegetables irrigated with contaminated groundwater	**No**	Site not suitable for agricultural development
	Consumption of beef contaminated from ingesting biota or water	**No**	Site not suitable for agricultural development
	Consumption of dairy products contaminated from soil, biota or water	**No**	Site not suitable for agricultural development
	Consumption of pork contaminated from ingesting biota or water	**No**	Site not suitable for agricultural development
	Consumption of poultry contaminated from ingesting water	**No**	Site not suitable for agricultural development
	Consumption of game (deer, rabbits and quail)	**No**	Site is an enclosed industrial site
Current/future recreational user	Ingestion of groundwater as drinking water	**No**	Groundwater not in use
	Inhalation of VOCs emitted during showering	**No**	Groundwater not in use
	Dermal contact with groundwater while showering	**No**	Groundwater not in use
	External exposure to radiation while showering	**No**	Groundwater not in use
	Inhalation of VOCs from groundwater irrigation	**No**	Groundwater not in use
	Ingestion of soil	**No**	Sediment rather than soil considered exposure point
	Dermal contact with soil	**No**	Sediment rather than soil considered exposure point
	Inhalation of particulates emitted from soil	**No**	Sediment rather than soil considered exposure point
	Inhalation of VOCs emitted from soil	**No**	Sediment rather than soil considered exposure point
	External exposure to radiation emitted by soil	**No**	Sediment rather than soil considered exposure point
	Ingestion of surface water in outfalls	**No**	Ingestion would be insignificant from wading activity
	Dermal contact with surface water in outfalls	Yes	Dermal contact with surface water may occur
	External exposure to radiation emitted in surface water in NSDD	**No**	Water shields ionizing radiation
	Incidental ingestion of sediment in NSDD	Yes	Sediment may be ingested
	Dermal contact with sediment in NSDD	Yes	Dermal contact with sediment may occur
	Inhalation of particulates emitted from sediment	Yes	Inhalation of particulates and VOCs in sediment may occur
	External exposure to radiation emitted in sediment in NSDD	Yes	External radiation exposure may occur
	Consumption of fish from drainages	**No**	Drainages do not support fish of the size and type sought by anglers

Table D.6 (Continued)

Land use scenario	**Exposure route, medium, and exposure point**	**Route quantified**	**Reason for selection or dismissal**
Current/future recreational user (continued)	Consumption of vegetables raised in contaminated soil	**No**	Industrial area not conducive for agricultural use
	Consumption of vegetables irrigated with contaminated groundwater	**No**	Industrial area not conducive for agricultural use
	Consumption of beef contaminated from ingesting biota or water	**No**	Industrial area not conducive for agricultural use
	Consumption of dairy products contaminated from soil, biota or water	**No**	Industrial area not conducive for agricultural use
	Consumption of pork contaminated from ingesting biota or water	**No**	Industrial area not conducive for agricultural use
	Consumption of poultry contaminated from ingesting water	**No**	Industrial area not conducive for agricultural use
	Consumption of game (deer, rabbits and quail)	Yes	Game may be hunted and consumed

COPC – Chemical of potential concern.
SWOU – Surface water operable unit.
NSDD – North-south diversion ditch.
VOC – Volatile organic compounds.

Table D.7. Soil/Sediment EPCs

COPC	Outfall 001 EU 13 Hot Spot		Outfall 001 EU 14 Hot Spot		Outfall 001 EU 15 Hot Spot		Outfall 001 EU 16 Hot Spot		Outfall 001 EU 18 Hot Spot		Outfall 001 EU 20 Hot Spot	
	Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Inorganic chemicals (metals)												
Aluminum	8880	8880	8163	7542	7490	7490	8190	8190	11500	11500	9040	9040
Antimony	9.86	9.86	15	19	9.79	9.79	9.62	9.62	9.93	9.93	9.74	9.74
Arsenic	5.17	5.17	5.0	5.3	9.55	9.55	10.7	10.7	4.68	4.68	6.84	6.84
Barium	91.4	91.4	87	91	48.4	48.4	71	71	61.4	61.4	69.2	69.2
Beryllium	0.493	0.493	0.48	0.49	ND	ND	0.663	0.663	0.604	0.604	ND	ND
Cadmium	ND	ND	1.9	2.0	2.8	2.8	19.3	19.3	ND	ND	ND	ND
Chromium	43.5	43.5	71	77	72.7	72.7	23.5	23.5	21.6	21.6	11.4	11.4
Copper	12.9	12.9	43	44	47.7	47.7	13.9	13.9	49	49	ND	ND
Iron	15200	15200	11527	11667	11700	11700	182000	182000	15700	15700	11200	11200
Lead	21.9	21.9	23	22	64.6	64.6	21.1	21.1	ND	ND	ND	ND
Manganese	788	788	339	354	342	342	1540	1540	847	847	471	471
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	ND	ND	4.68	4.7	23.9	23.9	ND	ND	21	21	ND	ND
Nickel	12.7	12.7	16	19	520	520	10.3	10.3	182	182	7.24	7.24
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	2.47	2.47	2.4	2.5	2.45	2.45	2.41	2.41	2.48	2.48	2.44	2.44
Uranium	48.5	48.5	7.8	7.8	642	642	14.3	14.3	90.8	90.8	19.4	19.4
Vanadium	16.5	16.5	19	21	15.6	15.6	25.3	25.3	22.7	22.7	19.6	19.6
Zinc	112	112	155	165	1370	1370	67.8	67.8	86.7	86.7	29.7	29.7
Organic compounds												
Fluoranthene	0.49	0.49	200	200	7.6	7.6	1.1	1.1	0.5	0.5	0.49	0.49
Pyrene	0.49	0.49	46	46	5.6	5.6	1.2	1.2	0.5	0.5	0.49	0.49
Total PCB	3.3	3.3	22	22	52	52	1.8	1.8	1.5	1.5	0.71	0.71
Total PAH	1.1	1.1	184	184	5.2	5.2	1.4	1.4	1.1	1.1	1.1	1.1
Radionuclides												
Americium-241	ND	ND	ND	ND	0.127	0.127	ND	ND	0.521	0.521	0.061	0.061
Cesium-137	0.301	0.301	0.12	0.094	0.681	0.681	0.175	0.175	9.38	9.38	0.282	0.282
Cobalt-60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Neptunium-237	0.60	0.60	0.068	0.059	0.335	0.335	0.0697	0.0697	2.88	2.88	0.521	0.521
Plutonium-239/240	0.0699	0.0699	0.079	0.079	0.625	0.625	0.0565	0.0565	3.62	3.62	0.404	0.404
Technetium-99	10.3	10.3	4.7	4.3	36.5	36.5	6.12	6.12	229	229	6.22	6.22
Thorium-228	0.347	0.347	0.39	0.44	0.324	0.324	ND	ND	0.353	0.353	0.632	0.632
Thorium-230	2.98	2.98	1.8	2.6	4.32	4.32	0.658	0.658	12.2	12.2	4.33	4.33
Thorium-232	0.448	0.448	0.44	0.47	0.349	0.349	0.196	0.196	0.392	0.392	0.664	0.664
Uranium-234	4.4	4.4	2.0	2.4	11.4	11.4	0.725	0.725	2.51	2.51	3.72	3.72
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238	16.3	16.3	2.6	2.2	11.5	11.5	1.96	1.96	12.9	12.9	4.29	4.29

Table D.7 (Continued)

COPC	Outfall 008 Hot Spot		Outfall 010 Hot Spot		Outfall 011 Hot Spot		Outfall 015 Hot Spot		NSDD Hot Spot		NSDD, Excluding the Hot Spot		Within the Fence, Excluding the Hot Spots	
	Surface	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**	**Surface**	**Subsurface**
Inorganic chemicals (metals)														
Aluminum	9113	9113	12900	12900	10378	10378	6720	6720	8095	8395	6425	6639	7170	7170
Antimony	9.7	9.7	9.67	9.67	17	17	11	11	14	17	10	11	11	11
Arsenic	5.7	5.7	12.6	12.6	13	13	10	10	5.8	5.4	6.0	6.0	6.0	6.0
Barium	73	73	95.1	95.1	92	92	77	77	78	74	66	69	70	70
Beryllium	0.53	0.53	0.48	0.48	0.96	0.96	0.57	0.57	0.65	0.52	0.58	0.59	0.52	0.52
Cadmium	ND	ND	ND	ND	2.8	2.8	2.1	2.1	ND	ND	2.1	2.0	3.6	3.6
Chromium	14	14	23.3	23.3	149	149	23	23	85	59	39	40	17	17
Copper	18	18	18.3	18.3	202	202	20	20	123	52	35	35	11	11
Iron	12418	12418	15600	15600	23320	23320	14665	14665	11177	11937	9331	9302	10720	10720
Lead	22	22	75.2	75.2	52	52	45	45	21	21	21	21	21	21
Manganese	469	469	323	323	595	595	530	530	417	358	456	447	345	345
Mercury	0.10	0.10	0.31	0.31	0.17	0.17	0.16	0.16	0.60	0.42	0.11	0.13	0.11	0.11
Molybdenum	8.2	8.2	13.9	13.9	7.3	7.3	5.5	5.5	8.3	8.3	4.6	4.6	6.3	6.3
Nickel	17	17	21.8	21.8	14	14	29	29	94	65	16	18	9.9	9.9
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	20	20	22	27	20	20
Silver	2.4	2.4	2.42	2.42	2.5	2.5	2.6	2.6	3.4	3.4	2.9	3.1	2.6	2.6
Uranium	96	96	26.4	26.4	439	439	920	920	328	328	164	234	208	208
Vanadium	21	21	27.8	27.8	42	42	19	19	20	24	17	18	18	18
Zinc	50	50	252	252	764	764	114	114	102	75	38	39	72	72
Organic compounds														
Fluoranthene	0.58	0.58	5.1	5.1	43	43	0.68	0.68	0.68	0.68	2.2	2.2	0.73	0.73
Pyrene	0.50	0.50	3.5	3.5	130	130	0.63	0.63	0.56	0.53	1.4	1.3	0.68	0.68
Total PCB	32	32	19	19	7.6	7.6	1.1	1.1	2.7	2.7	1.1	1.1	0.63	0.63
Total PAH	1.2	1.2	3.1	3.1	58	58	1.1	1.1	1.0	0.66	1.2	1.2	1.0	1.0
Radionuclides														
Americium-241	1.0	1.0	ND	ND	ND	ND	0.56	0.56	4.4	3.7	0.48	0.45	0.20	0.25
Cesium-137	0.55	0.55	0.726	0.726	0.54	0.54	31	31	4.2	3.7	0.76	0.73	0.43	0.45
Cobalt-60	ND	ND	ND	ND	ND	ND	0.18	0.18	ND	ND	ND	ND	0.14	0.15
Neptunium-237	0.66	0.66	0.0636	0.0636	ND	ND	0.42	0.42	5.3	5.3	0.28	0.33	0.065	0.11
Plutonium-239/240	9.1	9.1	0.109	0.109	0.046	0.046	27	27	21	21	4.8	4.6	0.050	0.056
Technetium-99	7.4	7.4	8.44	8.44	7.5	7.5	21	21	596	240	32	34	5.9	5.9
Thorium-228	0.59	0.59	0.328	0.328	0.48	0.48	0.51	0.51	2.0	1.1	0.47	0.49	0.32	0.32
Thorium-230	84	84	0.821	0.821	1.1	1.1	16	16	497	497	67	70	0.77	0.77
Thorium-232	0.67	0.67	0.271	0.271	0.50	0.50	0.55	0.55	2.4	1.4	0.56	0.58	0.33	0.33
Uranium-234	3.1	3.1	7.42	7.42	3.1	3.1	6.1	6.1	29	14	3.0	2.8	1.4	1.4

Table D.7 (Continued)

COPC	Outfall 008 Hot Spot		Outfall 010 Hot Spot		Outfall 011 Hot Spot		Outfall 015 Hot Spot		NSDD Hot Spot		NSDD, Excluding the Hot Spot		Within the Fence, Excluding the Hot Spots	
	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Radionuclides (continued)														
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9	5.9
Uranium-238	4.6	4.6	8.81	8.81	17	17	33	33	26	11	4.3	4.1	3.7	3.8

NA – Not analyzed ND – Not detected Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g. COPC = chemical of potential concern
EPC = exposure point concentration.
EU = exposure unit.
NSDD = North-South Diversion Ditch.
PCB = Polychlorinated biphenyl
PAH = Polycyclic aromatic hydrocarbon
Total PAH = PAHs were totaled in accordance with EPA Region 4 guidance (EPA 1995) and the Methods Document (DOE 2001).
Total PCB = PCBs were totaled in accordance with Methods Document (DOE 2001).

Table D.8. Surface Water EPCs

COPC	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	NSDD Hot Spot	NSDD, Excluding the Hot Spot	Within the Fence, Excluding Hot Spots
Inorganic chemicals (metals)													
Aluminum	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Antimony	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Barium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Beryllium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cadmium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chromium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Copper	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Iron	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Lead	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Manganese	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mercury	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Molybdenum	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nickel	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Selenium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Silver	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Uranium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table D.8 (Continued)

COPC	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	NSDD Hot Spot	NSDD, Excluding the Hot Spot	Within the Fence, Excluding Hot Spots
Inorganic chemicals (metals) (continued)													
Vanadium	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic compounds													
Fluoranthene	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Pyrene	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total PCB	NA	4.70E-04	NA	NA	NA	NA	NA	NA	4.14E-04	7.50E-05	NA	NA	4.70E-04
Total PAH	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Radionuclides													
Americium-241	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cesium-137	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cobalt-60	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Neptunium-237	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Plutonium-239/240	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Technetium-99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thorium-228	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thorium-230	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thorium-232	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Uranium-234	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Uranium-235	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Uranium-238	NA	ND	NA	NA	NA	NA	NA	NA	ND	NA	NA	1590	1650
Volatile organic compounds													
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	NA	ND	NA	NA	NA	NA	NA	NA	0.13	0.002	NA	0.0014	0.002

COPC – Chemical of potential concern.
EPC – Exposure point concentration.
EU – Exposure unit.
NA = Not Applicable.
ND – Not detected.
NS – Not selected as a COPC.
NSDD = North-South Diversion Ditch.
PCB – Polychlorinated biphenyl.
PAH – Polycyclic aromatic hydrocarbon.
Total PAH – PAHs were totaled in accordance with EPA Region 4 guidance (EPA 1995) and the Methods Document (DOE 2001).
Total PCB – PCBs were totaled in accordance with Methods Document (DOE 2001).
Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

EPCs for lead in soil/sediment were calculated for each area as described in this section. EPCs ranged from12 mg/kg to 75.2 mg/kg in both surface soil/sediment and subsurface soil. The maximum EPC, 75.2 mg/kg, occurred at the Outfall 010 Hot Spot. Lead was not detected at concentrations above the reporting limit in soil in two of the areas evaluated (Outfall 001 EU 18 Hot Spot and Outfall 001 EU 20 Hot Spot). The residential screening level for lead is 400 mg/kg (EPA 2004). This screening level is considered protective of young children in a residential setting; a screening level that is protective for young children is expected to be protective for older population subgroups (e.g., industrial workers, excavation workers, and recreational users). All EPCs for lead in soil are well below the residential soil screening value for lead; therefore, lead is eliminated from further consideration in the BHHRA.

D.3.3.7 Chronic Daily Intakes

CDIs of each of the COPCs were calculated using standard exposure parameters and equations presented in the Methods Document (DOE 2001). Additionally, two scenarios were evaluated using site-specific information. The exposure frequency for the current industrial worker was reduced from the 250 days per year in the Methods Document to 14 days per year to reflect the more realistic site-specific limited exposure industrial workers have to the ditches. The 250-day exposure frequency was calculated, however, for the future industrial worker. In addition, the exposure frequency for the current child recreational user for exposure to soil/sediment and surface water was reduced to 10 days over a one- year period, assuming each visit lasted 4 hours. The future child recreational user, however, was evaluated using the default exposure assumptions of 140 days per year over six years, assuming 5 hours per visit, as provided in the Methods Document (DOE 2001). The exposure parameters employed to calculate CDIs are presented in Attachment D2. Calculations are presented in Attachment D4.

D.3.3.8 Summary of Exposure Assessment

Soil/sediment and surface water were identified as contaminated media for the SWOU. Industrial land use currently characterizes the site. Current/future on-site receptors are industrial workers and excavation workers within the fenced plant and, additionally, recreational users (adults, teens, and children) at the NSDD. Recreational parameters employed are those for a local resident.

Several potential exposure pathways exist for each of these receptors. Pathways retained for quantitative evaluation of cancer risks and noncancer hazards for the current and potential future industrial worker are ingestion of surface soil/sediment, dermal contact with surface soil/sediment, inhalation of particulates emitted from surface soil/sediment, and external exposure to ionizing radiation emitted from surface soil/sediment. In addition, dermal contact with surface water is quantified for the industrial worker.

Pathways retained for quantitative evaluation for the potential excavation worker are ingestion of surface and subsurface soil/sediment, dermal contact with surface and subsurface soil/sediment, inhalation of particulates emitted from surface and subsurface soil/sediment, and external exposure to ionizing radiation emitted from surface and subsurface soil/sediment.

Pathways retained for the current/future recreational user are ingestion of deer, rabbit, and quail ranging in the NSDD study area, arising from hypothetical hunting activities. In addition, dermal contact with surface water, incidental ingestion of soil/sediment, dermal contact with soil/sediment, inhalation of particulates emitted from soil/sediment, and external exposure to ionizing radiation emitted from soil/sediment.

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D.4 TOXICITY ASSESSMENT

This section summarizes the potential toxicological effects of the COPCs on exposed populations. Many of the toxicological effects summaries and nearly all of the toxicity values included in this section were obtained from information drawn from http://risk.lsd.ornl.gov/. This Website (DOE 2006a) is the *Risk Assessment Information System* (RAIS) prepared by the University of Tennessee and the Toxicology and Risk Analysis (TARA) Section of Oak Ridge National Laboratory (ORNL) for DOE. This site is a compilation of toxicity values taken from EPA's most recent Integrated Risk Information System (IRIS) database (EPA 2006) and the Health Effects Assessment Summary Table (HEAST) database (EPA 1997). For those chemicals not profiled in RAIS, a brief summary of information drawn from the Agency for Toxic Substances and Disease Registry (ATSDR) or other secondary sources is included in this section. The last paragraph of each profile contains the toxicity values used in this BHHRA. Note that references follow each profile and are not repeated in Section D.9, References.

The toxicity information considered in the assessment of potential carcinogenic risks includes (1) a weight-of-evidence classification and (2) a slope factor (SF). The weight-of-evidence classification qualitatively describes the likelihood that an agent is a human carcinogen, based on the available data from animal and human studies. A chemical may be placed in one of three groups to indicate its potential for carcinogenic effects: Group A, a known human carcinogen; Group B, a probable human carcinogen; and Group C, a possible human carcinogen. Group B is divided into Subgroups Bl and B2. Assignment of a chemical to Subgroup Bl indicates that the judgment that the chemical is a probable human carcinogen is based on limited human data, and assignment of a chemical to Subgroup B2 indicates that the judgment that the chemical is a probable human carcinogen is based on animal data because human data are lacking or inadequate. Chemicals that cannot be classified as human carcinogens because of a lack of data are categorized in Group D, and those for which there is evidence of noncarcinogenicity in humans are categorized in Group E.

The SF for chemicals is defined as a plausible upperbound estimate of the probability of a response (i.e., development of cancer) per unit intake of a chemical over a lifetime (EPA 2006). SFs are specific for each chemical and route of exposure. SFs currently are available for ingestion and inhalation pathways. Those values used for oral and inhalation routes of exposure for the nonradionuclide COPCs evaluated in this report are shown in Table D.9. The SFs for radionuclides are presented in Table D.10.

Chronic reference doses (RfDs) are toxicity values used in calculations of noncarcinogenic risk. The chronic RfD is defined as "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA 2006). RfD values are specific to the route of exposure. Thus, the RfDs used for oral and inhalation routes of exposure for the COPCs considered in this report are presented in Tables D.11 and D.12, respectively.

For the dermal routes of exposure (i.e., dermal exposure to contaminated surface water during wading or dermal contact with contaminated soil), it is necessary to consider the absorbed dose received by a receptor. This is reflected by the addition of an absorption coefficient in the equations used to calculate the CDI for these pathways. Because the CDI is expressed as an absorbed dose, it is necessary to use RfDs and SFs that also are expressed in terms of absorbed dose. Currently, EPA has not produced lists of RfDs and SFs based on absorbed dose; however, they have produced guidance concerning the estimation of absorbed dose RfDs and SFs from administered dose RfDs and SFs. This may be found in RAGS (EPA 1992), and states that to convert an administered dose SF to an absorbed dose SF, the administered dose SF is divided by the GI absorption efficiency of the contaminant. Alternatively, in

Table D.9. Slope Factors Employed in the BHHRA for Nonradionuclides

Chemical	WOE	Oral SF (mg/kg-day)$^{-1}$	Oral Tumor Type	Oral Unit Risk (mg/L)$^{-1}$	Dermal SF (mg/kg-day)$^{-1}$	Inhalation SF (mg/kg-day)$^{-1}$	Inhalation Unit Risk (mg/m^3)$^{-1}$	Inhalation Tumor Type
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	A	1.5E+00 [I]	skin cancer	5.E-02 [I]	3.66E+00 [C]	1.5E+01 [U]	4.3E+00 [I]	lung cancer
Barium	D	NA	NA	NA	NA	NA	NA	NA
Beryllium	B1	NA	NA	NA	NA	8.4E+00 [U]	2.4E+00 [I]	lung tumors
Cadmium (Diet)	B1	NA	NA	NA	NA	6.3E+00 [U]	1.8E+00 [I]	lung tumors
Chromium (III)	D	NA	NA	NA	NA	NA	NA	NA
Copper	D	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	B2	NA	NA	NA	NA	NA	NA	NA
Manganese (Diet)	D	NA	NA	NA	NA	NA	NA	NA
Mercury	D	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	D	NA	NA	NA	NA	NA	NA	NA
Silver	D	NA	NA	NA	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium Pentoxide	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	D	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	D	NA	NA	NA	NA	NA	NA	NA
Pyrene	D	NA	NA	NA	NA	NA	NA	NA
Total PCBs (high risk)	B2	2.00E+00 [I]	liver tumors	NA	2.22E+00 [C]	2.00E+00 [I]	5.70E-01 [V]	NA
Total PAHs (BaPE)	B2	7.30E+00 [I]	forestomach papillomas, carcinomas	2.1E-01 [I]	2.35E+01 [C]	3.08E+00 [U]	8.80E-01 [E]	NA
Trichloroethene	NA	4E-01 [E]	NA	NA	2.67E+00 [C]	4E-01 [U]	1.10E-01 [E]	NA

A – Human carcinogen.
B – Probably human carcinogen based on limited evidence of carcinogenicity.
B – Probably human carcinogen based on sufficient evident of carcinogenicity in animals.
D – Not classifiable as to human carcinogenicity.
WOE – weight of evidence.
NA – Not available.
[I] – IRIS.
[H] – HEAST.
[E] – NCEA.
[C] – Calculated.
[U] – Inhalation slope factor was calculated from inhalation unit risk.
[V] – Inhalation unit risk was calculated from inhalation slope factor.

Table D.10. Slope Factors Employed in the BHHRA for Radionuclides

Chemical	Soil Ingestion SF (risk/pCi)	External SF (risk/yr per pCi/g soil)	Inhalation SF (risk/pCi)
Am-241	2.17E-10 [H]	2.76E-08 [H]	2.81E-08 [H]
Ce-137	3.64E-13 [H]	4.46E-08 [H]	4.11E-14 [H]
Co-60	4.03E-11 [H]	1.24E-05 [H]	3.58E-11 [H]
Np-237+D	1.62E-10 [H]	7.97E-07 [H]	1.77E-08 [H]
Pu-239	2.76E-10 [H]	2E-10 [H]	3.33E-08 [H]
Tc-99	7.66E-12 [H]	8.14E-11 [H]	1.41E-11 [H]
Th-228+D	8.09E-10 [H]	7.76E-06 [H]	1.43E-07 [H]
Th-230	2.02E-10 [H]	8.19E-10 [H]	2.85E-08 [H]
Th-232	2.31E-10 [H]	3.42E-10 [H]	4.33E-08 [H]
U-234	1.58E-10 [H]	2.52E-10 [H]	1.14E-08 [H]
U-235	1.57E-10 [H]	5.18E-07 [H]	1.01E-08 [H]
U-238	1.43E-10 [H]	4.99E-11 [H]	9.32E-09 [H]

C – Calculated
H – HEAST
I – IRIS

Table D.11. Oral/Dermal Reference Doses Employed in the BHHRA

Chemical	Oral RfD–chronic (mg/kg-day)	Oral RfD confidence interval	Oral RfD critical effect	Oral RfD target organ	Oral RfD modifying/ uncertainty factors	Oral RfD–subchronic (mg/kg-day)	Dermal RfD–chronic (mg/kg-day)	Dermal RfD–subchronic (mg/kg-day)	Inhalation RfD–chronic (mg/kg-day)	Inhalation RfD–subchronic (mg/kg-day)
Aluminum	1E+00 ^{E}	Low	Neurotoxicity in offspring	Nervous system	100	NA	1E-01 ^{C}	NA	1.43E-03	NA
Antimony	4E-04 ^{I}	Low	Longevity, blood glucose, cholesterol	Blood	1000	2E-04 ^{E}	8E-06 ^{C}	4E-06 ^{C}	NA	1.10E-04^{v}
Arsenic	3E-04 ^{I}	Medium	Hyperpigmentation, keratosis, and vascular complications	Skin	3	3.E-04 ^{H}	1.23E-04 ^{C}	1.23E-04 ^{C}	NA	NA
Barium	2E-01 ^{I}	Medium	Nephropathy	Liver	300	7E-02 ^{H}	1.40E-02 ^{C}	4.90E-03 ^{C}	1.43E-04^{C}	1.40E-03^{C}
Beryllium	2E-03 ^{I}	Low to medium	Lesions	Small intestine	300	5E-03 ^{H}	2E-05 ^{C}	5E-05 ^{C}	5.71E-06	NA
Cadmium (diet)	1E-03 ^{I}	High	Significant proteinuria	Renal cortex	10		1E-05 ^{C}	NA	NA	2.60E-04^{V}
Chromium (III)	1.50E+00 ^{I}	Low	No observed effects	NA	1000	1.50E+00 ^{H}	7.50E-03 ^{C}	7.50E-03 ^{C}	NA	NA
Copper	4E-02 ^{H}	NA	NA	NA	NA	4E-02 ^{H}	1.20E-02 ^{C}	1.20E-02 ^{C}	NA	NA
Iron	3E-01 ^{E}	NA	NA	NA	NA	NA	4.50E-02 ^{C}	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese (diet)	1.4E-01 ^{I}	Medium	Neurological effects	Nervous system	1	1.40E-01 ^{W}	5.60E-03 ^{C}	5.60E-03 ^{C}	1.43E-05	NA
Mercury	3E-04 ^{S}	NA	NA	NA		3E-04 ^{W}	2.10E-05 ^{C}	2.10E-05 ^{C}	NA	NA
Molybdenum	5E-03 ^{I}	Medium	Increased uric acid levels	Blood	30	NA	1.90E-03 ^{C}	NA	NA	NA
Nickel	2E-02 ^{I}	Medium	Decreased body and organ weight	NA	300	2E-02 ^{H}	5.4E-03 ^{C}	5.40E-03 ^{C}	NA	NA
Selenium	5E-03 ^{I}	High	Clinical selenosis	Hair, nails	3	5E-03 ^{H}	2.20E-03 ^{C}	2.20E-03 ^{C}	NA	NA
Silver	5E-03 ^{I}	Low	Argyria	Skin	3	5E-03 ^{H}	9E-04 ^{C}	9E-04 ^{C}	NA	NA
Uranium	6E-04 ^{F}	NA	Toxicity	Kidney	100		5.10E-04 ^{C}		NA	NA
Vanadium pentoxide	9E-03 ^{I}	Low	Decreased hair cystine	Hair	100	9E-03 ^{H}	1.80E-03 ^{C}	1.80E-03 ^{C}	NA	NA
Zinc	3E-01 ^{I}	Medium to high	Decreased erythrocyte ESOD activity	Blood	3	3E-01 ^{H}	6E-02 ^{C}	6E-02 ^{C}	NA	NA
Fluoranthene	4E-02 ^{I}	Low	Nephropathy, increased liver weight	Liver	3000	4E-01 ^{H}	1.24E-02 ^{C}	1.24E-01 ^{C}	NA	NA
Pyrene	3E-02 ^{I}	Low	Renal tubular pathology	Kidney	3000	3E-01 ^{H}	9.30E-03 ^{C}	9.30E-02 ^{C}	NA	NA
Total PCBs (1)	2E-05 ^{I}	Medium	Ocular exudate	Eye	300	5E-05 ^{H}	1.8E-05 ^{C}	4.50E-05 ^{C}	NA	NA
Total PAHs (as BaPE))	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	3E-04 ^{E}	NA	NA	NA	NA	NA	4.5E-05 ^{C}	NA	1.14E-02^{I}	NA

^{C} – Calculated
^{E} – NCEA
^{F} – *Federal Register*
^{H} – HEAST
^{I} – IRIS
^{v} – Provisional value
^{w} – Withdrawn

(1): The chronic and subchronic oral RfDs for Aroclor 1254 (high risk) were conservatively used as surrogate toxicity values for Total PCBs.

Table D.12. Inhalation Reference Doses Employed in the BHHRA

Chemical	Inhalation RfD–chronic (mg/kg-day)	Inhalation RfD confidence interval	Inhalation RfD critical effect	Inhalation RfD target organ	Inhalation RfD modifying/uncertainty factors	Inhalation RfD–subchronic (mg/kg-day)
Aluminum	1.43E-03 ^{E}	Low to medium	Psychomotor and cognitive impairment	Nervous system	300	NA
Antimony	NA	NA	NA	NA	NA	1.10E-04 ^{E}
Arsenic	NA	NA	NA	NA	NA	NA
Barium	1.43E-04 ^{H}	NA	Fetoxicity	Fetus	1000	1.40E-03 ^{E}
Beryllium	5.71E-06 ^{I}	Medium	Sensitization and progression to CBD	NA	10	
Cadmium (diet)	NA	NA	NA	NA	NA	2.60E-04 ^{E}
Chromium (III)	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Manganese (diet)	1.43E-05 ^{I}	Medium	Impairment of neurobehavioral function	Nervous system	1000	NA
Mercury	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	NA	NA
Vanadium pentoxide	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Total PCBs $^{(1)}$	NA	NA	NA	NA	NA	NA
Total PAHs (as BaPE))	NA	NA	NA	NA	NA	NA
Trichloroethene	1.14E-02 ^{E}	NA	Critical effects in CNS, liver,	Nervous system, liver	NA	NA

^{C} – Calculated
^{E} – NCEA
^{F} – *Federal Register*
^{H} – HEAST
^{I} – IRIS
^{W} – Withdrawn

(1): Inhalation reference doses were derived from inhalation reference concentrations (mg/m^{3}) from IRIS and HEAST by multiplying a conversion factor of 20 m^{3}/day per 70 kg by the reference concentrations.

converting an administered dose RfD to an absorbed dose RfD, the administered dose RfD is multiplied by the GI absorption efficiency of the contaminant. The dermal absorption factors used in converting the oral SFs to absorbed dose SFs, and oral RfDs to absorbed dose RfDs are presented in Table D.13.

Table D.13. Permeability Constant and Dermal Absorption Factor

Chemical	CAS #	Permeability constant (cm/hr)	Absorption factor, dermal
Aluminum	7429905	0.001	0.05
Americium-241	14596102		
Antimony (metallic)	7440360	0.001	0.03
Arsenic, inorganic	7440382	0.001	0.05
Barium	7440393	0.001	0.05
Benzo[a]pyrene	50328	1.24	0.13
Beryllium and compounds	7440417	0.001	0.05
Cadmium (diet)	7440439	0.001	0.001
Cesium-137	NA		
Chromium (III) (insoluble salts)	16065831	0.001	0.05
Cobalt-60	10198400		
Copper	7440508	0.001	0.05
Fluoranthene	206440	0.513	0.13
Iron	7439896	0.001	0.05
Lead and compounds	7439921	0.0001	0.05
Manganese (Diet)	7439965	0.001	0.05
Mercury, inorganic salts	7439976	0.001	0.05
Molybdenum	7439987	0.001	0.05
Neptunium-237+D	13994202		
Polychlorinated biphenyls (high risk)	1336363	0.922	0.14
Plutonium-239	15117483		
Plutonium -240	14119336		
Pyrene	129000	0.324	0.1
Selenium	7782492	0.001	0.05
Silver	7440224	0.0006	0.05
Techetium-99	14133767		
Thorium-228+D	14274829		
Thorium -230	14269637		
Thorium -232	7440291		
Trichloroethene	79016	0.0157	0.25
Uranium-234	13966295		
Uranium -235+D	15117961		
Uranium -238+D	7440611		
Uranium (soluble salts)	238	0.001	0.05
Vanadium, metallic	7440622	0.001	0.05
Zinc (metallic)	7440666	0.0006	0.05

Blank cells indicate there are no data available.
CAS – Chemical Abstracts Service.
cm – centimeter.
hr – hour.

EPA has adopted a TEF methodology for carcinogenic PAHs on the Target Compound List (TCL) as described in the *Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment, Interim Guidance* (EPA 1995). These TEFs are based on estimates of the potency of each compound relative to that of benzo(a)pyrene. Table D.14 lists the TEFs that were used to convert each concentration to an equivalent concentration of benzo(a)pyrene.

Table D.14. TEFs Used for Carcinogenic PAHs

Compound	TEF
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenzo(a,h)anthracene	1
Indeno(l,2,3-cd)pyrene	0.1

All TEFs taken from *Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment, Interim Guidance* (EPA 1995).
PAH – Polycyclic Aromatic Hydrocarbon.

D.4.1 INORGANIC COMPOUNDS

D.4.1.1 Aluminum (RAIS)

Aluminum is a silver-white flexible metal with a vast number of uses. It is poorly absorbed and efficiently eliminated. When absorption does occur, aluminum is distributed mainly in the bone, liver, testes, kidneys, and brain (ATSDR 1990a).

Aluminum may be associated with the onset of Alzheimer's disease (dialysis dementia), amyotrophic lateral sclerosis, and with Parkinsonism-Dementia Syndromes of Guam [Guam Alzheimers's-Parkinsonism-Demential (ALS-PD) ALS-PD complex] (ATSDR 1990a; Goyer 1991). For example, the aluminum content of brain, muscle, and bone increases in Alzheimer's patients and neurofibrillary tangles are found in patients suffering from aluminum encephalopathy and Alzheimer's disease. Symptoms of "dialysis dementia" include speech disorders, dementia, convulsions, and myoclonus.

People of Guam and Rota have an unusually high incidence of neurodegenerative diseases, a response potentially linked to exposure to the high levels of aluminum and manganese in volcanic soil in the region of Guam where the high incidence of ALS-PD occurs. Neurological effects also have been observed in rats orally exposed to aluminum compounds.

The respiratory system appears to be the primary target following inhalation exposure to aluminum. Alveolar proteinosis has been observed in guinea pigs, rats, and hamsters exposed to aluminum powders (Gross et al. 1973). Rats and guinea pigs exposed to aluminum chlorohydrate exhibited an increase in alveolar macrophages, increased relative lung weight, and multifocal granulomatous pneumonia (Cavender et al. 1978).

While no decrease in reproductive capacity, hormonal abnormalities, or testicular histopathology was observed in male rats exposed to aluminum in drinking water for 90 days (Dixon et al. 1979), male rats exposed to aluminum (as aluminum chloride) via gavage for six months exhibited decreased spermatozoa counts and sperm motility, and testicular histological and histochemical changes (Krasovskii et al. 1979).

Male rats exposed to drinking water containing aluminum (as aluminum potassium sulfate) for a lifetime exhibited increases in unspecified malignant and nonmalignant tumors (Schroeder and Mitchener 1975a), and similarly exposed female mice exhibited an increased incidence of leukemia (Schroeder and Mitchener 1975b). Rats and guinea pigs exposed via inhalation to aluminum chlorohydrate developed lung granulomas (Cavender et al. 1978), while granulomatous foci developed in similarly exposed male hamsters (Drew et al. 1974).

EPA has not evaluated aluminum or aluminum compounds for carcinogenicity, and no weight-of-evidence classification is currently assigned. Similarly, subchronic and chronic RfDs and reference concentrations (RfCs) have not been released officially by EPA in IRIS or HEAST.

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D.4.1.2 Antimony (RAIS)

Antimony (Sb) is a naturally occurring metal that is used in various manufacturing processes. It exists in valence states of 3 and 5 (Budavari 1989, ATSDR 1990). Antimony is a common urban air pollutant (Beliles 1979). Exposure to antimony may be via inhalation and oral and dermal routes (ATSDR 1990).

Antimony is sparingly absorbed following ingestion or inhalation (Felicetti et al. 1974a, Gerber et al. 1982, ATSDR 1990). Both GI and pulmonary absorption are a function of compound solubility. Antimony is transported in the blood, its distribution varying among species and dependent on its valence state (Felicetti et al. 1974b). Antimony is not metabolized, but may bind to macromolecules and react covalently with sulfhydryl and phosphate groups (ATSDR 1990). Excretion of antimony is primarily via the urine and feces, and is also dependent upon valence state (Cooper et al. 1968; Ludersdorf et al. 1987; ATSDR 1990).

Acute oral exposure of humans and animals to high doses of antimony or antimony-containing compounds (antimonials) may cause GI disorders (vomiting and diarrhea), respiratory difficulties, and death at extremely high doses (Bradley and Frederick 1941; Beliles 1979; ATSDR 1990). Subchronic and chronic oral exposure may affect hematologic parameters (ATSDR 1990). Long-term exposure to high doses of antimony or antimonials has been shown to adversely affect longevity in animals (Schroeder et al. 1970). Limited data suggest that prenatal and postnatal exposure of rats to antimony interferes with vasomotor responses (Marmo et al. 1987; Rossi et al. 1987).

Acute inhalation exposure of humans may cause GI disorders (probably due to ingestion of airborne antimony) (ATSDR 1990). Exposure of animals to high concentrations of antimony and antimonials (especially stibine gas) may result in pulmonary edema and death (Price et al. 1979). Long-term occupational exposure of humans has resulted in electrocardiac disorders, respiratory disorders, and possibly increased mortality (Renes 1953, Breiger et al. 1954). Antimony levels for these occupational exposure evaluations ranged from 2.2 to 11.98 mg Sb/m^3. Based on limited data, occupational exposure of women to metallic antimony and several antimonials has reportedly caused alterations in the menstrual cycle and an increased incidence of spontaneous abortions (Belyaeva 1967). Reproductive dysfunction has been demonstrated in rats exposed to antimony trioxide (Belyaeva 1967).

No data were available indicating that dermal exposure of humans to antimony or its compounds results in adverse effects; however, dermal application of high doses of antimony oxide (1584 mg Sb/kg) resulted in the death of rabbits within one day (Industrial Biotest Laboratories [IBTL] 1972). Eye irritation due to exposure to stibine gas and several antimony oxides has been reported for humans (Stevenson 1965; Potkonjak and Pavlovich 1983).

EPA (EPA 1991, 1992) has calculated subchronic and chronic oral RfDs of 4E-4 mg/kg/day based on decreased longevity and alteration of blood chemistry in rats chronically exposed to potassium antimony tartrate in the drinking water (5 parts per million [ppm] equivalent to 0.35 mg Sb/kg/day). An uncertainty factor of 1000 was applied: 10 for extrapolation from a lowest observed adverse effect level (LOAEL) to a no observed adverse effect level (NOAEL), 10 for extrapolation from animal data, and 10 for protection of sensitive populations.

The primary target organ for acute oral exposure to antimony appears to be the GI tract (irritation, diarrhea, vomiting), and targets for long-term exposure are the blood (hematological disorders) and liver (mild hepatotoxicity) (ATSDR 1990). Inhalation exposure to antimony affects the respiratory tract (pneumoconiosis and restrictive airway disorders), with secondary targets being the cardiovascular system (altered blood pressure and electrocardiograms) and kidneys (histological changes) (Renes 1953; Breiger et al. 1954). Only limited evidence exists for reproductive disorders due to antimony exposure (Belyaeva 1967). Although some data indicate that long-term exposure of rats to antimony trioxide and trisulfide increased the incidence of lung tumors (Wong et al. 1979; Watt 1980; Groth et al. 1986; Bio/dynamics 1989), EPA has not evaluated antimony or antimonials for carcinogenicity and a weight-of-evidence classification currently is unavailable.

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D.4.1.3 Arsenic (RAIS)

The toxicity of inorganic arsenic (As) depends on its valence state (-3, +3, or +5) and also on the physical and chemical properties of the compound in which it occurs. Trivalent (As^{+3}) compounds generally are more toxic than pentavalent (As^{+5}) compounds, and the more water-soluble compounds usually are more toxic and more likely to have systemic effects than the less soluble compounds. One of the most toxic inorganic arsenic compounds is arsine gas (AsH3).

Laboratory animals generally are less sensitive than humans to the toxic effects of inorganic arsenic. In addition, in rodents, the critical effects appear to be immunosuppression and associated with hepato-renal dysfunction. By contrast, the skin, vascular system, and peripheral nervous system appear to be the primary target organs in humans.

Water-soluble inorganic arsenic compounds are absorbed through the GI tract (> 90%) and lungs; distributed primarily to the liver, kidney, lung, spleen, aorta, and skin; and excreted mainly in the urine at rates as high as 80% in 61 hours following oral dosing (EPA 1984a, ATSDR 1989a, Crecelius 1977). Pentavalent arsenic is reduced to the trivalent form and then methylated in the liver to less toxic methylarsenic acids (ATSDR 1989a).

Symptoms of acute inorganic arsenic poisoning in humans are nausea, anorexia, vomiting, epigastric and abdominal pain, and diarrhea. Dermatitis (exfoliative erythroderma), muscle cramps, cardiac abnormalities, hepatotoxicity, bone marrow suppression and hematologic abnormalities (anemia), vascular lesions, and peripheral neuropathy (motor dysfunction, paresthesia) also have been reported (USAF 1990a; ATSDR 1989a; Franzblau and Lilis 1989; EPA 1984a; Armstrong et al. 1984; Hayes 1982a; Mizutaetal 1956).

Oral doses as low as 20 to 60 µg/kg-day have been reported to cause toxic effects in some individuals (ATSDR 1989a). Severe exposures can result in acute encephalopathy, congestive heart failure, stupor, convulsions, paralysis, coma, and death. The acute lethal dose to humans has been estimated to be about 0.6 mg/kg-day (ATSDR 1989a). General symptoms of chronic arsenic poisoning in humans are weakness, general debility and lassitude, loss of appetite and energy, loss of hair, hoarseness of voice, loss of weight, and mental disorders (Hindmarsh and McCurdy 1986). Primary target organs are the skin (hyperpigmentation and hyperkeratosis) (Terada et al. 1960; Tseng et al. 1968; Zaldivar 1974; Cebrian et al. 1983; Huang et al. 1985), nervous system (peripheral neuropathy) (Hindmarsh et al. 1977, 1986; Valentine et al. 1982; Heyman et al. 1956; Mizuta et al. 1956; Tay and Seah 1975), and vascular system (Tseng et al. 1968; Borgano and Greiber 1972; Salcedo et al. 1984; Wu et al. 1989; Hansen 1990). Anemia, leukopenia, hepatomegaly, and portal hypertension also have been reported (Terada et al. 1960; Viallet et al. 1972; Morris et al. 1974; Datta 1976). In addition, possible reproductive effects include a high male to female birth ratio (Lyster 1977).

In animals, acute oral exposures can cause GI and neurological effects (Heywood and Sortwell 1979). Lethal oral dose values for 50% of a population (LD_{50}) range from about 10 to 300 mg/kg (ATSDR 1989a; USAF 1990a). Subchronic exposure regimen can result in immunosuppression (Blakely et al. 1980) and hepato-renal effects (Mahaffey et al. 1981; Brown et al. 1976; Woods and Fowler 1977, 1978; Fowler and Woods 1979; Fowler et al. 1979). Chronic exposures also have resulted in mild hyperkeratosis and bile duct enlargement with hyperplasia, focal necrosis, and fibrosis (Baroni et al. 1963; Byron et al. 1967). Reduction in litter size, high male/female birth ratios, and fetotoxicity without significant fetal abnormalities have occurred following oral exposures (Schroeder and Mitchener 1971; Hood et al. 1977; Baxley et al. 1981); however, parental dosing has resulted in exencephaly, encephaloceles, skeletal defects, and urogenital system abnormalities (Ferm and Carpenter 1968, Hood and Bishop 1972, Beaudoin 1974, Burk and Beaudoin 1977).

Acute inhalation exposures to inorganic arsenic can damage mucous membranes, cause rhinitis, pharyngitis and laryngitis, and result in nasal septum perforation (EPA 1984a). Chronic inhalation exposures, such as those occurring in the workplace, can lead to rhino-pharyno-laryngitis, tracheobronchitis, (Lundgren 1954); dermatitis, hyperpigmentation, and hyperkeratosis (Perry et al. 1948, Pinto and McGill 1953); leukopenia (Kyle and Pease 1965, Hine et al. 1977); peripheral nerve dysfunction as indicated by abnormal nerve conduction velocities (Feldman et al. 1979, Blom et al. 1985, Landau et al. 1977); and peripheral vascular disorders as indicated by Raynaud's syndrome and increased vasospastic reactivity in fingers exposed to low temperatures (Lagerkvist et al. 1986). Higher rates of cardiovascular disease also have been reported in some arsenic-exposed workers (Lee and Fraumeni 1969, Axelson et al. 1978, Wingren and Axelson 1985). Possible reproductive effects include a high frequency of spontaneous abortions and reduced birth weights (Nordstrom et al. 1978a,b). Exposure to arsine gas (AsH_3), at concentrations as low as 3 to 10 ppm for several hours, can cause toxic effects. Hemolysis, hemoglobinuria, jaundice, hemolytic anemia, and necrosis of the renal tubules have been reported in exposed workers (ACGIH 1986a, Fowler and Weissberg 1974).

Animal studies have shown that intratracheal instillation of inorganic arsenic can cause pulmonary inflammation and hyperplasia (Webb et al. 1986, 1987), lung lesions (Pershagen et al. 1982), and immunosuppression (Hatch et al. 1985). Long-term inhalation exposures have resulted in altered conditioned reflexes and central nervous system (CNS) damage (Rozenshstein 1970). Reductions in fetal weight and in the number of live fetuses, and increases in fetal abnormalities due to retarded osteogenesis, have been observed following inhalation exposures (Nagymjtenyi et al. 1985).

Subchronic and chronic RfCs for inorganic arsenic have not been derived.

Epidemiological studies have revealed an association between arsenic concentrations in drinking water and increased incidences of skin cancers (including squamous cell carcinomas and multiple basal cell carcinomas), as well as cancers of the liver, bladder, and respiratory and GI tracts (EPA 1987a;

International Agency for Research on Cancer [IARC] 1987; Sommers and Manus 1953; Reymann et al. 1978; Dobson et al. 1965; Chen et al. 1985, 1986). Occupational exposure studies have shown a clear correlation between exposure to arsenic and lung cancer mortality (IARC 1987; EPA 1991a). EPA (2000) has placed inorganic arsenic in weight-of-evidence Group A, a known human carcinogen. A drinking water unit risk of 5E-05 $(\mu g/L)^{-1}$ has been proposed (EPA 2000) and is derived from drinking water unit risks for females and males that are equivalent to SFs of 1E-03 $(\mu g/kg/day)^{-1}$ (females) and 2E-03 $(\mu g/kg/day)^{-1}$ (males) (EPA 1987a). For inhalation exposures, a unit risk of 4.30E-03 $m^3/\mu g$ (EPA 2000) and a SF of 5.00E+1 $(mg/kg\text{-}day)^{-1}$ have been derived (EPA 1992).

The RfD for chronic oral exposures, 3E-04 mg/kg-day, is based on an NOAEL of 8E-04 mg/kg-day and an LOAEL of 1.40E-02 mg/kg-day for hyperpigmentation, keratosis, and possible vascular complications in a human population consuming arsenic-contaminated drinking water (EPA 1991a). Because of uncertainties in the data, EPA (1991a) states that "strong scientific arguments can be made for various values within a factor of 2 or 3 of the currently recommended RfD value." The subchronic RfD is the same as the chronic RfD, 3E-04 mg/kg-day (EPA 1997). The absorbed reference dose value is 1.23E-04 mg/kg-day based on a GI absorption factor of 41%.

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D.4.1.4 Barium (RAIS)

The soluble salts of barium, an alkaline earth metal, are toxic in mammalian systems in high concentrations. They are absorbed rapidly from the GI tract and are deposited in the muscles, lungs, and bone. Barium is excreted primarily in the feces.

At lower doses, barium can act as a muscle stimulant and at higher doses affects the nervous system, eventually leading to paralysis. Acute and subchronic oral doses of barium cause vomiting and diarrhea, followed by decreased heart rate and elevated blood pressure. Higher doses result in cardiac irregularities, weakness, tremors, anxiety, and dyspnea. A drop in serum potassium may account for some of the symptoms. Death can occur from cardiac and respiratory failure.

Subchronic and chronic oral or inhalation exposure to lower doses of the metal and its salts primarily affect the cardiovascular system resulting in elevated blood pressure. A LOAEL of 0.51 mg barium/kg-day based on increased blood pressure was observed in chronic oral rat studies (Perry et al. 1983), whereas human studies identified a NOAEL of 0.21 mg barium/kg-day (Wones et al. 1990; Brenniman and Levy 1984). EPA used human data to calculate chronic and subchronic oral RfDs.

The RfD is 7E-02 mg/kg-day (EPA 1997, 2000). In the Wones et al. study, human volunteers were given barium up to 10 mg/L in drinking water for 10 weeks. No clinically significant effects were observed. An epidemiological study was conducted by Brenniman and Levy in which human populations ingesting 2 to 10 mg/L of barium in drinking water were compared to a population ingesting 0 to 0.2 mg/L. No significant individual differences were seen; however, a significantly higher mortality rate from all combined cardiovascular diseases was observed with the higher barium level in the 65+ age group. The average barium concentration was 7.3 mg/L, which corresponds to a dose of 0.20 mg/kg-day. Confidence in the oral RfD is rated medium by EPA.

Subchronic and chronic inhalation exposure of human populations to barium-containing dust can result in a benign pneumoconiosis called baritosis. This condition often is accompanied by an elevated blood pressure, but does not result in a change in pulmonary function. Exposure to an air concentration of 5.2 mg barium carbonate/m^3 for 4 hours/day for six months has been reported to result in elevated blood pressure and decreased body weight gain in rats (Tarasenko et al. 1977). Reproduction and developmental effects also were observed. Increased fetal mortality was seen after untreated females were mated with males exposed to 5.2 mg/m^3 of barium carbonate. Similar results were obtained with female rats treated with 13.4 mg barium carbonate/m^3. The NOAEL for developmental effects was 1.15 mg/m^3 (equivalent to 0.8 mg barium/m^3). EPA calculated an RfC of 5E-03 mg/m^3 for subchronic and 5E-04 mg/m^3 for chronic exposure based on the NOAEL for developmental effects (EPA 1997). These effects have not been substantiated in humans or other animal systems.

EPA has not evaluated barium for evidence of human carcinogenic potential (EPA 2000).

In summary, subchronic or chronic oral or inhalation exposure primarily affects the cardiovascular system, resulting in elevated blood pressure. An LOAEL of 5.10E-01 mg barium/kg-day based on increased blood pressure was observed in chronic oral rat studies, whereas human studies identified a NOAEL of 2.1E-01 mg/kg-day.

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D.4.1.5 Beryllium (RAIS)

Beryllium is present in the earth's crust, in emissions from coal combustion; in surface water and soil; and in house dust, food, drinking water, and cigarette smoke (EPA 1987b); however, the highest risk for exposure occurs among workers employed in beryllium manufacturing, fabricating, or reclamation industries (ATSDR 1988a). Workers encounter dusts and fumes of many different beryllium compounds; the current occupational standard for worker exposure to beryllium is 0.002 mg/m^3 during an 8-hour work shift (Occupational Safety and Health Administration [OSHA] 1989).

Inhaled beryllium is absorbed slowly and localizes mainly in the lungs, bone, liver, and kidneys (Stiefel et al. 1980, Reeves et al. 1967; Reeves and Vorwald 1967; Zorn et al. 1988; Tepper et al. 1961; Meehan and Smyth 1967). Ingested beryllium undergoes limited absorption and localizes in the liver, kidneys, lungs, stomach, spleen, and the large and small intestines (Crowley et al. 1949; Furchner et al. 1973; Watanabe et al. 1985). Significant absorption of beryllium or its compounds through intact skin is unlikely because of its chemical properties (EPA 1987c). Beryllium per se is not biotransformed, but soluble salts may be converted to less soluble compounds in the lung (EPA 1987c). Most orally administered beryllium passes through the GI tract unabsorbed and is excreted in the feces (Reeves 1965), whereas inhaled water-soluble beryllium salts are excreted mainly by the kidneys (Zorn et al. 1988).

Limited data indicate that the oral toxicity of beryllium is low. No adverse effects were noted in mice given 5 ppm beryllium in drinking water in a lifetime bioassay (Schroeder and Mitchener 1975a,b). The dose (converted to 5.40E-01 mg/kg bw/day) was the NOAEL used in the calculation of the chronic oral RfD for beryllium of 5E-03 mg/kg-day (EPA 2000).

In contrast, the toxicity of inhaled beryllium is well documented. Humans inhaling “massive” doses of beryllium compounds (such as the water-soluble sulfate, fluoride, chloride, and oxide) may develop acute berylliosis (Constantinidis 1978). ATSDR (1988a) estimated that, based on existing data, the disease could develop at levels ranging from approximately 2 to 1000 g Be/m^3. This disease usually develops shortly after exposure and is characterized by rhinitis, pharyngitis, and/or tracheobronchitis and may progress to severe pulmonary symptoms. The severity of acute beryllium toxicity correlates with exposure levels, and the disease is now observed rarely in the United States because of improved industrial hygiene (Zorn et al. 1988; Kriebel et al. 1988).

Humans inhaling beryllium also may develop chronic berylliosis which, in contrast to acute berylliosis, is highly variable in onset, is more likely to be fatal, and can develop in a few months to greater than 20 years after exposure (Constantinidis 1978, Hall et al. 1959; Kriebel et al. 1988). Chronic beryllium disease is a systemic disease that primarily affects the lungs and is characterized by the development of noncaseating granulomas. The disease most likely results from a hypersensitivity response to beryllium as evidenced by positive patch tests (Nishimura 1966) and positive lymphocyte transformation tests (Williams and Williams 1983) in exposed individuals. Granulomas also may appear in the skin, liver, spleen, lymph nodes, myocardium, skeletal muscles, kidney, bone, and salivary glands (Kriebel et al. 1988; Freiman and Hardy 1970).

Epidemiologic studies have suggested that beryllium and its compounds could be human carcinogens. In a study that covered 15 regions of the United States, Berg and Burbank (1972) found a significant correlation between cancers of the breast, bone, and uterus and the concentration and detection frequency of beryllium in drinking water; however, imperfect analytical and sampling methods used in the study prompted EPA (1986a) to conclude that these results are insufficient proof of cause-and-effect relationships between cancer and beryllium in drinking water. Studies in workers exposed to beryllium, mostly via inhalation, have shown significant increases in “observed over expected” lung cancer incidences (Bayliss et al. 1971; Bayliss and Lainhart 1972; Bayliss and Wagoner 1977; Wagoner et al.1980; Mancuso 1970, 1979, and 1980). EPA (1986b), in evaluating the total database for the association of lung cancer with occupational exposure to beryllium, noted several limitations, but concluded that the results must be considered to be at least suggestive of a carcinogenic risk to humans. In laboratory studies, beryllium sulfate caused increased incidences of pulmonary tumors in rats and rhesus monkeys (Vorwald 1953, 1962, 1968; Vorwald et al. 1955 and 1966; Schepers et al. 1957; Reeves and Deitch 1969).

Based on sufficient evidence for animals and inadequate evidence for humans, beryllium has been placed in the EPA weight-of-evidence classification Bl—a probable human carcinogen (EPA 2000).

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D.4.1.6 Cadmium (RAIS)

Cadmium is a naturally occurring metal that is used in various chemical forms in metallurgical and other industrial processes and in the production of pigments. Environmental exposure can occur via the diet and drinking water (ATSDR 1989b).

Cadmium is absorbed more efficiently by the lungs (30 to 60%) than by the GI tract, the latter being a saturable process (Nordberg et al. 1985). Cadmium is transported in the blood and widely distributed in the body, but accumulates primarily in the liver and kidneys (Goyer 1991). Cadmium burden (especially in the kidneys and liver) tends to increase in a linear fashion up to about 50 or 60 years of age, after which the body burden remains somewhat constant. Metabolic transformations of cadmium are limited to its binding to protein and nonprotein sulfhydryl groups and various macromolecules, such as metallothionein, which is especially important in the kidneys and liver (ATSDR 1989b). Cadmium is excreted primarily in the urine.

Acute oral exposure to 20 to 30 g has caused fatalities in humans. Exposure to lower amounts may cause GI irritation, vomiting, abdominal pain, and diarrhea (ATSDR 1989b). An asymptomatic period of one-half to one hour may precede the onset of clinical signs. Oral LD_{50} values in animals range from 63 to 1,125 mg/kg, depending on the cadmium compound (USAF 1990b). Longer term exposure to cadmium primarily affects the kidneys, resulting in tubular proteinosis, although other conditions such as “itai-itai” disease may involve the skeletal system. Cadmium involvement in hypertension is not fully understood (Goyer 1991).

Inhalation exposure to cadmium and cadmium compounds may result in effects including headache, chest pains, muscular weakness, pulmonary edema, and death (USAF 1990b). The one-minute and ten-minute lethal concentration of cadmium for humans has been estimated to be about 2,500 and

250 mg/m^3, respectively (Barrett et al. 1947; Beton et al. 1966). An eight-hour, time-weighted average exposure level of 5 mg/m^3 has been estimated for lethal effects of inhalation exposure to cadmium, and exposure to 1 mg/m^3 is considered to be immediately dangerous to human health (Friberg 1950). Renal toxicity (tubular proteinosis) also may result from inhalation exposure to cadmium (Goyer 1991).

Chronic oral RfDs of 5E-04 and 1E-03 mg/kg-day have been established for cadmium exposure via drinking water and food, respectively (EPA 2000). Both values reflect incorporation of an uncertainty factor of 10 to protect sensitive subpopulations. The RfDs are based on an extensive database regarding toxicokinetics and toxicity in both human and animals, the critical effect being renal tubular proteinuria. Confidence in the RfD and database is high. Inhalation RfC values are currently unavailable.

The target organ for cadmium toxicity via oral exposure is the kidney (Goyer 1991). For inhalation exposure, both the lungs and kidneys are target organs for cadmium-induced toxicity (ATSDR 1989b, Goyer 1991).

There is limited evidence from epidemiologic studies for cadmium-related respiratory tract cancer (ATSDR 1989b). An inhalation unit risk of 1.80E-03 (μg/m^3)$^{-1}$ and an inhalation SF of 6.10E+00 (mg/kg-day)$^{-1}$ are based on respiratory tract cancer associated with occupational exposure (EPA 1997).

Based on limited evidence from multiple occupational exposure studies and adequate animal data, cadmium is placed in weight-of-evidence Group B1—probable human carcinogen.

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D.4.1.7 Chromium (RAIS)

Elemental chromium (Cr) does not occur in nature, but is present in ores, primarily chromite ($FeOCr_2O_3$) (Hamilton and Wetterhahn 1988). Only two of the several oxidation states of chromium, Cr(III) and Cr(VI), are reviewed in this report based on their predominance and stability in the ambient environment and their toxicity in humans and animals.

Chromium plays a role in glucose and cholesterol metabolism and, thus, is an essential element to man and animals (Schroeder et al. 1962). Nonoccupational exposure to the metal occurs via the ingestion of chromium-containing food and water, whereas occupational exposure occurs via inhalation (Langard 1982; Pedersen 1982). Workers in the chromate industry have been exposed to estimated chromium levels of 10 to 50 g/m^3 for Cr(III) and 5 to 1000 g/m^3 for Cr(VI); however, improvements in the newer chrome-plating plants have reduced the Cr(VI) concentrations in air 10- to 40-fold (Stern 1982).

Cr III is poorly absorbed, regardless of the route of exposure, whereas Cr(VI) is more readily absorbed (Hamilton and Wetterhahn 1988). Humans and animals localize chromium in the lung, liver, kidney, spleen, adrenals, plasma, bone marrow, and red blood cells (Langard 1982; ATSDR 1989c; Bragt and van Dura 1983; Hamilton and Wetterhahn 1988). There is no evidence that chromium is biotransformed, but Cr(VI) does undergo enzymatic reduction, resulting in the formation of reactive intermediates and Cr(III) (Hamilton and Wetterhahn 1988). The main routes for the excretion of chromium are via the kidneys/urine and the bile/feces (Guthrie 1982; Langard 1982).

Animal studies show that Cr(VI) generally is more toxic than Cr(III), but neither oxidation state is very toxic by the oral route. In long-term studies, rats were not adversely affected by approximately 1.90E+00 g/kg-day of chromic oxide [Cr(III)] (diet), 2.40E+00 mg/kg-day of Cr(III) as chromic chloride (drinking water), or 2.40E+00 mg/kg-day of Cr(VI) as potassium dichromate (drinking water) (Ivankovic and Preussmann 1975; MacKenzie et al. 1958).

The respiratory and dermal toxicity of chromium is well documented. Workers exposed to chromium have developed nasal irritation (at < 0.01 mg/m^3, acute exposure), nasal ulcers, perforation of the nasal septum (at approximately 2 g/m^3, subchronic or chronic exposure) (Hamilton and Wetterhahn 1988; ATSDR 1989c; Lindberg and Hedenstierna 1983) and hypersensitivity reactions and “chrome holes” of the skin (Pedersen 1982; Burrows 1983; USAF 1990c). Among the general population, contact dermatitis has been associated with the use of bleaches and detergents (Love 1983).

Compounds of both Cr(VI) and Cr(III) have induced developmental effects in experimental animals that include neural tube defects, malformations, and fetal deaths (Iijima et al. 1983; Danielsson et al. 1982; Matsumoto et al. 1976).

The respective subchronic and chronic oral RfD values are 1.00E+00 and 1.5E+00 mg/kg-day for Cr(III). The subchronic and chronic oral RfD values for Cr(VI) are 2E-02 and 3E-03 mg/kg-day, respectively (EPA 1997, 2000). The subchronic and chronic oral RfD values for Cr(VI) and Cr(III) are derived from NOAELs of 1.47 g/kg-day Cr(III) and 25 ppm of potassium dichromate (Cr[VI]) in drinking water, respectively (Ivankovic and Preussmann 1975; MacKenzie et al. 1958).

The inhalation of chromium compounds has been associated with the development of cancer in workers in the chromate industry. The relative risk for developing lung cancer has been calculated to be as much as 30 times that of controls (Hayes 1982; Leonard and Lauwerys 1980; Langard 1983). There also is evidence for an increased risk of developing nasal, pharyngeal, and GI carcinomas (Hamilton and Wetterhahn 1988). Quantitative epidemiological data were obtained by Mancuso and Hueper (1951), who observed an increase in deaths (18.2%, $p < 0.01$) from respiratory cancer among chromate workers compared with 1.2% deaths among controls. In a follow-up study that was conducted when more than 50% of the cohort had died, the observed incidence for lung cancer deaths had increased to approximately 60% (Mancuso 1975). The workers were exposed to 1 to 8 mg/m^3/year total chromium. Mancuso (1975) observed a dose response for total chromium exposure and attributed the lung cancer deaths to exposure to insoluble [Cr(III)], soluble [Cr(VI)], and total chromium. By contrast, the results of inhalation studies in animals have been equivocal or negative (Nettesheim et al. 1971, Glaser et al. 1986, Baetjer et al. 1959, Steffee and Baetjer 1965).

Based on sufficient evidence for humans and animals, Cr(VI) has been placed in the EPA weight-of-evidence classification A, a known human carcinogen (EPA 2000). For inhalation exposure, the unit risk value is 1.20E-02 (µg/m^3)$^{-1}$ and the SF is 4.10E+01 (mg/kg-day)$^{-1}$ (EPA 1997).

For estimation of risk from exposure to chromium, the toxicity values associated with Cr(VI) were used exclusively in this BHHRA. Cr(III) values were not used because most analytical results were not specific for this ionic species.

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D.4.1.8 Copper

Copper occurs naturally as a component of many minerals. Because of its high electrical and thermal conductivity, it is widely used in the manufacture of electrical equipment. Common copper salts—such as sulfate, carbonate, cyanide, oxide, and sulfide—are used as fungicides, as components of ceramics and pyrotechnics, for electroplating, and for numerous other industrial applications (ACGIH 1986b). Copper can be absorbed by the oral, inhalation, and dermal routes of exposure. It is an essential nutrient that is normally present in a wide variety of tissues (ATSDR 1990d; EPA 1987d).

In humans, ingestion of gram quantities of copper salts may cause GI, hepatic, and renal effects with symptoms such as severe abdominal pain, vomiting, diarrhea, hemolysis, hepatic necrosis, hematuria, proteinuria, hypotension, tachycardia, convulsions, coma, and death (USAP 1990d). GI disturbances and liver toxicity also have resulted from long-term exposure to drinking water containing 2.2 to 7.8 mg Cu/L (Mueller-Hoecker et al. 1988; Spitalny et al. 1984). The chronic toxicity of copper has been characterized in patients with Wilson’s disease, a genetic disorder causing copper accumulation in tissues. The clinical manifestations of Wilson’s disease include cirrhosis of the liver, hemolytic anemia, neurologic abnormalities, and corneal opacities (Goyer 1991; ATSDR 1990d; EPA 1987d). In animal studies, oral exposure to copper caused hepatic and renal accumulation of copper, associated with necrosis of these organs at doses of greater than or equal to 100 mg/kg-day. Hematological effects are evident at doses of 40 mg/kg-day (EPA 1986c; Haywood 1985, 1980; Rana and Kumar 1978; Gopinath et al. 1974; Kline et al. 1971).

Acute inhalation exposure to copper dust or fumes at concentrations of 0.075–0.12 mg Cu/m^3 may cause metal fume fever with symptoms such as cough, chills, and muscle ache (USAF 1990d). Among the reported effects in workers exposed to copper dust are GI disturbances, headache, vertigo, drowsiness, and hepatomegaly (Suciu et al. 1981). Vineyard workers chronically exposed to Bordeaux mixture (copper sulfate and lime) exhibit degenerative changes of the lungs and liver. Dermal exposure to copper may cause contact dermatitis in some individuals (ATSDR 1990d).

Oral or intravenous administration of copper sulfate increased fetal mortality and developmental abnormalities in experimental animals (Lecyk 1980; Ferm and Hanlon 1974). Evidence also indicates that copper compounds are spermicidal (ATSDR 1990d; Battersby et al. 1982).

No RfD for elemental copper is available (EPA 2000); however, EPA established an action level of 1300 µg/L for drinking water (56 *Federal Register* 26460, June 7, 1991). Data were insufficient to derive an RfC for copper.

No suitable bioassays or epidemiological studies are available to assess the carcinogenicity of copper. Therefore, EPA (2000) has placed copper in weight-of-evidence Group D—not classifiable as to human carcinogenicity.

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D.4.1.9 Iron

Iron is one of the most abundant metals in the environment and is used in many industrial processes. It is an essential element in the human diet. More than 80% of the iron present in the body is involved in the support of red blood cell production. In addition, the element is an essential component of hemoglobin, myoglobin, and various enzymes. Iron deficiency is the most common cause of anemia (Goodman and Gilman 1985); however, exposure to excessive levels of iron may cause GI damage and dysfunction and enlargement of the liver and pancreas (Goodman and Gilman 1985).

No cancer SFs for iron were found; therefore, carcinogenicity due to exposure to iron is excluded in the BHHRA.

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D.4.1.10 Lead (RAIS)

Lead occurs naturally as a sulfide in galena. It is a soft, bluish-white, silvery-gray, malleable metal with a melting point of 327.5°C. Elemental lead reacts with hot boiling acids and is attacked by pure water. The solubility of lead salts in water varies from insoluble to soluble, depending on the type of salt (IARC 1980; Goyer 1988; Budavari et al. 1989).

Lead is a natural element that is persistent in water and soil; however, most of the lead in environmental media is from anthropogenic sources. The mean concentration is 3.9 µg/L in surface water and 0.005 µg/L in sea water. River sediments contain about 20,000 µg/g and coastal sediments about 100,000 µg/g. Soil content varies with the location, ranging up to 30 µg/g in rural areas, 3000 µg/g in urban areas, and 20,000 µg/g near point sources. Human exposure occurs primarily through diet, air, drinking water, and ingestion of dirt and paint chips (EPA 1989b, 1989c; ATSDR 1993a).

The efficiency of lead absorption depends on the route of exposure, age, and nutritional status. Adult humans absorb about 10 to 15% of ingested lead, whereas children may absorb up to 50%, depending on whether lead is in the diet, dirt, or paint chips. More than 90% of lead particles deposited in the respiratory tract are absorbed into systemic circulation. Inorganic lead is inefficiently absorbed through the skin. Consequently, this route does not contribute considerably to the total body lead burden (EPA 1986d). Lead absorbed into the body is distributed to three major compartments: blood, soft tissue, and bone. The largest compartment is the bone, which contains about 95% of the total body lead burden in adults and about 73% in children. The half-life of bone lead is more than 20 years; however, the concentration of blood lead changes rapidly with exposure, as reflected in the half-life of only 25 to 28 days. Blood lead is in equilibrium with lead in bone and soft tissue. The soft tissues that take up lead are liver, kidneys, brain, and muscle. Lead is not metabolized in the body, but it may be conjugated with glutathione and excreted primarily in the urine (EPA 1986d, 1986e; ATSDR 1993a). Exposure to lead is evidenced by elevated blood lead levels.

The systemic toxic effects of lead in humans have been well documented by EPA (EPA 1986d, e, f, g, h; 1989c; 1990a) and ATSDR (1993a), which extensively reviewed and evaluated data reported in the literature up to 1991. The evidence shows that lead is a multitargeted toxicant, causing effects in the GI tract, hematopoietic system, cardiovascular system, central and peripheral nervous systems, kidneys, immune system, and reproductive system. Overt symptoms of subencephalopathic CNS effects and peripheral nerve damage occur at blood lead levels of 40 to 60 µg/dL, and no overt symptoms, such as peripheral nerve dysfunction, occur at levels of 30–50 µg/dL in adults. No clear threshold is evident for these effects. Cognitive and neuropsychological deficits are not usually the focus of studies in adults; however, there is some evidence of neuropsychological impairment (Ehle and McKee 1990) and cognitive deficits in lead workers with blood levels of 41–80 µg/dL (Stollery et al. 1991).

Although similar effects occur in adults and children, children are more sensitive to lead exposure than are adults. Irreversible brain damage occurs at blood lead levels greater than or equal to 100 (µg/dL in adults and at 80–100 µg/dL in children. Death can occur at the same blood levels in children, and those who survive these high levels of exposure suffer permanent severe mental retardation.

As discussed previously, neuropsychological impairment and cognitive [intelligence quotient (IQ)] deficits are sensitive indicators of lead exposure; both neuropsychological impairment and IQ deficits have been the subject of cross-sectional and longitudinal studies in children. One of the early studies reported IQ score deficits of 4 points at blood lead levels of 30 to 50 µg/dL and 1 to 2 points at levels of 15 to 30 µg/dL among 75 black children of low socioeconomic status (Schroeder and Hawk 1986).

Very detailed longitudinal studies have been conducted on children (starting at the time of birth) living in Port Pirie, Australia (Vimpani et al. 1985, 1989; McMichael et al. 1988; Wigg et al. 1988; Baghurst et al. 1987, 1992), Cincinnati, OH (Dietrich et al. 1986, 1991, 1992, 1993), and Boston, MA (Bellinger et al. 1984, 1987a, 1987b, 1990, 1992; Stiles and Bellinger 1993). Various measures of cognitive performance have been assessed in these children. Studies of the Port Pirie children up to 7 years of age revealed IQ deficits in 2-year-old children of 1.6 points for each 10 µg/dL increase in blood lead, deficits of 7.2 points in 4-year-old children, and deficits of 4.4 to 5.3 points in 7-year-old children as blood lead increased from 10 to 30 µg/dL. No significant neurobehavioral deficits were noted for children, 5 years or younger, who lived in the Cincinnati, OH, area. In 6.5-year-old children, performance IQ was reduced by 7 points in children whose lifetime blood level exceeded 20 µg/dL.

Children living in the Boston, MA, area have been studied up to the age of 10 years. Cognitive performance scores were negatively correlated with blood lead in the younger children in the high lead group (greater than or equal to 10 (µg/dL), and improvements were noted in some children at 57 months as their blood lead levels became lower. Furthermore, measures of IQ and academic performance in 10-year-old children showed a 5.8 -oint deficit in IQ and an 8.9-point deficit in academic performance as blood lead increased by 10 µg/dL within the range of 1 to 25 µg/dL. Because of the large database on subclinical neurotoxic effects of lead in children, only a few of the studies have been included here; however, EPA (EPA 1986e, 1990a) concluded that there is no clear threshold for neurotoxic effects of lead in children.

In adults, the cardiovascular system is a very sensitive target for lead. Hypertension (elevated blood pressure) is linked to lead exposure in occupationally exposed subjects and in the general population. Three large population-based studies have been conducted to study the relationship between blood lead levels and high blood pressure. The British Regional Heart Study (BRHS) (Pocock et al. 1984), the NHANES II study (Harlan et al. 1985; Pirkle et al. 1985; Landis and Flegal 1988; Schwartz 1991; EPA 1990a), and Welsh Heart Programme (Ellwood et al. 1988a, 1988b) comprise the major studies for the general population. The BRHS study showed that systolic pressure greater than 160 mm mercury and diastolic pressure greater than 100 mm mercury were associated with blood lead levels greater than 37 µg/dL (Pocock et al. 1984). An analysis of 9,933 subjects in the NHANES study showed positive correlations between blood pressure and blood lead among 12- to 74-year-old males, but not females (Harlan et al. 1985, Landis and Flegal et al. 1988); 40- to 59–year-old white males with blood levels ranging from 7–34 ng/dL (Pirkle et al. 1985); and males and females greater than 20 years old (Schwartz 1991). In addition, left ventricular hypertrophy was also positively associated with blood lead (Schwartz 1991). The Welsh study did not show an association among men and women with blood lead of 12.4 and 9.6 µg/dL, respectively (Ellwood et al. 1988a, 1988b). Although other, smaller studies have shown both positive and negative results, EPA concluded that increased blood pressure is positively correlated with blood lead levels in middle-aged men, possibly at concentrations as low as 7 µg/dL (EPA 1990a). In addition, EPA estimated that systolic pressure is increased by 1.5 to 3.0 mm of mercury in males and 1.0 to 2.0 mm mercury in females for every doubling of blood lead concentration.

The hematopoietic system is a target for lead as evidenced by frank anemia occurring at blood lead levels of 80 µg/dL in adults and 70 µg/dL in children. The anemia is primarily due to reduced hemesynthesis, which is observed in adults having blood levels of 50 µg/dL and in children having blood levels of 40 µg/dL. Reduced heme synthesis is caused by inhibition of key enzymes involved in the synthesis of heme. Inhibition of erythrocyte-aminolevulinic acid dehydratase (ALAD) activity (catalyzes formation of porphobilinogen from aminolevulinic acid) has been detected in adults and children having blood levels of less than 10 µg/dL. ALAD activity is the most sensitive measure of lead exposure, but erythrocyte zinc protoporphyrin is the most reliable indicator of lead exposure because it is a measure of the toxicologically active fraction of bone lead. The activity of another erythrocyte enzyme, pyrimidine-5-nucleotidase, also is inhibited by lead exposure. Inhibition has been observed at levels below 5 µg/dL; no clear threshold is evident.

Other organs or systems affected by exposure to lead are the kidneys, immune system, reproductive system, GI tract, and liver. These effects usually occur at high blood levels, or the blood levels at which they occur have not been documented sufficiently.

The EPA has not developed an RfD for lead because it appears that lead is a nonthreshold toxicant, and it is inappropriate to develop RfDs for these types of toxicants. Instead, EPA has developed the IEUBK Model to estimate the percentage of the population of children up to 6 years of age with blood lead levels above a critical value, 10 µg/dL. The model determines the contribution of lead intake from multimedia sources (diet, soil and dirt, air, and drinking water) on the concentration of lead in the blood. Site-specific concentrations of lead in various media are used when available; otherwise, default values are assumed. The EPA has established a screening level of 400 ppm (µg/g) for lead in soil (EPA 1994a).

Inorganic lead and lead compounds have been evaluated qualitatively for potential carcinogenicity by EPA (EPA 1989b, c, 1993a) and assigned to the B2 weight-of-evidence category—a probable human carcinogen. The data from human studies are inadequate for evaluating the potential carcinogenicity of lead; however, data from animal studies are sufficient based on numerous studies showing that lead induces renal tumors in experimental animals. A few studies have shown evidence for induction of tumors at other sites (cerebral gliomas; testicular, adrenal, prostate, pituitary, and thyroid tumors). Nonetheless, a SF has not yet been derived for inorganic lead or lead compounds.

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D.4.1.11 Manganese (RAIS)

Manganese is an essential trace element in humans that can elicit a variety of serious toxic responses upon prolonged exposure to elevated concentrations, either orally or by inhalation. The CNS is the primary target. Initial symptoms are headache, insomnia, disorientation, anxiety, lethargy, and memory loss. These symptoms progress with continued exposure and eventually include motor disturbances, tremors, and difficulty in walking, symptoms similar to those seen with Parkinsonism. These motor difficulties are often irreversible. Based on human epidemiological studies, 0.8 mg/kg-day for drinking water exposure and 0.34 mg/m^3 in air for inhalation exposure have been estimated LOAELs for CNS effects.

Effects on reproduction (decreased fertility, impotence) have been observed in humans as a result of inhalation exposure, and in animals with oral exposure at the same or similar doses that initiate the CNS effects. An increased incidence of coughs, colds, dyspnea during exercise, bronchitis, and altered lung ventilatory parameters also have been seen in humans and animals inhaling manganese. A possible effect on the immune system may account for some of these respiratory symptoms.

EPA's RfD evaluation of manganese resulted in the derivation of a chronic oral toxicity value for the element of 1.4E-01 mg/kg-day (EPA 2000), a consensus NOAEL based on composite data from several epidemiological studies (WHO 1973, NRC 1989, Freeland-Graves et al. 1987). This value is offered unmodified when the toxicity of the element is modeled from a dietary source; however, the use of a modifying factor of 3 is recommended by the EPA when the source of the element is drinking water or soil.

A RfC of 0.05 μg/m^3 (EPA 2000) for chronic inhalation exposure was calculated from a human LOAEL of 0.05 mg/m^3 for impairment of neurobehavioral function from an epidemiological study by Roels et al. (1992). The study population was occupationally exposed to airborne manganese dust with a median concentration of 0.948 mg/m^3 for 0.2 to 17.7 years with a mean duration of 5.3 years. Neurological examinations, psychomotor tests, lung function tests, blood tests, and urine tests were used to determine the possible effects of exposure. The LOAEL was derived from an occupational-lifetime integrated respirable dust concentration of manganese dioxide expressed as milligrams of manganese/m^3 × years. Confidence in the inhalation RfC is rated medium by EPA.

Some conflicting data exist on possible carcinogenesis following injections of manganese chloride and manganese sulfate in mice; however, the EPA weight-of-evidence classification is Group D, not classifiable as to human carcinogenicity based on no evidence in humans and inadequate evidence in animals (EPA 2000).

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D.4.1.12 Mercury (RAIS)

Mercury is a naturally occurring element existing in multiple forms and in various oxidation states. It is used in a wide variety of products and processes. In the environment, mercury may undergo transformations among its various forms and among its oxidation states. Exposure to mercury may occur in both occupational and environmental settings, the latter primarily involving dietary exposure (ATSDR 1989d).

Absorption, distribution, metabolism, and excretion of mercury are dependent upon its form and oxidation state (ATSDR 1989d; Goyer 1991). Organic mercurials are absorbed more readily than are inorganic forms. An oxidation-reduction cycle is involved in the metabolism of mercury and mercury compounds by both animals and humans (ATSDR 1989d). The urine and feces are primary excretory routes. The elimination half-life is 35 to 90 days for elemental mercury and mercury vapor and about 40 days for inorganic salts (Goyer 1991).

Ingestion of mercury metal is usually without effect (Goldwater 1972). Ingestion of inorganic salts may cause severe GI irritation, renal failure, and death with acute lethal doses in humans ranging from 1 to 4 g (ATSDR 1989d). Mercuric (divalent) salts usually are more toxic than are mercurous (monovalent) salts (Goyer 1991). Mercury also is known to induce hypersensitivity reactions such as contact dermatitis and acrodynia (pink disease) (Mathesson et al. 1980). Inhalation of mercury vapor may cause irritation of the respiratory tract, renal disorders, CNS effects characterized by neurobehavioral changes, peripheral nervous system toxicity, renal toxicity (immunologic glomerular disease), and death (ATSDR 1989d).

Toxicity resulting from subchronic and chronic exposure to mercury and mercury compounds usually involves the kidneys and/or CNS, the specific target and effect being dependent on the form of mercury (ATSDR 1989d). Organic mercury, especially methyl mercury, rapidly enters the CNS resulting in behavioral and neuromotor disorders (ATSDR 1989d; Goyer 1991). The developing CNS is especially sensitive to this effect, as documented by the epidemiologic studies in Japan and Iraq where ingestion of methyl mercury-contaminated food resulted in severe toxicity and death in adults and severe CNS effects in infants (Bakir et al. 1973; Amin-Zaki et al. 1974; Harada 1978; Marsh et al. 1987). Blood mercury levels of less than 10 µg/dL and 300 µg/dL corresponded to mild effects and death, respectively (Bakir et al. 1973). Teratogenic effects due to organic or inorganic mercury exposure do not appear to be well documented for humans or animals, although some evidence exists for mercury-induced menstrual cycle disturbances and spontaneous abortions (Derobert and Tara 1950; Amin-Zaki et al. 1974; ATSDR 1989d).

A subchronic and chronic oral RfD of 1E-04 mg/kg-day for methyl mercury is based on a benchmark dose of 1.10 µg/kg-day applicable to neurologic developmental abnormalities in human infants (EPA 1995, 1996). A subchronic and chronic oral RfD of 3E-04 mg/kg-day for mercuric chloride is based on a LOAEL of 6.30E-01 mg mercury/kg-day for immunological glomerulonephritis in rats (EPA 1987e). NOAELs were unavailable for oral exposure to inorganic mercury or methyl mercury. A subchronic and chronic inhalation RfC of 3E-04 mg mercury/m^3 for inorganic mercury (EPA 1997, 2000) is based on neurological disorders (increased frequency of intention tremors) following long-term occupational exposure to mercury vapor (Fawer et al. 1983). The LOAELs for subchronic and chronic inhalation exposures to inorganic mercury are 0.32 and 0.03 mg mercury/m^3, respectively. NOAELs were unavailable. An inhalation RfC for methyl mercury has not been determined.

No data were available regarding the carcinogenicity of mercury in humans or animals. EPA has placed elemental mercury in weight-of-evidence Classification D, not classifiable as to human carcinogenicity (EPA 2000). Weight-of-evidence Classifications of C (possible human carcinogen) have been assigned to inorganic forms of the element and to methyl mercury by EPA (2000) based upon limited evidence of carcinogenicity in rodents; however, no SFs have been calculated.

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D.4.1.13 Nickel (RAIS)

Nickel is a naturally occurring element that may exist in various mineral forms. It is used in a wide variety of applications including metallurgical processes and electrical components, such as batteries (ATSDR 1988b; USAF 1990e). Some evidence suggests that nickel may be an essential trace element for mammals.

The absorption of nickel is dependent on its physicochemical form, with water soluble forms being absorbed more readily. The metabolism of nickel involves conversion to various chemical forms and binding to various ligands (ATSDR 1988b). Nickel is excreted in the urine and feces with relative amounts for each route being dependent on the route of exposure and chemical form. Most nickel enters the body via food and water consumption, although inhalation exposure in occupational settings is a primary route for nickel-induced toxicity.

In large doses (> 0.5 g), some forms of nickel may be acutely toxic to humans when taken orally (Daldrup et al. 1983, Sunderman et al. 1988). Oral LD_{50} values in rats range from 67 mg nickel/kg (nickel sulfate hexahydrate) to > 9000 mg nickel/kg (nickel powder) (ATSDR 1988b). Toxic effects of oral exposure to nickel usually involve the kidneys with some evidence from animal studies showing a possible developmental/reproductive toxicity effect (ATSDR 1988b; Goyer 1991).

Inhalation exposure to some nickel compounds will cause toxic effects in the respiratory tract and immune system (Smialowicz et al. 1984, 1985, 1987; ATSDR 1988b; Goyer 1991). Inhalation LD_{50} values for animals range from 0.97 mg nickel/m^3 for rats (6-hour exposure) to 15 mg nickel/m^3 for guinea pigs (time not specified) (USAF 1990e). Acute inhalation exposure of humans to nickel may produce headache, nausea, respiratory disorders, and death (Goyer 1991; Rendall et al. 1994). Asthmatic conditions also have been documented for inhalation exposure to nickel (Goyer 1991). Soluble nickel compounds tend to be more toxic than insoluble compounds (Goyer 1991). In addition, nickel carbonyl is known to be extremely toxic to humans upon acute inhalation exposure (Goyer 1991).

Data on nickel-induced reproductive/developmental effects in humans following inhalation exposure are equivocal. No clinical evidence of developmental or reproductive toxicity were reported for women working in a nickel refinery (Warner 1979), but Chashschin et al. (1994) reported possible reproductive and developmental effects in humans of occupational exposure to nickel (0.13 to 0.2 mg nickel/m^3). Although not validated by quantitative epidemiologic data or statistical analyses, the authors reported an apparently abnormal increase in spontaneous and threatening abortions (16 to 17% in nickel-exposed workers versus 8 to 9% in nonexposed workers), and an increased incidence of nonspecified structural malformations (17% versus 6%) also was reported. Furthermore, sensitivity reactions to nickel are well documented and usually involve contact dermatitis reactions resulting from contact with nickel-containing items such as cooking utensils, jewelry, coins, etc. (ATSDR 1988b).

A chronic (EPA 2000) and subchronic (EPA 1997) oral RfD of 2E-02 mg/kg-day for soluble nickel salts is based on changes in organ and body weights of rats receiving dietary nickel sulfate hexahydrate (5 mg/kg-day) for 2 years. A NOAEL and LOAEL of 5 mg/kg-day and 50 mg/kg-day, respectively, were reported in the key study (Ambrose et al. 1976). An uncertainty factor of 300 reflects interspecies extrapolation uncertainty, protection of sensitive populations, and a modifying factor of 3 for a database deficient in reproductive/developmental studies. An inhalation RfC for soluble nickel salts is under review by the RfD/RfC Work Group (EPA 1995d) and currently is not available.

The primary target organs for nickel-induced systemic toxicity are the lungs and upper respiratory tract for inhalation exposure and the kidneys for oral exposure (ATSDR 1988b; Goyer 1991). Other target organs include the cardiovascular system, immune system, and the blood.

Epidemiologic studies have shown that occupational inhalation exposure to nickel dust (primarily nickel subsulfate) at refineries has resulted in increased incidences of pulmonary and nasal cancer (NAS 1975; Enterline and Marsh 1982; ATSDR 1988b). Inhalation studies using rats also have shown nickel subsulfate or nickel carbonyl to be carcinogenic (Sunderman et al. 1959; Sunderman and Donnelly 1965; Ottolenghi et al. 1974). Based on these data, EPA (2000) has classified nickel subsulfate and nickel refinery dust in weight-of-evidence Group A, human carcinogen. Carcinogenicity SFs of 1.70E+00 and 8.40E-01 $(\text{mg/kg-day})^{-1}$ and unit risks of 4.80E-04 $(\mu\text{g/m}^3)^{-1}$ and 2.40E-04 $(\mu\text{g/m}^3)^{-1}$ have been calculated for nickel subsulfide and nickel refinery dust, respectively (EPA 1997, 2000). Based on an increased incidence of pulmonary carcinomas and malignant tumors in animals exposed to nickel carbonyl by inhalation or by intravenous injection, this compound had been placed in weight-of-evidence Group B2, probable human carcinogen (EPA 2000). No unit risk values were available for nickel carbonyl. Recent analyses of epidemiologic data, however, indicate that definitive identification of a specific nickel compound as the causative agent is not yet possible (Easton et al. 1994; Langard 1994; Roberts et al. 1994).

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D.4.1.14 Selenium (RAIS)

Selenium is an essential trace element important in many biochemical and physiological processes, including the biosynthesis of coenzyme Q (a component of mitochondrial electron transport systems), regulation of ion fluxes across membranes, maintenance of the integrity of keratins, stimulation of antibody synthesis, and activation of glutathione peroxidase (an enzyme involved in preventing oxidative damage to cells). Recommended human dietary allowances (average daily intake) for selenium are as follows: infants up to 1 year, 10 to 15 µg; children 1 to 10 years, 20 to 30 µg; adult males 11 to 51+ years, 40 to 70 µg; adult females 11 to 51+ years, 45 to 55 µg; pregnant or lactating women, 65 to 75 µg. There appears to be a relatively narrow range between levels of selenium intake resulting in deficiency and those causing toxicity.

Selenium occurs in several valence states: -2 (hydrogen selenide, sodium selenide, dimethyl selenium, trimethyl selenium, and selenoamino acids, such as selenomethionine; 0 (elemental selenium);

+4 (selenium dioxide, selenious acid, and sodium selenite); and +6 (selenic acid and sodium selenate). Toxicity of selenium varies with valence state and water solubility of the compound in which it occurs. The latter can affect GI absorption rates.

GI absorption in animals and humans for various selenium compounds ranges from about 44% to 95% of the ingested dose (Thomson and Stewart, 1974; Bopp et al., 1982; Thomson, 1974). Respiratory tract absorption rates of 97% and 94% for aerosols of selenious acid have been reported for dogs and rats, respectively (Weissman et al., 1983; Medinsky et al., 1981). Selenium is found in all tissues of the body; highest concentrations occur in the kidney, liver, spleen, and pancreas (Schroeder and Mitchener, 1971a; Schroeder and Mitchener, 1972; Jacobs and Forst, 1981a; Julius et al., 1983; Shamberger, 1984; Echevarria et al., 1988). Excretion is primarily via the urine (0 to 15 g/L); however, excretory products also can be found in the feces, sweat, and in expired air.

In humans, acute oral exposures can result in excessive salivation, garlic odor to the breath, shallow breathing, diarrhea, pulmonary edema, and death (Civil and McDonald, 1978; Carter, 1966; Koppel et al., 1986). Other reported signs and symptoms of acute selenosis include tachycardia, nausea, vomiting, abdominal pain, abnormal liver function, muscle aches and pains, irritability, chills, and tremors. Acute toxic effects observed in animals include pulmonary congestion, hemorrhages and edema, convulsions, altered blood chemistry (increased hemoglobin and hematocrit); liver congestion; and congestion and hemorrhage of the kidneys (Smith et al., 1937; Anderson and Moxon, 1942; Hopper et al., 1985).

General signs and symptoms of chronic selenosis in humans include loss of hair and nails; acropachia (clubbing of the fingers), skin lesions (redness, swelling, blistering, and ulcerations); tooth decay (mottling, erosion and pitting); and nervous system abnormalities attributed to polyneuritis (peripheral anesthesia, acroparaethesia, pain in the extremities, hyperreflexia of the tendon, numbness, convulsions, paralysis, motor disturbances, and hemiplegia). In domesticated animals, subchronic and chronic oral exposures can result in loss of hair, malformed hooves, rough hair coat, and nervous system abnormalities (impaired vision and paralysis). Damage to the liver and kidneys and impaired immune responses have been reported to occur in rodents following subchronic and/or chronic oral exposures (Ganther and Baumann, 1962; Beems and van Beek, 1985; NCI, 1980a; Tinsley et al., 1967; Harr et al., 1967; Schroeder, 1967).

Selenium is teratogenic in birds and possibly also in domesticated animals (pigs, sheep, and cattle), but evidence of teratogenicity in humans and laboratory animals is lacking (ASTDR 1989); however, adverse reproductive and developmental effects (decreased rates of conception, increased rates of fetal resorption, and reduced fetal body weights) have been reported for domesticated and laboratory animals (Harr and Muth, 1972: Wahlstrom and Olson, 1959; Schroeder and Mitchener, 1971b).

The RfD for chronic oral exposures is 0.005 mg/kg/day for both selenium and selenious acid (EPA 1992a, 1992b). The subchronic RfDs for these compounds are the same as the chronic RfDs (EPA 1992c).

In humans, inhalation of selenium or selenium compounds primarily affects the respiratory system. Dusts of elemental selenium and selenium dioxide can cause irritation of the skin and mucous membranes of the nose and throat, coughing, nosebleed, loss of sense of smell, dyspnea, bronchial spasms, bronchitis, and chemical pneumonia (Clinton 1947; Hamilton 1949). Other signs and symptoms following acute inhalation exposures include lacrimation, irritation and redness of the eyes, GI distress (nausea and vomiting), depressed blood pressure, elevated pulse rate, headaches, dizziness, and malaise (ATSDR 1989). In animals, acute inhalation exposures also result in severe respiratory effects, including edema, hemorrhage, and interstitial pneumonitis (Hall et al. 1951; Dudley and Miller 1937) as well as in splenic damage (congestion, fissuring red pulp, and increased polymorphonuclear leukocytes), liver congestion, and mild central atrophy (Hall et al., 1951). Information on toxicity of selenium in humans and animals following chronic inhalation exposures is not available, and subchronic and chronic inhalation RfCs have not been derived.

Epidemiologic studies in humans have suggested a correlation between chronic oral exposures to selenium and an increased incidence of death due to neoplasms. Some studies have indicated that selenium may have anti-neoplastic properties (see Whanger 1983; Hocman 1988). In studies on laboratory animals, selenites or selenates have not been found to be carcinogenic; however, selenium sulfide produced a significant increase in the incidence of hepatocellular carcinomas in male and female rats and in female mice and a significant increase in alveolar/bronchiolar carcinomas and adenomas in female mice following chronic oral exposures (NCI 1980c). EPA has placed selenium and selenious acid in Group D, not classifiable as to carcinogenicity in humans (EPA 1992a, 1992b); while selenium sulfide is placed in Group B2, probable human carcinogen (EPA 1992d). Quantitative data, however, are insufficient to derive a SF for selenium sulfide. Pertinent data regarding the potential carcinogenicity of selenium by the inhalation route in humans or animals were not located in the available literature.

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D.4.1.15 Silver (RAIS)

Silver is a relatively rare metal that occurs naturally in the earth's crust and is released to the environment from various industrial sources. Human exposure to silver and silver compounds can occur orally, dermally, or by inhalation. Silver is found in most tissues, but has no known physiologic function.

In humans, accidental or intentional ingestion of large doses of silver nitrate has produced corrosive damage of the GI tract, abdominal pain, diarrhea, vomiting, shock, convulsions, and death (EPA, 1985). Respiratory irritation was noted following acute inhalation exposure to silver or silver compounds. Silver nitrate solutions are highly irritating to the skin, mucous membranes, and eyes (Stokinger 1981).

Ingestion, inhalation, or dermal absorption of silver may cause argyria, the most common indicator of long-term exposure to silver or silver compounds in humans. Argyria is a gray or blue-gray, permanent discoloration of the skin and mucous membranes that is not a toxic effect per se, but is considered cosmetically disfiguring. Chronic inhalation exposure of workers to silver oxide and silver nitrate dusts resulted in upper and lower respiratory irritation, deposition of granular silver-containing deposits in the eyes, impaired night vision, and abdominal pain (Rosenman et al. 1979). Mild allergic responses have been attributed to dermal contact with silver (ATSDR 1990).

In long-term oral studies with experimental animals, silver compounds have produced slight thickening of the basement membranes of the renal glomeruli, growth depression, shortened lifespan, and granular silver-containing deposits in skin, eyes, and internal organs (Matuk et al. 1981; Olcott 1948, 1950). Hypoactivity was seen in rats subchronically exposed to silver nitrate in drinking water (Rungby and Danscher 1984).

A RfD of 0.005 mg/kg/day for subchronic and chronic exposure was calculated from a LOAEL of 0.014 mg/kg/day for argyria observed in patients receiving intravenous injections of silver arsphenamine (EPA 1992a,b). Data are presently insufficient to derive a RfC for silver (EPA 1992a).

Data adequate for evaluating the carcinogenicity of silver to humans or animals by ingestion, inhalation, or other routes of exposure were not found. Based on EPA guidelines, silver is placed in weight-of-evidence Group D, not classifiable as to human carcinogenicity (EPA 1992a).

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D.4.1.16 Uranium

Uranium is a hard, silvery-white amphoteric metal and is a radioactive element. In its natural state it consists of three isotopes: uranium-234, uranium-235, and uranium-238. More than 100 uranium minerals exist; those of commercial importance are the oxides and oxygenous salts. The processing of uranium ore generally involves extraction then leaching either by an acid or a carbonate method. In addition, the metal may be obtained from its halides by fused salt electrolysis. The primary use of natural uranium is in nuclear energy as a fuel for nuclear reactors, in plutonium production, and as feeds for gaseous diffusion plants; it also is a source of radium salts. Uranium compounds are used in staining glass, glazing ceramics, and enameling; in photographic processes; for alloying steels; and as a catalyst for chemical reactions, radiation shielding, and aircraft counterweights (Sittig 1981).

Uranium soluble compounds cause kidney damage under acute exposure conditions and pneumoconiosis or pronounced blood changes under chronic exposure conditions. The element also is considered to induce cancer of the lung, osteosarcoma, and lymphoma as a result of its chemical properties (Sittig 1985a); however, no EPA weight-of-evidence classification for uranium metal or its salts was located in the available literature.

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D.4.1.17 Vanadium (RAIS)

Vanadium is a metallic element that occurs in six oxidation states and numerous inorganic compounds. Some of the more important compounds are vanadium pentoxide (V_2O_5), sodium metavanadate ($NaVO_3$), sodium orthovanadate (Na_3VO_4), vanadyl sulfate ($VOSO_4$), and ammonium vanadate (NH_4VO_3). Vanadium is used primarily as an alloying agent in steels and nonferrous metals (ATSDR 1990f). Vanadium compounds also are used as catalysts and in chemical, ceramic, or specialty applications.

Vanadium compounds are poorly absorbed through the GI system (0.5 to 2% of dietary amount) [National Research Council of Canada (NRCC) 1980; International Commission on Radiological Protection (ICRP) 1960; Byrne and Kosta 1978], but slightly more readily absorbed through the lungs (20 to 25%) (ICRP 1960; Davies and Bennett 1983). Absorbed vanadium is widely distributed in the body, but short-term localization occurs primarily in bone, kidneys, and liver (Vouk 1979; Roshchin et al. 1980; Parker et al. 1980; Sharma et al. 1980; Wiegmann et al. 1982). In the body, vanadium can undergo changes in oxidation state interconversion of vanadyl (+4) and vanadate (+5) forms, and it also can bind with blood protein (transferrin) (Harris et al. 1984). Vanadium is excreted primarily in the feces following oral exposures and primarily in the urine following inhalation exposures (Tipton et al. 1969; ATSDR 1990f).

The toxicity of vanadium depends on its physicochemical state, particularly on its valence state and solubility. Based on acute toxicity, pentavalent NH_4VO_3 has been reported to be more than twice as toxic as trivalent $VC1_3$ and more than 6 times as toxic as divalent VI_2. Pentavalent V_2O_5 has been reported to be more than 5 times as toxic as trivalent V_2O_3 (Roshchin 1967). In animals, acutely toxic oral doses cause vasoconstriction, diffuse desquamative enteritis, congestion and fatty degeneration of the liver, congestion and focal hemorrhages in the lungs and adrenal cortex (Gosselin et al. 1984). Minimal effects seen after subchronic oral exposures to animals include diarrhea, altered renal function, and decreases in erythrocyte counts, hemogloblin, and hematocrit (Domingo et al. 1985; Zaporowska and Wasilewski 1991). In humans, intestinal cramps and diarrhea may occur following subchronic oral exposures. These studies indicate that, for subchronic and chronic oral exposures, the primary targets are the digestive system, kidneys, and blood.

RfDs for chronic oral exposures are these: 7E-03 mg/kg-day for metallic vanadium; 9E-03 mg/kg-day for vanadium pentoxide; 2E-02 mg/kg-day for vanadyl sulfate; and 1E-03 mg/kg-day for sodium metavanadate (EPA 1987f, 1997, 2000). The subchronic RfDs for these compounds are the same as the chronic RfDs, except for sodium metavanadate, which is 1E-02 mg/kg-day (EPA 1987f, 1997, 2000).

Inhalation exposures to vanadium and vanadium compounds result primarily in adverse effects to the respiratory system (Sax 1984, ATSDR 1990f). In laboratory studies, minimal effects (throat irritation and coughing) occurred after an 8-hour exposure to 0.1 mg V/m^3 (Zenz and Berg 1967). In studies on workers occupationally exposed to vanadium, the most common reported symptoms were irritation of the respiratory tract, conjunctivitis, dermatitis, cough, bronchospasm, pulmonary congestion, and bronchitis (Symanski 1939; Sjoberg 1950, 1951, 1955, 1956; Vintinner et al. 1955; Lewis 1959; Tebrock and Machle 1968; Roshchin 1968; Kiviluoto et al. 1981). Quantitative data are insufficient to derive a subchronic or chronic inhalation RfC for vanadium or vanadium compounds.

There is little evidence that vanadium or vanadium compounds are reproductive toxins or teratogens. Neither is there substantial evidence that any vanadium compound is carcinogenic although, there are very few adequate studies available for evaluation. Vanadium has not been classified as to carcinogenicity by EPA (2000).

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D.4.1.18 Zinc (RAIS)

Zinc is used primarily in galvanized metals and metal alloys, but zinc compounds also have wide commercial applications as chemical intermediates, catalysts, pigments, vulcanization activators and accelerators in the rubber industry, ultraviolet stabilizers, and supplements in animal feeds and fertilizers. They also are used in rayon manufacture, smoke bombs, soldering fluxes, mordants for printing and dyeing, wood preservatives, mildew inhibitors, deodorants, antiseptics, and astringents (Lloyd 1984; ATSDR 1989e). In addition, zinc phosphide is used as a rodenticide.

Zinc is an essential element with a recommended daily allowance (RDA) ranging from 5 mg for infants to 15 mg for adult males (NRC 1989).

GI absorption of zinc is variable (20 to 80%) and depends on the chemical compound as well as on zinc levels in the body and dietary concentrations of other nutrients (EPA 1984c). In individuals with normal zinc levels in the body, GI absorption is 20 to 30% (ATSDR 1989e). Information on pulmonary absorption is limited and complicated by the potential for GI absorption due to mucociliary clearance from the respiratory tract and subsequent swallowing. Zinc is present in all tissues with the highest concentrations in the prostate, kidney, liver, heart, and pancreas. Zinc is a vital component of many metalloenzymes such as carbonic anhydrase, which regulates CO_2 exchange (Stokinger 1981d). Homeostatic mechanisms involving metallothionein in the mucosal cells of the GI tract regulate zinc absorption and excretion (ATSDR 1989e).

In humans, acutely toxic oral doses of zinc cause nausea, vomiting, diarrhea, and abdominal cramps and in some cases gastric bleeding (Elinder 1986, Moore 1978, ATSDR 1989e). Ingestion of zinc chloride can cause burning in the mouth and throat, vomiting, pharyngitis, esophagitis, hypocalcemia, and elevated amylase activity indicative of pancreatitis (Chobanian 1981). Zinc phosphide, which releases phosphine gas under acidic conditions in the stomach, can cause vomiting, anorexia, abdominal pain, lethargy, hypotension, cardiac arrhythmias, circulatory collapse, pulmonary edema, seizures, renal damage, leukopenia, and coma and death in days to weeks (Mack 1989). The estimated fatal dose is 40 mg/kg. Animals dosed orally with zinc compounds develop pancreatitis, GI and hepatic lesions, and diffuse nephrosis.

GI upset also has been reported in individuals taking daily dietary zinc supplements for up to six weeks (Samman and Roberts 1987). There also is limited evidence that the human immune system may be impaired by subchronic exposures (Chandra 1984). In animals, GI and hepatic lesions (Allen et al. 1983; Brink et al. 1959), pancreatic lesions (Maita et al. 1981; Drinker et al. 1927), anemia (ATSDR 1989e; Fox and Jacobs 1986; Maita et al. 1981), and diffuse nephrosis (Maita et al. 1981; Allen et al. 1983) have been observed following subchronic oral exposures.

Chronic oral exposures to zinc have resulted in hypochromic microcytic anemia associated with hypoceruloplasminemia, hypocupremia, and neutropenia in some individuals (Prasad et al. 1963; Porter et al. 1977). Anemia and pancreatitis were the major adverse effects observed in chronic animal studies (Aughey et al. 1977; Drinker et al. 1927; Walters and Roe 1965; Sutton and Nelson 1937). Teratogenic effects have not been seen in animals exposed to zinc; however, high oral doses can affect reproduction and fetal growth (Ketcheson et al. 1969; Schlicker and Cox 1967 and 1968; Sutton and Nelson 1937).

The RfD for chronic oral exposure to zinc is under review by EPA; the currently accepted RfD for both subchronic and chronic exposures is 3E-01 mg/kg-day, based on clinical data demonstrating zinc-induced copper deficiency and anemia in patients taking zinc sulfate for the treatment of sickle cell anemia (EPA 2000). The chronic oral RfD for zinc phosphide is 3E-04 mg/kg-day (EPA 199If), and the subchronic RfD is 3E-03 mg/kg-day (EPA 2000).

Under occupational exposure conditions, inhalation of zinc compounds (mainly zinc oxide fumes) can result in a condition identified as “metal fume fever,” which is characterized by nasal passage irritation, cough, rales, headache, altered taste, fever, weakness, hyperpnea, sweating, pains in the legs and chest, leukocytosis, reduced lung volume, and decreased diffusing capacity of carbon monoxide (ATSDR 1989e; Bertholf 1988). Inhalation of zinc chloride can result in nose and throat irritation, dyspnea, cough, chest pain, headache, fever, nausea and vomiting, and respiratory disorders such as pneumonitis and pulmonary fibrosis (ITII 1988; ATSDR 1989e; Nemery 1990). Pulmonary inflammation and changes in lung function also have been observed in inhalation studies on animals (Amur et al. 1982; Lam et al. 1985; Drinker and Drinker 1928).

Although “metal fume fever” occurs in occupationally exposed workers, it is primarily an acute and reversible effect that is unlikely to occur under chronic exposure conditions when zinc air concentrations are less than 8 to 12 mg/m^3 (ATSDR 1989e). GI distress, as well as enzyme changes indicative of liver dysfunction, also have been reported in workers occupationally exposed to zinc (NRC 1979; Stokinger 1981d; EPA 2000; Guja 1973; Badawy et al. 1987); however, it is unclear as to what extent these effects might have been caused by pulmonary clearance and subsequent GI absorption. Consequently, there are no clearly defined toxic effects that can be identified as resulting specifically from pulmonary absorption following chronic low-level inhalation exposures. Animal data for chronic inhalation exposures are not available.

An inhalation RfC has not been derived for zinc or zinc compounds (EPA 1997).

No case studies or epidemiologic evidence has been presented to suggest that zinc is carcinogenic in humans by the oral or inhalation route (EPA 2000). In animal studies, zinc sulfate in drinking water or zinc oleate in the diet of mice for a period of one year did not result in a statistically significant increase in hepatomas, malignant lymphomas, or lung adenomas (Walters and Roe 1965); however, in a three-year, five-generation study on tumor-resistant and tumor-susceptible strains of mice, exposure to zinc in drinking water resulted in increased frequencies of tumors from the F_o to the F_4 generation in the tumor-resistant strain (from 0.8 to 25.7% versus 0.0004% in the controls) and higher tumor frequencies in two tumor-susceptible strains (43.4% and 32.4% versus 15% in the controls) (Halme 1961).

Zinc is placed in weight-of-evidence Category D—not classifiable as to human carcinogenicity due to inadequate evidence in humans and animals (EPA 2000).

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D.4.2 ORGANIC COMPOUNDS

D.4.2.1 Fluoranthene (RAIS)

Fluoranthene is a PAH that can be derived from coal tar. Occurring ubiquitously in products of incomplete combustion of fossil fuels, fluoranthene has been identified in ambient air; surface, drinking, and wastewater; and in char-broiled foods. Currently, there is no commercial production or use of this compound (IARC 1983f).

Fluoranthene can be absorbed through the skin following dermal exposure (Storer et al. 1984b) and, by analogy to structurally related PAHs would be expected to be absorbed from the GI tract and lungs (EPA 1988b). An in vitro study identified 2-methylfluoranthene and 3-methylfluoranthene and their dihydrodiols as metabolites of fluoranthene (La Voie et al. 1982b).

Although a large body of literature exists on the toxicity and carcinogenicity of PAHs, primarily benzo(a)pyrene, toxicity data for fluoranthene are very limited. No human data were available that addressed the toxicity of fluoranthene. Acute toxicity data for animals include an oral LD_{50} of 2,000 mg/kg for rats; a dermal LD_{50} of 3,180 mg/kg for rabbits (Smyth et al. 1962); and an intravenous LD_{50} of 100 mg/kg for mice (RTECS 1993). Subchronic oral exposure to fluoranthene at doses of greater than or equal to 250 mg/kg produced nephropathy, increased liver weights, and increased liver enzyme levels in rats (EPA 1988b). A single intraperitoneal injection of fluoranthene to pregnant rats caused an increased rate of embryo resorptions (Irvin and Martin 1987). Fluoranthene was photosensitizing, enhancing erythema elicited by UV radiation in guinea pig skin (Kochevar et al. 1982) and was irritating to the eyes of rabbits (Grant 1986).

An RfD of 4E-01 mg/kg-day for subchronic oral exposure and 4E-02 mg/kg-day for chronic oral exposure to fluoranthene was calculated from a NOAEL of 125 mg/kg-day and a LOAEL of 250 mg/kg-day derived from a 13-week gavage study with mice (EPA 1997, 2000). The critical effects were nephropathy, increased liver weights, and changes in clinical and hematological parameters. Data were insufficient to derive an inhalation RfC for fluoranthene (EPA 1997, 2000).

No oral or inhalation bioassays were available to assess the carcinogenicity of fluoranthene. Bioassays by other exposure routes generally gave negative results. Studies involving topical application to the skin of mice (Horton and Christian 1974; Hoffmann et al. 1972; Wynder and Hoffmann 1959b; Suntzeff et al. 1957) and subcutaneous injection in mice (Shear 1938) provided no evidence of carcinogenicity. Fluoranthene also was inactive in mouse skin initiation and promotion assays (Van Duuren and Goldschmidt 1976; Hoffmann et al. 1972); however, fluoranthene has been shown to be active as a cocarcinogen when applied with benzo(a)pyrene to mice by skin application (Van Duuren and Goldschmidt 1976) and was active as a complete carcinogen in a short-term lung tumor assay with newborn mice (Busby et al. 1984).

Based on no human data and inadequate data from animal bioassays, EPA (1997, 2000) has placed fluoranthene in weight-of-evidence Group D, not classifiable as to human carcinogenicity.

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D.4.2.2 Polycyclic Aromatic Hydrocarbons (Total PAHs)

In this risk assessment, the PAHs are divided into two groups based on their potential carcinogenicity. Those compounds considered to be noncarcinogenic (fluoranthene and pyrene) are evaluated individually, whereas the carcinogens [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(l,2,3-cd)pyrene] are evaluated as a group under the title “Total PAHs.” As explained in Section D.4, the contribution of each carcinogenic PAH to the overall Total PAHs risk score is quantified using the TEF approach, in which the SWMU- and media-specific concentration of each component is multiplied by a factor capturing its supposed carcinogenic potency compared to that of benzo(a)pyrene. This forms the basis for the development of a compound-specific chronic daily dose relative to that of benzo(a)pyrene, the accepted benchmark carcinogenic PAH with a TEF of unity. The sum of the modified (BaPE) doses among the compounds then is factored with the SF for benzo(a)pyrene to estimate the risk for Total PAHs. The TEFs used in this risk assessment, values that have been developed largely from the compounds’ comparative tumorigenic potency in mouse skin painting studies, are listed in Table D.22.

IRIS records are available for all seven carcinogenic PAHs, each of which is assigned to the B2 qualitative weight-of-evidence of carcinogenicity category, indicative of a probable human carcinogen. A key feature of the group’s tumorigenicity is the profound “site-of-impact” effects of the compounds. Thus, a typical consequence of oral administration of the compounds is the development of tumors of the forestomach or at other sites in the anterior GI tract. Similarly, subcutaneous injection is frequently followed by the development of tumorous masses in and around the injection site [see, for example, EPA's carcinogenicity summary for benz(a)anthracene (EPA 2000)]; however, the compounds' intrinsic lipophilicity ensures that a portion of each substance is able to cross the absorption barrier, with the consequent formation of compound-related tumors at remote sites. For example, the oral administration of dibenzo(a,h)anthracene to DBA/2 mice induces carcinomas of the mammary gland, among other organs (Snell and Stewart 1962,1963).

As mentioned above, benzo(a)pyrene is regarded as the benchmark carcinogenic PAH, and it is on this compound that most of the toxicity/carcinogenicity studies on the PAHs have been focused. As discussed in IRIS, there are multiple animal studies in numerous species demonstrating the compound's carcinogenicity, in addition to its positive effects in a number of genotoxicity assays (EPA 2000). For example, dietary administration of benzo(a)pyrene has produced papillomas and carcinomas of the forestomach in mice (Neal and Rigdon 1967), and treatment by gavage has produced mammary tumors in rats (McCormick et al. 1981) and pulmonary adenomas in mice (Wattenberg and Leong 1970). Exposure by inhalation and intratracheal instillation has resulted in benign and malignant tumors of the respiratory and upper digestive tracts of hamsters (Ketkar et al. 1978; Thyssen et al. 1981). Numerous topical application studies have shown that benzo(a)pyrene induces skin tumors in several species, although mice are the most widely studied. Benzo(a)pyrene is a complete carcinogen and also an initiator of skin tumors (IARC 1983a; EPA 1991k). The compound also has been reported to induce tumors in animals when administered by other routes, such as intravenous, intraperitoneal, subcutaneous, intrapulmonary, and transplacental.

Numerous epidemiologic studies have shown a clear association between exposure to various mixtures of PAHs containing benzo(a)pyrene (e.g., coke oven emissions, roofing tar emissions, and cigarette smoke) and increased risk of lung cancer and other tumors. Because each substance also contains other potentially carcinogenic PAHs, it is impossible to evaluate the sole contribution of benzo(a)pyrene or of any other individual PAH component to the carcinogenicity of these mixtures in an environmental or occupational setting (IARC 1983a; EPA 1991k). This provides the justification for evaluating this subset of compounds as Total PAHs.

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D.4.2.3 Polychlorinated Biphenyls (Total PCBs)

PCBs are frequently detected in environmental samples taken from hazardous wastes sites despite the fact that this group of substances are not formed naturally in the environment and have not been manufactured in the United States since 1977. This disparity points to their very widespread use prior to that date and to their persistence in the environment once released as a result of spills, leaking electricity transformers, etc. PCBs have significant bioconcentration capability and tend to accumulate in the fat of fish, birds, mammals, and humans because of their marked lipophilicity. As summarized in ATSDR (1995), there are 209 PCB congeners, components that typically enter the environment as part of one of seven well-defined commercial mixtures—the aroclors (in the United States). Defined by their number of carbon atoms and their approximate percentage of chlorine complement by weight, the aroclors are readily identifiable in solvent extracts of environmental samples when separated by gas chromatography and analyzed using a suitable detection system.

Of the seven PCB mixtures that typically are identified in environmental media, three (aroclor-1016, -1248, and -1254) have been the subject of toxicity evaluations on IRIS (EPA 2000), although no carcinogenic toxicity values have been derived for them; however, IRIS also carries a toxicity evaluation for PCBs as a group, in which the compounds’ carcinogenicity is given a thorough quantitative assessment. In addition, the group is assigned a B2 qualitative weight-of-evidence classification—a probable human carcinogen based on inadequate evidence of carcinogenicity in epidemiological or occupational exposure studies, but on adequate evidence in laboratory studies involving experimental animals. For example, in but two examples of a large number of experimental studies in the primary toxicological literature, Brunner et al. (1996) exposed female Sprague-Dawley rats to dietary aroclor-1016, -1242, -1254, or -1260 and observed a dose-dependant increase in the incidence of liver adenomas, carcinomas, cholangiomas, and cholangiocarcinomas. These data support an earlier quantitative study of Aroclor-1260 by Norback and Weltman (1985).

IRIS (EPA 2000) uses data from both of these studies to derive a range of cancer potency values for PCB mixtures (tiered approach), in which central estimate and upper-bound SFs are offered according to whether the environmental conditions in which the compounds were detected represented high, low, or lowest risk conditions. Thus, respective upper-bound and central-estimate SFs for high risk and environmental persistence (e.g., Aroclor 1254) of the PCBs are 2.0 and 1.0 $(mg/kg\text{-}day)^{-1}$, 0.4 and 0.3 $(mg/kg\text{-}day)^{-1}$ for low risk and persistence, and 0.07 and 0.04 $(mg/kg\text{-}day)^{-1}$ for lowest risk and persistence (e.g., Aroclor 1016). Upper-bound SFs for high risk PCBs were conservatively used in all calculations. Similarly, chronic and subchronic oral RfDs for high risk PCBs (e.g., Aroclor 1254) were used in all calculations.

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D.4.2.4 Pyrene (RAIS)

Pyrene, also referred to as benzo(d,e,f)phenanthrene and -pyrene, is a PAH that can be derived from coal tar. Currently, there is no commercial production or use of this compound. Pyrene is ubiquitous in the environment as a product of incomplete combustion of fossil fuels and has been identified in surface and drinking water, numerous foods, and ambient air (EPA 1988a and 1987m; IARC 1983i).

Although a large body of literature exists on the toxicity and carcinogenicity of PAHs, toxicity data for pyrene are limited. No human data were available that addressed the toxicity of pyrene. Subchronic oral exposure to pyrene produced nephropathy, decreased kidney weights, increased liver weights, and slight hematological changes in mice (TRL 1989) and produced fatty livers in rats (White and White 1939). A single intraperitoneal injection of pyrene produced swelling and congestion of the liver and increased serum aspartate amino transferase (AST) and bilirubin levels in rats (Yoshikawa et al. 1985). No data were available concerning the toxic effects of inhalation exposure to pyrene or data regarding teratogenicity or other reproductive effects by any route of exposure.

An RfD of 3E-01 mg/kg-day for subchronic (EPA 1997) and 3E-02 mg/kg-day for chronic oral exposure (EPA 2000) to pyrene was calculated from a NOAEL of 75 mg/kg-day in a 13-week gavage study with mice (TRL 1989). Data were insufficient to derive an inhalation RfC for pyrene (EPA 1997, 2000).

No oral or inhalation bioassays were available to assess the carcinogenicity of pyrene. Studies involving other routes of exposure (intratracheal, dermal, and subcutaneous) generally gave negative results. Intratracheal administration of pyrene in combination with Fe_2O_3 particles did not induce tumors in hamsters (Sellakumar and Shubik 1974). Skin painting assays evaluating complete carcinogenesis in mice (Van Duuren and Goldschmidt 1976; Horton and Christian 1974; Roe and Grant 1964; Wynder and Hoffman 1959b); or initiating (Roe and Grant 1964); or promoting capacity (Wood et al. 1980; Scribner 1973; Salaman and Roe 1956) have been negative or inconclusive. Mice injected subcutaneously with pyrene did not develop tumors (Shear and Leiter 1941), but there is evidence that pyrene enhances the tumorigenicity of topically applied benzo(a)pyrene (Slaga et al. 1979; Van Duuren and Goldschmidt 1976; Goldschmidt et al. 1973).

Based on no human data and inadequate data from animal bioassays, EPA (1997, 2000) has placed pyrene in weight-of-evidence Group D, not classifiable as to human carcinogenicity.

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D.4.3 RADIONUCLIDES

Radionuclides are unstable atoms of chemical elements that emit charged particles or energy or both to achieve a more stable state. These charged particles are termed “alpha and beta radiation.” Energy is termed “neutral gamma rays.” Interaction of these charged particles (and gamma rays) with matter will produce ionization events, or radiation, which may cause living cell tissue damage. Because the deposition of energy by ionizing radiation is a random process, sufficient energy may be deposited (in a critical volume) within a cell and result in cell modification or death. In addition, ionizing radiation has sufficient energy that interactions with matter will produce an ejected electron and a positively charged ion (known as free radicals) that are highly reactive and may combine with other elements, or compounds within a cell to produce toxins or otherwise disrupt the overall chemical balance of the cell. These free radicals also can react with DNA, causing genetic damage, cancer induction, or even cell death.

Radionuclides are characterized by the type and energy level of the radiation emitted. Radiation emissions fall into two major categories: particulate (electrons, alpha particles, beta particles, and protons) or electromagnetic radiation (gamma and X-rays). Therefore, EPA classifies all radionuclides as Group A carcinogens based on their property of emitting ionizing radiation and on the extensive weight-of-evidence provided by epidemiological studies of humans with cancers induced by high doses of radiation. Alpha particles are emitted at a characteristic energy level for differing radionuclides. The alpha particle has a charge of +2 and a comparably large size (Helium nuclei). Alpha particles have the ability to react (and/or ionize) with other molecules, but they have very little penetrating power and lack the ability to pass through a piece of paper or human skin; however, alpha-emitting radionuclides are of concern when there is a potential for inhalation or ingestion of the radionuclide. Alpha particles are directly ionizing and deposit their energy in dense concentrations [termed high linear energy transfer (high LET)], resulting in short paths of highly localized ionization reactions. The probability of cell damage increases as a result of the increase in ionization events occurring in smaller areas; this also may be the reason for increased cancer incidence caused by inhalation of radon gas. In addition, cancer incidence in smokers may be attributed directly to the naturally occurring alpha emitter, polonium-210, in common tobacco products.

Beta emissions generally refer to beta negative particle emissions. Radionuclides with an excess of neutrons achieve stability by beta decay. Beta radiation, like alpha radiation, is directly ionizing; however, unlike alpha activity, beta particles deposit their energy along a longer track length (low-LET), resulting in more space between ionization events. Beta-emitting radionuclides can cause injury to the skin and superficial body tissue, but are most destructive when inhaled or ingested. Many beta emitters are similar chemically to naturally occurring essential nutrients and will, therefore, tend to accumulate in certain specific tissues. For example, strontium-90 is chemically similar to calcium and, as a result, accumulates in bone. Continuous exposure results when a radiation source becomes immobilized at a tissue site. The health effects of beta particle emissions depend upon the target organ. Those seeking the bones cause a prolonged exposure to the bone marrow and affect blood cell formation, possibly resulting in leukemia, other blood disorders, or bone cancers. Those seeking the liver result in liver diseases or cancer, while those seeking the thyroid cause thyroid and metabolic disorders. In addition, beta radiation may lead to damage of genetic material (DNA), causing hereditary defects.

Gamma emissions are the energy that has been released from transformations of the atomic nucleus. Gamma emitters and X-rays behave similarly, but differ in their origin: gamma emissions originate in nuclear transformations, and X-rays result from changes in the orbiting electron structure. Radionuclides that emit gamma radiation can induce internal and external effects. Gamma rays have high penetrating ability in living tissue and are capable of reaching all internal body organs. Without such sufficient shielding as lead, concrete, or steel, gamma radiation can penetrate the body from the outside and does not require ingestion or inhalation to penetrate sensitive organs. Gamma rays are characterized as low-LET radiation, as is beta radiation; however, the behavior of beta radiation differs from that of gamma radiation in that beta particles deposit most of their energy in the medium through which they pass, while gamma rays often escape the medium because of higher energies, thereby creating difficulties in determining actual internal exposure. For this reason, direct whole-body measurements are necessary to detect gamma radiation, while urine/fecal analyses usually are effective in detecting beta radiation.

People receive gamma radiation continuously from naturally occurring radioactive decay processes going on in the earth’s surface, from radiation naturally occurring inside their bodies, from the atmosphere as fallout from nuclear testing or explosions, and from space or cosmic sources. Cesium-137 (from nuclear fallout) decays to barium-137, the highest contributor to fallout-induced gamma radiation. Beta radiation from the soil is a less penetrating form of radiation but has many contributing sources. The most common environmental beta emitters are potassium-40, Cesium-137, lead-214, and bismuth-214. Tritium also is a beta emitter, but contributes little to the soil beta radiation because of the low energy of its emission and its low concentration in the atmosphere. Alpha radiation also is emitted by the soil, but is not measurable more than a few centimeters from the ground surface. The majority of alpha emissions are attributable to radon-222 and radon-220 and their decay products. This contributes to “background exposure” to radiation.

The general health effects of radiation can be divided into stochastic (related to dose) and nonstochastic (unrelated to dose) effects. The risk of development of cancer from exposure to radiation is a stochastic effect. Examples of nonstochastic effects include acute radiation syndrome and cataract formation, which occur only at high levels of exposures.

Radiation can damage cells in different ways. It can cause damage to DNA within the cell, and the cell either may not be able to recover from this type of damage or may survive but function abnormally. If an abnormally functioning cell divides and reproduces, a tumor or mutation in the tissue may develop. The rapidly dividing cells that line the intestines and stomach and the blood cells in bone marrow are extremely sensitive to this damage. Organ damage results from the damage caused to the individual cells. This type of damage has been reported with doses of 10 to 500 rads (0.1 to 5.0 gray, in SI units). Acute radiation sickness is seen only after doses of greater than 50 rads (0.5 gray), which is a dose rate usually achieved only in a nuclear accident.

When the radiation-damaged cells are reproductive cells, genetic damage can occur in the offspring of the person exposed. The developing fetus is especially sensitive to radiation. The type of malformation that may occur is related to the stage of fetal development and the cells that are differentiating at the time of exposure. Radiation damage to children exposed in the womb is related to the dose the pregnant mother receives. Mental retardation is a possible effect of fetal radiation exposure.

The most widely studied population that has had known exposure to radiation is the atomic bomb survivors of Hiroshima and Nagasaki, Japan. Data indicate an increase in the rate of leukemia and cancers in this population; however, the rate at which cancer incidence is significantly affected by low radiation exposures, such as results of exposure to natural background and industrially contaminated sites, still is undergoing study and is uncertain. In studies conducted to determine the rate of cancer and leukemia increase, as well as genetic defects, several radionuclides must be considered.

D.4.3.1 Americium-241

Americium is a man-made, radioactive element with no stable isotopes. Americium-241 can be formed when either uranium-238 or plutonium-238 or plutonium-239 are exposed to neutrons, as occurs in a nuclear reactor or nuclear explosion. The most common application of americium is in ionization smoke detectors. One gram of americium-241 provides enough active material for more than 5,000 smoke detectors.

Information regarding human health effects following exposure to americium-241 is limited to a single case study of an individual accidentally exposed to high levels from an internal dose from americium-241 absorbed through external wounds. Lymphopenia, thrombocytopenia, and signs of bone marrow peritrabecular fibrosis, bone cell depletion, and bone marrow atrophy were noted (Filipy et. al. 1995; Priest et. al. 1995). Damage to bone cells is supported by animal studies.

Experimental studies in animals demonstrate that internal exposure to americium-241 results in the development of cancer in the tissues that sequester this element. Animal studies indicate increased risk of bone cancer in areas of bone with relatively high levels of americium. Increases in bone cancer have occurred in dogs receiving a single inhalation exposure to americium-241 (Gillette et al. 1985) and in dogs (Jee et. al. 1985; Lloyd et. al. 1994a and 1994b), rats (Carter et. al. 1951) and mice (Schoeters et. al. 1991; Taylor et. al., 1983; Van Den Heuvel et. al. 1995) receiving a single intraperitoneal or intravenous injection ofamericium-241.

Studies of cancer risk specifically associated with human exposure to radioactive isotopes of americium were not located; however, EPA has determined that ionizing radiation is a Group A known carcinogen, and by extension, all radionuclides, including americium-241, are considered to be known carcinogens.

References

ATSDR (Agency for Toxic Substances and Disease Registry). 2004. *Toxicological Profile for Americium,* U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

Carter RE, Busch E, Johnson O. 1951. The relative physiological and toxicological properties of americium and plutonium. GRAI 14(NTIS/DEC95013620).

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Gillett NA, Hahn FF, Mewhinney JA, et. al., 1985. Osteosarcoma development following single inhalation exposure to americium-241 in beagle dogs. Radiat Res 104:83–93.

Jee WSS, Dell RB, Parks NJ, et al. 1985. Toxicity of plutonium and americium: Relationship of bone composition to location of radium-226, plutonium-239, and americium-241 induced bone sarcomas. EUR 9250:155–1724.

Lloyd RD, Miller SC, Taylor GN, et al. 1994a. Relative effectiveness of plutonium-239 and some other internal emitters for bone cancer induction in beagles. Health Phys 67:346–353.

Lloyd RD, Taylor GN, Angus W, et al. 1994b. Skeletal malignancies among beagles injected with americium-241. Health Phys 66(2):172–177.

Priest ND, Freemont A, Humphreys JAH, et al. 1995. Histopathology and americium-241 micro distribution in skeletal USTUR case 246. Health Phys 69(3):330–337.

Schoeters GER, Maison JR, Vanderborght OLJ, 1991. Toxicity of americium-241 in male C57BL mice: Relative risk versus radium-226. Radiat Res 126:198–205.

Taylor GN, Mays CW, Lloyd RD, et al. 1983. "Comparative toxicity of radium-226, plutonium-239, americium-241, californium-249, and californium-252 in C57BL/Do black and albino mice." Radiat Res 95:584–601.

Van Deb Heuvel R, Gerber GB, Leppens H, et al. 1995. "Long-term effects on tumor incidences and survival from americium-241 exposure of the BALB/c mouse in utero and during adulthood." Int J Radiat Biol 68(6):679–686.

D.4.3.2 Cesium-137

Cesium occurs in nature as cesium-133 in the aluminosilicates, pollucite (a hydrated silicate of aluminum and cesium) and lepidolite; in the borate, rhodizite; and in other sources (Budavari et al. 1989, Klaassen et al. 1986). As one of the artificial isotopes of cesium, cesium-137 is one of the principle radionuclides released to the environment in reactor effluent under abnormal operations. Cesium-137 also may be produced in nuclear and thermonuclear explosions, through which it would be a primary contributor to human exposure through fallout radiation, assimilation through the food chain, or beta dose to the skin (Budavari et al. 1989, Klaassen et al. 1986). In addition, cesium-137, along with stontium-90, as one of the most important fission products, will display widespread distribution in near-surface soils as a result of historical weapons testing. Measurable concentrations still exist today, almost exclusively in the upper 15 cm of soil, concentrations that decrease roughly exponentially with depth.

Cesium-137 also may have important roles in medical treatments (a teletherapy source or intercavity or interstitial radiation source in treatment of malignancies) and as an encapsulated energy source (Budavari et al. 1989; Casarett 1968). Cesium-137 decays to, and reaches radioactive equilibrium with, its daughter product, barium-137m (Budavari et al. 1989; Casarett 1968). The latter is a very short-lived gamma emitter that can contribute to external gamma exposure (Budavari et al. 1989).

References

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Casarett, A. P. 1968. *Radiation Biology,* Prentice-Hall, Englewood Cliffs, NJ.

Klaassen, C. D., Amdur, M. O., and Doull, J. (eds.) 1986. *Casarett and Doull's Toxicology: The Basic Science of Poisons,* 3rd ed., Macmillan Publishing Company, New York, NY.

D.4.3.3 Cobalt-60

Cobalt-60 is produced by irradiating cobalt-59 with thermal neutrons in a nuclear reactor and is used as a source of gamma rays for sterilizing medical equipment or consumer products, food irradiation, radiation therapy for treating cancer patients, and for manufacturing plastics.

Consistent with other radionuclides, cobalt-60 emits beta particles and gamma rays that may ionize molecules within cells penetrated by these emissions and result in tissue damage and disruption of cellular function. The most important exposure of radioactive cobalt is external exposure to the radiation released by the radioisotopes. Signs and symptoms of acute toxicity from external and internal exposure to high levels of radiation from cobalt-60 are typical of those observed in cases of high exposure to ionizing radiation in general. Depending on the dose, symptoms may include vomiting, nausea, and diarrhea, skin and ocular lesions, neurological signs, chromosomal abnormalities, compromised immune function and death.

Acute or repeated exposure of humans or animals to ionizing radiation from cobalt-60, and all other radionuclides in general, may result in reduced male fertility, abnormal neurological development following exposure during critical stages of fetal development and genotoxic effects such as increased frequencies of chromosomal aberrations, sister-chromatid exchanges, and micronucleus formation.

Due to the ionizing properties of radionuclides such as cobalt-60, increased cancer risk would be expected among exposed individuals. Specific studies of increased cancer risk could not be located for cobalt-60 for both humans and animals as well.

Reference

ATSDR (Agency for Toxic Substances and Disease Registry) 2004. *Toxicological Profile for Cobalt,* U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

D.4.3.4 Neptunium-237

Specific literature information for neptunium-237 is limited; however, available literature states that during neutron bombardment, neptunium-237 breaks down to plutonium-238, which produces small masses of high capacity energy that is useful for satellites and spacecraft (Moskalev et al. 1979).

The most common route of neptunium-237 exposure is inhalation of aerosols. According to studies conducted on rats, acute effects include injury to the liver and kidney and circulation disorders. Long-term effects include osteosarcomas and lung cancer. Extremely high doses cause immediate or premature death by destruction of the lungs (Moskalev et al. 1979).

Reference

Moskalev, Y. I., Buldakov, L. A., Zhuravleva, A. K., et al. 1979. *Toxicological and Radiobiology of Neptunium-237,* ORNL-TR-4936, Moscow Atomizdat Publishers.

D.4.3.5 Plutonium-239/240

Plutonium is a predominantly man-made radioactive metal that is produced from nuclear reactions with uranium. Plutonium-238 has been used as a nuclear power source for satellites and in thermoelectric generation systems in spacecraft, cardiac pacemakers, and other power sources [Harley 1980; Nuclear Energy Agency/Organization of Economic Cooperation and Development (NEA/OECD) 1981]. Plutonium-239 is associated mostly with nuclear weapons production and testing. It is generated in irradiated uranium fuel when neutrons are captured by uranium-238 nuclei. Commerce and the military principally use plutonium-238 and plutonium-239 because of their ease of production and long radioactive half-lives (86 and 24,000 years, respectively). Both plutonium-238 and plutonium-239 are artificial, alpha-emitting isotopes of plutonium. Plutonium-238 decays to radioactive uranium-234 via alphas of 5.5 MeV, and plutonium-239 decays to radioactive uranium-235 via alphas of 5.1 MeV.

Atmospheric testing of nuclear weapons has been the main source of plutonium dispersion in the environment, while accidents and routine releases from weapons production facilities are the primary sources of localized contamination. Plutonium released to the atmosphere reaches the earth’s surface through wet and dry deposition to the soil and surface water. Once in these media, plutonium can sorb to soil and sediment particles or bioaccumulate in terrestrial and aquatic food chains.

Because of the low solubility of plutonium isotopes, inhalation of contaminated dust particles is considered to be the most harmful means of human exposure. Plutonium that has been inhaled may be absorbed through the lungs and deposited in other body tissues. Subsequent translocation of some of the plutonium from the lungs to tissues and organs distant from the site of entry results in radiation damage to these tissues as well as to the lung. Liver and bone are the primary sites of plutonium deposition (ICRP 1986). The assumed biological retention half-lives of plutonium isotopes accumulated in the liver and bone of the human body are 20 and 50 years, respectively (ICRP 1986); therefore, a single exposure to plutonium isotopes can result in prolonged exposure to body organs from alpha radiation (EPA 1977). The permissible health levels for plutonium are the lowest of all the radioactive elements. This is occasioned by the concentration of plutonium directly on bone surfaces rather than the more uniform bone distribution shown by other heavy elements. This increases the possibility of damage from equivalent activities of plutonium and has led to adoption of extremely low permissible levels.

Inhaled plutonium-238 is solubilized and subsequently translocated from the lung to the bone and liver (Gillett et al. 1988). Inhaled plutonium-239 dioxide is insoluble and retained primarily in the lungs and associated lymph nodes. In laboratory tests with plutonium and animals, the pattern of nonmalignant toxicity among the species tested was similar (i.e., radiation pneumonitis and pulmonary fibrosis occurred in the higher radiation dose groups in all species tested); however, species differences in the induction of cancer were apparent. With the exception of Syrian hamsters, cancer developed in animals in the lower exposure groups or in animals that survived initial radiation damage to the lungs (ATSDR 1990).

References

ATSDR (Agency for Toxic Substances and Disease Registry). 1990. *Toxicological Profile for Plutonium,* U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

EPA (U.S. Environmental Protection Agency). 1977. *Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment,* EPA520/4-77-016, Washington, DC.

Gillet, N., B. Muggenberg, J. Mewhinney, et al. 1988. "Primary Liver Tumors in Beagle Dogs Exposed by Inhalation to Aerosols of Plutonium-238 Dioxide," *American Journal of Pathology* 133:265–276.

Harley, J. 1980. "Plutonium in the Environment—A Review," *J. Radiat. Res.* 21:83–104.

ICRP (International Commission on Radiological Protection). 1986. *The Metabolism of Plutonium and Related Elements,* ICRP Publication 48, Pergamon Press, Oxford, England.

NEA/OECD (Nuclear Energy Agency/Organization of Economic Cooperation and Development). 1981. *The Environmental and Biological Behavior of Plutonium and Some Other Transuranium Elements,* Nuclear Energy Agency, Paris, France.

D.4.3.6 Technetium-99

Technetium-99 is a low energy-emitting fission product of uranium with the capacity to form volatile fluorides that accompany uranium hexafluoride in the gaseous diffusion process. Highly mobile when released to the environment, the radionuclide is recognized as one of the most pervasive contaminants of groundwater at PGDP. Technetium-99 also may be obtained by the irradiation of molybdenum (Venugopal and Luckey 1978; Clarke and Podbielski 1988).

References

Clarke, M. J., and Podbielski, L. 1988. *Handbook on Toxicity of Inorganic Compounds,* Seiler et al., eds., Marcel Dekker, New York, NY.

Venugopal, B., and Luckey, T. D. 1978. *Metal Toxicity in Mammals. Volume 2, Chemical Toxicity of Metals and Metalloids,* Plenum Press, New York, NY.

D.4.3.7 Thorium-228, Thorium-230, and Thorium-232

Thorium is a naturally occurring, radioactive metal that displays a widespread distribution in the environment. Thorium is a metallic element of the actinide series and exists in several isotopic forms. While more than 99.99% of natural thorium is thorium-232, other isotopes, for example thorium-234 and thorium-230, are produced during the decay of naturally occurring uranium-238 (ATSDR 1990). The isotope ^{228}Th is formed through the decay of thorium-232, and the isotopes thorium-231 and thorium-227 during the decay of uranium-235.

Thorium is used to make ceramics, lantern mantles, metals used in the aerospace industry, and in nuclear reactions. Thorium also can be used as a fuel for generating nuclear energy. More than 30 years ago, thorium oxides were used in hospitals to make certain kinds of diagnostic X-ray photographs (ATSDR 1990).

Breathing dust contaminated with thorium is the primary pathway for thorium exposure to the body, a small amount of thorium being absorbed and deposited in bone. Other potential target organs of the element include the lung and pancreas. Increased incidences of tumor formation and liver diseases have been observed in persons who have been occupationally exposed to thorium. Similar effects have been observed in experimental studies; however, the element is not known to cause birth defects or to affect child-bearing abilities.

Reference

ATSDR (Agency for Toxic Substances and Disease Registry). 1990. *Toxicological Profile for Thorium* TP-90-25, U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

D.4.3.8 Uranium-234, Uranium-235, and Uranium-238

Uranium is a radioactive element that occurs widely in the earth's crust. Uranium emits alpha and gamma radiation, the former being unable to penetrate skin, but can travel short distances in the body if ingested or inhaled. Consequently, uranium represents a significant carcinogenic hazard only when taken into the body, since the penetrating (gamma) radiation of uranium is not considered to be significant (ATSDR 1989); however, one or more one of its daughter radionuclides is a gamma emitter.

Natural uranium contains the isotopes uranium-238 (which averages 99.27% of total uranium mass), uranium-235 (0.72%), and uranium-234 (0.0056%), each of which undergoes radioactive decay. Natural uranium, therefore, contains the parent isotopes and their respective daughters (Bowen 1979; ATSDR 1989).

The primary toxicological effect of the elements chemical reactivity is kidney damage. Studies in rabbits, mice, and dogs have shown the various impacts on the kidney to be dose-related. In addition, fetal skeletal abnormalities and fetal death were found in pregnant mice exposed to 6 mg/kg uranyl acetate dihydrate.

The primary human exposure studies on uranium have addressed the occupational health of uranium miners or factory workers exposed to the metal. The most notable effect among these cohorts was an increase in lung cancer deaths, potentially attributable to alpha emissions and/or the decay of uranium to radon and its daughters. These workers are exposed to high levels of uranium dust and fumes and to other radioactive elements in confined conditions (ATSDR 1989).

References

ATSDR 1989. Draft Toxicological Profile for Uranium and Compounds, U.S. Public Health Service, Atlanta, GA.

Bowen, H. J. M. 1979. Environmental Chemistry of the Elements, Academic Press: London, England.

D.4.4 CHEMICALS FOR WHICH NO EPA TOXICITY VALUES ARE AVAILABLE

Oral RfD values exist for all of the inorganic COPCs included in the BHHRA except lead. Provisional values are available for aluminum and iron. Oral RfDs exist for three out of the four organic COPCs included in the BHHRA, omitting total PAHs as BaPE.

Of the 19 inorganic COPCs included in the risk assessment, all except aluminum, barium, beryllium, and manganese lack inhalation RfD values. TCE was the only organic compound with an inhalation RfD value. Absorbed dose RfD values have been derived for all COPCs for which verified or provisional RfD values are available.

The only inorganic COPC for which an oral SF is available is arsenic. Oral SFs currently are available for three of the five organic compounds included in this assessment. These compounds are TCE, Total PCBs, and Total PAHs as BaPE.

EPA-approved (verified) inhalation SFs/carcinogenic unit risks are available for only a few of the COPCs. Inorganic COPCs with inhalation SFs are arsenic, beryllium, and cadmium. Organic COPCs with verified values are TCE, Total PCBs, and Total PAHs as BaPE. Each compound with an oral SF has an absorbed SF based on the GI absorption factor. All 12 radionuclide COPCs have oral, inhalation, and external exposure SFs.

D.4.5 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

Standard EPA RfDs and SFs were used to estimate potential noncarcinogenic and carcinogenic health effects from exposure to chemical contaminants detected at the SWOU. Considerable uncertainty is associated with the methodology applied to derive SFs and RfDs. EPA working groups review all relevant human and animal studies for each compound and select the studies pertinent to the derivation of the specific RfD and SF. These studies often involve data from experimental studies in animals, high exposure levels, and exposures under acute or occupational conditions. Extrapolation of these data to humans under low-dose, chronic conditions introduces uncertainties. The magnitude of these uncertainties is addressed by applying uncertainty factors to the dose response data for each applicable uncertainty. These factors are incorporated to provide a margin of safety for use in human health assessments.

The dose-response relationship between cancer and ionizing radiation has been evaluated in many reports. Derivation of risk factors is extrapolated from the cancer risk established using the Japanese Atomic Bomb Survivors database and a relative risk projection model. EPA methodology for estimating radionuclide carcinogenic risks is currently being reevaluated.

D.4.6 SUMMARY OF TOXICITY ASSESSMENT

A breakdown of the COPCs and their available toxicity information by site and by medium is provided in Table D.15.

Table D.15. Availability of Toxicity Information for COPCs by Medium

COPC	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	NSDD Hot Spot	NSDD, Excluding the Hot Spot	Within the Fence, Excluding the Hot Spots
Soil/Sediment													
Inorganic chemicals (metals)	14 / 15	16 / 17	15 / 16	15 / 16	15 / 15	12 / 12	16 / 17	16 / 17	17 / 18	17 / 18	17 / 18	18 / 19	18 / 19
Organic compounds	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4	4 / 4
Radionuclides	9 / 9	9 / 9	10 / 10	8 / 8	10 / 10	10 / 10	10 / 10	9 / 9	8 / 8	11 / 11	10 / 10	10 / 10	12 / 12
Surface Water													
Inorganic chemicals (metals)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organic compounds	NA	1 / 1	NA	NA	NA	NA	NA	NA	2 / 2	2 / 2	NA	1 / 1	NA
Radionuclides	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA – Medium not assessed for this location.
Values in this table are the number of COPCs with toxicity values for one or more routes of exposure over the total number of COPCs.

D.5. RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process. In this step, the information from the exposure and toxicity assessments is integrated to quantitatively estimate both carcinogenic health risks and noncarcinogenic hazard potential. For this assessment, risk is defined as the lifetime probability of excess cancer incidence for carcinogens and the estimate of exposure levels that may lead to toxic effects for noncarcinogens.

Risk characterization for the SWOU focuses on industrial workers, recreational users, and excavation workers. The current industrial worker and the current recreational user scenarios come the closest to representing the types of exposures that realistically could be anticipated for the narrow linear features (ditches) that comprise the OU. Future exposure scenarios for industrial workers, recreational users, and excavation workers were assessed using default exposure parameters in accordance with the Methods Document (DOE 2001). While a homestead residential scenario was not assessed (due to the physical features of the EUs) using the approach in the Methods Document, residential exposures are assessed via the recreational use scenario. Furthermore, residential risks are assessed in a semiquantitative fashion using comparisons to residential no action levels. This analysis is presented and discussed in Section 6, Uncertainties in the Risk Assessment.

D.5.1 DETERMINATION OF POTENTIAL FOR NONCANCER EFFECTS

Potential noncancer hazards are estimated through calculation of hazard quotients (HQ) and HIs. An HQ is defined as the threshold or “safe” exposure level for a single chemical. An HI is defined as the sum of two or more HQs.

In this risk assessment, the numeric estimate of the potential for noncancer effects is calculated as the ratio of CDI and RfD, calculated separately for each exposure pathway.

$$HQ = \frac{CDI}{RfD}$$

where

HQ = the hazard quotient, dimensionless
CDI = the CDI of a particular chemical, mg/kg-day
RfD = the chronic RfD for a particular chemical and pathway, mg/kg-day

(Note: Use of RfCs is similar for the inhalation pathway.)

Care is taken when performing this calculation to use the proper RfD for each estimate of CDI. For CDIs associated with ingestion, oral RfDs used typically are based on total amount of chemical ingested per exposure event. For CDIs associated with dermal contact, oral RfDs are used, but appropriate adjustments are made in the calculations to correct for the difference between oral and dermal absorption. Finally, for CDIs associated with inhalation, RfDs used typically are based on total amount of chemical inhaled per unit time. Further, RfDs appropriate for the duration of exposure are used. For all adult receptors, exposure duration is assumed to be greater than seven years; therefore, chronic RfDs were used. Seven years is EPA’s estimate for the minimum exposure duration that can be considered chronic. However, for all child receptors, regardless of duration, chronic RfDs also were used (EPA 1989; DOE 2001). Use of chronic RfDs for children, even in cases where exposure durations are less than seven years, is standard practice in EPA risk assessments, even though it may result in somewhat exaggerated estimates of noncancer hazards.

Potential noncancer hazards from exposure to multiple chemicals in the same exposure pathway is estimated by adding HQs for all COPCs associated with the pathway as the following equation: EPA 1989; DOE 2001):

$$Pathway\ HI\ =\ HQ,+HQ_2+HQ_3+...+HQ_n$$

where

Pathway HI = the sum of the individual chemical HQs, dimensionless
HQ, to HQ_n = the individual chemical HQs relevant to the pathway, dimensionless

Similarly, standard guidance (EPA 1989; DOE 2001) recommends summing pathway HIs for all pathways associated with a particular land use to develop a total HI.

$$Total\ HI\ =\ HI,+HI_2+HI_3+...+HI_n$$

where

Total HI = the sum of all pathways relevant to a single receptor, dimensionless
HI, to HI_n = the individual pathway HIs

Neither the HQ, the pathway HI, nor the total HI defines a dose-response relationship. That is, the magnitude of the HQ or HI does not represent a probability of incurring an adverse effect. If the HQ is less than 1, the estimated exposure to a substance typically is judged to be below a level that could present a human health hazard. If the HQ is greater than 1, a human health hazard may be present, depending on assumptions used to develop the CDI and assumptions used in deriving the RfD. Similarly, if the pathway HI is less than 1, exposure to multiple chemicals is not expected to represent a health hazard. If the pathway HI is greater than 1, exposure to multiple chemicals could represent a health hazard, depending on how chemicals actually interact in the body, details of which are seldom known. When an HI greater than 1 is observed, EPA guidance recommends recalculating HIs for groups of chemicals that affect the same target organ. Chemicals with similar targets in the body are thought more likely to interact. In cases where no organ-specific HI exceeds the target of 1, health hazards are assumed to be minimal, even if the HI that includes all COPCs for a site does exceed 1. Finally, if the total HI is less than 1, exposure to multiple chemicals over multiple pathways is not expected to represent a human health hazard. If the total HI is greater than 1, a hazard may be present, depending on the various factors listed above. Again, when an HI exceeds 1, target organ-specific HIs typically are calculated, and these latter estimates are assumed to be a better basis for evaluating noncancer hazards.

Uncertainties associated with combining of HQs across chemicals and exposure pathways are discussed in more detail in Section D.6.

D.5.2 DETERMINATION OF ELCR

Potential cancer risks are estimated by calculating ELCR. Generally, ELCR is defined as the incremental increase in the probability that a receptor may develop cancer as the result of exposure to chemicals and/or radionuclides.

D.5.2.1 Chemical Excess Lifetime Cancer Risk

The numeric estimate of the ELCR resulting from exposure to a single carcinogenic COPC is derived by multiplying the CDI by the chemical-specific SF as these calculations are performed separately for each exposure pathway.

$$\textit{Chemical-specific ELCR} = CDI \times SF$$

where

Chemical-specific ELCR = an estimate of the excess lifetime probability of developing cancer, dimensionless
CDI = the CDI of the chemical mg/kg-day
SF = the SF for the specific chemical (mg/kg-day)

As with the calculation used to derive HQs, care was taken when performing these calculations so that SFs were paired appropriately with exposure pathways. For CDIs associated with ingestion, SFs were based on total amount of COPCs ingested per day. For CDIs associated with dermal exposure, oral SFs were used, but calculations were adjusted to correct for the difference between oral and dermal absorption. Finally, for CDIs associated with inhalation exposure, SFs were used that are based on the total amount of COPCs inhaled per day.

Cancer risks associated with exposure to multiple chemicals are estimated by adding chemical-specific ELCRs of all carcinogenic COPCs associated with the exposure pathway (EPA 1989: DOE 2001).

$$\textit{Pathway ELCR} = ELCR, +ELCR_2 +ELCR_3 +...+ ELCR_n$$

where

Pathway ELCR = the sum of the chemical-specific ELCRs, dimensionless
ELCR to $ELCR_n$ = the chemical-specific ELCRs relevant to the pathway, dimensionless

Similarly, guidance (EPA 1989; DOE 2001) recommends adding pathway ELCRs for all pathways associated with a single land use. Total ELCR is not an actuarial estimate of an individual's probability of developing cancer. Instead, it provides some indication of possible cancer risks from potential cancer risks from exposure to multiple chemicals through multiple pathways.

$$\textit{Total ELCR} = ELCR_{P1} + ELCR_{P2} + ELCR_{P3} +... + ELCR_{Pn}$$

where

Total ELCR = the sum of all pathways relevant to a single receptor, dimensionless
$ELCR_{P1}$ to $ELCR_{p2}$ = the individual pathway ELCRs

The chemical-specific ELCR, the pathway ELCR, and total ELCR define a dose-response relationship. That is, an ELCR represents the increment increase in the risk of developing cancer under a given set of exposure assumptions. All exposure estimates for this assessment were developed under the concept of RME. Thus, all risk estimates are anticipated to fall well above the average and in the upper range of those that could be expected to occur. Typical risks will be substantially less.

Considerable uncertainties are associated with all quantitative estimates of cancer risk, and understanding these uncertainties is critical to interpretation and use of risk assessment information. These uncertainties are discussed in more detail in Section D.6.

D.5.2.2 Radionuclide Excess Lifetime Cancer Risk

Calculation of cancer risk due to exposure to radionuclides through ingestion or inhalation is conceptually similar to calculation of risks for chemical carcinogens. In performing these calculations, ELCR is calculated by multiplying the intake of the radionuclide by the route-specific cancer SF. This is represented by the following equation:

$$\text{Radionuclide-specific } ELCR = CDI \times SF$$

where

Radionuclide-specific ELCR = an estimate of the excess lifetime probability of developing cancer, dimensionless
CDI = the ingestion or inhalation CDI of the radionuclide, pCi
SF = the ingestion or inhalation slope factor for the specific radionuclide, risk/pCi

(Note: For external exposure, the units for CDI and SF are pCi-year/g and risk-g/pCi-year, respectively.)

As with the calculation used to derive chemical-specific ELCRs, care was taken when performing this calculation to ensure that the proper SF was used for each CDI.

Both the pathway ELCR for radionuclides and the total ELCR from exposure to multiple radionuclides within a pathway and across multiple pathways, respectively, are calculated as illustrated for chemical carcinogens in Section D.5.2. Uncertainties related to summing radionuclides with other nonradioactive chemicals to calculate a total ELCR are discussed in detail in Section D.6.

In this risk assessment, ELCRs due to exposure to chemicals and radionuclides were summed within pathways and across all pathways to indicate the potential health risk to a receptor that may be exposed to radionuclides and chemicals over all pathways. The uncertainties associated with combining radionuclide and chemical ELCRs are discussed in detail in Section D.6.

D.5.3 RISK CHARACTERIZATION FOR CURRENT/FUTURE LAND USE SCENARIOS AT CURRENT CONCENTRATIONS

This section presents risks associated with current/future land use (i.e., industrial) for EUs identified for the SWOU. Tables and discussions in this section provide the total HI or ELCR for each EU and identify major exposure routes and constituents that contribute to these risk estimates. Land use scenarios of concern, COCs, and POCs are discussed in Sections D.5.5.1, D.5.5.2, and D.5.5.3, respectively. Estimates presented in this section are total HIs and ELCRs for exposure to all COPCs and for exposure to soil/sediment and surface water. Risk calculations summarized in the tables and discussions in this section are presented in full in Attachment D5.

D.5.3.1 Noncancer Hazards

In this BHHRA, HIs for all receptor/land use combinations were estimated using the above methods and are discussed by receptor in the following sections. Table D.16 summarizes the HIs for each receptor at each EU.

As displayed in Table D.16, the total HI for current industrial workers, calculated using site-specific exposure assumptions, is less than or equal to 1 for all EUs.

HIs for future industrial workers and excavation workers calculated using default exposure assumptions are greater than 1 for all EUs based on contact with soil/sediment. Surface water HIs also exceeded the target HI of 1 for future industrial workers at two EUs. The total HI for a current child recreational user in the NSDD Hot Spot exceeded the target of 1, while the NSDD, Excluding the Hot Spot EUs, met the target of 1. The current child scenario is based on site-specific exposure assumptions. The total HI for future recreational users exceeded the target of 1 for both of the EUs.

Dermal contact with soil/sediment contributed the greatest amount to the total HI for the future industrial worker (Table D.17). Both dermal contact and ingestion contributed significantly to noncancer risk for the excavation worker. Dermal contact with soil/sediment dominated the risk estimates for all future recreational receptors.

Several COPCs made significant contributions to noncancer hazards. Total PCBs, antimony, iron, and uranium in soil/sediment and PCBs in surface water were major contributors for noncancer risk to future industrial workers and excavation workers. Antimony and uranium were major contributors for noncancer risk along with iron to future recreational users as well.

D.5.3.2 Excess Lifetime Cancer Risk

As shown in Table D.18, total ELCR associated with current industrial workers exceeded 1E-06 in all EUs, with two EUs (Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot) exceeding 1E-04. For current industrial workers, estimated ELCRs associated with surface water contact were within the risk range of 1E-06 to 1E-04 at three EUs (Outfall 001 EU 14 Hot Spot, Outfall 011 Hot Spot, and Within the Fence, Exluding the Hot Spots). For future industrial workers, estimated ELCRs for all EUs exceeded 1E-06, with six EUs with ELCRs greater than 1E-04 based on contact with soil/sediment. For future industrial workers, estimated ELCRs associated with surface water contact were within the risk range of 1E-06 to 1E-04 at five EUs (Outfall 001 EU 14 Hot Spot, Outfall 011 Hot Spot, Outfall 015 Hot Spot, Within the Fence, Excluding the Hot Spots, and NSDD, Excluding the Hot Spot). For excavation workers, all EUs estimated ELCRs exceeded 1E-06, with seven EUs with an ELCR greater than 1E-04 based on contact with soil/sediment. None of the ELCR estimates associated with either current or future recreational users exceeded EPA’s upper risk limit of 1E-04.

Dermal contact is the most important exposure route for cancer risk for current and future industrial workers (Table D.19). Both dermal contact and ingestion contributed significantly to cancer risk for excavation workers. The dermal pathway dominated cancer risks for all recreational receptors.

Chemicals that had the greatest contributions to cancer risk to current and future industrial workers were Total PAHs as BaPE and Total PCBs. Total PAHs as BaPE and Total PCBs also were the greatest contributor to cancer risk associated with the excavation worker, along with thorium-230.

Table D.16. Hazard Index Risk Summary

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Adult			
EU 13	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	3.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	1.E+00	100%	
	Total Risk =	1.E+00		No
Outfall 001	Recreational Adult			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Teen			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-01	83%	
	Surface Water	1.E-01	17%	
	Total Risk =	9.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	83%	
	Surface Water	3.E+00	17%	
	Total Risk =	2.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 001	Recreational Adult			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Current Recreational Child			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	1.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+00		No
	Future Industrial Worker			
	Soil	3.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E+01		**Yes**
	Excavation Worker			
	Soil	3.E+01	100%	
	Total Risk =	3.E+01		**Yes**
Outfall 001	Recreational Adult			
EU 16	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Future Recreational Child			
EU 16	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	7.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 001	Recreational Adult			
EU 18	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001 EU 18 Hot Spot (Cont.)	Current Industrial Worker			
	Soil	3.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	5.E+00	100%	
	Total Risk =	5.E+00		**Yes**
Outfall 001 EU 20 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-01		No
	Future Industrial Worker			
	Soil	4.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	4.E+00		**Yes**

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001 EU 20 Hot Spot (Cont.)	Excavation Worker			
	Soil	3.E+00	100%	
	Total Risk =	3.E+00		**Yes**
Outfall 008 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	9.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	9.E-01		No
	Future Industrial Worker			
	Soil	2.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E+01		**Yes**
	Excavation Worker			
	Soil	2.E+01	100%	
	Total Risk =	2.E+01		**Yes**
Outfall 010 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 010 Hot Spot (Cont.)	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	6.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	6.E-01		No
	Future Industrial Worker			
	Soil	1.E+01	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 011 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 011 Hot Spot (Cont.)	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	6.E-01	61%	
	Surface Water	4.E-01	39%	
	Total Risk =	1.E+00		No
	Future Industrial Worker			
	Soil	1.E+01	96%	
	Surface Water	4.E-01	4%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Outfall 015 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 015 Hot Spot (Cont.)	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-01	95%	
	Surface Water	3.E-02	5%	
	Total Risk =	5.E-01		No
	Future Industrial Worker			
	Soil	9.E+00	95%	
	Surface Water	5.E-01	5%	
	Total Risk =	1.E+01		**Yes**
	Excavation Worker			
	Soil	1.E+01	100%	
	Total Risk =	1.E+01		**Yes**
Within the Fence, Excluding the Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Within the Fence, Excluding the Hot Spot (Cont.)	Current Industrial Worker			
	Soil	3.E-01	66%	
	Surface Water	1.E-01	34%	
	Total Risk =	4.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	66%	
	Surface Water	3.E+00	34%	
	Total Risk =	8.E+00		**Yes**
	Excavation Worker			
	Soil	5.E+00	100%	
	Total Risk =	5.E+00		**Yes**
NSDD Hot Spot	Recreational Adult			
	Sediment	2.E+00	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	2.E+00		**Yes**
	Recreational Teen			
	Sediment	1.E+01	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	1.E+01		**Yes**
	Current Recreational Child			
	Sediment	2.E+00	99%	
	Game	1.E-02	1%	
	Surface Water	NC	0%	
	Total Risk =	2.E+00		**Yes**
	Future Recreational Child			
	Sediment	2.E+01	100%	
	Game	1.E-02	0%	
	Surface Water	NC	0%	
	Total Risk =	2.E+01		**Yes**
	Current Industrial Worker			
	Soil	4.E-01	100%	
	Surface Water	NC	0%	
	Total Risk =	4.E-01		No
	Future Industrial Worker			
	Soil	8.E+00	100%	
	Surface Water	NC	0%	
	Total Risk =	8.E+00		**Yes**

Table D.16. Hazard Index Risk Summary (Continued)

EU	Receptor	HI by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD Hot Spot (Cont.)	Excavation Worker			
	Soil	9.E+00	100%	
	Total Risk =	9.E+00		**Yes**
NSDD, Excluding the Hot Spot	Recreational Adult			
	Sediment	2.E+00	99%	
	Game	1.E-02	1%	
	Surface Water	5.E-11	0%	
	Total Risk =	2.E+00		**Yes**
	Recreational Teen			
	Sediment	7.E+00	100%	
	Game	8.E-03	0%	
	Surface Water	2.E-10	0%	
	Total Risk =	7.E+00		**Yes**
	Current Recreational Child			
	Sediment	1.E+00	99%	
	Game	9.E-03	1%	
	Surface Water	3.E-11	0%	
	Total Risk =	1.E+00		No
	Future Recreational Child			
	Sediment	1.E+01	100%	
	Game	9.E-03	0%	
	Surface Water	3.E-10	0%	
	Total Risk =	1.E+01		**Yes**
	Current Industrial Worker			
	Soil	3.E-01	100%	
	Surface Water	6.E-12	0%	
	Total Risk =	3.E-01		No
	Future Industrial Worker			
	Soil	5.E+00	100%	
	Surface Water	1.E-10	0%	
	Total Risk =	5.E+00		**Yes**
	Excavation Worker			
	Soil	2.E+00	100%	
	Total Risk =	2.E+00		**Yes**

NC: No COCs selected.

NE: Exposure to the media was not evaluated because the pathway is not complete. A fence surrounds the outfalls, precluding recreational exposure.

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway

Current Industrial Worker- Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 008 Hot Spot	5.11E-02	8.17E-01	1.36E-05	NA	8.68E-01
% Risk by Pathway	6%	94%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 010 Hot Spot	3.12E-02	5.78E-01	1.11E-05	NA	6.09E-01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 011 Hot Spot	3.60E-02	6.07E-01	1.70E-05	NA	6.43E-01
% Risk by Pathway	6%	94%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 015 Hot Spot	4.71E-02	4.67E-01	1.45E-05	NA	5.14E-01
% Risk by Pathway	9%	91%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 13 Hot Spot	9.79E-03	2.94E-01	2.13E-05	NA	3.04E-01
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 14 Hot Spot	3.37E-02	6.91E-01	1.03E-05	NA	7.25E-01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 15 Hot Spot	1.05E-01	1.32E+00	1.01E-05	NA	1.43E+00
% Risk by Pathway	7%	93%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 16 Hot Spot	2.26E-02	7.16E-01	3.91E-05	NA	7.39E-01
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 18 Hot Spot	9.73E-03	2.82E-01	2.94E-06	NA	2.92E-01
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 20 Hot Spot	4.61E-03	2.18E-01	1.36E-05	NA	2.23E-01
% Risk by Pathway	2%	98%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Within the Fence, Excluding Hot Spots	1.33E-02	2.78E-01	1.02E-05	NA	2.91E-01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	2.20E-02	3.99E-01	1.22E-05	NA	4.21E-01
% Risk by Pathway	5%	95%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Current Industrial Worker- Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	1.17E-02	2.60E-01	1.27E-05	NA	2.72E-01
% Risk by Pathway	4%	96%	0%	0%	

Current Industrial Worker - Surface Water

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 008 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 010 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 011 Hot Spot	NA	4.08E-01	NA	NA	4.08E-01
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 015 Hot Spot	NA	2.78E-02	NA	NA	2.78E-02
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 13 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 14 Hot Spot	NA	1.48E-01	NA	NA	1.48E-01
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 15 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 16 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 18 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 20 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Within the Fence, Excluding Hot Spots	NA	1.48E-01	NA	NA	1.48E-01
% Risk by Pathway	0%	100%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Current Industrial Worker - Surface Water (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	6.06E-12	NA	NA	6.06E-12
% Risk by Pathway	0%	100%	0%	0%	

Future Industrial Worker- Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 008 Hot Spot	9.12E-01	1.46E+01	2.43E-04	NA	1.55E+01
% Risk by Pathway	6%	94%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 010 Hot Spot	5.57E-01	1.03E+01	1.98E-04	NA	1.09E+01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 011 Hot Spot	6.43E-01	1.08E+01	3.03E-04	NA	1.15E+01
% Risk by Pathway	6%	94%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 015 Hot Spot	8.40E-01	8.34E+00	2.59E-04	NA	9.18E+00
% Risk by Pathway	9%	91%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 13 Hot Spot	1.75E-01	4.65E+00	3.79E-04	NA	4.83E+00
% Risk by Pathway	4%	96%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 14 Hot Spot	6.02E-01	1.23E+01	1.84E-04	NA	1.29E+01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 15 Hot Spot	1.87E+00	2.35E+01	1.80E-04	NA	2.54E+01
% Risk by Pathway	7%	93%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 16 Hot Spot	4.03E-01	1.28E+01	6.96E-04	NA	1.32E+01
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 18 Hot Spot	1.74E-01	5.04E+00	5.24E-05	NA	5.21E+00
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 20 Hot Spot	8.23E-02	3.88E+00	2.43E-04	NA	3.97E+00
% Risk by Pathway	2%	98%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Future Industrial Worker - Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Within the Fence, Excluding Hot Spots	2.37E-01	4.96E+00	1.81E-04	NA	5.20E+00
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	3.93E-01	7.12E+00	2.17E-04	NA	7.51E+00
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	2.09E-01	4.56E+00	2.26E-04	NA	4.77E+00
% Risk by Pathway	4%	96%	0%	0%	

Future Industrial Worker - Surface Water

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 008 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 010 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 011 Hot Spot	NA	4.29E-01	NA	NA	4.29E-01
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 015 Hot Spot	NA	4.95E-01	NA	NA	4.95E-01
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 13 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 14 Hot Spot	NA	2.62E+00	NA	NA	2.62E+00
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 15 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 16 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Future Industrial Worker - Surface Water (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 18 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 20 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Within the Fence, Excluding Hot Spots	NA	2.62E+00	NA	NA	2.62E+00
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	1.08E-10	NA	NA	1.08E-10
% Risk by Pathway	0%	100%	0%	0%	

Excavation Worker- Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 008 Hot Spot	6.49E+00	1.08E+01	1.80E-04	NA	1.73E+01
% Risk by Pathway	38%	62%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 010 Hot Spot	3.96E+00	7.61E+00	1.46E-04	NA	1.16E+01
% Risk by Pathway	34%	66%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 011 Hot Spot	4.57E+00	8.00E+00	2.24E-04	NA	1.26E+01
% Risk by Pathway	36%	64%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 015 Hot Spot	5.98E+00	6.16E+00	1.92E-04	NA	1.21E+01
% Risk by Pathway	49%	51%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 13 Hot Spot	1.24E+00	1.42E-01	2.80E-04	NA	1.38E+00
% Risk by Pathway	90%	10%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 14 Hot Spot	4.32E+00	9.89E+00	1.39E-04	NA	1.42E+01
% Risk by Pathway	30%	70%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 15 Hot Spot	1.33E+01	1.74E+01	1.33E-04	NA	3.07E+01
% Risk by Pathway	43%	57%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Excavation Worker- Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 16 Hot Spot	2.87E+00	9.43E+00	5.15E-04	NA	1.23E+01
% Risk by Pathway	23%	77%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 18 Hot Spot	1.24E+00	3.72E+00	3.06E-04	NA	4.96E+00
% Risk by Pathway	25%	75%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Outfall 001 EU 20 Hot Spot	5.85E-01	2.87E+00	1.80E-04	NA	3.46E+00
% Risk by Pathway	17%	83%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
Within the Fence, Excluding Hot Spots	1.69E+00	3.66E+00	1.34E-04	NA	5.35E+00
% Risk by Pathway	32%	68%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	2.81E+00	5.81E+00	1.42E-04	NA	8.62E+00
% Risk by Pathway	33%	67%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	1.90E+00	9.93E-02	1.65E-04	NA	2.00E+00
% Risk by Pathway	95%	5%	0%	0%	

Recreational User- Sediment- Adult

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	6.77E-02	2.37E+00	5.62E-05	NA	2.44E+00
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	3.62E-02	1.57E+00	5.86E-05	NA	1.61E+00
% Risk by Pathway	2%	98%	0%	0%	

Recreational User- Surface Water- Adult

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	4.87E-11	NA	NA	4.87E-11
% Risk by Pathway	0%	100%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Recreational User- Game- Adult

	Deer	**Quail**	**Rabbit**	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD Hot Spot	6.37E-04	4.62E-03	6.90E-03	1.22E-02
% Risk by Pathway	5%	38%	57%	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD, Excluding the Hot Spot	4.41E-04	4.47E-03	4.84E-03	9.75E-03
% Risk by Pathway	5%	46%	50%	

Recreational User- Sediment- Teen

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	1.48E-01	1.10E+01	1.24E-04	NA	1.11E+01
% Risk by Pathway	1%	99%	0%	0%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	7.94E-02	7.28E+00	1.29E-04	NA	7.36E+00
% Risk by Pathway	1%	99%	0%	0%	

Recreational User- Surface Water- Teen

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	1.70E-10	NA	NA	1.70E-10
% Risk by Pathway	0%	100%	0%	0%	

Recreational User- Game- Teen

	Deer	**Quail**	**Rabbit**	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD Hot Spot	1.04E-03	3.84E-03	5.58E-03	1.05E-02
% Risk by Pathway	10%	37%	53%	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD, Excluding the Hot Spot	7.19E-04	3.72E-03	3.92E-03	8.36E-03
% Risk by Pathway	9%	45%	47%	

Current Recreational User- Sediment- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	5.03E-01	1.18E+00	2.09E-05	NA	1.68E+00
% Risk by Pathway	30%	70%	0%	0%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	2.69E-01	7.78E-01	2.18E-05	NA	1.05E+00
% Risk by Pathway	26%	74%	0%	0%	

Table D.17. Noncancer Risk Summary by Receptor, EU and Pathway (Continued)

Current Recreational User- Surface Water- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	2.79E-11	NA	NA	2.79E-11
% Risk by Pathway	0%	100%	0%	0%	

Future Recreational User- Sediment- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	8.78E-01	1.65E+01	3.66E-04	NA	1.74E+01
% Risk by Pathway	5%	95%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	4.70E-01	1.09E+01	3.81E-04	NA	1.14E+01
% Risk by Pathway	4%	96%	0%	0%	

Future Recreational User- Surface Water- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total HI
NSDD, Excluding the Hot Spot	NA	2.54E-10	NA	NA	2.54E-10
% Risk by Pathway	0%	100%	0%	0%	

Current/Future Recreational User- Game- Child

	Deer	**Quail**	**Rabbit**	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD Hot Spot	6.74E-04	4.47E-03	6.65E-03	1.18E-02
% Risk by Pathway	6%	38%	56%	

Exposure Pathway	Ingestion	Ingestion	Ingestion	Total HI
NSDD, Excluding the Hot Spot	4.66E-04	4.32E-03	4.66E-03	9.45E-03
% Risk by Pathway	5%	46%	49%	

NA: The pathway is not complete, therefore no risk has been calculated.
NC: No COCs selected.

Table D.18. Excess Lifetime Cancer Risk Summary

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Adult			
EU 13	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	8.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	8.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Teen			
EU 14	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-04	99%	
	Surface Water	3.E-06	1%	
	Total Risk =	5.E-04		**Yes**
	Future Industrial Worker			
	Soil	9.E-03	99%	
	Surface Water	5.E-05	1%	
	Total Risk =	9.E-03		**Yes**
	Excavation Worker			
	Soil	2.E-03	100%	
	Total Risk =	2.E-03		**Yes**
Outfall 001	Recreational Adult			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Current Recreational Child			
EU 15	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
(Cont.)	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	3.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-05		**Yes**
	Future Industrial Worker			
	Soil	5.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-04		**Yes**
	Excavation Worker			
	Soil	6.E-04	100%	
	Total Risk =	6.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 16	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001				
EU 16	Future Industrial Worker			
Hot Spot	Soil	1.E-04	100%	
(Cont.)	Surface Water	NC	0%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 001	Recreational Adult			
EU 18	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 001	Recreational Adult			
EU 20	Sediment	NE	0%	
Hot Spot	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	100%	
	Surface Water	NC	0%	
	Total Risk =	5.E-06		**Yes**
	Future Industrial Worker			
	Soil	9.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	9.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
Outfall 008	Recreational Adult			
Hot Spot	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 008 Hot Spot (Cont.)	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	1.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-05		**Yes**
	Future Industrial Worker			
	Soil	3.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-04		**Yes**
	Excavation Worker			
	Soil	3.E-04	100%	
	Total Risk =	3.E-04		**Yes**
Outfall 010 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 010 Hot Spot (Cont.)	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-05		**Yes**
	Future Industrial Worker			
	Soil	3.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	3.E-04		**Yes**
	Excavation Worker			
	Soil	3.E-04	100%	
	Total Risk =	3.E-04		**Yes**
Outfall 011 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	2.E-04	92%	
	Surface Water	1.E-05	8%	
	Total Risk =	2.E-04		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Outfall 011 Hot Spot (Cont.)	Future Industrial Worker			
	Soil	3.E-03	100%	
	Surface Water	1.E-05	0%	
	Total Risk =	3.E-03		**Yes**
	Excavation Worker			
	Soil	3.E-03	100%	
	Total Risk =	3.E-03		**Yes**
Outfall 015 Hot Spot	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	7.E-06	93%	
	Surface Water	5.E-07	7%	
	Total Risk =	7.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	93%	
	Surface Water	9.E-06	7%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	2.E-04	100%	
	Total Risk =	2.E-04		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
Within the Fence, Excluding the Hot Spots	Recreational Adult			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Recreational Teen			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Future Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Recreational Child			
	Sediment	NE	0%	
	Game	NE	0%	
	Surface Water	NE	0%	
	Total Risk =	NE		No
	Current Industrial Worker			
	Soil	5.E-06	70%	
	Surface Water	2.E-06	30%	
	Total Risk =	8.E-06		**Yes**
	Future Industrial Worker			
	Soil	1.E-04	70%	
	Surface Water	4.E-05	30%	
	Total Risk =	1.E-04		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**
NSDD Hot Spot	Recreational Adult			
	Sediment	5.E-05	99%	
	Game	3.E-07	1%	
	Surface Water	NC	0%	
	Total Risk =	5.E-05		**Yes**
	Recreational Teen			
	Sediment	7.E-05	100%	
	Game	1.E-07	0%	
	Surface Water	NC	0%	
	Total Risk =	7.E-05		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD Hot Spot (Cont.)	Future Recreational Child			
	Sediment	5.E-05	100%	
	Game	4.E-08	0%	
	Surface Water	NC	0%	
	Total Risk =	5.E-05		**Yes**
	Current Recreational Child			
	Sediment	1.E-06	96%	
	Game	4.E-08	4%	
	Surface Water	NC	0%	
	Total Risk =	1.E-06		No
	Current Industrial Worker			
	Soil	1.E-05	100%	
	Surface Water	NC	0%	
	Total Risk =	1.E-05		**Yes**
	Future Industrial Worker			
	Soil	2.E-04	100%	
	Surface Water	NC	0%	
	Total Risk =	2.E-04		**Yes**
	Excavation Worker			
	Soil	4.E-04	100%	
	Total Risk =	4.E-04		**Yes**
NSDD, Excluding the Hot Spot	Recreational Adult			
	Sediment	3.E-05	96%	
	Game	2.E-07	1%	
	Surface Water	9.E-07	3%	
	Total Risk =	3.E-05		**Yes**
	Recreational Teen			
	Sediment	6.E-05	97%	
	Game	8.E-08	0%	
	Surface Water	2.E-06	3%	
	Total Risk =	6.E-05		**Yes**
	Future Recreational Child			
	Sediment	4.E-05	97%	
	Game	4.E-08	0%	
	Surface Water	1.E-06	3%	
	Total Risk =	4.E-05		**Yes**

Table D.18. Excess Lifetime Cancer Risk Summary (Continued)

EU	Receptor	ELCR by Media	Percentage of Risk by Media	Exceeds Risk Limit?
NSDD, Excluding the Hot Spot (Cont.)	Current Recreational Child			
	Sediment	7.E-07	92%	
	Game	4.E-08	5%	
	Surface Water	2.E-08	3%	
	Total Risk =	8.E-07		No
	Current Industrial Worker			
	Soil	5.E-06	98%	
	Surface Water	1.E-07	2%	
	Total Risk =	6.E-06		**Yes**
	Future Industrial Worker			
	Soil	9.E-05	97%	
	Surface Water	2.E-06	3%	
	Total Risk =	9.E-05		**Yes**
	Excavation Worker			
	Soil	1.E-04	100%	
	Total Risk =	1.E-04		**Yes**

NC: No COCs selected.

NE: Exposure to the media was not evaluated because the pathway is not complete. A fence surrounds the outfalls, precluding recreational exposure.

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway

Current Industrial Worker - Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 008 Hot Spot	1.17E-06	1.20E-05	6.58E-10	1.34E-06	1.45E-05
% Risk by Pathway	8%	83%	0%	9%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 010 Hot Spot	8.31E-07	1.41E-05	8.48E-11	6.74E-07	1.56E-05
% Risk by Pathway	5%	90%	0%	4%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 011 Hot Spot	4.55E-06	1.53E-04	1.20E-10	9.61E-07	1.59E-04
% Risk by Pathway	3%	97%	0%	1%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 015 Hot Spot	5.49E-07	4.04E-06	4.25E-10	2.03E-06	6.62E-06
% Risk by Pathway	8%	61%	0%	31%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 13 Hot Spot	2.93E-07	4.17E-06	9.17E-11	8.17E-07	5.28E-06
% Risk by Pathway	6%	79%	0%	15%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 14 Hot Spot	1.37E-05	4.80E-04	1.24E-10	7.91E-07	4.94E-04
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 15 Hot Spot	1.62E-06	2.79E-05	1.33E-10	7.23E-07	3.02E-05
% Risk by Pathway	5%	92%	0%	2%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 16 Hot Spot	3.03E-07	5.06E-06	4.86E-11	1.66E-08	5.38E-06
% Risk by Pathway	6%	94%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 18 Hot Spot	3.24E-07	3.66E-06	1.74E-10	1.41E-06	5.39E-06
% Risk by Pathway	6%	68%	0%	26%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 20 Hot Spot	2.45E-07	3.65E-06	8.94E-11	1.37E-06	5.27E-06
% Risk by Pathway	5%	69%	0%	26%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Within the Fence, Excluding Hot Spots	2.12E-07	3.29E-06	5.86E-11	1.88E-06	5.38E-06
% Risk by Pathway	4%	61%	0%	35%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	2.36E-06	3.82E-06	3.51E-09	5.25E-06	1.14E-05
% Risk by Pathway	21%	33%	0%	46%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Current Industrial Worker - Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	4.90E-07	3.93E-06	5.05E-10	1.02E-06	5.44E-06
% Risk by Pathway	9%	72%	0%	19%	

Current Industrial Worker - Surface Water

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 008 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 010 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 011 Hot Spot	NA	1.38E-05	NA	NA	1.38E-05
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 015 Hot Spot	NA	5.20E-07	NA	NA	5.20E-07
% of Total	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 13 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 14 Hot Spot	NA	2.84E-06	NA	NA	2.84E-06
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 15 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 16 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 18 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 20 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Current Industrial Worker - Surface Water (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Within the Fence, Excluding Hot Spots	NA	2.29E-06	NA	NA	2.29E-06
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	1.28E-07	NA	NA	1.28E-07
% Risk by Pathway	0%	100%	0%	0%	

Future Industrial Worker - Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 008 Hot Spot	2.10E-05	2.14E-04	1.17E-08	2.39E-05	2.59E-04
% Risk by Pathway	8%	83%	0%	9%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 010 Hot Spot	1.49E-05	2.52E-04	1.51E-09	1.20E-05	2.79E-04
% Risk by Pathway	5%	90%	0%	4%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 011 Hot Spot	8.13E-05	2.72E-03	2.14E-09	1.71E-05	2.82E-03
% Risk by Pathway	3%	97%	0%	1%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 015 Hot Spot	9.82E-06	7.21E-05	7.59E-09	3.63E-05	1.18E-04
% Risk by Pathway	8%	61%	0%	31%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 13 Hot Spot	5.23E-06	5.96E-05	1.64E-09	1.46E-05	7.94E-05
% Risk by Pathway	7%	75%	0%	18%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 14 Hot Spot	2.45E-04	8.56E-03	2.22E-09	1.41E-05	8.82E-03
% Risk by Pathway	3%	97%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 15 Hot Spot	2.90E-05	4.97E-04	2.38E-09	1.29E-05	5.39E-04
% Risk by Pathway	5%	92%	0%	2%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 16 Hot Spot	5.43E-06	9.03E-05	8.68E-10	2.96E-07	9.60E-05
% Risk by Pathway	6%	94%	0%	0%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Future Industrial Worker - Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 18 Hot Spot	5.79E-06	6.52E-05	3.11E-09	2.51E-05	9.61E-05
% Risk by Pathway	6%	68%	0%	26%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 20 Hot Spot	4.39E-06	6.51E-05	1.60E-09	2.44E-05	9.39E-05
% Risk by Pathway	5%	69%	0%	26%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Within the Fence, Excluding Hot Spots	3.79E-06	5.87E-05	1.05E-09	3.36E-05	9.61E-05
% Risk by Pathway	4%	61%	0%	35%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	4.22E-05	6.81E-05	6.27E-08	9.38E-05	2.04E-04
% Risk by Pathway	21%	33%	0%	46%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	8.77E-06	6.11E-05	9.03E-09	1.82E-05	8.81E-05
% Risk by Pathway	10%	69%	0%	21%	

Future Industrial Worker - Surface Water

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 008 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 010 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 011 Hot Spot	NA	1.18E-05	NA	NA	1.18E-05
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 015 Hot Spot	NA	9.28E-06	NA	NA	9.28E-06
% of Total	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 13 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 14 Hot Spot	NA	5.06E-05	NA	NA	5.06E-05
% Risk by Pathway	0%	100%	0%	0%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Future Industrial Worker - Surface Water (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 15 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 16 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 18 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 20 Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Within the Fence, Excluding Hot Spots	NA	4.09E-05	NA	NA	4.09E-05
% Risk by Pathway	0%	100%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	2.29E-06	NA	NA	2.29E-06
% Risk by Pathway	0%	100%	0%	0%	

Excavation Worker - Soil

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 008 Hot Spot	1.49E-04	1.58E-04	8.69E-09	1.77E-05	3.25E-04
% Risk by Pathway	46%	49%	0%	5%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 010 Hot Spot	1.05E-04	1.86E-04	1.12E-09	8.90E-06	3.00E-04
% Risk by Pathway	35%	62%	0%	3%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 011 Hot Spot	5.76E-04	2.01E-03	1.58E-09	1.27E-05	2.60E-03
% Risk by Pathway	22%	77%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 015 Hot Spot	6.96E-05	5.34E-05	5.62E-09	2.69E-05	1.50E-04
% Risk by Pathway	46%	36%	0%	18%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Excavation Worker - Soil (continued)

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 13 Hot Spot	3.71E-05	5.51E-05	1.21E-09	1.08E-05	1.03E-04
% Risk by Pathway	36%	53%	0%	10%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 14 Hot Spot	1.73E-03	7.73E-06	1.74E-09	1.17E-05	1.75E-03
% Risk by Pathway	99%	0%	0%	1%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 15 Hot Spot	2.05E-04	3.68E-04	1.76E-09	9.55E-06	5.83E-04
% Risk by Pathway	35%	63%	0%	2%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 16 Hot Spot	3.85E-05	6.68E-05	6.42E-10	2.19E-07	1.06E-04
% Risk by Pathway	36%	63%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 18 Hot Spot	4.11E-05	4.83E-05	2.30E-09	1.86E-05	1.08E-04
% Risk by Pathway	38%	45%	0%	17%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Outfall 001 EU 20 Hot Spot	3.11E-05	4.82E-05	1.18E-09	1.80E-05	9.73E-05
% Risk by Pathway	32%	50%	0%	18%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
Within the Fence, Excluding Hot Spots	2.69E-05	4.35E-05	7.84E-10	2.54E-05	9.58E-05
% Risk by Pathway	28%	45%	0%	27%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	2.77E-04	3.83E-05	4.49E-08	4.55E-05	3.61E-04
% Risk by Pathway	77%	11%	0%	13%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	6.33E-05	5.19E-05	6.90E-09	1.41E-05	1.29E-04
% Risk by Pathway	49%	40%	0%	11%	

Recreational User- Sediment- Adult

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	6.39E-06	2.03E-05	1.42E-08	2.12E-05	4.79E-05
% Risk by Pathway	13%	42%	0%	44%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	1.34E-06	2.09E-05	2.07E-09	4.14E-06	2.64E-05
% Risk by Pathway	5%	79%	0%	16%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Recreational User- Surface Water- Adult

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	9.09E-07	NA	NA	9.09E-07
% Risk by Pathway	0%	100%	0%	0%	

Recreational User- Game- Adult

	Deer	**Quail**	**Rabbit**	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD Hot Spot	9.30E-10	2.87E-07	1.03E-08	2.98E-07
% Risk by Pathway	0%	96%	3%	

Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD, Excluding the Hot Spot	1.27E-10	1.73E-07	1.41E-09	1.75E-07
% Risk by Pathway	0%	99%	1%	

Recreational User-Sediment- Teen

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	4.95E-06	5.13E-05	1.05E-08	1.56E-05	7.19E-05
% Risk by Pathway	7%	71%	0%	22%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	1.23E-06	5.28E-05	1.54E-09	3.05E-06	5.71E-05
% Risk by Pathway	2%	92%	0%	5%	

Recreational User-Surface Water- Teen

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	1.72E-06	NA	NA	1.72E-06
% Risk by Pathway	0%	100%	0%	0%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Recreational User- Game- Teen

	Deer	Quail	Rabbit	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD Hot Spot	5.14E-10	1.02E-07	2.79E-09	1.05E-07
% Risk by Pathway	0%	97%	3%	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD, Excluding the Hot Spot	6.92E-11	7.50E-08	3.81E-10	7.55E-08
% Risk by Pathway	0%	99%	1%	

Current Recreational User- Sediment- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	5.34E-07	4.58E-07	5.04E-11	9.32E-08	1.09E-06
% Risk by Pathway	49%	42%	0%	9%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	2.36E-07	4.72E-07	7.99E-12	1.82E-08	7.26E-07
% Risk by Pathway	32%	65%	0%	3%	

Current Recreational User- Surface Water- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	2.36E-08	NA	NA	2.36E-08
% Risk by Pathway	0%	100%	0%	0%	

Future Recreational User- Sediment- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	6.29E-06	3.84E-05	5.30E-09	7.83E-06	5.25E-05
% Risk by Pathway	12%	73%	0%	15%	
Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	2.48E-06	3.95E-05	8.38E-10	1.53E-06	4.35E-05
% Risk by Pathway	6%	91%	0%	4%	

Table D.19. Cancer Risk Summary by Receptor, EU, and Pathway (Continued)

Future Recreational User- Surface Water- Child

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD Hot Spot	NA	NA	NA	NA	0.00E+00
% Risk by Pathway	0%	0%	0%	0%	

Exposure Pathway	Ingestion	Dermal	Inhalation	External Exposure	Total ELCR
NSDD, Excluding the Hot Spot	NA	1.29E-06	NA	NA	1.29E-06
% Risk by Pathway	0%	100%	0%	0%	

Current/Future Recreational User- Game- Child

	Deer	**Quail**	**Rabbit**	
Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD Hot Spot	5.72E-11	4.22E-08	5.62E-10	4.28E-08
% Risk by Pathway	0%	99%	1%	

Exposure Pathway	Ingestion	Ingestion	Ingestion	Total ELCR
NSDD, Excluding the Hot Spot	7.59E-12	4.02E-08	7.67E-11	4.03E-08
% Risk by Pathway	0%	100%	0%	

NA: The pathway is not complete, therefore no risk has been calculated.
NC: No COCs selected.

D.5.4 NONCANCER HAZARDS AND CANCER RISK SUMMARIZED BY RECEPTOR AND PATHWAY

This section presents noncancer risk (hazards) and cancer risks summarized by primary pathway(s) and primary risk drivers (COPCs that contribute most to potential risks) for current/future land uses (i.e., industrial, recreational, and excavation) for SWOU EUs. Only those risks with an HI greater than 1 or an ELCR greater than 1E-04 are discussed below to highlight those areas that pose the most significant risk. All risk calculations are provided in Attachment D5.

D.5.4.1 Noncancer Hazards

HIs for COPCs are summarized below for each land use scenario and exposure pathway.

D.5.4.1.1 Current industrial worker

All calculated hazards for current industrial workers were at or below a cumulative HI estimate of 1 for all contact exposures associated with soil/sediment and for surface water for each of the SWOU EUs. The hazard estimates for current industrial workers were based on site-specific exposure assumptions. The current industrial worker risk calculations for soil/sediment are presented in Tables D5.1 through D5.13. The current industrial worker risk calculations for surface water are presented in Tables D5.14 through D5.26.

D.5.4.1.2 Future industrial worker

A cumulative HI estimate greater than 1 was estimated for each of the SWOU EUs for future industrial workers based on default exposure assumptions. HIs exceeded 1 for exposures associated with soil/sediment contact at each EU and with dermal contact with surface water at two EUs. Hazards are summarized below.

Soil/Sediment. Dermal risk at Outfall 008 presented 94% of the cumulative hazard estimate of 20. For the dermal exposure route, Total PCBs was the leading contributor to risk with a dermal HI of 10, followed by antimony (3), as presented in Table D5.27.

Dermal risk at Outfall 010 presented 95% of the cumulative hazard estimate of 10. Total PCBs was the leading contributor to risk with a dermal HI of 6, followed by antimony (3), as presented in Table D5.28.

Dermal risk at Outfall 011 presented 94% of the cumulative hazard estimate of 10. Antimony was the leading contributor to risk with a dermal HI of 5, followed by Total PCBs (3), and uranium (2), as presented in Table D5.29.

Dermal risk at Outfall 015 presented 91% of the cumulative hazard estimate of 9. For the dermal exposure route, uranium was the leading contributor to risk with a dermal HI of 4, followed by antimony (3), as presented in Table D5.30.

Dermal risk at Outfall 001 EU 13 Hot Spot presented 96% of the cumulative hazard estimate of 5. Antimony was the leading contributor to risk with a dermal HI of 3, followed by Total PCBs (0.5), and iron (0.7), as presented in Table D5.31.

Dermal risk at Outfall 001 EU 14 Hot Spot presented 95% of the cumulative hazard estimate of 10. Total PCBs was the leading contributor to risk with a dermal HI of 7, followed by antimony (4), as presented in Table D5.32.

Dermal risk at Outfall 001 EU 15 Hot Spot presented 93% of the cumulative hazard estimate of 30. Total PCBs was the leading contributor to risk with a dermal HI of 20, followed by uranium (3), and antimony (3), as presented in Table D5.33.

Dermal risk at Outfall 001 EU 16 Hot Spot presented 97% of the cumulative hazard estimate 10. Iron was the leading contributor to risk with a dermal HI of 9, followed by antimony (3), as presented in Table D5.34.

Dermal risk at Outfall 001 EU 18 Hot Spot presented 97% of the cumulative hazard estimate of 5. Antimony was the leading contributor to risk with a dermal HI of 3, followed by iron (0.7), and Total PCBs (0.5), as presented in Table D5.35.

Dermal risk at Outfall 001 EU 20 Hot Spot presented 98% of the cumulative hazard estimate of 4. Antimony was the leading contributor to risk with a dermal HI of 3, followed by iron (0.5), as presented in Table D5.36.

Dermal risk Within the Fence, Excluding Hot Spots presented 95% of the cumulative hazard estimate of 5. Antimony was the leading contributor to risk with a dermal HI of 3, followed by uranium (0.9) and iron (0.5), as presented in Table D5.37.

Dermal risk in the NSDD, Hot Spot presented 95% of the cumulative hazard estimate of 8. Antimony was the leading contributor to risk with a dermal HI of 4, followed by uranium (1), as presented in Table D5.38.

Dermal risk in the NSDD, Excluding the Hot Spot presented 96% of the cumulative hazard estimate of 5. Antimony was the leading contributor to risk with a dermal HI of 3, followed by uranium (0.7), as presented in Table D5.39.

Surface Water. Dermal contact with surface water was the only applicable exposure pathway for this medium and, therefore, contributed 100% of the cumulative hazard estimates.

Total PCBs was the only COPC identified at Outfall 001 EU 14 Hot Spot and Within the Fence, Excluding Hot Spots, with cumulative hazard estimates of 3 at both EUs, as presented in Tables D5.45 and D5.50.

D.5.4.1.3 Future excavation worker

A cumulative HI estimate greater than 1 was estimated for each of the SWOU EUs for excavation workers based on default exposure assumptions. HIs exceeded 1 for exposures associated with soil/sediment contact at each EU. Hazards are summarized below.

Soil/Sediment. Dermal risk and ingestion risk at Outfall 008 Hot Spot, respectively presented 62% and 38% of the cumulative HI estimate of 20. For both of these exposure routes, Total PCBs was the leading contributor to risk with respective dermal HIs of 8 and 6, as presented in Table D5.53.

Dermal risk at Outfall 010 Hot Spot presented 66% of the cumulative hazard estimate of 10, followed by ingestion risk (34%). For both of these exposure routes, Total PCBs was the leading contributor to risk with respective dermal and ingestion HIs of 5 and 3. Antimony also was a contributor to dermal risk at a level of 2, as presented in Table D5.54.

Dermal risk at Outfall 011 Hot Spot presented 64% of the cumulative hazard estimate of 10, followed by ingestion risk (36%). Antimony contributed the greatest risk to dermal risk with an HI of 3, followed Total PCBs (2) and uranium (1). Uranium was the leading contributor to ingestion risk with an HI of 3, followed by Total PCBs with an HI of 1, as presented in Table D5.55.

Dermal contact risk at Outfall 015 Hot Spot presented 51% of the cumulative HI estimate of 10, followed by ingestion risk (49%). Uranium was the leading contributor to ingestion risk with an HI of 5. Uranium was the leading contributor to dermal risk with an HI of 3, followed by antimony (2), as presented in Table D5.56.

Dermal risk at Outfall 001 EU 14 Hot Spot presented 70% of the cumulative HI estimate of 10, followed by ingestion risk (30%). Total PCBs was the greatest contributor to dermal risk (5) followed by antimony (4). Total PCBs was the greatest contributor to ingestion risk (4) followed by antimony (0.2), as presented in Table D5.58.

Dermal contact risk at Outfall 001 EU 15 Hot Spot presented 57% of the cumulative HI estimate of 30, followed by ingestion (43%). Total PCBs was the leading contributor to dermal risk with an HI of 10, followed by uranium (2). Total PCBs was the greatest contributor to ingestion risk (9) followed by uranium (4), as presented in Table D5.59.

Dermal risk at Outfall 001 EU 16 Hot Spot presented 77% of the cumulative HI estimate of 10, followed by ingestion (23%). Iron was the leading contributor to dermal risk with an HI of 6, followed by antimony (2). Iron contributed the greatest ingestion risk with an HI of 2, as presented in Table D5.60.

Dermal risk at Outfall 001 EU 18 Hot Spot presented 75% of the cumulative HI estimate of 5, followed by ingestion (25%). Antimony was the leading contributor to dermal risk with an HI of 2, followed by iron (0.5), and Total PCBs (0.4). Uranium contributed the greatest ingestion risk with an HI of 0.5, followed by Total PCBs (0.3), as presented in Table D5.61.

Dermal risk at Outfall 001 EU 20 Hot Spot presented 83% of the cumulative HI estimate of 4, followed by ingestion (17%). Antimony was the leading contributor to dermal risk with an HI of 2, followed by iron (0.4). Iron contributed the greatest ingestion risk with an HI of 0.1, as presented in Table D5.62.

Dermal risk Within the Fence, Excluding Hot Spots presented 68% of the cumulative HI estimate of 5, followed by ingestion (32%). Antimony was the leading contributor to dermal risk with an HI of 2, followed by uranium (0.6). Uranium contributed the greatest ingestion risk with an HI of 1, followed by iron (0.1) and Total PCBs (0.1), as presented in Table D5.63.

Dermal risk in the NSDD, Hot Spot presented 67% of the cumulative HI estimate of 9, followed by ingestion (33%). Antimony was the leading contributor to dermal risk with an HI of 3, followed by uranium (1). Uranium was the leading contributor to ingestion risk with an HI of 2, followed by Total PCBs (0.5), as presented in Table D5.64.

Ingestion risk in the NSDD, Excluding the Hot Spot presented 95% of the cumulative HI estimate of 2. Uranium contributed the greatest ingestion risk with an HI of 1, followed by Total PCBs (0.2), as presented in Table D5.65.

D.5.4.1.4 Recreational user

HIs for potential exposures for recreational users (adults, teens, and children) are presented in the following subsections. Risks were assessed employing default exposure assumptions for adults, teens, and children considered representative of a potential future use exposure scenario. Children also were assessed employing site-specific exposure assumptions to represent a current use scenario. For each exposure scenario, risks associated with dermal contact with surface water and consuming game (including deer, quail, and rabbit) were below a HI of 1. Only direct contact with soil/sediment resulted in HI estimates greater than 1 for recreational users. The hazard calculations for surface water are presented in Tables D5.68 through D5.85. The hazard calculations for ingestion of game are presented in Tables D5.70, D5.71, D5.76, D5.77, D5.86, and D5.87. The soil/sediment results are summarized below.

Adult Sediment. Dermal risk at the NSDD Hot Spot presented 97% of the cumulative HI estimate of 2. For the dermal exposure route, antimony was the primary contributor to dermal risk with an HI of 1, followed by uranium (0.5), as presented in Table D5.66.

Dermal risk at the NSDD, Excluding the Hot Spot, presented 98% of the cumulative HI estimate of 2. For the dermal exposure route, antimony was the primary contributor to dermal risk with an HI of 0.9, followed by uranium (0.2), and iron (0.2), as presented in Table D5.67.

Teen Sediment. Dermal risk at the NSDD Hot Spot presented 99% of the cumulative HI estimate of 10. For the dermal exposure route, antimony was the primary contributor to dermal risk with an HI of 6, followed by uranium (2) and Total PCBs (1) as presented in Table D5.72.

Dermal risk at the NSDD, Excluding the Hot Spot, presented 99% of the cumulative HI estimate of 7. For the dermal exposure route, antimony, uranium, and iron were the primary contributors to risk with HIs of 4, 1, and 0.7, respectively, as presented in Table D5.73.

Future Child (employing default exposure assumptions) Sediment. Dermal risk at the NSDD Hot Spot presented 95% of the cumulative HI estimate of 20. For the dermal exposure route, antimony was the primary contributor to risk with an HI of 9, followed by uranium (3) and Total PCBs (2), as presented in Table D5.82.

Dermal risk at the NSDD, Excluding the Hot Spot presented 96% of the cumulative HI estimate of 10. For the dermal exposure route, antimony was the primary contributor to risk with an HI of 6, followed by uranium (3), and iron (1), as presented in Table D5.83.

Current Child (employing site-specific exposure assumptions) Sediment. Dermal risk at the NSDD Hot Spot presented 70% of the cumulative HI estimate of 2, followed by ingestion risk (30%). For the dermal exposure route, antimony was the primary contributor to risk with an HI of 0.6, followed by uranium (0.2). For the ingestion exposure route, uranium was the primary contributor to risk with an HI of 0.3, as presented in Table D5.78.

Dermal risk at the NSDD, Excluding the Hot Spot presented 74% of the cumulative HI estimate of 1, followed by ingestion risk (26%). For the dermal exposure route, antimony was the primary contributor to risk with an HI of 0.4, followed by uranium (0.1). For the ingestion exposure route, uranium was the primary contributor to risk with an HI of 0.2, as presented in Table D5.79.

D.5.4.2 Excess Lifetime Cancer Risk

ELCR estimates for all land use scenarios and exposure pathways are summarized below.

D.5.4.2.1 Current industrial worker

A cumulative ELCR greater than 1E-04 was estimated for two of the SWOU EUs for current industrial workers based on site-specific exposure assumptions. The ELCR estimates greater than 1E-04 are based on direct contact exposures to soil/sediment. All ELCR estimates associated with dermal contact with surface water were below 1E-04 and are presented in Tables D5.101 through D5.113. Soil/sediment cancer risk calculations for current industrial workers are presented in Tables D5.88 through D5.100. ELCR estimates greater than 1E-04 are summarized below to highlight those areas that pose the most significant risk.

Soil/Sediment. Dermal risk at Outfall 011 presented 97% of the total ELCR of 2E-04. For the dermal exposure route, Total PAHs as BaPE was the leading contributor to risk with an ELCR of 2E-04, as presented in Table D5.90.

Dermal risk at Outfall 001 EU 14 Hot Spot presented 97% of the total ELCR of 5E-04. For the dermal exposure route, Total PAHs as BaPE was the leading contributor to risk with an ELCR of 5E-04, as presented in Table D5.93.

D.5.4.2.2 Future industrial worker

A cumulative ELCR greater than 1E-04 was estimated for six of the SWOU EUs for future industrial workers based on default exposure assumptions. The ELCR estimates greater than 1E-04 are based on direct contact exposures to soil/sediment. All ELCR estimates associated with dermal contact with surface water were below 1E-04 and are presented in Tables D5.127 through D5.139. Soil/sediment cancer risk calculations for future industrial workers are presented in Tables D5.114 through D5.126. ELCR estimates greater than 1E-04 are summarized below to highlight those areas that pose the most significant risk.

Soil/Sediment. Dermal risk at Outfall 008 Hot Spot presented 83% of the total ELCR of 3E-04, followed by external exposure (9%) and ingestion (8%). For the dermal exposure route, Total PCBs and Total PAHs as BaPE were the leading contributors to risk with respective ELCRs of 2E-04 and 6E-05, as presented in Table D5.114.

Dermal risk at Outfall 010 Hot Spot presented 90% of the total ELCR of 3E-04. For the dermal exposure route, Total PAHs as BaPE and Total PCBs were the leading contributors to risk with respective ELCRs of 1E-04 and 9E-05, respectively, as presented in Table D5.115.

Dermal risk at Outfall 011 Hot Spot presented 97% of the total ELCR of 3E-03. For the dermal exposure route, Total PAHs as BaPE was the leading contributor to risk with an ELCR of 3E-03, as presented in Table D5.116.

Dermal risk at the Outfall 001 EU 14 Hot Spot presented 97% of the total ELCR of 9E-03. For the dermal exposure route, Total PAHs as BaPE was the leading contributor to risk with an ELCR of 9E-03, as presented in Table D5.119.

Dermal risk at Outfall 001 EU 15 Hot Spot presented 92% of the total ELCR of 5E-04. For the dermal exposure route, Total PAHs as BaPE and Total PCBs were the leading contributors to risk, both COPCs with ELCRs of 2E-04, as presented in Table D5.120.

External exposure risk in the NSDD Hot Spot presented 46% of the total ELCR of 2E-04, followed by dermal exposure (33%) and ingestion (21%). Thorium-228 was the greatest contributor to external exposure risk with an ELCR of 7E-05, followed by thorium-230 (3E-05). For the dermal exposure route, Total PAHs as BaPE and Total PCBs were the leading contributors to risk with respective ELCRs of 5E-05 and 1E-05. Thorium-230 was the greatest contributor to ingestion risk with an ELCR of 3E-05, as presented in Table D5.125.

D.5.4.2.3 Future excavation worker

A cumulative ELCR greater than 1E-04 was estimated for seven of the SWOU EUs for excavation workers based on default exposure assumptions. The ELCR estimates greater than 1E-04 are based primarily on direct contact exposures to soil/sediment. Soil/sediment cancer risk calculations for excavation workers are presented in Tables D5.140 through D5.152. ELCR estimates greater than 1E-04 are summarized below.

Soil/Sediment. Dermal risk at Outfall 008 Hot Spot presented 49% of the total ELCR of 3E-04, followed by ingestion (46%). For the dermal exposure route, Total PCBs and Total PAHs as BaPE were the leading contributors to risk with respective ELCRs of 1E-04 and 4E-05. For the ingestion exposure route, Total PCBs, thorium-230, and Total PAHs as BaPE were the leading contributors to risk with respective ELCRs of 8E-05, 4E-05, and 1E-05,, as presented in Table D5.140.

Dermal risk at Outfall 010 Hot Spot presented 62% of the total ELCR of 3E-04, followed by ingestion (35%). For the dermal exposure route, Total PAHs as BaPE, Total PCBs, and arsenic were the leading contributors to risk with respective ELCRs of 1E-04, 7E-05, and 2E-05. For the ingestion exposure route, Total PCBs, Total PAHs as BaPE, and arsenic were the leading contributors to risk with respective ELCRs of 5E-05, 3E-05, and 2E-05, as presented in Table D5.141.

Dermal risk at Outfall 011 Hot Spot presented 77% of the total ELCR of 3E-03, followed by ingestion (22%). For both of these exposure routes, Total PAHs as BaPE was the leading contributor to risk with respective ELCRs of 2E-03 and 5E-04, as presented in Table D5.142.

Ingestion risk at Outfall 015 Hot Spot presented 46% of the total ELCR of 2E-04, followed by dermal contact (36%) and external exposure (18%). For the ingestion exposure route, arsenic and Total PAHs as BaPE were the leading contributors to risk with respective ELCRs of 2E-05 and 1E-05. Total PAHs as BaPE (4E-05) and arsenic (1E-05) were the greatest contributors to dermal risk. Thorium-228 (1E-05) was the greatest contributor to external exposure risk, as presented in Table D5.143.

Dermal risk at Outfall 001 EU 14 Hot Spot presented 78% of the total ELCR of 8E-03, followed by ingestion (21%). For the dermal and ingestion exposure routes, Total PAHs as BaPE was the leading contributor to risk with respective ELCRs of 6E-03 and 2E-03, as presented in Table D5.145.

Dermal risk at Outfall 001 EU 15 Hot Spot presented 63% of the total ELCR of 6E-04, followed by ingestion (35%). For the dermal exposure route, Total PAHs as BaPE and Total PCBs were the leading contributors to risk, both with ELCRs of 2E-04. For the ingestion exposure route, Total PCBs and Total PAHs as BaPE were the leading contributors to risk with respective ELCRs of 1E-04 and 5E-05, respectively, as presented in Table D5.146.

Ingestion risk in the NSDD Hot Spot presented 77% of the total ELCR of 4E-04, followed by external exposure (13%) and dermal contact (11%). Thorium-230 was the greatest contributor to ingestion risk with an ELCR of 2E-04. Thorium-228 was the greatest contributor to external exposure risk with an ELCR of 3E-05. Total PAHs as BaPE and Total PCBs were the greatest contributors to dermal risk with respective ELCRs of 2E-05 and 9E-06, as presented in Table D5.151.

D.5.4.2.4 Recreational user

ELCR estimated for recreational users (adults, teens, and children) were all less than 1E-04. Risks were assessed employing default exposure assumptions for adults, teens, and children considered representative of a potential future use exposure scenario. Children also were assessed employing site-specific exposure assumptions to represent a current use scenario. For each exposure scenario, risks associated with direct contact with soil/sediment, dermal contact with surface water, and consuming game (including deer, quail, and rabbit) were all below 1E-04. Cancer risk calculations for recreational users are presented in Tables D5.153 through D5.174.

D.5.5 IDENTIFICATION OF LAND USE SCENARIOS, PATHWAYS, MEDIA, AND CHEMICALS OF CONCERN

This section identifies the land use scenarios of concern, POCs, media of concern (MOC), and COCs for EUs in the SWOU. COCs are a subset of COPCs that are identified as “risk drivers.” A risk driver is a COPC that contributes significantly to site-related risks and hazards and may be more important for risk management of a site. This section also evaluates all land use scenarios to identify the land use scenarios, contaminants, and pathways to consider when choosing appropriate remedial actions. Section D.8 presents RGOs for each location and land use combination using the information compiled in this section.

According to the Methods Document (DOE 2001), risk characterization results for total noncancer risk (total HI) and total cancer risk (total ELCR) for each land use scenario at each EU should be compared to benchmarks of 1 and lE-06 for HI and ELCR, respectively, to identify land use scenarios of concern. Land use scenarios with total HIs exceeding the benchmark of 1 are deemed land use scenarios of concern for noncancer risk. Land use scenarios with total ELCR exceeding the benchmark of lE-06 are deemed land use scenarios of concern for cancer risk. To highlight those land use scenarios that pose the greatest risk, discussion focuses on those scenarios with HIs greater than 1 and ELCRs greater than 1E-04.

Similarly, to identify POCs, the Methods Document (DOE 2001) recommends comparing exposure route HI and ELCR estimates across all COPCs for each land use scenario of concern to benchmarks of 0.1 and lE-06 for exposure route HI and ELCR, respectively. Exposure pathways with HIs and ELCRs that exceed these benchmarks are deemed POCs for the associated land use scenario..

To identify COCs, the Methods Document recommends comparing chemical-specific HI and ELCR contributed by each COPC across all pathways within a land use scenario of concern to benchmarks of 0.1 and lE-06 for HI and cancer risk, respectively. COPCs with chemical-specific HIs or ELCRs that exceed these benchmarks are deemed COCs for that land use scenario of concern. From this select list of COCs, “priority” COCs were identified further as those chemicals exceeding benchmarks of HIs greater than 1 and ELCR greater than 1E-04. COCs and priority COCs are identified on Table D.20 for soil/sediment and Table D.21 for surface water.

MOCs are identified by examining POCs and selecting all media associated with the POCs as MOCs.

D.5.5.1 Land Use Scenarios of Concern

As was presented in Table D.16 (HI risk) and Table D.18 (ELCR), the current industrial worker land use scenario is a scenario of concern at each of the EUs based on actual site-specific exposure assumptions. Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot are of particular concern based on an ELCR greater than 1E-04.

The future industrial worker and excavation worker scenarios are land use scenarios of concern for the entire SWOU based on default exposure assumptions. An excess noncancer risk greater than 1 was calculated for all EUs for the future industrial worker scenario and for 12 of the 13 EUs for the excavation worker scenario. An ELCR greater than 1E-04 was calculated for six EUs for the future industrial worker scenario and seven EUs for the future excavation worker scenario. The future recreational land use scenario is a land use scenario of concern at the NSDD Hot Spot and NSDD, Excluding the Hot Spot, based on excess noncancer risk greater than 1.

D.5.5.2 Chemicals of Concern

Only those contaminants whose chemical-specific ELCRs summed across all pathways within a land use scenario of concern are greater than or equal to 1E-06 or whose HQs summed across all pathways are greater than or equal to 0.1 are identified as COCs.

The COCs in soil/sediment across all land use scenarios for noncancer risk are summarized in Table D.20. In this table, contaminants that are COCs within a land use scenario of concern and have chemical-specific HIs between 0.1 and 1 are marked with an “O,” and HIs greater than 1 are marked with an “X.” Contaminants that are COCs within a land use scenario of concern and have a chemical-specific ELCR between 1E-06 and 1E-04 are marked with a yellow cell, while cells with ELCRs exceeding 1E-04 are shaded with pink. Contaminants that are not COCs within a land use scenario are not marked (i.e., cell left blank).

As shown in Table D.20, there are nine metals identified as COCs for noncancer hazards in soil/sediment in the SWOU, along with Total PCBs, and Total PAHs. Total PAHs, Total PCBs, 11 of the 12 radionuclides, and arsenic also are identified as COCs based on cancer risk in soil/sediment. In surface water, Total PCBs and TCE are the identified COCs based on both noncancer and cancer risk as presented in Table D.21. As shown in Table D.22, no COCs were selected for ingestion of game.

Table D.20. Summary of COCs in Soil/Sediment

	Outfall 8 Hot Spot			Outfall 10 Hot Spot			Outfall 11 Hot Spot			Outfall 15 Hot Spot			Outfall 1 EU 13 Hot Spot			Outfall 1 EU 14 Hot Spot			Outfall 1 EU 15 Hot Spot			Outfall 1 EU 16 Hot Spot			Outfall 1 EU 18 Hot Spot			Outfall 1 EU 20 Hot Spot			Within the Fence, Excluding Hot Spots			NSDD Hot Spot							NSDD, Excluding the Hot Spot						
COPC	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Current Industrial Worker	Future Industrial Worker	Excavation worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child	Current Industrial Worker	Future Industrial Worker	Excavation worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child
Inorganic Chemicals (Metals)																																															
Aluminum		O	O		O	O		O	O		O	O		O			O	O		O	O		O	O		O	O		O	O		O	O		O	O		O		O			O			O		O
Antimony	O	X	X	O	X	X	O	X	X	O	X	X	O	X	O	O	X	X	O	X	X	O	X	X	O	X	X	O	X	X	O	X	X	O	X	X	X	X	O	X	O	X	O	O	X	O	X
Arsenic			O		O	O		O	O		O	O						O		O	O		O	O						O			O			O				O		O			O		O
Barium																																															
Beryllium								O																														O		O							O
Cadmium																								O																							
Chromium																																															
Copper																																															
Iron		O	O		O	O		X	X		O	O		O	O		O	O		O	O	O	X	X		O	O		O	O		O	O		O	O	O	O	O	X		O	O	O	O		X
Lead																																															
Manganese		O	O		O			O	O		O	O		O			O	O		O	O		O	O		O	O		O	O		O	O		O	O		O		O			O			O		O
Mercury																																															
Molybdenum																																															
Nickel																				O	O																										
Selenium																																															
Silver																																															
Uranium		O	O		O	O	O	X	X	O	X	X		O	O				O	X	X			O		O	O			O		X	X		X	X	O	X	O	X		O	X	O	X	O	X
Vanadium																																															
Zinc																																															
Organic Compounds																																															
Fluoranthene																																															
Pyrene																																															
Total PCB	O	X	X	O	X	X	O	X	X		O	O		O	O	O	X	X	O	X	X		O	O		O	O		O	O		O	O		O	X	O	X	O	X		O	O	O	O		O
Total PAHs (as BaPE)																																															

Table D.20 Summary of COCs in Soil/Sediment (Continued)

COPC	**Outfall 8 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 10 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 11 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 15 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 13 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 14 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 15 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 16 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 18 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Outfall 1 EU 20 Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**Within the Fence, Excluding Hot Spots**	Current Industrial Worker	Future Industrial Worker	Excavation worker	**NSDD Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child	**NSDD, Excluding the Hot Spot**	Current Industrial Worker	Future Industrial Worker	Excavation worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child
Radionuclides																																																												
Americium-241																																																🟨													
Cesium-137															🟨	🟨																			🟨	🟨																									
Cobalt-60															🟨	🟨																											🟨	🟨																	
Neptunium-237			🟨	🟨											🟨	🟨			🟨	🟨							🟨	🟨							🟨	🟨			🟨	🟨						🟨	🟨	🟨	🟨	🟨		🟨			🟨	🟨				
Plutonium-239/240				🟨											🟨	🟨																				🟨											🟨	🟨								🟨				
Technetium-99																																				🟨											🟨	🟨												
Thorium-228		🟨	🟨	🟨			🟨	🟨			🟨	🟨		🟨	🟨	🟨			🟨	🟨			🟨	🟨			🟨	🟨							🟨	🟨		🟨	🟨	🟨			🟨	🟨		🟨	🟨	🟨	🟨	🟨		🟨			🟨	🟨	🟨	🟨		🟨
Thorium-230			🟨	🟨											🟨	🟨				🟨				🟨				🟨								🟨				🟨						🟨	🟨	🟥	🟨	🟨		🟨			🟨	🟨				
Thorium-232																																																												
Uranium-234				🟨				🟨				🟨				🟨				🟨								🟨												🟨							🟨	🟨												
Uranium-235																																											🟨	🟨																
Uranium-238				🟨				🟨				🟨			🟨	🟨				🟨								🟨								🟨				🟨				🟨			🟨	🟨								🟨				

O: Indicates that HI is greater than 0.1 but less than 1.

X: Indicates that HI is greater than 1.

Yellow shading indicates an ELCR is between 1.0E-6 and 1.0E-4.

Pink shading indicates an ELCR greater than 1.0E-4.

Blank cells indicate no COPCs were selected or neither the HI or ELCR risk limits of 0.1 and ELCR, respectively, were not exceeded.

Table D.21. Summary of COCs in Surface Water

COPC	Outfall 8 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 10 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 11 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 15 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 13 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 14 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 15 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 16 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 18 Hot Spot	Current Industrial Worker	Future Industrial Worker	Outfall 1 EU 20 Hot Spot	Current Industrial Worker	Future Industrial Worker	Within the Fence, Excluding Hot Spots	Current Industrial Worker	Future Industrial Worker	NSDD Hot Spot	Current Industrial Worker	Future Industrial Worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child	NSDD, Excluding the Hot Spot	Current Industrial Worker	Future Industrial Worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child
Inorganic Chemicals (Metals)																																															
Aluminum																																															
Antimony																																															
Arsenic																																															
Barium																																															
Beryllium																																															
Cadmium																																															
Chromium																																															
Copper																																															
Iron																																															
Lead																																															
Manganese																																															
Mercury																																															
Molybdenum																																															
Nickel																																															
Selenium																																															
Silver																																															
Uranium																																															
Vanadium																																															
Zinc																																															
Organic Compounds																																															
Fluoranthene																																															
Pyrene																																															
Total PCB								O	O			O					O	X															O	X														
Total PAHs (as BaPE)																																															

Table D.21. Summary of COCs in Surface Water (Continued)

COPC	**Outfall 8 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 10 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 11 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 15 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 13 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 14 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 15 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 16 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 18 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Outfall 1 EU 20 Hot Spot**	Current Industrial Worker	Future Industrial Worker	**Within the Fence, Excluding Hot Spots**	Current Industrial Worker	Future Industrial Worker	**NSDD Hot Spot**	Current Industrial Worker	Future Industrial Worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child	**NSDD, Excluding the Hot Spot**	Current Industrial Worker	Future Industrial Worker	Recreational User- Adult	Recreational User- Teen	Current Recreational User- Child	Future Recreational User- Child
<u>Radionuclides</u>																																															
Americium-241																																															
Cesium-137																																															
Cobalt-60																																															
Neptunium-237																																															
Plutonium-239/240																																															
Technetium-99																																															
Thorium-228																																															
Thorium-230																																															
Thorium-232																																															
Uranium-234																																															
Uranium-235																																															
Uranium-238																																															
<u>VOCs</u>																																															
Trichloroethylene								O 🟨	O 🟨			🟨																					🟨										🟨		🟨		🟨

O: Indicates that HI is greater than 0.1 but less than 1.

X: Indicates that HI is greater than 1.

Yellow shading indicates an ELCR is between 1.0E-6 and 1.0E-4.

Pink shading indicates an ELCR greater than 1.0E-4.

Blank cells indicate no COPCs were selected or neither the HI or ELCR risk limits of 0.1 and ELCR, respectively, were not exceeded.

Table D.22. Summary of COCs for Ingestion of Game

COPC	**NSDD Hot Spot**	Recreational User- Adult	Recreational User- Teen	Current/future Recreational User- Child	**NSDD, Excluding the Hot Spot**	Recreational User- Adult	Recreational User- Teen	Current/future Recreational User- Child
<u>Inorganic Chemicals (Metals)</u>								
Aluminum								
Antimony								
Arsenic								
Barium								
Beryllium								
Cadmium								
Chromium								
Copper								
Iron								
Lead								
Manganese								
Mercury								
Molybdenum								
Nickel								
Selenium								
Silver								
Uranium								
Vanadium								
Zinc								
<u>Organic Compounds</u>								
Fluoranthene								
Pyrene								
Total PCB								
Total PAHs (as BaPE)								
<u>Radionuclides</u>								
Americium-241								
Cesium-137								
Cobalt-60								
Neptunium-237								
Plutonium-239/240								
Technetium-99								
Thorium-228								
Thorium-230								
Thorium-232								
Uranium-234								
Uranium-235								
Uranium-238								

O: Indicates that HI is greater than 0.1 but less than 1.
X: Indicates that HI is greater than 1.
Yellow shading indicates an ELCR is between 1.0E-6 and 1.0E-4.
Pink shading indicates an ELCR greater than 1.0E-4.
Blank cells indicate no COPCs were selected or neither the HI or ELCR risk limits of 0.1 and ELCR, respectively, were not exceeded.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, COCs that can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the current industrial worker are presented in Table D.23.

Table D.23. Summary of COCs for Soil/Sediment by EU for Current Industrial Workers

Exposure unit	COCs
Outfall 008 Hot Spot	None
Outfall 010 Hot Spot	None
Outfall 011 Hot Spot	Total PAHs (as BaPE)
Outfall 015 Hot Spot	None
Outfall 001 EU 13 Hot Spot	None
Outfall 001 EU 14 Hot Spot	Total PAHs (as BaPE)
Outfall 001 EU 15 Hot Spot	None
Outfall 001 EU 16 Hot Spot	None
Outfall 001 EU 18 Hot Spot	None
Outfall 001 EU 20 Hot Spot	None
Within the Fence, Excluding Hot Spots	None
NSDD Hot Spot	None
NSDD, Excluding the Hot Spot	None

Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, there are no COCs (Table D.24) that can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for the current industrial worker.

Table D.24. Summary of COCs for Surface Water by EU for Current Industrial Workers

Exposure unit	COCs
Outfall 008 Hot Spot	None
Outfall 010 Hot Spot	None
Outfall 011 Hot Spot	None
Outfall 015 Hot Spot	None
Outfall 001 EU 13 Hot Spot	None
Outfall 001 EU 14 Hot Spot	None
Outfall 001 EU 15 Hot Spot	None
Outfall 001 EU 16 Hot Spot	None
Outfall 001 EU 18 Hot Spot	None
Outfall 001 EU 20 Hot Spot	None
Within the Fence, Excluding Hot Spots	None
NSDD Hot Spot	None
NSDD, Excluding the Hot Spot	None

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, COCs that can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future industrial worker are presented in Table D.25.

Table D.25. Summary of COCs for Soil/Sediment by EU for Future Industrial Workers

Exposure unit	COCs
Outfall 008 Hot Spot	Antimony and Total PCBs
Outfall 010 Hot Spot	Antimony and Total PCBs
Outfall 011 Hot Spot	Antimony, iron, uranium, Total PCBs, and Total PAHs (as BaPE)
Outfall 015 Hot Spot	Antimony and uranium
Outfall 001 EU 13 Hot Spot	Antimony
Outfall 001 EU 14 Hot Spot	Antimony, Total PCBs, and Total PAHs (as BaPE)
Outfall 001 EU 15 Hot Spot	Antimony, uranium, Total PCBs, and Total PAHs (as BaPE)
Outfall 001 EU 16 Hot Spot	Antimony and iron
Outfall 001 EU 18 Hot Spot	Antimony
Outfall 001 EU 20 Hot Spot	Antimony
Within the Fence, Excluding Hot Spots	Antimony and uranium
NSDD Hot Spot	Antimony and uranium
NSDD, Excluding the Hot Spot	Antimony

Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.26) can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for the future industrial worker.

Table D.26 Summary of COCs for Surface Water by EU for Future Industrial Workers

Exposure unit	COCs
Outfall 008 Hot Spot	None
Outfall 010 Hot Spot	None
Outfall 011 Hot Spot	None
Outfall 015 Hot Spot	None
Outfall 001 EU 13 Hot Spot	None
Outfall 001 EU 14 Hot Spot	Total PCBs
Outfall 001 EU 15 Hot Spot	None
Outfall 001 EU 16 Hot Spot	None
Outfall 001 EU 18 Hot Spot	None
Outfall 001 EU 20 Hot Spot	None
Within the Fence, Excluding Hot Spots	Total PCBs
NSDD Hot Spot	None
NSDD, Excluding the Hot Spot	None

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.27) can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the excavation worker.

Table D.27. Summary of COCs for Soil/Sediment by EU for Excavation Workers

Exposure unit	COCs
Outfall 008 Hot Spot	Antimony and Total PCBs
Outfall 010 Hot Spot	Antimony and Total PCBs
Outfall 011 Hot Spot	Antimony, iron, uranium, Total PCBs, and Total PAHs (as BaPE)
Outfall 015 Hot Spot	Antimony and uranium
Outfall 001 EU 13 Hot Spot	None
Outfall 001 EU 14 Hot Spot	Antimony, Total PCBs, and Total PAHs (as BaPE)
Outfall 001 EU 15 Hot Spot	Antimony, uranium, Total PCBs, and Total PAHs (as BaPE)
Outfall 001 EU 16 Hot Spot	Antimony and iron
Outfall 001 EU 18 Hot Spot	Antimony
Outfall 001 EU 20 Hot Spot	Antimony
Within the Fence, Excluding Hot Spots	Antimony and uranium
NSDD Hot Spot	Antimony, uranium,Total PCBs, and thorium-230
NSDD, Excluding the Hot Spot	Uranium

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.28) can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the current child recreational user.

Table D.28. Summary of COCs for Soil/Sediment by EU for Current Child Recreational Users

Exposure unit	COCs
Child	
NSDD Hot Spot	None
NSDD, Excluding the Hot Spot	None

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.29) can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future adult recreational user.

Table D.29. Summary of COCs for Soil/Sediment by EU for Adult Recreational Users

Exposure unit	COCs
Adult	
NSDD Hot Spot	Antimony
NSDD, Excluding the Hot Spot	None

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.30) can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future teen recreational user.

Table D.30. Summary of COCs for Soil/Sediment by EU for Teen Recreational Users

Exposure Unit	COCs
Teen	
NSDD Hot Spot	Antimony,uranium, and Total PCBs
NSDD, Excluding the Hot Spot	Antimony and uranium

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs (Table D.31) can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future child recreational user.

Table D.31. Summary of COCs for Soil/Sediment by EU for Future Child Recreational Users

Exposure unit	COCs
Child	
NSDD Hot Spot	Antimony, iron, uranium, and Total PCBs
NSDD, Excluding the Hot Spot	Antimony, iron, and uranium

Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, , no COCs can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for any of the recreational users.

Combining the results from Table D.22 and considering the magnitude of the chemical-specific HIs and ELCRs, no COCs can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) for ingestion of game for any of the recreational users.

D.5.5.3 Pathways of Concern

Table D.32 presents pathways of concern with a pathway HI greater than 0.1 or a pathway ELCR greater than 1E-06 across all contaminants within a land use scenario. Priority POCs are identified in Table D.32 as those with an "X" for hazards greater than one and those shaded pink with an ELCR greater than 1E-04.

As presented in Table D.32, ingestion and dermal contact with soil, external exposure to radionuclides, and dermal contact with surface water are POCs at one or more EUs. Inhalation of vapors and/or particulates from soil, sediment, and surface water are not POCs. In addition, external exposures from radionuclides and ingestion of game are not POCs at any.

Table D.32. Summary of Pathways of Concern

	Pathways of Potential Concern										
	Soil/sediment				Surface Water				Ingestion of Game		
EUs and Land Use Scenarios	Ingestion	Dermal Contact	Inhalation	External Exposure	Ingestion	Dermal Contact	Inhalation	External Exposure	Deer	Quail	Rabbit
Outfall 008 Hot Spot											
Current Industrial Worker	🟨	🟨 O		🟨							
Future Industrial Worker	🟨 O	🟥 X		🟨							
Excavation worker	🟨 X	🟥 X		🟨							
Outfall 010 Hot Spot											
Current Industrial Worker		🟨 O									
Future Industrial Worker	🟨 O	🟥 X		🟨							
Excavation worker	🟥 X	🟥 X		🟨							
Outfall 011 Hot Spot											
Current Industrial Worker	🟨	🟥 O				🟨 O					
Future Industrial Worker	🟨 O	🟥 X		🟨		🟨 O					
Excavation worker	🟥 X	🟥 X		🟨							
Outfall 015 Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨		🟨 O					
Excavation worker	🟨 X	🟨 X		🟨							
Outfall 001 EU 13 Hot Spot											
Current Industrial Worker		🟨 O									
Future Industrial Worker	🟨 O	🟨 X		🟨							
Excavation worker	🟨 X	🟨 O		🟨							
Outfall 001 EU 14 Hot Spot											
Current Industrial Worker	🟨	🟥 O				🟨 O					
Future Industrial Worker	🟥 O	🟥 X		🟨		🟨 X					
Excavation worker	🟥 X	🟥 X		🟨							
Outfall 001 EU 15 Hot Spot											
Current Industrial Worker	🟨 O	🟨 X									
Future Industrial Worker	🟨 O	🟥 X		🟨							
Excavation worker	🟥 X	🟥 X		🟨							
Outfall 001 EU 16 Hot Spot											
Current Industrial Worker		🟨 O									
Future Industrial Worker	🟨 O	🟨 X									
Excavation worker	🟨 X	🟨 X									
Outfall 001 EU 18 Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨							
Excavation worker	🟨 X	🟨 X		🟨							
Outfall 001 EU 20 Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨	🟨 X		🟨							
Excavation worker	🟨 O	🟨 X		🟨							
Within the Fence, Excluding Hot Spots											
Current Industrial Worker		🟨 O		🟨		🟨 O					
Future Industrial Worker	🟨 O	🟨 X		🟨		🟨 X					
Excavation worker	🟨 X	🟨 X		🟨							
NSDD Hot Spot											
Current Industrial Worker	🟨	🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨							
Excavation worker	🟥 X	🟨 X		🟨							
Recreational User- Adult	🟨	🟨 X		🟨							
Recreational User- Teen	🟨 O	🟨 X		🟨							
Current Recreational User- Child	O	X									
Future Recreational User- Child	🟨 O	🟨 X		🟨							
NSDD, Excluding the Hot Spot											
Current Industrial Worker		🟨 O		🟨							
Future Industrial Worker	🟨 O	🟨 X		🟨		🟨					
Excavation worker	🟨 X	🟨 O		🟨							
Recreational User- Adult	🟨	🟨 X		🟨							
Recreational User- Teen	🟨	🟨 X		🟨		🟨					
Current Recreational User- Child	O	O									
Future Recreational User- Child	🟨 O	🟨 X		🟨		🟨					

O: Indicates that HI is greater than 0.1 but less than 1.

X: Indicates that HI is greater than 1.

Yellow shading indicates an ELCR is between 1.0E-6 and 1.0E-4.

Pink shading indicates an ELCR greater than 1.0E-4.

Blank cells indicate no COPCs were selected or neither the HI or ELCR risk limits of 0.1 and ELCR, respectively, were not exceeded.

EU = exposure unit.

NSDD = north-south diversion ditch.

D.5.5.4 Media of Concern

MOCs are those media that appear in at least one POC. Based on the information presented in Section D.5.5.3 and Tables D.16 through D.19 and summarized in Table D.33, surface and subsurface soil/sediment are MOC at each SWOU EU for the current industrial worker scenario.. Surface and subsurface soil/sediment are considered MOCs at each SWOU EU based on future scenarios as well as surface water in five EUs. It should be noted that surface and subsurface soil/sediment would be considered a priority medium of concern in only three outfalls for the current industrial worker (Outfall 011 Hot Spot; Outfall 001 EU 14 Hot Spot; Outfall 001 EU 15 Hot Spot), and surface water would be considered a priority medium of concern in just two locations (Outfall 001 EU 14 Hot Spot; Within the Fence, Excluding Hot Spots) with either a hazard greater than 1 or an ELCR greater than 1E-04.

Table D.33. Summary of MOC by EU

Exposure unit	Future scenarios Media of concern	Current scenarios Media of concern
Outfall 008 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 010 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 011 Hot Spot	Surface and subsurface soil/sediment	Surface and subsurface soil/sediment
Outfall 015 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 001 EU 13 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 001 EU 14 Hot Spot	Surface and subsurface soil/sediment and surface water	
Outfall 001 EU 15 Hot Spot	Surface and subsurface soil/sediment	Surface and subsurface soil/sediment
Outfall 001 EU 16 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 001 EU 18 Hot Spot	Surface and subsurface soil/sediment	None
Outfall 001 EU 20 Hot Spot	Surface and subsurface soil/sediment	None
Within the Fence, Excluding Hot Spots	Surface and subsurface soil/sediment and surface water	None
NSDD Hot Spot	Surface and subsurface soil/sediment	Surface and subsurface soil/sediment
NSDD, Excluding the Hot Spot	Surface and subsurface soil/sediment and surface water	None

D.5.5.5 Summary of Soil/Sediment Non-Hot Spots and Hot Spots

To put into perspective the hazards and risks that each EU within the fence and outside of the fence poses to receptors, comparisons have been made between soil/sediment non-hot spot and potential "hot spot" areas for industrial workers within the fence, excavation workers both inside and outside of the fence, and recreational users outside of the fence. This comparison summarizes which areas contribute the greatest risk to the receptors and can aid in risk management decisions.

D.5.5.5.1 Noncancer Hazards

The following summarizes risks associated with industrial and excavation workers at each of the potential "hot spot" EUs compared with areas defined as non-hot spots by noncancer risks (Tables D.34 through D.39). Below, each EU is ranked according to its estimated HI relative to the acceptable HI limit of 1.

- All of the hazards for current industrial workers were at or below the HI limit of 1. The hazards were elevated in six of the ten EUs relative to their respective non-hot spot areas. Hazards were below 1 in both the non-hot spot and potential "hot spot" areas outside the fence for current industrial workers. The hazard calculated for the potential "hot spot" was greater than the non-hot spot area.

- All of the hazards for future industrial workers exceeded the HI limit of 1. Four of the EUs were comparable to their respective non-hot spot area. Seven of the EUs were elevated compared to their respective non-hot spot area, exceeding the HI limit by more than one order of magnitude.
- Hazards were elevated in both the non-hot spot and potential "hot spot" areas outside the fence for future industrial workers.
- At three of the potential "hot spots," estimated HIs for excavation workers within the fence were comparable to the HIs of non-hot spot areas. However, seven of the potential "hot spot" EU hazards were estimated above the non-hot spot area by more than one order of magnitude, but not two.
- Hazards were evaluated in both the non-hot spot and potential "hot spot" areas outside the fence for excavation workers. The estimated hazard in the potential "hot spot" area is comparable to the hazard found in the non-hot spot (within an order of magnitude).

Table D.34. Summary of Hazards to Current Industrial Workers Inside the Fence Compared to Hazard Limits

Industrial worker, inside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spot		
Within the Fence, Excluding Hot Spots	Below	
Hot Spots		
Outfall 008 Hot Spot	Below	
Outfall 010 Hot Spot	Below	
Outfall 011 Hot Spot	Meets	
Outfall 015 Hot Spot	Below	
Outfall 001 EU 13 Hot Spot	Below	
Outfall 001 EU 14 Hot Spot	Below	
Outfall 001 EU 15 Hot Spot	Meets	
Outfall 001 EU 16 Hot Spot	Below	
Outfall 001 EU 18 Hot Spot	Below	
Outfall 001 EU 20 Hot Spot	Below	

Table D.35. Summary of Hazards to Current Industrial Workers Outside the Fence Compared to Hazard Limits

Industrial worker, outside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Below	
Hot Spots		
NSDD Hot Spot	Below	

Table D.36. Summary of Hazards to Future Industrial Workers Inside the Fence Compared to Hazard Limits

Industrial worker, inside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spot		
Within the fence, excluding Hot Spots	Exceeds	Within 1 order of magnitude
Hot Spots		
Outfall 001 EU 20 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 13 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 18 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 015 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 010 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 011 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 14 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 16 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 008 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 15 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2

Table D.37. Summary of Hazards to Future Industrial Workers Outside the Fence Compared to Hazard Limits

Industrial worker, outside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Exceed	Within 1 order of magnitude
Hot Spots		
NSDD Hot Spot	Exceed	Within 1 order of magnitude

Table D.38. Summary of Hazards to Excavation Workers Inside the Fence Compared to Hazards Limits

Excavation worker, inside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spots		
Within the Fence, Excluding Hot Spots	Exceeds	Within 1 order of magnitude
Hot Spots		
Outfall 001 EU 15 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 20 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 13 Hot Spot	Meets	
Outfall 001 EU 18 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 010 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 14 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 011 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 015 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 16 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 008 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2

Table D.39. Summary of Hazards to Excavation Workers Outside the Fence Compared to Hazard Limits

Excavation worker, outside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Exceeds	Within 1 order of magnitude
Hot Spots		
NSDD Hot Spot	Exceeds	Within 1 order of magnitude

Although hazards were elevated in both the non-hot spot and potential "hot spot" areas outside the fence for all recreational users (Table D.40), hazards for each receptor in the potential "hot spot" area were greater than those in the non-hot spot area.

Table D.40. Summary of Hazards to Recreational Users Outside the Fence Compared to Hazard Limits

Recreational user, outside the fence	HI compared to limit of 1	Extent of exceedance >1
Non-Hot Spots		
NSDD, Excluding the Hot Spot		
Adult	Exceeds	Within 1 order of magnitude
Teen	Exceeds	Within 1 order of magnitude
Future Child	Exceeds	By more than 1 order of magnitude, but less than 2
Current Child	Meets	
Hot Spots		
NSDD Hot Spot		
Adult	Exceeds	Within 1 order of magnitude
Teen	Exceeds	By more than 1 order of magnitude, but less than 2
Future Child	Exceeds	By more than 1 order of magnitude, but less than 2
Current Child	Exceeds	Within 1 order of magnitude

D.5.5.5.2 Cancer Risks

The following summarizes cancer risks at each of the potential "hot spot" EUs compared with areas defined as non-hot spots by ELCR (Tables D.41 through D.46). Below, each EU is ranked according to where its estimated ELCR fell in comparison with the risk range of 1E-06 to 1E-04.

- At the majority of the potential "hot spots", estimated ELCRs for current industrial workers inside the fence were comparable to the ELCR of the non-hot spot area, within the acceptable risk range; however, two of the potential "hot spot" EU ELCRs were greater than 1E-04; all other ELCRs were within the risk range of 1E-06 to 1E-04.

- ELCR estimates for the non-hot spot and potential "hot spot" areas outside the fence for the current industrial worker were comparable. Both ELCRs were estimated to be within the risk range of 1E-06 to 1E-04.

- Estimated ELCRs for five EUs evaluated for future industrial workers inside the fence were comparable to the ELCR of the non-hot spot area; however, five of the potential "hot spot" EU ELCRs were greater than 1E-04. Two of the ELCRs exceeded 1E-04 by more than an order of magnitude.

- While the ELCR for the non-hot spot EU was within the risk range of 1E-06 to 1E-04, the ELCR estimate for the potential "hot spot" area outside the fence for the future industrial worker was greater than the non-hot spot area and exceeded 1E-04. The ELCR for the potential "hot spot" was estimated to be within an order of magnitude of 1E-04.

- Estimated ELCRs for excavation workers inside the fence at four of the potential "hot spot" EUs met the upper limit of the risk range of 1E-04 and were comparable to the ELCR of the non-hot spot area. The remaining six potential "hot spot" EU ELCRs were elevated compared to the non-hot spot area and exceeded an ELCR of 1E-04. Four of the EUs with elevated ELCRs were estimated to be within an order of magnitude of the upper limit of the risk range, and two were estimated to be more than an order of magnitude greater, but less than two orders of magnitude.

- The estimated ELCR for the non-hot spot EU met the upper risk limit of 1E-04; the ELCR estimate for the potential “hot spot” area outside the fence for the excavation worker was greater than the non-hot spot area and exceeded an ELCR of 1E-04. The estimated ELCRs were within an order of magnitude of 1E-04.

Table D.41. Summary of Risks to Current Industrial Workers Inside the Fence Compared to the Risk Range

Industrial worker, inside the fence	ELCR compared to risk range of 1E-06 to 1E-04	Extent of exceedance >1E-04
Non-Hot Spots		
Within the Fence, Excluding Hot Spots	Within	
Hot Spots		
Outfall 001 EU 13 Hot Spot	Within	
Outfall 001 EU 18 Hot Spot	Within	
Outfall 001 EU 20 Hot Spot	Within	
Outfall 001 EU 16 Hot Spot	Within	
Outfall 015 Hot Spot	Within	
Outfall 008 Hot Spot	Within	
Outfall 010 Hot Spot	Within	
Outfall 001 EU 15 Hot Spot	Within	
Outfall 011 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 14 Hot Spot	Exceeds	Within 1 order of magnitude

Table D.42. Summary of Risks to Current Industrial Workers Outside the Fence Compared to the Risk Range

Industrial worker, outside the fence	ELCR compared to risk range of 1E-06 to 1E-04	Extent of exceedance >1E-04
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Within	
Hot Spots		
NSDD Hot Spot	Within	

Table D.43. Summary of Risks to Future Industrial Workers Inside the Fence Compared to the Risk Range

Industrial worker, inside the fence	**ELCR compared to risk range of 1E-06 to 1.0E-04**	**Extent of exceedance >1E-04**
Non-Hot Spots		
Within the fence, excluding Hot Spots	Meets upper limit	
Hot Spots		
Outfall 001 EU 13 Hot Spot	Within	
Outfall 001 EU 20 Hot Spot	Within	
Outfall 001 EU 16 Hot Spot	Meets upper limit	
Outfall 001 EU 18 Hot Spot	Meets upper limit	
Outfall 015 Hot Spot	Meets upper limit	
Outfall 008 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 010 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 15 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 011 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 14 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2

Table D.44. Summary of Risks to Future Industrial Workers Outside the Fence Compared to the Risk Range

Industrial worker, outside the fence	**ELCR compared to risk range of 1E-06 to 1.0E-04**	**Extent of exceedance >1E-04**
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Within	
Hot Spots		
NSDD Hot Spot	Exceeds	Within 1 order of magnitude

Table D.45. Summary of Risks to Excavation Workers Inside the Fence Compared to the Risk Range

Excavation worker, inside the fence	**ELCR compared to risk range of 1E-06 to 1E-04**	**Extent of exceedance >1E-04**
Non-Hot Spots		
Within the Fence, Excluding Hot Spots	Meets upper limit	
Hot Spots		
Outfall 001 EU 13 Hot Spot	Meets upper limit	
Outfall 001 EU 20 Hot Spot	Meets upper limit	
Outfall 001 EU 16 Hot Spot	Meets upper limit	
Outfall 001 EU 18 Hot Spot	Meets upper limit	
Outfall 015 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 010 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 008 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 001 EU 15 Hot Spot	Exceeds	Within 1 order of magnitude
Outfall 011 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2
Outfall 001 EU 14 Hot Spot	Exceeds	By more than 1 order of magnitude, but less than 2

Table D.46. Summary of Risks to Future Excavation Workers Outside the Fence Compared to the Risk Range

Excavation worker, outside the fence	ELCR compared to risk range of 1E-06 to 1.0E-04	Extent of exceedance >1E-04
Non-Hot Spots		
NSDD, Excluding the Hot Spot	Meets upper limit	
Hot Spots		
NSDD Hot Spot	Exceeds	Within 1 order of magnitude

ELCR estimates for the non-hot spot and potential "hot spot" areas outside the fence for the recreational user were comparable (Table D.47). All ELCRs were estimated to be within the acceptable risk range of 1E-06 to 1E-04. The current child recreational scenario was below the risk range.

Table D.47. Summary of Risks to Recreational Users Outside the Fence Compared to the Risk Range

Recreational user, outside the fence	ELCR compared to risk range of 1E-06 to 1.0E-04	Extent of exceedance >1E-04
Non-Hot Spots		
NSDD, Excluding the Hot Spot		
Adult	Within	
Teen	Within	
Future Child	Within	
Current Child	Below	
Hot Spots		
NSDD Hot Spot		
Adult	Within	
Teen	Within	
Future Child	Within	
Current Child	Within	

D.5.6 SUMMARY OF THE BHHRA

For the current industrial worker scenario, Total PAHs (as BaPE) was the risk driver at the two EU locations with an ELCR greater than 1E-04. Surface water risks for current industrial workers were within the 1E-06 to 1E-04 risk range. Risks calculated for current child recreational users at the NSDD were within or below the 1E-06 to 1E-04 risk range. Noncancer hazards were at or greater than 1 for current child recreational users at the NSDD. Cumulative hazards for the future child recreational user exceeded an HI of 1 at the NSDD Hot Spot. The noncancer risk was based on dermal contact with soil/sediment and the primary risk drivers were antimony and uranium.

Total cancer risk estimates were relatively high for future industrial workers and excavation workers, falling within or above EPA's cancer risk range of 1E-06 to 1E-04, primarily based on dermal contact with Total PAHs and Total PCBs in soil/sediment and external exposure to thorium-230. Similarly, noncancer hazards for future industrial workers and excavation workers also were relatively high, falling at or above a target HI of 1, primarily based on contact with antimony, iron, uranium, and Total PCBs in soil/sediment. Excess risk was calculated for surface water from Outfall 011 Hot Spot; Outfall 001 EU14 Hot Spot; and Within the Fence, Excluding Hot Spots for the future industrial worker based on dermal contact with total PCBs and TCE as the risk drivers.

Cancer risk estimates were within the target range of 1E-06 to 1E-04 for future recreational users at the NSDD Hot Spot and the NSDD, Excluding the Hot Spots. Cumulative hazard estimates were greater than 1 at both EUs for all groups based on dermal contact with soil/sediment, with the exception of the current child at the NSDD, Excluding the Hot Spot, which met the hazard limit. The primary risk drivers were antimony, iron, uranium in both areas and PCBs as well in the NSDD Hot Spot. Ingestion of game by future recreational users and dermal contact with surface water, regardless of age, were relatively insignificant pathways. Cancer risk and noncancer HIs were estimated to be two orders of magnitude lower than those for ingestion and dermal contact with soil/sediment and fall at or below EPA thresholds.

Cancer risk and noncancer hazard estimates for current industrial workers and current recreational users (outside the security fence) are more appropriate receptors for this OU relative to future risk estimates for industrial workers, excavation workers, and recreational users using default Methods Document exposure assumptions. Cancer risks and noncancer hazards for the current industrial worker were estimated based on a 14-day per year exposure frequency, making it more representative of possible future site risks that would be applicable to the narrow system of drainages ditches that make up the SWOU. Future industrial workers spending 8 hours per day, 250 days per year for 25 years, as the Methods Document directs, in one or more ditches is not realistic. Similarly, the current recreational user visits the NSDD 10 days per year for one year in contrast to the future recreational user that spends 140 days per year for six years. Therefore, the priority areas of concern are Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot based on current risk to industrial workers. In addition to summary tables, detailed calculations for the risk assessment are presented in Attachments D3, D4, and D5. The information in the tables was used to construct the risk characterization and summary tables presented earlier in this section.

D.6 UNCERTAINTY IN THE RISK ASSESSMENT

Uncertainties are associated with each step of the risk assessment process. The potential effect of the uncertainties on the final risk characterization must be considered and, where possible, quantified when interpreting the results of the risk characterization because a number of assumptions are made during the risk assessment. Types of uncertainty to be considered are divided into four broad categories, namely those associated with data, with exposure assessment, with toxicity assessment, and with risk characterization. Specific uncertainties in each of these broad categories are discussed in the following sections, with the magnitude of the effect of the uncertainty on the risk characterization being categorized as small, moderate, or large. Uncertainties categorized as small do not affect the risk estimates by more than one order of magnitude; those categorized as moderate may affect the risk estimates by between one and two orders of magnitude, while uncertainties categorized as large may affect the risk estimate by more than two orders of magnitude.

In evaluating these uncertainties and their estimated effect on the risk estimates, it should be remembered that the following uncertainties are neither independent nor mutually exclusive; therefore, the total effect of all uncertainties discussed in the following sections on the risk estimates (i.e., total HIs and ELCRs) is not necessarily the sum of the estimated effects.

D.6.1 UNCERTAINTIES ASSOCIATED WITH DATA AND DATA EVALUATION

Several uncertainties are associated with the data set and the selection of COPCs. Specific uncertainties discussed in the following sections are (1) representativeness of available data for the SWOU, (2) selection of COPCs, and (3) determination of EPCs under current and future conditions.

D.6.1.1 Data Representativeness

A large number of samples of soil and sediment have been collected to support this risk assessment. For chemicals identified as COPCs and particularly for the major risk drivers, the dataset consists of results from several hundred unique sampling locations. This density of sampling along the length of the drainages in the SWOU provides a robust characterization of contamination; however, for some of the other chemicals, fewer samples were collected and confidence in site characterization for these COPCs is less. At one extreme, only two samples for chlorinated dioxins/furans were available in the SWOU data base. These two samples cannot be assumed to characterize adequately the presence or absence of dioxins/furans or the concentrations of these contaminants at the site. For chemicals not included on the COPC list developed for the SAP (DOE 2005), previous investigations at the site have to be depended upon to have identified all of the chemicals that might be important for evaluation of human health threats. Since the PGDP has been extensively investigated over a period of many years, confidence is high that no important COPC has been overlooked.

D.6.1.2 Selection of COPCs

Uncertainty in the selection of COPCs is derived primarily from the initial selection of COPCs. For those chemicals, data from very large numbers of samples collected throughout the SWOU are available to support selection of COPCs, and it is unlikely that any of these chemicals was selected improperly as COPCs. Selection of chemicals as COPCs that do not contribute substantially to site-related risks is not of great concern, since a detailed evaluation of these chemicals follows in the analysis.

Chemicals detected in soil and sediment samples from the SWOU were selected only if they were identified as potential COPCs in Table 5.1 of the SAP (DOE 2005) and were detected at maximum concentrations that exceeded residential no action levels. A few other chemicals might have been selected as COPCs in a traditional COPC screen (Table D.48). These chemicals were detected infrequently in a relatively small number of total samples. Moreover, these chemicals have not been identified as significant risk drivers in past risk assessment for the site and are unlikely to be important for risk management at the site. Some additional discussion of these chemicals is included below.

Table D.48. Other Possible COPCs for the SWOU

Chemical Name	Units	Minimum	Mean	Maximum	Percent detect	Residential no action level	Selected as a COPC?	Qualitative analysis?
1,1-Dichloroethene	mg/kg	0.01	0.06	0.508	2%	0.0276	No	Yes
1,2-Diphenylhydrazine	mg/kg	0.46	0.48	0.5	14%	0.117	No	Yes
2,4-Dinitrotoluene	mg/kg	0.46	0.49	0.5	4%	0.209	No	Yes
2,6-Dinitrotoluene	mg/kg	0.46	0.49	0.5	4%	0.209	No	Yes
3,3'-Dichlorobenzidine	mg/kg	0.46	0.49	0.5	9%	0.208	No	Yes
Bis(2-chloroethyl) ether	mg/kg	0.46	0.49	0.5	7%	0.029	No	Yes
Carbazole	mg/kg	0.46	0.56	7.3	9%	6.14	No	Yes
Dieldrin	mg/kg	0.003	0.03	0.062	3%	0.0059	No	Yes
Hexachlorobutadiene	mg/kg	0.46	0.49	0.5	8%	0.32	No	Yes
Nitrobenzene	mg/kg	0.46	0.49	0.5	6%	0.492	No	Yes
N-Nitrosodimethylamine	mg/kg	0.46	0.48	0.5	14%	0.0018	No	Yes
N-Nitroso-di-n-propylamine	mg/kg	0.46	0.49	0.5	6%	0.0073	No	Yes

Several potential COPCs were detected a frequency of less than 5% (1,1-dichlorethene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, and dieldrin). Standard EPA guidance (EPA 1989) suggests that chemicals detected at a frequency of 5% can be eliminated as COPCs, so long as the chemicals are not known human carcinogens. The low frequency of detection for these four chemicals, combined with the lack of previous assessments that identified these chemicals as site-related risk drivers, suggests that no significant underestimation of risks resulted as a result of not including these chemicals in the risk analysis.

Two other chemicals, n-nitrosodimethylamine (NDMA) and n-dinitroso-di-n-propylamine, are common disinfection byproducts and may be present occasionally as result of releases of municipal water into the drainage system. These chemicals are not likely to be related specifically to plant operations and would be unlikely to be important for risk management for the site.

Nitrobenzene was detected at concentrations near the detection limits and only marginally above the residential no action level. Bis(2-chlorethyl)ether also was detected only at concentrations marginally above detection limits and at a frequency of detection of 6%. The detection limit for this chemical was about an order of magnitude above its residential no action level; thus, it could contribute somewhat to total risks at the site. Other COPCs that are risk drivers for the site are present at maximum concentrations ranging from several hundred to over 10,000 times higher than their respective no action levels; thus, bis(2-chlorethyl)ether is unlikely to be a significant contributor to total site related health risks.

Additionally, carbazole was reported infrequently in soil and sediment within the SWOU. Carbazole is a noncarcinogen and conceivably could contribute to noncancer hazards. However, HI estimates were low and mostly below the threshold of concern of 1. Since risk drivers for the site do not suggest significant noncancer hazards, carbazole is unlikely to suggest significant health hazards.

Benzidine was detected in 3 of 29 samples at the reported detection limit (approximately 0.50 mg/kg). The detected results were estimated based on poor surrogate recoveries. The detection limit for this chemical was approximately three orders of magnitude above the residential no action level and 2.5X the action level. Benzidine was historically used in large amounts for the production of dyes for cloth, paper, and leather. However, it has not been manufactured in the United States since the mid-1970s and is no longer used in medical laboratories or in the rubber and plastic industries. As such, the presence of benzidine in 10% of the historical samples is not likely to be related specifically to plant operations and the reported results are more likely an artifact of the historical laboratory analyses; therefore, benzidine would be unlikely to be important for risk management for the site.

Hexachlorobenzene was detected in 4 of 52 samples at the reported detection limit (approximately 0.50 mg/kg). The detection limit for this chemical was an order of magnitude greater than the residential no action level; thus, it could contribute somewhat to total risk of the SWOU. However, the reported concentrations were two orders of magnitude less than the action level and it is unlikely to be a significant contributor to total site related health risks. Other COPCs that are risk drivers for the site are present at maximum concentrations ranging from several hundred to over 10,000 times higher than their respective no action levels.

Finally, dioxins/furans were not selected as COPCs for use in the BHHRA because limited characterization information is available for the PGDP outfalls and ditches. Two historical soil/sediment samples from Outfall 010 were analyzed for dioxins/furans. The maximum concentrations of the majority of the dioxins/furans analyzed are below the residential no action levels as presented in the Risk Methods Document. Other COPCs that are risk drivers for the site are present at maximum concentrations ranging from several hundred to over 10,000 times higher than their respective no action levels.[1]

Overall, chemicals not selected as COPCs for the site are unlikely to contribute significantly to site-related cancer risks or noncancer hazards. For the reasons cited here and also because of conservative assumptions used throughout the BHHRA process, risks and hazards presented in Section D.5 are likely to reflect accurately the upper range of those possible for the site.

D.6.1.3 Uncertainties Related to Background Conditions and Laboratory Analysis

Maximum detected concentrations of each analyte in soil/sediment were compared to estimated background concentrations for PGDP. Background values used in this comparison were taken from *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1997). Chemicals with maximum detected concentrations at or below background are considered to be at a level of no significant risk and it is acceptable to eliminate them from further consideration in the remedial phase of the project. Primary contributors to HI are antimony, manganese, and iron. For the most part, manganese and iron likely are present at concentrations within the background range for PGDP. The range of EPCs for manganese (maximum of 1,540 mg/kg) is below the estimated background of 7,700 mg/kg. Likewise, all but one EPC for iron is less than the estimated background of 28,000 mg/kg. The single exception is a case where, due to statistical instability in the H-statistic calculation, the maximum detection of iron had to be used for the EPC. Likely, the high estimates of noncancer hazard are not due to site-related contamination.

There is uncertainty associated with the antimony analytical results, as all of the detected concentrations were reported either at or slightly above the detection limits. The detection limits also were high, likely due to matrix interferences, at concentrations ranging from 8.41 mg/kg to 9.97 mg/kg

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

(assumed to be a 1X dilution) or at 20 mg/kg (assumed to be a 2X dilution). Comparatively, the detected concentrations ranged from 8.41 mg/kg to 9.99 mg/kg or a value of exactly 20 mg/kg. The average concentration calculated with detected concentrations only (238 results) was 10.4 mg/kg, and the average concentration calculated using both detected and nondetected concentrations using full detection limits (433 results) was 10.8 mg/kg. Collectively, these results indicate that the detected and the nondetected results were virtually indistinguishable. Therefore, there is a high degree of uncertainty as to whether the antimony results from soil/sediment samples that are driving hazard risk are truly representative of actual detected concentrations in soil/sediment.

D.6.1.4 Determination of Exposure Point Concentrations—Current Conditions

Uncertainty in the calculated EPCs under current conditions cannot be quantified for this BHHRA; However, qualitative discussion of some uncertainties is informative. Most importantly, EPCs were developed for exposure areas identified using spatial analysis of data for three indicator chemicals. Exposure areas were identified based solely on these data and did not consider the human behavior patterns. That is, the likelihood that people would visit specific areas of the site could not be easily defined, and a basic assumption in the risk assessment is that all drainages would be visited with equal frequency by all receptors. This assumption is undoubtedly not true, but information is lacking to refine the analysis further. EPCs for the various refined EUs could, therefore, either under or over predict actual exposure concentrations for people that actual visit the drainages. Overall, the range of possible risks and hazards among the various EUs was not large, and it seems unlikely that other definitions of EUs would result in significantly different estimates of risk.

In addition, calculation of EPCs for different EUs is subject to uncertainty. For some chemicals in some EUs, the number of independent data points was too small to support calculation of 95% UCLs. EPCs in these instances was maximum detected concentrations. In other cases, the datasets for some chemicals gave unstable estimates for the 95% UCL using the H-statistic as required in the Methods Document (DOE 2001), and EPCs had to default to the maximum concentration. Finally, in some instances, an appropriate UCL might have been based either on a gamma distribution or on a nonparametric estimate. Instead, the Methods Document (DOE 2001) requires that all 95% UCL be calculated using the H-statistic, except when data are determined to follow a normal distribution.

For small data sets, use of the maximum concentration could either under- or over-estimate possible exposure concentrations. Since the data set is small, some higher concentrations within the EUs could have been missed; however, the maximum also could overestimate the average concentration within the EUs. It is not possible to quantify this uncertainty.

For larger datasets, defaulting to the maximum concentration likely substantially overestimated EPCs. An EPC is intended to represent average concentrations within an EU. Where the number of data points is reasonably large, the maximum is likely to overestimate such an average. Similarly, for larger datasets, failure to use a more appropriate statistical calculation and defaulting to the H-statistic would overestimate an actual EPC.

Overall, however, such cases only affected one or two COPCs for a given EU and would not cause substantial overestimation of total risks. The affect on total estimates for cancer risk and noncancer hazards is expected to be small.

D.6.1.5 Determination of Exposure Point Concentrations—Future Conditions

EPCs for future conditions were not estimated separately. Instead, EPCs for current conditions were assumed to be representative of future EPCs. That is, the risk assessment does not consider that concentrations of some contaminants may be lower in the future because of processes such as degradation and erosion, nor does it consider the potential for future release of contaminants from upgradient sources. Substantial degradation, including radioactive decay, will occur for the risk drivers at the SWOU, though such attenuation factors will work slowly and would require many years to produce significant reductions in exposure concentrations. However, erosion of contaminants in sediments in the drainages during periods of higher flows could be more important in gradual attenuation due to transport of materials downstream. Even this mechanism might be fairly inefficient because of the shallow gradients in the drainages. Water flows in the drainages should be fairly slow and generally may lack the energy to move large amounts a material.

Further release of contaminants is not likely from primary upgradient sources because of better waste management practices. Some upgradient EUs for the site have relatively high concentrations of contaminants that could be moved downstream in the future. Thus, the pattern of contamination in the ditches could change in the future, and thus the pattern of risk and hazard estimates for the site might also change. The magnitude of such risks is not, however, expected to change substantially, since no mechanisms that might lead to increased concentrations in soil/sediment are obvious.

Overall, EPCs estimated using current data are probably reasonable estimates for exposure conditions for several years, but increasingly will overestimate site concentrations over the longer term. Thus, the overall effect of this uncertainty is estimated to be small for near future, but would be suspect after longer periods of time.

D.6.1.6 Effect of Combining Soil and Sediment Data

Data available for use in the BHHRA for the SWOU include samples labeled either as soil or sediment. The drainages that comprise the SWOU are often dry and support growth of grasses. That is, the drainages are not typical aquatic habitat, in most instances, and the distinction between soil and sediment is blurred. Receptors visiting the drainages likely would contact any solid media, whether characterized as soil or sediment during any activities; thus, combining soil and sediment data sets seems reasonable. However, depending on whether water is present in the drainages, the magnitude of exposure to soil versus sediment could vary. For example, with water present, sediment could be washed off hands before being incidentally ingested while children played in the ditches. In this case, ingestion of soil could be enhanced because soil could adhere more readily to wet hands. Such nuances of exposure cannot be quantified, and it seems best to consider solid media, both soil and sediment, as a single source of exposure within the ditches.

In terms of site characterization, ditch contamination in the SWOU probably is well defined by available sediment data. Data categorized as soil, however, are much fewer and, by themselves, would not be representative of all areas within the OU. That is, few soil sampling locations for soil would be located in some EUs, and EPCs calculated from these data would be suspect; thus, to some extent, combining of soil and sediment data was necessary for the evaluation.

Within the fenced area, sediment also was combined with soil for the evaluation of both industrial workers and excavation workers because, as discussed above, the distinction between soil and sediment is unclear. Exposure to sediments in the bottom of ditches inside the security fence seems unlikely, especially when water is present. Unless workers are specifically assigned tasks that would require them to work in the ditches, it is difficult to rationalize visits to these areas. Workers on breaks, eating lunch outside, walking across the site, would be unlikely to make use of ditch bottoms; thus, combining soil and sediment data should have little impact.

Overall, exposure concentrations calculated from combined soil/sediment data is dominated by the more numerous sediment data; thus, the effect of combining data sets on EPCs is relatively small. However, uncertainties related to human activities in the ditches, and subsequent exposure to soil and sediments remains an important uncertainty. Such uncertainties are discussed in several of the following subsections.

D.6.2 UNCERTAINTIES ASSOCIATED WITH EXPOSURE ASSESSMENT

Uncertainties associated with the exposure assessment are from five sources, namely (1) biota fate and transport modeling, (2) use of the RME scenario, (3) development of the CSM and selection of pathways, (4) use of default values when estimating dermal absorbed dose, and (5) use of conservative exposure values for the excavation worker and industrial worker land use scenarios.

D.6.2.1 Uncertainties in Biota Fate and Transport Modeling

Modeling was used to estimate chemical concentrations and radionuclide activities in game that might be taken in the future for the area around the NSDD. Although the models used in this assessment are industry standards (DOE 2001), their output contains a considerable amount of uncertainty. Typically, actual data from biota samples is used to support modeling of contaminate concentrations from soil, through forage and into game species. Such data were not available for the SWOU, and all concentrations of contaminants in game species are estimated based solely on generic estimates of trophic transfer. For example, contaminant uptake factors derived for deer were used to estimate contaminant uptake in other herbivorous mammals, such as rabbits. Such species-to-species extrapolations add to the overall uncertainty regarding potential concentrations of contaminants in biological tissues. However, this approach is not totally unreasonable given the fact that both deer and rabbits are herbivorous mammals with reasonably similar diets and physiology. Although site-specific uptake or bioaccumulation factors (BAFs) for COPCs determined for this site are unavailable, data from other sites can be used to support the assumption that uptake of certain contaminants does not differ substantially between species with similar diets. For example, the mean BAF of Total PCBs from soil or sediment to herbivorous mammals ranged from 0.025 (deer mouse) to 0.08 (muskrat) at the Kalamazoo River in western Michigan (CDM 2003). Although these BAFs from a highly contaminated site should not be applied directly to this site, these data do support the assumption that extrapolating BAFs from one herbivorous mammal to another is unlikely to significantly affect risk estimates associated with these BAFs.

To ensure that fate and transport models generated values that were unlikely to underestimate dose (i.e., were conservative values), default modeling parameters were used in all cases. As with all default values, such parameters are chosen to represent the upper range of possibilities and often overestimate actual transfer when compared against field data. Such overestimation is likely for the SWOU analyses, but other considerations make a definitive conclusion difficult.

For example, considerable uncertainty exists in assumptions made concerning forage areas for game versus areas of contamination. Game will, of course, not recognize the boundaries established for the refined EUs used to estimate possible risks in this assessment. In fact, use of the ditches by game will vary with individuals of the same species within the OU. The problem is multiplied by the linear nature of the contaminated area. Some animals may spend considerable time in the ditches and move about mostly along the ditch axis; other may seldom visit the ditches at all. The relative proportion of animals that use or not use the ditches would play a large role in determining how much contaminated game could be taken from a reasonable hunting area.

Finally, the overall productivity of the NSDD area is not known, and assumptions that it could support substantial take of game over an extended period cannot be verified. If the area is relatively unproductive, it will not be visited frequently by hunters, while the converse is true if the area is very productive. Observations at the site suggest that the area would not be at either extreme, but data would be required to determine what impact productivity would have on estimated risks from this pathway.

In an absolute sense, use of default modeling parameters could result in a large overestimate of potential risks. Risk calculations suggest that relative to incidental ingestion, dermal contact, and inhalation pathways combined, consumption of contaminated game would not contribute significantly to risks. For example, total cancer risk for an adult consuming game from the site is about two orders of magnitude lower than the risk for an adult engaged in other recreational activities within the same EU; thus, recreational hunters are not a recreational population at greatest risk for the NSDD area. Although considerable uncertainty exists in the evaluation of game for the site, it seems unlikely that risks are underestimated by two orders of magnitude. Thus, the contribution of uncertainties for the game consumption pathway is judged to be small.

D.6.2.2 Uncertainties in Use of Reasonable Maximum Exposure Scenarios

For each exposure pathway modeled, assumptions were made about the number of times per year an activity could occur, applicable routes of exposure (ingestion, inhalation, dermal contact), and default rates of intake of contaminated media (soil/sediment, surface water, game). Because site-specific data were not available for many parameters, EPA and Commonwealth of Kentucky defaults were used (DOE 2001), with two exceptions. The first exception was the exposure frequency of the industrial worker. Based on process knowledge of ongoing maintenance activities and the low likelihood of workers spending an extended period of time in the drainage ditches, a more realistic exposure frequency of 14 days was implemented for current industrial workers. However, the default 250-day exposure frequency still was implemented for future industrial workers. The second exception was the exposure frequency, duration and time for the child recreational user. Current child users were assumed to be present 10 days per one year for 4 hours per visit. These more realistic exposure parameters were based on professional judgment and the unattractiveness of the area outside the fence. The default exposure parameters of 140 days, six years, and 5 hours per visit were employed for future child recreational users, as a conservative measure. Default parameters intentionally are conservative to prevent the underestimation of risk; thus, risk estimates based on defaults can be overly conservative when exposure scenarios do not match default conditions. Further, when several upper-bound values are combined, the derived value can exceed a level of exposure that may be reasonable at a site. In consideration of these problems, attention should be focused not on the fact that any individual dose model is overly conservative, because most are not, but on the fact that if results from several conservative dose models are combined, the resulting total dose may be overestimated.

D.6.2.3 Uncertainties Related to Development of the Site Conceptual Model and Selection of Pathways

Generally, the level of uncertainty in the development of the CSM is small. Data used to develop this model were from several previous investigations and from local experts; however, some of the uncertainties related to specific land use scenarios deserve additional explanation. These uncertainties involve the consideration or lack of consideration of specific pathways for some land use scenarios and the lack of consideration of a separate residential use land use scenario.

Uncertainties associated with elimination of exposure pathways for some land use scenarios is expected to be small. All pathways, as discussed in Section D.3, that could contribute significantly to exposures to workers in, or recreational users of, the SWOU were carried through the quantitative analysis. Some uncertainty remains due to the exclusive focus of the BHHRA on soil/sediment and surface water. More important may be uncertainties in the definition of exposure scenarios for the site. None of the typical receptors defined in the Methods Document (DOE 2001) fits well with the SWOU. These uncertainties are discussed in detail above.

Finally, a residential homestead scenario was not included in the risk assessment. This exclusion is appropriate given the nature of the SWOU (narrow linear drainage features); however, the recreational scenario served to evaluate risks to nearby residents.

D.6.2.4 Uncertainties Related to Use of Default Values When Estimating Dermal Absorbed Dose

In this assessment, default dermal absorption factors suggested by the Commonwealth of Kentucky in its *Risk Assessment Guidance* (KDEP 1995) (5% for inorganic COPCs, 10% for SVOCs, and 25% for VOCs) were employed. The few exceptions to this were arsenic, benzo(a)pyrene, cadmium, fluoranthene, and Total PCBs with respective chemical-specific dermal absorption factors of 0.03, 0.13, 0.001, 0.13, and 0.14. Use of default factors for the remaining chemicals instead of EPA Region 4 (EPA 1995) default values (0.1% for inorganic COPCs and 1% for organic COPCs) increases potential cancer risk and HI estimates by a factor of 50 for inorganic compounds and 10 for organic constituents. This factor of 50 increase in potential risk is particularly significant for the metals antimony, iron, and uranium, which were selected as priority COCs. Since no VOCs were selected as COPCs for thesoil/sediment, the factor of 25% for these chemicals would not have any influence.

Dermal absorption factors suggested as defaults by the Commonwealth of Kentucky are much higher than those commonly accepted in the risk assessment community and are likely to overestimate dermal absorption. A more important uncertainty is associated with dermal absorption of PCBs. PCBs tend to bind tightly to organic matter in soils/sediments and may have limited bioavailability for dermal absorption. The assumption used in this risk assessment, that dermal absorption of these chemicals for solid media is 14%, could overstate absorption considerably. Since dermal contact is the dominant route of exposure in terms of total risk and HI estimates, absorption of PCBs is of significance. Substantial overestimation of risk is possible, and the uncertainty is judged to be moderate to high.

D.6.2.5 Uncertainties Related to Evaluation of the Excavation and Industrial Worker Land Use Scenarios

The Commonwealth of Kentucky guidance (KDEP1995) recommends using 185 days per year and 25 years for the exposure frequency and the exposure duration, respectively, for the excavation worker. These values probably exceed any actual exposure intensity likely for the SWOU because excavation has not been, and likely will not be, an ongoing activity within any of the refined EUs. More likely than nearly continuous exposure over 25 years would be occasional excavation (ditch cleanout) occurring only every few to several years. If exposure duration were reduced to reflect such exposure, risk and HI estimates would be reduced by a factor of the new exposure duration divided by 25. For example, if cleanout was assumed to occur every fifth year, exposure duration would be 5 (five years of cleanout over the course of 25 years of employment) and risks estimates would be reduced to 20% of those reported in the risk assessment.

An exposure frequency of 185 days per year also may be too high. One would expect that ditch cleanout would be accomplished rapidly using machinery and would not take more than half a year to complete. Exposure frequency is difficult to determine for the SWOU; however, a value of 185 days is likely to overestimate risks to some degree.

Another uncertainty affecting the excavation worker scenario is the use of chronic toxicity criteria to evaluate subchronic exposures. Using EPA's definition, chronic exposures are those longer than seven years in length (RAGS). A more reasonable exposure duration for excavation workers for the SWOU may be only a few years and likely will be intermittent with long periods of no exposure interspersed with short periods of work in the ditches; thus, for the excavation worker land use scenario, toxicity values based on subchronic exposure likely are more appropriate. However, chronic values were used for the excavation land use scenario to remain consistent with Kentucky Environmental and Public Protection Cabinet (KEPPC) exposure duration (i.e., 25 years) and because subchronic values are unavailable for many chemicals.

The default exposure frequency for future industrial workers proved to overestimate risk and hazards for current workers. The default exposure frequency of 250 days/yr for the future industrial worker indicated cumulative risk above 1E-04 at Outfall 001 EU 14 Hot Spot; Outfall 008 Hot Spot; Outfall 010 Hot Spot; Outfall 011 Hot Spot; Outfall 015 Hot Spot; Within the Fence, Excluding the Hot Spots; and the NSDD Hot Spot. Current industrial worker risks, based on an exposure frequency of 14 days/yr, above 1E-04 were limited to Outfall 001 EU 14 Hot Spot; and Outfall 011 Hot Spot. Noncancer hazards associated with the future industrial worker were above 1 at all locations, while hazards for current workers were estimated below 1 at all locations.

Differences between subchronic and chronic toxicity values for systemic toxicity are often an order of magnitude; thus, by itself, uncertainty associated with the use of chronic toxicity criteria for short-term intermittent exposure could have moderate impact on HI estimates. When this uncertainty is combined with uncertainties in exposure duration and frequency, the overall impact on risk and hazard estimates for this BHHRA fall in the moderate to large range.

D.6.3 UNCERTAINTIES ASSOCIATED WITH TOXICITY ASSESSMENT

Uncertainties related to the toxicity assessment stem from three sources: (1) uncertainty because toxicity values are lacking for some chemicals, (2) uncertainty in the calculation of toxicity values by EPA, and (3) uncertainty in the calculation of absorbed dose toxicity values from administered dose toxicity values. Each of these is discussed in the following paragraphs.

D.6.3.1 Uncertainties Because Toxicity Values Are Lacking for Some Chemicals

Uncertainties due to lack of toxicity values for some chemicals result from three sources in this BHHRA, including use of provisional or withdrawn values, extrapolating a toxicity value for oral exposure to inhalation, and lack of site-specific information on chemical speciation for such elements as mercury and chromium.

Uncertainty associated with the use of provisional or withdrawn toxicity values may have a significant effect on the results of the BHHRA for some chemicals. One notable COPC with provisional or withdrawn criteria is lead. In lieu of using the value provided by KEPPC in a comment package on the WAG 17 RI/BHHRA, this assessment employed the Adult Lead Methodology (EPA 2003) to assess potential lead exposures. This model is more defensible than the provisional values provided by KEPPC and is in keeping with current risk assessment practice for evaluating lead exposure. Thus, uncertainties associated with use of unvalidated toxicity criteria had no impact on the assessment of risks related to lead exposure.

A more important example of the uncertainty of using provisional or withdrawn toxicity values to compute HIs and/or cancer risk estimates is the assessment of noncancer impacts from exposure to iron.

This issue is important in this risk assessment because iron appears as a risk driver for noncancer effects for some exposure pathways of the SWOU (e.g., adult recreational exposures to soil/sediment). One means of assessing the uncertainty in the iron RfD is to compare EPCs of iron with background concentrations. For the most part, EPCs for iron for the various refined EUs fall below a local estimate for background of 28,000 mg/kg; thus, HQ for iron reported in this assessment are, by and large, due to iron being present only at concentrations typical of soils in the vicinity of the PGDP. For those few exposure estimates where the iron HQ exceeds one, the impact of using the provisional RfD for iron is sufficiently great to affect risk management decisions; thus, the uncertainty assessment for iron is critical for proper interpretation of results of the risk assessment.

Another source of uncertainty associated with choice of toxicity values arises from metals such as chromium that can exist in more than one oxidation state. In this risk assessment, the simplifying assumption was made that all of the element was in the Cr III form. This approach may not be thought conservative because the lower (and therefore more stringent) chronic oral RfD is associated with Cr VI (3E-03 versus 1.5E+00 mg/kg-day, respectively) and because Cr VI is considered carcinogenic via inhalation. Typically, chromium will exist in the Cr III form in soils, except under extremely reducing conditions. Such conditions are not reported for the SWOU, thus, the assumption of Cr in the Cr III form is likely reasonable. Further, even with a factor of 1,000 between the RfDs for Cr VI and Cr III, HI estimates for exposure to chromium would not exceed the target HI of 1 even if all Cr was present as Cr VI. Since, at worst, only a fraction of chromium would be present as Cr VI, chromium would not present a significant hazard for receptors in the refined EU.

Further, the inhalation pathway is not an important contributor to cancer risks. For example, cancer risks due to arsenic (a carcinogenic metalloid with a relatively large inhalation SF) from inhalation exposure typically are four to five orders of magnitude less than those for either dermal contact or incidental ingestion of soil/sediment. Actual risk estimates fall in the range of 1.0E-10 to 1.0E-11. Similar estimates would be expected for an analysis for inhalation exposure to chromium as Cr VI. Further, since Cr VI is only carcinogenic via inhalation, estimates of cancer risk for Cr VI would be based only on this exposure and would be far less than the bottom of the EPA risk range (10^{-6}). In fact, when the most sensitive receptor to chromium, (identified as the future industrial receptor due to having the highest noncancer chromium hazard estimate) and the EU with the highest EPC are combined (Outfall 011) and the Region 4 Inhalation SF for Cr VI is factored into the equation, the chromium risk estimate is 1.4E-8. Given that this is the worst case scenario, analysis of chromium as Cr III instead of Cr VI in the risk assessment is unlikely to have had an influence on the results of risk calculations or on the overall conclusions of the evaluation.

Toxicity criteria for manganese also may overstate potential health risks, possibly because the forms of manganese in soil are not taken into account when addressing exposure. The HQ for manganese for residents is potentially higher than the threshold of 1 by two orders of magnitude (see above), yet EPCs for manganese are uniformly less than the background estimate for soil in and near the PGDP. Overall, overestimation of potential impacts of manganese on risk estimates is small because HQ for manganese among the refined EUs is less than the threshold of 1 for receptors quantitatively evaluated in this BHHRA.

In the past, there was uncertainty in the selection of the appropriate toxicity value for PCBs (e.g., Aroclor-1254, -1260, etc.) because of (1) difficulty in identifying specific Aroclors in a mixture, (2) different rates of decay among the Aroclors in environmental media, and (3) the effects of weathering processes on the congener-specific “fingerprint” over time, a process making the Aroclors appear to be more chlorinated than they actually are. To address these concerns and to ensure that the risk numbers for Aroclors are suitably conservative, KEPPC requires that all PCBs be evaluated as Aroclor-1260. This assessment conforms to KEPPC guidance because oral SFs for all Aroclors were assumed to be equal to

2.0 $(\text{mg/kg-day})^{-1}$, consistent with recent EPA guidance (EPA 1996) and identical to the current upper-bound SF for Total PCBs found on IRIS (EPA 2006). Results for exposures to multiple Aroclors are summed to generate a Total PCB-specific value. Unlike earlier assessments performed at PGDP in which the effect of uncertainty in the selection of toxicity values for PCBs on the final risk values may have been moderate, the effect of this uncertainty on ELCR determinations is likely to be small. This conclusion does not, however, suggest that the uncertainty in the SF itself is small. Discussion of uncertainties in toxicity criteria are discussed in Section D.6.3.2.

Including inhalation toxicity values extrapolated from administered doses in the risk characterization would not have significantly affected the results of the BHHRA. EPA guidance (RAGS) recommends against extrapolating between oral and inhalation toxicity values because of the differing path a chemical entering through the lungs follows before target tissues or organs compared to that of a chemical entering via the intestines. In particular, chemicals absorbed from the gut may be metabolized in the liver prior to being distributed in the body (the "first pass" effect). However, inclusion of this extrapolation and discussion of this uncertainty in assessments for PGDP was requested by the regulatory community. Previous work at PGDP, in which this effect was examined quantitatively, demonstrated that including extrapolated inhalation toxicity values in the risk characterization resulted in insignificant changes in the final risk estimates, because the relative contribution of the inhalation pathway is small relative to ingestion and dermal contact, often by orders of magnitude. [This was quantitatively examined by the Risk Assessment Working Group (RAWG) as part of their review of the Action/No Action Level calculation in May 2000. It is specific to contributions to risk/hazard from metals and radionuclides in soil. Additionally, the minutes from the RAWG indicate that extrapolation should follow Region 9 guidance.] Therefore, the estimated effect of this uncertainty on the risk results is small.

D.6.3.2 Uncertainties in Deriving Toxicity Values

Standard EPA RfDs and SFs were used to estimate potential noncarcinogenic and carcinogenic health effects from exposure to chemicals. However, considerable uncertainty is associated with the method applied to derive SFs and RfDs, even though EPA has working groups that review all relevant human and animal studies for each compound and select studies pertinent to the derivation of the specific RfD and SF. For example, the primary information often involves data from experimental studies in animals, high exposure levels, and exposures under acute or occupational conditions. Extrapolation of these data to humans under low-dose and chronic conditions introduces uncertainties, the magnitude of which is addressed by applying uncertainty factors to the dose response data for each applicable uncertainty. These factors are incorporated to provide a margin of safety for use in human health risk assessments. Generally, the effect of uncertainties in calculating chemical toxicity values is judged to be moderate.

Estimates for SFs for PCBs are particularly important for this BHHRA because PCBs are the primary risk driver for the SWOU. Considerable uncertainty still exists in assessment of whether PCBs cause cancer at all at low levels typical of environmental contamination. High dose animal studies may be affected by cellular responses to systemic toxicity, and epidemiological studies of populations exposed to PCBs are insufficient to show a casual relationship between exposure and cancer. Possibly, PCBs do not cause human cancer at environmentally relevant concentrations. In such a case, risk estimates for the SWOU are dramatically overestimated. Additional understanding of basic toxicological mechanisms for PCBs will be necessary to resolve this uncertainty. Currently, the potential impact of uncertainty in deriving cancer SFs for PCBs cannot be quantified; therefore, it is believed that risks for PCBs may be overestimated.

Unlike uncertainty associated with chemical toxicity, quantitative uncertainty associated with radionuclide toxicity values is probably small. The dose-response relationship between cancer and ionizing radiation has been evaluated in many reports, including many on human epidemiology, and is well established. In addition, unlike toxicity values for chemicals, risk factors for radionuclides are extrapolated from the cancer risk established using the Japanese Atomic Bomb Survivors database and a relative risk projection model. Accordingly, carcinogenic SFs for radionuclides are based on human data and are likely to be more accurate. Cancer SFs based on such data are likely to be associated with relatively small uncertainties.

D.6.3.3 Uncertainties Due to Calculation of Absorbed Dose Toxicity Values from Administered Dose Toxicity Values

Uncertainty exists in the validity of the calculations used to convert an administered dose toxicity value to an absorbed dose. Of particular importance is the lack of consideration of point-of-contact effects in this calculation. For example, some organic analytes (e.g., PAHs) can cause a toxic or carcinogenic response in skin, an effect that is not considered in the calculation of absorbed dose toxicity values from administered dose toxicity values using EPA protocols. Similarly, the administered dose-response for many chemicals relies on the delivery of a high concentration of contaminants to the liver via the portal system after ingestion. This effect is not seen if a contaminant is absorbed through the skin because of the larger distribution space for the contaminant absorbed through the skin. However, even with these uncertainties, the effect of the uncertainty in calculation of absorbed dose toxicity values from administered dose toxicity values upon the risk estimates is likely to be relatively small. That is, the impact on risk estimates is probably within an order of magnitude.

D.6.4 UNCERTAINTIES ASSOCIATED WITH RISK CHARACTERIZATION

Three important uncertainties related to risk characterization are discussed below. The first is the validity of combining HQs and chemical-specific ELCRs across pathways and of combining pathway HIs and ELCRs to derive a total HI and ELCR. The second is the justification for combining risks from chemicals and radionuclides. The third is the assumption that all arsenic related risks and hazards are site related. These uncertainties are discussed in the following sections.

D.6.4.1 Combining Chemical-Specific Risk Values and Pathway Risk Values

The method used to calculate pathway HIs and ELCRs in the BHHRA follows EPA protocols (RAGS, Methods Document) and involves the simple addition of chemical-specific HQs and ELCRs to obtain pathway HIs and ELCRs, respectively. The method assumes that all effects among chemicals are additive, an assumption made by EPA in the absence of any evidence to the contrary. The following are certain limitations of the approach that have been noted by EPA in RAGS:

- Little is known about the effects of chemical mixtures. Although additivity is assumed, the interaction of multiple chemicals possibly could be synergistic or antagonistic. In many cases, no interaction at all would occur.

- Confidence in RfDs and RfCs is unequal across chemicals because of differences in the quality of toxicological data. Further, these criteria are not based on the same severity of effects.

- Dose additivity seems the most reasonable general assumption for COPCs that affect similar target organs or tissues. However, this approach, recommended by EPA, could overestimate cumulative systemic toxicity for chemicals that act by different mechanisms and/or on different target tissue or organs. Similarly, the approach could result in underestimation of effects for chemicals that interact synergistically.

The effect of this uncertainty on HI estimates depends on how many contaminants are significant contributors to noncancer hazards and on whether risk drivers act on the same or different target tissues or organs. In this BHHRA, comparatively few contaminants drive systemic toxicity for most land use scenarios, and often PCBs are the only risk drivers; therefore, interactions among multiple chemicals is unlikely to have more than a small effect on HI estimates.

EPA has reported specific limitations for this approach in regard to chemical carcinogenesis (RAGS):

- Cancer risks (i.e., ELCRs) are based on SFs that represent an upper 95th percentile estimate of potency, the probability distributions of which are unlikely to be strictly additive; therefore, summing these risks can result in an overly conservative estimate of lifetime ELCR.

- Cancer risks may not be additive. By analogy to systemic toxicity effects, target tissues and organs differ by chemical, and mechanisms of cancer induction vary by chemical class and route of entry. In theory, carcinogens may act additively, synergistically, or antagonistically.

- EPA assigns qualitative weight-of-evidence descriptors to its designation of chemicals as carcinogens or noncarcinogens [A, B, C, D, or E, as specified in EPA's current guidelines (EPA 1986), or "known/likely," "cannot be determined," or "not likely," as suggested in their recent proposed guidelines (EPA 1996)]. Where quantitative data are sufficient, the EPA develops SFs for compounds assigned to the A, B, C or "known/likely" categories. Uncertainty estimates for known human carcinogens are expected to be less than for chemicals with no or equivocal human data; however, the simple combination of ELCRs for potential carcinogens "across the board" in this BHHRA does not take this hierarchy into account.

Uncertainties involved in combining chemical-specific ELCRs and pathway ELCRs potentially are considerable; however, the effect of these uncertainties on the total ELCRs presented in the BHHRA is small because, for the most part, only a few COPCs dominate ELCR estimates

D.6.4.2 Combining Cancer Risk Estimates from Chemical and Radionuclide Exposure

Uncertainty associated with adding risks from chemical exposure to those from exposure to radionuclides arises from two sources. First, the mechanism by which chemicals cause cancer may differ from the mechanism by which radionuclides cause cancer (see Section D.4). This difference in mechanism of action could elevate the importance of uncertainties (as discussed in Section D.6.4.1) that assume cancer risks are additive. Second, as noted in Section D.4, SFs used to characterize the risk from chemicals are derived differently from SFs used to characterize risk from radionuclides. This difference may result in estimates of chemical exposure risks that may be considered to be upper-bound risk estimates and estimates of radionuclide exposure risks that may be considered to be central tendency (i.e., "best") estimates. Combining chemical exposure and radionuclide exposure risk estimates to derive total risk for a land use scenario may place too much emphasis on the risk due to chemical exposure. Overall, the effect of this uncertainty on the total risk value for each land use scenario is difficult to assess. On one hand, only a few COCs drive the risks at the SWOU being assessed in this BHHRA; on the other, PCBs in particular, probably act by very different mechanisms than does radiation. Within the SWOU, where organic chemicals, arsenic, and radionuclides drive risk, the effect of this uncertainty is assumed to be moderate.

D.6.5 SUMMARY OF UNCERTAINTIES

As shown in the above sections, risk estimates may vary if different assumptions are used in deriving risk estimates or if better information became available for some parameters. The following text and table (Table D.49) summarize the estimated effects of each uncertainty discussed previously.

A key uncertainty in the risk assessment is the lack of defined exposure scenarios for the unique environmental setting of the SWOU. None of the receptors in the Methods Document (DOE 2001) are well adapted for assessing the types of exposures anticipated for narrow linear features, used as drainages ditches that typify the OU. Available exposure scenarios and associated exposure parameters probably overestimate potential exposures and risks, possibly by a large margin.

Finally, uncertainties in the derivation of PCB cancer SFs are high, and dermal absorption of PCBs from soil/sediment is relatively high. It is possible that PCBs are not carcinogenic at environmentally relevant concentrations, and binding of PCBs to organic matter in soils and sediment greatly reduces its availability for dermal absorption. Since PCBs are the major risk driver for risks associated with soil/sediment and surface water, and dermal absorption is the most important exposure route, risks related to PCB exposure could be overestimated dramatically and even may be zero.

Table D.49. Summary of Uncertainty Assessment

Uncertainty	Impact on risk/HI estimates	Possible magnitude of impact
Data and Data Evaluation		
Data Representativeness	Under- or Overestimate	Small
Selection of COPCs	Underestimate	Small
Exposure Point Concentrations—Current Conditions	Under- or Overestimate	Small
Exposure Point Concentrations—Future Conditions	Overestimate	Small initially, becoming greater after several years.
Combining Soil and Sediment Datasets	Under- or Overestimate	Small
Exposure Assessment		
Biota Fate and Transport Modeling	Probably Overestimate	Small overall; potentially large when pathway is considered separately.
Use of RME Scenario	Overestimate	Small to moderate
Development of SCEM and Selection of Exposure Pathways	Under- or Overestimate	Small
Use of Default Values for Dermal Exposure	Overestimate	Moderate
Applicability of Industrial and Excavation Worker Scenarios	Overestimate	Moderate to large
Toxicity Assessment		
Lack of Validated Toxicity Criteria for Some Chemicals	Overestimate	Small overall. Use of provisional RfD for iron results may be important for recreational users (adult).
Derivation of Toxicity Criteria	Under- or Overestimate	Large. The assumption that PCBs are carcinogenic in human at low environmental exposures is controversial. Actual cancer risks could be much lower than those estimated and could even be zero.
Calculation of Absorbed Dose	Under- or Overestimate	Small
Risk Characterization		
Combining Risk and Hazard Estimates Across Pathways	Under- or Overestimate	Small
Combining Cancer Risk Estimates for Chemicals and Radionuclides	Under- or Overestimate	Moderate

The following are uncertainties with effects estimated to be moderate:

- Use of chronic toxicity values to evaluate excavation worker exposures,
- Derivation of toxicity values for chemicals,
- Combining risks across chemicals and radionuclides, and
- Use of site-specific exposure values on systemic toxicity for the current industrial worker.

The following is a list of uncertainties with effects estimated to be small:

- Representativeness in database,
- Selection of COPCs,
- Inclusion of biota exposure pathways,
- Extrapolation of BAFs from one herbivorous mammal to another,
- Exclusion of possible COPCs not on the initial COPC list in the SAP,
- Combining soil and sediment data,
- Assumption that current soil/sediment and surface water concentrations represent future concentrations,
- Development of the CSM and selection of pathways,
- Use of RME default exposure values instead of central tendency exposure values,
- Use of site-specific exposure values on systemic toxicity and cancer risks for the excavation worker,
- Use of site-specific exposure values on systemic toxicity for the current industrial worker,
- Use of chronic toxicity values for the excavation worker land use scenario,
- Use of provisional and withdrawn toxicity values on the total systemic toxicity and cancer risks,
- Assumption that all chromium in soil/sediment is present as Cr III,
- Use of inhalation toxicity values extrapolated from oral toxicity values,
- Development of radionuclide toxicity values,
- Use of absorbed toxicity values calculated from administered toxicity values,
- Combining pathway risks to determine land use scenario risk, and
- Use of “+D” radiological SFs to derive carcinogenic risk for all members of an isotopic decay series.

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D.7 CONCLUSIONS AND SUMMARIES

This section summarizes the results and conclusions of the risk assessment. The primary purpose of this section is to provide a concise summary of each of the risk assessment steps without the use of tables, extensive explanations, or justifications. This section also includes a series of observations that help integrate the analysis of uncertainties with the risk assessment.

D.7.1 CONTAMINANTS OF POTENTIAL CONCERN

COPCs were selected from data collected in the recently completed SWOU field investigation and previous investigations. This dataset was screened to produce a list of COPCs by medium and depth of sampling (for solid media). Soil and sediment data were combined into one medium, and then separate datasets were developed for each COPC for surface soil/sediment (0–1 ft bgs), subsurface soil/sediment (1–6 ft bgs), and surface water. A list of COPCs for the SWOU was identified based on previous investigations at PGDP (DOE 2005). Screening of maximum concentrations of these COPCs against the lesser of the lifetime excess cancer-based and child hazard-based no action levels identified 36 chemicals as COPCs for risk assessment in the SWOU as listed in Table D.1. As shown in Table D.1, 19 inorganic chemicals, 4 organic chemicals, 12 radionuclides, and 1 VOC were retained for risk assessment.

D.7.2 EXPOSURE ASSESSMENT

Previous studies identified the following three indicator chemicals for the SWOU: PCBs, cesium-137, and uranium-238 Extensive data for these three chemicals were collected during the recent site characterization effort. These data were used to identify reaches within the system of drainage ditches where contaminant concentrations, and, consequently, potential health risks could be elevated significantly above adjacent reaches. Such potential “hot spots” were evaluated as separate EUs within the SWOU. This analysis identified 13 separate EUs for the risk analysis. Risk assessment data sets identified in the COPC selection process were separated by EU in Table D.50 and used to calculate EPCs for use in risk calculations.

Historical information and newly collected data were used to develop a CSM for the SWOU EUs. After consideration of all data, land use scenarios selected for assessment were these: industrial worker, excavation worker, and recreational user (adult, teen, and child). Currently the only land use scenario applicable to the SWOU is industrial, but plausible future land use scenarios include industrial, excavation, and recreational scenarios.

Land use as a residential homestead is not anticipated for the SWOU; however, local residents are assumed to be the adults, teens, and children recreating at the site in the recreational scenario.

Table D.50. Summary of Redefined EUs

Redefined EU	SWOU risk areas included in the EU
NSDD Hot Spot	NSDD Section 3 EU 01
	NSDD Section 3 EU 02
Outfall 001 EU 13 Hot Spot	Outfall 001 EU 13
Outfall 001 EU 14 Hot Spot	Outfall 001 EU 14
Outfall 001 EU 15 Hot Spot	Outfall 001 EU 15
Outfall 001 EU 16 Hot Spot	Outfall 001 EU 16
Outfall 001 EU 18 Hot Spot	Outfall 001 EU 18
Outfall 001 EU 20 Hot Spot	Outfall 001 EU 20
Outfall 008 Hot Spot	Outfall 008 EU 08
	Outfall 008 EU 11
Outfall 010 Hot Spot	Outfall 010 EU 10
Outfall 011 Hot Spot	Outfall 011 EU 01
Outfall 015 Hot Spot	Outfall 015 EU 01
	Outfall 015 EU 02
	Outfall 015 EU 03
	Outfall 015 EU 04
	Outfall 015 EU 07
	Outfall 015 EU 08
NSDD, Excluding the Hot Spot	NSDD Section 3 EU 03
	NSDD Section 4 All EUs
	NSDD Section 5 All EUs
Within the Fence, Excluding Hot Spots	Outfall 001 EUs 01-12, 17, 19, 21-23
	Outfall 002 All EUs
	Outfall 008 EUs 01-07, 09, 10, 12-14
	Outfall 010 EUs 01-09
	Outfall 012 All EUs
	Outfall 015 EUs 05, 06, 09-11

Development of the CSM identified several potential exposure pathways within each of three land use scenarios selected for quantitative evaluation. By receptor, these pathways are detailed in Table D.51.

Table D.51. Summary of Receptors and Exposure Pathways

Current/future industrial worker	• Incidental ingestion of soil/sediment (surface) • Dermal contact with soil/sediment (surface) • Inhalation of particulates emitted from soil/sediment (surface) • External exposure to ionizing radiation emitted from soil/sediment (surface) • Dermal contact with surface water

Table D.51 (Continued)

Current/future excavation worker	• Incidental ingestion of soil/sediment (subsurface) • Dermal contact with soil/sediment (subsurface) • Inhalation of particulates emitted from soil/sediment (subsurface) • External exposure to ionizing radiation emitted from soil/sediment (subsurface)
Current/future recreational user (adult, teen and child)	• Incidental ingestion of soil/sediment • Dermal contact with soil/sediment • Inhalation of particulates emitted from soil/sediment • External exposure to ionizing radiation emitted from soil/sediment • Dermal contact with surface water • Ingestion of deer grazing on vegetation grown in contaminated soil/sediment • Ingestion of rabbit grazing on vegetation grown in contaminated soil/sediment • Ingestion of quail grazing on vegetation grown in contaminated soil/sediment

For each of the exposure pathways identified for potential site receptors, chronic daily intakes (CDIs) were calculated using the EPCs calculated for each EU and standard exposure models identified in risk assessment guidance for the PGDP (Methods Document, DOE 2001). Most parameters used in models were default values; however, site-specific information for the industrial worker and biota pathways was included.

D.7.3 TOXICITY ASSESSMENT

Toxicity values used in the risk assessment were those approved by EPA or recommended by KEPPC. Toxicity criteria for all COPCs were available for ingestion or inhalation exposure. Brief descriptions of toxicology of COPCs were provided in Section 4 of the BHHRA.

D.7.4 RISK CHARACTERIZATION

Risks were characterized by combining CDIs calculated during the exposure assessment (Section D.3) with appropriate toxicity criteria (Section D.4). Potential health risks estimated using the above methods are summarized by receptor and EUs below. Total noncancer HIs and cancer risks were summarized by receptor and pathway in Tables D.17 and D.19.

D.7.4.1 Current Industrial Worker

Soil hazards (total HIs) for the current industrial worker were at or below a cumulative hazard estimate of 1 for all contact exposures associated with soil/sediment (risks calculated at Outfall 001 EU 15 Hot Spot met the risk limit) and for surface water at all EUs. A cumulative ELCR greater than 1E-06 was estimated for all EUs. A cumulative ELCR greater than 1E-04 was estimated for two of the EUs for current industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the current industrial worker exceeded 1E-04 at Outfall 011 Hot Spot and Outfall 001 EU

14 Hot Spot. The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern is soil/sediment.

D.7.4.2 Future Industrial Worker

Cumulative HIs for the future industrial worker were greater than 1 for all EUs based on soil/sediment contact exposures. Hazard estimates greater than 1 also were identified for two EUs (Outfall 001 EU 14 Hot Spot; and Within the Fence, Excluding the Hot Spots) due to surface water exposures. Soil cancer risks (total ELCRs) for the future industrial worker exceeded 1E-06 at all EUs and 1E-04 at six locations: Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall 001 EU 15 Hot Spot, and NSDD Hot Spot. The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern is soil/sediment.

D.7.4.3 Current/Future Excavation Worker

A cumulative HI greater than 1 was estimated for 12 of 13 EUs for excavation workers (Outfall 001 EU 13 Hot Spot met the risk limit), with antimony, iron, uranium, and Total PCBs being the risk drivers, and soil/sediment being the only medium of concern. A cumulative ELCR at or greater than 1E-06 was estimated for all EUs. A cumulative ELCR greater than 1E-04 was estimated for seven EUs (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 015 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall 001 EU 15 Hot Spot, and the NSDD Hot Spot) based on direct contact exposures to soil/sediment. The major contaminants driving risk at all EUs are Total PCBs, Total PAHs (as BaPE), and thorium-230, and the driving medium of concern is soil/sediment.

D.7.4.4 Current/Future Recreational Users

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

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

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

D.7.4.5 Land Use Scenarios of Concern

According to the Methods Document, risk characterization results for total noncancer risk (total HI), and total cancer risk (total ELCR) for each land use scenario at each EU should be compared to benchmarks of 1 and 1E-06 for HI and ELCR, respectively, to identify land use scenarios of concern. Land use scenarios with total HIs exceeding the benchmark of 1 are deemed land use scenarios of concern for noncancer risk. Land use scenarios with total ELCR exceeding the benchmark of lE-06 are deemed land use scenarios of concern for cancer risk.

As was presented in Table D.16 (HI risk) and Table D.18 (ELCR), the current industrial worker land use scenario is a scenario of concern at each of the EUs based on actual site-specific exposure assumptions. Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot are of particular concern based on an ELCR greater than 1E-04. The site-specific current recreational use land use scenario is a scenario of concern at the NSDD Hot Spot based on excess noncancer risk. The future industrial worker and excavation worker scenarios are land use scenarios of concern for the entire SWOU based on default exposure assumptions. Excess noncancer risk was calculated for each EU and excess cancer risk was calculated for all EUs for the future industrial worker scenario. Excess noncancer risk was calculated for 12 of 13 EUs and excess cancer risk was calculated for all EUs for the excavation worker scenario. The future recreational land use scenario is a land use scenario of concern at the NSDD Hot Spot and NSDD, Excluding the Hot Spot, based on excess noncancer risk and estimated ELCR.

D.7.4.6 Contaminants of Concern

To identify COCs, the Methods Document recommends comparing chemical-specific HI and ELCR contributed by each COPC across all pathways within a land use scenario of concern to benchmarks of 0.1 and lE-06 for HI and cancer risk, respectively. COPCs with chemical-specific HIs or ELCRs that exceed these benchmarks are deemed COCs for that land use scenario of concern. From this select list of COCs, “priority” COCs were further identified as those chemicals exceeding benchmarks of HIs greater than 1 and ELCR greater than 1E-04. COCs and priority COCs are identified on Table D.20 for soil/sediment and D.21 for surface water.

As shown in Table D.20, there are nine metals identified as COCs for noncancer hazards in soil/sediment in the SWOU, along with Total PCBs and Total PAHs. Total PAHs, Total PCBs, 11 of the 12 radionuclides, and arsenic also are identified as COCs based on cancer risk in soil/sediment. In surface water, Total PCBs, and TCE are the identified COCs based on both noncancer and cancer risk as presented in Table D.21. As shown in Table D.22, no COCs were selected for ingestion of game.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, Total PAH (as BaPE) is the only COC that can be considered a “priority COC” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the current industrial worker at Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot. No priority COCs were identified in the remaining EUs.Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, there are no COCs that can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for the current industrial worker.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, COCs that can be considered “priority COCs” (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future industrial worker are as follows: antimony in all EUs; Total PCBs at Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 15 Hot Spot; Total PAHs (as BaPE) in Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 15 Hot Spot; uranium at Outfall 011 Hot Spot, Outfall 015 Hot Spot, Outfall 001 EU 15 Hot Spot, Within the Fence, Excluding Hot Spots, and NSDD Hot Spot; and iron at Outfall 011 Hot Spot and Outfall 001 EU 16 Hot Spot.

Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for the future industrial worker: Total PCBs at Outfall 001 EU14 Hot Spot and Within the Fence, Excluding Hot Spots. No priority COCs were identified in the remaining EUs.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, the following COCs can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the excavation worker: antimony in all EUs except Outfall 001 EU 13 and NSDD, Excluding the Hot Spot; Total PCBs at Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot and, Outfall 001 EU 14, Outfall 001 EU 15 Hot Spot, and NSDD Hot Spot; Total PAHs (as BaPE) in Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 15 Hot Spot; uranium at Outfall 011 Hot Spot, Outfall 015 Hot Spot, Outfall 001 EU 15 Hot Spot, Within the Fence, Excluding Hot Spots, NSDD Hot Spot, and NSDD Excluding the Hot Spot; iron at Outfall 011 Hot Spot and Outfall 001 EU 16 Hot Spot; and thorium-230 at NSDD Hot Spot.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, there are no COCs that are considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds one or 1E-04, respectively) in soil/sediment for the current child recreational user. The cumulative HI for the child recreational scenario at the NSDD Hot Spot was 2. The primary risk drivers of antimony and uranium were individually less than an HI of 1.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, antimony can be considered a "priority COC" (COC with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future adult recreational user. No Priority COCs were identified for NSDD, Excluding the Hot Spot.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, antimony and uranium can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future teen recreational user at both the NSDD Hot Spot and NSDD, Excluding the Hot Spot. Total PCBs also can be considered a priority COC at the NSDD Hot Spot.

Combining the results from Table D.20 and considering the magnitude of the chemical-specific HIs and ELCRs, antimony, iron, and uranium can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in soil/sediment for the future child recreational user at both the NSDD Hot Spot and NSDD, Excluding the Hot Spot. Total PCBs also can be considered a priority COC at the NSDD Hot Spot.

Combining the results from Table D.21 and considering the magnitude of the chemical-specific HIs and ELCRs, no COCs can be considered "priority COCs" (COCs with a chemical-specific HI or ELCR that exceeds 1 or 1E-04, respectively) in surface water for any of the recreational users.

D.7.4.7 Pathways of Concern

Only those pathways with a pathway HI greater than 0.1 or a pathway ELCR greater than 1E-06 across all contaminants within a land use scenario are considered a pathway of concern. The POCs for each land use scenario of concern are presented in Table D.32. Ingestion and dermal contact with soil, external exposure to radionuclides, and dermal contact with surface water are POCs at one or more EUs. Ingestion of game and inhalation of vapors and/or particulates from soil, sediment, and surface water are not POCs at any EU. In addition, external exposures from radionuclides and ingestion of game are not

POCs at any EU other than the NSDD, Excluding the Hot Spot (future teen recreational user contact with surface water).

D.7.4.8 Media of Concern

MOCs are those media that appear in at least one POC. Based on the information presented in Section D.5.5.3 and Tables D.16 through D.19 and summarized in Table D.33, surface and subsurface soil/sediment are MOC at each SWOU EU for the current industrial worker scenario. Surface and subsurface soil/sediment are considered MOC at each SWOU EU based on future scenarios as well as surface water in five EUs. It should be noted that surface and subsurface soil/sediment would be considered a priority medium of concern in only three outfalls for the current industrial worker (Outfall 011 Hot Spot; Outfall 001 EU 14 Hot Spot; Outfall 001 EU 15 Hot Spot) and surface water would be considered a priority medium of concern in just two locations (Outfall 001 EU 14 Hot Spot; Within the Fence, Excluding Hot Spots) with a hazard greater than 1 or an ELCR greater than 1E-04.

D.7.4.9 Summary of Soil/Sediment Non-Hot Spots and Hot Spots

To put into perspective the hazards and risks that each EU within the fence and outside of the fence poses to receptors, comparisons have been made between soil/sediment non-hot spot and potential "hot spot" areas for industrial workers (current and future) both inside and outside the fence, excavation workers both inside and outside of the fence, and recreational users outside of the fence. This comparison summarizes which areas contribute the greatest risk to the receptors and can aid in risk management decisions.

D.7.4.9.1 Noncancer Hazards

The following summarizes risks associated with industrial and excavation workers at each of the potential "hot spot" EUs compared with areas defined as non-hot spots by noncancer risks. Below, each EU is ranked according to its estimated HI relative to the acceptable HI limit of 1.

- All of the hazards for current industrial workers were at or below the HI limit of 1. With the exception of Outfall 001 EU 13 Hot Spot, Outfall 001 EU 18 Hot Spot, and Outfall 001 EU 20 Hot Spot, the hazards calculated for all of the remaining EUs were elevated relative to the non-hot spot areas.

- Hazards were below 1 in both the non-hot spot and potential "hot spot" areas outside the fence for current industrial workers. The hazard calculated for the potential "hot spot" was greater than the non-hot spot area.

- All of the hazards for future industrial workers exceeded the HI limit of 1. Three of the EUs were comparable to the non-hot spot area. Seven of the EUs were elevated compared to the non-hot spot area, exceeding the HI limit by more than one order of magnitude.

- Hazards were elevated in both the non-hot spot and potential "hot spot" areas outside the fence for future industrial workers.

- At three of the potential "hot spots," estimated HIs for excavation workers within the fence were comparable to the HIs of non-hot spot areas. However, seven of the potential "hot spot" EU hazards were estimated above the non-hot spot area by more than one order of magnitude, but not two.

- Hazards were elevated in both the non-hot spot and potential “hot spot”areas outside the fence for excavation workers. The estimated hazard in the potential “hot spot” area is comparable to the risk found in the non-hot spot (within an order of magnitude).

Although hazards were elevated in both the non-hot spot and potential “hot spot” areas outside the fence for all recreational users, hazards for each receptor in the potential “hot spot” area were greater those in the non-hot spot area.

D.7.4.9.2 Cancer Risks

The following summarizes cancer risks associated with future industrial and excavation workers at each of the potential “hot spot” EUs compared with areas defined as non-hot spots by ELCR. Below, each EU is ranked according to where its estimated ELCR fell in comparison with the acceptable risk range of 1E-06 to 1E-04.

- At the majority of the potential “hot spots”, estimated ELCRs for current industrial workers inside the fence were comparable to the ELCR of the non-hot spot area; however, two of the potential “hot spot” EU estimated ELCRs were greater than 1E-04.

- ELCR estimates for the non-hot spot and potential “hot spot” areas outside the fence for the current industrial worker were comparable. Both ELCRs were estimated to be within the risk range of 1E-06 to 1E-04.

- Estimated ELCRs for four EUs evaluated for future industrial workers inside the fence were comparable to the ELCR of the non-hot spot area; however, five of the potential “hot spot” EU estimated ELCRs were greater than 1E-04. Two of the estimated ELCRs were greater than 1E-03.

- While the ELCR for the non-hot spot EU was within the risk range of 1E-06 to 1E-04, the ELCR estimate for the potential “hot spot” area outside the fence for the future industrial worker was greater than the non-hot spot area and exceeded an ELCR of 1E-04.

- Estimated ELCRs for excavation workers inside the fence at four of the potential “hot spot” EUs met the upper limit of the risk range of 1E-06 to 1E-04 and were comparable to the ELCR of the non-hot spot area. The remaining six potential “hot spot” EU ELCRs were elevated compared to the non-hot spot area and exceeded 1E-04. Four of the EUs with elevated ELCRs were estimated to be within an order of magnitude of the upper limit of the risk range, and two were estimated to be more than an order of magnitude greater, but less than two orders of magnitude.

- While the ELCR for the non-hot spot EU met the risk limit of 1E-04, the ELCR estimate for the potential “hot spot” area outside the fence for the excavation worker was greater than the non-hot spot area and exceeded 1E-04.

ELCR estimates for the non-hot spot and potential “hot spot” areas outside the fence for the recreational user were comparable. All total estimated ELCRs were within or below the risk range of 1E-06 to 1E-04. The estimated ELCR for the current child recreational scenario was below the risk range.

D.7.5 POTENTIAL RISKS TO OFF-SITE RECEPTORS BASED ON FATE AND TRANSPORT MODELING

Chapter 5 of this SI presents fate and transport modeling employing the MUSLE (Mills et al. 1982) and the SWMM (Huber and Dickinson 1988). The models predict likely future contaminant concentrations within the outfalls (just before mixing in the creeks) and within the creeks (at the point where each of the outfalls discharges to the surrounding creeks) and at the creek integrator points located immediately downgradient of the outfalls. Predicted average and maximum concentrations of Total PCBs and uranium-238 in the surface water runoff in the outfalls (just before mixing in the creeks), as well as in the creeks adjacent to the outfall discharge points and at the integrator points for Bayou Creek (B09) and Little Bayou Creek (L07), were calculated and compared to risk based action and no action levels taken from the Methods Document. As presented in Section 5, Total PCBs exceed the child recreational and industrial worker no action screening levels for surface water runoff in the outfalls, but Total PCBs concentrations do not exceed other risk criteria. For uranium-238, the only exceedance of the modeled concentrations is in the Outfall 001 runoff for the no action child recreational screening level. No predicted concentration within the creeks exceeded a no action screening criteria. Refer to Chapter 5 for the complete analysis.

D.7.6 SUMMARY OF BHHRA UNCERTAINTIES

Risk estimates may vary if different assumptions are used in deriving risk estimates or if better information is available for some parameters. The following text summarizes the estimated effects of important uncertainties and provides some perspective for risk managers.

A key uncertainty in the risk assessment is the lack of defined exposure scenarios for the unique environmental setting of the SWOU. None of the receptors in the Methods Document (DOE 2001) are well adapted for assessing the types of exposures anticipated for narrow linear features, used as drainage ditches that typify the OU. Available exposure scenarios and associated exposure parameters probably overestimate potential exposures and risks, possibly by a large margin.

Another factor in the risk assessment that makes a large contribution to uncertainty is the use of KEPPC defaults versus site-specific estimates for the exposure duration and frequency at which a current industrial worker will be exposed to contamination at the SWOU. The environmental setting, narrow linear drainage ditches, favors the interpretation that exposures would be much less intense for these workers than implied by KEPPC default assumptions; therefore, an exposure frequency of 14 days per year was employed based on site-specific information.

The KEPPC default versus site-specific estimates for the exposure duration and frequency at which child recreational user will be exposed to contamination in the SWOU also contributes uncertainty. The accessible areas (outside the fence) are not very attractive to a recreational user and are unlikely to be visited frequently as KEPPC default assumptions imply; therefore, an exposure frequency of 10 days, exposure period of one year, and exposure time of four hours/day were employed based on information provided in the approved SAP (DOE 2001).

Finally, assessment of cancer risks and noncancer hazards associated with dermal exposure is associated with significant uncertainty. Probably, all estimates of risk and hazard for this pathway are overestimated. Since the dermal exposure route is the dominant one in estimates of potential risk, accounting for the majority of potential site related impacts, understanding of uncertainty associated with this pathway is critical to interpretation of risk results. The Commonwealth of Kentucky’s dermal default values as presented in its *Risk Assessment Guidance* (KDEP 1995) employed in this assessment result in risk estimates 50 times higher than if the EPA Region 4 default absorption values had been used. This is significant for the metals, antimony, iron, and uranium that were identified as priority COCs. In addition, dermal absorption of PCBs, a primary risk driver for the site, particularly for dermal contact risk, could be greatly overestimated. PCBs tend to bind tightly to organic matter in soil and typically are poorly available for absorption through the skin. Actual exposures and associated health impacts are likely to be much less than those estimated in the total risk and HI calculations presented in Section D.5.

Following are uncertainties with effects estimated to be moderate:

- Use of chronic toxicity values to evaluate excavation worker exposures;
- Calculation of toxicity values for chemicals; and
- Combining risks across chemicals and radionuclides.

All of these uncertainties suggest that risks may be overestimated rather than underestimated. Consequently, risk estimates provided in the risk assessment are conservative (protective) and could be overly conservative for the excavation worker scenario and probably others.

Other uncertainties are estimated to have small effects on estimates of cancer risks and noncancer hazards. These uncertainties, along with those discussed above, are summarized in Table D.37.

D.7.7 OBSERVATIONS

This section presents observations based on the risk results and uncertainties presented in the previous sections.

Dermal contact with soil was a driving exposure route in previous BHHRAs at PGDP, with most of this risk arising from contact with metals in soil/sediment. Although chemical-specific ABS values were used when available, default ABS values were used for most chemicals, such as aluminum, because chemical-specific values were not available. These default values, which estimate the percentage of contaminant in soil or sediment crossing the skin and entering the body, are 5 percent for inorganic chemicals, 10 percent for semivolatile organic compounds, and 25 percent for volatile organic compounds. The use of the identified default values likely results in an overestimation of risk as these default values are significantly greater than Region 4 default factors (0.1 percent for inorganic chemicals and 1 percent for organic chemicals). Chemical-specific ABS values were available for PCBs and employed in this BHHRA.

Iron was identified as a priority COC at several EUs based on contact with soil/sediment for future exposure scenarios. Remedial decisions focused on iron may be inappropriate since iron likely is consistent with background values. All but one EPC for iron were below the background concentration of 28,000 mg/kg. The single exception is a case where the maximum detected concentration was used as the EPC due to a statistical instability in the H-statistic calculation. Additionally, the derived oral RfD for iron is very conservative, further overestimating iron risks.

There is uncertainty associated with the antimony analytical results, as all of the detected concentrations were reported either at or slightly above the detection limits. The detection limits also were high, likely due to matrix interferences, at concentrations ranging from 8.41 mg/kg to 9.97 mg/kg (assumed to be a 1X dilution) or at 20 mg/kg (assumed to be a 2X dilution). Comparatively, the detected concentrations ranged from 8.41 mg/kg to 9.99 mg/kg or a value of exactly 20 mg/kg. The average concentration calculated with detected concentrations only (238 results) was 10.4 mg/kg and the average concentration calculated using both detected and nondetected concentrations using full detection limits

(433 results) was 10.8 mg/kg. Collectively, these results indicate that the detected and the nondetected results were virtually indistinguishable. Therefore, there is a high degree of uncertainty as to whether the antimony results from soil/sediment samples that are driving hazard risk are truly representative of actual detected concentrations in soil/sediment.

The identification of Total PAHs as risk drivers in soil at several SWOU EUs for future industrial workers and excavation workers agrees with previous PGDP risk assessments; however, the significance of this finding should be considered along with the sources previously and currently identified as PGDP. Generally, before taking actions to address PAH contamination in soil/sediment at SWOU EUs, it may be prudent to consider the widespread nature of PAH contamination at PGDP, the continuing sources of contamination (e.g., motorized vehicles, asphalt paving, etc.), and the level of PAH contamination at areas outside PGDP.

The use of KEPPC default exposure assumptions contributes significantly to uncertainty in the BHHRA. Cancer risk and noncancer hazard estimates for current industrial workers and current recreational users (outside the security fence) are more appropriate receptors for this OU relative to future risk estimates for industrial workers, excavation workers, and recreational users using default Methods Document exposure assumptions. Cancer risks and noncancer hazards for the current industrial workers were estimated based on a 14 day per year exposure frequency, making it more representative of possible future site risks that would be applicable to the narrow system of drainages ditches that make up the SWOU. Future industrial workers spending 8 hours per day, 250 days per year for 25 years, as the Methods Document directs, in one or more ditches is not realistic. Similarly, the current recreational user visits the NSDD 10 days per year for one year in contrast to the future recreational user that spends 140 days per year for six years. Given the unattractiveness of the NSDD EUs that essentially are swales and ditches, the default exposure assumptions are not realistic for the site; therefore, the priority areas of concern are Outfall 008 Hot Spot and Outfall 001 EU 14 Hot Spot based on current risk to industrial workers.

Finally, the risks to excavation workers are likely unrealistic. If any excavation work were to be conducted within the SWOU, workers would be required to follow soil management plans and/or health and safety plans that would stipulate that proper PPE and clothing be used, preventing contact with soils/sediments.

If the final BHHRA risks are reevaluated considering key uncertainties and conservative assumptions described in the observations section, risks are considerably reduced as described below:

- Excess cancer risk greater than 1E-04 calculated for current industrial workers at two potential “hot spot” locations (Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot) was driven by dermal contact with PAHs in soil/sediment. If the risk due to PAHs is segregated from the total risk, then the total risk would decrease by approximately two orders of magnitude. Overall, all cancer risks would be within or below acceptable risk limits of 1.0E-06 to 1.0E-04. All calculated noncancer hazards were below the risk limit of 1.

- Excess cancer risk greater than 1E-04 calculated for future industrial workers using default exposure assumptions at six potential “hot spot” locations (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall EU 15 Hot Spot, and NSDD Hot Spot) was driven by dermal contact with PCBs and PAHs in five outfall potential “hot spot” locations and primarily by external exposure to radionuclides in the NSDD Hot Spot in soil/sediment. If the risk due to PAHs and PCB is segregated from the total risk, then the total risk at all EUs would be within or below acceptable risk limits of 1E-06 to 1E-04.

- Excess noncancer risk with hazards greater than 1 was calculated for all 13 EUs for the future industrial worker. Dermal contact with metals such as antimony, iron, and uranium, as well as dermal contact with PCBs in soil/sediment, accounted for over 90% of the risk at each location. If that dermal contact with metals is overestimated by a factor of 50 and PCB dermal risk is overestimated by a factor of 10, then excess risk is only found for two areas: Outfall 008 Hot Spot and Outfall 001 EU 15 Hot Spot based on ingestion and dermal contact with PCBs.

- Excess cancer risk greater than 1E-04 was calculated for excavation workers using default exposure assumptions at seven potential “hot spot” locations: five driven by dermal contact with PCBs and PAHs (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 15 Hot Spot) and two driven by ingestion of PCBs and radionuclides in soil/sediment (Outfall 015 Hot Spot, and NSDD Hot Spot). If the risk due to PAHs and PCB is segregated from the total risk, then the total risk at the five EUs would be within or below acceptable risk limits of 1E-06 to 1E-04. Excess cancer risk greater than 1E-04 would remain at the two EUs (Outfall 001 EU 15 Hot Spot and NSDD Hot Spot) driven by ingestion of soil/sediment.

D.8 REMEDIAL GOAL OPTIONS

This section presents remedial goal options (RGOs) for the COCs identified in Section D.5 and the methods used to calculate the RGOs. These RGOs should not be interpreted as being cleanup goals, but instead as risk-based values that may be used to guide the development of cleanup goals by risk managers. Cleanup goals will be determined in the decision document. Methods used for calculation, as described below, would yield the same RGOs for each of the refined EUs addressed in the risk assessment; thus, only one set of RGO calculations is necessary. RGOs were calculated for soil/sediment COCs that resulted in an HI greater than or equal to 0.1 or a risk greater than or equal to 1E-06 in any of the refined EUs addressed in the risk assessment. RGOs were calculated for each receptor (i.e., current industrial worker; future industrial worker; excavation worker; and adult, teen, and child recreational user).

Total PCBs was the only priority COC identified in surface water that resulted in excess risk. Calculation of a RGO for PCBs in surface water results in a risk-based concentration (0.0005 ug/L) significantly below accepted detection limits for PCBs in water (0.054 to 0.9 µg/L by gas chromatography; SW-846, Method 8082); therefore, the RGO would be the detection limit for Total PCBs. Further, it should be noted that remediation typically is not focused on surface water, but instead on sources of contaminants in surface water (e.g., sediments, source areas, and groundwater). RGOs also were not calculated for ingestion of game because none of the potential COCs associated with this exposure pathway resulted in excess risk.

D.8.1 CALCULATION OF RGOs

EPA guidance (EPA 1991) indicates that RGOs for each COPC are to be calculated by rearranging the equations used to calculate each COPC's HQ or chemical-specific ELCR so that the equation can be used to solve for a concentration of the COPC that will result in a target HI of 1.0 and a target ELCR of 1E-06. In accordance with the Risk Methods document (DOE 2001) RGOs were calculated for ELCRs of 1E-04, 1E-05, and 1E-06, and HIs of 0.1, 1, and 3. Although rearranging the risk equations and solving for a concentration is one approach to calculating RGOs, risks are calculated by linearly combining a series of exposure factors and toxicity factors with each analyte's environmental concentration; therefore, the risk posed by an analyte at any given concentration is directly related to the risk posed by that analyte at any other concentration. This relationship is illustrated in the following equation:

$$\frac{Concentration}{Risk} = \frac{RGO}{Target\ Risk}$$

where

Concentration = the exposure concentration for the medium
Risk = the risk posed by exposure to the contaminated medium
RGO = the remedial goal option
Target Risk = one of the values listed above

It should be noted that risks are relative to the EPC, therefore, when the EPC is divided by the risk, the result is always the same. The different RGO levels (i.e., ELCR= 1E-4, 1E-5, 1E-6, and HI= 0.1, 1, and 3) then are calculated simply by multiplying each RGO by the appropriate target risk.

Since EPCs have no bearing on the RGO calculated, yet it is very important to calculate an RGO for each COC, risk and hazard calculations for an HHEU with all COCs should be employed for the RGO calculations. The NSDD Hot Spot was selected as for the RGO calculations because each sitewide COC was identified in the dataset.

D.8.2 PRESENTATION OF RGOs

The equation developed in the previous section was applied for each COC. The RGOs developed for all land use scenarios of concern, POCs, and COPCs for the SWOU are presented in Tables D.52 through D.58. In addition, these tables present the representative exposure concentration used in the BHHRA. RGOs presented in Tables D.52 through D.58 are the lower of the RGOc and the RGOnc; the RGOc is based on an ELCR of 1E-06, and the RGOnc is based on an HI of 1. A summary of RGOs is included in Tables D.59 and D.60. Table D.59 presents RGOs for ELCRs of 1E-04, 1E-05, and 1E-06 for all receptors. Table D.60 presents RGOs for all receptors based on HIs of 0.1, 1, and 3. RGOs for the recreational receptor are the most conservative RGO for recreational users (i.e., adult, teen, and child). It should be noted that the calculated RGOs may be below detection limits or below background levels. In the decision document, the cleanup goals may be adjusted up to background values or detection limits for one or more chemicals.

Table D.52. RGOs for Excavation Worker Scenario

COPC	**NSDD Hot Spot EPC**	**Excavation Worker**				
		ELCR	**HI**	**RGOc**	**RGOnc**	**RGO**
Inorganic Chemicals—Metals (mg/kg in Subsurface Soil/Sediment)						
Aluminum	8.4E+03	NA	1.60E-01	NA	5E+04	5E+04
Antimony	171.70E+01	NA	3.45E+00	NA	5E+00	5E+00
Arsenic	55.40E+00	2.10E-05	1.31E-01	3E-01	4E+01	3E-01
Beryllium	15.20E-01	7.04E-12	4.13E-02	7E+04	1E+01	1E+01
Cadmium	ND	NA	ND	NA	NA	NA
Iron	1.19E+04	NA	5.51E-01	NA	2E+04	2E+04
Manganese	3.58E+02	NA	1.08E-01	NA	3E+03	3E+03
Nickel	6.50E+01	NA	3.00E-02	NA	2E+03	2E+03
Uranium	3.28E+02	NA	2.90E+00	NA	1E+02	1E+02
Organic Compounds (mg/kg in Subsurface Soil/Sediment)						
Total PCB	2.70E+00	1.07E-05	7.50E-01	3E-01	4E+00	3E-01
Total PAH (as BaPE)	6.60E-01	2.32E-05	NA	3E-02	NA	3E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	3.70E+00	2.13E-06	NA	2E+00	NA	2E+00
Cesium-137	3.70E+00	5.61E-07	NA	7E+00	NA	7E+00
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.30E+00	1.62E-05	NA	3E-01	NA	3E-01
Plutonium-239/240	2.10E+01	1.29E-05	NA	2E+00	NA	2E+00
Technetium-99	2.40E+02	4.15E-06	NA	6E+01	NA	6E+01
Thorium-228	1.10E+00	3.08E-05	NA	4E-02	NA	4E-02
Thorium-230	4.97E+02	2.24E-04	NA	2E+00	NA	2E+00
Uranium-234	1.40E+01	4.92E-06	NA	3E+00	NA	3E+00
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	1.10E+01	3.49E-06	NA	3E+00	NA	3E+00

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.53. RGOs for Current Industrial Worker Scenario

COPC	NSDD Hot Spot EPC	Current Industrial Worker ELCR	Current Industrial Worker HI	RGOc	RGOnc	RGO
Inorganic Chemicals—Metals (mg/kg in Surface Soil/Sediment)						
Aluminum	8095	NA	9.78E-03	NA	8E+05	8E+05
Antimony	14	NA	2.07E-01	NA	7E+01	7E+01
Arsenic	5.8	9.77E-07	6.09E-03	6E+00	1E+03	6E+00
Beryllium	0.65	6.65E-13	3.84E-03	1E+06	2E+02	2E+02
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	3.03E-02	NA	4E+05	4E+05
Manganese	417	NA	8.87E-03	NA	5E+04	5E+04
Nickel	94	NA	2.18E-03	NA	4E+04	4E+04
Uranium	328	NA	9.09E-02	NA	4E+03	4E+03
Organic Compounds (mg/kg in Surface Soil/Sediment)						
Total PCB	3	3.56E-07	2.49E-02	8E+00	1E+02	8E+00
Total PAH (as BaPE)	1.0	2.05E-06	NA	5E-01	NA	5E-01
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	4.77E-08	NA	9E+01	NA	9E+01
Cesium-137	4.2	4.75E-08	NA	9E+01	NA	9E+01
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	1.10E-06	NA	5E+00	NA	5E+00
Plutonium-239/240	21	1.01E-07	NA	2E+02	NA	2E+02
Technetium-99	596	9.23E-08	NA	6E+03	NA	6E+03
Thorium-228	2.0	4E-06	NA	5E-01	NA	5E-01
Thorium-230	497	1.86E-06	NA	3E+02	NA	3E+02
Uranium-234	29	8.21E-08	NA	4E+02	NA	4E+02
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	6.54E-08	NA	4E+02	NA	4E+02

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.54. RGOs for Future Industrial Worker Scenario

COPC	NSDD Hot Spot EPC	Future Industrial Worker		RGOc	RGOnc	RGO
		ELCR	HI			
Inorganic Chemicals—Metals (mg/kg in Surface Soil/Sediment)						
Aluminum	8095	NA	1.74E-01	NA	5E+04	5E+04
Antimony	14	NA	3.70E+00	NA	4E+00	4E+00
Arsenic	5.8	1.74E-05	1.09E-01	3E-01	5E+01	3E-01
Beryllium	0.65	1.19E-11	6.86E-02	5E+04	9E+00	9E+00
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	5.41E-01	NA	2E+04	2E+04
Manganese	417	NA	1.58E-01	NA	3E+03	3E+03
Nickel	94	NA	3.89E-02	NA	2E+03	2E+03
Uranium	328	NA	1.62E+00	NA	2E+02	2E+02
Organic Compounds (mg/kg in Surface Soil/Sediment)						
Total PCB	2.7	6.35E-06	4.45E-01	4E-01	6E+00	4E-01
Total PAH (as BaPE)	1.0	3.66E-05	NA	3E-02	NA	3E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	8.52E-07	NA	5E+00	NA	5E+00
Cesium-137	4.2	8.48E-07	NA	5E+00	NA	5E+00
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	1.96E-05	NA	3E-01	NA	3E-01
Plutonium-239/240	21	1.80E-06	NA	1E+01	NA	1E+01
Technetium-99	596	1.65E-06	NA	4E+02	NA	4E+02
Thorium-228	2.0	7.14E-05	NA	3E-02	NA	3E-02
Thorium-230	497	3.33E-05	NA	3E+01	NA	1E+01
Uranium-234	29	1.47E-06	NA	2E+01	NA	2E+01
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	1.17E-06	NA	2E+01	NA	2E+01

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.55. RGOs for Adult Recreational User Scenario

COPC	NSDD Hot Spot EPC	ELCR	HI	RGOc	RGOnc	RGO
Inorganic Chemicals—Metals (mg/kg in Surface Soil/Sediment)						
Aluminum	8095	NA	5.82E-02	NA	1E+05	1E+05
Antimony	14	NA	1.25E+00	NA	1E+01	1E+01
Arsenic	5.8	4.99E-06	3.51E-02	1E+00	2E+02	1E+00
Beryllium	0.65	2.72E-12	2.31E-02	2E+05	3E+01	3E+01
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	1.80E-01	NA	6E+04	6E+04
Manganese	417	NA	5.31E-02	NA	8E+03	8E+03
Nickel	94	NA	1.28E-02	NA	7E+03	7E+03
Uranium	328	NA	5.03E-01	NA	7E+02	7E+02
Organic Compounds (mg/kg in Surface Soil/Sediment)						
Total PCB	2.7	1.76E-06	1.39E-01	2E+00	2E+01	2E+00
Total PAH (as BaPE)	1.0	1.07E-05	NA	9E-02	NA	9E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	ND	NA	NA	NA	NA
Cesium-137	4.2	1.93E-07	NA	2E+01	NA	2E+01
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	4.43E-06	NA	1E+00	NA	1E+00
Plutonium-239/240	21	2.76E-07	NA	7E+01	NA	7E+01
Technetium-99	596	2.68E-07	NA	2E+03	NA	2E+03
Thorium-228	2.0	1.62E-05	NA	1E-01	NA	1E-01
Thorium-230	497	5.22E-06	NA	1E+02	NA	1E+02
Uranium-234	29	2.26E-07	NA	1E+02	NA	1E+02
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	1.79E-07	NA	1E+02	NA	1E+02

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.56. RGOs for Current/Future Teen Recreational User Scenario

COPC	NSDD Hot Spot EPC	ELCR	HI	RGOc	RGOnc	RGO
Inorganic Chemicals—Metals (mg/kg in Soil/Sediment)						
Aluminum	8095	NA	2.69E-01	NA	3E+04	3E+04
Antimony	14	NA	5.78E+00	NA	2E+00	2E+00
Arsenic	5.8	1.23E-05	1.59E-01	5E-01	4E+01	5E-01
Beryllium	0.65	3.25E-12	1.07E-01	2E+05	6E+00	6E+00
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	8.27E-01	NA	1E+04	1E+04
Manganese	417	NA	2.46E-01	NA	2E+03	2E+03
Nickel	94	NA	5.83E-02	NA	2E+03	2E+03
Uranium	328	NA	2.22E+00	NA	1E+02	1E+02
Organic Compounds (mg/kg in Soil/Sediment)						
Total PCB	2.7	4.24E-06	6.19E-01	6E-01	4E+00	6E-01
Total PAH (as BaPE)	1.0	2.68E-05	NA	4E-02	NA	4E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	ND	NA	NA	NA	NA
Cesium-137	4.2	1.42E-07	NA	3E+01	NA	3E+01
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	3.27E-06	NA	2E+00	NA	2E+00
Plutonium-239/240	21	2.03E-07	NA	1E+02	NA	1E+02
Technetium-99	596	1.97E-07	NA	3E+03	NA	3E+03
Thorium-228	2.0	1.20E-05	NA	2E-01	NA	2E-01
Thorium-230	497	3.84E-06	NA	1E+02	NA	1E+02
Uranium-234	29	1.66E-07	NA	2E+02	NA	2E+02
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	1.31E-07	NA	2E+02	NA	2E+02

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.57. RGOs for Current Child Recreational User Scenario

COPC	NSDD Hot Spot EPC	ELCR	HI	RGOc	RGOnc	RGO
Inorganic Chemicals—Metals (mg/kg in Soil/Sediment)						
Aluminum	8095	NA	3.36E-02	NA	2E+05	2E+05
Antimony	14	NA	6.39E-01	NA	2E+01	2E+01
Arsenic	5.8	1.85E-07	2.88E-02	3E+01	2E+02	3E-01
Beryllium	0.65	4.59E-14	1.17E-02	1E+07	6E+01	6E+01
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	1.11E-01	NA	1E+05	1E+05
Manganese	417	NA	2.81E-02	NA	1E+04	1E+04
Nickel	94	NA	9.10E-03	NA	1E+04	1E+04
Uranium	328	NA	5.71E-01	NA	6E+02	6E+02
Organic Compounds (mg/kg in Soil/Sediment)						
Total PCB	2.7	8.50E-08	1.49E-01	3E+01	2E+01	3E+01
Total PAH (as BaPE)	1.0	2.38E-07	NA	4E+00	NA	4E+00
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	ND	NA	NA	NA	NA
Cesium-137	4.2	8.53E-10	NA	5E+03	NA	5E+03
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	2.22E-08	NA	2E+02	NA	2E+02
Plutonium-239/240	21	1.90E-08	NA	1E+03	NA	1E+03
Technetium-99	596	1.54E-08	NA	4E+04	NA	4E+04
Thorium-228	2.0	7.63E-08	NA	3E+01	NA	3E+01
Thorium-230	497	3.36E-07	NA	1E+03	NA	1E+03
Uranium-234	29	1.53E-08	NA	2E+03	NA	2E+03
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	1.24E-08	NA	2E+03	NA	2E+03

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.58. RGOs for Future Child Recreational User Scenario

COPC	NSDD Hot Spot EPC	ELCR	HI	RGOc	RGOnc	RGO
Inorganic Chemicals—Metals (mg/kg in Soil/Sediment)						
Aluminum	8095	NA	4.08E-01	NA	2E+04	2E+04
Antimony	14	NA	8.67E+00	NA	2E+00	2E+00
Arsenic	5.8	9.80E-06	2.54E-01	6E-01	2E+01	6E-01
Beryllium	0.65	4.81E-12	1.61E-01	1E+05	4E+00	4E+00
Cadmium	ND	ND	ND	NA	NA	NA
Iron	11177	NA	1.27E+00	NA	9E+03	9E+03
Manganese	417	NA	3.71E-01	NA	1E+03	1E+03
Nickel	94	NA	9.11E-02	NA	1E+03	1E+03
Uranium	328	NA	3.78E+00	NA	9E+01	9E+01
Organic Compounds (mg/kg in Soil/Sediment)						
Total PCB	2.7	3.56E-06	1.04E+00	8E-01	3E+00	8E-01
Total PAH (as BaPE)	1.0	2.06E-05	NA	5E-02	NA	5E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.4	ND	NA	NA	NA	NA
Cesium-137	4.2	7.13E-08	NA	6E+01	NA	6E+01
Cobalt-60	ND	ND	NA	NA	NA	NA
Neptunium-237	5.3	1.65E-06	NA	3E+00	NA	3E+00
Plutonium-239/240	21	2.01E-07	NA	1E+02	NA	1E+02
Technetium-99	596	1.78E-07	NA	3E+03	NA	3E+03
Thorium-228	2.0	6.02E-06	NA	3E-01	NA	3E-01
Thorium-230	497	3.67E-06	NA	1E+02	NA	1E+02
Uranium-234	29	1.63E-07	NA	2E+02	NA	2E+02
Uranium-235	NA	NA	NA	NA	NA	NA
Uranium-238	26	1.31E-07	NA	2E+02	NA	2E+02

RGOc = Goal based on potential cancer risks (Target Risk = 1E-06).
RGOnc = Goal based on potential noncancer hazards (HI = 1).
RGO = Lower of RGOc and RGOnc.

Table D.59. RGO Summary Risk

COPC	Exposure Scenario											
	Excavation Worker			**Current Industrial Worker**			**Future Industrial Worker**			**Recreational User**[a]		
	Risk = 10^{-6}	**Risk = 10^{-5}**	**Risk = 10^{-4}**	**Risk = 10^{-6}**	**Risk = 10^{-5}**	**Risk = 10^{-4}**	**Risk = 10^{-6}**	**Risk = 10^{-5}**	**Risk = 10^{-4}**	**Risk = 10^{-6}**	**Risk = 10^{-5}**	**Risk = 10^{-4}**
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)												
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	3.E-01	3.E+00	3.E+01	6.E+00	6.E+01	6.E+02	3.E-01	3.E+00	3.E+01	5.E-01	5.E+00	5.E+01
Beryllium	7.E+04	7.E+05	7.E+06	1.E+06	1.E+07	1.E+08	5.E+04	5.E+05	5.E+06	1.E+05	1.E+06	1.E+07
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organic Compounds (mg/kg in Soil/Sediment)												
Total PCB	3.E-01	3.E+00	3.E+01	8.E+00	8.E+01	8.E+02	4.E-01	4.E+00	4.E+01	6.E-01	6.E+00	6.E+01
Total PAH (as (BaPE)	3.E-02	3.E-01	3.E+00	5.E-01	5.E+00	5.E+01	3.E-02	3.E-01	3.E+00	4.E-02	4.E-01	4.E+00
Radionuclides (pCi/g in Soil/Sediment)												
Americium-241	2.E+00	2.E+01	2.E+02	9.E+01	9.E+02	9.E+03	5.E+00	5.E+01	5.E+02	NA	NA	NA
Cesium-137	7.E+00	7.E+01	7.E+02	9.E+01	9.E+02	9.E+03	5.E+00	5.E+01	5.E+02	2.E+01	2.E+02	2.E+03
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Neptunium-237	3.E-01	3.E+00	3.E+01	5.E+00	5.E+01	5.E+02	3.E-01	3.E+00	3.E+01	1.E+00	1.E+01	1.E+02
Plutonium-239/240	2.E+00	2.E+01	2.E+02	2.E+02	2.E+03	2.E+04	1.E+01	1.E+02	1.E+03	7.E+01	7.E+02	7.E+03
Technetium-99	6.E+01	6.E+02	6.E+03	6.E+03	6.E+04	6.E+05	4.E+02	4.E+03	4.E+04	2.E+03	2.E+04	2.E+05
Thorium-228	4.E-02	4.E-01	4.E+00	5.E-01	5.E+00	5.E+01	3.E-02	3.E-01	3.E+00	1.E-01	1.E+00	1.E+01
Thorium-230	2.E+00	2.E+01	2.E+02	3.E+02	3.E+03	3.E+04	1.E+01	1.E+02	1.E+03	1.E+02	1.E+03	1.E+04
Uranium-234	3.E+00	3.E+01	3.E+02	4.E+02	4.E+03	4.E+04	2.E+01	2.E+02	2.E+03	1.E+02	1.E+03	1.E+04
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238	3.E+00	3.E+01	3.E+02	4.E+02	4.E+03	4.E+04	2.E+01	2.E+02	2.E+03	1.E+02	1.E+03	1.E+04

[a] RGOs for the recreational user are based on the minimum RGO among the adult, teen, and child (current and future) receptors for this land use scenario.

Table D.60. RGO Summary HI

	Exposure Scenario											
	Excavation Worker			Current Industrial Worker			Future Industrial Worker			Recreational User[a]		
COPC	HQ = 0.1	HQ = 1	HQ = 3	HQ = 0.1	HQ = 1	HQ = 3	HQ = 0.1	HQ = 1	HQ = 3	HQ = 0.1	HQ = 1	HQ = 3
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)												
Aluminum	5.E+03	5.E+04	2.E+05	8.E+04	8.E+05	>1E-6	5.E+03	5.E+04	1.E+05	2.E+03	2.E+04	6.E+04
Antimony	5.E-01	5.E+00	1.E+01	7.E+00	7.E+01	2.E+02	4.E-01	4.E+00	1.E+01	2.E-01	2.E+00	5.E+00
Arsenic	4.E+00	4.E+01	1.E+02	1.E+02	1.E+03	3.E+03	5.E+00	5.E+01	2.E+02	2.E+00	2.E+01	7.E+01
Beryllium	1.E+00	1.E+01	4.E+01	2.E+01	2.E+02	5.E+02	9.E-01	9.E+00	3.E+01	4.E-01	4.E+00	1.E+01
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.E+00	0.E+00	0.E+00
Iron	2.E+03	2.E+04	6.E+04	4.E+04	4.E+05	>1e-6	2.E+03	2.E+04	6.E+04	9.E+02	9.E+03	3.E+04
Manganese	3.E+02	3.E+03	1.E+04	5.E+03	5.E+04	1.E+05	3.E+02	3.E+03	8.E+03	1.E+02	1.E+03	3.E+03
Nickel	2.E+02	2.E+03	6.E+03	4.E+03	4.E+04	1.E+05	2.E+02	2.E+03	7.E+03	1.E+02	1.E+03	3.E+03
Uranium	1.E+01	1.E+02	3.E+02	4.E+02	4.E+03	1.E+04	2.E+01	2.E+02	6.E+02	9.E+00	9.E+01	3.E+02
Organic Compounds (mg/kg in Soil/Sediment)												
Total PCB	4.E-01	4.E+00	1.E+01	1.E+01	1.E+02	3.E+02	6.E-01	6.E+00	2.E+01	3.E-01	3.E+00	8.E+00
Total PAH (as (BaPE)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.E+00	0.E+00	0.E+00
Radionuclides (pCi/g in Soil/Sediment)												
Americium-241	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Neptunium-237	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] RGOs for the recreational user are based on the minimum RGO among the adult, teen, and child receptors for this land use scenario.

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ATTACHMENT D1a

APPENDIX B

HISTORICAL RISK ASSESSMENT SUMMARY

from

Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

DOE/OR/07-2137&D2/R2

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CONTENTS

TABLES

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APPENDIX B.1

NSDD SECTIONS 3, 4, AND 5
HISTORICAL RISK ASSESSMENT SUMMARY

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B.1 NSDD SECTION 3, 4, 5 – HISTORICAL RISK ASSESSMENT SUMMARY

Two recent risk assessments are available for the NSDD. These are the SHHRA and SERA performed in support of the ROD for the NSDD (DOE 2002), and the SHHRA performed to support discussions with the regulators in 2003 (BJC 2003a).

In the SHHRA and SERA performed in support of the ROD for the NSDD (DOE 2002), the data set was divided into samples taken from the portions of the NSDD located inside the security fence (i.e., SWMU 59 or Sections 1 and 2) and samples taken from the portions of the NSDD located outside the security fence (i.e., SWMU 58 or Sections 3, 4, and 5). Because SWMU 59 has undergone remediation and because the scope of this SAP is limited to SWMU 58, only results from SHHRA and SERA for SWMU 58 are reported here.

Data used in the SWMU 58 SHHRA and SERA were taken from the PGDP OREIS database in fall 2001. These data consisted of soil and sediment samples collected during all previous investigation activities from 1989 to fall 2001. Data were subsequently segregated by depths, and results from samples collected at a depth greater than 10 ft bgs were not used in the risk assessment. Table B1-1 presents a summary of these data for the COCs identified in the SHHRA. In this table, a COC is a chemical with a maximum concentration at a point of exposure (POE) that exceeds a residential use risk-based screening level or is without a residential use risk-based screening level. Residential use risk-based screening levels (i.e., no action screening levels) used in the selection of COCs and used in subsequent human health risk calculations for the industrial worker and recreational user are in Table B1-2.

As shown in Table B1-1, there are 41 COCs for SWMU 58. Of the 41 COCs listed, 22 are inorganic chemicals, 9 are organic compounds, and 10 are radionuclides. Because COCs were derived from comparisons between maximum detected concentrations and the no action screening levels, the screening assessment was biased toward the identification of unacceptable levels of risk even if risk levels were acceptable (i.e., the assessment was extremely conservative).

Table B1-3 shows the chemical-specific cancer risks and hazards for SWMU 58. (Note that the recreational user considered here is defined as a resident who routinely partakes in recreational activities in the areas where contamination is found.) In addition, the cumulative risks and hazards for each receptor are shown by analyte class and over all contaminants.

As shown in Table B1-3, the total hazard and cancer risk for the most likely future receptor (i.e., the resident using the area for recreational purposes) are 47.5 and 6×10^{-4}, respectively. Chemicals contributing a hazard greater than 0.1 to the total and considered to be COCs for hazard for this receptor are aluminum, antimony, arsenic, barium, beryllium, chromium, iron, manganese, thallium, uranium, and vanadium. The driving contaminants for hazard are inorganic chemicals, which make up all of the total hazard. The driving contaminants and their percentage of total hazard are manganese (25%), chromium (21%), iron (20%), antimony (14%), vanadium (15%), and thallium (6%). Chemicals contributing a cancer risk greater than 1×10^{-6} to the total risk (and considered to be COCs for risk for this receptor) are arsenic, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, PCBs, ^{137}Cs, ^{237}Np, ^{239}Pu, ^{230}Th, ^{235}U, and ^{238}U. The driving contaminants for risk are organic compounds, which make up the majority of the risk (51%). The driving contaminants and their percentage of total risk are PCBs (48%), arsenic (29%), ^{237}Np (8%), and ^{238}U (8%). (Note that lead is also a COC in the on-site area as discussed in the footnote to Table B1-3.)

Table B1-1. Summary of COCs[a] and exposure point concentrations for soils and sediments found in NSDD Sections 3, 4, and 5 (results from DOE 2000)

Exposure Point[b]	COCs	Concentration Detected		Units	Frequency of Detection[c]	Exposure Point Concentration	EPC Units	Statistical Measure[d]
		Min	Max					
Sediment and Soil				***Inorganic Chemicals***				
	Aluminum	687	22200	mg/kg	36/36	22200	mg/kg	max
	Antimony	0.550	1.40	mg/kg	3/36	1.40	mg/kg	max
	Arsenic	1.60	57.1	mg/kg	29/30	57.1	mg/kg	max
	Barium	11.6	319	mg/kg	36/36	319	mg/kg	max
	Beryllium	0.160	6.50	mg/kg	35/39	6.50	mg/kg	max
	Chromium	6.10	120	mg/kg	39/39	120	mg/kg	max
	Copper	2.70	80.8	mg/kg	36/36	80.8	mg/kg	max
	Iron	4380	82600	mg/kg	36/36	82600	mg/kg	max
	Lead	3.60	58.9	mg/kg	34/36	58.9	mg/kg	max
	Manganese	62.4	4470	mg/kg	36/36	4470	mg/kg	max
	Nickel	2.30	41.6	mg/kg	36/36	41.6	mg/kg	max
	Niobium	6.00	6.00	mg/kg	1/6	6.00	mg/kg	max
	Ruthenium	17.9	22.0	mg/kg	2/2	22.0	mg/kg	max
	Silver	1.10	7.20	mg/kg	3/36	7.20	mg/kg	max
	Tantalum	2.00	2.97	mg/kg	2/6	2.97	mg/kg	max
	Thallium	0.560	8.40	mg/kg	13/36	8.40	mg/kg	max
	Thorium	5.40	16.0	mg/kg	5/6	16.0	mg/kg	max
	Titanium	151	388	mg/kg	6/6	388	mg/kg	max
	Tungsten	16.0	78.8	mg/kg	2/6	78.8	mg/kg	max
	Uranium	0.16	200	mg/kg	23/25	200	mg/kg	max
	Vanadium	10.0	104	mg/kg	32/36	104	mg/kg	max
	Zirconium	9.92	18.0	mg/kg	6/6	18.0	mg/kg	max
				Organic Compounds				
	Benz(a)anthracene	0.200	0.250	mg/kg	2/8	0.250	mg/kg	max
	Benzo(a)pyrene	0.190	0.190	mg/kg	1/8	0.190	mg/kg	max
	Benzo(b)fluoranthene	0.150	0.210	mg/kg	2/8	0.210	mg/kg	max
	PCB-1242	0.200	0.200	mg/kg	1/46	0.200	mg/kg	max
	PCB-1248	0.700	29.0	mg/kg	3/46	29.0	mg/kg	max
	PCB-1254	0.100	0.500	mg/kg	4/47	0.500	mg/kg	max
	PCB-1260	0.048	6.10	mg/kg	8/46	6.10	mg/kg	max
	Phenanthrene	0.440	0.500	mg/kg	2/8	0.500	mg/kg	max
	PCBs (Total)	0.044	35.1	mg/kg	25/67	35.1	mg/kg	max
				Radionuclides				
	^{241}Am	0.0621	15.2	pCi/g	27/32	15.2	pCi/g	max
	^{137}Cs	0.0694	1.23	pCi/g	11/11	1.23	pCi/g	max
	^{237}Np	0.0310	43.2	pCi/g	20/28	43.2	pCi/g	max
	^{239}Pu	0.0370	240	pCi/g	16/20	240	pCi/g	max
	^{99}Tc	0.740	3900	pCi/g	50/54	3900	pCi/g	max
	^{230}Th	0.00430	470	pCi/g	25/25	470	pCi/g	max
	^{234}U	0.140	120	pCi/g	54/55	120	pCi/g	max
	^{235}U	0.0130	12	pCi/g	50/50	12	pCi/g	max
	^{238}U	0.140	314	pCi/g	54/55	314	pCi/g	max
	Uranium (Total)	5.21	35.5	pCi/g	2/3	35.5	pCi/g	max

Notes:

Min = Minimum; Max = Maximum; EPC = Exposure Point Concentration

[a] COCs were selected through a comparison between the exposure point concentration and the residential use risk-based screening level. (See Table B1-2). Macroelements such as calcium and potassium are not listed. Only radionuclides commonly found at the PGDP are listed.

[b] Sediment and soil in Sections 3, 4, and 5 of the NSDD.

[c] Number of samples in which COC was detected over total number of samples. Chemicals with total number of samples equal to 1 are not listed.

[d] For the human health risk assessment, the maximum detected concentration was selected as the exposure point concentration. Lower concentrations at other locations were not included in the assessment

Table B1-2. Risk-based screening levels[a] for COCs in soil and sediment (from DOE 2000)

Chemical[c]	Industrial Worker[b]			Recreational User[b]			Resident[b]		
	Hazard	Cancer	No Action	Hazard	Cancer	No Action	Hazard	Cancer	No Action
Inorganic Chemicals (mg/kg)									
Aluminum	4.64E+03		4.64E+03	1.98E+03		1.98E+03	7.32E+02		7.32E+02
Antimony (metallic)	3.79E-01		3.79E-01	1.61E-01		1.61E-01	6.35E-02		6.35E-02
Arsenic, Inorganic	8.41E+00	5.23E-01	5.23E-01	3.60E+00	3.46E-01	3.46E-01	9.59E-01	1.32E-01	1.32E-01
Barium	2.29E+02		2.29E+02	9.78E+01		9.78E+01	3.70E+01		3.70E+01
Beryllium and compounds	9.48E-01	5.47E+04	9.48E-01	4.04E-01	6.02E+04	4.04E-01	1.60E-01	1.55E+04	1.60E-01
Cadmium (Diet)	2.13E+01	7.53E+04	2.13E+01	9.12E+00	8.30E+04	9.12E+00	2.64E+00	2.14E+04	2.64E+00
Chromium (III) (Insoluble Salts)	3.56E+02		3.56E+02	1.52E+02		1.52E+02	6.05E+01		6.05E+01
Chromium VI (particulates)	2.84E+00	1.12E+04	2.84E+00	1.21E+00	1.23E+04	1.21E+00	4.76E-01	3.18E+03	4.76E-01
Copper	4.93E+02		4.93E+02	2.11E+02		2.11E+02	6.81E+01		6.81E+01
Iron	2.07E+03		2.07E+03	8.83E+02		8.83E+02	3.14E+02		3.14E+02
Lead And Compounds			5.00E+01			5.00E+01			5.00E+01
Manganese (Water)	8.66E+01		8.66E+01	3.70E+01		3.70E+01	1.43E+01		1.43E+01
Mercury, Inorganic Salts	9.82E-01		9.82E-01	4.19E-01		4.19E-01	1.58E-01		1.58E-01
Nickel Soluble Salts	2.42E+02		2.42E+02	1.03E+02		1.03E+02	3.40E+01		3.40E+01
Selenium	9.49E+01		9.49E+01	4.06E+01		4.06E+01	1.21E+01		1.21E+01
Silver	4.11E+01		4.11E+01	1.75E+01		1.75E+01	6.12E+00		6.12E+00
Thallium Chloride	7.27E-01		7.27E-01	3.10E-01		3.10E-01	1.07E-01		1.07E-01
Uranium (Soluble Salts)	1.01E+02		1.01E+02	4.34E+01		4.34E+01	1.08E+01		1.08E+01
Vanadium, Metallic	3.32E+00		3.32E+00	1.42E+00		1.42E+00	5.62E-01		5.62E-01
Organic Compounds (mg/kg)									
Benz[a]anthracene		2.12E-01	2.12E-01		1.33E-01	1.33E-01		6.70E-02	6.70E-02
Benzo[a]pyrene		2.12E-02	2.12E-02		1.33E-02	1.33E-02		6.70E-03	6.70E-03
Benzo[b]fluoranthene		2.12E-01	2.12E-01		1.33E-01	1.33E-01		6.70E-02	6.70E-02
Benzo[k]fluoranthene		2.12E+00	2.12E+00		1.33E+00	1.33E+00		6.70E-01	6.70E-01
Bis(2-ethylhexyl)phthalate	8.84E+01	8.84E+00	8.84E+00	3.77E+01	5.53E+00	5.53E+00	1.40E+01	2.84E+00	2.84E+00
Indeno[1,2,3-cd]pyrene		2.12E-01	2.12E-01		1.33E-01	1.33E-01		6.70E-02	6.70E-02
PCB-1242		1.99E-01	1.99E-01		1.27E-01	1.27E-01		5.74E-02	5.74E-02
PCB-1248		1.99E-01	1.99E-01		1.27E-01	1.27E-01		5.74E-02	5.74E-02
PCB-1254	2.84E-01	1.99E-01	1.99E-01	1.22E-01	1.27E-01	1.22E-01	3.88E-02	5.74E-02	3.88E-02
PCB-1260		1.99E-01	1.99E-01		1.27E-01	1.27E-01		5.74E-02	5.74E-02
PCBs (Total)		1.99E-01	1.99E-01		1.27E-01	1.27E-01		5.74E-02	5.74E-02
Radionuclides (pCi/g)									
^{241}Am		8.09E+00	8.09E+00		2.05E+01	2.05E+01		1.49E+00	1.49E+00
^{137}Cs+D		1.05E-01	1.05E-01		2.18E-01	2.18E-01		1.56E-02	1.56E-02
^{237}Np+D		4.54E-01	4.54E-01		9.53E-01	9.53E-01		6.82E-02	6.82E-02
^{239}Pu		1.01E+01	1.01E+01		2.68E+01	2.68E+01		1.96E+00	1.96E+00
^{99}Tc		2.27E+03	2.27E+03		6.02E+03	6.02E+03		4.40E+02	4.40E+02
^{230}Th		8.34E+01	8.34E+01		2.20E+02	2.20E+02		1.62E+01	1.62E+01
^{234}U		7.13E+01	7.13E+01		1.89E+02	1.89E+02		1.38E+01	1.38E+01
^{235}U+D		8.16E-01	8.16E-01		1.70E+00	1.70E+00		1.22E-01	1.22E-01
^{238}U+D		3.13E+00	3.13E+00		6.60E+00	6.60E+00		4.73E-01	4.73E-01
Uranium (Total)		3.13E+00	3.13E+00		6.60E+00	6.60E+00		4.73E-01	4.73E-01

Notes:

Blank cells indicate that a value is not available for the chemical. Chemicals listed in Table B1-1 but without any screening levels are not listed here

[a] Hazard values based on a target hazard index of 0.1. Cancer values based on a target cancer risk of 1×10^{-6}. The No Action value is the lesser of the hazard- and cancer-based values. All values from December 2000 revision of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000).

[b] The industrial worker values are based upon exposure through incidental ingestion, inhalation of dust, inhalation of vapors, dermal contact, and external exposure to ionizing radiation. The frequency and duration of exposure are 250 days/year and 25 years, respectively.

The recreational user values are based upon exposure through incidental ingestion, inhalation of dust, inhalation of vapors, dermal contact, and external exposure to ionizing radiation. All hazard values are based upon a child's exposure of 140 days/year for 6 years. All cancer values are based upon a lifetime exposure duration of 40 years during which the child and teen are exposed for 140 days/year, and the adult is exposed for 104 days/year.

The resident values are based upon exposure through incidental ingestion, inhalation of dust, inhalation of vapors, dermal contact, and external exposure to ionizing radiation. All hazard values are based upon a child's exposure of 350 days/year for 6 years. All cancer values are based upon a lifetime exposure duration of 40 years during which both the child and the adult are exposed for 350 days/year.

[c] Only COCs with risk-based screening levels are shown.

Table B1-3. Risk characterization[a] for off-site areas of the NSDD
(results from DOE 2000)

Chemical[b]	Off-site EPC	Industrial Worker Hazard	Industrial Worker Cancer	Recreational user Hazard	Recreational user Cancer	Resident Hazard	Resident Cancer
Inorganic Chemicals (EPCs in mg/kg)							
Aluminum	22200	0.5	NV	1.1	NV	3.0	NV
Antimony (metallic)	1.4	0.4	NV	0.9	NV	2.2	NV
Arsenic, Inorganic	57.1	0.7	1.E-04	1.6	2E-04	6.0	4.E-04
Barium	319	0.1	NV	0.3	NV	0.9	NV
Beryllium and compounds	6.50	0.7	1.E-10	1.6	1.E-10	4.1	4.E-10
Chromium VI (particulates)	120	4.2	1.E-08	9.9	1E-08	25.2	4.E-08
Copper	80.8	<0.1	NV	<0.1	NV	0.1	NV
Iron	82600	4.0	NV	9.4	NV	26.3	NV
Manganese (Water)	4470	5.2	NV	12.1	NV	31.3	NV
Nickel Soluble Salts	41.6	<0.1	NV	<0.1	NV	0.1	NV
Silver	7.2	<0.1	NV	<0.1	NV	0.1	NV
Thallium Chloride	8.4	1.2	NV	2.7	NV	7.9	NV
Uranium (Soluble Salts)	200	0.2	NV	0.5	NV	1.9	NV
Vanadium, Metallic	104	3.1	NV	7.3	NV	18.5	NV
Subtotal Inorganic Chemicals		20.3	1.E-04	47.5	2.E-04	127.5	4.E-04
Organic Compounds (EPCs in mg/kg)							
Benz[a]anthracene	0.250	NV	1.E-06	NV	2.E-06	NV	4.E-06
Benzo[a]pyrene	0.190	NV	9.E-06	NV	1.E-05	NV	3.E-05
Benzo[b]fluoranthene	0.210	NV	1.E-06	NV	2.E-06	NV	3.E-06
PCBs (Total)	35.1	NV	2.E-04	NV	3.E-04	NV	6.E-04
Subtotal Organic Compounds		0.0	2.E-04	0.0	3.E-04	0.0	6.E-04
Radionuclides (EPCs in pCi/g)							
^{241}Am	15.2	NV	2.E-06	NV	7.E-07	NV	1.E-05
^{137}Cs+D	1.23	NV	1.E-05	NV	6.E-06	NV	8.E-05
^{237}Np+D	43.2	NV	1.E-04	NV	5.E-05	NV	6.E-04
^{239}Pu	240	NV	2.E-05	NV	9.E-06	NV	1.E-04
^{99}Tc	3900	NV	2.E-06	NV	6.E-07	NV	9.E-06
^{230}Th	470	NV	6.E-06	NV	2.E-06	NV	3.E-05
^{234}U	120	NV	2.E-06	NV	6.E-07	NV	9.E-06
^{235}U+D	12.0	NV	1.E-05	NV	7.E-06	NV	1.E-04
^{238}U+D	314	NV	1.E-04	NV	5.E-05	NV	7.E-04
Subtotal Radionuclides		0.0	3.E-04	0.0	1.E-04	0.0	2.E-03
Total		20.3	6.E-04	47.5	6.E-04	127.5	3.E-03

Notes:

Lead also is a COC in the on-site area. Contribution from lead is not included above because risk characterization for lead is determined using alternative methods (DOE 2000).

[a] Risks and hazard derived as discussed in text.

[b] Only chemicals with screening values are shown.

For the SERA, the analytes considered were those identified as COCs by the SHHRA. (See Table B1-1.) The maximum concentrations of these COCs were subsequently compared to PGDP soil and sediment USVs for ecological receptors (Table B1-4). [In principle, if any constituent exceeds its USV, then undesirable effects are likely for receptors exposed.] Ecological USVs for soil, sediment, and surface water used were taken from *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000).

Table B1-4 shows that samples from soils and sediment from Sections 3, 4, and 5 of the NSDD contain arsenic, barium, chromium, nickel, uranium, and PCBs at concentrations that exceed the USVs for ecological receptors and, thus, are very likely to pose a risk to ecological receptors exposed by direct contact with sediment or soil in the NSDD or by ingesting contaminated prey so exposed. Based on the single line of evidence provided by comparing site concentrations to concentrations predicted to be associated with adverse effects on one or more classes of ecological receptors, it can be concluded that there is a high probability that one or more constituents in soil or sediment of Sections 3, 4, and 5 of NSDD could pose an ecological risk if the exposure and toxicity assumptions of the USVs are realized at the site. This is particularly true for certain heavy metals and PCBs (total) in sediment, if the elevated concentrations occur in areas of suitable habitat for benthic invertebrate communities.

In the SHHRA performed as part of discussions with the regulators in 2003 (BJC 2003a), the data set used in the SSHRA and SERA performed in support of the ROD (DOE 2002) was augmented with more recently collected data and was refined by only retaining data determined to be associated with NSDD sediment or soil. Specific steps taken in refining the data set were as follows.

- Result was from a station located within 17.5 ft of the centerline of the NSDD.
- Result was from a sample collected at an end depth equal to or less than 2 ft bgs. (Samples without an end depth but listed as being from sediment were assumed to meet this depth requirement.)
- Result was from a sample collected after 12/31/1994. (Data were segregated by date to develop a data set that better represents current contaminant levels found in SWMU 58. This decision was made after considering the results of the walk-over survey and sampling performed by the Commonwealth of Kentucky’s Radiation Control Branch in fall 2000.)
- Result was for a chemical, compound, or radionuclide that had a maximum detected concentration over the entire SWMU 58 data set that was greater than both the analyte’s background concentration and residential use no action screening value. Analytes that were never detected were not included in the analysis.

The summary statistics for the resulting data set that were used to derive exposure concentrations are shown in Table B1-5. Generally, for each COPC, the exposure concentration was the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL) on the mean value of the appropriate distribution (i.e., normal or log normal). However, when five or fewer results were available, the maximum concentration was used as the exposure concentration. Additionally, when more than five but fewer than ten results were available, then data were assumed to be log normally distributed.

Exposure concentrations were compared to risk-based concentrations calculated for the following four scenarios to develop risk estimates:

- Default industrial use – direct contact with soil and sediment for 250 days per year over a 25-year period (exposure time of 8 hours per day).

Table B1-4. Comparison of human health chemicals of concern[a] and PGDP USVs for ecological receptors (results from DOE 2000)

Exposure Point[b]	COC	Concentration Detected		Units	Frequency of Detection[c]	Soil USV (mg/kg)	Sediment USV (mg/kg)
		Min	Max				
Sediment and Soil	***Inorganic Chemicals***						
	Aluminum	687	22200	mg/kg	36/36	50000	no value
	Antimony	0.550	1.40	mg/kg	3/36	3500	no value
	Arsenic	1.60	57.1	mg/kg	29/30	17	17
	Barium	11.6	319	mg/kg	36/36	90.9	no value
	Beryllium	0.160	6.50	mg/kg	35/39	30.3	no value
	Chromium	6.10	120	mg/kg	39/39	90	90
	Copper	2.70	80.8	mg/kg	36/36	149	149
	Iron	4380	82600	mg/kg	36/36	200000	no value
	Lead	3.60	58.9	mg/kg	34/36	91.3	91.3
	Manganese	62.4	4470	mg/kg	36/36	100000	no value
	Nickel	2.30	41.6	mg/kg	36/36	36	36
	Niobium	6.00	6.00	mg/kg	1/6	no value	no value
	Ruthenium	17.9	22.0	mg/kg	2/2	no value	no value
	Silver	1.10	7.20	mg/kg	3/36	2000	no value
	Tantalum	2.00	2.97	mg/kg	2/6	no value	no value
	Thallium	0.560	8.40	mg/kg	13/36	1000	no value
	Thorium	5.40	16.0	mg/kg	5/6	no value	no value
	Titanium	151	388	mg/kg	6/6	1000000	no value
	Tungsten	16.0	78.8	mg/kg	2/6	400000	no value
	Uranium	0.16	200	mg/kg	23/25	28.1	no value
	Vanadium	10.0	104	mg/kg	32/36	2000	no value
	Zirconium	9.92	18.0	mg/kg	6/6	no value	no value
	Organic Compounds						
	Benz(a)anthracene	0.200	0.250	mg/kg	2/8	0.385	0.385
	Benzo(a)pyrene	0.190	0.190	mg/kg	1/8	0.782	0.782
	Benzo(b)fluoranthene	0.150	0.210	mg/kg	2/8	no value	no value
	PCB-1242	0.200	0.200	mg/kg	1/46	no value	no value
	PCB-1248	0.700	29.0	mg/kg	3/46	no value	no value
	PCB-1254	0.100	0.500	mg/kg	4/47	no value	no value
	PCB-1260	0.048	6.10	mg/kg	8/46	no value	no value
	Phenanthrene	0.440	0.500	mg/kg	2/8	0.515	0.515
	PCBs (Total)	0.044	35.1	mg/kg	25/67	0.118	0.277
	Radionuclides						
	^{241}Am	0.0621	15.2	pCi/g	27/32	no value	no value
	^{137}Cs	0.0694	1.23	pCi/g	11/11	no value	no value
	^{237}Np	0.0310	43.2	pCi/g	20/28	no value	no value
	^{239}Pu	0.0370	240	pCi/g	16/20	no value	no value
	^{99}Tc	0.740	3900	pCi/g	50/54	no value	no value
	^{230}Th	0.00430	470	pCi/g	25/25	no value	no value
	^{234}U	0.140	120	pCi/g	54/55	no value	no value
	^{235}U	0.0130	12	pCi/g	50/50	no value	no value
	^{238}U	0.140	314	pCi/g	54/55	no value	no value
	Uranium (Total)	5.21	35.5	pCi/g	2/3	no value	no value

Notes:

Min = Minimum; Max = Maximum

[a] Human health COCs were selected through a comparison between the exposure point concentration and residential use risk-based screening level. Macroelements such as calcium and potassium are not listed.

[b] Sediment and soil in Sections 3, 4, and 5 of the NSDD.

[c] Number of samples in which COC was detected over total number of samples.

Table B1-5. Summary statistics for detected analytes from SHHRA of Sections 3, 4, and 5 of the NSDD
(results from BJC 2003a)

Analyte[a]	Total Number of Results	Data Summary for Detected Results				Background Concentration[c]	Residential No Action Screening Value[d]	COPC?[e]
		Number of Detected Results	Minimum Concentration	Maximum Concentration	Average Concentration[b]			
				Inorganic Chemicals				
Aluminum	26	26	1,970	12,500	8276	13,000	732	No
Arsenic	26	16	2.4	32.7	8.55	12	0.132	Yes
Barium	26	26	12	146	73.5	200	37	No
Beryllium	26	13	0.31	1.9	0.837	0.67	0.16	Yes
Cadmium	26	1	0.41	0.41	0.410	0.21	2.64	No
Calcium	26	26	420	83,000	7,079	200,000	NV	No
Chromium	26	26	8.09	120	45.418	16	60.5	Yes
Cobalt	26	25	1.4	23.4	6.20	14	209	No
Copper	26	26	2.7	135	33.52	19	68.1	Yes
Iron	26	26	5,260	50,900	14541	28,000	314	Yes
Lead	26	14	3.6	38.1	19.45	36	50	No
Lithium	15	11	5.32	8.75	6.791	NV	69.8	No
Magnesium	26	26	107	2,480	1,121	7,700	NV	No
Manganese	26	26	72.7	1,780	348.46	1,500	7.46	Yes
Mercury	26	14	0.03	1.49	0.442	0.2	0.158	Yes
Molybdenum	11	10	0.2	1.8	0.80	NV	10.9	No
Nickel	26	24	2.3	101	38.41	21	34	Yes
Potassium	11	7	224	807	478	1300	NV	No
Silicon	11	11	343	881	721	NV	NV	No[h]
Silver	26	6	3.08	19.6	9.152	2.3	6.12	Yes
Sodium	11	10	29	447	98.9	320	NV	No[h]
Thallium	26	8	0.56	2.8	1.241	0.21	0.107	Yes
Tin	15	12	113	217	165	NV	439	No
Uranium	30	13	5.17	234	51.288	4.9	2.16	Yes
Vanadium	26	26	13.6	74.7	28.77	38	0.562	Yes
Zinc	26	26	6	138	53.8	65	62,200	No
				Organic Compounds				
Methylene chloride	15	1	0.017	0.017	0.017	NV	3.92	No
PCB-1248	29	3	0.37	11.3	5.090	NV	0.0574	Yes[f]
PCB-1254	29	6	0.3	5.9	2.73	NV	0.0388	Yes[f]
PCB-1260	29	12	0.1	3.8	1.18	NV	0.0574	Yes[f]
Total PCBs	18	12	0.1	20	3.82	NV	0.0574	Yes
				Radionuclides				
^{241}Am	25	20	0.06	4.26	1.045	NV	0.836	Yes
^{137}Cs	15	13	0.03	4.16	1.750	0.49	0.0128	Yes
^{237}Np	25	18	0.08	3	1.245	0.1	0.0405	Yes
^{238}Pu	26	2	0.24	0.31	0.275	0.073	2.27	No
^{239}Pu	26	23	0.16	20.6	4.263	0.025	2.22	Yes
^{99}Tc	25	23	2.91	153	43.345	2.5	67.4	Yes
^{228}Th	15	15	0.27	4.38	1.318	1.6	0.00418	Yes[g]
^{230}Th	15	15	0.35	497	139.491	1.5	2.85	Yes
^{232}Th	15	15	0.29	5.07	1.553	1.5	2.61	Yes
^{234}U	26	22	0.69	31.2	6.381	2.5	3.81	Yes
^{235}U	26	26	0.03	1.94	0.342	0.14	0.0591	Yes
^{238}U	26	25	0.79	40	7.235	1.2	0.261	Yes

Notes:
NV = no value.
COPC = Chemical of potential concern.
All concentrations for inorganic chemicals and organic compounds are in units of mg/kg. All concentrations for radionuclides are in units of pCi/g.

[a] Only analytes that are detected in at least one sample are listed.

[b] Arithmetic average of reported results.

[c] Background concentrations are for surface soil and are taken from Table A.12 in DOE 2000 (the Methods Doc).

[d] Residential no action screening values are those for the child resident taken from Table A.14 in DOE 2000.

[e] "Yes" indicates that the maximum detected concentration exceeds both the background concentration and the residential no action screening value. "No" indicates that the maximum detected concentration is less than the background concentration or less than the residential no action screening value, if the background value is exceeded. Please see footnotes f, g, and h as well.

[f] Risk from PCB mixtures was derived using results for Total PCBs only. Individual PCB mixtures were not retained as COPCs.

[g] ^{228}Th has a short half-life and is not expected to be in the environment at the PGDP. This radionuclide was not retained as a COPC per comment from the Commonwealth of Kentucky Radiation Control Branch.

[h] Not retained as COPCs because no toxicity value is available.

- Site-specific industrial use – direct contact with soil and sediment for 16 days per year over a 25-year period (exposure time of 8 hours per day).

- Default recreational use – direct contact with soil and sediment for 140 days per year (child and teen) or 104 days per year (adult) over a 40-year period.

- Site-specific recreational use – direct contact with soil and sediment as an adult or teen-aged youth (i.e., 7 to 18 years of age) for 10 days per year over a 1-year period. (Exposure time of 4 hours per day).

Analytes identified as COPCs through comparisons of maximum detected concentrations with surface soil background and child residential use no action screening values are in Table B1-5. This list of COPCs is similar to that derived earlier in support of the NSDD ROD.

The hazards and cancer risks derived for all of SWMU 58 and for Sections 3, 4, and 5 individually are in Tables B1-6 and B1-7, respectively. As shown in Table B1-6, the hazard for both the default industrial worker and default recreational user scenarios is of concern for SWMU 58 and for the three sections (i.e., cumulative hazard is greater than 1). However, the hazard for the site-specific industrial worker and site-specific recreational user scenarios is not of concern for these areas (i.e., cumulative hazard is less than 1). For SWMU 58, the COCs, in order of importance, for the two default scenarios are manganese, vanadium, iron, uranium, thallium, mercury, and arsenic. Results for the sections are similar. COCs are highlighted in italicized font in Table B1-6.

As shown in Table B1-7, the cancer risk for both the default industrial worker and default recreational user is of concern from SWMU 58 and Section 3, but not for Sections 4 and 5 (i.e., cumulative cancer risk is greater than 1×10^{-4}). However, as with hazard, the site-specific industrial worker and the site-specific recreational user risks are lower and within or below EPA's generally acceptable risk range for site-related exposure (i.e., 10^{-6} to 10^{-4}). For SWMU 58, the COCs, in order of importance, for the two default scenarios are total PCBs, ^{230}Th, ^{137}Cs, arsenic, ^{237}Np, ^{238}U, and ^{235}U. The results for the sections are similar. COCs are highlighted in italicized font in Table B1-7.

Taken in absence of uncertainties and site-specific conditions, the hazards and cancer risks reported here indicate that use of the area containing Sections 3, 4, and 5 of the NSDD may need to be controlled to reduce risks to below the benchmarks used at PGDP to determine areas of concern. However, as shown by the results for the site-specific scenarios assessed in the later of the two SHHRAs, controls currently in place that limit exposure reduce both the cumulative hazards and cancer risks to levels within EPA's generally acceptable risk range for site-related exposures.

Table B1-6. Chemical-specific and cumulative hazards[a] posed by COPCs found in Sections 3, 4, and 5 of the NSDD (results from BJC 2003a)

COPCs	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
		Hazard – SWMU 58		
Arsenic	*0.10*	0.01	*0.13*	0.01
Beryllium	0.07	<0.01	*0.12*	<0.01
Chromium	0.02	<0.01	0.03	<0.01
Copper	0.01	<0.01	0.02	<0.01
Iron	*0.84*	0.17	*1.28*	0.17
Manganese	*1.06*	<0.01	*1.66*	<0.01
Mercury	*0.11*	<0.01	*0.17*	<0.01
Nickel	0.03	<0.01	0.05	<0.01
Silver	0.01	<0.01	0.02	<0.01
Thallium	*0.39*	<0.01	*0.58*	<0.01
Uranium	*0.47*	0.01	*0.64*	0.01
Vanadium	*1.00*	<0.01	*1.57*	<0.01
Total PCBs	NV	NV	NV	NV
^{241}Am	NV	NV	NV	NV
^{137}Cs	NV	NV	NV	NV
^{237}Np	NV	NV	NV	NV
^{239}Pu	NV	NV	NV	NV
^{99}Tc	NV	NV	NV	NV
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	NV	NV	NV	NV
^{235}U	NV	NV	NV	NV
^{238}U	NV	NV	NV	NV
Total for SWMU 58	***4.11***	0.20	***6.27***	0.21
		Hazard – Section 3		
Arsenic	0.05	<0.01	0.08	0.01
Beryllium	0.04	<0.01	0.06	<0.01
Chromium	0.02	<0.01	0.03	<0.01
Copper	0.02	<0.01	0.03	<0.01
Iron	*0.58*	0.12	*0.89*	0.12
Manganese	*0.56*	<0.01	*0.87*	<0.01
Mercury	*0.10*	<0.01	*0.15*	<0.01
Nickel	0.03	<0.01	0.04	<0.01
Silver	0.02	<0.01	0.03	<0.01
Thallium	ND	ND	ND	ND
Uranium	*0.47*	0.01	*0.64*	0.01
Vanadium	*0.77*	<0.01	*1.21*	<0.01
Total PCBs	NV	NV	NV	NV
^{241}Am	NV	NV	NV	NV
^{137}Cs	NV	NV	NV	NV
^{237}Np	NV	NV	NV	NV
^{239}Pu	NV	NV	NV	NV
^{99}Tc	NV	NV	NV	NV
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	NV	NV	NV	NV
^{235}U	NV	NV	NV	NV
^{238}U	NV	NV	NV	NV
Total for Section 3	***2.66***	0.14	***4.03***	0.15
		Hazard – Section 4		
Arsenic	*0.11*	0.01	*0.15*	0.01
Beryllium	*0.10*	<0.01	*0.16*	<0.01

Table B1-6. Chemical-specific and cumulative hazards[a] posed by COPCs found in Sections 3, 4, and 5 of the NSDD (results from BJC 2003a) (continued)

COPCs	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
Chromium	0.01	<0.01	0.01	<0.01
Copper	<0.01	<0.01	0.01	<0.01
Iron	*1.03*	0.21	*1.58*	0.21
Manganese	*1.44*	0.01	*2.24*	0.01
Mercury	0.01	<0.01	0.01	<0.01
Nickel	0.01	<0.01	0.01	<0.01
Silver	ND	ND	ND	ND
Thallium	*0.17*	<0.01	*0.25*	<0.01
Uranium	NV	NV	NV	NV
Vanadium	*1.17*	<0.01	*1.83*	<0.01
Total PCBs	NV	NV	NV	NV
^{241}Am	NV	NV	NV	NV
^{137}Cs	NV	NV	NV	NV
^{237}Np	NV	NV	NV	NV
^{239}Pu	NV	NV	NV	NV
^{99}Tc	NV	NV	NV	NV
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	NV	NV	NV	NV
^{235}U	NV	NV	NV	NV
^{238}U	NV	NV	NV	NV
Total for Section 4	***4.04***	0.23	***6.25***	0.24
Hazard – Section 5				
Arsenic	*0.39*	0.02	*0.55*	0.04
Beryllium	*0.20*	<0.01	*0.31*	<0.01
Chromium	0.02	<0.01	0.03	<0.01
Copper	0.01	<0.01	0.01	<0.01
Iron	*2.46*	0.51	*3.77*	0.51
Manganese	*3.94*	0.02	*6.14*	0.02
Mercury	ND	ND	ND	ND
Nickel	0.01	<0.01	0.02	<0.01
Silver	ND	ND	ND	ND
Thallium	*0.39*	<0.01	*0.58*	<0.01
Uranium	NV	NV	NV	NV
Vanadium	*2.25*	<0.01	*3.52*	0.01
Total PCBs	NV	NV	NV	NV
^{241}Am	NV	NV	NV	NV
^{137}Cs	NV	NV	NV	NV
^{237}Np	NV	NV	NV	NV
^{239}Pu	NV	NV	NV	NV
^{99}Tc	NV	NV	NV	NV
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	NV	NV	NV	NV
^{235}U	NV	NV	NV	NV
^{238}U	NV	NV	NV	NV
Total for Section 5	***9.66***	0.56	***14.93***	0.58

[a] Hazard values less than 0.01 are listed as "<0.01".
COPC = chemical of potential concern
SWMU = solid waste management unit
NV = a hazard value could not be derived because a hazard toxicity value is not available.
ND = a hazard value could not be derived because the COPC was not detected.

Table B1-7. Chemical-specific and cumulative cancer risk posed by COPCs found in Sections 3, 4 and 5 of the NSDD (results from BJC 2003a)

COPCs	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
Cancer Risk – SWMU 58				
Arsenic	*1.54E-05*	9.87E-07	*2.33E-05*	7.07E-08
Beryllium	1.29E-11	7.06E-12	1.17E-11	7.06E-12
Chromium	6.83E-09	7.44E-10	6.20E-09	7.44E-10
Copper	NV	NV	NV	NV
Iron	NV	NV	NV	NV
Manganese	NV	NV	NV	NV
Mercury	NV	NV	NV	NV
Nickel	NV	NV	NV	NV
Silver	NV	NV	NV	NV
Thallium	NV	NV	NV	NV
Uranium	NV	NV	NV	NV
Vanadium	NV	NV	NV	NV
Total PCBs	*1.01E-04*	6.60E-06	*1.57E-04*	4.59E-07
^{241}Am	4.92E-07	3.15E-08	2.19E-07	8.06E-10
^{137}Cs	*2.55E-05*	1.63E-06	*1.23E-05*	2.05E-08
^{237}Np	*1.11E-05*	7.09E-07	*5.31E-06*	9.23E-09
^{239}Pu	*1.79E-06*	1.15E-07	6.80E-07	5.71E-09
^{99}Tc	2.72E-07	1.75E-08	1.06E-07	7.83E-10
^{230}Th	*3.34E-05*	2.13E-06	*1.27E-05*	1.02E-07
^{232}Th	2.46E-07	6.36E-08	9.30E-08	7.72E-10
^{234}U	5.10E-07	3.27E-08	1.93E-07	1.61E-09
^{235}U	*1.70E-06*	1.09E-07	8.11E-07	1.44E-09
^{238}U	*7.37E-06*	4.72E-07	*3.46E-06*	7.88E-09
Total for SWMU 58	***1.98E-04***	1.29E-05	***2.17E-04***	6.81E-07
Cancer Risk – Section 3				
Arsenic	*8.70E-06*	5.57E-07	*1.32E-05*	3.99E-08
Beryllium	6.16E-12	3.37E-12	5.60E-12	3.37E-12
Chromium	7.23E-09	7.88E-10	6.57E-09	7.88E-10
Copper	NV	NV	NV	NV
Iron	NV	NV	NV	NV
Manganese	NV	NV	NV	NV
Mercury	NV	NV	NV	NV
Nickel	NV	NV	NV	NV
Silver	NV	NV	NV	NV
Thallium	NV	NV	NV	NV
Uranium	NV	NV	NV	NV
Vanadium	NV	NV	NV	NV
Total PCBs	*1.01E-04*	6.60E-06	*1.57E-04*	4.59E-07
^{241}Am	8.26E-07	5.29E-08	3.67E-07	1.35E-09
^{137}Cs	*2.55E-05*	1.63E-06	*1.23E-05*	2.05E-08
^{237}Np	*6.86E-06*	4.40E-07	*3.29E-06*	5.72E-09
^{239}Pu	*1.79E-06*	1.15E-07	6.80E-07	5.71E-09
^{99}Tc	4.23E-07	2.71E-08	1.65E-07	1.21E-09
^{230}Th	*3.34E-05*	2.13E-06	*1.27E-05*	1.02E-07
^{232}Th	2.46E-07	6.36E-08	9.30E-08	7.72E-10
^{234}U	*1.49E-06*	9.58E-08	5.67E-07	4.71E-09
^{235}U	*4.91E-06*	3.14E-07	*2.35E-06*	4.16E-09
^{238}U	*2.02E-05*	1.30E-06	*9.51E-06*	2.16E-08
Total for Section 3	*2.05E-04*	1.33E-05	***2.13E-04***	6.67E-07
Cancer Risk – Section 4				
Arsenic	1.72E-05	1.10E-06	2.59E-05	7.87E-08
Beryllium	1.80E-11	9.84E-12	1.63E-11	9.84E-12

Table B1-7. Chemical-specific and cumulative cancer risk posed by COPCs found in Sections 3, 4 and 5 of the NSDD (results from BJC 2003a) (continued)

COPCs	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
Chromium	1.97E-09	2.15E-10	1.79E-09	2.15E-10
Copper	NV	NV	NV	NV
Iron	NV	NV	NV	NV
Manganese	NV	NV	NV	NV
Mercury	NV	NV	NV	NV
Nickel	NV	NV	NV	NV
Silver	NV	NV	NV	NV
Thallium	NV	NV	NV	NV
Uranium	NV	NV	NV	NV
Vanadium	NV	NV	NV	NV
Total PCBs	ND	ND	ND	ND
^{241}Am	4.84E-08	3.10E-09	2.16E-08	7.94E-11
^{137}Cs	NV	NV	NV	NV
^{237}Np	1.33E-06	8.51E-08	6.37E-07	1.11E-09
^{239}Pu	6.43E-08	4.13E-09	2.44E-08	2.05E-10
^{99}Tc	5.62E-08	3.60E-09	2.20E-08	1.62E-10
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	1.68E-07	1.08E-08	6.38E-08	5.29E-10
^{235}U	5.57E-07	3.57E-08	2.66E-07	4.72E-10
^{238}U	2.54E-06	1.63E-07	1.19E-06	2.71E-09
Total for Section 4	2.19E-05	1.40E-06	2.82E-05	8.42E-08
Cancer Risk – Section 5				
Arsenic	6.25E-05	4.00E-06	9.45E-05	2.87E-07
Beryllium	3.47E-11	1.90E-11	3.16E-11	1.90E-11
Chromium	5.26E-09	5.73E-10	4.78E-09	5.73E-10
Copper	NV	NV	NV	NV
Iron	NV	NV	NV	NV
Manganese	NV	NV	NV	NV
Mercury	NV	NV	NV	NV
Nickel	NV	NV	NV	NV
Silver	NV	NV	NV	NV
Thallium	NV	NV	NV	NV
Uranium	NV	NV	NV	NV
Vanadium	NV	NV	NV	NV
Total PCBs	ND	ND	ND	ND
^{241}Am	1.38E-07	8.81E-09	6.12E-08	2.25E-10
^{137}Cs	NV	NV	NV	NV
^{237}Np	1.77E-06	1.13E-07	8.50E-07	1.48E-09
^{239}Pu	1.09E-07	6.98E-09	4.13E-08	3.46E-10
^{99}Tc	8.55E-08	5.48E-09	3.34E-08	2.46E-10
^{230}Th	NV	NV	NV	NV
^{232}Th	NV	NV	NV	NV
^{234}U	2.52E-07	1.61E-08	9.56E-08	7.93E-10
^{235}U	7.59E-07	4.86E-08	3.63E-07	6.44E-10
^{238}U	4.28E-06	2.74E-07	2.01E-06	4.58E-09
Total for Section 5	6.99E-05	4.48E-06	9.80E-05	2.96E-07

COPC = chemical of potential concern
SWMU = solid waste management unit
NV = a cancer risk value could not be derived because a cancer toxicity value is not available.
ND = a cancer risk value could not be derived because the COPC was not detected.

APPENDIX B.2

OUTFALLS 001, 008, 010, 011, AND 015
HISTORICAL RISK ASSESSMENT SUMMARY

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B.2 OUTFALLS 001, 008, 010, 011, AND 015 – HISTORICAL RISK ASSESSMENT SUMMARY

Two recent risk assessments have been completed for Outfalls 001, 008, 010, 011, and 015. (As noted in Section 3, no recent risk assessment results are available for Outfall 002.) These are the SHHRA and SERA performed in support of the SWSC Project and a SHHRA performed to support discussion with the regulators (BJC 2003b).

In the SHHRA performed in support of the SWSC Project, maximum detected concentrations of chemicals and compounds detected in surface water and sediment at Outfalls 001, 008, 010, 011, and 015 were compared to no action and action screening values presented in Appendix A in DOE 2000.

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 this comparison were risk-based values calculated using either a target cancer risk value of 1×10^{-4} or a target HI value of 3.

Tables B2-1 and B2-2 summarize the SHHRA and present a summary of the chemicals and compounds detected in samples collected from outfall soils/sediments and surface water, respectively. 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 recreational user screening value, and the industrial worker and recreational user screening values.

Results in Tables B2-1 and B2-2 show that several chemicals and compounds have been detected in sediments, soils, and surface water associated with the 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 exceedances of these levels are used at PGDP to determine the need for early 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 ^{238}U. The only chemical in soil and sediments at Outfall 015 that exceeds the industrial worker and child recreator action levels is ^{137}Cs.

As noted earlier, only Outfall 011 has a detection in surface water that exceeds an action level. 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.

In the SERA performed in support of the SWSC Project, maximum detected concentrations of chemicals and compounds detected in sediment and surface water at Outfalls 001, 008, 010, 011, and 015 were compared to effects-based concentrations for ecological receptors taken from DOE 2000. Effect-based concentrations considered were the PGDP NFA values and USVs.

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project)

OUTFALL 001

			Frequency of Detection[b] above			
Chemical or Compound	**Units**	**Maximum Detect**	**Industrial Worker Action Level[c]**	**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
^{137}Cs	pCi/g	51	4/32	3/32	10.5	21.8
^{237}Np	pCi/g	60	1/47	0/47	45.4	95.3
^{238}U	pCi/g	314	2/34	0/34	313	660

			Frequency 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]**
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

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 001

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]
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
^{241}Am	pCi/g	9.43	1/33	0/33	8.09	20.5
^{137}Cs	pCi/g	51	11/32	8/32	0.105	0.218
^{237}Np	pCi/g	63	13/47	12/47	0.454	0.953
^{239}Pu	pCi/g	240	10/40	6/40	10.1	26.8
^{99}Tc	pCi/g	3,900	2/59	0/59	2,270	6,030
^{230}Th	pCi/g	1,300	7/45	5/45	83.4	220
^{234}U	pCi/g	150	4/34	0/34	71.3	189
^{235}U	pCi/g	12	13/33	9/33	0.816	1.7
^{238}U	pCi/g	314	25/34	22/34	3.13	6.6

OUTFALL 008

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]
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+01
PCB-1248	mg/kg	3.50E+01	0/160	1/160	4.25E+01	2.83E+01
PCB-1254	mg/kg	1.43E+02	2/167	2/167	1.82E+01	7.81E+01
Polychlorinated biphenyl	mg/kg	1.43E+02	1/56	1/56	4.25E+01	2.83E+01

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 008

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	1.42E+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
PCB-1254	mg/kg	1.43E+02	14/167	14/167	1.99E-01	1.22E-01
PCB-1260	mg/kg	1.10E+01	19/166	20/166	1.99E-01	1.27E-01

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 008

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]
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
^{137}Cs	pCi/g	1.50E+00	7/21	4/21	1.05E-01	2.18E-01
^{237}Np	pCi/g	1.22E+01	6/40	3/40	4.54E-01	9.53E-01
^{239}Pu	pCi/g	1.30E+01	1/29	0/29	1.01E+01	2.68E+01
^{228} Th	pCi/g	1.40E+00	2/2	2/2	3.52E-02	7.33E-02
^{230}Th	pCi/g	1.88E+02	1/38	0/38	8.34E+01	2.20E+02
^{234}U	pCi/g	7.60E+01	1/66	0/66	7.13E+01	1.89E+02
^{235}U	pCi/g	4.00E+00	3/60	2/60	8.16E-01	1.70E+00
^{238}U	pCi/g	1.20E+02	20/66	12/66	3.13E+00	6.60E+00

OUTFALL 010

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]
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

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels^a (from materials developed to support the SWSC Project) (continued)

OUTFALL 010

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
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
^{137}Cs	pCi/g	1.90E+00	1/8	1/8	1.05E-01	2.18E-01
^{237}Np	pCi/g	1.28E+01	1/4	1/4	4.54E-01	9.53E-01
^{99}Tc	pCi/g	2.65E+03	1/30	0/30	2.27E+03	6.03E+03
^{238}U	pCi/g	5.17E+01	13/22	7/22	3.13E+00	6.60E+00

OUTFALL 011

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
^{238}U	pCi/g	2.74E+03	3/11	2/11	3.13E+02	6.60E+02

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 011

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
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

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 011

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]
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
^{137}Cs	pCi/g	1.58E-01	2/17	0/17	1.05E-01	2.18E-01
^{234}U	pCi/g	3.79E+02	2/11	1/11	7.13E+01	1.89E+02
^{235}U	pCi/g	4.90E+01	3/34	3/34	8.16E-01	1.70E+00
^{238}U	pCi/g	2.74E+03	11/11	11/11	3.13E+00	6.60E+00

OUTFALL 015

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]
^{137}Cs	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[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
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	9/9	9/9	5.23E-01	3.46E-01
Barium	mg/kg	1.98E+02	0/9	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	8/9	2.84E+00	1.21E+00
Iron	mg/kg	2.46E+04	9/9	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+01	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

Table B2-1. Chemicals and compounds detected in soil and sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 015

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]
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
^{137}Cs	pCi/g	5.23E+01	3/4	3/4	1.05E-01	2.18E-01
^{237}Np	pCi/g	1.22E+01	1/9	1/9	4.54E-01	9.53E-01
^{230}Th	pCi/g	1.88E+02	1/9	0/9	8.34E+01	2.20E+02
^{238}U	pCi/g	1.40E+01	4/8	2/8	3.13E+00	6.60E+00

[a] Information presented in this table taken from information prepared for the SWSC Project in 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 DOE 2000. 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 any outfall.

[d] Action levels taken from App. A of DOE 2000. 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 any outfall.

[e] No action levels taken from App. A of DOE 2000. 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 any outfall

[f] No action levels taken from App. A of DOE 2000. Child recreator no action level derived using either a target cancer risk of 1 × 10^{-6} or a target hazard index of 0.1, 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 any outfall.

Table B2-2. Chemicals and compounds detected in surface water at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project)

OUTFALL 001

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

			Frequency 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

OUTFALL 008

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

			Frequency 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	4.10E-03	0/22	2/22	7.31E-03	3.12E-03

Table B2-2. Chemicals and compounds detected in surface water at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 010

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	8.00E-03	1/24	4/24	7.31E-03	3.12E-03
Chromium	mg/L	2.89E-02	0/24	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	1.10E-02	0/4	1/4	1.51E-02	8.82E-03

OUTFALL 011

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]**		
Lead	mg/L	2.04E-01	2/100	2/100	3.00E-02	3.00E-02

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]**		
Cadmium	mg/L	2.00E-02	1/100	1/100	4.57E-03	1.95E-03
Chromium	mg/L	1.56E-01	5/363	7/363	5.48E-02	2.34E-02
Lead	mg/L	2.04E-01	3/100	3/100	1.50E-02	1.50E-02
Manganese	mg/L	3.55E+00	1/13	2/13	1.68E+00	7.17E-01
Uranium	mg/L	4.40E+00	1/447	2/447	2.33E+00	9.94E-01
cis-1,2-Dichloroethene	mg/L	4.20E-01	0/22	1/22	9.14E-01	3.90E-01
PCB-1248	mg/L	3.60E-04	1/7	2/7	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	19/329	31/329	1.65E-04	9.61E-05
Trichloroethene	mg/L	2.20E-01	15/175	27/175	2.18E-02	1.27E-02

Table B2-2. Chemicals and compounds detected in surface water at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding human health screening levels[a] (from materials developed to support the SWSC Project) (continued)

OUTFALL 015

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above		Industrial Worker Action Level[c]	Child Recreator Action Level[i]
			Industrial Worker Action Level[c]	Child Recreator Action Level[i]		
None	—	—	—	—	—	—
Chemical or Compound	**Units**	**Maximum Detect**	**Frequency of Detection[i] above**		**Industrial Worker No Action Level[i]**	**Child Recreator No Action Level[f]**
			Industrial Worker No Action Level[i]	**Child Recreator No Action Level[i]**		
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 information prepared for the SWSC Project in 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 DOE 2000. 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 any outfall.

[d] Action levels taken from App. A of DOE 2000. 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 any outfall.

[e] No action levels taken from App. A of DOE 2000. 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 any outfall.

[f] No action levels taken from App. A of DOE 2000. 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 any outfall.

As shown in Tables B2-3 and B2-4, several metals and organic compounds were detected in sediments and surface water, respectively, at concentrations that exceed the NFA values and USVs. The presence of substances at concentrations exceeding PGDP sediment and surface water NFA values indicates that there is a potential for adverse effects on ecological receptors, not that adverse effects did or are expected to occur. 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 or surface water; however, adverse effects may not be realized at the site due to site-specific sediment or surface water properties that potentially can mitigate exposure and toxicity to biota. Some of these site-specific properties for sediment 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.

In the SHHRA performed as part of discussions with the regulators in 2003 (BJC 2003b), the data set used in previous SHHRA described above was refined by only retaining data determined to be associated with the outfall sediment or soil. Specific steps taken in refining the data set were as follows:

- Result was from a station located within 17.5 ft of the centerline of the outfall ditch and located along the ditch between the point where the outfall meets either Bayou or Little Bayou Creek and a point approximately 500 ft inside the security fence.
- Result was from a sample collected at an end depth equal to or less than 2 ft bgs. (Samples without an end depth but listed as being from sediment were assumed to meet this depth requirement.)
- Result was from a sample collected since the initiation of the site investigation performed in 1989 and 1990.
- Result was for a chemical, compound, or radionuclide that had a maximum detected concentration over the outfall's data set that was greater than both the analyte's background concentration and residential use no action screening value. Analytes that never were detected were not included in the analysis.

The summary statistics for the resulting data set are shown in Table B2-5. These summary statistics were then used to derive exposure concentrations. Generally, for each COPC, the exposure concentration was the lesser of the maximum detected concentration and the 95UCL on the mean value of the appropriate distribution (i.e., normal or log normal). However, when five or fewer results were available, the maximum concentration was used as the exposure concentration. Additionally, when more than five but fewer than ten results were available, then data were assumed to be log normally distributed. Exposure concentrations were compared to risk-based concentrations calculated for the following four scenarios to develop risk estimates:

- Default industrial use – direct contact with soil and sediment for 250 days per year over a 25-year period. (Exposure time of 8 hours per day);
- Site-specific industrial use – direct contact with soil and sediment for 16 days per year over a 25-year period. (Exposure time of 8 hours per day);
- Default recreational use – direct contact with soil and sediment for 140 days per year (child and teen) or 104 days per year (adult) over a 40-year period; and
- Site-specific recreational use– direct contact with soil and sediment as an adult or teen-aged youth (i.e., 7 to 18 years of age) for 10 days per year over a 1-year period (Exposure time of 4 hours per day).

Table B2-3. Chemicals and compounds detected in sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a]

(from materials developed to support the SWSC Project)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
Outfall 001						
Antimony	mg/kg	2	–	6	2/6	NA
Arsenic	mg/kg	5.9	17	33.7	4/6	3/6
Cadmium	mg/kg	0.27	3.53	3.4	4/6	0/6
Chromium	mg/kg	37.3	90	80.8	2/6	0/6
Copper	mg/kg	30	149	123	1/6	0/6
Iron	mg/kg	2000	–	42000	6/6	NA
Lead	mg/kg	12	91.3	36.5	4/6	0/6
Manganese	mg/kg	614	–	4150	1/6	NA
Mercury	mg/kg	0.16	0.486	0.43	2/6	0/6
Nickel	mg/kg	16	36	73.5	5/6	2/6
Selenium	mg/kg	0.05	–	6.2	6/6	NA
Silver	mg/kg	0.00038	–	3.8	6/6	NA
Vanadium	mg/kg	0.2	–	80.7	6/6	NA
Zinc	mg/kg	4.7	315	140	6/6	0/6
Acetone	mg/kg	0.091	–	0.25	1/11	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	0/6
Benzo(b)fluoranthene	mg/kg	0.004	–	0.69	6/6	NA
Bis(2-ethylhexyl)phthalate	mg/kg	0.018	–	0.58	6/6	NA
Carbon disulfide	mg/kg	0.00086	–	0.011	8/11	NA
Chrysene	mg/kg	0.033	0.862	0.69	5/6	0/6
Fluoranthene	mg/kg	0.054	2.23	0.69	4/6	0/6
Naphthalene	mg/kg	0.01465	0.561	0.69	5/6	2/6
Phenanthrene	mg/kg	0.0419	0.515	0.69	4/6	3/6
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
Pyrene	mg/kg	0.053	0.875	0.69	5/6	0/6
Outfall 008						
Cadmium	mg/kg	0.27	3.53	2	5/6	0/6
Chromium	mg/kg	37.3	90	85.3	1/6	0/6
Copper	mg/kg	30	149	44.3	1/6	0/6
Iron	mg/kg	2000	–	48500	6/6	NA
Lead	mg/kg	12	91.3	48.5	2/6	0/6
Manganese	mg/kg	614	–	1750	2/6	NA
Mercury	mg/kg	0.16	0.486	3.28	2/6	1/6
Nickel	mg/kg	16	36	33.7	2/6	0/6
Selenium	mg/kg	0.05	–	1	6/6	NA
Vanadium	mg/kg	0.2	–	97.2	6/6	NA
Zinc	mg/kg	4.7	315	170	6/6	0/6
Acetone	mg/kg	0.091	–	0.19	3/4	NA
Bis(2-ethylhexyl)phthalate	mg/kg	0.018	–	2.8	4/4	NA
Fluoranthene	mg/kg	0.054	2.23	2.8	4/4	1/4
Phenanthrene	mg/kg	0.0419	0.515	2.8	4/4	1/4
Polychlorinated Biphenyl	mg/kg	0.032	0.277	1.4	4/8	4/8
Pyrene	mg/kg	0.053	0.875	2.8	4/4	1/4

Table B2-3. Chemicals and compounds detected in sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a] (continued)

(from materials developed to support the SWSC Project)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
Outfall 010						
Arsenic	mg/kg	5.9	17	11.3	4/8	0/8
Cadmium	mg/kg	0.27	3.53	2.73	8/8	0/8
Chromium	mg/kg	37.3	90	74	3/8	0/8
Iron	mg/kg	2000	–	41900	8/8	NA
Lead	mg/kg	12	91.3	22.3	7/8	0/8
Manganese	mg/kg	614	–	878	1/8	NA
Nickel	mg/kg	16	36	19.7	1/8	0/8
Selenium	mg/kg	0.05	–	1	8/8	NA
Silver	mg/kg	0.00038	–	6.5	8/8	NA
Vanadium	mg/kg	0.2	–	75.5	8/8	NA
Zinc	mg/kg	4.7	315	92.2	8/8	0/8
Tetrachloroethene	mg/kg	0.032	–	1	1/5	NA
Outfall 011						
Arsenic	mg/kg	5.9	17	12.5	1/2	0/2
Cadmium	mg/kg	0.27	3.53	2	2/2	0/2
Chromium	mg/kg	37.3	90	160	2/2	1/2
Copper	mg/kg	30	149	39.7	1/2	0/2
Iron	mg/kg	2000	–	20500	2/2	NA
Lead	mg/kg	12	91.3	28	1/2	0/2
Magnesium	mg/kg	–	–	1730	NA	NA
Nickel	mg/kg	16	36	24.9	1/2	0/2
Selenium	mg/kg	0.05	–	0.17	2/2	NA
Vanadium	mg/kg	0.2	–	42.9	2/2	NA
Zinc	mg/kg	4.7	315	169	2/2	0/2
Acenaphthene	mg/kg	0.089	–	0.52	2/2	NA
Anthracene	mg/kg	0.023	0.845	0.52	2/2	0/2
Benz(a)anthracene	mg/kg	0.0317	0.385	1.1	2/2	1/2
Benzo(a)pyrene	mg/kg	0.0319	0.782	1.2	2/2	1/2
Benzo(b)fluoranthene	mg/kg	0.004	–	1.4	2/2	NA
Benzo(k)fluoranthene	mg/kg	0.004	–	1.1	2/2	NA
Chrysene	mg/kg	0.033	0.862	1.3	2/2	1/2
Fluoranthene	mg/kg	0.054	2.23	2.9	2/2	1/2
Fluorene	mg/kg	0.01	0.536	0.52	2/2	0/2
Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	–	0.68	2/2	NA
Naphthalene	mg/kg	0.01465	0.561	0.52	2/2	0/2
Phenanthrene	mg/kg	0.0419	0.515	2.3	2/2	2/2
Polychlorinated Biphenyl	mg/kg	0.032	0.277	55	52/66	52/66
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1.61	22.8	16.18	21/22	0/22
Pyrene	mg/kg	0.053	0.875	2.3	2/2	1/2
Trichloroethene	mg/kg	0.052	–	5.34	1/6	NA
Outfall 015						
Arsenic	mg/kg	5.9	17	9.7	2/2	0/2
Cadmium	mg/kg	0.27	3.53	2	2/2	0/2
Iron	mg/kg	2000	–	22200	2/2	NA
Lead	mg/kg	12	91.3	18	2/2	0/2
Manganese	mg/kg	614	–	1500	1/2	NA
Nickel	mg/kg	16	36	33	2/2	0/2

Table B2-3. Chemicals and compounds detected in sediment at Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a] (continued)

(from materials developed to support the SWSC Project)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
Selenium	mg/kg	0.05	–	0.21	2/2	NA
Silver	mg/kg	0.00038	–	3	2/2	NA
Vanadium	mg/kg	0.2	–	37.8	2/2	NA
Zinc	mg/kg	4.7	315	59	2/2	0/2
Acetone	mg/kg	0.091	–	25	1/2	NA
Polychlorinated Biphenyl	mg/kg	0.032	0.277	0.8	2/6	2/6

[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
NA = Not applicable; no NFA or USV
USV = Upper Screening Value
– = No NFA or USV

Table B2-4. Chemicals and compounds detected in surface water Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a]

(from materials developed to support the SWSC Project)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
***Outfall* 001**						
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
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
Mercury	mg/L	0.000012	0.0017	0.0002	22/22	0/22
Nickel	mg/L	0.029	0.261	0.1	18/29	0/29
Selenium	mg/L	0.005	0.02	0.2	7/23	6/23
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
2-Propanol	mg/L	0.0075	0.13	1	3/3	3/3
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.02	7/7	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
Polychlorinated Biphenyl	mg/L	0.0000014	0.002	0.0004	10/48	0/48
Outfall 008						
Aluminum	mg/L	0.087	0.75	1.71	20/22	1/22
Antimony	mg/L	0.16	0.18	0.2	9/22	9/22
Barium	mg/L	0.004	0.11	0.043	22/22	0/22
Beryllium	mg/L	0.00053	0.035	0.005	20/22	0/22
Boron	mg/L	0.75	0.03	2	9/22	21/22
Cadmium	mg/L	0.00142	0.00206	0.02	20/22	15/22
Cobalt	mg/L	0.023	1.5	0.05	20/22	0/22
Copper	mg/L	0.00516	0.00728	0.025	15/22	13/22
Iron	mg/L	1	4	2.37	1/22	0/22
Lead	mg/L	0.00132	0.03378	0.2	22/22	9/22
Mercury	mg/L	0.000012	0.0017	0.0002	21/21	0/21
Nickel	mg/L	0.029	0.261	0.05	15/22	0/22
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
Outfall 010						
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
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
Cobalt	mg/L	0.023	1.5	0.05	21/24	0/24

Table B2-4. Chemicals and compounds detected in surface water Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a]

(from materials developed to support the SWSC Project) (continued)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
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
Manganese	mg/L	0.12	2.3	0.18	1/24	0/24
Nickel	mg/L	0.029	0.261	0.05	18/24	0/24
Silver	mg/L	0.000012	0.00123	0.025	24/24	23/24
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
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
Outfall 011						
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
Copper	mg/L	0.005	0.007	0.05	158/162	158/162
Iron	mg/L	1	4	8.4	13/220	2/220
Lead	mg/L	0.0013	0.034	0.2	88/100	43/100
Manganese	mg/L	0.12	2.3	3.5	2/13	1/13
Nickel	mg/L	0.029	0.261	0.19	158/161	0/161
Sulfide	mg/L	0.002	–	2	3/3	NA
Uranium	mg/L	0.0026	0.046	4	440/447	164/447
Vanadium	mg/L	0.02	0.28	0.05	1/6	0/6
Zinc	mg/L	0.067	0.0665	0.39	31/359	31/359
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.025	5/5	0/5
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
Polychlorinated Biphenyl	mg/L	0.0000014	0.002	0.0026	54/329	2/329
Trichloroethene	mg/L	0.047	0.44	0.22	8/175	0/175
Outfall 015						
Aluminum	mg/L	0.087	0.75	34	124/124	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	11/11	2/11
Beryllium	mg/L	0.00053	0.035	0.01	15/19	0/19
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
Cobalt	mg/L	0.023	1.5	0.05	5/11	0/11
Copper	mg/L	0.00516	0.00728	0.1	131/133	127/133
Iron	mg/L	1	4	23	79/133	20/133
Lead	mg/L	0.0013	0.034	0.25	72/77	31/77
Manganese	mg/L	0.12	2.3	0.2	2/11	0/11
Nickel	mg/L	0.029	0.261	0.26	133/133	0/133
Sulfide	mg/L	0.002	–	2	3/3	NA
Thallium	mg/L	0.004	0.11	0.25	17/18	8/18
Uranium	mg/L	0.0026	0.046	1	95/95	72/95

Table B2-4. Chemicals and compounds detected in surface water Outfalls 001, 008, 010, 011, and 015 at concentrations exceeding ecological NFA values and USVs[a]

(from materials developed to support the SWSC Project) (continued)

Analyte	Units	PGDP NFA	PGDP USV	Maximum site concentration[a]	Frequency of detection above NFA	Frequency of detection above USV
Zinc	mg/L	0.067	0.0665	0.539	1/77	1/77
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.025	3/3	0/3

[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

Analytes identified as COPCs through comparisons of maximum detected concentrations with surface soil background and child residential use no action screening values are in Table B2-5.

The hazards and cancer risks derived for each outfall are in Table B2-6. The following are results by outfall area.

- Outfall 001 – The default recreational user scenario with a cumulative hazard estimate of 1.14 is the only scenario of concern. The only COC for this scenario is beryllium, which contributes 96% of the cumulative hazard. The hazard and cancer risk estimates for the site-specific exposure scenarios fall below levels of concern (i.e., defined in the assessment as a cumulative hazard level of 1 and a cumulative cancer risk level of 1×10^{-4}) and are within or below EPA's acceptable risk range for site-related exposures (i.e., 10^{-6} to 10^{-4}).

- Outfall 008 – Both the default industrial worker and the default recreational user scenarios, with cumulative hazard estimates of 4.27 and 10.00, respectively, are scenarios of concern. The COCs for these scenarios and their percentage contribution to cumulative hazard in both scenarios of concern are manganese (42%), iron (20%), vanadium (18%), antimony (13%), mercury (4%), and beryllium (2%). The hazard and cancer risk estimates for the site-specific exposure scenarios fall below levels of concern and are within or below EPA's acceptable risk range for site-related exposures.

- Outfall 010 – Both the default industrial worker and the default recreational user scenarios, with cumulative hazard estimates of 2.51 and 5.89, respectively, are scenarios of concern. The COCs for these scenarios and their percentage contribution to cumulative hazard in both scenarios of concern are vanadium (42%), iron (38%), antimony (12%), beryllium (4%), and arsenic (4%). The hazard and cancer risk estimates for the site-specific exposure scenarios fall below levels of concern and are within or below EPA's acceptable risk range for site-related exposures.

- Outfall 011 – Both the default industrial worker and the default recreational user scenarios are scenarios of concern. Unlike Outfalls 001, 008, and 010, for Outfall 011 these scenarios are scenarios of concern for both hazard and cancer risk. Cumulative hazard estimates are 4.32 and 10.04, respectively. Cumulative cancer risk estimates are 5.24×10^{-4} and 7.93×10^{-4}, respectively. For cumulative hazard, the COCs and their contribution to the estimate for both scenarios are uranium (45%), vanadium (30%), beryllium (18%), arsenic (3%), and TCE (2%). For cumulative cancer risk, the COCs and their contribution to the estimate for the default industrial worker scenario are Total PAHs (69%), Total PCBs (20%), ^{238}U (6%), arsenic (5%), TCE (<1%), and ^{235}U (<1%). Results for COCs for the default recreational user scenario are similar. The hazard and cancer risk estimates for the site-specific exposure scenarios fall below levels of concern and are within or below EPA's acceptable risk range for site-related exposures.

- Outfall 015 – Both the default industrial worker and the default recreational user scenarios are scenarios of concern for both hazard and cancer risk. Cumulative hazard estimates are 1.06 and 2.48, respectively. Cumulative cancer risk estimates are 6.14×10^{-4} and 2.98×10^{-4}, respectively. For cumulative hazard, the COCs and their contribution to the estimate for both scenarios are beryllium (70%) and antimony (27%). For cumulative cancer risk, the COCs and their contribution to the estimate for the default industrial worker scenario are ^{137}Cs (99%), ^{238}U (<1%), Total PCBs (<1%), and ^{239}Pu (<1%). Results for COCs for the default recreational user scenario are similar. The hazard and cancer risk estimates for the site-specific exposure scenarios fall below levels of concern and are within or below EPA's acceptable risk range for site-related exposures.

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b)

		Data Summary for Detected Results						
Analyte[a]	**Total Number of Results**	**Number of Detected Results**	**Minimum Concentration**	**Maximum Concentration**	**Average Concentration[b]**	**Background Concentration[c]**	**Residential No Action Screening Value[d]**	**COPC?[e]**
OUTFALL 001								
Inorganic Chemicals								
Aluminum	2	2	7,460	8,420	7,460	13,000	732	No
Arsenic	2	2	1.8	3.9	1.8	12	0.132	No
Barium	2	2	56.5	63.2	56.5	200	37	No
Beryllium	2	2	0.36	4.4	0.36	0.67	0.160	Yes
Cadmium	2	1	0.88	0.88	0.88	0.21	2.64	No
Calcium	2	2	1,630	2,110	1,630	200,000	NV	No
Chromium	2	2	28.1	80.8	28.1	16	60.5	Yes
Cobalt	2	2	5.4	6	5.4	14	209	No
Copper	2	2	17.4	21.7	17.4	19	68.1	No
Iron	2	2	9,920	11,800	9,920	28,000	314	No
Lead	2	2	9.5	26.5	9.5	36	50	No
Magnesium	2	2	1,090	1,120	1,090	7,700	NV	No
Manganese	2	2	129	248	129	1,500	7.46	No
Nickel	2	2	16.2	20.4	16.2	21	34	No
Potassium	2	2	493	556	493	1,300	NV	No
Sodium	2	2	126	140	126	320	NV	No
Vanadium	2	2	17.8	18.9	17.8	38	0.562	No
Zinc	2	2	76.2	129	76.2	65	401	No
Organic Compounds								
Benz(a)anthracene	2	1	0.13	0.13	0.13	NV	0.0670	Yes[g]
Benzo(a)pyrene	2	1	0.14	0.14	0.14	NV	0.00670	Yes[g]
Benzo(b)fluoranthene	2	1	0.15	0.15	0.15	NV	0.0670	Yes[g]
Benzo(g,h,i)perylene	2	1	0.099	0.099	0.099	NV	NV	No[h]
Benzo(k)fluoranthene	2	1	0.11	0.11	0.11	NV	0.670	No
Chrysene	2	1	0.17	0.17	0.17	NV	6.70	No
Di-n-butyl phthalate	2	1	0.067	0.067	0.067	NV	264	No
Fluoranthene	2	1	0.34	0.34	0.34	NV	34.3	No
Hexadecanoic acid	1	1	0.3	0.3	0.3	NV	NV	No[h]
Indeno(1,2,3-cd)pyrene	2	1	0.095	0.095	0.095	NV	0.0670	Yes[g]
Methylene chloride	2	1	0.005	0.005	0.005	NV	3.92	No
Octathiocane	2	1	0.26	0.26	0.26	NV	NV	No[h]
PCB-1260	2	1	0.66	0.66	0.66	NV	0.0574	Yes[f]
Phenanthrene	2	1	0.18	0.18	0.18	NV	NV	No
Total PAHs	1	1	0.179	0.179	0.179	NV	0.00670	Yes[g]
Total PCBs	3	2	0.66	0.66	0.66	NV	0.0574	Yes[f]
Pyrene	2	1	0.28	0.28	0.28	NV	25.7	No

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

Analyte[a]	Total Number of Results	Data Summary for Detected Results: Number of Detected Results	Minimum Concentration	Maximum Concentration	Average Concentration[b]	Background Concentration[c]	Residential No Action Screening Value[d]	COPC?[e]
Radionuclides								
^{99}Tc	3	3	6.8	67	27	2.5	67.4	No
^{230}Th	2	2	0.76	1.4	1.08	1.5	2.85	No
^{234}U	1	1	4.9	4.9	4.9	2.5	3.81	Yes
^{235}U	1	1	0.18	0.18	0.18	0.14	0.0591	Yes
^{238}U	1	1	2.9	2.9	2.9	1.2	0.261	Yes
OUTFALL 008								
Inorganic Chemicals								
Aluminum	20	20	2,720	11,100	5,751	13,000	732	No
Antimony	20	4	0.53	2.1	1.10	0.21	0.0635	Yes
Arsenic	20	12	1.5	6.58	4.53	12	0.132	No
Barium	20	20	27.1	112	71.2	200	37	No
Beryllium	20	11	0.32	3	0.868	0.67	0.16	Yes
Cadmium	20	8	0.25	2.6	1.05	0.21	2.64	No
Calcium	20	20	822	78,000	12,437	200,000	NV	No
Chromium	20	20	4.5	137	32.2	16	60.5	Yes
Cobalt	20	20	2.66	14.1	6.48	14	209	No
Copper	20	20	6.6	106	29.7	19	68.1	Yes
Cyanide	5	1	0.35	0.35	0.35	NV	12.6	No
Iron	20	20	6,180	48,500	14,053	28,000	314	Yes
Lead	20	16	7.4	121	29.9	36	50	Yes
Magnesium	20	20	334	2,710	1,231	7,700	NV	No
Manganese	20	20	69.1	2,390	521	1,500	7.46	Yes
Mercury	20	14	0.0282	3.28	0.802	0.2	0.158	Yes
Molybdenum	15	5	0.28	2	1.00	NV	10.9	No
Nickel	20	20	5.3	86.5	28.3	21	34	Yes
Potassium	20	18	170	1,290	427	1,300	NV	No
Selenium	20	4	0.183	2.3	1.10	0.8	12.1	No
Silicon	15	7	215	507	333	NV	NV	No[g]
Silver	20	2	0.59	0.8	0.695	2.3	6.12	No
Sodium	20	7	41.5	223	86.5	320	NV	No
Vanadium	20	20	7.07	97.2	21.1	38	0.562	Yes
Zinc	20	20	19.1	398	105	65	401	No
Organic Compounds								
1,2,3,4,6,7,8-Heptachloro dibenzo-p-dioxin	1	1	0.00305	0.00305	0.00305	NV	0.000149	Yes
1,2-Benzenedicarboxylic acid	1	1	0.2	0.2	0.2	NV	NV	No[g]
1-Octadecene	1	1	0.7	0.7	0.7	NV	NV	No[g]

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

		Data Summary for Detected Results						
Analyte[a]	**Total Number of Results**	**Number of Detected Results**	**Minimum Concentration**	**Maximum Concentration**	**Average Concentration[b]**	**Background Concentration[c]**	**Residential No Action Screening Value[d]**	**COPC?[e]**
Benzene	4	1	0.005	0.005	0.005	NV	0.327	No
Bis(2-ethylhexyl)phthalate	5	2	0.16	0.29	0.225	NV	2.84	No
			Organic Compounds					
Di-n-butyl phthalate	5	2	0.067	0.26	0.164	NV	264	No
Fluoranthene	5	2	0.16	0.62	0.39	NV	34.3	No
Heptachloro-dibenzo[b,e][1,4]dioxin	2	1	0.00535	0.00535	0.00535	NV	0.000149	Yes
Methylene chloride	4	2	0.019	0.054	0.0365	NV	3.92	No
Octachloro-dibenzo[b,e][1,4]dioxin	2	1	0.03927	0.03927	0.0393	NV	0.00415	Yes
Octachlorodibenzofuran	2	2	0.0008	0.0018	0.0013	NV	0.00415	No
PCB-1260	19	10	0.1	1.2	0.557	NV	0.0574	Yes[f]
Phenanthrene	5	2	0.1	0.6	0.35	NV	NV	No
Phenol	5	1	1.8	1.8	1.8	NV	1,480	No
Pyrene	5	2	0.19	0.68	0.435	NV	25.7	No
Toluene	4	1	0.004	0.004	0.004	NV	31.2	No
Total PCBs	10	6	0.1	0.7	0.5	NV	0.0574	Yes[f]
Trichloroethene	4	1	0.001	0.001	0.001	NV	0.741	No
			Radionuclides					
^{241}Am	10	1	0.1666	0.1666	0.167	NV	0.836	No
^{137}Cs	1	1	0.07	0.07	0.07	0.49	0.0128	No
^{237}Np	13	6	0.1939	0.6641	0.361	0.1	0.0405	Yes
^{239}Pu	3	2	0.012	0.017	0.0145	0.025	2.22	No
$^{239/240}$Pu	11	9	0.04196	0.6837	0.359	0.025	2.22	No
^{234m}Pa	9	6	9.01	27.74	15.0	NV	NV	No[h]
^{99}Tc	15	13	1.33	236.2	38.3	2.5	67.4	Yes
^{230}Th	3	3	0.29	1.31	0.673	1.5	2.85	No
^{234}Th	9	9	1.654	15.63	8.13	1.5	1.64	Yes[h]
^{234}U	16	16	0.28	14.41	4.59	2.5	3.81	Yes
^{235}U	15	15	0.013	0.5698	0.231	0.14	0.0591	Yes
^{238}U	16	16	0.31	15.17	5.91	1.2	0.261	Yes
			OUTFALL 010					
			Inorganic Chemicals					
Aluminum	24	24	2,240	12,600	7,435	13,000	732	No
Antimony	24	4	0.66	1.1	0.855	0.21	0.0635	Yes
Arsenic	24	14	2.8	19.5	8.08	12	0.132	Yes
Barium	24	24	13.9	161	72.0	200	37	No
Beryllium	24	13	0.33	4.6	1.07	0.67	0.16	Yes
Cadmium	24	10	0.32	2.73	0.977	0.21	2.64	Yes
Calcium	24	24	677	53,400	5,996	200,000	NV	No
Chromium	24	24	8.44	74	26.4	16	60.5	Yes

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

		Data Summary for Detected Results						
Analyte[a]	**Total Number of Results**	**Number of Detected Results**	**Minimum Concentration**	**Maximum Concentration**	**Average Concentration**[b]	**Background Concentration**[c]	**Residential No Action Screening Value**[d]	**COPC?**[e]
Cobalt	24	22	3.26	10.3	6.42	14	209	No
Copper	24	24	9.83	52.8	15.69	19	68.1	No
Iron	24	24	2,730	41,900	15,015	28,000	314	Yes
Lead	24	11	8.8	33.5	15.9	36	50	No
Magnesium	24	24	462	3,850	1,324	7,700	NV	No
Manganese	24	24	64.8	878	324	1,500	7.46	No
Mercury	24	8	0.037	0.19	0.0821	0.2	0.158	No
Molybdenum	23	8	0.28	1.1	0.67	NV	10.9	No
Nickel	24	23	6.08	19.7	11.1	21	34	No
Potassium	24	24	150	1490	485	1,300	NV	Yes[g]
Selenium	24	1	0.29	0.29	0.29	0.8	12.1	No
Silicon	23	8	222	950	384	NV	NV	No
Silver	24	1	6.5	6.5	6.5	2.3	6.12	Yes
Sodium	24	10	46.2	525	126	320	NV	Yes[g]
Vanadium	24	24	3.89	75.5	25.8	38	0.562	Yes
Zinc	24	24	26.7	276	74.1	65	401	No
			Organic Compounds					
Methylene chloride	1	1	0.006	0.006	0.006	NV	3.92	No
PCB-1254	27	2	0.042	0.09	0.066	NV	0.0388	Yes[f]
PCB-1260	27	1	0.1	0.1	0.1	NV	0.0574	Yes[f]
Tetrachloroethene	3	1	0.008	0.008	0.008	NV	1.17	No
Total PCBs	17	1	0.1	0.1	0.1	NV	0.0574	Yes[f]
			Radionuclides					
^{241}Am	13	1	0.1037	0.104	0.1037	NV	0.836	No
^{239}Pu	14	1	0.0034	0.003	0.0034	0.025	2.22	No
^{234m}Pa	13	5	8.132	20.9	14.4	NV	NV	No[h]
^{99}Tc	14	11	0.42	8.42	2.41	2.5	67.4	No
^{230}Th	1	1	0.24	0.24	0.24	1.5	2.85	No
^{234}Th	13	13	1.499	13.58	5.21	NV	1.64	Yes[h]
^{234}U	14	14	0.542	3.032	1.31	2.5	3.81	No
^{235}U	14	13	0.04	0.293	0.115	0.14	0.0591	Yes
^{238}U	14	14	0.6201	15.11	4.43	1.2	0.261	Yes
			OUTFALL 011					
			Inorganic Chemicals					
Aluminum	3	3	6,670	10,800	8,990	13,000	732	No
Arsenic	3	2	3.5	12.5	8	12	0.132	Yes
Barium	3	3	101	148	117	200	37	No
Beryllium	3	2	4.3	7.4	5.85	0.67	0.16	Yes

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

Analyte[a]	Total Number of Results	Data Summary for Detected Results: Number of Detected Results	Minimum Concentration	Maximum Concentration	Average Concentration[b]	Background Concentration[c]	Residential No Action Screening Value[d]	COPC?[e]
Inorganic Chemicals								
Cadmium	3	2	1.9	2.3	2.1	0.21	2.64	No
Calcium	3	3	1,750	117,000	41,610	200,000	NV	No
Chromium	3	3	8.39	160	82.13	16	60.5	Yes
Cobalt	3	3	4.74	10.9	6.81	14	209	No
Copper	3	3	4.44	39.7	23.9	19	68.1	No
Iron	3	3	8,360	20,500	13,820	28,000	314	No
Lead	3	2	11.8	28.2	20	36	50	No
Lithium	1	1	5.92	5.92	5.92	NV	69.8	No
Magnesium	3	3	1,240	8,830	3,933	7,700	NV	Yes[h]
Manganese	3	3	97.4	593	388	1,500	7.46	No
Nickel	3	2	13.3	24.9	19.1	21	34	No
Potassium	3	3	415	546	502	1,300	NV	No
Selenium	3	1	0.17	0.17	0.17	0.8	12.1	No
Sodium	3	2	91.8	118	104	320	NV	No
Strontium	1	1	223	223	223	NV	801	No
Uranium	12	12	63	1,030	240	4.9	2.16	Yes
Vanadium	3	3	16	42.9	27.7	38	0.562	Yes
Zinc	3	3	45.1	169	109	65	401	No
Organic Compounds								
Acenaphthene	3	1	0.25	0.25	0.25	NV	49	No
Anthracene	3	1	0.46	0.46	0.46	NV	526	No
Benz(a)anthracene	3	2	0.24	1.1	0.67	NV	0.067	Yes[g]
Benzo(a)pyrene	3	2	0.17	1.2	0.685	NV	0.0067	Yes[g]
Benzo(b)fluoranthene	3	2	0.19	1.4	0.795	NV	0.067	Yes[g]
Benzo(g,h,i)perylene	2	1	0.74	0.74	0.74	NV	NV	No[h]
Benzo(k)fluoranthene	3	1	1.1	1.1	1.1	NV	0.67	Yes[g]
Organic Compounds								
Carbazole	2	1	0.3	0.3	0.3	NV	6.14	No
Chrysene	3	2	0.25	1.3	0.775	NV	6.7	No[g]
Dibenzofuran	3	1	0.15	0.15	0.15	NV	2.93	No
Fluoranthene	3	2	0.59	2.9	1.75	NV	34.3	No
Fluorene	3	1	0.24	0.24	0.24	NV	50.1	No
Indeno(1,2,3-cd)pyrene	3	1	0.68	0.68	0.68	NV	0.067	Yes[g]
Methylene chloride	2	2	0.009	0.013	0.011	NV	3.92	No
Naphthalene	3	1	0.21	0.21	0.21	NV	3.47	No
PCB-1242	7	2	0.6	1	0.8	NV	0.0574	Yes[f]
PCB-1248	10	8	1.3	14	4.53	NV	0.0574	Yes[f]
PCB-1254	17	15	0.016	6	1.82	NV	0.0388	Yes[f]

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

Analyte[a]	Total Number of Results	Data Summary for Detected Results: Number of Detected Results	Data Summary for Detected Results: Minimum Concentration	Data Summary for Detected Results: Maximum Concentration	Data Summary for Detected Results: Average Concentration[b]	Background Concentration[c]	Residential No Action Screening Value[d]	COPC?[e]
PCB-1260	18	15	0.319	7.5	2.21	NV	0.0574	Yes[f]
Phenanthrene	3	2	0.58	2.3	1.44	NV	NV	No[h]
Pyrene	3	2	0.5	2.3	1.4	NV	25.7	No
Total PAH	3	2	0.2135	7.63	3.92	NV	0.0067	Yes[g]
Total PCBs	31	31	0.016	40	6.54	NV	0.0574	Yes[f]
Trichloroethene	5	1	5.343	5.343	5.34	NV	0.741	Yes
Radionuclides								
^{137}Cs	3	2	0.114	0.158	0.136	0.49	0.0128	No
^{239}Pu	2	1	0.0109	0.0109	0.0109	0.025	2.22	No
^{99}Tc	5	4	0.917	2.2	1.54	2.5	67.4	No
^{230}Th	4	4	0.26	0.509	0.384	1.5	2.85	No
^{234}U	2	2	5.8	7.9	6.85	2.5	3.81	Yes
^{235}U	3	2	0.31	0.6	0.455	0.14	0.0591	Yes
^{238}U	2	2	48	52	50	1.2	0.261	Yes
OUTFALL 015								
Inorganic Chemicals								
Aluminum	2	2	9,360	13,100	11,230	13,000	732	Yes
Arsenic	2	2	9	9	9	12	0.132	No
Barium	2	2	108	192	150	200	37	No
Beryllium	2	2	4	7	5.5	0.67	0.16	Yes
Cadmium	2	2	1	2	1.5	0.21	2.64	No
Calcium	2	2	2,290	2,890	2,590	200,000	NV	No
Chromium	2	2	14	22	18	16	60.5	No
Cobalt	2	2	6	62	34	14	209	No
Copper	2	2	13	18	15.5	19	68.1	No
Iron	2	2	13,700	22,200	17,950	28,000	314	No
Lead	2	2	12	18	15	36	50	No
Magnesium	2	2	1,290	1,820	1,555	7,700	NV	No
Manganese	2	2	365	1,500	933	1,500	7.46	No
Nickel	2	2	20	33	26.5	21	34	No
Potassium	2	2	594	679	637	1,300	NV	No
Silver	2	1	3	3	3	2.3	6.12	No
Sodium	2	2	99	105	102	320	NV	No
Uranium	13	13	2	14	5.33	4.9	2.16	Yes
Vanadium	2	2	34	37	35.5	38	0.562	No
Zinc	2	2	44	59	51.5	65	401	No
Organic Compounds								
2-Propanol	1	1	1.3	1.3	1.3	NV	NV	No[g]
Acetone	2	1	25	25	25	NV	53.4	No

Table B2-5. Summary statistics for detected analytes from SHHRA of Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

Analyte[a]	Total Number of Results	Data Summary for Detected Results				Background Concentration[c]	Residential No Action Screening Value[d]	COPC?[e]
		Number of Detected Results	Minimum Concentration	Maximum Concentration	Average Concentration[b]			
Methylene chloride	2	2	0.007	0.007	0.007	NV	3.92	No
PCB-1260	4	1	0.4	0.4	0.4	NV	0.0574	Yes[f]
Total PCBs	3	2	0.4	0.4	0.4	NV	0.0574	Yes[f]
Radionuclides								
^{241}Am	1	1	2	2	2	NV	0.836	Yes
^{137}Cs	1	1	52	52	52	0.49	0.0128	Yes
^{239}Pu	3	1	18	18	18	0.025	2.22	Yes
^{99}Tc	3	3	3	17	8.67	2.5	67.4	No
^{230}Th	3	1	22	22	22	1.5	2.85	Yes
^{234}U	2	2	1	1	1	2.5	3.81	No
^{238}U	2	2	2	5	3.5	1.2	0.261	Yes

Notes:
NV = no value.
COPC = Chemical of potential concern.
All concentrations for inorganic chemicals and organic compounds are in units of mg/kg. All concentrations for radionuclides are in units of pCi/g.

[a] Only analytes that are detected in at least one sample are listed.

[b] Arithmetic average of detected results.

[c] Background concentrations are for surface soil and are taken from Table A.12 in DOE 2000.

[d] Residential no action screening values are those for the child resident taken from Table A.14 in DOE 2000.

[e] "Yes" indicates that the maximum detected concentration exceeds both the background concentration and the residential no action screening value. "No" indicates that the maximum detected concentration is less than the background concentration or less than the residential no action screening value, if the background value is exceeded. Please see footnotes f, g, and h as well.

[f] Risk from PCB mixtures was derived using results for Total PCBs only. Individual PCB mixtures were not retained as COPCs.

[g] Not retained as a COPC because no toxicity value is available.

[h] Not retained as COPCs because no toxicity value is available.

Table B2-6. Chemical-specific and cumulative hazards and cancer risks posed by COPCs found in soil and sediment in Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b)

COPCs[a]	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
OUTFALL 001				
Hazard				
Beryllium	0.46	0.00066	***1.09***	0.0012
Chromium	0.023	8.1E-05	0.053	8.1E-05
Cumulative Hazard	0.49	0.00074	***1.14***	0.0013
Cancer Risk				
Beryllium	8.04E-11	4.40E-11	7.31E-11	4.40E-11
Chromium	7.41E-09	8.08E-10	6.73E-09	8.08E-10
Total PAHs	8.44E-06	5.41E-07	1.35E-05	3.80E-08
Total PCBs	3.32E-06	2.18E-07	5.20E-06	1.51E-08
^{234}U	2.47E-07	1.59E-08	9.39E-08	7.79E-10
^{235}U	4.56E-07	2.92E-08	2.18E-07	3.86E-10
^{238}U	1.70E-06	1.09E-07	7.97E-07	1.81E-09
Cumulative Cancer Risk	1.42E-05	9.13E-07	1.98E-05	5.70E-08
OUTFALL 008				
Hazard				
Antimony	***0.55***	0.00087	***1.30***	0.0016
Beryllium	0.084	0.00012	***0.20***	0.00021
Chromium	0.014	5.1E-05	0.033	5.1E-05
Copper	0.010	5.5E-05	0.024	0.00011
Iron	***0.84***	0.017	***1.96***	0.017
Manganese	***1.81***	0.0034	***4.24***	0.0062
Mercury	***0.16***	0.00037	***0.38***	0.00070
Nickel	0.021	0.00011	0.050	0.00021
Vanadium	***0.77***	0.0011	***1.81***	0.0020
Cumulative Hazard	***4.27***	0.023	***10.00***	0.028
Cancer Risk				
Beryllium	1.45E-11	7.94E-12	1.32E-11	7.94E-12
Chromium	4.63E-09	5.05E-10	4.21E-09	5.05E-10
Heptachloro-dibenzo[b,e][1,4]dioxin	8.64E-06	5.53E-07	1.29E-05	3.96E-08
Octachloro-dibenzo[b,e][1,4]dioxin	6.34E-06	4.06E-07	9.46E-06	2.91E-08
Total PCBs	3.52E-06	2.31E-07	5.51E-06	1.61E-08
^{237}Np	2.45E-06	1.57E-07	1.18E-06	2.04E-09
^{99}Tc	6.52E-07	4.18E-08	2.55E-07	1.87E-09
^{234}U	7.22E-07	4.63E-08	2.74E-07	2.27E-09
^{235}U	1.44E-06	9.24E-08	6.90E-07	1.22E-09
^{238}U	8.89E-06	5.69E-07	4.18E-06	9.50E-09
Cumulative Cancer Risk	3.27E-05	2.10E-06	3.44E-05	1.02E-07
OUTFALL 010				
Hazard				
Antimony	***0.29***	0.00046	***0.68***	0.00082
Arsenic	0.092	0.0059	***0.22***	0.011
Beryllium	0.098	0.00014	***0.23***	0.00025
Cadmium	0.0056	0.00036	0.013	0.00064
Chromium	0.0092	3.3E-05	0.022	3.3E-05
Iron	***0.95***	0.020	***2.24***	0.020
Silver	0.0057	2.2E-05	0.013	4.2E-05
Vanadium	***1.06***	0.0015	***2.47***	0.0027
Cumulative Hazard	***2.51***	0.028	***5.89***	0.035

Table B2-6. Chemical-specific and cumulative hazards and cancer risks posed by COPCs found in soil and sediment in Outfalls 001, 008, 010, 011, and 015 (results from BJC 2003b) (continued)

COPCs[a]	Default Industrial Worker	Site-specific Industrial Worker	Default Recreational User	Site-specific Recreational User
		Cancer Risk		
Arsenic	1.48E-05	9.47E-07	2.24E-05	6.79E-08
Beryllium	1.69E-11	9.25E-12	1.54E-11	9.25E-12
Chromium	3.02E-09	3.29E-10	2.74E-09	3.29E-10
Total PCBs	2.86E-07	1.88E-08	4.48E-07	1.31E-09
^{235}U	5.01E-07	3.21E-08	2.40E-07	4.25E-10
^{238}U	4.77E-06	3.06E-07	2.24E-06	5.10E-09
Cumulative Cancer Risk	2.04E-05	1.30E-06	2.53E-05	7.51E-08
		OUTFALL 011		
		Hazard		
Arsenic	***0.15***	0.0095	***0.35***	0.017
Beryllium	***0.78***	0.0011	***1.83***	0.0020
Chromium	0.045	0.00016	***0.11***	0.00016
Uranium	***1.94***	0.022	***4.50***	0.045
Vanadium	***1.29***	0.0018	***3.02***	0.0033
Trichloroethene	***0.11***	0.0073	***0.23***	0.0091
Cumulative Hazard	***4.32***	0.042	***10.04***	0.077
		Cancer Risk		
Arsenic	***2.39E-05***	1.53E-06	***3.61E-05***	1.10E-07
Beryllium	1.35E-10	7.40E-11	1.23E-10	7.40E-11
Chromium	1.47E-08	1.60E-09	1.33E-08	1.60E-09
Total PAHs	***3.60E-04***	2.31E-05	***5.74E-04***	1.62E-06
Total PCBs	***1.06E-04***	6.93E-06	***1.65E-04***	4.82E-07
Trichloroethene	***2.13E-06***	1.36E-07	***2.97E-06***	7.49E-09
^{234}U	3.99E-07	2.56E-08	1.51E-07	1.26E-09
^{235}U	1.52E-06	9.72E-08	7.26E-07	1.29E-09
^{238}U	3.04E-05	1.95E-06	1.43E-05	3.25E-08
Cumulative Cancer Risk	***5.24E-04***	3.37E-05	***7.93E-04***	2.26E-06
		OUTFALL 015		
		Hazard		
Aluminum	***0.28***	0.013	***0.66***	0.013
Beryllium	***0.74***	0.0011	***1.73***	0.0019
Uranium	0.038	0.00044	0.087	0.00088
Cumulative Hazard	***1.06***	0.015	***2.48***	0.016
		Cancer Risk		
Beryllium	1.28E-10	7.00E-11	1.16E-10	7.00E-11
Total PCBs	***2.01E-06***	1.32E-07	***3.15E-06***	9.17E-09
^{241}Am	3.88E-07	2.48E-08	1.72E-07	6.35E-10
^{137}Cs	***6.06E-04***	3.88E-05	***2.92E-04***	4.86E-07
^{239}Pu	***1.57E-06***	1.01E-07	5.94E-07	4.99E-09
^{230}Th	***1.48E-06***	9.44E-08	5.64E-07	4.51E-09
^{238}U	***2.92E-06***	1.87E-07	***1.37E-06***	3.13E-09
Cumulative Cancer Risk	***6.14E-04***	3.93E-05	***2.98E-04***	5.08E-07

Notes:

COPC = chemical of potential concern. PAHs = polynuclear aromatic hydrocarbons.

Values reported as 0 when either the analyte was not a COPC or when a toxicity value was not available for the analyte.

[a] Only COPCs with nonzero hazard or cancer risk values shown. COCs are indicated using bold, italicized font for the COPC's hazard or cancer risk value. A COC is either a COPC with a hazard value greater than 0.1 in a scenario with a cumulative hazard greater than 1 or a COPC with a cancer risk value greater than 1×10^{-6} in a scenario with a cumulative cancer risk greater than 1×10^{-4}. Note that scenarios of concern (i.e. those with a cumulative hazard greater than 1 or a cumulative cancer risk greater than 1×10^{-4}) also have their cumulative value in bold, italic font.

As with the list of COPCs, the COCs identified from the risk analyses are similar to those identified in other assessments of ditches at the PGDP. Important COCs over all outfalls are antimony, beryllium, Total PAHs, Total PCBs, and the uranium isotopes. Other notable COCs over all outfalls are iron, manganese, and ^{137}Cs.

Taken in absence of uncertainties and site-specific conditions, the hazards and cancer risks reported here indicate that use of the area containing outfalls may need to be controlled to reduce risks to below the benchmarks used at PGDP to determine areas of concern. However, as shown by the results for the site-specific scenarios assessed in the later of the two SHHRAs, controls currently in place that limit exposure reduce both the cumulative hazards and cancer risks to levels within or below EPA's generally acceptable risk range for site-related exposures.

APPENDIX B.3

AREAS ASSOCIATED WITH OUTFALLS (SWMU 97)
HISTORICAL RISK ASSESSMENT SUMMARY

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B.3 AREAS ASSOCIATED WITH OUTFALLS (SWMU 97) – HISTORICAL RISK ASSESSMENT SUMMARY

BHHRA and SERA were completed for SWMU 97 as part of the site evaluation report for WAG 15 (DOE 1996a). In these risk assessments, the methods used were consistent with those in DOE 2000; therefore, results are comparable to the SHHRAs presented for the outfall ditches in Section B.2.

In both the BHHRA and the SERA, results used were from soil samples collected during the site evaluation and were limited to PAHs as shown in Table B3-1, which presents the summary statistics for the COPCs identified in surface soil (0 to 1 ft bgs) in the BHHRA. (Note that metals, PCBs, and ^{238}U were included in samples collected from a "background" area. The results for these analytes are not included in Table B2-6 or in the subsequent risk assessment results.)

The cancer risks for the industrial worker for each of the COPCs and over all COPCs for each route of exposure considered and derived using default exposure parameters are presented in Table B3-2. Hazard results are not presented because none of the COPCs have a toxicity value that allows for evaluation of hazard.

As shown in Table B3-2, cumulative cancer risk to the industrial worker under default exposure equals 8.10×10^{-5}, which is within the EPA acceptable risk range for site-related exposures. The driving contaminant is benzo(a)pyrene, which makes up 76% of the total cancer risk.

In the uncertainty section of the BHHRA, the cumulative cancer risk to the industrial worker under site-specific exposure is reported to be 9×10^{-7}. This value, which was calculated using the exposure parameters presented in Table B3-3, falls below the EPA acceptable risk range for site-related exposures.

Similar to the BHHRA, which determined that risks under site-specific exposures are below levels of concern, the SERA concluded that contamination at SWMU 97 does not currently pose a threat to any ecological receptor due to the location of the SWMU.

Table B3-1. Summary statistics for SWMU 97 surface soil samples

Analyte[a]	Frequency of Detect[b]	Nondetected Range	Detected Range	Arithmetic Mean[c]	Risk Screening Value[d]	Distribution[e]	Representative Concentration[f]	Units
Benz(a)anthracene	6/18	9.99E-01 – 5.00E+00	6.00E-02 – 2.18E+00	7.06E-01	8.5E-03	L	1.45E+00	mg/kg
Benzo(a)pyrene	4/18	9.99E-01 – 5.00E+00	1.20E-02 – 1.68E+00	3.78E+00	8.5E-04	N	1.68E+00	mg/kg
Benzo(b)fluoranthene	4/18	9.99E-01 – 5.00E+00	2.20E-02 – 2.45E+00	3.82E+00	8.5E-03	N	2.45E+00	mg/kg
Benzo(g,h,i)perylene	2/5	2.50E-02 – 1.21E+00	1.60E-01 – 3.20E-01	5.43E-01	None	N	3.20E-01	mg/kg
Benzo(k)fluoranthene	3/18	9.99E-01 – 5.00E+00	1.10E-02 – 1.60E-01	3.75E+00	8.5E-02	N	1.60E-01	mg/kg
Chrysene	3/18	5.00E-02 – 5.00E+00	1.40E-01 – 2.42E+00	3.82E+00	8.5E-01	N	2.42E+00	mg/kg
Dibenz(a,h)anthracene	2/18	1.00E-02 – 5.00E+00	1.20E-01 – 1.40E-01	3.75E+00	8.5E-04	N	1.40E-01	mg/kg
Indeno(1,2,3-cd)pyrene	2/18	1.40E-02 – 5.00E+00	7.80E-02 – 9.20E-02	3.74E+00	8.5E-03	N	9.20E-02	mg/kg
Phenanthrene	3/18	2.10E-01 – 4.20E-01	3.80E-01 – 4.32E+00	7.42E-02	None	L	5.96E-01	mg/kg

[a] Only results for COPCs from surface samples (0 to 1 ft bgs) collected from SWMU 97 are included.
[b] Number of detected results over the total number of samples.
[c] Arithmetic mean of detected concentrations.
[d] Risk-based screening value derived for the residential user at a ELCR of 1×10^{-7}.
[e] Distribution considered when deriving the representative concentration. N = normal distribution. L = Log normal distribution.
[f] The lesser of the maximum detected concentration and the 95% upper confidence limit on the mean concentration. Value presented is used as the exposure concentration in the BHHRA.

Table B3-2. Summary of hazard and cancer risk to an industrial worker exposed to surface soil

Analyte[a]	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Volatiles and Particulates Emitted from Soil	Total ELCR Across All Exposure Routes	Cumulative ELCR
Benz(a)anthracene	1.59E-07	5.14E-06	7.35E-12	5.30E-06	
Benzo(a)pyrene	1.84E-06	5.93E-05	8.50E-11	6.12E-05	
Benzo(b)fluoranthene	2.69E-07	8.67E-06	1.24E-11	8.94E-06	
Benzo(g,h,i)perylene[b]	NV	NV	NV	NV	
Benzo(k)fluoranthene	1.76E-09	5.66E-08	8.09E-14	5.84E-08	
Chrysene	2.65E-09	8.56E-08	1.22E-13	8.83E-08	
Dibenz(a,h)anthracene	1.54E-07	4.95E-06	7.08E-12	5.11E-06	
Indeno(1,2,3-cd)pyrene	1.01E-08	3.26E-07	4.65E-13	3.37E-07	
Phenanthrene[b]	NV	NV	NV	NV	
Total ELCR Across All Analytes	2.43E-06	7.86E-05	1.09E-10		
Cumulative ELCR					**8.10E-05**

[a] Only cancer risk results are presented because none of the COPCs have a toxicity value for hazard.

[b] Neither benzo(g,h,i)perylene not phenanthrene have a toxicity value for cancer risk; therefore, a value could not be derived.

Table B3-3. Comparison of exposure parameters for the industrial worker under default and site specific conditions

Parameter	Default Value	Site-specific Value
Exposure duration	250 yr	5 yr
Exposure frequency	250 d/yr	25 d/yr
Exposure time	8 hr/d	4 hr/d

APPENDIX B.4

STORM SEWER SYSTEM
HISTORICAL RISK ASSESSMENT SUMMARY

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B.4 STORM SEWER SYSTEM – HISTORICAL RISK ASSESSMENT SUMMARY

Risk assessment information is not presented for the storm sewer system because no risk assessments have been completed for that area.

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ATTACHMENT D1b

DATA SUMMARIES

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Table D1b.1. Summary of Soil/Sediment Data

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
Aluminum	mg/kg	504/504	581-15500	16.8-178	6730.581
Americium-241	pCi/g	141/523	0.0124-15.24	0.01-13	1.505
Antimony	mg/kg	253/498	0.53-20	6-20	10.503
Arsenic	mg/kg	234/498	0.00304-57.1	0.94-20	6.486
Barium	mg/kg	498/498	12-319	1-5	65.678
Benz(a)anthracene	mg/kg	187/462	0.061-51	0.09-0.56	1.479
Benzo(a)pyrene	mg/kg	183/460	0.064-130	0.09-0.56	1.924
Benzo(b)fluoranthene	mg/kg	204/461	0.072-290	0.09-0.56	3.234
Benzo(k)fluoranthene	mg/kg	173/422	0.46-29	0.09-0.56	1.099
Beryllium	mg/kg	156/507	0.31-3.3	0.36-0.5	0.688
Cadmium	mg/kg	42/498	0.28-19.3	0.5-2	2.473
Cesium-137	pCi/g	373/489	0.00861-181	0.01-0.86	1.641
Chromium	mg/kg	500/501	2.5-473	2.37-2.37	23.190
Chrysene	mg/kg	194/460	0.074-41	0.09-0.56	1.287
Cobalt-60	pCi/g	29/486	-0.0014-4.6	0.00676-1.2	1.282
Copper	mg/kg	475/498	2.16-234	2.13-5	18.090
Dibenz(a,h)anthracene	mg/kg	164/425	0.1-14	0.063-0.56	0.617
Fluoranthene	mg/kg	200/423	0.14-200	0.09-0.56	2.979
Indeno(1,2,3-cd)pyrene	mg/kg	179/461	0.04-54	0.09-0.56	1.122
Iron	mg/kg	498/498	1560-182000	5-188	10978.715
Lead	mg/kg	106/498	3.6-303	14.7-20	33.527
Manganese	mg/kg	504/504	17.8-4470	1-10	341.254
Mercury	mg/kg	78/507	0.03-3.28	0.04-0.2	0.347
Neptunium-237	pCi/g	169/473	-0.0582-12.8	0.009-0.419	0.554
Nickel	mg/kg	430/504	2.3-520	4.27-5	17.399
PCB-1016	mg/kg	33/3103	0.09-9.55	0.0001-105	0.916
PCB-1221	mg/kg	43/3103	0.12-12.4	0.00013-3.25	0.784
PCB-1232	mg/kg	43/3103	0.09-9.55	0.0001-2.5	0.605
PCB-1242	mg/kg	47/3103	0.05-5.73	0.00006-1.5	0.418
PCB-1248	mg/kg	71/3103	0.09-13.8	0.041-2.5	1.264
PCB-1254	mg/kg	387/3103	0.037-61.2	0.041-2.25	1.340
PCB-1260	mg/kg	839/3103	0.035-609	0.041-0.545	4.125
PCB-1262	mg/kg	0/25	-	0.041-0.08	
PCB-1268	mg/kg	49/3076	0.07-7.64	0.00008-2	0.460
Plutonium-239/240	pCi/g	268/505	-0.01-61.45	0.005-7.34	1.757
Pyrene	mg/kg	201/460	0.1-130	0.09-0.56	2.452
Selenium	mg/kg	27/495	1.01-27.9	0.5-20	15.084
Silver	mg/kg	214/504	0.59-19.6	1-10.3	2.676
Technetium-99	pCi/g	348/521	-0.84-2650	0.126-6.94	31.804
Thorium-228	pCi/g	396/417	0.0522-4.38	0.14-0.17	0.394
Thorium-230	pCi/g	433/458	0.00347-497	0.19-0.26	11.263
Thorium-232	pCi/g	412/417	0.0218-5.07	0.04-0.16	0.421
Uranium	mg/kg	370/472	0.1-943	0.00006-200	33.512
Uranium-234	pCi/g	454/482	0.031-56.14	0.103-0.728	2.254
Uranium-238	pCi/g	482/483	0.033-317	0.18-0.18	4.834
Vanadium	mg/kg	498/498	4.27-104	2.0-2.5	18.493
Zinc	mg/kg	470/498	6-1430	17.1-20	72.365

Note:

FOD: Frequency of Detection

Table D1b.2. Summary of Surface Water Data

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
1,1,1-Trichloroethane	mg/L	0/20	-	0.005-0.005	
1,1,2,2-Tetrachloroethane	mg/L	0/13	-	0.005-0.005	
1,1,2-Trichloroethane	mg/L	0/13	-	0.005-0.005	
1,1-biphenyl	mg/L	0/2	-	0.001-0.001	
1,1-Dichloroethane	mg/L	0/13	-	0.005-0.005	
1,1-Dichloroethene	mg/L	0/13	-	0.005-0.005	
1,2,4-Trichlorobenzene	mg/L	0/12	-	0.005-0.01	
1,2-Dichlorobenzene	mg/L	0/12	-	0.005-0.01	
1,2-Dichloroethane	mg/L	0/13	-	0.005-0.005	
1,2-Dichloropropane	mg/L	0/13	-	0.005-0.005	
1,2-Diphenylhydrazine	mg/L	0/8	-	0.005-0.01	
1,3-Dichlorobenzene	mg/L	0/12	-	0.005-0.01	
1,4-Dichlorobenzene	mg/L	0/12	-	0.005-0.01	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	ng/L	0/4	-	0.03-0.22	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	pg/L	0/3	-	0.7199-21.171	
2,4,5-Trichlorophenol	mg/L	0/4	-	0.005-0.005	
2,4,6-Trichlorophenol	mg/L	0/12	-	0.005-0.01	
2,4'-DDD	mg/L	0/2	-	0.00005-0.00005	
2,4'-DDE	mg/L	0/2	-	0.00005-0.00005	
2,4'-DDT	mg/L	0/2	-	0.00005-0.00005	
2,4-Dichlorophenol	mg/L	0/12	-	0.005-0.01	
2,4-Dimethylphenol	mg/L	0/12	-	0.005-0.01	
2,4-Dinitrophenol	mg/L	0/12	-	0.005-0.01	
2,4-Dinitrotoluene	mg/L	0/12	-	0.005-0.01	
2,6-Dimethylnaphthalene	mg/L	0/2	-	0.001-0.001	
2,6-Dinitrotoluene	mg/L	0/12	-	0.005-0.01	
2-Butanone	mg/L	0/5	-	0.01-0.01	
2-Chloroethyl vinyl ether	mg/L	0/8	-	0.01-0.01	
2-Chloronaphthalene	mg/L	0/12	-	0.005-0.01	
2-Chlorophenol	mg/L	0/12	-	0.005-0.01	
2-Hexanone	mg/L	0/5	-	0.01-0.01	
2-Methyl-4,6-dinitrophenol	mg/L	0/8	-	0.005-0.05	
2-Methylnaphthalene	mg/L	0/6	-	0.001-0.005	
2-Methylphenol	mg/L	0/4	-	0.005-0.005	
2-Nitrobenzenamine	mg/L	0/4	-	0.005-0.005	
2-Nitrophenol	mg/L	0/12	-	0.005-0.01	
2-Propanol	mg/L	0/28	-	1-1	
3,3'-Dichlorobenzidine	mg/L	0/12	-	0.005-0.01	
3-Nitrobenzenamine	mg/L	0/4	-	0.005-0.005	
4,4'-DDD	mg/L	0/9	-	0.00005-0.0001	
4,4'-DDE	mg/L	0/9	-	0.00005-0.0001	
4,4'-DDT	mg/L	0/9	-	0.00005-0.0001	
4-Bromophenyl phenyl ether	mg/L	0/12	-	0.005-0.01	
4-Chloro-3-methylphenol	mg/L	0/12	-	0.005-0.01	
4-Chlorobenzenamine	mg/L	0/4	-	0.005-0.005	
4-Chlorophenyl phenyl ether	mg/L	0/12	-	0.005-0.01	
4-Methyl-2-pentanone	mg/L	0/5	-	0.01-0.01	
4-Nitrobenzenamine	mg/L	0/4	-	0.005-0.005	
4-Nitrophenol	mg/L	0/12	-	0.005-0.01	
Acenaphthene	mg/L	0/14	-	0.001-0.01	
Acenaphthylene	mg/L	0/14	-	0.001-0.01	
Acetone	mg/L	5/33	0.01-0.015	0.1-1	0.012
Acrolein	mg/L	0/8	-	0.01-0.01	
Acrylonitrile	mg/L	0/8	-	0.01-0.01	
Activity of U-235	pCi/L	4/18	2.2-38.9	0.09-2.2	21.800
Aldrin	mg/L	0/9	-	0.00004-0.00005	

Table D1b.2. Summary of Surface Water Data (Continued)

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
Alpha activity	pCi/L	9/14	0-53.8	3.56-170	17.316
alpha-BHC	mg/L	0/9	-	0.00004-0.00005	
alpha-Chlordane	mg/L	0/9	-	0.00004-0.00005	
Aluminum	mg/L	33/62	0.2-4.31	0.2-0.2	0.631
Americium-241	pCi/L	5/63	-10-17.1	0.0496-96.1	6.770
Ammonia	mg/L	7/51	0.2-3.5	0.2-0.2	1.247
Anthracene	mg/L	0/14	-	0.001-0.01	
Antimony	mg/L	17/115	0.005-0.2	0.005-0.2	0.028
Arsenic	mg/L	11/115	0.005-0.2	0.005-0.2	0.148
Azinphos-methyl	mg/L	0/2	-	0.0025-0.0025	
Barium	mg/L	29/29	0.0272-0.142	0.005-0.025	0.073
Benz(a)anthracene	mg/L	0/14	-	0.001-0.01	
Benzene	mg/L	0/13	-	0.005-0.005	
Benzidine	mg/L	0/8	-	0.005-0.01	
Benzo(a)pyrene	mg/L	0/14	-	0.001-0.01	
Benzo(b)fluoranthene	mg/L	0/14	-	0.001-0.01	
Benzo(e)pyrene	mg/L	0/2	-	0.001-0.001	
Benzo(ghi)perylene	mg/L	0/14	-	0.001-0.01	
Benzo(k)fluoranthene	mg/L	0/14	-	0.001-0.01	
Beryllium	mg/L	5/115	0.005-0.01	0.001-0.01	0.006
Beta activity	pCi/L	10/14	0-84.89	5.5-170	27.942
beta-BHC	mg/L	0/9	-	0.00004-0.00005	
Bis(2-chloroethoxy)methane	mg/L	0/12	-	0.005-0.01	
Bis(2-chloroethyl) ether	mg/L	0/4	-	0.005-0.005	
Bis(2-chloroisopropyl) ether	mg/L	0/12	-	0.005-0.01	
Bis(2-ethylhexyl)phthalate	mg/L	2/12	0.04-0.045	0.005-0.01	0.043
Boron	mg/L	0/8	-	2-2	
Bromide	mg/L	0/11	-	1-1	
Bromodichloromethane	mg/L	0/13	-	0.005-0.005	
Bromoform	mg/L	0/13	-	0.005-0.005	
Bromomethane	mg/L	0/8	-	0.005-0.005	
Butyl benzyl phthalate	mg/L	0/8	-	0.005-0.005	
Cadmium	mg/L	12/148	0.001-0.05	0.001-0.05	0.008
Calcium	mg/L	19/19	11.4-36.5	1-10	25.626
Calcium hardness	mg/L	8/8	10-273	10-15	142.250
Carbazole	mg/L	0/4	-	0.005-0.005	
Carbon disulfide	mg/L	0/5	-	0.005-0.005	
Carbon tetrachloride	mg/L	0/13	-	0.005-0.005	
Cesium-134	pCi/L	0/58	-	1.88-23	
Cesium-137	pCi/L	0/58	-	2.18-26.6	
Chlordane	mg/L	0/5	-	0.00005-0.0005	
Chloride	mg/L	63/63	2.5-98.1	1-2	30.343
Chlorobenzene	mg/L	0/13	-	0.005-0.005	
Chloroethane	mg/L	0/13	-	0.005-0.005	
Chloroform	mg/L	0/13	-	0.005-0.005	
Chloromethane	mg/L	0/9	-	0.005-0.005	
Chromium	mg/L	11/148	0.02-0.05	0.02-0.05	0.025
Chrysene	mg/L	0/14	-	0.001-0.01	
Chrysene C1	mg/L	0/2	-	0.001-0.001	
cis-1,2-Dichloroethene	mg/L	0/5	-	0.005-0.005	
cis-1,3-Dichloropropene	mg/L	0/5	-	0.005-0.005	
Cobalt	mg/L	7/29	0.001-0.00117	0.001-0.025	0.001
Cobalt-60	pCi/L	1/58	14.3-14.3	2.21-30.4	14.300
Copper	mg/L	42/148	0.005-0.1	0.005-0.1	0.014
Co-Ral	mg/L	0/2	-	0.0005-0.0005	
Cyanide	mg/L	3/51	0.02-0.02	0.02-0.05	0.020
delta-BHC	mg/L	0/9	-	0.00004-0.00005	
Diazinon	mg/L	0/2	-	0.0005-0.0005	
Dibenz(a,h)anthracene	mg/L	0/14	-	0.001-0.01	
Dibenzofuran	mg/L	0/4	-	0.005-0.005	
Dibenzothiophene	mg/L	0/1	-	0.001-0.001	

Table D1b.2. Summary of Surface Water Data (Continued)

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
Dibenzothiophene C1	mg/L	0/2	-	0.001-0.001	
Dibenzothiophene C2	mg/L	0/2	-	0.001-0.001	
Dibromochloromethane	mg/L	0/13	-	0.005-0.005	
Dichlorvos	mg/L	0/2	-	0.0005-0.0005	
Dieldrin	mg/L	0/9	-	0.00005-0.0001	
Diethyl phthalate	mg/L	0/12	-	0.005-0.01	
Dimethoate	mg/L	0/2	-	0.0005-0.0005	
Dimethyl phthalate	mg/L	0/12	-	0.005-0.01	
Di-n-butyl phthalate	mg/L	0/12	-	0.005-0.01	
Di-n-octylphthalate	mg/L	0/12	-	0.005-0.01	
Dissolved Beta	pCi/L	90/143	-1.77-228	7.56-17	38.149
Endosulfan I	mg/L	0/9	-	0-0.00005	
Endosulfan II	mg/L	0/9	-	0-0.0001	
Endosulfan sulfate	mg/L	0/9	-	0-0.0001	
Endrin	mg/L	0/9	-	0.00005-0.0001	
Endrin aldehyde	mg/L	0/9	-	0-0.0001	
Endrin ketone	mg/L	0/8	-	0.0001-0.0001	
Ethion	mg/L	0/2	-	0.0005-0.0005	
Ethylbenzene	mg/L	0/13	-	0.005-0.005	
Famphur	mg/L	0/2	-	0.001-0.001	
Fensulfothion	mg/L	0/2	-	0.0025-0.0025	
Fenthion	mg/L	0/2	-	0.0005-0.0005	
Fluoranthene	mg/L	0/14	-	0.001-0.01	
Fluoranthene C1	mg/L	0/2	-	0.001-0.001	
Fluorene	mg/L	0/14	-	0.001-0.01	
Fluorene C1	mg/L	0/2	-	0.001-0.001	
Fluorene C2	mg/L	0/2	-	0.001-0.001	
Fluoride	mg/L	11/11	0.15-0.54	0.1-0.1	0.356
gamma-Chlordane	mg/L	0/9	-	0.00004-0.00005	
Heptachlor	mg/L	1/9	0.000032-0.000032	0.00004-0.00005	0.000
Heptachlor epoxide	mg/L	0/9	-	0-0.00005	
Hexachlorobenzene	mg/L	0/12	-	0.005-0.01	
Hexachlorobutadiene	mg/L	0/12	-	0.005-0.01	
Hexachlorocyclopentadiene	mg/L	0/12	-	0.005-0.01	
Hexachloroethane	mg/L	0/12	-	0.005-0.01	
Indeno(1,2,3-cd)pyrene	mg/L	0/14	-	0.001-0.01	
Iron	mg/L	128/148	0.2-2.99	0.2-0.2	0.723
Isophorone	mg/L	0/12	-	0.005-0.01	
Kjeldahl Nitrogen	mg/L	2/3	2.8-20	1-1	11.400
Lead	mg/L	4/148	0.005-0.2	0.005-0.25	0.056
Lindane	mg/L	0/6	-	0.00005-0.00005	
m,p-Cresol	mg/L	0/4	-	0.005-0.005	
Magnesium	mg/L	27/27	2.46-26.5	0.025-2	8.926
Malathion	mg/L	0/2	-	0.0012-0.0012	
Manganese	mg/L	20/29	0.005-0.429	0.005-0.025	0.172
MBAS	mg/L	0/11	-	0.08-0.08	
Mercury	mg/L	16/115	0.0002-0.0002	0.0002-0.0002	0.000
Methoxychlor	mg/L	0/9	-	0.0001-0.0005	
Methyl parathion	mg/L	0/2	-	0.0005-0.0005	
Methylene chloride	mg/L	0/13	-	0.01-0.01	
Mirex	mg/L	0/2	-	0.00005-0.00005	
Mocap	mg/L	0/2	-	0.0005-0.0005	
Molybdenum	mg/L	0/10	-	0.025-0.05	
Naphthalene	mg/L	0/14	-	0.001-0.01	
Naphthalene C1	mg/L	0/2	-	0.001-0.001	
Naphthalene C2	mg/L	0/2	-	0.001-0.001	
Naphthalene C3	mg/L	0/2	-	0.001-0.001	
Naphthalene C4	mg/L	0/2	-	0.001-0.001	
Neptunium-237	pCi/L	7/63	-14-11.7	0.1-1.11	-2.446

Table D1b.2. Summary of Surface Water Data (Continued)

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
Nickel	mg/L	37/148	0.005-0.1	0.005-0.1	0.014
Nitrobenzene	mg/L	0/12	-	0.005-0.01	
N-Nitrosodimethylamine	mg/L	0/8	-	0.005-0.01	
N-Nitroso-di-n-propylamine	mg/L	0/12	-	0.005-0.01	
N-Nitrosodiphenylamine	mg/L	0/12	-	0.005-0.01	
Oil and Grease	mg/L	7/476	5.9-10	5-10	8.871
Parathion	mg/L	0/2	-	0.0005-0.0005	
PCB-1016	mg/L	0/271	-	0.00012-0.0002	
PCB-1221	mg/L	0/271	-	0.00017-0.00094	
PCB-1232	mg/L	0/271	-	0.00013-0.00017	
PCB-1242	mg/L	1/271	0.00011-0.00011	0.00009-0.00017	0.000
PCB-1248	mg/L	3/271	0.00016-0.00047	0.00011-0.00017	0.000
PCB-1254	mg/L	5/271	0.000075-0.00023	0.00007-0.00017	0.000
PCB-1260	mg/L	5/271	0.00008-0.000414	0.00005-0.00017	0.000
PCB-1268	mg/L	1/271	0.00025-0.00025	0.00007-0.00055	0.000
Pentachlorophenol	mg/L	0/12	-	0.005-0.01	
Perylene	mg/L	0/2	-	0.001-0.001	
Phenanthrene	mg/L	0/14	-	0.001-0.01	
Phenanthrene C1	mg/L	0/2	-	0.001-0.001	
Phenanthrene C2	mg/L	0/2	-	0.001-0.001	
Phenanthrene C3	mg/L	0/2	-	0.001-0.001	
Phenanthrene C4	mg/L	0/2	-	0.001-0.001	
Phenol	mg/L	0/12	-	0.005-0.01	
Phenols	mg/L	0/4	-	0.05-0.05	
Phorate	mg/L	0/2	-	0.0005-0.0005	
Phosphorous	mg/L	407/426	0.05-1.27	0.03-0.15	0.207
Phosphorous, Dissolved	mg/L	4/4	0.07-0.18	0.05-0.05	0.120
Plutonium-238	pCi/L	0/58	-	0.09-0.851	
Plutonium-239/240	pCi/L	5/63	-0.0313-0.094	0.03-0.223	0.002
Polychlorinated biphenyl	mg/L	12/271	0.000075-0.00047	0.00005-0.00094	0.000
Potassium	mg/L	19/19	1.08-6.64	0.2-0.2	2.392
Potassium-40	pCi/L	5/58	60.8-594	20.6-528	270.360
Pyrene	mg/L	0/14	-	0.001-0.005	
Pyrene C1	mg/L	0/1	-	0.001-0.001	
Pyridine	mg/L	0/4	-	0.005-0.005	
Radium	pCi/L	2/8	0.612-0.899	0.444-0.628	0.756
Selenium	mg/L	3/115	0.005-0.005	0.005-0.2	0.005
Silver	mg/L	35/115	0.001-0.05	0.001-0.05	0.011
Sodium	mg/L	19/19	4.31-52.6	1-10	27.158
Strontium	mg/L	2/2	0.192-0.244	0.025-0.025	0.218
Styrene	mg/L	0/5	-	0.005-0.005	
Sulfate	mg/L	38/38	7.1-414.4	5-5	59.668
Sulfide	mg/L	0/8	-	1-2	
Sulfite	mg/L	0/11	-	3-3	
Suspended Alpha	pCi/L	27/134	-3.39-13.4	0.804-27.5	2.415
Suspended Beta	pCi/L	45/136	-7.42-162	7.07-14.3	16.706
Suspended Solids	mg/L	15/83	10-54	10-50	22.867
Technetium-99	pCi/L	53/150	-0.907-96.9	14.5-21.8	28.373
Tetrachloroethene	mg/L	0/13	-	0.005-0.005	
Thallium	mg/L	21/115	0.01-0.2	0.01-0.25	0.037
Thorium-228	pCi/L	0/58	-	0.0993-0.64	
Thorium-230	pCi/L	6/63	-0.361-0.505	0.177-1.32	0.059
Thorium-232	pCi/L	0/58	-	0.13-1.39	
Thorium-234	pCi/L	0/24	-	31-332	
Tin	mg/L	3/8	1-1	1-1	1.000
Titanium	mg/L	0/8	-	0.025-0.025	
Toluene	mg/L	0/13	-	0.005-0.005	
Total Metals	mg/L	8/83	0.307-5	0.28-5	1.704

Table D1b.2. Summary of Surface Water Data (Continued)

Chemical Name	Units	FOD	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations
Total Xylene	mg/L	0/5	-	0.015-0.015	
Toxaphene	mg/L	0/9	-	0.0025-0.005	
trans-1,2-Dichloroethene	mg/L	0/13	-	0.005-0.005	
trans-1,3-Dichloropropene	mg/L	0/13	-	0.005-0.005	
Trichloroethene	mg/L	21/181	0.001-0.13	0.001-0.001	0.010
Tritium	pCi/L	0/23	-	300-300	
Uranium	mg/L	87/128	0.001-0.58	0.001-0.05	0.064
Uranium	pCi/L	4/28	30-1650	1.12-584	1090.000
Uranium-234	pCi/L	4/24	1.18-594	0.66-204	298.795
Uranium-235	mg/L	1/1	-	NA	
Uranium-235	NA	1/1	-	NA	
Uranium-235	pCi/L	0/2	-	0.386-0.561	
Uranium-235	wt %	121/122	0.263-2	NA	0.426
Uranium-238	pCi/L	12/45	0.35-1020	0.32-312	229.982
Vanadium	mg/L	0/21	-	0.02-0.025	
Vinyl chloride	mg/L	0/8	-	0.002-0.005	
Zinc	mg/L	49/148	0.02-0.539	0.02-0.2	0.047

Note:
FOD: Frequency of Detection
NA: Not Applicable.

ATTACHMENT D2

CHEMICAL DAILY INTAKE CALCULATIONS AND EXPOSURE PARAMETERS

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Attachment D2.1. Summary of Current Industrial Chemical Daily Intake Calculations and Exposure Parameters

Soil - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{\text{Cs * CF * EF * ED * IR * FI}}{\text{BW * AT}}$$

$$\text{Radionuclide Intake (pCi)} = \text{As * CFrad * EF * ED * IR * FI}$$

Where:

Cs mg/kg = chemical-specific
CF kg/mg = 1.0E-06
Ased pCi/g = chemical-specific
CFrad g/mg = 1.0E-03
EF day/yr = 14
ED year = 25
IR mg/day = 50
FI unitless = 1
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{\text{Cs * CFd * SA * AF * ABS * EF * ED}}{\text{BW * AT}}$$

Where:

Cs mg/kg = chemical-specific
CFd (kg-cm^2)/(mg-m^2) = 0.01
SA m^2/day = 0.430
AF mg/cm^2 = 1
ABS unitless chemical-specific
EF = day/yr = 14
ED year = 25
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Inhalation of Particulates

$$\text{Absorbed Dose mg/kg*day} = \frac{\text{Cs * EF * ED * ET * (1/PEF) * IRair}}{\text{BW * AT}}$$

$$\text{Radionuclide Intake (pCi)} = \text{As * EF * ED * ET * CF * (1/PEF) * IRair}$$

Where:

Cs mg/kg = chemical-specific
As pCi/g = chemical-specific
EF = day/yr = 14
ED year = 25
ET hr/day = 8
CF g/Kg = 1.0E+03
PEF m^3/kg = 3.21E+10
IRair m^3/hr = 2.5
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Attachment D2.1. Summary of Current Industrial Chemical Daily Intake Calculations and Exposure Parameters (Continued)

Soil - External Exposure

Absorbed dose ((pCi * year)/g) = As * EF * ED * (1-Se) * Te

Where:

As pCi/g = chemical-specific
EF = day/day = 3.84E-02
ED year = 25
Se unitless = 0.2
Te hr/hr = 3.33E-01

Surface Water- Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{Csw * SA * Pc * CF * EF * ED * ET}{BW * AT}$$

Where:

Csw mg/L = chemical-specific
SA m^2/day = 0.430
Pc cm/hr = chemical-specific
ET hr/day = 2.6
EF = day/yr = 14
ED year = 25
CF L/(cm-m^2) 10
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Attachment D2.2. Summary of Future Industrial Chemical Daily Intake Calculations and Exposure Parameters

Soil - Ingestion

Chemical Intake mg/kg*day = $\frac{Cs * CF * EF * ED * IR * FI}{BW * AT}$

Radionuclide Intake (pCi) = As * CFrad * EF * ED * IR * FI

Where:

Cs mg/kg = chemical-specific
CF kg/mg = 1.0E-06
Ased pCi/g = chemical-specific
CFrad g/mg = 1.0E-03
EF day/yr = 250
ED year = 25
IR mg/day = 50
FI unitless = 1
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Dermal Contact

Chemical Intake mg/kg*day = $\frac{Cs * CFd * SA * AF * ABS * EF * ED}{BW * AT}$

Where:

Cs mg/kg = chemical-specific
CFd (kg-cm^2)/(mg-m^2) = 0.01
SA m^2/day = 0.430
AF mg/cm^2 = 1
ABS unitless chemical-specific
EF = day/yr = 250
ED year = 25
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Inhalation of Particulates

Absorbed Dose mg/kg*day = $\frac{Cs * EF * ED * ET * (1/PEF) * IRair}{BW * AT}$

Radionuclide Intake (pCi) = As * EF * ED * ET * CF * (1/PEF) * IRair

Where:

Cs mg/kg = chemical-specific
As pCi/g = chemical-specific
EF = day/yr = 250
ED year = 25
ET hr/day = 8
CF g/Kg = 1.0E+03
PEF m^3/kg = 3.21E+10
IRair m^3/hr = 2.5
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Attachment D2.2. Summary of Future Industrial Chemical Daily Intake Calculations and Exposure Parameters (Continued)

Soil - External Exposure

Absorbed dose ((pCi * year)/g) = As * EF * ED * (1-Se) * Te

Where:

As pCi/g = chemical-specific
EF = day/day = 6.85E-01
ED year = 25
Se unitless = 0.2
Te hr/hr = 3.33E-01

Surface Water- Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{Csw * SA * Pc * CF * EF * ED * ET}{BW * AT}$$

Where:

Csw mg/L = chemical-specific
SA m^2/day = 0.430
Pc cm/hr = chemical-specific
ET hr/day = 2.6
EF = day/yr = 250
ED year = 25
CF L/(cm-m^2) 10
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Attachment D2.3. Summary of Excavation Chemical Daily Intake Calculations and Exposure Parameters

Soil - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{Cs * CF * EF * ED * IR * FI}{BW * AT}$$

Radionuclide Intake (pCi) = As * CFrad * EF * ED * IR * FI

Where:

Cs mg/kg = chemical-specific
CF kg/mg = 1.0E-06
Ased pCi/g = chemical-specific
CFrad g/mg = 1.0E-03
EF day/yr = 185
ED year = 25
IR mg/day = 480
FI unitless = 1
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{Cs * CFd * SA * AF * ABS * EF * ED}{BW * AT}$$

Where:

Cs mg/kg = chemical-specific
CFd (kg-cm^2)/(mg-m^2) = 0.01
SA m^2/day = 0.430
AF mg/cm^2 = 1
ABS unitless chemical-specific
EF = day/yr = 185
ED year = 25
BW kg = 70
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - Inhalation of Particulates

$$\text{Absorbed Dose mg/kg*day} = \frac{Cs * EF * ED * ET * (1/PEF) * IRair}{BW * AT}$$

Radionuclide Intake (pCi) = As * EF * ED * ET * CF * (1/PEF) * IRair

Where:

Cs mg/kg = chemical-specific
As pCi/g = chemical-specific
EF = day/yr = 185
ED year = 25
ET hr/day = 8
CF g/Kg = 1.0E+03
PEF m^3/kg = 3.21E+10
IRair m^3/hr = 2.5
AT yr*day/yr cancer = 25550
noncancer = 9125

Soil - External Exposure

Absorbed dose [(pCi * year)/g] = As * EF * ED * (1-Se) * Te

Where:

As pCi/g = chemical-specific
EF = day/Day = 5.07E-01
ED year = 25
Se unitless = 0.2
Te hr/hr = 3.33E-01

Attachment D2.4. Summary of Recreational Chemical Daily Intake Calculations and Exposure Parameters for Sediment

Sediment - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{Csed * CF * EF * ED * ET * CF2 * IR * FI}{BW * AT}$$

$$\text{Radionuclide Intake (pCi)} = Ased * CFrad * EF * ED * ET * CF2 * IR * FI$$

Where:

Csed mg/kg = chemical-specific
CF kg/mg = 1.0E-05
Ased pCi/g = chemical-specific
CFrad g/mg = 1.0E-02
EF = day/yr adult = 104
teen = 140
current child = 10
future child = 140
ED year adult = 22
teen = 12
current child = 1
future child = 6
ET hr/day = adult = 5
teen = 5
current child = 4
future child = 5
CF2 day/hr = 4.2E-02
IR mg/day adult = 100
teen = 100
current child = 200
future child = 200
FI unitless = 1
BW kg adult = 70
teen = 43
current child = 14.5
future child = 14.5
AT yr*day/yr cancer = 25550
noncancer adult = 8030
teen = 4380
current child = 365
future child = 2190

Sediment - Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{Csed * CFd * SA * AF * ABS * EF * ED}{BW * AT}$$

Csed mg/kg = chemical-specific
CFd (kg-cm^2)/(mg-m^2) = 0.01
SA m^2/day adult = 0.350
teen = 0.740
current child = 0
future child = 0.373
AF mg/cm^2 = 1.0E+00
ABS unitless = chemical-specific
EF = day/yr adult = 104
teen = 140
current child = 10
future child = 140
ED year adult = 22
teen = 12
current child = 1
future child = 6

Attachment D2.4. Summary of Recreational Chemical Daily Intake Calculations and Exposure Parameters for Sediment

BW kg	adult =	70
	teen =	43
	current child =	14.5
	future child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult=	8030
	teen=	4380
	current child =	365
	future child =	2190

Sediment - Inhalation of Particulates

$$\text{Absorbed Dose mg/kg*day} = \frac{\text{Csed} * \text{EF} * \text{ED} * \text{ET} * (1/\text{PEF}) * \text{IRair}}{\text{BW} * \text{AT}}$$

Radionuclide Intake (pCi) = Ased * EF * ED * ET * CF * (1/PEF) * IRair

Where:

	Csed mg/kg =	chemical-specific
	Ased pCi/g =	chemical-specific
EF = day/yr	adult =	104
	teen =	140
	current child =	10
	future child =	140
ED year	adult =	22
	teen =	12
	current child =	1
	future child =	6
ET hr/day =	adult =	5
	teen =	5
	current child =	4
	future child =	5
	CF kg/mg =	1.0E+03
	PEF m^3/kg =	3.2E+10
	IRair m^3/hr =	2.5
BW kg	adult =	70
	teen =	43
	current child =	14.5
	future child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult=	8030
	teen=	4380
	current child =	365
	future child =	2190

Sediment - External Exposure

Absorbed dose ((pCi * year)/g) = Ased * EF * ED * (1-Se) * Te

Where:

	Ased pCi/g =	chemical-specific
EF = day/yr	adult =	2.85.E-01
	teen =	3.84.E-01
	current child =	2.74.E-02
	child =	3.84.E-01
ED year	adult =	22
	teen =	12
	current child =	1
	child =	6
	Se unitless =	0.2
	Te hr/hr =	2.08E-01

Attachment D2.5. Summary of Recreational Chemical Daily Intake Calculations and Exposure Parameters for Surface Water

Dermal Contact

$$\text{Chemical Intake mg/kg*day} = \frac{C_{sw} * SA * P_c * CF * ED * EF * ET}{BW * AT}$$

Where:

	C_{sw} mg/L =	chemical-specific
SA m^2	adult =	0.930
	teen =	0.740
	current child =	0.373
	future child =	0.373
	P_c cm/hr=	chemical-specific
	CF L/(cm-m^2) =	10
ED year	adult =	22
	teen =	12
	current child =	1
	future child =	6
EF day/yr	adult =	52
	teen =	140
	current child =	10
	future child =	140
ET hr/day	adult =	2.6
	teen =	2.6
	current child =	4.0
	future child =	2.6
BW kg	adult =	70
	teen =	43
	current child =	14.5
	future child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult =	8030
	teen =	4380
	current child =	365
	future child =	2190

Attachment D2.6. Summary of Recreational Chemical Daily Intake Calculations and Exposure Parameters for Game

Deer - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{\text{Cdeer * EF * ED * IRd * FId}}{\text{BW * AT}}$$

Radionuclide Intake (pCi) = Adeer * FId * EF * ED * CF * IRd

Where:

	Cdeer mg/kg =	chemical-specific
	Adeer pCi/g =	chemical-specific
	CF g/kg =	1000
	FId unitless =	1
	EF = day/yr	350
ED year	adult =	22
	teen =	12
	child =	6
IRd kg/day	adult =	0.032
	teen =	0.032
	child =	0.007
BW kg	adult =	70
	teen =	43
	child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult =	8030
	teen =	4380
	child =	2190

Quail - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{\text{Cquail * EF * ED * IRq * FIq}}{\text{BW * AT}}$$

Radionuclide Intake (pCi) = Aquail * FIq * EF * ED * CF * IRq

	Cquail mg/kg =	chemical-specific
	Aquail pCi/g =	chemical-specific
	CF g/kg =	1000
	FIq unitless =	1
	EF = meals/yr	350
ED year	adult =	22
	teen =	12
	child =	6
IRq kg/meal	adult =	0.0047
	teen =	0.0024
	child =	0.00094
BW kg	adult =	70
	teen =	43
	child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult =	8030
	teen =	4380
	child =	2190

Rabbit - Ingestion

$$\text{Chemical Intake mg/kg*day} = \frac{\text{Crabbit * EF * ED * IRr * FIr}}{\text{BW * AT}}$$

Radionuclide Intake (pCi) = Arabbit * FIr * EF * ED * CF * IRr

Where:

	Crabbit mg/kg =	chemical-specific
	Arabbit pCi/g =	chemical-specific
	CF g/kg =	1000
	FIr unitless =	1
	EF = meals/yr	350
ED year	adult =	22
	teen =	12
	child =	6
IRr kg/meal	adult =	0.0165
	teen =	0.0082
	child =	0.0033
BW kg	adult =	70
	teen =	43
	child =	14.5
AT yr*day/yr	cancer =	25550
noncancer	adult =	8030
	teen =	4380
	child =	2190

Attachment D2.7. Summary of Calculations and Exposure Parameters for Estimating Chemical Concetrations and Activities in Game

Deer

Chemical concentration in deer, C_{deer} (mg/kg or pCi/g)= $F_{deer} * [(C_{forage} * AC * f_s * Q_f) + (C_s * AC * Q_s) + (C_{sw} * CF_{rad} * Q_{sw})]$

Chemical concentration in forage, C_{forage} (mg/kg or pCi/g)= $(C_s * R_{upp}) + (C_s * R_{es})$

Where:

C_{deer} mg/kg or pCi/g= chemical-specific
F_{deer} day/kg = chemical-specific
C_{forage} mg/kg or pCi/g = chemical-specific
AC unitless= AS/AD
AS acres= SWMU-specific
AD acres= 494
f_s unitless= 1.0
Q_f kg/day= 1.74
C_s mg/kg or pCi/g= chemical-specific
Q_s kg/day= 0.034
C_{sw} mg/L or pCi/L= chemical-specific
CF_{rad} kg/g= 10^-3
Q_{sw} L/day= 3.61
R_{upp} unitless= chemical-specific or $38*K_{ow}^{-0.58}$
R_{es} unitless= 0.25

Quail

Chemical concentration in quail, C_{quail} (mg/kg or pCi/g)= $F_{quail} * [(C_{forage} * AC * f_s * Q_f) + (C_s * AC * Q_s) + (C_{sw} * CF_{rad} * Q_{sw}) + (C_i + AC + Q_i)]$

Chemical concentration in forage, C_{forage} (mg/kg or pCi/g)= $(C_s * R_{upp}) + (C_s * R_{es})$

Chemical concentration in invertebrates, Ci= $(C_s * BAF_i)$

Where:

C_{quail} mg/kg or pCi/g= chemical-specific
F_{quail} day/kg = chemical-specific
C_{forage} mg/kg or pCi/g = chemical-specific
AC unitless= AS/AQ
AS acres= SWMU-specific
AQ acres= 15.4
f_s unitless= 1.0
Q_f kg/day= 0.01499
C_i mg/kg or pCi/g= chemical-specific
Q_i kg/day= 0.002006
C_s mg/kg or pCi/g= chemical-specific
Q_s kg/day= 0.00158
C_{sw} mg/L or pCi/L= chemical-specific
CF_{rad} kg/g= 10^-3
Q_{sw} L/day= 0.024
R_{upp} unitless= chemical-specific or $38*K_{ow}^{-0.58}$
R_{es} unitless= 0.25

Rabbit

Chemical concentration in rabbit, C_{rabbit} (mg/kg or pCi/g)= $F_{rabbit} * [(C_{forage} * AC * f_s * Q_f) + (C_s * AC * Q_s) + (C_{sw} * CF_{rad} * Q_{sw})]$

Chemical concentration in forage, C_{forage} (mg/kg or pCi/g)= $(C_s * R_{upp}) + (C_s * R_{es})$

Where:

C_{rabbit} mg/kg or pCi/g= chemical-specific
F_{rabbit} day/kg = chemical-specific
C_{forage} mg/kg or pCi/g = chemical-specific
AC unitless= AS/AR
AS acres= SWMU-specific
AR acres= 3.6
f_s unitless= 1.0
Q_f kg/day= 0.237
C_s mg/kg or pCi/g= chemical-specific
Q_s kg/day= 0.0149
C_{sw} mg/L or pCi/L= chemical-specific
CF_{rad} kg/g= 10^-3
Q_{sw} L/day= 0.116
R_{upp} unitless= chemical-specific or $38*K_{ow}^{-0.58}$
R_{es} unitless= 0.25

Attachment D2.8. Acronym List for Tables D2.1 Through D2.7

Acronym	Definition
ABS	absorption factor
AC	area of contact
AD	area of deer range
Adeer	radiological activity in venison
AF	adherence factor
AQ	area of quail range
Aquail	radiological activity in quail
AR	area of rabbit range
Arabbit	radiological activity in rabbit
As	activity in soil
AS	area of SWMU
Ased	activity in sediment
AT	averaging time
BW	body weight
Cdeer	chemical concentration in deer
CF	conversion factor
CF2	conversion factor (#2)
CFd	conversion factor - dermal
Cforage	chemical concentration in forage
CFrad	conversion factor
Ci	chemical concentration in invertebrates
Cquail	chemical concentration in quail
Crabbit	chemical concentration in rabbit
Cs	concentration in soil
Csed	concentration in sediment
Csw	concentration in surface water
ED	exposure duration
EF	exposure frequency
ET	exposure time
Fdeer	forage-deer transfer factor
FI	fraction ingested
FId	diet fraction
FIq	diet fraction
FIr	diet fraction
Fquail	forage-quail transfer factor
Frabbit	forage-rabbit transfer factor
fs	fraction of deer/quail/rabbit's food from when on site
IR	ingestion rate
IRair	total inhalation rate
IRd	ingestion rate
IRq	ingestion rate

IRr	ingestion rate
Pc	permeability constant
PEF	particulate emission factor
Qf	quantity of forage ingested daily by deer/quail/rabbit
Qi	quantity of invertebrates ingested daily by quail
Qs	quantity of soil ingested daily by deer/quail/rabbit
Qsw	quantity of surface water ingested daily by deer/quail/rabbit
Res	soil resuspension multiplier
Rupp	soil to plant uptake (dry)
SA	surface area
Se	gamma shielding factor
Te	gamma exposure time factor

ATTACHMENTS

D3, ProUCL OUTPUT,
D4, CHEMICAL DAILY INTAKE CALCULATIONS,
AND
D5, RISK CALCULATIONS

CD:

APPENDIX D, ATTACHMENT D3, ProUCL OUTPUT

APPENDIX D, ATTACHMENT D4, CHEMICAL DAILY INTAKE CALCULATIONS, AND

APPENDIX D, D5, RISK CALCULATIONS

APPENDIX E

SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
(STEPS 1 AND 2)

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CONTENTS

FIGURES

TABLES

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ACRONYMS

ASER	Annual Site Environmental Report
BAF	bioaccumulation factor
BAP	benzo(a)pyrene
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
BSAF	biota-sediment accumulation factor
CCME	Canadian Council of Ministers of the Environment
CDM	CDM Federal Services Inc.
CFR	*Code of Federal Regulations*
COPC	chemical of potential concern
CSM	conceptual site model
D&D	decontamination and decommissioning
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERAWP	Ecological Risk Assessment Working Group
ESV	ecological screening value
EU	exposure unit
HQ	hazard quotient
K_d	partitioning coefficient
KDEP	Kentucky Department for Environmental Protection
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
LOAEL	lowest observed adverse effect level
mgd	million gallons per day
NCRP	National Council on Radiation Protection
NFA	No Further Action
NOAEL	no observed adverse effect level
NSDD	North-South Diversion Ditch
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen-ion concentration notation
RCRA	Resource Conservation and Recovery Act
SAP	sampling and analysis plan
SERA	screening-level ecological risk assessment
SI	site investigation
SMDP	scientific/management decision point

SVOA	semivolatile organic analyte
SWMU	solid waste management unit
SWOU	surface water operable unit
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TEC	threshold effects concentration
TEF	toxicity equivalence factor
TEL	threshold effect level
TEQ	toxicity equivalent
TOC	total organic carbon
TRV	toxicity reference value
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
USEC	United States Enrichment Corporation
VOA	volatile organic analyte
WAG	Waste Area Grouping
WHO	World Health Organization
WKWMA	West Kentucky Wildlife Management Area

E.1. INTRODUCTION

This section presents the results of a screening-level ecological risk assessment (SERA) for the surface water operable unit (SWOU) at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky. The overall purpose of this SERA is to investigate the nature and extent of site-related contamination and to begin to address site-related ecological risks.

This report was prepared in accordance with the U.S. Department of Energy's (DOE's) eight-step process presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1506/V2&D2, (DOE 2001) and with the U.S. Environmental Protection Agency's (EPA's) *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS) (EPA 1997). Because this is a screening-level assessment, conservative assumptions are used at this stage of the ecological risk assessment (ERA) process to evaluate the potential for local ecological receptors to be adversely affected by exposure to site-related contaminants.

The objective of this SERA is to identify qualitatively and quantitatively, where appropriate, the potential current and future environmental risks associated with the site that would exist if no further remedial action is taken. Specifically, the DOE guidance states that, "The purpose of the screening-level risk assessment is to evaluate whether existing data justify a decision that site contaminants do not pose a risk to ecological receptors, or whether additional evaluation is necessary" (DOE 2001). Per guidance, conservative assumptions were used in this SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks.

As presented in the Methods Document (DOE 2001), Steps 1 and 2 of the ERA process at PGDP constitute a SERA. Step 1 includes the Problem Formulation and Effects Evaluation, while Step 2 contains an Exposure Estimate and Risk Calculations.

The four steps utilized to assess site-related ecological risks for a reasonable maximum exposure scenario are described below:

- Problem Formulation—The planning stage of the SERA includes a qualitative evaluation of contaminant release, migration, and fate; identification of receptors, exposure pathways, and known ecological effects of the contaminants; and selection of endpoints for further study in order to develop a preliminary conceptual site model (CSM).

- Ecological Effects Evaluation—Conduct literature reviews, field studies, and toxicity tests that link contaminant concentrations to effects on ecological receptors; description of No Further Action (NFA) values and applicable screening values.

- Exposure Assessment—Complete a quantitative evaluation of contaminant release, migration, and fate; characterization of exposure pathways and receptors; and measurement or estimation of exposure point concentrations.

- Risk Calculation—Measure or estimate both current and future potential for adverse effects.

E.1.1 SITE LOCATION

PGDP is an active uranium enrichment facility located in Paducah, Kentucky, that is owned by DOE. The Paducah site is located in a generally rural area of McCracken County, Kentucky. PGDP is about ten miles west of Paducah, Kentucky, and three miles south of the Ohio River. The industrial portion of PGDP is situated within a fenced security area and constitutes approximately 748 acres. Within this area, designated as secured industrial land use, are numerous active and inactive production buildings, offices, equipment and material storage areas, active and inactive waste management units, and other support facilities. The additional DOE-owned land at the Paducah site is 2,675 acres. Of this land, there is a 689 acre "buffer zone" that surrounds PGDP and is designated as unsecured industrial land. There are no residences on DOE property at the Paducah site. The area surrounding PGDP is primarily rural land with residences and farms in the vicinity of the plant. Adjacent to PGDP is the West Kentucky Wildlife Management Area (WKWMA), which includes 6,817 acres of managed habitat deeded or licensed to the state of Kentucky (Bechtel Jacobs Company LLC [BJC] 2005).

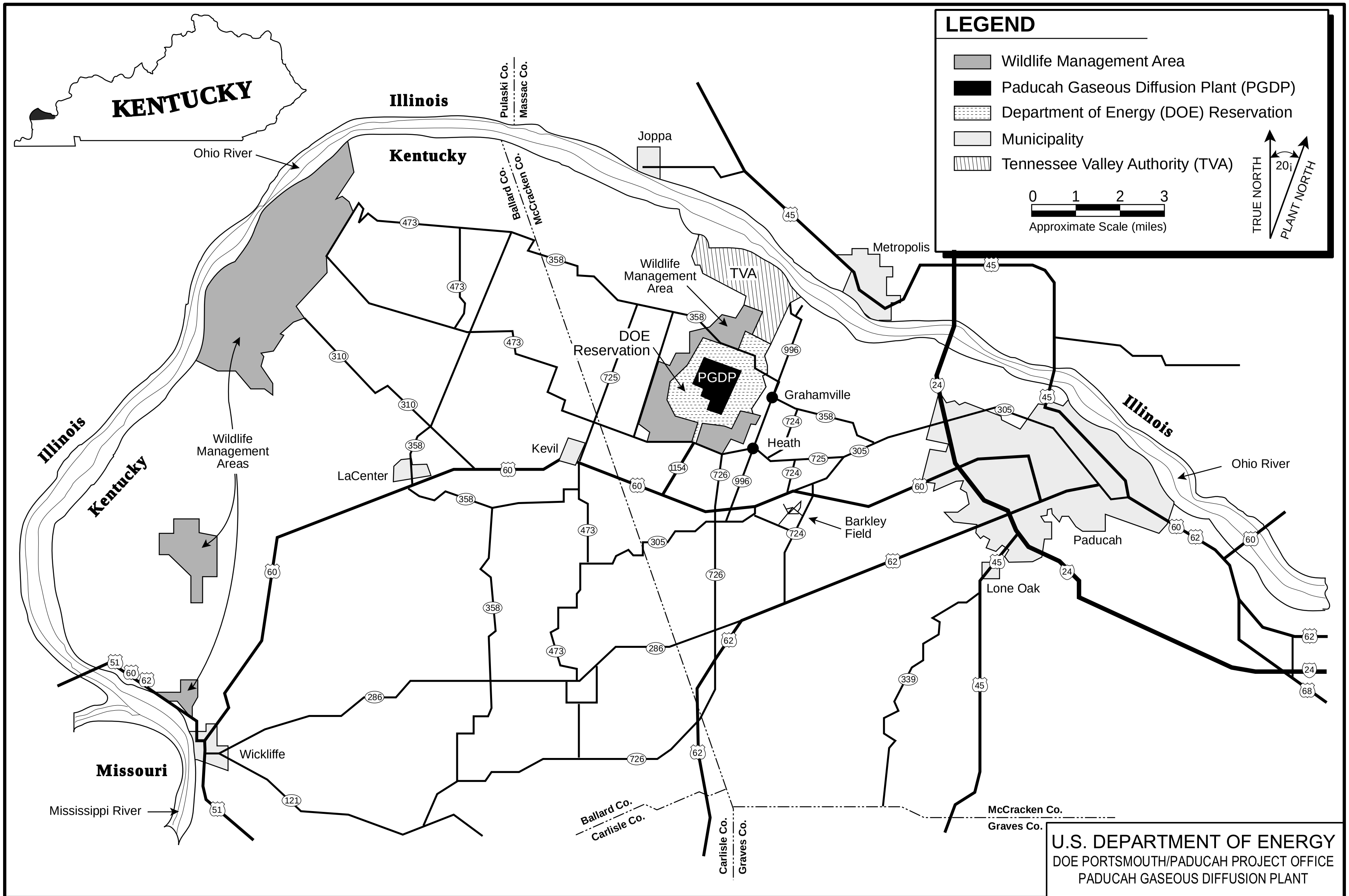
The areas of contamination at PGDP have been organized into six operable units, one of which is the SWOU. The SWOU consists of source units that contain surface water contamination or may contribute to surface water contamination. The portions of the SWOU included in this study are the North-South Diversion Ditch (NSDD) Sections 3, 4, and 5; Outfalls 001, 002, 008, 010, 011, 012, and 015 and their associated internal ditches and areas; and PGDP storm water sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 (DOE 2005). Figures E.1 and E.2 present the PGDP site location and site layout, respectively.

E.1.2 SITE HISTORY

Before World War II, the area now occupied by PGDP was used for agricultural purposes. Numerous small farms produced various grain crops and provided pasture for livestock. Early in the war, a 16,126 acre tract was assembled for construction of the Kentucky Ordnance Works (KOW), which subsequently was operated by the Atlas Powder Company until the end of the war. At that time, it was turned over to the Federal Farm Mortgage Corporation and then to the General Services Administration.

In 1950, the U.S. Department of Defense (DOD) and DOE's predecessor, the Atomic Energy Commission, began efforts to expand fissionable material production capacity. As part of this effort, the National Security Resources Board was instructed to designate power areas within a strategically safe area of the United States. Eight government-owned sites initially were selected as candidate areas, one of which was the KOW site. In October 1950, as a result of joint recommendations from DOD, Department of State, and the Atomic Energy Commission, President Truman directed the Atomic Energy Commission to further expand production of atomic weapons. One of the principal facets of this expansion program was the provision for a new gaseous diffusion plant. On October 18, 1950, the Atomic Energy Commission approved the Paducah site for uranium enrichment operations and formally requested the Department of the Army to transfer the site from the General Services Administration to the Atomic Energy Commission.

Although construction of PGDP was not completed until 1954, production of enriched uranium began in 1952. The plant's mission, uranium enrichment, has continued unchanged, and the original facilities are still in operation, albeit with substantial upgrading and refurbishment. Of the 7,566 acres acquired by the Atomic Energy Commission in 1950, 1,361 acres subsequently were transferred to the



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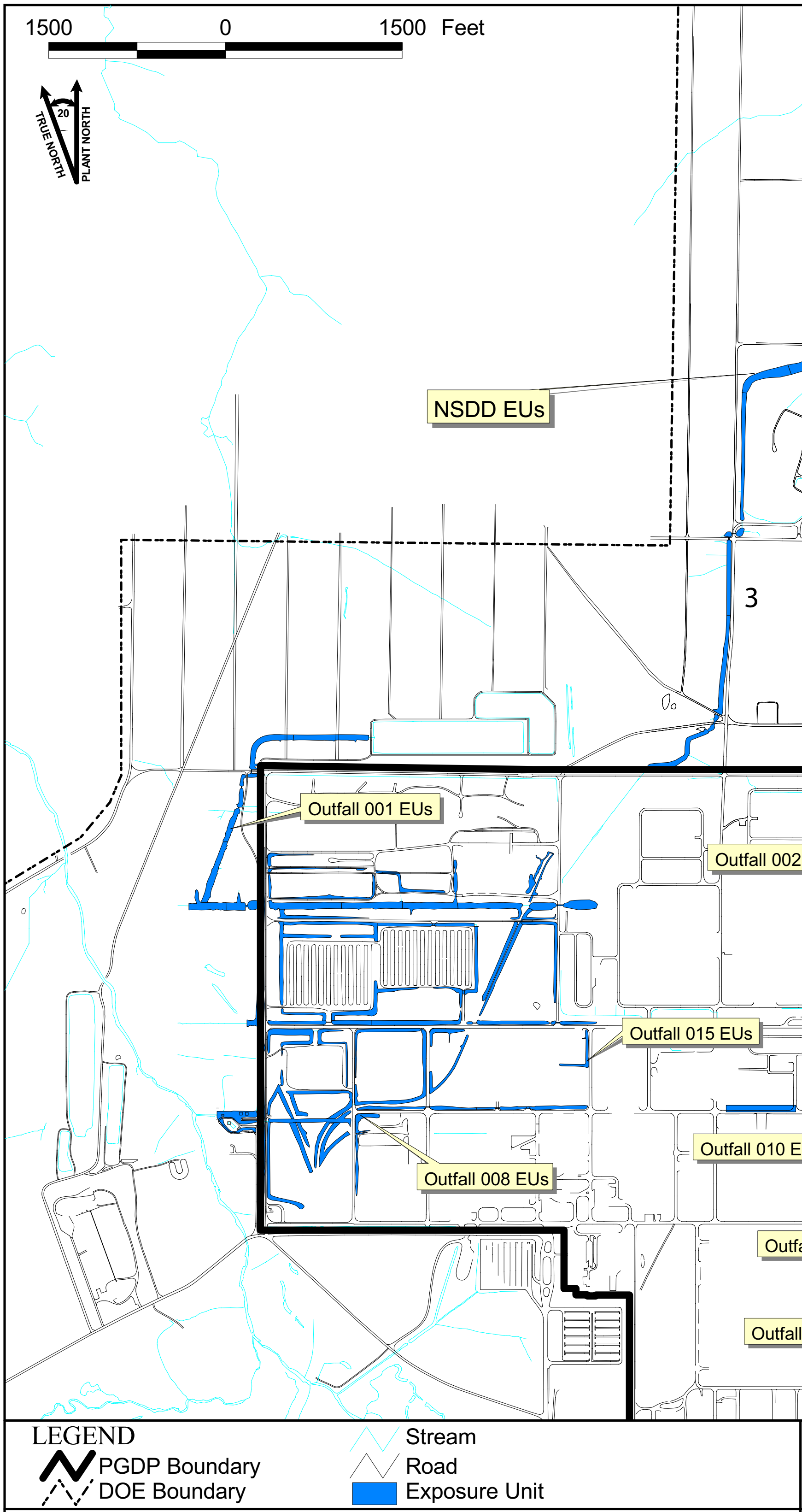
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Fig. E.1. Paducah Gaseous Diffusion Plant site location map.

DOCUMENT No. DOE/LX/07-0001



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PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH
Remediation Services
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Fig. E.2. Site layout.

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DATE 07-31-06

Tennessee Valley Authority (Shawnee Steam Plant site) and 2,781 acres were conveyed to the Commonwealth of Kentucky for wildlife conservation and for recreational purposes (the WKWMA). DOE's current holdings at the Paducah site total 3,423 acres.

At Paducah's uranium enrichment plant, recycled uranium from nuclear reactors was introduced into the PGDP enrichment "cascade" in 1953 and continued through 1964. In 1964, cascade feed material was switched solely to virgin-mined uranium. Use of recycled uranium resumed in 1969 and continued through 1976. In 1976, the practice of recycling uranium feed material from nuclear reactors was halted and never resumed. During the recycling time periods, Paducah received approximately 100,000 tons of recycled uranium containing an estimated 328 g of plutonium-239, 18,400 g of neptunium-237, and 661,000 g of technetium-99. The majority of the plutonium-239 and neptunium-237 was separated out as waste during the initial chemical conversion to uranium hexafluoride (UF_6). Concentrations of transuranics (e.g., plutonium-239 and neptunium-237) and technetium-99 are believed to have been deposited on internal surfaces of process equipment and in waste products.

In October 1992, congressional passage of the National Energy Policy Act established the United States Enrichment Corporation (USEC). Effective July 1, 1993, DOE leased the plant production operation facilities to USEC. Under the terms of the lease, USEC assumed responsibility for environmental compliance activities directly associated with uranium enrichment operations.

Under the lease agreement with USEC, DOE retained responsibility for the site Environmental Restoration Program; the Enrichment Facilities Program; and the Legacy Waste Management Program, including all waste inventories predating July 1, 1993, and wastes generated by subsequent DOE activities. DOE is responsible for Kentucky Pollutant Discharge Elimination System (KPDES) compliance at outfalls not leased to USEC. DOE also has retained manager and co-operator status of facilities not leased to USEC. DOE and USEC have negotiated the lease of specific plant site facilities, written memoranda of agreement to define their respective roles and responsibilities under the lease, and developed organizations and budgets to support their respective functions. DOE is the owner, and Paducah Remediation Services, LLC, together with DOE, operates the Resource Conservation and Recovery Act (RCRA)-permitted facilities and both are responsible for compliance with the RCRA permit (DOE 2004).

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E.2. STEP 1: SCREENING-LEVEL PROBLEM FORMULATION

E.2.1 PRELIMINARY CONCEPTUAL SITE MODEL

Steps 1 and 2 of the ERA process in the Methods Document (DOE 2001) constitute a SERA. Step 1 includes the Problem Formulation and Effects Evaluation. As part of the Problem Formulation, a CSM is developed. Included in the CSM are a description of the environmental setting of the site, the site's immediate surroundings, and site contaminants. Fate and transport mechanisms by which site contaminants migrate off-site and ways in which site contaminants likely may affect receptors also are included in the CSM. Each of these aspects of the CSM is described in detail below and illustrated on Figure E.3.

E.2.1.1 Site Reconnaissance Observations

In 2003, an Annual Site Environmental Report (ASER) documented current site conditions and environmental management activities that occurred that calendar year (DOE 2004). Vegetative communities and wildlife species present at the PGDP site were described. Additionally, the presence of critical habitat in the vicinity of the PGDP site for threatened or endangered species was discussed. Information obtained from the ASER regarding vegetation and wildlife communities is summarized in Sections 2.1.3 and 2.5.1–2.5.3.

In March 2005, a site walkover was conducted to view the outfalls and storm sewers that are part of site drainage included in the SWOU at PGDP. As part of that site visit, a photo log was created and is included in Attachment E1.

E.2.1.2 Existing Data

Areas of contamination at PGDP were divided into six operable units for evaluation of remedial actions, including the SWOU. The SWOU includes source areas within PGDP that contain or contribute to surface water contamination. More than 3000 samples were collected from the SWOU during historical sampling events and activities related to the SI. Soil and sediment samples were collected from NSDD Sections 3, 4, 5; Outfalls 001, 002, 008, 010, 012, and 015 and their associated internal ditches and areas; and water discharging from storm sewers C-333-A, C-337-A, C-340, C-535, and C-537 to evaluate the nature and extent of contamination to the SWOU related to historical and current site activities. Contaminants present in one or more media within the SWOU include metals, polychlorinated biphenyls (PCBs), radionuclides, semivolatile organic analytes (SVOAs), volatile organic analytes (VOAs), dioxins, and furans. A detailed discussion of site-related contaminants present in SWOU surface soil, sediment, and surface water is presented in Section 4 of the site investigation (SI) report.

E.2.1.3 Site Environmental Setting and Habitat Descriptions

PGDP is situated between Bayou Creek to the west and Little Bayou Creek to the east. The confluence of these two water bodies is a marsh approximately three miles to the north of PGDP. The discharge ultimately reaches the Ohio River. The primary source of flow in the two creeks is PGDP effluent (BJC 2000). The area surrounding PGDP is primarily rural lands, with residences and farms surrounding the plant. Immediately adjacent to the PGDP site is the WKWMA (BJC 2005).

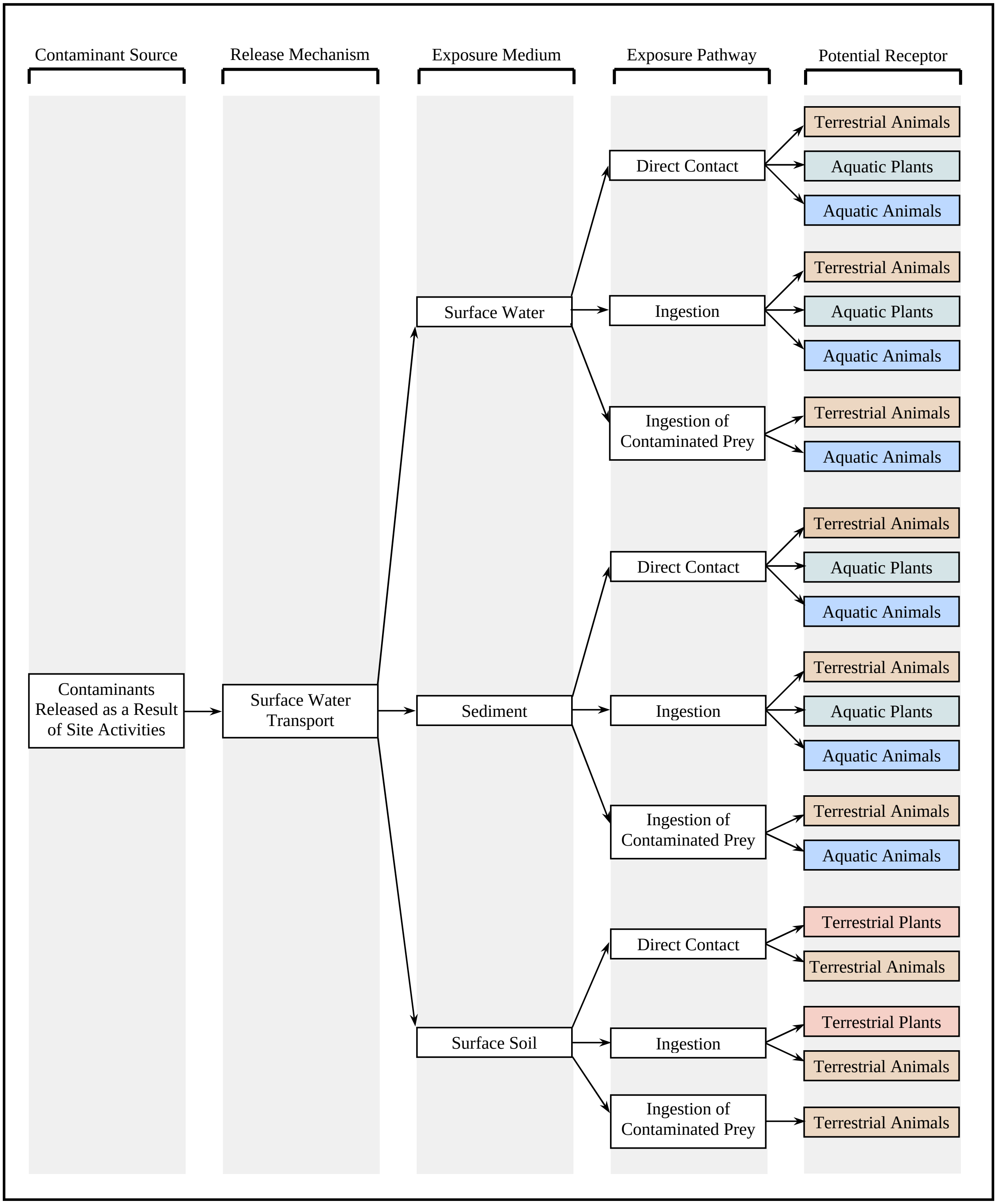

Figure E.3. Conceptual site model.

Aquatic communities

PGDP is situated in the western part of the Ohio River basin. The confluence of the Ohio River with the Tennessee River is approximately 15 miles upstream of the site, and the confluence of the Ohio River with the Mississippi River is approximately 35 miles downstream. The plant is located on a local drainage divide with surface water flow from the plant to the east and northeast toward Little Bayou Creek and to the west and northwest toward Bayou Creek.

Bayou Creek is a perennial stream that flows toward the Ohio River along a nine mile course. Little Bayou Creek is an intermittent stream that flows north toward the Ohio River along a seven mile course. The two creeks converge three miles north of the plant before emptying into the Ohio River and are depicted on Figure E.4.

Flooding in the area is associated with Bayou Creek, Little Bayou Creek, and the Ohio River. Maps of the calculated 100-year flood elevations show that all three drainage systems have 100-year floodplains located within the DOE boundary at PGDP. These 100-year floodplains range from approximately 340 to 380 ft above mean sea level. Plant elevations range from about 370 to 385 ft above mean sea level (DOE 2004).

Terrestrial communities

As described in the ASER (DOE 2004), much of the Paducah site has been impacted by human activity. Vegetation communities on the property are indicative of old field succession (e.g., grassy fields, field scrub-shrub, and upland mixed hardwoods). The open grassland areas, most of which are managed by WKWMA personnel, are periodically mowed or burned to maintain early successional vegetation, which is dominated by members of the compositae family and various grasses. Management practices on the WKWMA encourage reestablishment of once common native grasses such as eastern gamma grass and Indian grass. Other species commonly cultivated for wildlife forage are corn, millet, milo, and soybean.

Field scrub-shrub communities consist of sun-tolerant wooded species such as persimmon, maples, black locust, sumac, and oaks. The undergrowth may vary depending on the location of the woodlands. Wooded areas near maintained grasslands may have an undergrowth dominated by grasses. Other communities may contain a thick undergrowth of shrubs, including sumac, pokeweed, honeysuckle, blackberry, and grape.

Upland mixed hardwoods contain a variety of upland and transitional species. Dominant species include oaks, shagbark and shellbark hickory, and sugarberry. Undergrowth may vary from open, with limited vegetation for more mature stands of trees, to dense undergrowth similar to that described for a scrub-shrub community.

More than 1100 separate wetlands, totaling over 1,600 acres, were found in and around the Paducah site. These wetlands have been classified into 16 cover types. More than 60% of the total wetland area is forested.

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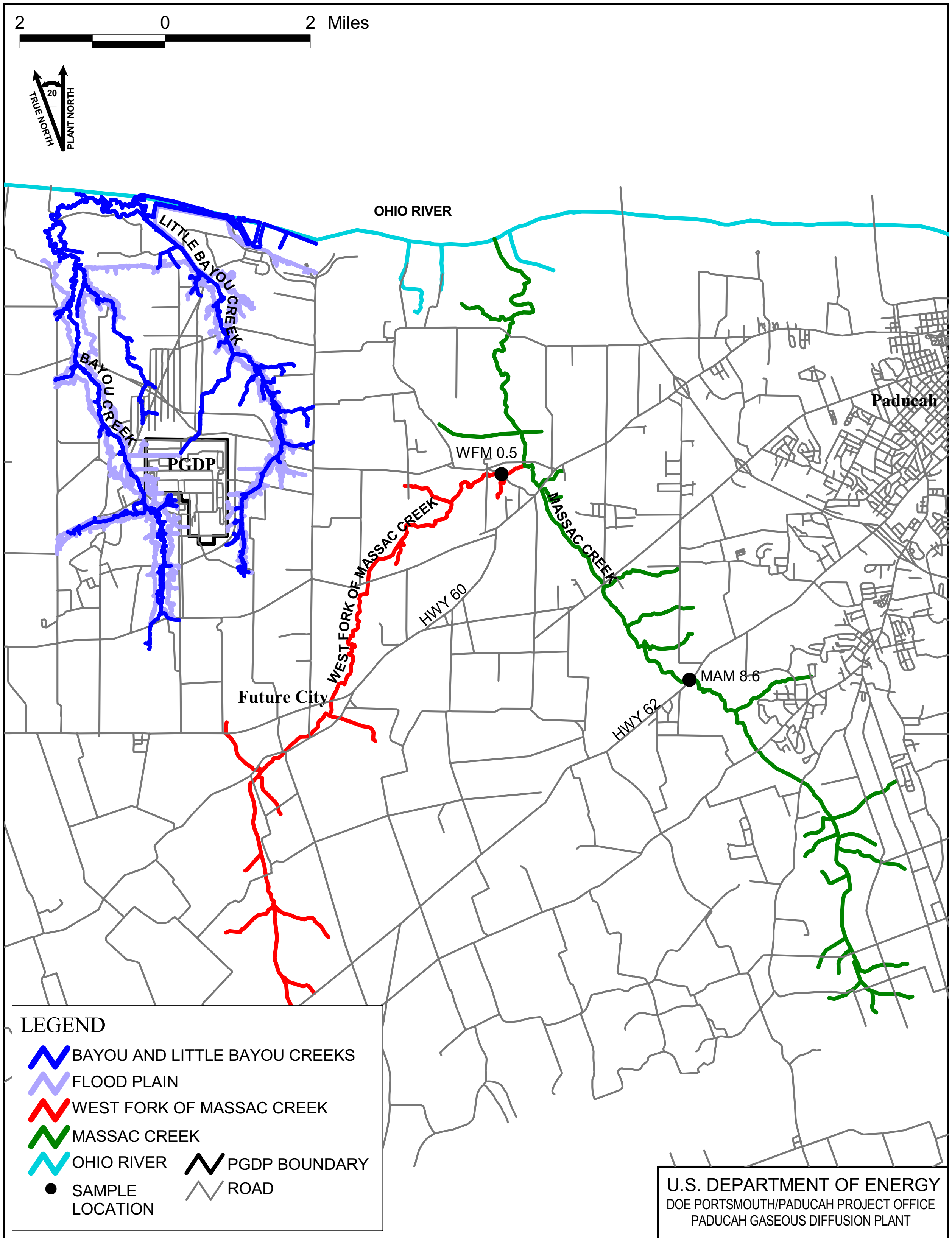

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Fig. E.4. Bayou Creek and Little Bayou Creek stream flow.

Figure No. C5AC90005sk006.apr
DATE 07-31-06

E.2.1.4 Near-Site Environmental Setting

NSDD Sections 3, 4, and 5

As described in the *Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* (DOE 2005), the entire NSDD is located on property owned by DOE. For the purposes of response actions at PGDP, the NSDD has been divided into sections that are numbered south to north. Sections 1 and 2 [solid waste management unit (SWMU) 59] are within the plant security-fenced area; Sections 3, 4, and 5 (SWMU 58) are outside the security-fenced area. The NSDD originates within the north–central portion of PGDP and discharges into Little Bayou Creek to the north of the plant. Little Bayou Creek originates within the WKWMA, south of PGDP, and flows northward to the Ohio River. Little Bayou Creek is intermittent in its upper reaches, becoming perennial downgradient of its confluence with Outfall 010, with a continuous flow outfall from PGDP. The confluence of Little Bayou Creek and Outfall 010 is upstream of the NSDD's confluence with Little Bayou Creek.

The portion of the NSDD within the security-fenced area (SWMU 59), which includes Sections 1 and 2, is approximately 2,600 ft long. This portion of the ditch varies in width from approximately 8 to 10 ft, and the depth ranges from approximately 0.5 to 5 ft. Inside the plant security fence, the ditch flows from Virginia Avenue north, beyond the C-616-C Lift Station, to the plant fence. Remediation of Sections 1 and 2, including excavation of soils to a depth of 4 ft below ground surface (bgs), was completed in 2004; therefore, this area was not evaluated in this SERA.

The portion of the NSDD outside the security-fenced area (SWMU 58), which includes Sections 3, 4, and 5, is approximately 8,400 ft long. This portion of the ditch varies in width from approximately 15 to 36 ft, and the depth ranges from approximately 5 to 15 ft. The banks of the NSDD outside of the security-fenced area generally are vegetated with grasses and brush, and trees line some sections of the bank. Approximately 3,000 ft of the NSDD (i.e., the portion nearest to Little Bayou Creek) fall within the 500-year floodplain of the Ohio River, and some portions of this segment fall within the 100-year floodplain of the Ohio River. Section 5 of the NSDD, downstream of the C-746-U Landfill access road, is a natural, relatively unmodified stream channel. Stream flow in this channel is intermittent in the southernmost reaches, but becomes perennial as it approaches Little Bayou Creek. Upstream of the C-746-U Landfill access road, the NSDD is channeled and bordered by mown grasses (Section 4), except for a short wooded segment immediately downstream of the security fence (Section 3). The NSDD outside of the security-fenced area is posted for radiological contamination (pursuant to 10 CFR 835 [*Code of Federal Regulations*] requirements)

Historically, the NSDD received wastewater from the C-400 Cleaning Building, coal pile runoff, and storm water. The primary functions of the C-400 Cleaning Building included cleaning, metal plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and uranium tetrafluoride (green salt) pulverization. Sources of storm water runoff to the ditch included a steam plant (C-600), process buildings (C-335 and C-337), a cooling tower (C-635), electrical switchyards (C-535 and C-537), a neutralizing pit (C-403), and a feed plant (C-410). As a consequence, the soil and sediment in the ditch have been contaminated. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed nearly filled the southern portion of Section 1 of the NSDD. This caused runoff from heavy rainfall events to overflow the ditch, primarily near 10th Street. In order to restore adequate flow, sediments periodically were dredged from the NSDD, and the spoils were placed near the banks of the ditch.

In 2003 and 2004, the remediation of Sections 1 and 2 of the NSDD was accomplished by the excavation and disposal of all soil in those sections of the ditch to a depth of 4 ft bgs and the excavated area was restored to grade with clay and/or soil. The distal end of Section 2 was plugged to prevent further discharge of any type of flow to downstream portions of the NSDD ditch. A surge basin was constructed surrounding the C-616-C Lift Station and all flow from Sections 1 and 2 of the NSDD, including effluent of the C-335 and C-337 Process Buildings and the C-535 and C-537 Switchyards that is transferred into the NSDD by the C-616-H Lift Station (Ditch 001 Lift Station), now is transmitted to the C-616-F Full Flow Lagoon (Figure E.5) for settlement of suspended solids prior to discharge through the KPDES.

Outfall 001

Outfall 001 has the largest watershed at PGDP and receives drainage from an area of about 203 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 001 drains the northwestern part of the plant and is approximately 20,420 ft in length, approximately 0.5 to 12 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951 and discharges directly to Bayou Creek. The reported monthly average flow through Outfall 001 into Bayou Creek is 2.79 million gallons per day (mgd). Outfall 001 became the responsibility of DOE under the KPDES permit in 1997.

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); 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); and the C-600 Steam Plant and Supporting Facilities. Runoff from the C-400, C-410, C-415, C-535, C-537, and settling pond areas drains to the NSDD Detention Basin, 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. Historically, Outfall 001 also has received runoff from scrap metal storage yards located in the northwestern portion (approximately 50.5 acres) of the Outfall 001 watershed. On August 28, 1995, a groundwater pump-and-treat system went on line near Outfall 001 and runs continuously. Groundwater is pumped from four groundwater extraction wells, which are part of the Northwest Plume groundwater system, and is treated for trichloroethene (TCE) and technetium-99. Approximately 200 gal/min are extracted and treated. The treated groundwater then is discharged to Outfall 001 at an approximate rate of 200 gal/min. In 2002, a sediment basin was constructed to collect storm water discharge from the scrap metal storage yards. This storm water is discharged to Outfall 001 following analysis of and, if necessary, treatment for hydrogen-ion concentration (pH) and total suspended solids (DOE 2005).

Outfall 002

Outfall 002 receives drainage from an area of approximately 55 acres, which includes the internal plant ditches that drain to it. The internal plant ditch system to Outfall 002 drains the northeastern part of the plant and is approximately 3,150 ft in length, approximately 2 to 3 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. Flow through Outfall 002 is transferred by lift station to the C-617-B Treatment Lagoon (Figure E.6) and is treated for residual chlorine, pH, and excess temperature. The effluent then is discharged to the Outfall 010 ditch through Outfall 010 downstream of the lift station and the C-337-A catch basin to Little Bayou Creek. In the event that a rainfall event exceeds the capacity of the lift station pumps, Outfall 002 may emit some flow directly to Little Bayou Creek. During these overflow events, USEC is required to measure and sample the flow. An average of these measurements during 2000 and 2001 indicates that Outfall 002 averages a discharge of 1.43 mgd during overflow events.

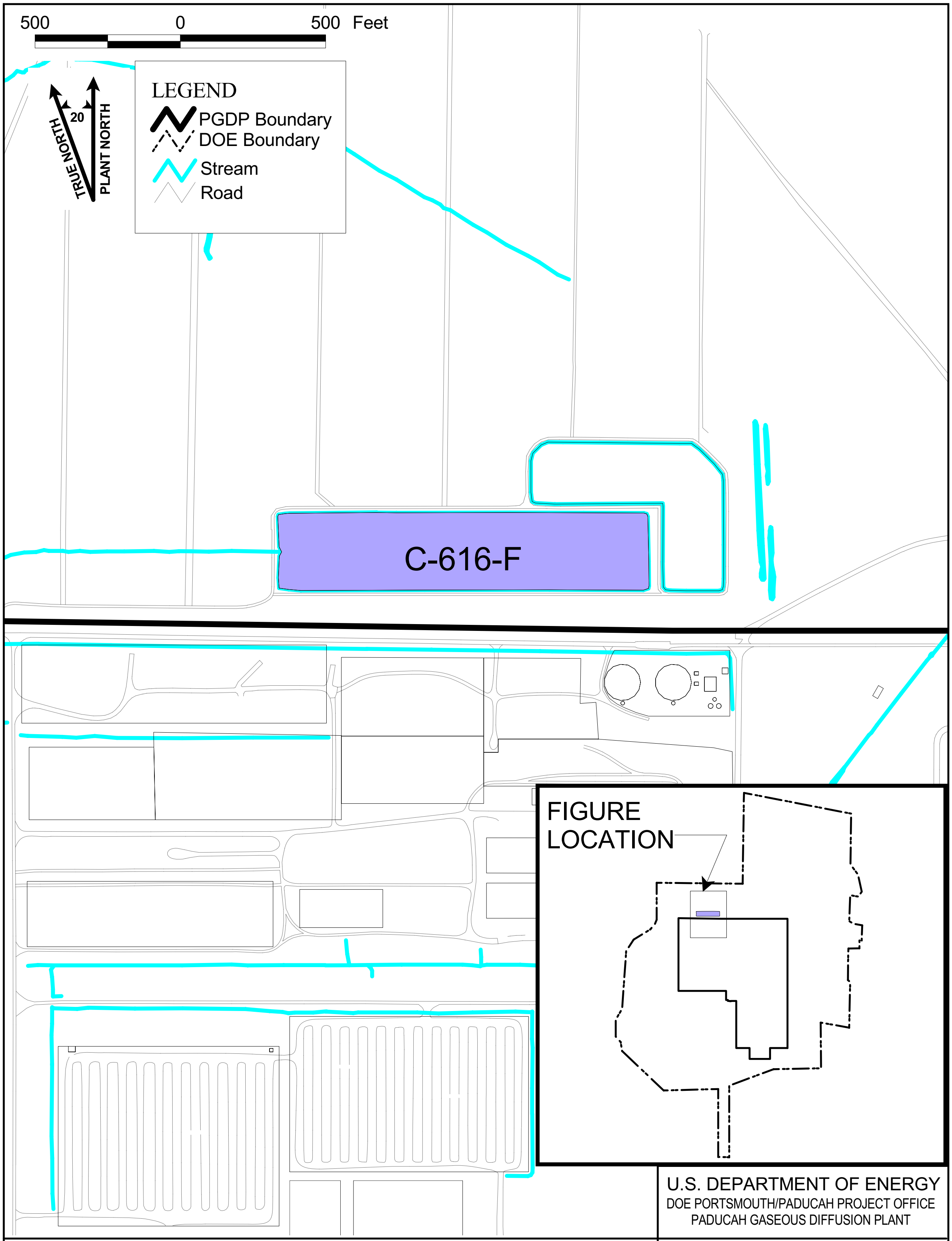

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Fig. E.5. C-616-F Full Flow Lagoon.

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Figure No. swourimaps-E.apr
DATE 07-31-06

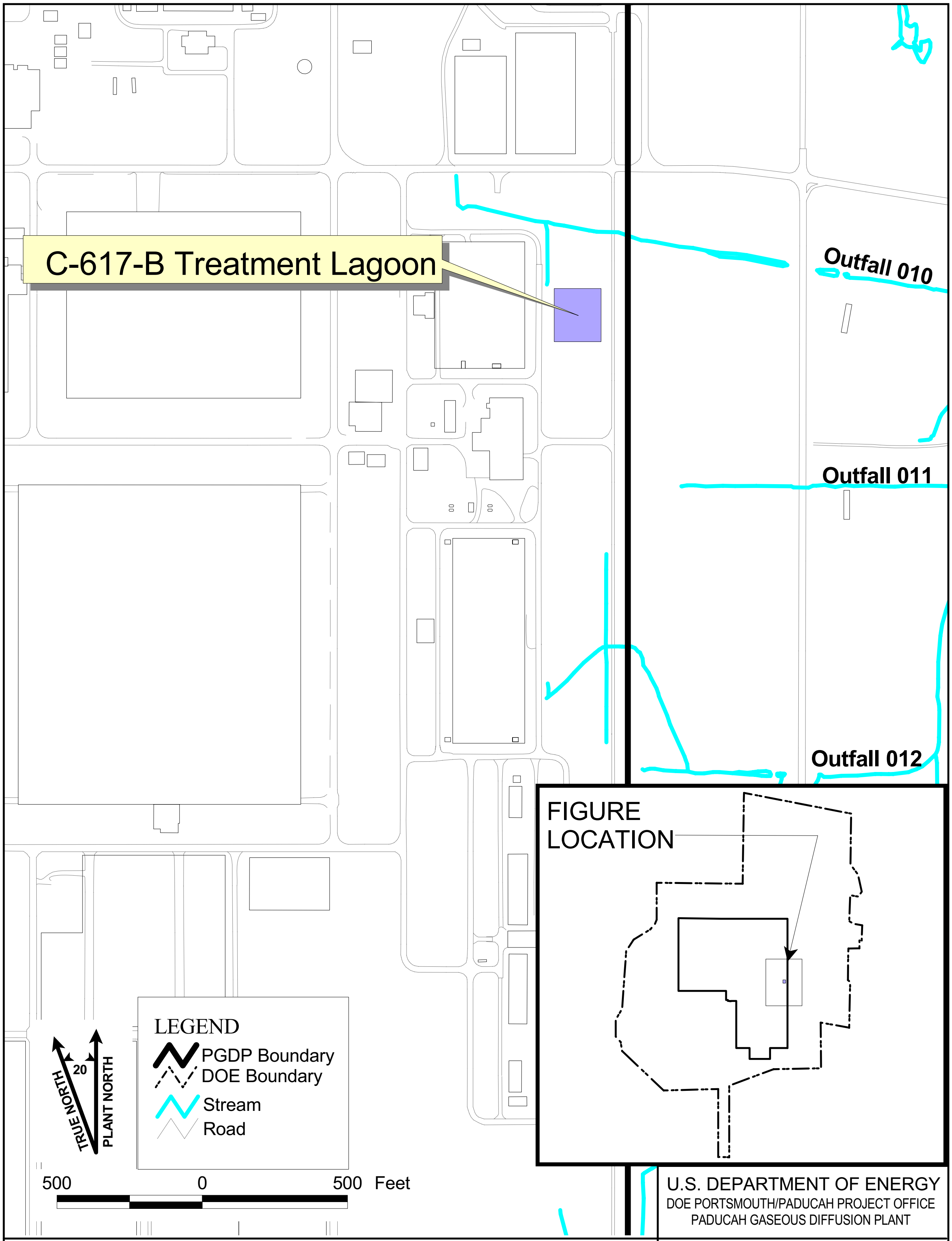

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Fig. E.6. C-617-B Treatment Lagoon.

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Releases from the internal plant ditches to Outfall 002 are characterized by historical information about the facilities that drain into the ditches and by samples associated with them. Facilities that drain into Outfall 002 include the C-360 Toll Transfer and Sampling Building; the C-637 Buildings (i.e., C-637-1, -2A, -2B, -3, -4, -5, and -6); and the southeastern portion of C-337. The C-637 buildings and the southeastern portion of the C-337 Building drain to Outfall 002 via the storm sewer system; therefore, they will not contaminate the internal plant ditches to Outfall 002. The C-360 Toll Transfer and Sampling Building, however, discharges to Outfall 002 via internal plant ditches. Contamination from the C-360 building may have been carried via surface water and sediment to Outfall 002 (DOE 2005).

Outfall 008

Outfall 008 receives drainage from an area of approximately 90.4 acres, which includes the internal plant ditches that drain to it. The internal plant ditch system to Outfall 008 drains the southwestern part of the plant and is approximately 12,215 ft in length, ranges from approximately 0.5 to 4 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow through Outfall 008 is 1.22 mgd. The KPDES permit for Outfall 008 is maintained by the USEC.

Outfall 008 receives multiple waste streams from the southwest corner of the plant and discharges directly to Bayou Creek. These sources include storm water runoff from the surrounding area and flow from the Waste Water Treatment Plant that discharge 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; and the C-747 Burial Yard. Because these waste streams 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.

Outfall 010

Outfall 010 is located on the east side of PGDP and receives drainage from an area of approximately 22 acres, including the internal plant ditches that drain into it. The internal plant ditch system to Outfall 010 drains the eastern part of PGDP and is approximately 7,400 ft in length, approximately 2 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow is 0.56 mgd. Outfall 010 is equipped with a containment dam that can be used, if necessary, during releases.

Facilities draining into the Outfall 010 drainage area include 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 may have been carried via surface water and sediments to Outfall 010 (DOE 2005). Flow from Outfall 010 is transferred to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. From this mixing chamber, the wastewater typically is discharged to the Outfall 010 ditch through Outfall 010 downstream of the lift station and eventually discharges to Little Bayou Creek.

Outfall 011

Outfall 011 is located on the east side of PGDP and receives drainage from an area of approximately 31 acres, including the area of the internal plant effluent ditches. The internal plant ditch system to Outfall 011 drains the eastern part of PGDP and is approximately 5,400 ft in length, approximately 2 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow for Outfall 011 is 0.34 mgd.

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, 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 Waste Area Grouping (WAG) 23.

Under normal conditions, discharge from Outfall 011 is collected in a sump and pumped to the C-617-B Treatment Lagoon via a lift station and then is discharged to Little Bayou Creek via the ditch downstream of the lift station and Outfall 010. 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 waste streams when Lift Station 011 is bypassed due to failures, maintenance, or excessive rainfall events that overwhelm existing discharge controls. During such bypass events, the water discharged through Outfall 011 flows directly to Little Bayou Creek. Maintenance activities, which occur on an as-needed basis, include cleaning the underflow weir that was installed in 1991 (DOE 2005).

Outfall 012

Outfall 012 lies on the east side of PGDP and receives drainage from an area of approximately 61 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 012 drains the southeast part of the plant and is approximately 3,200 ft in length, approximately 3 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The KPDES permit for Outfall 012 is maintained by USEC (DOE 2005). Specifically, under normal conditions, surface water discharges through Outfall 012 to a catchment and then to a lift station. The surface water then is discharged to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. Following treatment, the wastewater typically is discharged to the Outfall 010 ditch through Outfall 010 downstream of the lift station and catch basin C-333-A. Surface water eventually discharges to Little Bayou Creek.

Specific facilities contained in the Outfall 012 drainage area that drain via the internal plant ditches are the C-533-1 Switch House and Appurtenant Structures (C-533-3A, C-533-3B, C-533-3C, and C-533-3D Fire Valve Houses). A portion of the C-340 Building also drains to Outfall 012 via the internal plant ditches. The C-333 Process Building and the C-633-1 Fire House and Appurtenant Structures drain to Outfall 012 through the storm sewer system (DOE 2005).

Outfall 015

Outfall 015, which discharges directly to Bayou Creek, lies on the west side of PGDP and receives drainage from an area of approximately 49 acres, including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 015 drains the west–central part of the plant and is approximately 10,665 ft in length, ranges from approximately 0.5 to 5 ft deep, and is unlined. This ditch system was trenched when PGDP was built in 1951. The reported monthly average flow for Outfall 015 is 0.281 mgd. DOE is responsible for Outfall 015 under the KPDES permit.

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 (DOE 2005).

Storm sewers

C-333-A. The C-333-A Vaporizer is located on the south side of the C-333 Process Building. The C-333-A Building is a one-story building covering approximately 8,232 ft^2. The main contents of the building are a north and south bank of autoclaves. Building operations began in September 1951. An upgrade of the C-337-A facility was completed in 1987.

The storm sewer system downstream of C-333-A connects with the storm sewer system for the east side of C-333. Surface water, roof, and floor drain runoff enters the system through fourteen 6- and 8-in. diameter lines that run to a series of larger diameter lines east and south of the building. These lines empty to a 48-in. diameter line that discharges to the Outfall 012 ditch (DOE 2005). Specifically, water discharges from the C-333-A storm sewer to a catchment and then to the lift station. The surface water then discharges through Outfall 012 to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. Treated effluent then leaves the treatment lagoon via Outfall 010 downstream of the lift station and the catch basin and discharges to Little Bayou Creek.

C-337-A. The C-337-A Vaporizer is located on the east side of the C-337 Process Building. A one-story building covering approximately 8,500 ft^2 houses the facility. The main contents of the building are an east and west bank of autoclaves, each containing five units. Building operations began in 1958. An upgrade of the C-337-A facility was completed in 1988.

The storm sewer system adjacent to the south side of C-337-A and the southeast corner of the C-337 Process Building collects surface, roof, and floor drain runoff that discharges to Outfall 002. Runoff enters 6- to 12-in. diameter piping at 12 locations. These lines run into a 60-in. diameter line southeast of the building that discharges to the Outfall 002 ditch (DOE 2005). Specifically, water discharges from the C-337-A storm sewer to a catchment and then to the lift station. The surface water then discharges through Outfall 002 to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. Treated effluent then leaves the treatment lagoon via Outfall 010 downstream of the lift station and the catch basin and discharges to Little Bayou Creek.

C-340. The C-340 Reduction and Metals Facility was built in 1952 and is located on the east side of the plant. The facility went online on December 28, 1956, and continued operations until 1977, when shutdown of the facility began. In subsequent years, all of the drains leading to the storm sewers were plugged. The building currently is inactive, but formerly was used to reduce UF_6 to uranium tetrafluoride (UF_4) and to convert green salt to metallic uranium. The C-340 complex has been locked since 1991 and is listed for decontamination and decommissioning (D&D).

The storm sewer system for the C-340 Reduction and Metals Facility receives storm water runoff. Runoff enters the system through three 4-in. diameter lines on the east side of the building and two 6-in. diameter lines on the west side of the building. The lines on the east side run to a 12-in. diameter, north–south trending line and the lines on the west side run to a 15-in. diameter, north–south trending line. Both of the north–south trending lines empty to a 48-in. diameter line that discharges to the Outfall 011 ditch (DOE 2005). Specifically, water discharges from the C-340 storm sewer to a catchment and then to the lift station. The surface water then discharges through Outfall 011 to the C-617-B Treatment Lagoon, where it is treated for residual chlorine, pH, and excess temperature. Treated effluent then leaves the treatment lagoon via Outfall 010 downstream of the lift station and the catch basin and discharges to Little Bayou Creek.

C-535. The C-535 Electrical Switchyard is located in the northeastern portion of PGDP just north of the C-335 Process Building and inside the fenced perimeter of the plant area. The switchyard has been in operation since April 30, 1954, and remains active today, supplying electrical power to various buildings at the plant. The switchyard is enclosed by 8 ft tall chain-link fencing to limit access to the facility, and the ground surface is covered with gravel to provide storm water drainage. Field observations made during a March 1997 site walkover suggested that the switchyards are equipped with underdrain systems designed to collect storm water from the facility and direct it to a series of drainage pipes that discharge to drainage ditches. Drainage ditches for the C-535 switchyard are on the northern side of the facilities and eventually discharge to Outfall 001.

The storm sewer system for the C-535 switchyard collects surface water and roof drain runoff. Runoff enters the system through a series of 6- and 8-in. diameter, north–south trending lines, which run to larger lines and, ultimately, to a 54-in. diameter line that discharges to the Outfall 001 ditch west of the switchyard (DOE 2005). Specifically, water discharges from the C-535 storm sewer to a catchment and then to the lift station. The surface water then discharges through Outfall 001 to Bayou Creek.

C-537. The C-537 Electrical Switchyard is located in the northeastern portion of PGDP just north of the C-337 Process Building and inside the fenced perimeter of the plant area. The switchyard has been in operation since December 24, 1954, and remains active today, supplying electrical power to various buildings at the plant. The switchyard is enclosed by a security fence to limit access to the facility, and the ground surface is covered with gravel to provide storm water drainage. Field observations made during a March 1997 site walkover suggested that the switchyards are equipped with underdrain systems designed to collect storm water from the facility and direct it to a series of drainage pipes that discharge to drainage ditches. Drainage ditches for the C-537 Switchyard are on the northern side of the facilities and eventually discharge to Outfall 001.

The storm sewer system for the C-537 Switchyard collects surface water and roof drain runoff. Runoff enters the system through a series of 6- and 8-in. diameter, north–south trending lines, which run to larger lines and ultimately to a 54-in. diameter line that discharges to the Outfall 001 ditch west of the switchyard (DOE 2005). Specifically, water discharges from the C-537 storm sewer to a catchment and then to the lift station. The surface water then discharges through Outfall 001 to Bayou Creek.

E.2.1.5 Known Site Contaminants

The SWOU includes source areas within PGDP that contain surface water contamination or may continue to contribute to surface water contamination. The SWOU includes the NSDD Sections 3, 4, and 5; Outfalls 001, 002, 008, 010, 011, 012, and 015 and their associated internal ditches and areas; and storm sewers C-333-A, C-337-A, C-340, C-535, and C-537. As described in the sampling and analysis plan (SAP) (DOE 2005), historical elevated concentrations of metals, polycyclic aromatic hydrocarbons (PAHs), radionuclides, and PCBs were detected in soil and sediment samples collected from the NSDD. Historically, elevated concentrations of radionuclides were detected in surface water and sediment samples collected in the vicinity of Outfall 001. Historical samples collected from the vicinity of Outfall 002 indicated that surface water and sediment may be contaminated with PCBs and radionuclides. Potential contaminants associated with Outfall 008 include uranium and PCBs. Sediment samples collected during the Phase I SI contained elevated concentrations of radionuclides, TCE, and mixed hydrocarbons. PCBs were not detected during the Phase II SI sediment sampling. During the Phase I and Phase II SI sampling conducted at Outfall 010, contaminants in surface water included radionuclides and TCE. The primary sediment contaminants included dioxins, PCBs, and metals. During Phase I and Phase II sediment sampling, radionuclides, metals, PAHs, and organic contaminants were present in sediment samples collected from Outfall 011. Additional contaminants present in soil or sediment collected from Outfall 011 were TCE and PCBs. Radionuclides were detected in surface water samples collected from Outfall 012 during the Phase I SI. Additionally, xylenes and PCBs were detected in soil and TCE was detected in sediment. Metals and radionuclides were detected in sediment samples collected from Outfall 015 during the Phase I and Phase II SIs.

Historical sampling of the storm sewers indicated the presence of PCB contamination associated with storm sewers C-333-A, C-337-A, C-340, C-535, and C-537. Additionally, uranium contamination was associated with storm sewer C-337-A, while TCE and mineral spirits contamination was associated with storm sewers C-535 and C-537. Food web modeling typically is not included in Step 1–2 SERAs; however, because of DOE concerns, the fact that the areas are located outside of the industrialized area of PGDP, and that game can be harvested from adjacent land associated with the WKWMA limited food web modeling has been completed for Total PCBs in two specific areas. The first area modeled is the NSDD Sections 3, 4, and 5. The second area is Outfall 001, Exposure Units (EUs) 1, 4, 5, 6, and 7.

E.2.1.6 Fate and Transport Mechanisms

As described in detail above, the outfalls and their associated internal ditches and areas associated with the SWOU receive drainage from numerous sources associated with activities occurring on the PGDP property, including roof and floor drains, ground surface runoff, treated wastewater effluent, and also storm water. Surface water discharges from Outfalls 001, 008, and 015 and their associated internal ditches and areas to Bayou Creek, located west of the PGDP property, and from Outfalls 002, 010, 011, and 012 and their associated internal ditches and areas to Little Bayou Creek, located east of the PGDP property. Site-related contaminants in surface water or sediment may reach the receiving creeks via these discharge pathways. Site-related soil contaminants may reach the off-site creeks via erosion into the drainage ditches, storm sewers, and outfalls and their associated internal ditches and areas, especially during above normal precipitation events when water overflows the banks of the drainage ditches that lead from the outfalls and their associated internal ditches and areas to the creeks.

E.2.1.7 Contaminant Effects on Potential Receptors

Chemicals detected in site surface soils, sediment, and surface water include a wide variety of potentially toxic VOAs, SVOAs, pesticides, PCBs, dioxins, furans, and inorganic metals and metalloids. These classes of chemicals and individual chemicals within each class are not equally toxic to ecological receptors. Potential toxicity to ecological receptors differs for each chemical and for each type of ecological receptor that may be exposed. In addition, the chemical form of a chemical has significant influence on its ecotoxicity. Finally, the site-specific characteristics of surface water (e.g., hardness), sediment [e.g., total organic carbon (TOC)], and surface soil (e.g., pH) can affect chemical bioavailability and, therefore, potential toxicity. An overview of the general characteristics (e.g., bioavailability) and toxicity of the major chemical classes and identified chemicals of potential concern (COPCs) found in abiotic media at the site is presented below.

E.2.1.7.1 VOAs

VOAs rarely are implicated as major contributors to adverse ecological effects, primarily because they often are not persistent in surface media. In some cases, however, VOAs can cause adverse effects where a continuing source occurs, such as a groundwater discharge to surface waters. VOAs are not persistent in sediments or surface soils, but may persist in groundwater and deeper soils. Exposure to VOAs, therefore, can be a concern for burrowing mammals and other wildlife that may contact deeper contaminated soils. Some VOAs can be quite toxic to exposed aquatic biota such as fish and larval amphibians. For example, tetrachloroethene (PCE) has been shown to cause adverse chronic effects in daphnids at 750 µg/L (Suter and Tsao 1996). Other VOAs can be substantially less toxic to aquatic life. For example, daphnids exposed to 1,1,2-trichloroethane in water begin to suffer adverse chronic effects at 18,400 µg/L (Suter and Tsao 1996). The likelihood of VOAs contributing significantly to adverse ecological effects increases where highly contaminated sources continue to release VOAs to surface media, especially surface water (see Figure E.3).

E.2.1.7.2 SVOAs

SVOAs include a wide variety of potential contaminants, most importantly the PAHs. PAHs include both low and high molecular weight compounds consisting of hydrogen and carbon arranged in the form of two or more fused benzene rings. Of most concern are PAHs with molecular weights ranging from about 128 (naphthalene) to about 300 (coronene) (Eisler 1987). Within this range are many potentially toxic compounds commonly found in environmental media. Many of the lower molecular weight compounds are acutely toxic, but not carcinogenic. In contrast, some of the higher molecular weight compounds exhibit low toxicity, but are carcinogenic, mutagenic, or teratogenic to fish, amphibians, birds, and mammals. Benzo(a)pyrene (BAP) is an example of one of the most potent and ubiquitous of the carcinogenic PAHs. BAP toxicity data for plants are inconclusive, and concentrations in soil as high as 48,000 mg/kg resulted in no adverse effects in exposed earthworms (Canadian Council of Ministers of the Environment [CCME] 2002). These data support the assumption of low acute toxicity for the higher molecular weight PAHs. The Oak Ridge National Laboratory derived a secondary chronic value for BAP in sediment of 140 µg/kg at one percent TOC. In water, BAP caused chronic toxicity in daphnids at 0.30 µg/L (Suter and Tsao 1996). Naphthalene is an example of a more mobile and often acutely toxic PAH. Naphthalene concentrations of 54 mg/kg resulted in 25% mortality in exposed earthworms (Environment Canada 1995 in CCME 2002). Fish and daphnids exhibited chronic effects from naphthalene exposures in sediment at 12,000 and 23,000 µg/kg, respectively (one percent TOC; Jones, Suter, and Hull 1996). Daphnids and aquatic plants exposed to naphthalene in water suffered chronic effects at 1,163 and 33,000 µg/L, respectively (Suter and Tsao 1996). In spite of the high lipid solubility of some PAHs, they have low bioaccumulation potential in vertebrates because these compounds are rapidly metabolized. PAHs can accumulate in invertebrates that cannot metabolize these compounds. PAHs have low potential for biomagnification and food web effects.

E.2.1.7.3 Pesticides and PCBs

Several potentially toxic and bioaccumulative pesticides and herbicides have been detected in site abiotic media. Some of these, such as 4,4'-dichlorodiphenyltrichloroethane (DDT) and related compounds [dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD)], are highly toxic to a wide variety of ecological receptors and readily accumulate in biological tissues. Some are known to biomagnify, resulting in higher concentrations in higher trophic level biota. For this reason, even very low concentrations of these compounds in soil, water, or sediment can contribute to severe adverse effects at the top of food webs. The adverse effect of DDT and related compounds on bald eagles (due primarily to eggshell thinning) is a well-known example of biomagnification from water and sediment to fish to piscivorous birds. PCBs are another group of toxic and bioaccumulative compounds that can cause adverse effects in lower and especially in upper trophic level biota. PCBs include many individual congeners, some of which are highly toxic, while others are less so. PCB concentrations can be reported as concentrations of individual congeners, as Total PCBs or as Aroclors. Aroclors such as 1242, 1248, 1254, and 1260 are industry-derived mixtures of various congeners. PCBs are readily accumulated in aquatic biota; therefore, predators linked to aquatic environments such as mink, raccoons, and piscivorous birds can be at significant risk. Some fish can accumulate high levels of PCBs without suffering observable effects, while posing substantial risks to piscivorous wildlife. PCBs and many pesticides and herbicides are persistent in the environment and degradation by biological and other means is minimal. Most of these compounds are lipophilic, with a tendency to accumulate in the liver and other fatty tissues of biota. Levels of PCBs, pesticides, and herbicides assumed to be safe for exposed biota are often very low due to bioaccumulation-related risks. Safe levels of Total PCBs and DDT in soil generally are considered to be at or below about 1 part per million (mg/kg), depending on the receptor warranting protection. For sediments, consensus-based threshold levels for Total PCBs and total DDT (sum of DDT, DDD, and DDE) are about 60 µg/kg and about 5 µg/kg, respectively (MacDonald et al. 2000). These thresholds were derived from multiple sources and probably best describe the overall average concentrations at which adverse effects may begin to be observed. For surface water exposures, concentrations of Total PCBs and total DDT below 1 µg/L can cause adverse effects in exposed aquatic biota.

E.2.1.7.4 Dioxins and furans

Several (17) dioxin and furan compounds have been detected in surface soil samples from localized areas (Outfall 010) and from other media (surface water) in a few instances. Dioxin and furan data for many on-site locations and media are sparse, so assumptions about presence or absence of these compounds are uncertain. Some of the compounds detected are highly toxic [e.g., 2,3,7,8,-tetrachlorodibenzo-p-dioxin (TCDD)], and most are resistant to microbial breakdown. Dioxins and furans generally are concentrated in fatty tissues, but bioaccumulation is variable. TCDD is the most studied and highly toxic of the dioxins and furans. Toxicity equivalence factors (TEFs) often are used to estimate the toxicity of other compounds relative to TCDD. Several sources have derived compound-specific TEFs. The most recent and widely accepted of these are the TEFs proposed by the World Health Organization (WHO) (Van den Berg et al. 1998). WHO TEFs are used is this assessment, and these vary from 1.0 (toxicity equal to 2,3,7,8-TCDD) to fractions of one (e.g., 0.001, which equates to 1/1000th the toxicity of TCDD). Concentrations of individual dioxins and furans expressed as concentrations of TCDD using TEFs are termed toxicity equivalents (TEQs). A TEQ of 0.5 ng/kg is equal to 0.5 ng of TCDD per kilogram of soil or sediment. TCDD has been shown to be acutely toxic, carcinogenic, teratogenic, mutagenic, and associated with adverse reproductive, immunologic, and histopathologic effects. Acceptable levels of dioxins and furans in soil generally are considered to be at or near zero. CCME (2002), for example, suggests a soil screening level for agricultural use of 0.004 µg TEQ/kg. This value, which is the same as the NFA screening level, equates to the sum of the TEF-derived concentrations for all dioxins and furans. For sediments, CCME (2002) suggests a screening value of 0.85 ng TEQ/kg. This equates to 0.00085 µg TEQ/kg. Eisler (1986) recommends a conservative surface water limit of 0.01 part per trillion (0.00001 µg/L) 2,3,7,8-TCDD to protect aquatic life. Seven dioxins and ten furans have been detected in the surface soils taken from EU6 at Outfall 010. A single dioxin or furan also was observed in surface water samples taken from the NSDD, Outfall 001, and Outfall 015. Dioxins and furans either were not detected or were not analyzed for in other media and at other locations.

E.2.1.7.5 Metals and metalloids

Metals and metalloids (e.g., selenium) have been detected in on-site surface water, sediment, and surface soil. Many inorganic chemicals, including metals and metalloids, are relatively nontoxic to ecological receptors, and some are essential for life. These include, for example, calcium, magnesium, sodium, potassium, copper, and zinc. Some of the essential elements can be toxic at elevated concentrations or in certain forms. For example, elevated levels of dissolved copper and zinc can be quite toxic to fish and other aquatic life even though low concentrations are biologically essential. Other metals and metalloids, such as cadmium, mercury, and arsenic are not essential and, in fact, can be highly toxic at very low exposure concentrations. Some of the most toxic metals like mercury and cadmium also accumulate in biological tissues. Mercury is known to biomagnify, resulting in adverse effects in upper trophic level receptors. The bioavailability and toxicity of metals can be affected by the chemical form of the metal. For example, dissolved metals frequently are implicated in toxic effects, while metals bound to particulate matter generally are less bioavailable and exhibit lower toxicity to aquatic life. Higher hardness values in surface water (based on concentrations of calcium and magnesium) are associated with reduced toxicity for certain metals (cadmium, copper, chromium, lead, nickel, and zinc). The aquatic toxicity of other metals, such as aluminum, is most influenced by surface water pH. In soils, increased acidity (lower pH) often increases the bioavailability of metals. Metals in sediment can be toxic under certain conditions such as release of metals to sediment pore water or ingestion of metals-contaminated fine particulates. The variable toxicity of metals can be revealed by comparing accepted criteria, standards, benchmark concentrations, or screening levels for individual metals. For example, EPA chronic freshwater criteria for dissolved metals in surface water, at a hardness of 100 mg calcium carbonate, range from 0.25 µg/L for cadmium to 150 µg/L for arsenic. Similar values for other commonly detected metals are trivalent chromium (74 µg/L), hexavalent chromium (11 µg/L), copper (9.0 µg/L), lead (2.5 µg/L), mercury (0.77 µg/L), nickel (52 µg/L), selenium (5.0 µg/L), and zinc (120 µg/L). These chronic criteria are intended to protect 95% of the nation’s aquatic life from adverse chronic effects such as mortality, reproductive effects, and growth effects. Consensus-based threshold concentrations for metals in sediment (MacDonald et al. 2000) provide insight into the relative toxicity of metals in sediment. These threshold concentrations range from 0.18 mg/kg for mercury to 121 mg/kg for zinc. Similarly derived threshold concentrations for arsenic, cadmium, copper, lead, and nickel in sediments fall within this range. The toxicity of metals and metalloids in surface soil is more difficult to interpret because of numerous factors (e.g., soil pH) affecting bioavailability. EPA Region 4 has developed ecological screening values for numerous chemicals found in surface soils and other media, including the most common metals and metalloids. EPA Region 4 ecological screening levels for commonly detected metals in soils are 3.5 mg/kg (antimony), 10 mg/kg (arsenic), 1.1 mg/kg (beryllium), 1.6 mg/kg (cadmium), 40 mg/kg (copper), 50 mg/kg (lead), 0.100 mg/kg (mercury), 30 mg/kg (nickel), 0.81 mg/kg (selenium), 2 mg/kg (silver), and 50 mg/kg (zinc) (EPA 2001).

E.2.1.7.6 Radionuclides

Unlike other chemical classes, exposures to radionuclides are expressed as the dose rate (e.g., rad per day, or rad d^{-1}) rather than as a concentration. Dose rates accounting for biological effects are additive, with the total dose rate being equal to the sum of the normalized dose rates for each radionuclide. Most developed screening values include exposures from all major alpha, beta, and gamma emissions for each isotope. Total dose rates can be compared to such screening values to determine if additional investigation is necessary. Literature-based bioconcentration factors (BCFs) for fish and sediment-water partition coefficients (or K_d values) are available for many radionuclides. These data reveal widely variable K_d values and BCFs for the investigated radionuclides. Generic BCFs from one literature source range from 1 (hydrogen) to 250,000 (phosphorus, BJC 1998). K_d values from the same generic literature source range from 3.75 (technetium) to 75,000 (plutonium, BJC 1998). None of these values are site-specific and are not used in the screening level ERA. Instead, screening level benchmarks from the literature are used generally to describe the potential toxicity of radionuclides. Site-specific K_ds and BCFs, including those that might serve as inputs to various models, are likely to differ from these generic literature-based values. The low screening level benchmarks (BJC 1998) for thorium-228, thorium-229, thorium-230, radium-226, polonium-210, actinium-227, cesium-137, phosphorous-132, and potassium-40 suggest that these may be among the most hazardous radionuclides to fish.

E.2.2 POTENTIALLY COMPLETE EXPOSURE PATHWAYS

An environmental exposure pathway is a means by which contaminants are transported from a source to ecological receptors. The PGDP SWOU includes source areas that contain or primarily contribute to surface water contamination; however, there are three media to which ecological receptors likely are exposed. The primary avenues for contamination include the following: (1) on-site soil has been contaminated from site operations; (2) multiple waste streams are discharged from the plant to ditches, storm sewers, and outfalls, which contribute to surface water and sediment contamination in those portions of the site; and (3) Bayou Creek and Little Bayou Creek receive surface water and sediment contaminants via discharge from the plant directly to or via the outfalls.

Exposure of ecological receptors to contaminants may occur via direct contact with or ingestion of contaminated surface soil, sediment, and surface water. Exposure of higher trophic-level receptors can occur through food web exposure via ingestion of prey that has become contaminated through site-related exposure (see Figure E.3).

E.2.3 EXPOSURE ENDPOINTS

In SERAs, assessment endpoints usually are considered to be any adverse effects from site contamination to any ecological receptors at the site. Specific preliminary assessment endpoints for the PGDP SWOU included the following:

- Protection of federal or state designated threatened or endangered flora and fauna species and their critical habitats;
- Protection of plants and soil-dwelling invertebrate communities from negative impacts associated with exposure to contaminants in soil;
- Protection of aquatic invertebrate and fish communities from the toxic effects (on survival and growth) of site-related contaminants present in sediment and surface water;
- Protection of piscivorous bird and mammal communities to ensure that ingestion of contaminants in surface water, sediment, and prey does not have negative impacts on growth, survival, and reproduction;
- Protection of insectivorous bird and mammal communities to ensure that ingestion of contaminants in surface water, sediment, soil, and prey does not have negative impacts on growth, survival, and reproduction;
- Protection of omnivorous bird and mammal communities to ensure that ingestion of contaminants in surface water, sediment, soil, plants, and prey does not have negative impacts on growth, survival, and reproduction; and
- Protection of carnivorous bird and mammal communities (which include piscivorous and insectivorous species) to ensure that ingestion of contaminants in prey does not have negative impacts on growth, survival, and reproduction.

E.2.4 POTENTIALLY CONTAMINATED MEDIA

Potential risks to ecological receptors due to exposure to contaminants in surface soil (0–1 ft bgs), sediment, and surface water within the SWOU are evaluated in this SERA. Risks to ecological receptors due to exposure to contaminants in groundwater or subsurface soils (greater than 1 ft bgs) are not evaluated, because exposures to undiluted groundwater or deeper soils are unlikely or are extremely limited for most ecological receptors. A description of each abiotic medium and the associated analytical samples included in this SERA are discussed below.

E.2.4.1 Surface Soil

Potential source areas, as determined by the analytical results from field activities, are examined and potential site-related contaminants are identified. Past discharges from PGDP may have resulted in the contamination of soil along the NSDD Sections 3, 4, and 5; the outfalls and their associated internal ditches; and areas surrounding the ditches. In addition to historical samples, soil samples were collected as part of Activity 1 and Activity 2 of the SAP (DOE 2005) for the SI. Collectively, historical and SI soil samples were analyzed for the following: metals, PCBs, radionuclides, SVOAs, VOAs, dioxins, and furans. The nature and extent of soil contamination is discussed in detail in Section 4 of the SI.

E.2.4.2 Sediment

Potential source areas, as determined by the analytical results from field activities, are examined and potential site-related contaminants are identified. Past discharges from PGDP may have resulted in the contamination of sediment in the NSDD Sections 3, 4, and 5; the outfalls and their associated internal ditches; and areas surrounding the ditches. In addition to historical samples, sediment samples were collected as part of Activity 1 and Activity 2 of the SAP for the SI. Collectively, historical and SI sediment samples were analyzed for the following: metals, PCBs, radionuclides, SVOAs, and VOAs. The nature and extent of sediment contamination is discussed in detail in Section 4 of the SI.

E.2.4.3 Surface Water

Surface water samples were collected from Sections 3, 4, and 5 of the NSDD; the outfalls and their associated internal ditches and areas; and storm sewers associated with the SWOU. Surface water sampling was conducted to characterize potential releases at discharge points from PGDP. In addition to historical samples, surface water samples were collected from the storm sewers during a three-step process as part of SAP activities for the SI. Collectively, historical and SI surface water samples were analyzed for the following: metals, PCBs, radionuclides, SVOAs, dioxins, furans, and VOAs. The nature and extent of surface water contamination is discussed in detail in Section 4 of the SI.

E.2.5 POTENTIALLY EXPOSED RECEPTORS

Wildlife species known to be present or potentially present on the PGDP site, including threatened and endangered species, are described in this section. Although a survey has not been conducted to compile a comprehensive list of wildlife species at the plant as part of this SI, results from previous studies (DOE 2004) provide a list of wildlife species observed at PGDP. These are presented in Tables E.1 and E.2, respectively.

E.2.5.1 Reported or Likely Receptors

According to the ASER (DOE 2004), wildlife species indigenous to hardwood forests, scrub-shrub, and open grassland communities are present at PGDP. Grassy fields are frequented by rabbits, mice, songbirds, and a variety of other small mammals and birds. Blackbirds, killdeer, cardinals, mourning doves, bobwhite quail, meadowlarks, warblers, sparrows, kestrels, and red-tailed hawks have been observed in such areas. Scrub-shrub communities support a variety of wildlife, including opossums, beavers, voles, moles, raccoons, gray squirrels, killdeer, blue jays, redwing blackbirds, bluebirds, cardinals, mourning doves, shrike, warblers, turkeys, and meadowlarks. Deer, squirrels, raccoon, turkeys, songbirds, and great horned owls are found within the mature woodlands of the DOE reservation. In addition, the Ohio River located about three miles directly north of the site, serves as a major flyway for migratory birds, which occasionally are seen on PGDP property. Additionally, bobcats have been known to inhabit the area and have been observed on the PGDP property.

Amphibians and reptiles are common throughout PGDP. Amphibians likely to inhabit the area include the American and Woodhouse toads as well as several other anurans and salamanders. Most of these are likely to frequent wetter areas with sufficient vegetative cover. Reptiles observed on-site include the eastern box turtle and several species of snakes. In addition, other species of turtles and several species of lizards also are likely to occur on or near the site where suitable habitat exists. Fish populations in Bayou Creek and Little Bayou Creek are numerically dominated by various species of sunfish. Other fish species reported or expected to occur on-site include stoneroller (*Campostoma* sp.) and largemouth bass. Small, unidentified fish species have been seen in many of the outfall ditches (DOE 2004). Animal species known to be present or potentially present on the PGDP site are listed in Table E.1.

E.2.5.2 Threatened, Endangered, Candidate, and Monitored Species

According to the ASER (DOE 2004), a threatened and endangered species investigation identified federally-listed, proposed, or candidate species potentially occurring at or near PGDP. Potential habitat for seven species of federal concern exists in the vicinity of the site. The seven species that potentially could be present on the PGDP site are listed in Table E.2. Six of these species are listed as endangered under the Endangered Species Act of 1973, and one is listed as threatened.

Of the seven species shown on Table E.2, two are birds (bald eagle and interior least tern) and four are freshwater mussels. The seventh species is the Indiana bat.

Of note, significant potential summer habitat exists at PGDP for the Indiana bat, a federally-listed endangered species; however, neither the Indiana bat nor any other federally-listed or candidate specie has been found at PGDP. Also, no property at PGDP has been designated as “critical habitat” in accordance with the Endangered Species Act of 1973.

The Commonwealth of Kentucky has designated several plant and animal species as warranting monitoring due to their population status. These designations are specific to each county within the Commonwealth. A wide variety of plant and animal species have been designated as monitored species for McCracken County, Kentucky. These include 19 plant species, 4 gastropods, 10 bivalves, 2 crustaceans, 2 insects, 15 fish, 3 amphibians, 3 reptiles, 9 birds, and 3 mammals. In addition, two community types are listed as monitored for McCracken County. These are Floodplain Ridge/Terrace Forest and Wet Prairie. A complete list of all the monitored species for McCracken County can be found at *http://nrepcapps.ky.gov/ksnpc/countysearch.html* (Kentucky State Nature Preserves Commission 2002).

Table E.1. Wildlife Species Present or Potentially Present at the PGDP Site

Common name	Scientific name
Fish	
Bluegill sunfish	*Lepomis macrochirus*
Common name	**Scientific name**
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Longear sunfish	*Lepomis megalotis*
Stoneroller	*Campostoma sp.*
Reptiles and Amphibians	
American toad	*Bufo americanus*
Eastern box turtle	*Terrapene carolina*
Salamanders	Various species
Snakes	Various species
Woodhouse toad	*Bufo woodhousei*
Birds	
American robin	*Turdus migratorius*
American woodcock	*Scolopax minor*
Bald eagle	*Haliaeetus leucocephalus*
Belted kingfisher	*Ceryle alcyon*
Blue jay	*Cyanocitta cristata*
Eastern bluebird	*Sialia sialus*
Eastern meadowlark	*Sturnella magna*
Great-horned owl	*Bubo virginianus*
Hawks	Various species
Herons and egrets	Various species
Killdeer	*Charadrius vociferus*
Loggerhead shrike	*Lanius ludovicianus*
Mourning dove	*Zenaida macroura*
Northern bobwhite (aka bobwhite quail)	*Colinus virginianus*
Northern cardinal	*Cardinalis cardinalis*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Song sparrow	*Melospiza melodia*
Warblers	Various species
Wild turkey	*Meleagris gallopavo*
Wood duck	*Aix sponsa*
Wrens	Various species
Mammals	
American beaver	*Castor canadensis*
American mink (aka mink)	*Mustela vison*
Bats	Various species
Bobcat	*Lynx rufus*
Common muskrat	*Ondatra zibethicus*
Coyote	*Canis latrans*
Eastern cottontail	*Sylvilagus floridanus*
Eastern grey squirrel	*Sciurus carolinensis*
Indiana bat	*Myotis sodalist*
Mice	Various species
Moles	Various species
Opposum	*Didelphis virginiana*
Raccoon	*Procyon lotor*
Shrews	Various species
Voles	Various species
White-tailed deer	*Odocoileus virginianus*

Table E.2. Federally-Listed, Proposed, and Candidate Species Potentially Occurring Within the Paducah Site Study Area in 2004[a]

Common name	Scientific name	Animal Type	Endangered Species Act status
Indiana bat[b]	*Myotis sodalist*	Mammal	Listed endangered
Interior least tern	*Sterna antillarum athalassos*	Bird	Listed endangered
Pink mucket	*Lampsilis abrupta*	Mussel	Listed endangered
Ring pink	*Obovaria retusa*	Mussel	Listed endangered
Orangefoot pimpleback	*Plethobasus cooperianus*	Mussel	Listed endangered
Fat pocketbook	*Potamilus capax*	Mussel	Listed endangered
Bald eagle	*Haliaeetus leucocephalus*	Bird	Listed threatened

[a] All of the listed species are discussed in *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume III*, COE Nashville District, May 1994. Note that the study area encompasses 11,719 acres and extends to include the Ohio River, which is over three miles north of the DOE reservation. None of these species have been reported as sighted on the DOE reservation, although potential summer habitat exists there for the Indiana bat. No critical habitat for any of these species has been designated anywhere in the study area.

[b] Specimens of the Indiana bat were collected from WKWMA property in 1991 and 1999.

There is some overlap between Commonwealth monitored species and federal threatened and endangered species listed for McCracken County. For example, the Indiana bat, pink mucket, and ring pink both are endangered and monitored.

E.2.5.3 Potential Impacts on State and Federally Listed Species

Potential impacts to threatened, endangered, and monitored species are assessed using multiple approaches. The most specific of these is the performance of food web modeling for the Indiana bat, based in part on input data for the closely related little brown bat. The results of this modeling reveal potential risks to the Indiana bat using conservative assumptions. Risks to monitored terrestrial plants are addressed by comparing maximum concentrations of contaminants in surface soil to ecological screening values that, for the most part, incorporate phytotoxic endpoints. Risks to protected or monitored bivalves and other aquatic invertebrates are addressed by comparing maximum contaminant concentrations in surface water and sediment to conservative ecological screening levels for those media. The majority of the screening levels used initially to assess risks incorporate toxicity data associated with sensitive invertebrates and fish. Most often those values are based on the most sensitive of tested species; therefore, protection of less sensitive species is likely where screening values are not exceeded by site contaminant levels.

In summary, risks to threatened, endangered, and monitored species are assessed by using conservative approaches and screening levels that incorporate toxicity data for sensitive species. In addition, on-site habitat suitability differs for each of these species. For the most part, on-site habitats within specific areas of concern to this SERA are limited in quantity and quality for many of these special species. Some are wide ranging (e.g., bald eagle) and unlikely to spend much time within small contaminated areas. Others require relatively undisturbed conditions and developed areas of the site are, therefore, unlikely to support such species. Risk estimates for aquatic and terrestrial species derived from comparisons to screening levels or from food web modeling are likely to address adequately the risks for endangered, threatened, and monitored species because these species have not been shown to be any more sensitive to contamination than more common species. In fact, many of the screening levels used to initially assess risks are based on the most sensitive species and endpoints tested, regardless of the population status of the tested species.

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E.3. STEP 1: SCREENING-LEVEL EFFECTS EVALUATION

E.3.1 PGDP NFA LEVELS

The Ecological Risk Assessment Working Group (ERAWP), composed of representatives from the U.S. Fish and Wildlife Service, Kentucky Department of Fish and Wildlife Resources, Kentucky Department for Environmental Protection (KDEP), EPA, and DOE, have established NFA levels for a limited number of constituents in abiotic media at PGDP. The NFA level identified for a constituent is based upon risk to an organism exposed to that constituent via direct contact in soil, sediment, or surface water. "NFA levels are generally conservative estimates of chemical concentrations that will not adversely affect ecological receptors with high probability" (DOE 2001). The NFA levels are used to screen detected constituents in order to identify COPCs that would need to be evaluated further in the risk assessment process. They are not intended to be protective of receptors exposed via ingestion to constituents that may bioconcentrate in prey and thus bioaccumulate. The following is a summary of the selection or derivation of NFA levels for contaminants in soil, sediment, and surface water as presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1506/V2&D2 (DOE 2001).

The NFA level for radionuclides is a threshold "no effect" dose. The threshold dose is for the combined exposure to all radionuclides present at a site. NFA levels cannot be derived for individual radionuclides unless a relative abundance of radionuclides is specified and the relative abundance of radionuclides is a site-specific property. For any specified distribution of radionuclides at a site, NFA levels resulting in the threshold dose can be derived (DOE 2001).

E.3.1.1 Surface Water NFA Levels

Surface water NFA levels for constituents, excluding radionuclides, were selected from four sources, including the Kentucky state warm water chronic criterion as the primary source or the lower of KDEP freshwater screening values, EPA Region 4 freshwater ecological screening values, and the chronic Tier II value calculated by Suter and Tsao (1996).

The surface water NFA levels for radionuclides were calculated from the NFA dose established by the ERAWG. The NFA dose for receptors exposed to radionuclides in PGDP surface water was 0.1 rad/day, which is the recommended National Council on Radiation Protection (NCRP) threshold dose for aquatic receptors (1 rad/day) times a safety factor of 0.1. In lieu of site-specific radionuclide relative abundance data, the PGDP NFA levels for surface water were the radionuclide surface water-screening benchmarks for small fish, multiplied by a safety factor of 0.1 to correspond to PGDP surface water NFA radiological doses of 0.1 rad/day. Screening benchmarks for small fish were used because vertebrates are thought to be more sensitive than invertebrates.

These NFA values are discussed in further detail in Appendix A of the Methods Document, Volume 2, Ecological (DOE 2001).

E.3.1.2 Sediment NFA Levels

The sediment NFA levels for constituents, excluding radionuclides, were selected from four sources, including the Canadian threshold effect levels (TELs) (Smith et al. 1996); consensus-based threshold effects concentrations (TECs) (Ingersoll and MacDonald 1999), which are predictive of toxicity (MacDonald et al. 2000); KDEP values provided by Al Westerman; and TELs for the sediment-dwelling amphipod, *Hyalella azteca,* compiled and published by Buchman (1998). For sediment NFAs, KDEP values and *H. azteca* TELs were used only to supplement Canadian TELs when no Canadian TEL was available. When both TEL and TEC values were available for a constituent, the lower of the two was employed as the sediment NFA.

The sediment NFA levels for radionuclides were calculated from the NFA dose established by the ERAWG. The NFA dose for receptors exposed to radionuclides in PGDP sediment was 0.1 rad/day, which is the recommended NCRP threshold dose for aquatic receptors (1 rad/day) times a safety factor of 0.1. Screening benchmarks for small fish were used because vertebrates are more sensitive than invertebrates (DOE 2001).

These NFA values are discussed in further detail in Appendix A of the Methods Document, Volume 2, Ecological (DOE 2001).

E.3.1.3 Surface Soil NFA Levels

The soil NFA levels for constituents, excluding radionuclides, were the more conservative of the EPA Region 4 soil screening values and the KDEP soil screening values provided by Al Westerman of KDEP.

The soil NFA levels for radionuclides were calculated from the NFA dose established by the ERAWG. The NFA dose for receptors exposed to radionuclides in PGDP soil was 0.1 rad/day, which was the recommended NCRP threshold dose for soil invertebrates (1 rad/day) multiplied by a safety factor of 0.1. Screening benchmarks for soil invertebrates were used because external exposure of invertebrates is higher than that of terrestrial mammals (DOE 2001).

These NFA values are discussed in further detail in Appendix A of the Methods Document, Volume 2, Ecological (DOE 2001).

E.3.2 FOOD WEB MODEL SCREENING LEVELS

Food web modeling is performed for bioaccumulative chemicals (limited to Total PCBs at this stage of the ERA) and for a specific set of mammalian and avian receptors that are representative of sensitive species known or expected to occur on-site. The output of the food web model is a dose, expressed in milligrams of contaminant per kilogram of body weight per day (mg/kg-d). The dose resulting from the modeling is compared to dose-based toxicity reference values (TRVs).

Generally, two dose-based TRVs are selected for use in the models—the no effect dose and the low effect dose. The former is based on experimental or estimated no observed adverse effect level (NOAEL) and the latter is based on experimental or estimated lowest observed adverse effect level (LOAEL). Both of these values are taken from the literature source that follows:

- *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample, Opresko, and Suter II 1996)—PCBs (based on Aroclor-1254 toxicity data).

NOAELs and LOAELs are selected without further adjustment if the test species is the same as the receptor of choice. If not, then the test species NOAELs and LOAELs are adjusted using the specific ingestion rates and body weights of the selected receptor. TRVs for selected mammalian receptors are adjusted for each specie by incorporation of physiological scaling factors based on body surface area.

Recent research suggests that use of physiological scaling factors is not appropriate for interspecies extrapolation among birds (Sample et al. 1996); therefore, the PCB-specific TRVs for birds are the same for all species. For both birds and mammals, the TRVs are based on Aroclor-1254, among the most toxic and well-studied of the Aroclors commonly comprising “total” PCBs. The specific receptors selected for food web modeling are discussed in subsequent sections of the SERA. Table E.3 presents the dose-based TRVs used in food web modeling for Total PCBs (again, based on Aroclor-1254 toxicity). Although the model incorporates both the LOAEL and LOAEL doses into the risk estimates, only the NOAEL-based TRVs are used in the SERA for determining whether or not additional investigations (e.g., performance of the baseline ecological risk assessment [BERA]) are warranted.

Table E.3. Food Web Model Ecological Screening Levels for Total PCBs

Receptor	NOAEL (mg/kg-d)
Shrew	0.067
Vole	0.051
Mink	0.14
Bat	0.079
Kestrel	0.18
Woodcock	0.18
Robin	0.18
Quail	0.18
Wren	0.18
Kingfisher	0.18

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E.4. STEP 2: SCREENING-LEVEL EXPOSURE ESTIMATES

Maximum concentrations of chemicals detected in site surface water, sediment, and surface soil are compared to available NFA screening levels for selection of chemicals that require further investigation. These chemicals are termed COPCs. Where chemicals were analyzed for but not detected, one-half of the highest detection limit is used for comparison to the NFA screening levels. Although conservative, this approach ensures that no chemical with potential to contribute to adverse ecological effects is prematurely eliminated as a COPC.

E.4.1 DATA SUMMARY

The result of these comparisons is a list of area-specific and media-specific COPCs that are retained for subsequent investigations that may follow Steps 1 and 2 of the ERA process. These results are summarized below for each of the areas evaluated in Table E.4. Tables E.5 to E.26 present more detailed data summaries, including all the individual chemicals identified as COPCs for surface water, sediment, and surface soil for Sections 3, 4, and 5 of the NSDD and Outfalls 001, 002, 008, 010, 011, 012, and 015 and their associated internal ditches and areas. In addition, Attachment E2 presents the details of the screening for COPC selection, including chemicals eliminated as COPCs. (Note: Each COPC eliminated is noted in bold on each of the attached tables.)

Table E.4. Data Summary—Surface Water, Sediment, and Surface Soil—All Areas of the SWOU

Area	Media	Number of COPCs					
		Dioxin/furan	**Metal**	**Pesticide/PCB**	**Rad**	**SVOA**	**VOA**
NSDD	SW	1	28	10	9	57	17
	SED	—	26	10	4	17	—
	SS	—	27	10	2	34	21
Outfall 001	SW	1	28	10	9	44	18
	SED	—	25	10	5	139	4
	SS	—	26	9	28	54	22
Outfall 002	SW	—	18	—	4	—	1
	SED	—	21	9	4	17	—
	SS	—	—	—	28	—	—
Outfall 008	SW	—	17	9	4	—	1
	SED	—	27	10	4	63	25
	SS	—	26	10	28	—	—
Outfall 010	SW	—	19	—	6	—	13
	SED	—	26	10	4	139	4
	SS	17	26	9	2	54	7
Outfall 011	SW	—	22	9	4	38	3
	SED	—	24	10	30	137	4
	SS	—	24	9	—	49	2
Outfall 012	SW	—	9	—	4	—	1
	SED	—	20	9	4	139	4
	SS	—	—	—	—	—	—
Outfall 015	SW	1	22	10	6	31	10
	SED	—	25	9	4	64	25
	SS	—	—	—	—	—	—

Parameters with no value indicate that the chemical was not sampled for or the data did not meet the criteria for COPC selection.
SED – Sediment SS – Surface soil SW – Surface water

Table E.5. NSDD Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Dioxins/furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Yes	ASL			
Metals					
Aluminum	Yes	ASL	Manganese	Yes	ASL
Antimony	Yes	ASL	Mercury	Yes	ASL
Arsenic	Yes	ASL	Nickel	Yes	ASL
Barium	Yes	ASL	Phosphorous	Yes	NV
Beryllium	Yes	ASL	Potassium	Yes	NV
Boron	Yes	ASL	Selenium	Yes	ASL
Cadmium	Yes	ASL	Silver	Yes	ASL
Calcium	Yes	NV	Sodium	Yes	NV
Chromium	Yes	ASL	Thallium	Yes	ASL
Copper	Yes	ASL	Tin	Yes	ASL
Cyanide	Yes	ASL	Titanium	Yes	NV
Iron	Yes	ASL	Total Metals	Yes	NV
Lead	Yes	ASL	Uranium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	ASL	PCB-1254	Yes	ASL
PCB-1221	Yes	ASL	PCB-1260	Yes	ASL
PCB-1232	Yes	ASL	PCB-1268	Yes	NV
PCB-1242	Yes	ASL	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	ASL			
Radionuclides					
Activity of U-235	Yes	NV	Suspended Beta	Yes	NV
Alpha activity	Yes	NV	Thorium-234	Yes	NV
Beta activity	Yes	NV	Tritium	Yes	NV
Radium	Yes	NV	Uranium-235	Yes	NV
Suspended Alpha	Yes	NV			
Semivolatile organic analytes					
1,1-biphenyl	Yes	NV	Co-Ral	Yes	NV
1,2-Diphenylhydrazine	Yes	ASL	delta-BHC	Yes	NV
2,4,6-Trichlorophenol	Yes	ASL	Diazinon	Yes	NV
2,4'-DDD	Yes	NV	Dibenzothiophene	Yes	NV
2,4'-DDE	Yes	NV	Dichlorvos	Yes	NV
2,4'-DDT	Yes	NV	Dieldrin	Yes	ASL
2,6-Dinitrotoluene	Yes	NV	Dimethoate	Yes	NV
2-Chloronaphthalene	Yes	NV	Di-n-octylphthalate	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	ASL	Endosulfan sulfate	Yes	NV
2-Methylnaphthalene	Yes	NV	Endrin	Yes	ASL
3,3'-Dichlorobenzidine	Yes	NV	Endrin ketone	Yes	NV
4,4'-DDE	Yes	ASL	Endrin aldehyde	Yes	NV
4,4'-DDT	Yes	ASL	Ethion	Yes	NV
4,4'-DDD	Yes	ASL	Famphur	Yes	NV
4-Bromophenyl phenyl ether	Yes	NV	Fensulfothion	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	Fenthion	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	gamma-Chlordane	Yes	NV
alpha-Chlordane	Yes	NV	Heptachlor	Yes	ASL
Azinphos-methyl	Yes	NV	Heptachlor epoxide	Yes	ASL
Benzo(e)pyrene	Yes	NV	Hexachlorobenzene	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	Hexachlorobutadiene	Yes	ASL
Bis(2-chloroisopropyl) ether	Yes	NV	Hexachlorocyclopentadiene	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	ASL	Malathion	Yes	ASL
Chlordane	Yes	ASL	Methoxychlor	Yes	ASL

Table E.5 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
Mirex	Yes	ASL	Methyl parathion	Yes	NV
Mocap	Yes	NV	Perylene	Yes	NV
N-Nitrosodimethylamine	Yes	NV	Phenol	Yes	ASL
N-Nitroso-di-n-propylamine	Yes	NV	Phorate	Yes	NV
Parathion	Yes	ASL	Toxaphene	Yes	ASL
Volatile organic analytes					
Bromomethane	Yes	NV	Dibromochloromethane	Yes	NV
Carbon disulfide	Yes	ASL	MBAS	Yes	NV
Chloroethane	Yes	NV	Styrene	Yes	NV
Chloromethane	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
cis-1,2-Dichloroethene	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
cis-1,3-Dichloropropene	Yes	NV	Vinyl chloride	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.6. NSDD Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Boron	Yes	NV	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silicon	Yes	NV
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Iron	Yes	ASL	Uranium	Yes	NV
Lead	Yes	ASL	Vanadium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1262	Yes	NV
PCB-1242	Yes	NV	PCB-1268	Yes	NV
PCB-1248	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV
Semivolatile organic analytes					
Acenaphthene	Yes	ASL	Dibenz(a,h)anthracene	Yes	ASL
Acenaphthylene	Yes	NV	Fluoranthene	Yes	ASL
Anthracene	Yes	ASL	Fluorene	Yes	ASL
Benz(a)anthracene	Yes	ASL	Indeno(1,2,3-cd)pyrene	Yes	ASL
Benzo(a)pyrene	Yes	ASL	Naphthalene	Yes	ASL
Benzo(b)fluoranthene	Yes	ASL	Phenanthrene	Yes	ASL
Benzo(ghi)perylene	Yes	NV	Pyrene	Yes	ASL
Benzo(k)fluoranthene	Yes	ASL	Total PAHs	Yes	ASL
Chrysene	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.7. NSDD Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	ASL	Nickel	Yes	ASL
Beryllium	Yes	ASL	Potassium	Yes	NV
Boron	Yes	ASL	Selenium	Yes	ASL
Cadmium	Yes	ASL	Silicon	Yes	NV
Calcium	Yes	NV	Silver	Yes	ASL
Chromium	Yes	ASL	Sodium	Yes	NV
Cobalt	Yes	ASL	Thallium	Yes	ASL
Copper	Yes	ASL	Tin	Yes	ASL
Iron	Yes	ASL	Uranium	Yes	ASL
Lead	Yes	ASL	Vanadium	Yes	ASL
Lithium	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1262	Yes	NV
PCB-1242	Yes	NV	PCB-1268	Yes	NV
PCB-1248	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
Radionuclides					
Alpha activity	Yes	NV	Beta activity	Yes	NV
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	4-Chlorobenzenamine	Yes	NV
1,3-Dichlorobenzene	Yes	NV	4-Chlorophenyl phenyl ether	Yes	NV
2,4-Dichlorophenol	Yes	NV	4-Methylphenol	Yes	NV
2,4-Dimethylphenol	Yes	NV	4-Nitrobenzenamine	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Bis(2-chloroethoxy)methane	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Bis(2-chloroethyl) ether	Yes	NV
2-Chloronaphthalene	Yes	NV	Bis(2-chloroisopropyl) ether	Yes	NV
2-Chlorophenol	Yes	NV	Bis(2-ethylhexyl)phthalate	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	NV	Butyl benzyl phthalate	Yes	NV
2-Methylnaphthalene	Yes	NV	Carbazole	Yes	NV
2-Methylphenol	Yes	NV	Di-n-octylphthalate	Yes	NV
2-Nitrobenzenamine	Yes	NV	Hexachloroethane	Yes	NV
2-Nitrophenol	Yes	NV	Isophorone	Yes	NV
3,3’-Dichlorobenzidine	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
3-Nitrobenzenamine	Yes	NV	Pentachlorophenol	Yes	ASL
4-Bromophenyl phenyl ether	Yes	NV	Phenol	Yes	ASL
4-Chloro-3-methylphenol	Yes	NV	Pyridine	Yes	ASL
Volatile organic analytes					
1,1,1-Trichloroethane	Yes	NV	Acetone	Yes	NV
1,1,2,2-Tetrachloroethane	Yes	NV	Bromodichloromethane	Yes	NV
1,1,2-Trichloroethane	Yes	NV	Bromoform	Yes	NV
1,1-Dichloroethane	Yes	NV	Bromomethane	Yes	NV
1,1-Dichloroethene	Yes	NV	Carbon disulfide	Yes	NV
1,2-Dichlorobenzene	Yes	NV	m,p-Xylene	Yes	NV
1,2-Dimethylbenzene	Yes	NV	Methylene chloride	Yes	NV
1,4-Dichlorobenzene	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
2-Butanone	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
2-Hexanone	Yes	NV	Trichloroethene	Yes	ASL
4-Methyl-2-pentanone	Yes	NV			

Rationale: ASL – Above screening value NV – No screening value

Table E.8. Outfall 001 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Dioxins/furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Yes	ASL			
Metals					
Aluminum	Yes	ASL	Manganese	Yes	ASL
Antimony	Yes	ASL	Mercury	Yes	ASL
Arsenic	Yes	ASL	Nickel	Yes	ASL
Barium	Yes	ASL	Phosphorous	Yes	NV
Beryllium	Yes	ASL	Potassium	Yes	NV
Boron	Yes	ASL	Selenium	Yes	ASL
Cadmium	Yes	ASL	Silver	Yes	ASL
Calcium	Yes	NV	Sodium	Yes	NV
Chromium	Yes	ASL	Thallium	Yes	ASL
Copper	Yes	ASL	Tin	Yes	ASL
Cyanide	Yes	ASL	Titanium	Yes	NV
Iron	Yes	ASL	Total metals	Yes	NV
Lead	Yes	ASL	Uranium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	ASL	PCB-1254	Yes	ASL
PCB-1221	Yes	ASL	PCB-1260	Yes	ASL
PCB-1232	Yes	ASL	PCB-1268	Yes	NV
PCB-1242	Yes	ASL	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	ASL			
Radionuclides					
Activity of U-235	Yes	NV	Suspended alpha	Yes	NV
Alpha activity	Yes	NV	Suspended beta	Yes	NV
Beta activity	Yes	NV	Thorium-234	Yes	NV
Gamma Activity	Yes	NV	Tritium	Yes	NV
Radium	Yes	NV			
Semivolatile organic analytes					
1,2-Diphenylhydrazine	Yes	ASL	Carbazole	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	Chlordane	Yes	ASL
2,4,6-Trichlorophenol	Yes	ASL	delta-BHC	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Dieldrin	Yes	ASL
2-Chloronaphthalene	Yes	NV	Di-n-octylphthalate	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	ASL	Endosulfan sulfate	Yes	NV
2-Methylnaphthalene	Yes	NV	Endrin	Yes	ASL
2-Methylphenol	Yes	NV	Endrin aldehyde	Yes	NV
2-Nitrobenzenamine	Yes	NV	Endrin ketone	Yes	NV
3,3'-Dichlorobenzidine	Yes	NV	gamma-Chlordane	Yes	NV
3-Nitrobenzenamine	Yes	NV	Heptachlor	Yes	ASL
4,4'-DDD	Yes	ASL	Heptachlor epoxide	Yes	ASL
4,4'-DDE	Yes	ASL	Hexachlorobenzene	Yes	NV
4,4'-DDT	Yes	ASL	Hexachlorobutadiene	Yes	ASL
4-Bromophenyl phenyl ether	Yes	NV	Hexachlorocyclopentadiene	Yes	ASL
4-Chloro-3-methylphenol	Yes	NV	m,p-Cresol	Yes	NV
4-Chlorobenzenamine	Yes	NV	Methoxychlor	Yes	ASL
4-Chlorophenyl phenyl ether	Yes	NV	N-Nitrosodimethylamine	Yes	NV
4-Nitrobenzenamine	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
alpha-Chlordane	Yes	NV	Phenol	Yes	ASL
Bis(2-chloroethoxy)methane	Yes	NV	Pyridine	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	Toxaphene	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	ASL			

Table E.8 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Volatile organic analytes					
1,2-Dibromoethane	Yes	NV	Chloromethane	Yes	NV
2-Hexanone	Yes	NV	cis-1,2-Dichloroethene	Yes	NV
2-Propanol	Yes	ASL	cis-1,3-Dichloropropene	Yes	NV
4-Methyl-2-pentanone	Yes	NV	Dibromochloromethane	Yes	NV
Acrolein	Yes	ASL	MBAS	Yes	NV
Bromodichloromethane	Yes	NV	Styrene	Yes	NV
Bromomethane	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
Carbon disulfide	Yes	ASL	trans-1,3-Dichloropropene	Yes	NV
Chloroethane	Yes	NV	Vinyl chloride	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.9. Outfall 001 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Selenium	Yes	ASL
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Cyanide	Yes	NV	Uranium	Yes	NV
Iron	Yes	ASL	Vanadium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Technetium-99	Yes	NV
Alpha activity	Yes	NV	Tritium	Yes	NV
Beta activity	Yes	NV			
Semivolatile organic analytes					
1,1-Biphenyl	Yes	NV	2,6,10,14-Tetramethylhexadecane	Yes	NV
1,2,4-Trichlorobenzene	Yes	NV	2,6,10,14-Tetramethylpentadecane	Yes	NV
1,2-Diphenylhydrazine	Yes	NV	2,6-Dichlorophenol	Yes	NV
1,3-Dichlorobenzene	Yes	ASL	2,6-Dinitrotoluene	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	2-Chloronaphthalene	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	2-Chlorophenol	Yes	NV
2,4'-DDD	Yes	NV	2-Methyl-4,6-dinitrophenol	Yes	NV
2,4'-DDE	Yes	NV	2-Methylnaphthalene	Yes	NV
2,4'-DDT	Yes	NV	2-Methylphenol	Yes	NV
2,4-Dichlorophenol	Yes	NV	2-Nitrobenzenamine	Yes	NV
2,4-Dimethylphenol	Yes	NV	2-Nitrophenol	Yes	NV
2,4-Dinitrophenol	Yes	NV	3,3'-Dichlorobenzidine	Yes	NV
2,4-Dinitrotoluene	Yes	NV	3-Nitrobenzenamine	Yes	NV

Table E.9 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
4,4'-DDD	Yes	ASL	Hexachlorobenzene	Yes	NV
4,4'-DDE	Yes	ASL	Hexachlorobutadiene	Yes	NV
4,4'-DDT	Yes	ASL	Hexachlorocyclopentadiene	Yes	NV
4-Bromophenyl phenyl ether	Yes	NV	Hexachloroethane	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	Hexacosane	Yes	NV
4-Chlorobenzenamine	Yes	NV	Hexadecane	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Isophorone	Yes	NV
4-Methylphenol	Yes	NV	Lindane	Yes	ASL
4-Nitrobenzenamine	Yes	NV	m,p-Cresol	Yes	NV
4-Nitrophenol	Yes	NV	Malathion	Yes	ASL
Aldrin	Yes	NV	Methoxychlor	Yes	NV
alpha-BHC	Yes	NV	Methyl parathion	Yes	NV
alpha-Chlordane	Yes	NV	Mirex	Yes	NV
Aniline	Yes	NV	Mocap	Yes	NV
Azinphos-methyl	Yes	NV	n-Hentriacontane	Yes	NV
Benzenemethanol	Yes	NV	Nitrobenzene	Yes	NV
Benzidine	Yes	NV	N-Nitrosodimethylamine	Yes	NV
Benzo(e)pyrene	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
Benzoic acid	Yes	NV	N-Nitrosodiphenylamine	Yes	NV
beta-BHC	Yes	NV	n-Octacosane	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	Nonacosane	Yes	NV
Bis(2-chloroethyl) ether	Yes	NV	Nonadecane	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	n-Pentacosane	Yes	NV
Bis(2-ethylhexyl)phthalate	Yes	ASL	n-Tetracosane	Yes	NV
Butyl benzyl phthalate	Yes	NV	n-Triacontane	Yes	NV
Carbazole	Yes	NV	n-Tricosane	Yes	NV
Chlordane	Yes	ASL	n-Tritriacontane	Yes	NV
Co-Ral	Yes	NV	Octadecane	Yes	NV
delta-BHC	Yes	NV	Parathion	Yes	NV
Demeton	Yes	NV	Pentachlorophenol	Yes	NV
Dibenzofuran	Yes	NV	Pentadecane	Yes	NV
Dichlorvos	Yes	NV	Perylene	Yes	NV
Dieldrin	Yes	ASL	Phenol	Yes	NV
Diethyl phthalate	Yes	ASL	Phorate	Yes	NV
Dimethoate	Yes	NV	Pyridine	Yes	NV
Dimethyl phthalate	Yes	NV	Tetradecane	Yes	NV
Di-n-butyl phthalate	Yes	NV	Tetratriacontane	Yes	NV
Di-n-octylphthalate	Yes	NV	Toxaphene	Yes	ASL
Docosane	Yes	NV	Tridecane	Yes	NV
Dodecane	Yes	NV	Undecane	Yes	NV
Dotriacontane	Yes	NV	Acenaphthene	Yes	ASL
Eicosane	Yes	NV	Acenaphthylene	Yes	NV
Endosulfan I	Yes	ASL	Anthracene	Yes	ASL
Endosulfan II	Yes	ASL	Benz(a)anthracene	Yes	ASL
Endosulfan sulfate	Yes	NV	Benzo(a)pyrene	Yes	ASL
Endrin	Yes	ASL	Benzo(b)fluoranthene	Yes	ASL
Endrin aldehyde	Yes	NV	Benzo(ghi)perylene	Yes	NV
Ethion	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
Famphur	Yes	NV	Chrysene	Yes	ASL
Fensulfothion	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
Fenthion	Yes	NV	Fluoranthene	Yes	ASL
gamma-Chlordane	Yes	NV	Fluorene	Yes	ASL
Henicosane	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Heptachlor	Yes	NV	Naphthalene	Yes	ASL
Heptachlor epoxide	Yes	ASL	Phenanthrene	Yes	ASL
Heptacosane	Yes	NV	Pyrene	Yes	ASL
Heptadecane	Yes	NV			

Table E.9 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Volatile organic analytes					
1,2-Dichlorobenzene	Yes	ASL	2,6-Dimethylnaphthalene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Decane	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.10. Outfall 001 Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Magnesium	Yes	NV
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	ASL	Nickel	Yes	ASL
Beryllium	Yes	ASL	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silver	Yes	ASL
Chromium	Yes	ASL	Sodium	Yes	NV
Cobalt	Yes	ASL	Thallium	Yes	ASL
Copper	Yes	ASL	Tin	Yes	ASL
Iron	Yes	ASL	Uranium	Yes	ASL
Lead	Yes	ASL	Vanadium	Yes	ASL
Lithium	Yes	ASL	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Alpha activity	Yes	NV	Iridium-192	Yes	NV
Antimony-124	Yes	NV	Iron-59	Yes	NV
Barium-133	Yes	NV	Manganese-54	Yes	NV
Barium-140	Yes	NV	Mercury-203	Yes	NV
Beta activity	Yes	NV	Neodymium-147	Yes	NV
Cerium-139	Yes	NV	Neptunium-239	Yes	NV
Cerium-141	Yes	NV	Niobium-94	Yes	NV
Cerium-144	Yes	NV	Niobium-95	Yes	NV
Cesium-136	Yes	NV	Promethium-146	Yes	NV
Chromium-51	Yes	NV	Silver-110m	Yes	NV
Cobalt-56	Yes	NV	Sodium-22	Yes	NV
Cobalt-57	Yes	NV	Tin-113	Yes	NV
Cobalt-58	Yes	NV	Yttrium-88	Yes	NV
Europium-152	Yes	NV	Zirconium-95	Yes	NV
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	2-Methylnaphthalene	Yes	NV
1,3-Dichlorobenzene	Yes	NV	2-Methylphenol	Yes	NV
2,4-Dichlorophenol	Yes	NV	2-Nitrobenzenamine	Yes	NV
2,4-Dimethylphenol	Yes	NV	2-Nitrophenol	Yes	NV
2,4-Dinitrotoluene	Yes	NV	3,3'-Dichlorobenzidine	Yes	NV
2,6-Dinitrotoluene	Yes	NV	3-Nitrobenzenamine	Yes	NV
2-Chloronaphthalene	Yes	NV	4-Bromophenyl phenyl ether	Yes	NV
2-Chlorophenol	Yes	NV	4-Chloro-3-methylphenol	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	NV	4-Chlorobenzenamine	Yes	NV

Table E.10 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
4-Chlorophenyl phenyl ether	Yes	NV	Pyridine	Yes	ASL
4-Methylphenol	Yes	NV	Acenaphthene	Yes	BSL
4-Nitrobenzenamine	Yes	NV	Acenaphthylene	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	Anthracene	Yes	ASL
Bis(2-chloroethyl) ether	Yes	NV	Benz(a)anthracene	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	Benzo(a)pyrene	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	NV	Benzo(b)fluoranthene	Yes	NV
Butyl benzyl phthalate	Yes	NV	Benzo(ghi)perylene	Yes	NV
Carbazole	Yes	NV	Benzo(k)fluoranthene	Yes	NV
Dibenzofuran	Yes	NV	Chrysene	Yes	NV
Di-n-octylphthalate	Yes	NV	Dibenz(a,h)anthracene	Yes	NV
Hexachlorobenzene	Yes	ASL	Fluoranthene	Yes	ASL
Hexachlorobutadiene	Yes	NV	Fluorene	Yes	NV
Hexachloroethane	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	NV
Isophorone	Yes	NV	Naphthalene	Yes	ASL
N-Nitroso-di-n-propylamine	Yes	NV	Phenanthrene	Yes	ASL
Pentachlorophenol	Yes	ASL	Pyrene	Yes	ASL
Phenol	Yes	ASL	Total PAHs	Yes	ASL
Volatile organic analytes					
1,1,1-Trichloroethane	Yes	NV	Acetone	Yes	NV
1,1,2,2-Tetrachloroethane	Yes	NV	Bromodichloromethane	Yes	NV
1,1,2-Trichloroethane	Yes	NV	Bromoform	Yes	NV
1,1-Dichloroethane	Yes	NV	Bromomethane	Yes	NV
1,1-Dichloroethene	Yes	NV	Carbon disulfide	Yes	NV
1,2-Dichlorobenzene	Yes	NV	m,p-Xylene	Yes	NV
1,2-Dimethylbenzene	Yes	NV	Methylene chloride	Yes	NV
1,4-Dichlorobenzene	Yes	NV	Tetrachloroethene	Yes	ASL
2-Butanone	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
2-Hexanone	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
4-Methyl-2-pentanone	Yes	NV	Trichloroethene	Yes	ASL

Rationale: ASL – Above screening value NV – No screening value

Table E.11. Outfall 002 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Magnesium	Yes	NV
Barium	Yes	ASL	Mercury	Yes	ASL
Beryllium	Yes	ASL	Nickel	Yes	ASL
Cadmium	Yes	ASL	Phosphorous	Yes	NV
Calcium	Yes	NV	Potassium	Yes	NV
Copper	Yes	ASL	Silver	Yes	ASL
Cyanide	Yes	ASL	Sodium	Yes	NV
Iron	Yes	ASL	Thallium	Yes	ASL
Lead	Yes	ASL	Uranium	Yes	ASL
Radionuclides					
Activity of U-235	Yes	NV	Suspended beta	Yes	NV
Suspended alpha	Yes	NV	Thorium-234	Yes	NV
Volatile organic analytes					
2-Propanol	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.12. Outfall 002 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Molybdenum	Yes	NV
Barium	Yes	NV	Potassium	Yes	NV
Beryllium	Yes	NV	Selenium	Yes	ASL
Cadmium	Yes	ASL	Silver	Yes	ASL
Calcium	Yes	NV	Sodium	Yes	NV
Chromium	Yes	ASL	Thallium	Yes	NV
Cobalt	Yes	NV	Uranium	Yes	NV
Iron	Yes	ASL	Vanadium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV
Semivolatile organic analytes					
Acenaphthene	Yes	ASL	Dibenz(a,h)anthracene	Yes	ASL
Acenaphthylene	Yes	NV	Fluoranthene	Yes	ASL
Anthracene	Yes	ASL	Fluorene	Yes	ASL
Benz(a)anthracene	Yes	ASL	Indeno(1,2,3-cd)pyrene	Yes	ASL
Benzo(a)pyrene	Yes	ASL	Naphthalene	Yes	ASL
Benzo(b)fluoranthene	Yes	ASL	Phenanthrene	Yes	ASL
Benzo(ghi)perylene	Yes	NV	Pyrene	Yes	ASL
Benzo(k)fluoranthene	Yes	ASL	Total PAHs	Yes	ASL
Chrysene	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.13. Outfall 002 Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Radionuclides					
Alpha activity	Yes	NV	Iridium-192	Yes	NV
Antimony-124	Yes	NV	Iron-59	Yes	NV
Barium-133	Yes	NV	Manganese-54	Yes	NV
Barium-140	Yes	NV	Mercury-203	Yes	NV
Beta activity	Yes	NV	Neodymium-147	Yes	NV
Cerium-139	Yes	NV	Neptunium-239	Yes	NV
Cerium-141	Yes	NV	Niobium-94	Yes	NV
Cerium-144	Yes	NV	Niobium-95	Yes	NV
Cesium-136	Yes	NV	Promethium-146	Yes	NV
Chromium-51	Yes	NV	Silver-110m	Yes	NV
Cobalt-56	Yes	NV	Sodium-22	Yes	NV
Cobalt-57	Yes	NV	Tin-113	Yes	NV
Cobalt-58	Yes	NV	Yttrium-88	Yes	NV
Europium-152	Yes	NV	Zirconium-95	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.14. Outfall 008 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Magnesium	Yes	NV
Barium	Yes	ASL	Mercury	Yes	ASL
Beryllium	Yes	ASL	Phosphorous	Yes	NV
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Silver	Yes	ASL
Copper	Yes	ASL	Sodium	Yes	NV
Cyanide	Yes	ASL	Thallium	Yes	ASL
Iron	Yes	ASL	Uranium	Yes	ASL
Lead	Yes	ASL			
Polychlorinated biphenyls					
PCB-1016	Yes	ASL	PCB-1254	Yes	ASL
PCB-1221	Yes	ASL	PCB-1260	Yes	ASL
PCB-1232	Yes	ASL	PCB-1268	Yes	NV
PCB-1242	Yes	ASL	Polychlorinated biphenyls (PCBs)	Yes	ASL
PCB-1248	Yes	ASL			
Radionuclides					
Activity of U-235	Yes	NV	Suspended beta	Yes	NV
Suspended alpha	Yes	NV	Thorium-234	Yes	NV
Volatile organic analytes					
2-Propanol	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.15. Outfall 008 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Boron	Yes	NV	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silicon	Yes	NV
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Cyanide	Yes	NV	Uranium	Yes	NV
Iron	Yes	ASL	Vanadium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1262	Yes	NV
PCB-1242	Yes	NV	PCB-1268	Yes	NV
PCB-1248	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV

Table E.15 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	Diethyl phthalate	Yes	ASL
1,3-Dichlorobenzene	Yes	ASL	Dimethyl phthalate	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	Di-n-butyl phthalate	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	Di-n-octylphthalate	Yes	NV
2,4-Dichlorophenol	Yes	NV	Hexachlorobenzene	Yes	NV
2,4-Dimethylphenol	Yes	NV	Hexachlorobutadiene	Yes	NV
2,4-Dinitrophenol	Yes	NV	Hexachlorocyclopentadiene	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Hexachloroethane	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Isophorone	Yes	NV
2-Chloronaphthalene	Yes	NV	Nitrobenzene	Yes	NV
2-Chlorophenol	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	NV	N-Nitrosodiphenylamine	Yes	NV
2-Methylnaphthalene	Yes	NV	Pentachlorophenol	Yes	NV
2-Methylphenol	Yes	NV	Phenol	Yes	NV
2-Nitrobenzenamine	Yes	NV	Acenaphthene	Yes	ASL
2-Nitrophenol	Yes	NV	Acenaphthylene	Yes	NV
3,3'-Dichlorobenzidine	Yes	NV	Anthracene	Yes	ASL
3-Nitrobenzenamine	Yes	NV	Benz(a)anthracene	Yes	ASL
4-Bromophenyl phenyl ether	Yes	NV	Benzo(a)pyrene	Yes	ASL
4-Chloro-3-methylphenol	Yes	NV	Benzo(b)fluoranthene	Yes	ASL
4-Chlorobenzenamine	Yes	NV	Benzo(ghi)perylene	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
4-Methylphenol	Yes	NV	Chrysene	Yes	ASL
4-Nitrobenzenamine	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
4-Nitrophenol	Yes	NV	Fluoranthene	Yes	ASL
Bis(2-chloroethoxy)methane	Yes	NV	Fluorene	Yes	ASL
Bis(2-chloroethyl) ether	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Bis(2-chloroisopropyl) ether	Yes	NV	Naphthalene	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	ASL	Phenanthrene	Yes	ASL
Butyl benzyl phthalate	Yes	NV	Pyrene	Yes	ASL
Carbazole	Yes	NV	Total PAHs	Yes	ASL
Dibenzofuran	Yes	NV			
Volatile organic analytes					
1,1,2,2-Tetrachloroethane	Yes	NV	Chlorobenzene	Yes	NV
1,1-Dichloroethene	Yes	ASL	Chloroethane	Yes	NV
1,2-Dichlorobenzene	Yes	ASL	Chloromethane	Yes	NV
1,2-Dichloropropane	Yes	NV	cis-1,2-Dichloroethene	Yes	NV
1,2-Dimethylbenzene	Yes	NV	cis-1,3-Dichloropropene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Dibromochloromethane	Yes	NV
2-Butanone	Yes	NV	m,p-Xylene	Yes	NV
2-Hexanone	Yes	NV	Methylene chloride	Yes	NV
4-Methyl-2-pentanone	Yes	NV	Styrene	Yes	NV
Bromodichloromethane	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
Bromoform	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
Bromomethane	Yes	NV	Vinyl chloride	Yes	NV
Carbon disulfide	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.16. Outfall 008 Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Magnesium	Yes	NV
Arsenic	Yes	ASL	Manganese	Yes	ASL
Barium	Yes	ASL	Mercury	Yes	ASL
Beryllium	Yes	ASL	Nickel	Yes	ASL
Boron	Yes	ASL	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silicon	Yes	NV
Chromium	Yes	ASL	Sodium	Yes	NV
Cobalt	Yes	ASL	Thallium	Yes	ASL
Copper	Yes	ASL	Tin	Yes	ASL
Iron	Yes	ASL	Uranium	Yes	ASL
Lead	Yes	ASL	Vanadium	Yes	ASL
Lithium	Yes	ASL	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1262	Yes	NV
PCB-1242	Yes	NV	PCB-1268	Yes	NV
PCB-1248	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
Radionuclides					
Alpha activity	Yes	NV	Iridium-192	Yes	NV
Antimony-124	Yes	NV	Iron-59	Yes	NV
Barium-133	Yes	NV	Manganese-54	Yes	NV
Barium-140	Yes	NV	Mercury-203	Yes	NV
Beta activity	Yes	NV	Neodymium-147	Yes	NV
Cerium-139	Yes	NV	Neptunium-239	Yes	NV
Cerium-141	Yes	NV	Niobium-94	Yes	NV
Cerium-144	Yes	NV	Niobium-95	Yes	NV
Cesium-136	Yes	NV	Promethium-146	Yes	NV
Chromium-51	Yes	NV	Silver-110m	Yes	NV
Cobalt-56	Yes	NV	Sodium-22	Yes	NV
Cobalt-57	Yes	NV	Tin-113	Yes	NV
Cobalt-58	Yes	NV	Yttrium-88	Yes	NV
Europium-152	Yes	NV			

Rationale: ASL – Above screening value NV – No screening value

Table E.17. Outfall 010 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	ASL	Nickel	Yes	ASL
Beryllium	Yes	ASL	Phosphorous	Yes	NV
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Silver	Yes	ASL
Copper	Yes	ASL	Sodium	Yes	NV
Cyanide	Yes	ASL	Thallium	Yes	ASL
Iron	Yes	ASL	Uranium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Suspended Alpha	Yes	NV
Alpha activity	Yes	NV	Suspended Beta	Yes	NV
Beta activity	Yes	NV	Thorium-234	Yes	NV
Volatile organic analytes					
2-Hexanone	Yes	NV	cis-1,2-Dichloroethene	Yes	NV
2-Propanol	Yes	ASL	cis-1,3-Dichloropropene	Yes	NV
4-Methyl-2-pentanone	Yes	NV	Dibromochloromethane	Yes	NV
Bromodichloromethane	Yes	NV	Styrene	Yes	NV
Carbon disulfide	Yes	ASL	trans-1,2-Dichloroethene	Yes	NV
Chloroethane	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
Chloromethane	Yes	NV			

Rationale: ASL – Above screening value NV – No screening value

Table E.18. Outfall 010 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Boron	Yes	NV	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silicon	Yes	NV
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Iron	Yes	ASL	Uranium	Yes	NV
Lead	Yes	ASL	Vanadium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1262	Yes	NV
PCB-1242	Yes	NV	PCB-1268	Yes	NV
PCB-1248	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV

Table E.18 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes					
1,1-biphenyl	Yes	NV	Endrin	Yes	ASL
1,2,4-Trichlorobenzene	Yes	NV	Endrin aldehyde	Yes	NV
1,2-Diphenylhydrazine	Yes	NV	Ethion	Yes	NV
1,3-Dichlorobenzene	Yes	ASL	Famphur	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	Fensulfothion	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	Fenthion	Yes	NV
2,4'-DDD	Yes	NV	gamma-Chlordane	Yes	NV
2,4'-DDE	Yes	NV	Henicosane	Yes	NV
2,4'-DDT	Yes	NV	Heptachlor	Yes	NV
2,4-Dichlorophenol	Yes	NV	Heptachlor epoxide	Yes	ASL
2,4-Dimethylphenol	Yes	NV	Heptacosane	Yes	NV
2,4-Dinitrophenol	Yes	NV	Heptadecane	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Hexachlorobenzene	Yes	NV
2,6,10,14-Tetramethylhexadecane	Yes	NV	Hexachlorobutadiene	Yes	NV
2,6,10,14-Tetramethylpentadecane	Yes	NV	Hexachlorocyclopentadiene	Yes	NV
2,6-Dichlorophenol	Yes	NV	Hexachloroethane	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Hexacosane	Yes	NV
2-Chloronaphthalene	Yes	NV	Hexadecane	Yes	NV
2-Chlorophenol	Yes	NV	Isophorone	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	NV	Lindane	Yes	ASL
2-Methylnaphthalene	Yes	NV	m,p-Cresol	Yes	NV
2-Methylphenol	Yes	NV	Malathion	Yes	ASL
2-Nitrobenzenamine	Yes	NV	Methoxychlor	Yes	NV
2-Nitrophenol	Yes	NV	Methyl parathion	Yes	NV
3,3'-Dichlorobenzidine	Yes	NV	Mirex	Yes	NV
3-Nitrobenzenamine	Yes	NV	Mocap	Yes	NV
4,4'-DDD	Yes	ASL	n-Hentriacontane	Yes	NV
4,4'-DDE	Yes	ASL	Nitrobenzene	Yes	NV
4,4'-DDT	Yes	ASL	N-Nitrosodimethylamine	Yes	NV
4-Bromophenyl phenyl ether	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	N-Nitrosodiphenylamine	Yes	NV
4-Chlorobenzenamine	Yes	NV	n-Octacosane	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Nonacosane	Yes	NV
4-Methylphenol	Yes	NV	Nonadecane	Yes	NV
4-Nitrobenzenamine	Yes	NV	n-Pentacosane	Yes	NV
4-Nitrophenol	Yes	NV	n-Tetracosane	Yes	NV
Aldrin	Yes	NV	n-Triacontane	Yes	NV
alpha-BHC	Yes	NV	n-Tricosane	Yes	NV
alpha-Chlordane	Yes	NV	n-Tritriacontane	Yes	NV
Aniline	Yes	NV	Octadecane	Yes	NV
Azinphos-methyl	Yes	NV	Parathion	Yes	NV
Benzenemethanol	Yes	NV	Pentachlorophenol	Yes	NV
Benzidine	Yes	NV	Pentadecane	Yes	NV
Benzo(e)pyrene	Yes	NV	Perylene	Yes	NV
Benzoic acid	Yes	NV	Phenol	Yes	NV
beta-BHC	Yes	NV	Phorate	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	Pyridine	Yes	NV
Bis(2-chloroethyl) ether	Yes	NV	Tetradecane	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	Tetratriacontane	Yes	NV
Bis(2-ethylhexyl)phthalate	Yes	ASL	Toxaphene	Yes	ASL
Butyl benzyl phthalate	Yes	NV	Tridecane	Yes	NV
Carbazole	Yes	NV	Undecane	Yes	NV
Chlordane	Yes	ASL	Acenaphthene	Yes	ASL

Table E.18 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
Co-Ral	Yes	NV	Acenaphthylene	Yes	NV
delta-BHC	Yes	NV	Anthracene	Yes	ASL
Dibenzofuran	Yes	NV	Benz(a)anthracene	Yes	ASL
Dichlorvos	Yes	NV	Benzo(a)pyrene	Yes	ASL
Dieldrin	Yes	ASL	Benzo(b)fluoranthene	Yes	ASL
Diethyl phthalate	Yes	ASL	Benzo(ghi)perylene	Yes	NV
Dimethoate	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
Dimethyl phthalate	Yes	NV	Chrysene	Yes	ASL
Di-n-butyl phthalate	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
Di-n-octylphthalate	Yes	NV	Fluoranthene	Yes	ASL
Docosane	Yes	NV	Fluorene	Yes	ASL
Dodecane	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Dotriacontane	Yes	NV	Naphthalene	Yes	ASL
Eicosane	Yes	NV	Phenanthrene	Yes	ASL
Endosulfan I	Yes	ASL	Pyrene	Yes	ASL
Endosulfan II	Yes	ASL	Total PAHs	Yes	ASL
Endosulfan sulfate	Yes	NV			
Volatile organic analytes					
1,2-Dichlorobenzene	Yes	ASL	2,6-Dimethylnaphthalene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Decane	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.19. Outfall 010 Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Dioxins/furans					
1,2,3,4,6,7,8-Heptachlorodibenzofuran	Yes	NV	1,2,3,7,8-Pentachlorodibenzofuran	Yes	NV
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	Yes	NV	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	Yes	NV
1,2,3,4,7,8,9-Heptachlorodibenzofuran	Yes	NV	2,3,4,6,7,8-Hexachlorodibenzofuran	Yes	NV
1,2,3,4,7,8-Hexachlorodibenzofuran	Yes	NV	2,3,4,7,8-Pentachlorodibenzofuran	Yes	NV
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	Yes	NV	2,3,7,8-Tetrachlorodibenzofuran	Yes	NV
1,2,3,6,7,8-Hexachlorodibenzofuran	Yes	NV	2,3,7,8-Tetrachlorodibenzo-p-dioxin	Yes	NV
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	Yes	NV	Octachloro-dibenzo[b,e][1,4]dioxin	Yes	NV
1,2,3,7,8,9-Hexachlorodibenzofuran	Yes	NV	Octachlorodibenzofuran	Yes	NV
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	Yes	NV			
Metals					
Aluminum	Yes	ASL	Magnesium	Yes	NV
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	ASL	Molybdenum	Yes	ASL
Beryllium	Yes	ASL	Nickel	Yes	ASL
Boron	Yes	ASL	Potassium	Yes	NV
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silver	Yes	ASL
Chromium	Yes	ASL	Sodium	Yes	NV
Cobalt	Yes	ASL	Strontium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	ASL
Iron	Yes	ASL	Vanadium	Yes	ASL
Lithium	Yes	ASL	Zinc	Yes	ASL

Table E.19 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Alpha activity	Yes	NV	Beta activity	Yes	NV
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	Dibenzofuran	Yes	NV
1,3-Dichlorobenzene	Yes	NV	Di-n-octylphthalate	Yes	NV
2,4-Dichlorophenol	Yes	NV	Hexachlorobenzene	Yes	ASL
2,4-Dimethylphenol	Yes	NV	Hexachlorobutadiene	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Hexachloroethane	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Isophorone	Yes	NV
2-Chloronaphthalene	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
2-Chlorophenol	Yes	NV	Pentachlorophenol	Yes	ASL
2-Methyl-4,6-dinitrophenol	Yes	NV	Phenol	Yes	ASL
2-Methylnaphthalene	Yes	NV	Pyridine	Yes	ASL
2-Methylphenol	Yes	NV	Acenaphthene	Yes	BSL
2-Nitrobenzenamine	Yes	NV	Acenaphthylene	Yes	NV
2-Nitrophenol	Yes	NV	Anthracene	Yes	ASL
3,3'-Dichlorobenzidine	Yes	NV	Benz(a)anthracene	Yes	NV
3-Nitrobenzenamine	Yes	NV	Benzo(a)pyrene	Yes	ASL
4-Bromophenyl phenyl ether	Yes	NV	Benzo(b)fluoranthene	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	Benzo(ghi)perylene	Yes	NV
4-Chlorobenzenamine	Yes	NV	Benzo(k)fluoranthene	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Chrysene	Yes	NV
4-Methylphenol	Yes	NV	Dibenz(a,h)anthracene	Yes	NV
4-Nitrobenzenamine	Yes	NV	Fluoranthene	Yes	ASL
Bis(2-chloroethoxy)methane	Yes	NV	Fluorene	Yes	NV
Bis(2-chloroethyl) ether	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	Naphthalene	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	NV	Phenanthrene	Yes	ASL
Butyl benzyl phthalate	Yes	NV	Pyrene	Yes	ASL
Carbazole	Yes	NV	Total PAHs	Yes	ASL
Volatile organic analytes					
1,1-Dichloroethene	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
1,2-Dichlorobenzene	Yes	NV	Trichloroethene	Yes	ASL
1,4-Dichlorobenzene	Yes	NV	Vinyl chloride	Yes	ASL
cis-1,2-Dichloroethene	Yes	NV			

Rationale: ASL – Above screening value NV – No screening value

Table E.20. Outfall 011 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	ASL	Nickel	Yes	ASL
Beryllium	Yes	ASL	Phosphorous	Yes	NV
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Selenium	Yes	ASL
Copper	Yes	ASL	Silver	Yes	ASL
Cyanide	Yes	ASL	Sodium	Yes	NV
Iron	Yes	ASL	Thallium	Yes	ASL
Lead	Yes	ASL	Uranium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	ASL	PCB-1254	Yes	ASL
PCB-1221	Yes	ASL	PCB-1260	Yes	ASL
PCB-1232	Yes	ASL	PCB-1268	Yes	NV
PCB-1242	Yes	ASL	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	ASL			
Radionuclides					
Activity of U-235	Yes	NV	Suspended Beta	Yes	NV
Suspended Alpha	Yes	NV	Thorium-234	Yes	NV
Semivolatile organic analytes					
1,1-biphenyl	Yes	NV	Endosulfan sulfate	Yes	NV
2,4'-DDD	Yes	NV	Endrin	Yes	ASL
2,4'-DDE	Yes	NV	Endrin aldehyde	Yes	NV
2,4'-DDT	Yes	NV	Ethion	Yes	NV
2-Methylnaphthalene	Yes	NV	Famphur	Yes	NV
4,4'-DDD	Yes	ASL	Fensulfothion	Yes	NV
4,4'-DDE	Yes	ASL	Fenthion	Yes	NV
4,4'-DDT	Yes	ASL	gamma-Chlordane	Yes	NV
alpha-Chlordane	Yes	NV	Heptachlor	Yes	ASL
Azinphos-methyl	Yes	NV	Heptachlor epoxide	Yes	ASL
Benzo(e)pyrene	Yes	NV	Malathion	Yes	ASL
Chlordane	Yes	ASL	Methoxychlor	Yes	ASL
Co-Ral	Yes	NV	Methyl parathion	Yes	NV
delta-BHC	Yes	NV	Mirex	Yes	ASL
Diazinon	Yes	NV	Mocap	Yes	NV
Dibenzothiophene	Yes	NV	Parathion	Yes	ASL
Dichlorvos	Yes	NV	Perylene	Yes	NV
Dieldrin	Yes	ASL	Phorate	Yes	NV
Dimethoate	Yes	NV	Toxaphene	Yes	ASL
Volatile organic analytes					
2,6-Dimethylnaphthalene	Yes	NV	Trichloroethene	Yes	ASL
2-Propanol	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.21. Outfall 011 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Selenium	Yes	ASL
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Iron	Yes	ASL	Uranium	Yes	NV
Lead	Yes	ASL	Vanadium	Yes	ASL
Magnesium	Yes	NV	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Iridium-192	Yes	NV
Alpha activity	Yes	NV	Iron-59	Yes	NV
Antimony-124	Yes	NV	Manganese-54	Yes	NV
Barium-133	Yes	NV	Mercury-203	Yes	NV
Barium-140	Yes	NV	Neodymium-147	Yes	NV
Beta activity	Yes	NV	Neptunium-239	Yes	NV
Cerium-139	Yes	NV	Niobium-94	Yes	NV
Cerium-141	Yes	NV	Niobium-95	Yes	NV
Cerium-144	Yes	NV	Promethium-146	Yes	NV
Cesium-136	Yes	NV	Silver-110m	Yes	NV
Chromium-51	Yes	NV	Sodium-22	Yes	NV
Cobalt-56	Yes	NV	Technetium-99	Yes	NV
Cobalt-57	Yes	NV	Tin-113	Yes	NV
Cobalt-58	Yes	NV	Yttrium-88	Yes	NV
Europium-152	Yes	NV	Zirconium-95	Yes	NV
Semivolatile organic analytes					
1,1-Biphenyl	Yes	NV	2-Methylnaphthalene	Yes	NV
1,2,4-Trichlorobenzene	Yes	NV	2-Methylphenol	Yes	NV
1,2-Diphenylhydrazine	Yes	NV	2-Nitrobenzenamine	Yes	NV
1,3-Dichlorobenzene	Yes	ASL	2-Nitrophenol	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	3,3'-Dichlorobenzidine	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	3-Nitrobenzenamine	Yes	NV
2,4'-DDD	Yes	NV	4,4'-DDD	Yes	ASL
2,4'-DDE	Yes	NV	4,4'-DDE	Yes	ASL
2,4'-DDT	Yes	NV	4,4'-DDT	Yes	ASL
2,4-Dichlorophenol	Yes	NV	4-Bromophenyl phenyl ether	Yes	NV
2,4-Dimethylphenol	Yes	NV	4-Chloro-3-methylphenol	Yes	NV
2,4-Dinitrophenol	Yes	NV	4-Chlorobenzenamine	Yes	NV
2,4-Dinitrotoluene	Yes	NV	4-Chlorophenyl phenyl ether	Yes	NV
2,6,10,14-Tetramethylhexadecane	Yes	NV	4-Methylphenol	Yes	NV
2,6,10,14-Tetramethylpentadecane	Yes	NV	4-Nitrobenzenamine	Yes	NV
2,6-Dichlorophenol	Yes	NV	4-Nitrophenol	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Aldrin	Yes	NV
2-Chloronaphthalene	Yes	NV	alpha-BHC	Yes	NV
2-Chlorophenol	Yes	NV	alpha-Chlordane	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	NV	Aniline	Yes	NV

Table E.21 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
Azinphos-methyl	Yes	NV	m,p-Cresol	Yes	NV
Benzenemethanol	Yes	NV	Malathion	Yes	ASL
Benzidine	Yes	NV	Methoxychlor	Yes	NV
Benzo(e)pyrene	Yes	NV	Methyl parathion	Yes	NV
Benzoic acid	Yes	NV	Mirex	Yes	NV
beta-BHC	Yes	NV	Mocap	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	n-Hentriacontane	Yes	NV
Bis(2-chloroethyl) ether	Yes	NV	Nitrobenzene	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	N-Nitrosodimethylamine	Yes	NV
Bis(2-ethylhexyl)phthalate	Yes	ASL	N-Nitroso-di-n-propylamine	Yes	NV
Butyl benzyl phthalate	Yes	NV	N-Nitrosodiphenylamine	Yes	NV
Carbazole	Yes	NV	n-Octacosane	Yes	NV
Chlordane	Yes	ASL	Nonacosane	Yes	NV
Co-Ral	Yes	NV	Nonadecane	Yes	NV
delta-BHC	Yes	NV	n-Pentacosane	Yes	NV
Demeton	Yes	NV	n-Tetracosane	Yes	NV
Dibenzofuran	Yes	NV	n-Triacontane	Yes	NV
Dichlorvos	Yes	NV	n-Tricosane	Yes	NV
Dieldrin	Yes	ASL	n-Tritriacontane	Yes	NV
Diethyl phthalate	Yes	ASL	Octadecane	Yes	NV
Dimethoate	Yes	NV	Parathion	Yes	NV
Dimethyl phthalate	Yes	NV	Pentachlorophenol	Yes	NV
Di-n-butyl phthalate	Yes	NV	Pentadecane	Yes	NV
Di-n-octylphthalate	Yes	NV	Perylene	Yes	NV
Docosane	Yes	NV	Phenol	Yes	NV
Dodecane	Yes	NV	Phorate	Yes	NV
Dotriacontane	Yes	NV	Pyridine	Yes	NV
Eicosane	Yes	NV	Tetradecane	Yes	NV
Endosulfan sulfate	Yes	NV	Tetratriacontane	Yes	NV
Endrin	Yes	ASL	Toxaphene	Yes	ASL
Endrin aldehyde	Yes	NV	Tridecane	Yes	NV
Ethion	Yes	NV	Undecane	Yes	NV
Famphur	Yes	NV	Acenaphthene	Yes	ASL
Fensulfothion	Yes	NV	Acenaphthylene	Yes	NV
Fenthion	Yes	NV	Anthracene	Yes	ASL
gamma-Chlordane	Yes	NV	Benz(a)anthracene	Yes	ASL
Henicosane	Yes	NV	Benzo(a)pyrene	Yes	ASL
Heptachlor	Yes	NV	Benzo(b)fluoranthene	Yes	ASL
Heptachlor epoxide	Yes	ASL	Benzo(ghi)perylene	Yes	NV
Heptacosane	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
Heptadecane	Yes	NV	Chrysene	Yes	ASL
Hexachlorobenzene	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
Hexachlorobutadiene	Yes	NV	Fluoranthene	Yes	ASL
Hexachlorocyclopentadiene	Yes	NV	Fluorene	Yes	ASL
Hexachloroethane	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Hexacosane	Yes	NV	Naphthalene	Yes	ASL
Hexadecane	Yes	NV	Phenanthrene	Yes	ASL
Isophorone	Yes	NV	Pyrene	Yes	ASL
Lindane	Yes	ASL	Total PAHs	Yes	ASL
Volatile organic analytes					
1,2-Dichlorobenzene	Yes	ASL	2,6-Dimethylnaphthalene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Decane	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.22. Outfall 011 Surface Soil Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Lithium	Yes	ASL
Antimony	Yes	ASL	Magnesium	Yes	NV
Arsenic	Yes	ASL	Manganese	Yes	ASL
Barium	Yes	ASL	Mercury	Yes	ASL
Beryllium	Yes	ASL	Nickel	Yes	ASL
Cadmium	Yes	ASL	Selenium	Yes	ASL
Calcium	Yes	NV	Silver	Yes	ASL
Chromium	Yes	ASL	Thallium	Yes	ASL
Cobalt	Yes	ASL	Tin	Yes	ASL
Copper	Yes	ASL	Uranium	Yes	ASL
Iron	Yes	ASL	Vanadium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	Butyl benzyl phthalate	Yes	NV
1,3-Dichlorobenzene	Yes	NV	Carbazole	Yes	NV
2,4-Dichlorophenol	Yes	NV	Di-n-octylphthalate	Yes	NV
2,4-Dimethylphenol	Yes	NV	Hexachloroethane	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Isophorone	Yes	NV
2,6-Dinitrotoluene	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
2-Chloronaphthalene	Yes	NV	Pentachlorophenol	Yes	ASL
2-Chlorophenol	Yes	NV	Phenol	Yes	ASL
2-Methyl-4,6-dinitrophenol	Yes	NV	Pyridine	Yes	ASL
2-Methylnaphthalene	Yes	NV	Acenaphthene	Yes	BSL
2-Methylphenol	Yes	NV	Acenaphthylene	Yes	NV
2-Nitrobenzenamine	Yes	NV	Anthracene	Yes	ASL
2-Nitrophenol	Yes	NV	Benz(a)anthracene	Yes	NV
3,3'-Dichlorobenzidine	Yes	NV	Benzo(a)pyrene	Yes	ASL
3-Nitrobenzenamine	Yes	NV	Benzo(b)fluoranthene	Yes	NV
4-Bromophenyl phenyl ether	Yes	NV	Benzo(ghi)perylene	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	Chrysene	Yes	NV
4-Chlorobenzenamine	Yes	NV	Dibenz(a,h)anthracene	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Fluorene	Yes	NV
4-Methylphenol	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	NV
4-Nitrobenzenamine	Yes	NV	Naphthalene	Yes	ASL
Bis(2-chloroethoxy)methane	Yes	NV	Phenanthrene	Yes	ASL
Bis(2-chloroethyl) ether	Yes	NV	Pyrene	Yes	ASL
Bis(2-chloroisopropyl) ether	Yes	NV	Total PAHs	Yes	ASL
Bis(2-ethylhexyl)phthalate	Yes	NV			
Volatile organic analytes					
1,2-Dichlorobenzene	Yes	NV	1,4-Dichlorobenzene	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.23. Outfall 012 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Aluminum	Yes	ASL	Lead	Yes	ASL
Cadmium	Yes	ASL	Phosphorous	Yes	NV
Copper	Yes	ASL	Uranium	Yes	ASL
Cyanide	Yes	ASL	Zinc	Yes	ASL
Iron	Yes	ASL			
Radionuclides					
Activity of U-235	Yes	NV	Suspended Beta	Yes	NV
Suspended Alpha	Yes	NV	Thorium-234	Yes	NV
Volatile organic analytes					
2-Propanol	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

Table E.24. Outfall 012 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Magnesium	Yes	NV
Arsenic	Yes	ASL	Molybdenum	Yes	NV
Barium	Yes	NV	Potassium	Yes	NV
Beryllium	Yes	NV	Selenium	Yes	ASL
Cadmium	Yes	ASL	Silver	Yes	ASL
Calcium	Yes	NV	Sodium	Yes	NV
Chromium	Yes	ASL	Thallium	Yes	NV
Cobalt	Yes	NV	Uranium	Yes	NV
Copper	Yes	ASL	Vanadium	Yes	ASL
Iron	Yes	ASL	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV
Semivolatile organic analytes					
1,1-Biphenyl	Yes	NV	2,6,10,14-Tetramethylhexadecane	Yes	NV
1,2,4-Trichlorobenzene	Yes	NV	2,6,10,14-Tetramethylpentadecane	Yes	NV
1,2-Diphenylhydrazine	Yes	NV	2,6-Dichlorophenol	Yes	NV
1,3-Dichlorobenzene	Yes	ASL	2,6-Dinitrotoluene	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	2-Chloronaphthalene	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	2-Chlorophenol	Yes	NV
2,4'-DDD	Yes	NV	2-Methyl-4,6-dinitrophenol	Yes	NV
2,4'-DDE	Yes	NV	2-Methylnaphthalene	Yes	NV
2,4'-DDT	Yes	NV	2-Methylphenol	Yes	NV
2,4-Dichlorophenol	Yes	NV	2-Nitrobenzenamine	Yes	NV
2,4-Dimethylphenol	Yes	NV	2-Nitrophenol	Yes	NV
2,4-Dinitrophenol	Yes	NV	3,3'-Dichlorobenzidine	Yes	NV
2,4-Dinitrotoluene	Yes	NV	3-Nitrobenzenamine	Yes	NV
4,4'-DDD	Yes	ASL	Hexachlorobutadiene	Yes	NV

Table E.24 (continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
4,4'-DDE	Yes	ASL	Hexachlorocyclopentadiene	Yes	NV
4,4'-DDT	Yes	ASL	Hexachloroethane	Yes	NV
4-Bromophenyl phenyl ether	Yes	NV	Hexacosane	Yes	NV
4-Chloro-3-methylphenol	Yes	NV	Hexadecane	Yes	NV
4-Chlorobenzenamine	Yes	NV	Isophorone	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Lindane	Yes	ASL
4-Methylphenol	Yes	NV	m,p-Cresol	Yes	NV
4-Nitrobenzenamine	Yes	NV	Malathion	Yes	ASL
4-Nitrophenol	Yes	NV	Methoxychlor	Yes	NV
Aldrin	Yes	NV	Methyl parathion	Yes	NV
alpha-BHC	Yes	NV	Mirex	Yes	NV
alpha-Chlordane	Yes	NV	Mocap	Yes	NV
Aniline	Yes	NV	n-Hentriacontane	Yes	NV
Azinphos-methyl	Yes	NV	Nitrobenzene	Yes	NV
Benzenemethanol	Yes	NV	N-Nitrosodimethylamine	Yes	NV
Benzidine	Yes	NV	N-Nitroso-di-n-propylamine	Yes	NV
Benzo(e)pyrene	Yes	NV	N-Nitrosodiphenylamine	Yes	NV
Benzoic acid	Yes	NV	n-Octacosane	Yes	NV
beta-BHC	Yes	NV	Nonacosane	Yes	NV
Bis(2-chloroethoxy)methane	Yes	NV	Nonadecane	Yes	NV
Bis(2-chloroethyl) ether	Yes	NV	n-Pentacosane	Yes	NV
Bis(2-chloroisopropyl) ether	Yes	NV	n-Tetracosane	Yes	NV
Bis(2-ethylhexyl)phthalate	Yes	ASL	n-Triacontane	Yes	NV
Butyl benzyl phthalate	Yes	NV	n-Tricosane	Yes	NV
Carbazole	Yes	NV	n-Tritriacontane	Yes	NV
Chlordane	Yes	ASL	Octadecane	Yes	NV
Co-Ral	Yes	NV	Parathion	Yes	NV
delta-BHC	Yes	NV	Pentachlorophenol	Yes	NV
Dibenzofuran	Yes	NV	Pentadecane	Yes	NV
Dichlorvos	Yes	NV	Perylene	Yes	NV
Dieldrin	Yes	ASL	Phenol	Yes	NV
Diethyl phthalate	Yes	ASL	Phorate	Yes	NV
Dimethoate	Yes	NV	Pyridine	Yes	NV
Dimethyl phthalate	Yes	NV	Tetradecane	Yes	NV
Di-n-butyl phthalate	Yes	NV	Tetratriacontane	Yes	NV
Di-n-octylphthalate	Yes	NV	Toxaphene	Yes	ASL
Docosane	Yes	NV	Tridecane	Yes	NV
Dodecane	Yes	NV	Undecane	Yes	NV
Dotriacontane	Yes	NV	Acenaphthene	Yes	ASL
Eicosane	Yes	NV	Acenaphthylene	Yes	NV
Endosulfan I	Yes	ASL	Anthracene	Yes	ASL
Endosulfan II	Yes	ASL	Benz(a)anthracene	Yes	ASL
Endosulfan sulfate	Yes	NV	Benzo(a)pyrene	Yes	ASL
Endrin	Yes	ASL	Benzo(b)fluoranthene	Yes	ASL
Endrin aldehyde	Yes	NV	Benzo(ghi)perylene	Yes	NV
Ethion	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
Famphur	Yes	NV	Chrysene	Yes	ASL
Fensulfothion	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
Fenthion	Yes	NV	Fluoranthene	Yes	ASL
gamma-Chlordane	Yes	NV	Fluorene	Yes	ASL
Henicosane	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Heptachlor	Yes	NV	Naphthalene	Yes	ASL
Heptachlor epoxide	Yes	ASL	Phenanthrene	Yes	ASL
Heptacosane	Yes	NV	Pyrene	Yes	ASL
Heptadecane	Yes	NV	Total PAHs	Yes	ASL
Hexachlorobenzene	Yes	NV			

Table E.24 (continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Volatile organic analytes					
1,2-Dichlorobenzene	Yes	ASL	2,6-Dimethylnaphthalene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Decane	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.25. Outfall 015 Surface Water Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Dioxins/furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Yes	ASL			
Metals					
Aluminum	Yes	ASL	Mercury	Yes	ASL
Arsenic	Yes	ASL	Nickel	Yes	ASL
Barium	Yes	ASL	Phosphorous	Yes	NV
Beryllium	Yes	ASL	Selenium	Yes	ASL
Boron	Yes	ASL	Silver	Yes	ASL
Copper	Yes	ASL	Thallium	Yes	ASL
Cyanide	Yes	ASL	Tin	Yes	ASL
Iron	Yes	ASL	Titanium	Yes	NV
Lead	Yes	ASL	Total Metals	Yes	NV
Magnesium	Yes	NV	Uranium	Yes	ASL
Manganese	Yes	ASL	Zinc	Yes	ASL
Polychlorinated biphenyls					
PCB-1016	Yes	ASL	PCB-1254	Yes	ASL
PCB-1221	Yes	ASL	PCB-1260	Yes	ASL
PCB-1232	Yes	ASL	PCB-1268	Yes	NV
PCB-1242	Yes	ASL	Polychlorinated biphenyl (Total PCBs)	Yes	ASL
PCB-1248	Yes	ASL			
Radionuclides					
Alpha activity	Yes	NV	Suspended alpha	Yes	NV
Beta activity	Yes	NV	Suspended beta	Yes	NV
Radium	Yes	NV	Tritium	Yes	NV
Semivolatile organic analytes					
2,6-Dinitrotoluene	Yes	NV	Di-n-octylphthalate	Yes	NV
2-Chloronaphthalene	Yes	NV	Endosulfan sulfate	Yes	NV
2-Methyl-4,6-dinitrophenol	Yes	ASL	Endrin	Yes	ASL
3,3'-Dichlorobenzidine	Yes	NV	Endrin aldehyde	Yes	NV
4,4'-DDD	Yes	ASL	Endrin ketone	Yes	NV
4,4'-DDE	Yes	ASL	gamma-Chlordane	Yes	NV
4,4'-DDT	Yes	ASL	Heptachlor	Yes	ASL
4-Bromophenyl phenyl ether	Yes	NV	Heptachlor epoxide	Yes	ASL
4-Chloro-3-methylphenol	Yes	NV	Hexachlorobenzene	Yes	NV
4-Chlorophenyl phenyl ether	Yes	NV	Hexachlorobutadiene	Yes	ASL
alpha-Chlordane	Yes	NV	Hexachlorocyclopentadiene	Yes	ASL
Bis(2-chloroethoxy)methane	Yes	NV	Methoxychlor	Yes	ASL
Bis(2-chloroisopropyl) ether	Yes	NV	N-Nitrosodimethylamine	Yes	NV
Bis(2-ethylhexyl)phthalate	Yes	ASL	N-Nitroso-di-n-propylamine	Yes	NV
delta-BHC	Yes	NV	Phenol	Yes	ASL
Dieldrin	Yes	ASL	Toxaphene	Yes	ASL

Table E.25 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Volatile organic analytes					
Acrolein	Yes	ASL	Dibromochloromethane	Yes	NV
Bromodichloromethane	Yes	NV	MBAS	Yes	NV
Bromomethane	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
Chloroethane	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
Chloromethane	Yes	NV	Vinyl chloride	Yes	NV

Rationale: ASL – Above screening value NV – No screening value

Table E.26. Outfall 015 Sediment Selected COPCs

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Metals					
Antimony	Yes	ASL	Manganese	Yes	ASL
Arsenic	Yes	ASL	Mercury	Yes	ASL
Barium	Yes	NV	Molybdenum	Yes	NV
Beryllium	Yes	NV	Nickel	Yes	ASL
Cadmium	Yes	ASL	Potassium	Yes	NV
Calcium	Yes	NV	Selenium	Yes	ASL
Chromium	Yes	ASL	Silver	Yes	ASL
Cobalt	Yes	NV	Sodium	Yes	NV
Copper	Yes	ASL	Thallium	Yes	NV
Cyanide	Yes	NV	Uranium	Yes	NV
Iron	Yes	ASL	Vanadium	Yes	ASL
Lead	Yes	ASL	Zinc	Yes	ASL
Magnesium	Yes	NV			
Polychlorinated biphenyls					
PCB-1016	Yes	NV	PCB-1254	Yes	NV
PCB-1221	Yes	NV	PCB-1260	Yes	NV
PCB-1232	Yes	NV	PCB-1268	Yes	NV
PCB-1242	Yes	NV	Polychlorinated biphenyls (PCBs)	Yes	ASL
PCB-1248	Yes	NV			
Radionuclides					
Activity of U-235	Yes	NV	Beta activity	Yes	NV
Alpha activity	Yes	NV	Technetium-99	Yes	NV
Semivolatile organic analytes					
1,2,4-Trichlorobenzene	Yes	NV	4-Bromophenyl phenyl ether	Yes	NV
1,3-Dichlorobenzene	Yes	ASL	4-Chloro-3-methylphenol	Yes	NV
2,4,5-Trichlorophenol	Yes	NV	4-Chlorobenzenamine	Yes	NV
2,4,6-Trichlorophenol	Yes	NV	4-Chlorophenyl phenyl ether	Yes	NV
2,4-Dichlorophenol	Yes	NV	4-Methylphenol	Yes	NV
2,4-Dimethylphenol	Yes	NV	4-Nitrobenzenamine	Yes	NV
2,4-Dinitrophenol	Yes	NV	4-Nitrophenol	Yes	NV
2,4-Dinitrotoluene	Yes	NV	Bis(2-chloroethoxy)methane	Yes	NV
2,6-Dinitrotoluene	Yes	NV	Bis(2-chloroethyl) ether	Yes	NV
2-Chloronaphthalene	Yes	NV	Bis(2-chloroisopropyl) ether	Yes	NV
2-Chlorophenol	Yes	NV	Bis(2-ethylhexyl)phthalate	Yes	ASL
2-Methyl-4,6-dinitrophenol	Yes	NV	Butyl benzyl phthalate	Yes	NV
2-Methylnaphthalene	Yes	NV	Carbazole	Yes	NV
2-Methylphenol	Yes	NV	Dibenzofuran	Yes	NV
2-Nitrobenzenamine	Yes	NV	Diethyl phthalate	Yes	ASL
2-Nitrophenol	Yes	NV	Dimethyl phthalate	Yes	NV
3,3'-Dichlorobenzidine	Yes	NV	Di-n-butyl phthalate	Yes	NV
3-Nitrobenzenamine	Yes	NV	Di-n-octylphthalate	Yes	NV

Table E.26 (Continued)

Chemical	COPC	Rationale	Chemical	COPC	Rationale
Semivolatile organic analytes (continued)					
Hexachlorobenzene	Yes	NV	Benz(a)anthracene	Yes	ASL
Hexachlorobutadiene	Yes	NV	Benzo(a)pyrene	Yes	ASL
Hexachlorocyclopentadiene	Yes	NV	Benzo(b)fluoranthene	Yes	ASL
Hexachloroethane	Yes	NV	Benzo(ghi)perylene	Yes	NV
Isophorone	Yes	NV	Benzo(k)fluoranthene	Yes	ASL
Nitrobenzene	Yes	NV	Chrysene	Yes	ASL
N-Nitroso-di-n-propylamine	Yes	NV	Dibenz(a,h)anthracene	Yes	ASL
N-Nitrosodiphenylamine	Yes	NV	Fluoranthene	Yes	ASL
Pentachlorophenol	Yes	NV	Fluorene	Yes	ASL
Phenol	Yes	NV	Indeno(1,2,3-cd)pyrene	Yes	ASL
Pyridine	Yes	NV	Naphthalene	Yes	ASL
Acenaphthene	Yes	ASL	Phenanthrene	Yes	ASL
Acenaphthylene	Yes	NV	Pyrene	Yes	ASL
Anthracene	Yes	ASL	Total PAHs	Yes	ASL
Volatile organic analytes					
1,1,2,2-Tetrachloroethane	Yes	NV	Chlorobenzene	Yes	NV
1,1-Dichloroethene	Yes	ASL	Chloroethane	Yes	NV
1,2-Dichlorobenzene	Yes	ASL	Chloromethane	Yes	NV
1,2-Dichloropropane	Yes	NV	cis-1,2-Dichloroethene	Yes	NV
1,2-Dimethylbenzene	Yes	NV	cis-1,3-Dichloropropene	Yes	NV
1,4-Dichlorobenzene	Yes	ASL	Dibromochloromethane	Yes	NV
2-Butanone	Yes	NV	m,p-Xylene	Yes	NV
2-Hexanone	Yes	NV	Methylene chloride	Yes	NV
4-Methyl-2-pentanone	Yes	NV	Styrene	Yes	NV
Bromodichloromethane	Yes	NV	trans-1,2-Dichloroethene	Yes	NV
Bromoform	Yes	NV	trans-1,3-Dichloropropene	Yes	NV
Bromomethane	Yes	NV	Vinyl chloride	Yes	NV
Carbon disulfide	Yes	ASL			

Rationale: ASL – Above screening value NV – No screening value

E.5. STEP 2: SCREENING-LEVEL COMPARISONS

Risk characterization integrates information from the exposure and effects assessments to estimate risks to representative ecological receptors. Exposure point concentrations used for this integration are maximum concentrations (either maximum detected concentrations or half the maximum detection limits for nondetect data). Several approaches can be used to integrate exposure and effects data, with selected approaches often dependent on the availability of specific types of data and the level of the ERA (e.g., SERA versus BERA). The primary method of risk estimation used in this SERA is a comparison of maximum concentrations to NFA screening levels.

E.5.1 COMPARISONS OF SITE DATA TO NFA SCREENING LEVELS

Screening level risk estimates based on direct exposure (direct contact and ingestion) to contaminated media are assessed at this (SERA) stage of the ERA by comparing maximum detected chemical concentrations or one-half the highest detection limits for nondetect data to NFA screening levels.

Any chemical for which the maximum detected concentration or one-half the highest detection limit exceeds the NFA screening level is retained as a COPC. Designation of a chemical as a COPC indicates potential for adverse effects and further evaluation is required. Chemicals for which the maximum detected concentration or the highest detection limit does not exceed the NFA screening level are eliminated as COPCs and require no additional investigation. All chemicals for which no NFA screening level exists are retained as COPCs. Finally, all major (or important) bioaccumulative chemicals are retained as COPCs regardless of the magnitude of the maximum detected concentrations.

Tables E.5 through E.26 present the chemicals that are retained as COPCs because either (1) the maximum detected concentration exceeds the NFA screening level, (2) half the maximum detection limit (for nondetect data only) exceeds the NFA screening level, or (3) no NFA screening level exists.

A slightly different approach was taken for assessing the measured concentrations of dioxins and furans in site media. Dioxins and furans detected in surface water samples were not quantitatively screened because (1) no NFA screening levels are available for these compounds in surface water and (2) dioxin and furan data are extremely limited for surface water. Screening of dioxins and furans detected in surface soil samples taken from Outfall 010 is based on the TEF approach discussed previously. The maximum concentrations of detected dioxins and furans in surface soil, as well as the highest detection limit concentrations for nondetect samples, first were converted to 2,3,7,8-TCDD equivalents or TEQs. These TEQs are derived for mammals, fish, and birds. They differ because the toxicity of dioxins and furans can differ for each of the receptor groups. The resulting receptor-specific TEQs for each individual dioxin and furan then were summed, and this total dioxin and furan concentration, expressed as a 2,3,7,8-TCDD equivalent or TEQ, is compared to the NFA screening level for 2,3,7,8-TCDD in surface soil. For all receptor groups (fish, birds, and mammals), the total 2,3,7,8-TCDD equivalent concentrations exceed the surface soil screening level of 0.004 µg/kg. The magnitude of these exceedances ranges from about 5-fold (fish) to about 9-fold (birds). The degree of exceedance for mammals, which also applies to humans, is about 6-fold. Based on the results of this screening, shown on Table E.27, dioxins and furans are selected as COPCs in surface soil. Data limitations preclude designating dioxins and furans in other media or at other locations as definitive COPCs or as not present.

Table E.27. Soil Screening for Dioxin/Furans, Outfall 010, Exposure Unit 6

	WHO TEF			Soil concentration (µg/kg)	TEQ		
	Fish	Mammal	Bird		Fish	Mammal	Bird
Dioxins							
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1	1	1	0.00122	0.00122	0.00122	0.00122
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1	1	1	0.00122	0.00122	0.00122	0.00122
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.5	0.1	0.05	0.0066	0.0033	0.00066	0.00033
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.01	0.1	0.01	0.0182	0.000182	0.00182	0.000182
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.01	0.1	0.1	0.00943	0.0000943	0.000943	0.000943
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.001	0.01	*0.001*	0.45	0.00045	0.0045	0.00045
Octachloro-dibenzo(b,e)(1,4)dioxin	*0.0001*	0.0001	0.0001	25.3	0.00253	0.00253	0.00253
Furans							
2,3,7,8-Tetrachlorodibenzofuran	0.05	0.1	1	0.012	0.00122	0.0012	0.012
1,2,3,7,8-Pentachlorodibenzofuran	0.05	0.05	0.1	0.00161	0.0000805	0.0000805	0.000161
2,3,4,7,8-Pentachlorodibenzofuran	0.5	0.5	1	0.0144	0.0072	0.0072	0.0144
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1	0.1	0.1	0.00856	0.000856	0.000856	0.000856
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1	0.1	0.1	0.00439	0.000439	0.000439	0.000439
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1	0.1	0.1	0.00304	0.000304	0.000304	0.000304
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1	0.1	0.1	0.00304	0.000304	0.000304	0.000304
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01	0.01	0.01	0.0637	0.000637	0.000637	0.000637
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01	0.01	0.01	0.0059	0.000059	0.000059	0.000059
Octachlorodibenzofuran	*0.0001*	0.0001	0.0001	0.175	0.0000175	0.0000175	1.75E-05
				Total TEQ	0.0201133	0.02399	0.036053
				SOIL ESV (ug/kg)	0.004	0.004	0.004
				Screening HQ	**5.03**	**6.00**	**9.01**

TEF values in *italics* are "<" values (qualifier removed for calculations)
Soil ESV = Surface soil ecological screening value for 2,3,7,8-TCDD
Soil ESV = CCME SQG (2002) for agricultural use (4 ng TEQ/kg)

Notes:
ESV – Ecological screening value
HQ – Hazard quotient
TEF – Toxicity equivalence factor
TEQ – Toxicity equivalent
WHO – World Health Organization

E.5.2 HAZARD QUOTIENTS—FOOD WEB MODEL

The comparisons of maximum detected concentrations to NFA screening levels presented in the previous section reflect potential direct exposures of aquatic and terrestrial biota to contaminants in surface water, sediments, and surface soils. For contaminants that do not bioaccumulate to a significant degree, these types of exposures are most important. Risks based on direct exposure to contaminated media do not consider bioaccumulation and transfer of contaminants through food webs. Food web exposures are most important for bioaccumulative contaminants and contaminants that biomagnify. Food web exposures include consumption of contaminated food items, ingestion of contaminants in drinking water, and incidental ingestion of contaminated soil or sediment.

Food web modeling generally is performed for the most highly bioaccumulative site-related contaminants for a specific suite of mammalian and avian receptors. As stated previously, food web modeling is performed only for Total PCBs at the SWOU in this SERA. The food web model receptors selected are based primarily on PGDP guidance with some modification to (1) ensure assessment of all important food webs that might be linked to site-related contaminants and (2) ensure the availability of adequate input parameters for the model. These modeled receptors include the following:

- Soil-based receptors
    - Short-tailed shrew
    - Meadow vole
    - American kestrel
    - American woodcock
    - American robin
    - Bobwhite quail (aka Northern bobwhite)

- Sediment-water-based receptors
    - Mink (aka American mink)
    - Little brown bat
    - Marsh wren
    - Belted kingfisher

Each of these receptors is assumed to be adequately representative of species that occur on-site. In some cases, the species modeled may, in fact, occur on-site. In others, the modeled species will not occur on-site, but is closely related to potential on-site residents.

The approach used to assess risks to these receptors via food web transfer is based on the hazard quotient (HQ) method where the exposure concentration (expressed as an estimated dose) is divided by the effects concentration (in this case the no effect dose). The resulting ratio is the HQ.

$$Food\ web\ model\ HQ\ =\ \frac{Estimated\ daily\ dose\ of\ contaminant\ (mg/kg-d)}{No\ observed\ adverse\ effect\ level\ dose\ (mg/kg-d)}$$

Sediment-based exposures are linked to ditch sediments, and soil-based exposures are linked to the surface soils collected from specific portions of NSDD and Outfall 001 areas.

The output of the food web model and the numerator in the above equation is an estimated average daily dose, expressed in milligrams of Total PCBs per kilogram of body weight per day (mg/kg-d). For this SERA, the average daily dose is conservative because the estimated dose is based on the maximum

Total PCB concentration in the primary exposure medium (sediment or surface soil). Many of the other input parameters such as foraging range, ingestion rate, etc. are based on average values. This dose estimation is based on the following formula from EPA (1993):

$$ADD_{pot} = \sum_{K=1}^{n} \left(C_k \times FR_k \times NIR_k \right)$$

where

ADD_{pot} = Potential average daily dose (mg PCB/kg BW-day)
C_k = Average COPC concentration in the k^{th} food type (mg/kg)
FR_k = Dietary fraction of intake of the k^{th} food type (range 0 to 1.0)
NIR_k = Normalized ingestion rate of the k^{th} food type (wet weight of prey ingested per day, kg/d)
n = Number of contaminated food types

Normalized ingestion rate is the ingestion rate normalized for body weight:

$$NIR_k = \frac{IR_k}{BW}$$

where

IR_k = Ingestion rate (kg/d) of the predator
BW = Body weight (kg) of the predator

As stated above, this term is expressed as wet weight, or NIR_{ww}. For species for which incidental soil or sediment ingestion is significant, an additional term is added to the equation presented above, as shown below.

$$ADD_{pot} = \sum_{K=1}^{n} \left(C_k \times FR_k \times NIR_k \right) + \left(NIR_{dw} \times C_{soil} \times FR_{soil} \right)$$

The use of both NIR_{ww} and NIR_{dw} is required because contaminant concentrations in biota serving as prey are expressed as wet weight, and soil (or sediment) contaminant concentrations are expressed as dry weight. The term C_{soil} represents the maximum contaminant concentration in soil or sediment, and FR_{soil} represents the fraction of soil or sediment incidentally ingested.

The concentration of PCBs in food items can be based on directly measured values or on values estimated using bioaccumulation factors (BAFs) or biota-sediment accumulation factors (BSAFs). For this SERA, BAFs and BSAFs are taken from literature sources because site-specific data are lacking. The selected BAFs and BSAFs, as well as the sources of these values, are shown in Attachment E3 (food web models).

As described above, the estimated daily dose resulting from the modeling is compared to the no effect dose represented by the NOAEL. Resulting HQs that remain below 1.0 suggest no significant potential for adverse effects. This conservative approach is appropriate for screening-level food web modeling. The food web models, presented as Attachment E3, reveal the input parameters, NOAEL-based risk estimates, and other details of the models. In addition, these models include some information not used in the SERA, but is considered useful for evaluating the need for further investigations. This information includes risk estimates based on the higher LOAELs and preliminary remediation goals back-calculated from the model input parameters. These types of information have little use in the SERA, but are standard components of the models. As such, they may be useful in future investigations.

Food web model HQs greater than 1.0 indicate significant risk. Table E.28 (below) summarizes the food web modeling-based HQs for the selected receptors. The underlying basis for the different risk estimates presented is the different maximum PCB concentrations in surface soil (terrestrial receptors: shrew, vole, kestrel, woodcock, robin, and quail) or sediment (aquatic-associated receptors: mink, bat, wren, kingfisher). The association of a receptor to a primary exposure medium (e.g., surface soil) is based on the primary source of prey items. For example, the primary prey of the woodcock is earthworms, which are linked to surface soil. PCB concentrations in surface water also are included and these contribute, although only slightly, to differences in model HQs for both areas.

Table E.28. Food Web Model Risk Estimates for the NSDD and Outfall 001 Areas (Total PCBs)

Receptor		Dose (mg/kg-d)	NOAEL TRV (mg/kg-d)	HQ[a]	Significant risk?
		NSDD area			
Terrestrial receptors	Shrew	34.3	0.067	**511**	**Yes**
	Vole	0.086	0.051	**1.7**	**Yes**
	Kestrel	0.44	0.18	**2.4**	**Yes**
	Woodcock	13.6	0.18	**75.3**	**Yes**
	Robin	10.3	0.18	**57.5**	**Yes**
	Quail	0.12	0.18	0.69	No
Aquatic-associated receptors	Mink	0.66	0.14	**4.7**	**Yes**
	Bat	57.3	0.079	**725**	**Yes**
	Wren	42.7	0.18	**237**	**Yes**
	Kingfisher	16.6	0.18	**92.4**	**Yes**
		Outfall 001 area			
Terrestrial receptors	Shrew	0.69	0.067	**10.2**	**Yes**
	Vole	0.0018	0.051	0.035	No
	Kestrel	0.0068	0.18	0.038	No
	Woodcock	0.21	0.18	**1.2**	**Yes**
	Robin	0.21	0.18	**1.2**	**Yes**
	Quail	0.0025	0.18	0.0014	No
Aquatic-associated receptors	Mink	0.0092	0.14	0.065	No
	Bat	1.0	0.079	**13.0**	**Yes**
	Wren	0.77	0.18	**4.3**	**Yes**
	Kingfisher	0.30	0.18	**1.7**	**Yes**

[a] Bolded values are those greater than one.

Finally, it should be noted that the risk estimates presented are conservative in many respects. Primary among these is the use of the maximum Total PCB concentration determined for any location within Sections 3, 4, and 5 of the NSDD area and within EUs 1, 4, 5, 6, and 7 of the Outfall 001 area. In some cases, the maximum concentrations of PCBs in surface soil are from a location different from where the maximum sediment concentration was taken. For the Outfall 001 area, the highest concentrations of Total PCBs are from EU6 (surface water) and EU5 (sediment). The maximum concentration of Total PCBs in surface soil, for the purposes of modeling, is assumed equal for all EUs because of limited data.

The highest Total PCB concentrations for the NSDD area are from Section 5 (surface water) and Section 3 (sediment and surface water). These data which are discussed in Section E.4 drive the risk estimates presented in Table E.28.

E.6. UNCERTAINTIES

E.6.1 LACK OF SCREENING BENCHMARKS FOR CONSTITUENTS

Risks associated with direct exposure to several contaminants detected at PGDP could not be adequately evaluated, since NFA values have not been established for every constituent present at PGDP; therefore, overall risks to ecological receptors present at PGDP may be underestimated.

E.6.2 LACK OF ANALYTICAL DATA FOR CONSTITUENT

All media cannot be sampled at all locations, so data interpolation and extrapolation are necessary. It is assumed, however, that sufficient samples were collected from all relevant media and were analyzed to adequately describe the nature and extent of contamination resulting from the release of site-related chemicals.

E.6.3 FUTURE LAND USE AND FUTURE HABITAT TYPES

Risks to ecological receptors were evaluated based on current site conditions and were estimated with the assumption that site conditions would not deteriorate or improve. Additionally, it was assumed that habitat types would not be altered dramatically in the future. If site conditions or habitat types were to change in the future, the exposure assumptions, receptors, risks, and conclusions presented in this SERA may not be applicable.

E.6.4 SPECIES PRESENT OR MIGHT BE PRESENT AT THE PGDP SITE

Biological and ecological surveys were not performed as part of this SI; therefore, a potential source of uncertainty is a lack of complete biological or ecological survey data to support this SERA. The type of surveys needed to aid in the determination of cause and effect relationships, especially at the community or population level, are highly dependent on the quality and quantity of information compiled during site reconnaissance. A quantitative survey of species present at PGDP has not been conducted. Instead, recent observations based on a more general site visit were used to evaluate habitat use, habitat quality, presence of receptors, and observations of adverse impacts.

E.6.5 USE OF MAXIMUM DETECTED CONCENTRATION AS EXPOSURE CONCENTRATION AND NFA VALUES AS SCREENING CRITERIA

All screening values, including NFA values, are biased toward overprotection. Additionally, ecological receptors are unlikely to be exposed to the maximum detected concentration of each contaminant across the site. It is unlikely, therefore, that risks to ecological receptors are underestimated for exposure to the maximum detected concentration of contaminants for which screening values are available. In fact, it is possible that the risks to environmental receptors are overestimated, since exposure to the maximum detected concentrations is unlikely and the conservative nature of the NFA values likely resulted in the retention of COPCs that would be excluded following evaluation beyond a screening-level assessment.

E.6.6 SUBSURFACE SOIL EXPOSURES

Exposure to subsurface soil was not evaluated, since the majority of wildlife likely would be exposed to the zero to one-foot depth interval; however, burrowing animals could be exposed to soil below one foot. If concentrations of contaminants are greater in subsurface soil, doses received by burrowing animals from exposure to these soils may be greater than those estimated using surface soil alone.

E.6.7 NFA VALUES FOR SILVER

All screening values, including NFA values, are biased toward overprotection. Two NFA values listed for silver in the methods document are extremely conservative. The listed surface water NFA value is 0.000012 mg/L and the sediment value is 0.00038 mg/kg. These ecological screening values are several orders of magnitude lower than other NOAEL-based toxicity benchmarks, including National Oceanic and Atmospheric Administration ER-L for silver of 1.00E+00 mg/kg and Florida Department of Environmental Protection TEL value of 0.73 mg/kg. The ER-Ls are the 10th percentile of the range of concentrations of chemicals associated with biological effects, as documented by Long and Morgan (1991). The FDEP TELs are calculated using an approach similar to that used for the ER-Ls, but also incorporate chemical concentrations observed, or predicted to be associated, with no adverse biological effects. The TEL represents the upper limit of the range of sediment chemical concentrations dominated by “no effects” data. Thus, the PGDP NFA value appears to be extremely conservative relative to other screening benchmarks and was replaced with an alternative value.

E.6.8 MULTIPLE CONTAMINANT EXPOSURES

Ecological receptors often are exposed to multiple contaminants concurrently within a medium; however, toxicological screening values were established to estimate risk due to exposure to individual contaminants. Some contaminants may act synergistically or antagonistically, so single contaminant evaluation may overestimate or underestimate risk.

E.6.9 FOOD WEB MODEL

There are several sources of uncertainty with the food web models. First, the modeling effort is limited to assessing food web effects for only Total PCBs. Other bioaccumulative contaminants detected in the site abiotic media such as mercury, DDT, and other pesticides and herbicides are not modeled. Upper trophic level receptors are likely to be exposed to a wide variety of contaminants via ingestion of prey and drinking water, and incidental ingestion of soil and sediment. Second, the risk estimates resulting from the model are based on maximum Total PCB concentrations from more than one medium, from more than one location. The maximum concentrations are unlikely to occur at the same locations for all media (surface water, sediment, and surface soil). Third, concentrations of Total PCBs in prey items (plants and animals) are based on literature sources and may not reflect the site-specific uptake and accumulation of PCBs. Fourth, assumptions regarding home or foraging range are conservative, which probably overestimate risk. This conservatism is offset to some degree by the assumption that off-site foraging takes place in areas free of PCB contamination. Fifth, the NOAEL-based TRVs used to estimate dose-based risks in the model are, in fact, no effect values, and exceedance of these values does not necessarily equate to unacceptable risk. Finally, the food web model approach is, by definition, a conservative method to estimate daily doses. At nearly all steps of the modeling process, assumptions are biased toward risk overestimation.

E.6.10 HARDNESS DEPENDENT METAL NFA

Six metals, cadmium, chromium, copper, lead, nickel and zinc, in surface water are hardness dependent. The NFA values for these metals presented in the guidance (DOE 2001) assume a hardness of 50 mg/L calcium carbonate. The NFA values as presented in the guidance were employed for these metals in lieu of using site-specific hardness NFA values. The average hardness for the site is within range of the default hardness employed; however, if surface water hardness is lower than the default value employed, then the calculated risk associated with exposure to these metals would be underestimated. In the same respect, if surface water hardness is higher than the default value employed, then the calculated risk associated with exposure to these metals would be overestimated.

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E.7. SCIENTIFIC/MANAGEMENT DECISION POINT 1

The screening results and site information for a given unit are used at the Scientific/Management Decision Point (SMDP) 1 to support a decision whether to continue evaluating ecological risk. PGDP ERA guidance provides a path forward, following completion of the SERA. This guidance states the following:

> If any constituents in an abiotic medium to which organisms are potentially exposed are present at a concentration exceeding the PGDP NFA level or if there is not an NFA level for a constituent, then further evaluation of the potential for risk will be required. A decision not to take further action may be justified if no constituent exceeds the NFA level, the synergistic effects of COPCs are not known, and there are no critical data gaps.

Based on this guidance, further evaluation of the potential for risk is required. This conclusion is based on significant and extensive exceedance of NFA levels at multiple locations and the lack of NFA levels for many constituents. If this further evaluation includes a BERA it would include Steps 3-8 of the ERA process. Future assessments will include, as applicable, any area of the creeks (Bayou and Little Bayou) that could serve as a habitat or source of prey for ecological receptor populations

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ATTACHMENT E1

PHOTO LOG FROM MARCH 3 SITE VISIT

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Photo 1

Outfall 001, Exposure Unit 6—
North of C-612-T-1

Photo 2

Outfall 001, Exposure Unit 6—Pump and Treat Effluent, 200 gpm

Photo 3

Outfall 001, Exposure Unit 6—Ditch and Sample Point, Looking North

Photo 4

Outfall 001, Exposure Units 5 and 4—Habitats

Photo 5

Outfall 001, Exposure Units 2 and 1—South of Scrap Metal Sediment Basin

Photo 6

Outfall 001, Exposure Unit 1—South of Scrap Metal Sediment Basin

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Photo 7

**Outfall 008, Exposure Unit 1—
Outside of Fence**

Photo 8

**Outfall 008, Exposure Unit 1—
Looking East**

Photo 9

**Outfall 008, Exposure Unit 1—
Looking West, Including Trees**

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Photo 10

Outfall 008, Exposure Unit 1—Area of Cattails

Photo 11

Outfall 015, Exposure Unit 1—Outside Fence Looking West

Photo 12

Outfall 001, Exposure Units 10, 11, and 12—Looking East

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Photo 13

Outfall 001, Exposure Units 12, 13, and 14—Looking West

Photo 14

Storm Sewer W337-06—Directly on Top of Bank

Photo 15

Outfall 015, Exposure Units 2 and 3—Looking East

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Photo 16

Outfall 015, Exposure Unit 8—Looking East

Photo 17

Outfall 008, Exposure Unit 3—Drain

Photo 18

Outfall 008, Exposure Unit 7—Grass Habitat

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Photo 19

**Outfall 015, Exposure Unit 4—
Shrub Habitat Along Ditch**

Photo 20

**Outfall 010, Exposure Unit 10—
Sample Locations**

Photo 21

**Outfall 010, Exposure Unit 4—
Deep Ditch, West of Electrical Yard**

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Photo 22

**Outfall 010, Exposure Unit 5—
Feed into Outfall 010,
Exposure Unit 4**

Photo 23

Outfall 002, Sump W337-01

Photo 24

**Outfall 002, Exposure Unit 1
Overflow**

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Photo 25

Outfall 002 Toward Plant

Photo 26

Outfall 012 Lift Station

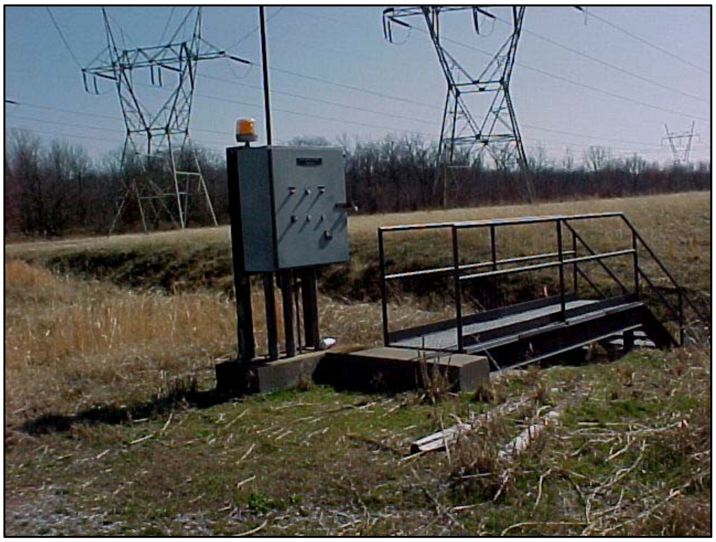

Photo 27

Outfall 012 Sump

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Photo 28

Outfall 012 Drainage from Plant

Photo 29

Outfall 012 Overflow

Photo 30

Outfall 011 Lift Station

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Photo 31

Outfall 011 Sump

Photo 32

Outfall 011 Overflow

Photo 33

Outfall 010 Lift Station

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Photo 34

Outfall 010 Sump

Photo 35

Outfall 010 Drainage from Plant

Photo 36

Outfall 010 Overflow

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Photo 37

C-617 Lagoon

Photo 38

C-617 Lagoon

Photo 39

C-617 Lagoon

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Photo 40

Return of C-617B Lagoon Treated Water to Outfall 010

Photo 41

North-South Diversion Ditch, Section 3 Exposure Unit 1

Photo 42

North-South Diversion Ditch, Section 3 Exposure Unit 2 Looking North

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Photo 43

North-South Diversion Ditch, Section 4 Exposure Unit 4 Looking North

Photo 44

North-South Diversion Ditch, Section 4 Exposure Unit 4 Dogleg

Photo 45

North-South Diversion Ditch, Sections 4 and 5 Interchange Looking South

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Photo 46

North-South Diversion Ditch, Sections 4 and 5 Interchange Looking North to River

Photo 47

North-South Diversion Ditch, Sections 4 and 5 Interchange Looking North at Trees

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ATTACHMENT E2

ECOLOGICAL SCREENING TABLES

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Table E2.1. Ecological Screening of Surface Water Data – North-South Diversion Ditch

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Dioxin/furan	2,3,7,8-Tetrachlorodibenzo-p-dioxin	µg/L	0.0000014	2	0	0	—	—	—	0.000008	—	0	—	—	—	—	—	3.5995E-07	0.000015	1	Yes	ASL
Field parameters	pH	Std. unit	—	84	84	100	6.67	8.82	K019	7.86	—	0	7.08	14.16	6.24	8.2	—	—	—	—	Yes	NV
Metal	Aluminum	mg/L	0.087	13	13	100	0.241	4.31	L8	0.86	13	0	0.55	1.1	0.2	2.92	13	—	—	—	Yes	ASL
Metal	Antimony	mg/L	0.16	33	5	15.15	0.005	0.2	K019	0.05	1	0	0.03	0.05	0.005	0.005	0	0.0025	0.1	0	Yes	ASL
Metal	Arsenic	mg/L	0.05	33	2	6.06	0.2	0.2	K019	0.04	2	0	0.03	0.05	—	—	—	0.0025	0.1	7	Yes	ASL
Metal	Barium	mg/L	0.004	13	13	100	0.0272	0.07	L8	0.05	13	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	33	1	3.03	0.01	0.01	K019	0.002	1	0	0	0.002	—	—	—	0.0005	0.005	16	Yes	ASL
Metal	Boron	mg/L	0.0016	2	0	0	—	—	—	1	—	0	—	—	—	—	—	1	1	2	Yes	ASL
Metal	Cadmium	mg/L	0.00142	33	5	15.15	0.001	0.05	K019	0.005	1	0	0.01	0.02	0.001	0.001	0	0.0005	0.025	9	Yes	ASL
Metal	Calcium	mg/L	—	9	9	100	11.4	36.5	L8	27.66	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	Chromium	mg/L	0.04885	33	4	12.12	0.02	0.05	K019	0.01	1	0	0.02	0.03	0.02	0.05	1	0.01	0.025	0	Yes	ASL
Metal	**Cobalt**	**mg/L**	**0.023**	**13**	**5**	**38.46**	**0.001**	**0.00117**	**L8**	**0.004**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0125**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	33	10	30.3	0.0052	0.1	K019	0.01	10	0	0.02	0.04	0.0052	0.038	8	0.0025	0.05	14	Yes	ASL
Metal	Cyanide	mg/L	0.0052	11	0	0	—	—	—	0.02	—	0	0.02	0.03	—	—	—	0.01	0.025	11	Yes	ASL
Metal	Iron	mg/L	1	33	33	100	0.205	2.99	L8	0.89	10	0	0.98	1.95	0.488	2.6	5	—	—	—	Yes	ASL
Metal	Lead	mg/L	0.00132	33	3	9.09	0.005	0.2	K019	0.05	3	0	0.06	0.13	—	—	—	0.0025	0.125	30	Yes	ASL
Metal	Magnesium	mg/L	—	11	11	100	2.46	12	L8	6.27	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	Manganese	mg/L	0.12	13	11	84.62	0.0522	0.429	L8	0.22	9	0	0.24	0.48	0.108	0.329	12	0.0125	0.0125	0	Yes	ASL
Metal	Mercury	mg/L	0.000012	33	2	6.06	0.0002	0.0002	K019, L8	0.0001	2	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	31	Yes	ASL
Metal	**Molybdenum**	**mg/L**	**0.37**	**4**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.01**	**0.02**	—	—	—	**0.0125**	**0.025**	**0**	**No**	**BSL**
Metal	Nickel	mg/L	0.029	33	7	21.21	0.005	0.1	K019	0.02	3	0	0.02	0.04	0.005	0.05	1	0.0025	0.05	1	Yes	ASL
Metal	Phosphorous	mg/L	—	11	10	90.91	0.07	0.41	L8	0.13	—	0	0.06	0.12	0.05	0.18	—	0.025	0.025	—	Yes	NV
Metal	Potassium	mg/L	—	9	9	100	2.16	6.64	L8	3.76	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	Selenium	mg/L	0.005	33	0	0	—	—	—	0.02	—	0	0	0.006	—	—	—	0.0025	0.1	12	Yes	ASL
Metal	Silver	mg/L	0.000012	33	12	36.36	0.001	0.05	K019	0.01	12	0	0	0.007	0.001	0.001	1	0.0005	0.025	21	Yes	ASL
Metal	Sodium	mg/L	—	9	9	100	4.31	52.6	L8	23.55	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	**Strontium**	**mg/L**	**1.5**	**2**	**2**	**100**	**0.192**	**0.244**	**L8**	**0.22**	**0**	**0**	**0.09**	**0.18**	**0.072**	**0.107**	**0**	—	—	—	**No**	**BSL**
Metal	Thallium	mg/L	0.004	33	6	18.18	0.01	0.01	K019, L8	0.05	6	0	0.03	0.06	0.01	0.01	3	0.005	0.125	27	Yes	ASL
Metal	Tin	mg/L	0.073	2	1	50	1	1	K019	0.75	1	0	—	—	—	—	—	0.5	0.5	1	Yes	ASL
Metal	Titanium	mg/L	—	2	0	0	—	—	—	0.01	—	0	—	—	—	—	—	0.0125	0.0125	—	Yes	NV
Metal	Total Metals	mg/L	—	19	1	5.26	0.702	0.702	K019	2.33	—	0	—	—	—	—	—	1	2.5	—	Yes	NV
Metal	Uranium	mg/L	0.0026	32	10	31.25	0.001	0.01	L8	0.002	4	0	0	0.002	0.001	0.001	0	0.0005	0.0025	0	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**11**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	Zinc	mg/L	0.067	33	10	30.3	0.02	0.2	K019	0.05	1	0	0.07	0.14	0.02	0.2	1	0.01	0.1	8	Yes	ASL
PCB	Endrin ketone	µg/L	—	2	0	0	—	—	—	0.05	—	0	—	—	—	—	—	0.05	0.05	—	Yes	NV
PCB	PCB-1016	µg/L	0.014	34	0	0	—	—	—	0.08	—	0	0.08	0.17	—	—	—	0.06	0.085	34	Yes	ASL
PCB	PCB-1221	µg/L	0.014	34	0	0	—	—	—	0.11	—	0	0.09	0.18	—	—	—	0.085	0.47	34	Yes	ASL
PCB	PCB-1232	µg/L	0.014	34	0	0	—	—	—	0.08	—	0	0.08	0.16	—	—	—	0.07	0.085	34	Yes	ASL
PCB	PCB-1242	µg/L	0.014	34	0	0	—	—	—	0.07	—	0	0.07	0.14	—	—	—	0.045	0.085	34	Yes	ASL
PCB	PCB-1248	µg/L	0.014	34	0	0	—	—	—	0.07	—	0	0.08	0.15	—	—	—	0.06	0.085	34	Yes	ASL
PCB	PCB-1254	µg/L	0.014	34	0	0	—	—	—	0.07	—	0	0.08	0.16	0.23	0.23	1	0.035	0.085	34	Yes	ASL
PCB	PCB-1260	µg/L	0.014	34	0	0	—	—	—	0.06	—	0	0.06	0.13	—	—	—	0.025	0.085	34	Yes	ASL
PCB	PCB-1268	µg/L	—	34	0	0	—	—	—	0.06	—	0	0.07	0.14	—	—	—	0.035	0.085	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	µg/L	0.0014	34	0	0	—	—	—	0.11	—	0	0.09	0.19	0.23	0.23	1	0.085	0.47	34	Yes	ASL
Rads	Activity of Uranium-235	pCi/L	—	6	1	16.67	2.2	2.2	L8	0.93	—	0	0.63	1.25	—	—	—	0.00675	1.1	—	Yes	NV
Rads	Alpha activity	pCi/L	—	4	2	50	0	2.39	L223	0.96	—	0	—	—	—	—	—	0.1095	1.345	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**17**	**2**	**11.76**	**0.0509**	**17.1**	**L8**	**0.14**	**0**	**0**	**-3.81**	**-7.62398947**	—	—	—	**-14.35**	**6**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/L	—	4	2	50	0	0	L223, L8	1.44	—	0	—	—	—	—	—	0.745	5	—	Yes	NV
Rads	**Cesium-134**	**pCi/L**	**11000**	**15**	**0**	**0**	—	—	—	**-1.90250333**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-8.05**	**0.2345**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**15**	**0**	**0**	—	—	—	**0.03**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-2.025**	**4.13**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**15**	**1**	**6.67**	**14.3**	**14.3**	**L8**	**1.12**	**0**	**0**	**-0.22**	**-0.43722632**	—	—	—	**-1.775**	**2.405**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**17**	**3**	**17.65**	**-8.14**	**1.51**	**L8**	**-0.78626941**	**0**	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.3505**	**0.0885**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**15**	**0**	**0**	—	—	—	**-0.01070567**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.079**	**0.0307**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**17**	**2**	**11.76**	**-0.0272**	**-0.0246**	**L223**	**-0.008865**	**0**	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.0333**	**0.01145**	**0**	**No**	**BSL**

Table E2.1. Ecological Screening of Surface Water Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Potassium-40**	**pCi/L**	**761**	**15**	**1**	**6.67**	**236**	**236**	**L8**	**5.65**	**0**	**0**	**-23.74**	**-47.4747368**	—	—	—	**-121.5**	**78.5**	**0**	**No**	**BSL**
Rads	Radium	pCi/L	—	2	0	0	—	—	—	0.19	—	0	—	—	—	—	—	0.152	0.2215	—	Yes	NV
Rads	Suspended Alpha	pCi/L	—	33	5	15.15	-3.39	0.67	K019	0.28	—	0	0.66	1.32	-2.29	7.68	—	-2.02	8.45	—	Yes	NV
Rads	Suspended Beta	pCi/L	—	34	5	14.71	-7.42	48.6	L8	2.29	—	0	0.17	0.34	-9.72	5.37	—	-3.55	3.875	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**38**	**12**	**31.58**	**-0.907**	**24.4**	**L8**	**5.09**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-3.875**	**7.95**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**15**	**0**	**0**	—	—	—	**-0.00842233**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.158**	**0.0392**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**17**	**2**	**11.76**	**-0.0698**	**0.0654**	**L8**	**-0.01360382**	**0**	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.374**	**0.3205**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**15**	**0**	**0**	—	—	—	**0.003**	—	**0**	**0**	**0.009**	—	—	—	**-0.04875**	**0.03785**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	9	0	0	—	—	—	4.92	—	0	-0.52	-1.035	—	—	—	-13.3	41.6	—	Yes	NV
Rads	Tritium	pCi/L	—	2	0	0	—	—	—	-46.1975	—	0	—	—	—	—	—	-92	-0.395	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**10**	**3**	**30**	**1.18**	**575**	**L8**	**70.39**	**0**	**0**	**10.29**	**20.58**	—	—	—	**0.176**	**25**	**0**	**No**	**BSL**
Rads	Uranium-235	wt %	—	1	1	100	0.593	0.593	L8	0.59	—	0	-1.62	—	—	—	—	—	—	—	Yes	NV
Rads	**Uranium-238**	**pCi/L**	**4550**	**10**	**9**	**90**	**0.35**	**981**	**L8**	**98.9**	**0**	**0**	**0.1**	**0.2**	—	—	—	**0.175**	**0.175**	**0**	**No**	**BSL**
SVOA	1,1-biphenyl	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	**1,2,4-Trichlorobenzene**	**µg/L**	**44.9**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	1,2-Diphenylhydrazine	µg/L	2.7	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	1	Yes	ASL
SVOA	**1,3-Dichlorobenzene**	**µg/L**	**50.2**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2,4,6-Trichlorophenol	µg/L	3.2	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	1	Yes	ASL
SVOA	2,4'-DDD	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	2,4'-DDE	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	2,4'-DDT	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	**2,4-Dichlorophenol**	**µg/L**	**36.5**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dimethylphenol**	**µg/L**	**21.2**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrophenol**	**µg/L**	**6.2**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrotoluene**	**µg/L**	**310**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2,6-Dinitrotoluene	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	2-Chloronaphthalene	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**2-Chlorophenol**	**µg/L**	**43.8**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2-Methyl-4,6-dinitrophenol	µg/L	2.3	1	0	0	—	—	—	19	—	0	—	—	—	—	—	19	19	1	Yes	ASL
SVOA	2-Methylnaphthalene	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	**2-Nitrophenol**	**µg/L**	**3500**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	3,3'-Dichlorobenzidine	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4,4'-DDD	µg/L	0.0064	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	4	Yes	ASL
SVOA	4,4'-DDE	µg/L	0.01	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	4	Yes	ASL
SVOA	4,4'-DDT	µg/L	0.001	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	4	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**4-Nitrophenol**	**µg/L**	**82.8**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Aldrin**	**µg/L**	**0.3**	**4**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.02**	**0.025**	**0**	**No**	**BSL**
SVOA	**alpha-BHC**	**µg/L**	**500**	**4**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.02**	**0.025**	**0**	**No**	**BSL**
SVOA	alpha-Chlordane	µg/L	—	4	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.02	0.025	—	Yes	NV
SVOA	Azinphos-methyl	µg/L	—	2	0	0	—	—	—	1.25	—	0	1.25	2.5	—	—	—	1.25	1.25	—	Yes	NV
SVOA	**Benzidine**	**µg/L**	**25**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Benzo(e)pyrene	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	**beta-BHC**	**µg/L**	**5000**	**4**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.02**	**0.025**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	µg/L	0.12	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	2	Yes	ASL
SVOA	**Butyl benzyl phthalate**	**µg/L**	**22**	**1**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Chlordane	µg/L	0.0043	3	0	0	—	—	—	0.18	—	0	0.25	0.5	—	—	—	0.025	0.25	3	Yes	ASL
SVOA	Co-Ral	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	delta-BHC	µg/L	—	4	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.02	0.025	—	Yes	NV
SVOA	Diazinon	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Dibenzothiophene	µg/L	—	1	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV

Table E2.1. Ecological Screening of Surface Water Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Dichlorvos	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Dieldrin	µg/L	0.0019	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	4	Yes	ASL
SVOA	**Diethyl phthalate**	**µg/L**	**521**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Dimethoate	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	**Dimethyl phthalate**	**µg/L**	**330**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Di-n-butyl phthalate**	**µg/L**	**9.4**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Di-n-octylphthalate	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**Endosulfan I**	**µg/L**	**0.056**	**4**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.02**	**0.025**	**0**	**No**	**BSL**
SVOA	**Endosulfan II**	**µg/L**	**0.056**	**4**	**0**	**0**	—	—	—	**0.04**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.05**	**0**	**No**	**BSL**
SVOA	Endosulfan sulfate	µg/L	—	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	—	Yes	NV
SVOA	Endrin	µg/L	0.0023	4	0	0	—	—	—	0.03	—	0	0.02	0.05	—	—	—	0.00325	0.05	4	Yes	ASL
SVOA	Endrin aldehyde	µg/L	—	4	0	0	—	—	—	0.04	—	0	0.02	0.05	—	—	—	0.025	0.05	—	Yes	NV
SVOA	Ethion	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Famphur	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	Fensulfothion	µg/L	—	2	0	0	—	—	—	1.25	—	0	1.25	2.5	—	—	—	1.25	1.25	—	Yes	NV
SVOA	Fenthion	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	gamma-Chlordane	µg/L	—	4	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.01	0.025	—	Yes	NV
SVOA	Heptachlor	µg/L	0.0038	4	1	25	0.032	0.032	K019	0.03	1	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	Heptachlor epoxide	µg/L	0.0038	4	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.0095	0.025	4	Yes	ASL
SVOA	Hexachlorobenzene	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	Hexachlorobutadiene	µg/L	0.93	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	2	Yes	ASL
SVOA	Hexachlorocyclopentadiene	µg/L	0.07	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	2	Yes	ASL
SVOA	**Hexachloroethane**	**µg/L**	**9.8**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Isophorone**	**µg/L**	**1170**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Lindane**	**µg/L**	**0.08**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Malathion	µg/L	0.1	2	0	0	—	—	—	0.6	—	0	0.6	1.2	—	—	—	0.6	0.6	2	Yes	ASL
SVOA	Methoxychlor	µg/L	0.03	4	0	0	—	—	—	0.14	—	0	0.05	0.1	—	—	—	0.05	0.25	4	Yes	ASL
SVOA	Methyl parathion	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Mirex	µg/L	0.001	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	2	Yes	ASL
SVOA	Mocap	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	**Nitrobenzene**	**µg/L**	**270**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	N-Nitrosodimethylamine	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	µg/L	—	2	0	0	—	—	—	3.75	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**µg/L**	**58.5**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Parathion	µg/L	0.013	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	2	Yes	ASL
SVOA	**Pentachlorophenol**	**µg/L**	**14.9**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Perylene	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	**Phenol**	**µg/L**	**256**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Phorate	µg/L	—	2	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Toxaphene	µg/L	0.0002	4	0	0	—	—	—	2.19	—	0	2.5	5	—	—	—	1.25	2.5	4	Yes	ASL
SVOA	**Acenaphthene**	**µg/L**	**17**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**0**	**No**	**BSL**
SVOA	**Acenaphthylene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Anthracene**	**µg/L**	**0.73**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**2**	**No**	**ASL**
SVOA	**Benz(a)anthracene**	**µg/L**	**0.027**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**4**	**No**	**ASL**
SVOA	**Benzo(a)pyrene**	**µg/L**	**0.014**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**4**	**No**	**ASL**
SVOA	**Benzo(b)fluoranthene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Benzo(ghi)perylene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Benzo(k)fluoranthene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Chrysene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Dibenz(a,h)anthracene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Fluoranthene**	**µg/L**	**39.8**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**0**	**No**	**BSL**
SVOA	**Fluorene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Indeno(1,2,3-cd)pyrene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Naphthalene**	**µg/L**	**62**	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	**0**	**No**	**BSL**
SVOA	**Phenanthrene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**

Table E2.1. Ecological Screening of Surface Water Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**Pyrene**	**µg/L**	—	**4**	**0**	**0**	—	—	—	**2.12**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**5**	—	**No**	**NV**
SVOA	**Total PAHs**	**µg/L**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**No**	**ND**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2,2-Tetrachloroethane**	**µg/L**	**240**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2-Trichloroethane**	**µg/L**	**940**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**µg/L**	**47**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethene**	**µg/L**	**303**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichlorobenzene**	**µg/L**	**15.8**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloroethane**	**µg/L**	**2000**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**µg/L**	**525**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,4-Dichlorobenzene**	**µg/L**	**11.2**	**2**	**0**	**0**	—	—	—	**3.75**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
VOA	2,6-Dimethylnaphthalene	µg/L	—	2	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
VOA	**2-Butanone**	**µg/L**	**14000**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**2-Chloroethyl vinyl ether**	**µg/L**	**3540**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	2-Hexanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	4-Methyl-2-pentanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	**Acetone**	**µg/L**	**1500**	**2**	**2**	**100**	**11**	**15**	**L8**	**13**	**0**	**0**	**500**	**1000**	—	—	—	—	—	—	**No**	**BSL**
VOA	Acrolein	µg/L	2.1	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	2	Yes	ASL
VOA	**Acrylonitrile**	**µg/L**	**75.5**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**Benzene**	**µg/L**	**53**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Bromoform**	**µg/L**	**29**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromomethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Carbon disulfide	µg/L	0.92	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
VOA	**Carbon tetrachloride**	**µg/L**	**352**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**µg/L**	**195**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloroethane	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Chloroform**	**µg/L**	**289**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloromethane	µg/L	—	3	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,2-Dichloroethene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,3-Dichloropropene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Dibromochloromethane	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Ethylbenzene**	**µg/L**	**453**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	MBAS	mg/L	—	2	0	0	—	—	—	0.04	—	0	—	—	—	—	—	0.04	0.04	—	Yes	NV
VOA	**Methylene chloride**	**µg/L**	**1930**	**4**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	Styrene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Tetrachloroethene**	**µg/L**	**84**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Toluene**	**µg/L**	**175**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Total Xylene**	**µg/L**	**13**	**2**	**0**	**0**	—	—	—	**7.5**	—	**0**	—	—	—	—	—	**7.5**	**7.5**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	trans-1,3-Dichloropropene	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Trichloroethene**	**µg/L**	**47**	**23**	**3**	**13.04**	**2**	**3**	**L8**	**0.78**	**0**	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
VOA	Vinyl chloride	µg/L	—	2	0	0	—	—	—	1	—	0	—	—	—	—	—	1	1	—	Yes	NV
Wetchem	Hardness – total as CaCO3	mg/L	—	31	31	100	42	137	L8	80	—	0	52.25	104.5	32	179	—	—	—	—	—	—
Wetchem	Total organic carbon (TOC)	mg/L	—	2	2	100	1.8	6.1	K019	3.95	—	0	—	—	—	—	—	—	—	—	—	—

Notes:

ASL – Above screening value
BSL – Below screening value
BHC – Benzene hexachloride
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
ND – Not detected
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem- wet chemistry
mg/L - milligrams/liter
pCi/L - picocuries/liter
ug/L - micrograms/liter
wt % - weight percent
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.2. Ecological Screening of Surface Sediment Data – North-South Diversion Ditch

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Aluminum**	**mg/kg**	**25500**	**94**	**94**	**100**	**1010**	**12600**	**NSDDB-03-01**	**6335.32**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	94	47	50	8.52	9.99	NSDDB-09-05, NSDDB-10-03	6.87	47	3	4.975	47	Yes	ASL
Metal	Arsenic	mg/kg	5.9	94	43	45.74	1.2	57.1	NS-SD-15	5.41	21	0.474	2.5	0	Yes	ASL
Metal	Barium	mg/kg	—	94	94	100	12	319	AIPNSD2000-15	65.56	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	94	44	46.81	0.31	3.3	NS-SD-15	0.51	—	0.213	0.25	—	Yes	NV
Metal	Boron	mg/kg	—	13	0	0	—	—	—	10	—	10	10	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	94	5	5.32	2.27	4.91	NSDDB-08-06	0.97	5	0.25	1	76	Yes	ASL
Metal	Calcium	mg/kg	—	94	94	100	236	83000	AIPNSD2000-01	5147.85	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	94	94	100	6.45	473	NSDDB-08-07	36.5	20	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	94	89	94.68	1.4	46.6	AIPNSD2000-15	5.79	—	1.065	1.24	—	Yes	NV
Metal	Copper	mg/kg	30	94	90	95.74	2.7	234	NSDDB-03-06	28.12	18	1.13	1.23	0	Yes	ASL
Metal	Iron	mg/kg	2000	94	94	100	2430	82600	AIPNSD2000-15	11297.66	94	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	94	23	24.47	3.6	58.9	NS-SD-15	13.16	19	8.5	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	94	94	100	77.3	2690	NSDDB-02-01	838.85	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	94	94	100	17.8	4470	NS-SD-15	449.03	18	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	94	21	22.34	0.03	0.76	NSDDB-01-08	0.08	9	0.0305	0.05	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	94	25	26.6	0.2	23.9	NSDDB-02-07	2.74	—	1.085	2.5	—	Yes	NV
Metal	Nickel	mg/kg	16	94	79	84.04	2.3	150	NSDDB-02-05	15.92	21	2.135	2.48	0	Yes	ASL
Metal	Potassium	mg/kg	—	94	85	90.43	152	1030	NSDDB-01-08	431.69	—	42.65	1250		Yes	NV
Metal	Selenium	mg/kg	0.05	94	1	1.06	27.9	27.9	NSDDB-08-06	8.4	1	0.25	10	93	Yes	ASL
Metal	Silicon	mg/kg	—	13	13	100	593	881	NS-SD-09	764.15	—	—	—	—	Yes	NV
Metal	Silver	mg/kg	0.00038	94	47	50	2.13	10.6	NSDDB-08-07	2.21	47	0.5	10.2	47	Yes	ASL
Metal	Sodium	mg/kg	—	94	34	36.17	29	447	NS-SD-09	77.77	—	42.6	49.95	—	Yes	NV
Metal	Thallium	mg/kg	—	94	11	11.7	0.56	4.2	AIPNSD2000-15	8.36	—	0.5	10	—	Yes	NV
Metal	Uranium	mg/kg	—	162	142	87.65	0.671	328	NSDDB-01-08	16.18	—	0.176	0.795	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	94	94	100	6.55	104	NS-SD-15	20.35	94	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	94	78	82.98	6	196	NSDDB-01-08	39.57	78	8.55	9.9	16	Yes	ASL
PCB	PCB-1016	mg/kg	—	421	10	2.38	0.37	1.38	NSDDA-250	0.06	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	421	3	0.71	0.63	0.65	NSDDB-08-07, NSDDB-08-07	0.07	—	0.0205	0.065	—	Yes	NV
PCB	PCB-1232	mg/kg	—	421	3	0.71	0.49	0.5	NSDDB-08-07, NSDDB-08-07	0.05	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	421	5	1.19	0.25	3.42	NSDDA-077	0.04	—	0.02	0.03	—	Yes	NV
PCB	PCB-1248	mg/kg	—	421	10	2.38	0.16	0.5	NSDDB-08-07, NSDDB-08-07	0.06	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	421	35	8.31	0.11	19.6	NSDDA-004	0.14	—	0.0205	0.045	—	Yes	NV
PCB	PCB-1260	mg/kg	—	421	83	19.71	0.05	9.28	NSDDA-004	0.15	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1262	mg/kg	—	13	0	0	—	—	—	0.02	—	0.0205	0.0255	—	Yes	NV
PCB	PCB-1268	mg/kg	—	421	5	1.19	0.14	0.4	NSDDB-08-07, NSDDB-08-07	0.04	—	0.0205	0.04	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	408	84	20.59	0.13	28.9	NSDDA-004	0.29	84	0.045	0.065	324	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	80	68	85	0.0198	0.857	NSDDB-02-09	0.13	—	-0.00103	0.0092	—	Yes	NV
Rads	Alpha activity	pCi/g	—	81	81	100	2.31	401	NSDDB-01-08	40.02	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**89**	**54**	**60.67**	**0.0415**	**4.39**	**NSDDB-01-08**	**0.42**	**0**	**-0.009**	**0.035**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	81	81	100	2.35	713	NSDDB-01-09	65.03	—	—	—	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**81**	**64**	**79.01**	**0.0628**	**4.1**	**NSDDB-02-05**	**0.6**	**0**	**-0.0111**	**0.0685**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**81**	**0**	**0**	—	—	—	**0.0006**	—	**-0.01915**	**0.04175**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**81**	**45**	**55.56**	**0.0332**	**5.3**	**NSDDB-01-09**	**0.4**	**0**	**-0.0073**	**0.01945**	**0**	**No**	**BSL**
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**22300**	**8**	**4**	**50**	**0.285**	**0.4829**	**NSD2000-12 sedi**	**0.21**	**0**	**0.02949**	**0.0805**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**89**	**13**	**14.61**	**0.0563**	**0.307**	**NSDDB-01-08**	**0.03**	**0**	**-0.00895**	**0.38415**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**89**	**69**	**77.53**	**0.027**	**16.1**	**NSDDB-01-08**	**1.72**	**0**	**-0.7675**	**0.01085**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	89	73	82.02	2.91	596	NSDDB-01-09	40.19	—	0.4755	1.875	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**81**	**76**	**93.83**	**0.167**	**2.08**	**NSDDB-01-08**	**0.44**	**0**	**0.0364**	**0.081**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**81**	**79**	**97.53**	**0.188**	**199**	**NSDDB-01-08**	**25.34**	**0**	**0.1125**	**0.1135**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**81**	**81**	**100**	**0.175**	**3.07**	**NSDDB-08-07**	**0.55**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**89**	**89**	**100**	**0.0959**	**11.7**	**NSDDB-02-09**	**2.09**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**8**	**8**	**100**	**0.0381**	**0.3094**	**NSD2000-11 sedi**	**0.14**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**89**	**89**	**100**	**0.117**	**15.1**	**NSDDB-02-09**	**2.76**	**0**	—	—	—	**No**	**BSL**

Table E2.2. Ecological Screening of Surface Sediment Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Acenaphthene	mg/kg	0.089	81	6	7.41	0.46	2	NSDDB-06-03	0.29	6	0.23	0.25	75	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	81	3	3.7	0.46	0.5	NSDDB-09-06	0.25	—	0.23	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	81	10	12.35	0.46	3.3	NSDDB-06-03	0.35	10	0.23	0.25	71	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	81	24	29.63	0.46	7.7	NSDDB-06-03	0.62	24	0.23	0.25	57	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	81	21	25.93	0.46	5.7	NSDDB-06-03	0.51	21	0.23	0.25	60	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	81	29	35.8	0.46	12	NSDDB-06-03	0.94	29	0.23	0.25	52	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg	—	81	17	20.99	0.46	3	NSDDB-08-01	0.39	—	0.23	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	81	20	24.69	0.46	3.5	NSDDB-06-03	0.43	20	0.23	0.25	61	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	81	27	33.33	0.46	7.6	NSDDB-06-03	0.68	27	0.23	0.25	54	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	81	5	6.17	0.46	0.8	NSDDB-08-01	0.26	5	0.23	0.25	76	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	81	33	40.74	0.46	18	NSDDB-06-03	1.48	33	0.23	0.25	48	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	81	6	7.41	0.46	1.5	NSDDB-06-03	0.28	6	0.23	0.25	75	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	81	19	23.46	0.46	3.3	NSDDB-08-01	0.43	19	0.23	0.25	62	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	81	3	3.7	0.46	0.5	NSDDB-09-06	0.25	3	0.23	0.25	78	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	81	28	34.57	0.46	16	NSDDB-06-03	1.06	28	0.23	0.25	53	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	81	31	38.27	0.46	13	NSDDB-06-03	1.03	31	0.23	0.25	50	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	98.4	—	—	—	—	—	—	Yes	ASL

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

The NFA value for silver is referenced in Appendix E, Section E.6.7.

Table E2.3. Ecological Screening of Surface Soil Data – North-South Diversion Ditch

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	Aluminum	mg/kg	5	14	14	100	6020	12500	NSD030	8561.43	14	—	—	—	Yes	ASL
Metal	**Antimony**	**mg/kg**	**1.9**	**14**	**1**	**7.14**	**0.55**	**0.55**	**SEC3A-3SO**	**6.73**	**0**	**3.8**	**10**	**13**	**No**	**BSL**
Metal	Arsenic	mg/kg	1	14	10	71.43	3.1	8.6	SEC3A-6SO	4.74	10	2.5	2.5	4	Yes	ASL
Metal	Barium	mg/kg	20	14	14	100	58.7	176	SEC3A-3SO	95.34	14	—	—	—	Yes	ASL
Metal	Beryllium	mg/kg	0.19	14	7	50	0.44	0.78	SEC3A-3SO	0.43	7	0.25	0.25	7	Yes	ASL
Metal	Boron	mg/kg	0.5	7	0	0	—	—	—	13.3	—	12.65	13.85	7	Yes	ASL
Metal	Cadmium	mg/kg	0.11	14	7	50	0.28	0.64	SEC3A-3SO	0.71	7	1	1	7	Yes	ASL
Metal	Calcium	mg/kg	—	14	14	100	903	12700	SEC3A-1SO	3412.36	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	0.4	14	14	100	8.29	90.4	NSD027	36.97	14	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	2.5	14	14	100	3.55	9.8	SEC3A-6SO	5.29	14	—	—	—	Yes	ASL
Metal	Copper	mg/kg	0.45	14	14	100	7.11	134	NSD030	33.04	14	—	—	—	Yes	ASL
Metal	Iron	mg/kg	110	14	14	100	8650	14100	SEC3A-6SO	11062.14	14	—	—	—	Yes	ASL
Metal	Lead	mg/kg	20	14	9	64.29	8.9	32.2	NSD030	16.11	4	10	10	0	Yes	ASL
Metal	Lithium	mg/kg	2	7	5	71.43	5.32	8.75	NSD030	5.46	5	2.5	2.5	2	Yes	ASL
Metal	Magnesium	mg/kg	—	14	14	100	625	1760	SEC3A-1SO	1137.14	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	25	14	14	100	117	1900	SEC3A-6SO	553.29	14	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.1	14	13	92.86	0.06	1.49	NSD026	0.35	7	0.1	0.1	1	Yes	ASL
Metal	**Molybdenum**	**mg/kg**	**2**	**7**	**7**	**100**	**0.29**	**0.48**	**SEC3A-6SO**	**0.4**	**0**	—	—	—	**No**	**BSL**
Metal	Nickel	mg/kg	11	14	13	92.86	8.2	99.6	NSD030	35.91	9	2.5	2.5	0	Yes	ASL
Metal	Potassium	mg/kg	—	7	7	100	441	738	SEC3A-5SO	570.57	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.21	14	0	0	—	—	—	0.42	—	0.315	0.5	14	Yes	ASL
Metal	Silicon	mg/kg	—	7	7	100	212	343	SEC3A-1SO	292.43	—	—	—	—	Yes	NV
Metal	Silver	mg/kg	1	14	4	28.57	3.08	8.66	NSD030	2.27	4	0.65	1.25	3	Yes	ASL
Metal	Sodium	mg/kg	—	7	0	0	—	—	—	332.5	—	316.5	346.5	—	Yes	NV
Metal	Thallium	mg/kg	1	14	0	0	—	—	—	5.34	—	0.65	10	7	Yes	ASL
Metal	Tin	mg/kg	5.6	7	6	85.71	139	185	NSD024	146	6	50	50	1	Yes	ASL
Metal	Uranium	mg/kg	5	7	1	14.29	164	164	NSD030	66.29	1	50	50	6	Yes	ASL
Metal	Vanadium	mg/kg	2	14	14	100	18.7	28.2	NSD030	21.35	14	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	8.5	14	14	100	18.5	138	NSD030	57.76	14	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	21	0	0	—	—	—	0.03	—	0.021	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	21	0	0	—	—	—	0.04	—	0.021	0.05	—	Yes	NV
PCB	PCB-1232	mg/kg	—	21	0	0	—	—	—	0.04	—	0.021	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	21	0	0	—	—	—	0.04	—	0.021	0.05	—	Yes	NV
PCB	PCB-1248	mg/kg	—	21	1	4.76	11.3	11.3	NSD027	0.57	—	0.021	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	21	3	14.29	0.6	5.9	NSD027, NSD029	0.62	—	0.021	0.05	—	Yes	NV
PCB	PCB-1260	mg/kg	—	21	7	33.33	0.5	3.9	NS-SS-10	0.69	—	0.021	0.05	—	Yes	NV
PCB	PCB-1262	mg/kg	—	7	0	0	—	—	—	0.02	—	0.021	0.023	—	Yes	NV
PCB	PCB-1268	mg/kg	—	21	0	0	—	—	—	0.04	—	0.021	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.02	14	7	50	0.5	20	NSD027	2.72	7	0.05	0.05	7	Yes	ASL
Rads	**Activity of Uranium-235**	**pCi/g**	**1750**	**7**	**7**	**100**	**0.0429**	**1.94**	**NSD027**	**0.84**	**0**	—	—	—	**No**	**BSL**
Rads	Alpha activity	pCi/g	—	2	2	100	8.12	10	NS-SD-07	9.06	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**975**	**22**	**20**	**90.91**	**0.103**	**15.24**	**NSD2000-10 bank**	**1.65**	**0**	**0.0165**	**0.02245**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	2	2	100	6.89	9.99	NS-SD-07	8.44	—	—	—	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**825**	**7**	**0**	**0**	—	—	—	**-0.00298571**	—	**-0.01735**	**0.004665**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/g**	**1240**	**7**	**7**	**100**	**0.032**	**4.16**	**NSD027**	**2.49**	**0**	—	—	—	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**7860**	**7**	**0**	**0**	—	—	—	**-0.002485**	—	**-0.0107**	**0.00735**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**1680**	**7**	**6**	**85.71**	**1.22**	**3**	**NSD029**	**1.94**	**0**	**0.00389**	**0.00389**	**0**	**No**	**BSL**
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**1680**	**15**	**14**	**93.33**	**0.083**	**4.7**	**NSD2000-10 bank**	**0.63**	**0**	**0.0015**	**0.0015**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**1900**	**22**	**6**	**27.27**	**0.056**	**1.257**	**NSD2000-10 bank**	**0.11**	**0**	**-0.02115**	**0.1195**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**2020**	**22**	**21**	**95.45**	**0.0224**	**61.45**	**NSD2000-10 bank**	**6.62**	**0**	**0.00162**	**0.00162**	**0**	**No**	**BSL**
Rads	**Technetium-99**	**pCi/g**	**6570**	**22**	**22**	**100**	**-0.84**	**1192.85**	**NSD2000-10 bank**	**92.09**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-228**	**pCi/g**	**154**	**7**	**7**	**100**	**0.27**	**4.38**	**NSD027**	**1.97**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**3990**	**7**	**7**	**100**	**0.359**	**497**	**NSD027**	**223.32**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**1900**	**7**	**7**	**100**	**0.292**	**5.07**	**NSD027**	**2.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**1990**	**22**	**21**	**95.45**	**0.5241**	**56.14**	**NSD2000-10 bank**	**8.83**	**0**	**0.3265**	**0.3265**	**0**	**No**	**BSL**

Table E2.3. Ecological Screening of Surface Soil Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Uranium-235**	**pCi/g**	**1750**	**15**	**15**	**100**	**0.0299**	**3.201**	**NSD2000-10 bank**	**0.39**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**1060**	**22**	**22**	**100**	**0.5752**	**71.56**	**NSD2000-10 bank**	**11.37**	**0**	—	—	—	**No**	**BSL**
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**2,4,5-Trichlorophenol**	**mg/kg**	**4**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	**2,4,6-Trichlorophenol**	**mg/kg**	**10**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dichlorophenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**2,4-Dinitrophenol**	**mg/kg**	**20**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dinitrotoluene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**4-Nitrophenol**	**mg/kg**	**7**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Butyl benzyl phthalate	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Carbazole	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**Hexachlorocyclopentadiene**	**mg/kg**	**10**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Hexachloroethane	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	Isophorone	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**Nitrobenzene**	**mg/kg**	**40**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**mg/kg**	**20**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Pentachlorophenol	mg/kg	0.002	7	0	0	—	—	—	0.24	—	0.24	0.25	7	Yes	ASL
SVOA	Phenol	mg/kg	0.05	7	0	0	—	—	—	0.24	—	0.24	0.25	7	Yes	ASL
SVOA	**Acenaphthene**	**mg/kg**	**20**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	**Acenaphthylene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Anthracene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**7**	**No**	**ASL**
SVOA	**Benz(a)anthracene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Benzo(a)pyrene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**7**	**No**	**ASL**
SVOA	**Benzo(b)fluoranthene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Benzo(ghi)perylene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Chrysene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Fluorene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Indeno(1,2,3-cd)pyrene**	**mg/kg**	—	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	—	**No**	**NV**
SVOA	**Naphthalene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**7**	**No**	**ASL**
SVOA	**Phenanthrene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**7**	**No**	**ASL**
SVOA	**Pyrene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.25**	**7**	**No**	**ASL**

Table E2.3. Ecological Screening of Surface Soil Data – North-South Diversion Ditch (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**Total PAHs**	**mg/kg**	**1**	—	—	—	—	—	—	—	—	—	—	—	**No**	**ND**
SVOA	Pyridine	mg/kg	0.1	7	0	0	—	—	—	0.24	—	0.24	0.25	7	Yes	ASL
VOA	1,1,1-Trichloroethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,1,2,2-Tetrachloroethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,1,2-Trichloroethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,1-Dichloroethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,1-Dichloroethene	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,2-Dichlorobenzene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
VOA	**1,2-Dichloroethane**	**mg/kg**	**0.4**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**mg/kg**	**700**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,2-Dimethylbenzene	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	—	7	0	0	—	—	—	0.24	—	0.24	0.25	—	Yes	NV
VOA	2-Butanone	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	2-Hexanone	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	4-Methyl-2-pentanone	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Acetone	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Benzene**	**mg/kg**	**0.05**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromoform	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromomethane	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Carbon disulfide	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Carbon tetrachloride**	**mg/kg**	**160**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**mg/kg**	**0.05**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Ethylbenzene**	**mg/kg**	**0.05**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	m,p-Xylene	mg/kg	—	7	0	0	—	—	—	0.01	—	0.01	0.01	—	Yes	NV
VOA	Methylene chloride	mg/kg	—	7	3	42.86	0.01	0.017	NSD029	0.008	—	0.005	0.005	—	Yes	NV
VOA	**Styrene**	**mg/kg**	**0.1**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Tetrachloroethene**	**mg/kg**	**0.01**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Toluene**	**mg/kg**	**0.05**	**7**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	trans-1,3-Dichloropropene	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Trichloroethene	mg/kg	0.001	7	0	0	—	—	—	0.005	—	0.005	0.005	7	Yes	ASL

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
ND – Not detected
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001

Table E2.4. Ecological Screening of Surface Water Data – Outfall 001

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Dioxin/furans	2,3,7,8-Tetrachlorodibenzo-p-dioxin	µg/L	0.0000014	3	0	0	—	—	—	0.00001	—	0	—	—	—	—	—	0.000004116	0.000015	3	Yes	ASL
Field parameters	pH	Std. unit	—	780	780	100	6	8.96	K001	7.51	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	65	30	46.15	0.2	8.4	L5	0.43	30	0	0.55	1.1	0.2	2.92	13	0.1	0.5	35	Yes	ASL
Metal	Antimony	mg/L	0.16	70	13	18.57	0.005	0.2	K001	0.04	1	0	0.03	0.05	0.005	0.005	0	0.0025	0.1	0	Yes	ASL
Metal	Arsenic	mg/L	0.05	70	4	5.71	0.01	0.2	K001, K001	0.03	2	0	0.03	0.05	—	—	—	0.0025	0.1	13	Yes	ASL
Metal	Barium	mg/L	0.004	33	33	100	0.00926	0.142	C612	0.06	33	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	70	3	4.29	0.005	0.005	K001	0.002	3	0	0	0.002	—	—	—	0.0005	0.005	27	Yes	ASL
Metal	Boron	mg/L	0.0016	4	0	0	—	—	—	1	—	0	—	—	—	—	—	1	1	4	Yes	ASL
Metal	Cadmium	mg/L	0.00142	102	5	4.9	0.001	0.021	K001	0.006	2	0	0.01	0.02	0.001	0.001	0	0.0005	0.025	44	Yes	ASL
Metal	Calcium	mg/L	—	29	29	100	14.3	48.4	L5	25.92	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	Chromium	mg/L	0.04885	102	10	9.8	0.02	0.05	L5	0.01	1	0	0.02	0.03	0.02	0.05	1	0.01	0.025	0	Yes	ASL
Metal	**Cobalt**	**mg/L**	**0.023**	**33**	**8**	**24.24**	**0.001**	**0.00317**	**L5**	**0.002**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0125**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	102	34	33.33	0.005	0.0312	K001	0.01	32	0	0.02	0.04	0.0052	0.038	8	0.0025	0.05	54	Yes	ASL
Metal	Cyanide	mg/L	0.0052	47	2	4.26	0.02	0.02	C612	0.01	2	0	0.02	0.03	—	—	—	0.01	0.025	45	Yes	ASL
Metal	Iron	mg/L	1	102	76	74.51	0.2	6.71	L5	0.48	7	0	0.98	1.95	0.488	2.6	5	0.1	0.1	0	Yes	ASL
Metal	Lead	mg/L	0.00132	102	1	0.98	0.00853	0.00853	L5	0.05	1	0	0.06	0.13	—	—	—	0.0025	0.125	101	Yes	ASL
Metal	Magnesium	mg/L	—	33	33	100	3.39	26.5	K001	9.74	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	Manganese	mg/L	0.12	33	27	81.82	0.005	0.28	L5	0.04	2	0	0.24	0.48	0.108	0.329	12	0.0025	0.0025	0	Yes	ASL
Metal	Mercury	mg/L	0.000012	70	13	18.57	0.0002	0.0002	C612, K001, K006, L5	0.0001	13	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	57	Yes	ASL
Metal	**Molybdenum**	**mg/L**	**0.37**	**4**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.0125**	**0.0125**	**0**	**No**	**BSL**
Metal	Nickel	mg/L	0.029	102	27	26.47	0.005	0.05	K001, L5	0.02	2	0	0.02	0.04	0.005	0.05	1	0.0025	0.05	7	Yes	ASL
Metal	Phosphorous	mg/L	—	431	411	95.36	0.05	0.57	K001	0.18	—	0	0.06	0.12	0.05	0.18	—	0.025	0.025	—	Yes	NV
Metal	Potassium	mg/L	—	29	29	100	0.221	10.8	L5	3.32	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	Selenium	mg/L	0.005	70	1	1.43	0.005	0.005	K001	0.02	1	0	0	0.006	—	—	—	0.0025	0.1	20	Yes	ASL
Metal	Silver	mg/L	0.000012	70	19	27.14	0.001	0.025	K001	0.006	19	0	0	0.007	0.001	0.001	1	0.0005	0.025	51	Yes	ASL
Metal	Sodium	mg/L	—	29	29	100	8.12	84.8	L5	32.54	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	Thallium	mg/L	0.004	70	14	20	0.01	0.2	K001	0.04	14	0	0.03	0.06	0.01	0.01	3	0.005	0.125	56	Yes	ASL
Metal	Tin	mg/L	0.073	4	2	50	1	1	K001	0.75	2	0	—	—	—	—	—	0.5	0.5	2	Yes	ASL
Metal	Titanium	mg/L	—	4	0	0	—	—	—	0.01	—	0	—	—	—	—	—	0.0125	0.0125	—	Yes	NV
Metal	Total Metals	mg/L	—	36	4	11.11	0.307	5	K001	2.33	—	0	—	—	—	—	—	1	2.5	—	Yes	NV
Metal	Uranium	mg/L	0.0026	99	56	56.57	0.001	0.22	K001	0.01	41	0	0	0.002	0.001	0.001	0	0.00002575	0.025	4	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**29**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.01**	**0**	**No**	**BSL**
Metal	Zinc	mg/L	0.067	102	39	38.24	0.02	0.6	L5	0.06	6	0	0.07	0.14	0.02	0.2	1	0.01	0.1	30	Yes	ASL
PCB	Endrin ketone	µg/L	—	4	0	0	—	—	—	0.05	—	0	—	—	—	—	—	0.05	0.05	—	Yes	NV
PCB	PCB-1016	µg/L	0.014	174	0	0	—	—	—	0.08	—	0	0.08	0.17	—	—	—	0.06	0.1	174	Yes	ASL
PCB	PCB-1221	µg/L	0.014	174	0	0	—	—	—	0.09	—	0	0.09	0.18	—	—	—	0.085	0.47	174	Yes	ASL
PCB	PCB-1232	µg/L	0.014	174	0	0	—	—	—	0.08	—	0	0.08	0.16	—	—	—	0.065	0.085	174	Yes	ASL
PCB	PCB-1242	µg/L	0.014	174	1	0.57	0.11	0.11	K001	0.07	1	0	0.07	0.14	—	—	—	0.045	0.085	173	Yes	ASL
PCB	PCB-1248	µg/L	0.014	174	3	1.72	0.16	0.47	W337-06	0.08	3	0	0.08	0.15	—	—	—	0.055	0.085	171	Yes	ASL
PCB	PCB-1254	µg/L	0.014	174	5	2.87	0.08	0.23	K001	0.07	5	0	0.08	0.16	0.23	0.23	1	0.035	0.085	169	Yes	ASL
PCB	PCB-1260	µg/L	0.014	174	2	1.15	0.08	0.102	C612	0.06	2	0	0.06	0.13	—	—	—	0.025	0.085	172	Yes	ASL
PCB	PCB-1268	µg/L	—	174	1	0.57	0.25	0.25	C612	0.07	—	0	0.07	0.14	—	—	—	0.035	0.085	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	µg/L	0.0014	174	8	4.6	0.102	0.47	W337-06	0.1	8	0	0.09	0.19	0.23	0.23	1	0.085	0.47	166	Yes	ASL
Rads	Activity of Uranium-235	pCi/L	—	24	2	8.33	0.825	38.9	C612	2.66	—	0	0.63	1.25	—	—	—	-0.01315	11	—	Yes	NV
Rads	Alpha activity	pCi/L	—	6	4	66.67	-20	20.87	K001	3.89	—	0	—	—	—	—	—	-1.165	0	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1,170**	**56**	**2**	**3.57**	**-14.1**	**-10**	**K001**	**-2.10511841**	**0**	**0**	**-3.81**	**-7.62398947**	—	—	—	**-16.95**	**13.3**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/L	—	6	5	83.33	0	84.89	K001	33.03	—	0	—	—	—	—	—	50	50	—	Yes	NV
Rads	**Cesium-134**	**pCi/L**	**11,000**	**54**	**0**	**0**	—	—	—	**-1.94355556**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-11.95**	**2.165**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7,720**	**54**	**0**	**0**	—	—	—	**0.05**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-4.69**	**5.45**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107,000**	**54**	**0**	**0**	—	—	—	**-0.10426852**	—	**0**	**-0.22**	**-0.43722632**	—	—	—	**-5.05**	**5.4**	**0**	**No**	**BSL**
Rads	Gamma activity	pCi/L	—	6	6	100	77	15,800	L5	8933.33	—	0	8,829.40	17,658.80	56.4	15,600	—	—	—	—	Yes	NV
Rads	**Neptunium-237**	**pCi/L**	**1,340**	**63**	**8**	**12.7**	**-6.57**	**0.45**	**L5**	**-0.2153023**	**0**	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.488**	**0.266**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1,170**	**54**	**1**	**1.85**	**0.289**	**0.289**	**K006**	**0.0002**	**0**	**0**	**0**	**-0.00833632**	—	—	—	**-0.1135**	**0.071**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1,240**	**63**	**8**	**12.7**	**-0.0229**	**1.26**	**L5**	**0.02**	**0**	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.0246**	**0.0332**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**54**	**4**	**7.41**	**60.8**	**712**	**K006**	**9.76**	**0**	**0**	**-23.74**	**-47.47473684**	—	—	—	**-145**	**74**	**0**	**No**	**BSL**

Table E2.4. Ecological Screening of Surface Water Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	Radium	pCi/L	—	4	1	25	0.899	0.899	K001	0.34	—	0	—	—	—	—	—	0.102	0.2565	—	Yes	NV
Rads	Suspended alpha	pCi/L	—	88	21	23.86	-4.59	6.74	K001	0.32	—	0	0.66	1.32	-2.29	7.68	—	-1.85	1.72	—	Yes	NV
Rads	Suspended beta	pCi/L	—	91	27	29.67	-3.16	25.1	K001	2.18	—	0	0.17	0.34	-9.72	5.37	—	-3.35	3.695	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1,940,000**	**100**	**32**	**32**	**-2.22**	**96.9**	**K001**	**8.28**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-7.35**	**7.45**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**54**	**0**	**0**	—	—	—	**0.0005**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.054**	**0.04505**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**62**	**10**	**16.13**	**-0.374**	**1.86**	**L5**	**0.08**	**0**	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.093**	**0.3555**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**54**	**0**	**0**	—	—	—	**0.005**	—	**0**	**0**	**0.009**	—	—	—	**-0.0325**	**0.068**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	32	0	0	—	—	—	-10.14073437	—	0	-0.52	-1.035	—	—	—	-133.5	162.5	—	Yes	NV
Rads	Tritium	pCi/L	—	12	0	0	—	—	—	-14.01041667	—	0	—	—	—	—	—	-111.5	123.5	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4,040**	**28**	**3**	**10.71**	**0.757**	**594**	**C612**	**36.83**	**0**	**0**	**10.29**	**20.58**	—	—	—	**-0.0053**	**150**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/L**	**4,370**	**2**	**0**	**0**	—	—	—	**0.55**	—	**0**	**-1.62**	—	—	—	—	**0**	**1.1**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4,550**	**33**	**11**	**33.33**	**0.42**	**1,020**	**C612**	**48.52**	**0**	**0**	**0.1**	**0.2**	—	—	—	**-0.0119**	**124.5**	**0**	**No**	**BSL**
SVOA	**1,2,4-Trichlorobenzene**	**µg/L**	**44.9**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	1,2-Diphenylhydrazine	µg/L	2.7	4	0	0	—	—	—	3.12	—	0	—	—	—	—	—	2.5	5	1	Yes	ASL
SVOA	**1,3-Dichlorobenzene**	**µg/L**	**50.2**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2,4,5-Trichlorophenol	µg/L		4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	µg/L	3.2	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	1	Yes	ASL
SVOA	**2,4-Dichlorophenol**	**µg/L**	**36.5**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dimethylphenol**	**µg/L**	**21.2**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrophenol**	**µg/L**	**6.2**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrotoluene**	**µg/L**	**310**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2,6-Dinitrotoluene	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	2-Chloronaphthalene	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**2-Chlorophenol**	**µg/L**	**43.8**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	2-Methyl-4,6-dinitrophenol	µg/L	2.3	6	0	0	—	—	—	10	—	0	—	—	—	—	—	2.5	25	6	Yes	ASL
SVOA	2-Methylnaphthalene	µg/L	—	4	0	0	—	—	—	2.5	—	0	0.5	1	—	—	—	2.5	2.5	—	Yes	NV
SVOA	2-Methylphenol	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	2-Nitrobenzenamine	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**2-Nitrophenol**	**µg/L**	**3,500**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	3,3'-Dichlorobenzidine	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	3-Nitrobenzenamine	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	4,4'-DDD	µg/L	0.0064	3	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	3	Yes	ASL
SVOA	4,4'-DDE	µg/L	0.01	3	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	3	Yes	ASL
SVOA	4,4'-DDT	µg/L	0.001	3	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	3	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4-Chlorobenzenamine	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	4-Nitrobenzenamine	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**4-Nitrophenol**	**µg/L**	**82.8**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Aldrin**	**µg/L**	**0.3**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	**alpha-BHC**	**µg/L**	**500**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	alpha-Chlordane	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	**Benzidine**	**µg/L**	**25**	**4**	**0**	**0**	—	—	—	**3.12**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**beta-BHC**	**µg/L**	**5,000**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**Bis(2-chloroethyl) ether**	**µg/L**	**2,380**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroisopropyl) ether	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	µg/L	0.12	8	2	25	40	45	K001	12.81	2	0	—	—	—	—	—	2.5	5	6	Yes	ASL
SVOA	**Butyl benzyl phthalate**	**µg/L**	**22**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Carbazole	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Chlordane	µg/L	0.0043	2	0	0	—	—	—	0.02	—	0	0.25	0.5	—	—	—	0.025	0.025	2	Yes	ASL
SVOA	delta-BHC	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	**Dibenzofuran**	**µg/L**	**3.7**	**4**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Dieldrin	µg/L	0.0019	3	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	3	Yes	ASL

Table E2.4. Ecological Screening of Surface Water Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**Diethyl phthalate**	**µg/L**	**521**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Dimethyl phthalate**	**µg/L**	**330**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Di-n-butyl phthalate**	**µg/L**	**9.4**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Di-n-octylphthalate	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**Endosulfan I**	**µg/L**	**0.056**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0**	**0.025**	**0**	**No**	**BSL**
SVOA	**Endosulfan II**	**µg/L**	**0.056**	**3**	**0**	**0**	—	—	—	**0.03**	—	**0**	**0.02**	**0.05**	—	—	—	**0**	**0.05**	**0**	**No**	**BSL**
SVOA	Endosulfan sulfate	µg/L	—	3	0	0	—	—	—	0.03	—	0	0.02	0.05	—	—	—	0	0.05	—	Yes	NV
SVOA	Endrin	µg/L	0.0023	3	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	3	Yes	ASL
SVOA	Endrin aldehyde	µg/L	—	3	0	0	—	—	—	0.03	—	0	0.02	0.05	—	—	—	0	0.05	—	Yes	NV
SVOA	gamma-Chlordane	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Heptachlor	µg/L	0.0038	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.009	0.025	3	Yes	ASL
SVOA	Heptachlor epoxide	µg/L	0.0038	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0	0.025	2	Yes	ASL
SVOA	Hexachlorobenzene	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	Hexachlorobutadiene	µg/L	0.93	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	8	Yes	ASL
SVOA	Hexachlorocyclopentadiene	µg/L	0.07	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	8	Yes	ASL
SVOA	**Hexachloroethane**	**µg/L**	**9.8**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Isophorone**	**µg/L**	**1,170**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Lindane**	**µg/L**	**0.08**	**2**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	m,p-Cresol	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Methoxychlor	µg/L	0.03	3	0	0	—	—	—	0.25	—	0	0.05	0.1	—	—	—	0.25	0.25	3	Yes	ASL
SVOA	**Nitrobenzene**	**µg/L**	**270**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	N-Nitrosodimethylamine	µg/L	—	4	0	0	—	—	—	3.12	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	µg/L	—	8	0	0	—	—	—	2.81	—	0	—	—	—	—	—	2.5	5	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**µg/L**	**58.5**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Pentachlorophenol**	**µg/L**	**14.9**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Phenol**	**µg/L**	**256**	**8**	**0**	**0**	—	—	—	**2.81**		**0**						**2.5**	**5**	**0**	**No**	**BSL**
SVOA	Pyridine	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Toxaphene	µg/L	0.0002	3	0	0	—	—	—	2.5	—	0	2.5	5	—	—	—	2.5	2.5	3	Yes	ASL
SVOA	**Acenaphthene**	**µg/L**	**17**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Acenaphthylene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Anthracene**	**µg/L**	**0.73**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**8**	**No**	**ASL**
SVOA	**Benz(a)anthracene**	**µg/L**	**0.027**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**8**	**No**	**ASL**
SVOA	**Benzo(a)pyrene**	**µg/L**	**0.014**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**8**	**No**	**ASL**
SVOA	**Benzo(b)fluoranthene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Benzo(ghi)perylene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Benzo(k)fluoranthene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Chrysene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Dibenz(a,h)anthracene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Fluoranthene**	**µg/L**	**39.8**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Fluorene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Indeno(1,2,3-cd)pyrene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Naphthalene**	**µg/L**	**62**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
SVOA	**Phenanthrene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Pyrene**	**µg/L**	—	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**5**	—	**No**	**NV**
SVOA	**Total PAHs**	**µg/L**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**No**	**ND**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**13**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2,2-Tetrachloroethane**	**µg/L**	**240**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2-Trichloroethane**	**µg/L**	**940**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**µg/L**	**47**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethene**	**µg/L**	**303**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	1,2-Dibromoethane	µg/L	—	1	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**1,2-Dichlorobenzene**	**µg/L**	**15.8**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloroethane**	**µg/L**	**2,000**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**µg/L**	**525**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,4-Dichlorobenzene**	**µg/L**	**11.2**	**8**	**0**	**0**	—	—	—	**2.81**	—	**0**	—	—	—	—	—	**2.5**	**5**	**0**	**No**	**BSL**

Table E2.4. Ecological Screening of Surface Water Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	**2-Butanone**	**µg/L**	**14,000**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**2-Chloroethyl vinyl ether**	**µg/L**	**3,540**	**4**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	2-Hexanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	2-Propanol	µg/L	7.5	28	0	0	—	—	—	500	—	0	500	1,000	—	—	—	500	500	28	Yes	ASL
VOA	4-Methyl-2-pentanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	**Acetone**	**µg/L**	**1,500**	**30**	**2**	**6.67**	**12**	**13**	**L5**	**467.5**	**0**	**0**	**500**	**1,000**	—	—	—	**500**	**500**	**0**	**No**	**BSL**
VOA	Acrolein	µg/L	2.1	4	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	4	Yes	ASL
VOA	**Acrylonitrile**	**µg/L**	**75.5**	**4**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**Benzene**	**µg/L**	**53**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	µg/L	—	6	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Bromoform**	**µg/L**	**29**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromomethane	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Carbon disulfide	µg/L	0.92	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
VOA	**Carbon tetrachloride**	**µg/L**	**352**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**µg/L**	**195**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloroethane	µg/L	—	6	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Chloroform**	**µg/L**	**289**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloromethane	µg/L	—	4	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,2-Dichloroethene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,3-Dichloropropene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Dibromochloromethane	µg/L	—	6	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Ethylbenzene**	**µg/L**	**453**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	MBAS	mg/L	—	6	0	0	—	—	—	0.04	—	0	—	—	—	—	—	0.04	0.04	—	Yes	NV
VOA	**Methylene chloride**	**µg/L**	**1,930**	**6**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	Styrene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Tetrachloroethene**	**µg/L**	**84**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Toluene**	**µg/L**	**175**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Total Xylene**	**µg/L**	**13**	**2**	**0**	**0**	—	—	—	**7.5**	—	**0**	—	—	—	—	—	**7.5**	**7.5**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	µg/L	—	6	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	trans-1,3-Dichloropropene	µg/L	—	6	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Trichloroethene**	**µg/L**	**47**	**173**	**14**	**8.09**	**1**	**2**	**C612**	**0.57**	**0**	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
VOA	Vinyl chloride	µg/L	—	4	0	0	—	—	—	1.75	—	0	—	—	—	—	—	1	2.5	—	Yes	NV
Wetchem	Hardness – total as CaCO3	mg/L	—	163	163	100	56	464	K001	202.06	—	0	52.25	104.5	32	179	—	—	—	—	—	—
Wetchem	Total organic carbon	mg/L	—	4	4	100	7.6	8.6	K001	8.12	—	0	—	—	—	—	—	—	—	—	—	—

Notes:

Screening levels for hardness dependent metals assume a hardness of the default concentration of 50 (mg/L as $CaCO_3$)

The more conservative screening value was employed for Plutonium-239/240

The screening value for Pentachlorophenol assumes pH of 7.8 since is pH dependent

The total PAH was not calculated as none of the individual PAH analytes was detected.

ASL – Above screening value
BSL – Below screening value
BHC – Benzene hexachloride
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
ND – Not detected
NV – No screening value
NTU – Nephelometric turbidity unit
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte

Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
mg/L - milligrams/liter
ug/L - micrograms/liter
pCi/L - picocuries/liter
wet chem - wet chemistry
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.5. Ecological Screening of Surface Sediment Data – Outfall 001

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field Parameters	pH	None	—	10	10	100	7.89	8.6	005-007	8.22	—	—	—	—	—	—
Metal	**Aluminum**	**mg/kg**	**25500**	**138**	**138**	**100**	**1310**	**13600**	**005-006**	**6024.78**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	134	54	40.3	8.41	20	005-004, 005-001, 005-002, 005-003, 005-005, 005-006, 005-007, C612, K001, K006, S1	7.88	54	3.685	10	80	Yes	ASL
Metal	Arsenic	mg/kg	5.9	134	56	41.79	1.06	25.5	OF01B-04-01	3.87	12	2.13	10	7	Yes	ASL
Metal	Barium	mg/kg	—	134	134	100	16.6	145	OF01B-04-01	55.85	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	138	35	25.36	0.424	1.41	OF01B-04-01	0.33	—	0.184	0.25	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	134	7	5.22	1.81	19.3	OF01B-16-01	1.17	7	0.735	1	127	Yes	ASL
Metal	Calcium	mg/kg	—	138	138	100	211	266000	OF01B-17-02	17318.28	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	134	134	100	5.34	90	OF01B-14-01	14.29	5	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	138	132	95.65	2.33	43.9	OF01B-07-03	5.05	—	1.12	1.25	—	Yes	NV
Metal	Copper	mg/kg	30	134	124	92.54	2.24	74.3	K006	12.21	10	1.065	2.5	0	Yes	ASL
Metal	Cyanide	mg/kg	—	7	0	0	—	—	—	0.5	—	0.5	0.5	—	Yes	NV
Metal	Iron	mg/kg	2000	134	134	100	2080	182000	OF01B-16-01	10749.4	134	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	134	16	11.94	20.9	64.6	OF01B-15-04	11.84	16	7.35	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	138	138	100	199	26900	OF01B-17-02	1664.92	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	138	138	100	21.4	2450	OF01B-07-03	294.73	10	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	138	7	5.07	0.19	0.34	OF01B-11-01	0.07	7	0.0255	0.1	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	101	19	18.81	4.2	23.9	OF01B-15-01	3.84	—	1.105	2.49	—	Yes	NV
Metal	Nickel	mg/kg	16	138	114	82.61	4.49	520	OF01B-15-02	15.95	14	2.21	2.5	0	Yes	ASL
Metal	Potassium	mg/kg	—	138	138	100	125	1090	OF01B-22-04	436.14	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	132	14	10.61	17.7	19.9	OF01B-03-01, OF01B-09-01	9.39	14	0.5	10	118	Yes	ASL
Metal	Silver	mg/kg	0.00038	138	78	56.52	2.1	2.5	C612, K001, S1, S1	1.92	78	0.92	2	60	Yes	ASL
Metal	Sodium	mg/kg	—	134	77	57.46	87.9	389	K001	122.1	—	42.45	125	—	Yes	NV
Metal	Thallium	mg/kg	—	134	1	0.75	15	15	005-002	9.4	—	7.35	10	—	Yes	NV
Metal	Uranium	mg/kg	—	233	192	82.4	0.1	642	OF01B-15-02	17.31	—	0.1	100	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	134	134	100	7.39	59.5	OF01B-04-01	16.33	134	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	134	126	94.03	12.4	1370	OF01B-15-02	63.62	126	8.7	10	8	Yes	ASL
PCB	Demeton	mg/kg	—	1	0	0	—	—	—	0.008	—	0.0075	0.0075	—	Yes	NV
PCB	PCB-1016	mg/kg	—	928	18	1.94	0.09	9.55	OF01A-441	0.18	—	0.03	52.5	—	Yes	NV
PCB	PCB-1221	mg/kg	—	928	18	1.94	0.12	12.4	OF01A-441	0.09	—	0.045	0.165	—	Yes	NV
PCB	PCB-1232	mg/kg	—	928	18	1.94	0.09	9.55	OF01A-441	0.07	—	0.035	0.125	—	Yes	NV
PCB	PCB-1242	mg/kg	—	928	19	2.05	0.06	5.73	OF01A-441	0.04	—	0.02	0.075	—	Yes	NV
PCB	PCB-1248	mg/kg	—	928	23	2.48	0.09	13.8	OF01A-433	0.09	—	0.035	0.125	—	Yes	NV
PCB	PCB-1254	mg/kg	—	928	108	11.64	0.08	30.3	OF01A-463	0.27	—	0.03	0.115	—	Yes	NV
PCB	PCB-1260	mg/kg	—	928	302	32.54	0.035	18.6	OF01A-463, OF01B-15-04	0.42	—	0.035	0.125	—	Yes	NV
PCB	PCB-1268	mg/kg	—	923	18	1.95	0.07	7.64	OF01A-441	0.06	—	0.03	0.1	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	923	311	33.69	0.08	48.9	OF01A-463	0.66	311	0.045	0.165	612	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	104	81	77.88	0.0196	0.592	OF01B-15-02	0.09	—	0.000615	0.0147	—	Yes	NV
Rads	Alpha activity	pCi/g	—	141	137	97.16	1.95	81.6	OF01B-15-02	10.02	—	0.865	1.575	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**141**	**19**	**13.48**	**0.0359**	**8.4**	**005-003**	**0.41**	**0**	**-0.01925**	**0.11**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g		141	139	98.58	1.51	411	OF01B-18-03	21.3	—	0.845	1.435	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**3390**	**1**	**1**	**100**	**0.0228**	**0.0228**	**C612**	**0.02**	**0**	—	—	—	**No**	**BSL**
Rads	**Cesium-137**	**pCi/g**	**9320**	**141**	**97**	**68.79**	**0.00861**	**9.38**	**OF01B-18-01**	**0.38**	**0**	**-0.019**	**0.052**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**141**	**10**	**7.09**	**0.88**	**4.6**	**005-004**	**0.11**	**0**	**-0.0253**	**0.0278**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**131**	**38**	**29.01**	**0.0193**	**2.88**	**OF01B-18-03**	**0.08**	**0**	**-0.0057**	**0.107**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**101**	**0**	**0**	—	—	—	**-0.00286839**	—	**-0.00995**	**0.0189**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**131**	**66**	**50.38**	**0.0111**	**3.62**	**OF01B-18-01**	**0.11**	**0**	**-0.0069**	**0.0128**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**31600**	**30**	**30**	**100**	**1.38**	**7.56**	**C612**	**4.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**175000**	**10**	**10**	**100**	**120**	**370**	**005-005**	**151**	**0**	—	—	—	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	141	83	58.87	0.0365	229	OF01B-18-03	7.6	—	-0.545	1.71	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**101**	**91**	**90.1**	**0.104**	**0.632**	**OF01B-20-02**	**0.26**	**0**	**-0.01945**	**0.074**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**131**	**124**	**94.66**	**0.00347**	**12.2**	**OF01B-18-03**	**0.87**	**0**	**0.053**	**0.1005**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**101**	**97**	**96.04**	**0.0794**	**0.664**	**OF01B-20-02**	**0.28**	**0**	**-0.00595**	**0.072**	**0**	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**175000**	**10**	**10**	**100**	**8.9**	**21**	**006-001, 006-002**	**15.89**	**0**	—	—	—	**No**	**BSL**

Table E2.5. Ecological Screening of Surface Sediment Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	Tritium	pCi/g	—	1	0	0	—	—	—	0.91		0.91	0.91	—	Yes	NV
Rads	**Uranium-234**	**pCi/g**	**10000000**	**116**	**111**	**95.69**	**0.031**	**11.4**	**OF01B-15-02**	**1.25**	**0**	**0.0446**	**0.0725**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**22**	**22**	**100**	**0.002**	**6.8**	**006-001**	**2.21**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**116**	**116**	**100**	**0.033**	**16.3**	**OF01B-13-04**	**2.97**	**0**	—	—	—	**No**	**BSL**
SVOA	1,1-biphenyl	mg/kg	—	16	0	0	—	—	—	0.04	—	0.015	0.065	—	Yes	NV
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	1,2-Diphenylhydrazine	mg/kg	—	16	2	12.5	0.47	0.5	S1	0.27	—	0.23	0.245	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	23	2	8.7	0.47	0.5	S1	0.26	2	0.23	0.25	21	Yes	ASL
SVOA	2,4,5-Trichlorophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2,4'-DDD	mg/kg	—	16	0	0	—	—	—	0.003	—	0.00029	0.006	—	Yes	NV
SVOA	2,4'-DDE	mg/kg	—	16	0	0	—	—	—	0.003	—	0.00029	0.006	—	Yes	NV
SVOA	2,4'-DDT	mg/kg	—	16	0	0	—	—	—	0.003	—	0.00029	0.006	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	23	3	13.04	0.46	0.5	S1	0.27	—	0.23	0.25	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	19	2	10.53	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2,6,10,14-Tetramethylhexadecane	mg/kg	—	16	1	6.25	0.059	0.059	S1	0.16	—	0.075	0.245	—	Yes	NV
SVOA	2,6,10,14-Tetramethylpentadecane	mg/kg	—	16	1	6.25	0.78	0.78	S1	0.21	—	0.075	0.245	—	Yes	NV
SVOA	2,6-Dichlorophenol	mg/kg	—	16	2	12.5	0.47	0.5	S1	0.27	—	0.23	0.245	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	27	1	3.7	0.47	0.47	S1	0.21	—	0.0315	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	23	3	13.04	0.46	0.5	S1	0.27	—	0.23	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4,4'-DDD	mg/kg	0.0033	16	2	12.5	0.0012	0.0033	S1	0.01	1	0.0055	0.031	14	Yes	ASL
SVOA	4,4'-DDE	mg/kg	0.00142	16	0	0	—	—	—	0.01	—	0.0015	0.031	16	Yes	ASL
SVOA	4,4'-DDT	mg/kg	0.0036	16	0	0	—	—	—	0.01	—	0.0015	0.031	15	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	15	1	6.67	0.47	0.47	S1	0.26	—	0.235	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Aldrin	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	alpha-BHC	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	alpha-Chlordane	mg/kg	—	16	1	6.25	0.003	0.003	K001	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Aniline	mg/kg	—	16	3	18.75	0.46	0.5	S1	0.28	—	0.23	0.245	—	Yes	NV
SVOA	Azinphos-methyl	mg/kg	—	16	0	0	—	—	—	0.06	—	0.055	0.075	—	Yes	NV
SVOA	Benzenemethanol	mg/kg	—	16	3	18.75	0.46	0.5	S1	0.28	—	0.23	0.245	—	Yes	NV
SVOA	Benzidine	mg/kg	—	16	3	18.75	0.46	0.5	S1	0.28	—	0.23	0.245	—	Yes	NV
SVOA	Benzo(e)pyrene	mg/kg	—	16	9	56.25	0.02	0.36	C612	0.06	—	0.015	0.045	—	Yes	NV
SVOA	Benzoic acid	mg/kg	—	16	2	12.5	0.5	0.51	K001	0.27	—	0.23	0.245	—	Yes	NV
SVOA	beta-BHC	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	23	1	4.35	0.47	0.47	S1	0.25	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	23	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	20	0	0	—	—	—	0.24	—	0.23	0.25	20	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	19	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV

Table E2.5. Ecological Screening of Surface Sediment Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Carbazole	mg/kg	—	23	3	13.04	0.46	0.5	S1	0.27	—	0.23	0.25	—	Yes	NV
SVOA	Chlordane	mg/kg	0.00028	16	0	0	—	—	—	0.12	—	0.0115	0.235	16	Yes	ASL
SVOA	Co-Ral	mg/kg	—	16	1	6.25	0.023	0.023	C612	0.01	—	0.011	0.0155	—	Yes	NV
SVOA	delta-BHC	mg/kg	—	16	1	6.25	0.00032	0.00032	C612	0.01	—	0.0055	0.031	—	Yes	NV
SVOA	**Diazinon**	**mg/kg**	**0.019**	**16**	**0**	**0**	—	—	—	**0.006**	—	**0.0055**	**0.0075**	**0**	**No**	**BSL**
SVOA	Dibenzofuran	mg/kg	—	23	4	17.39	0.086	1.65	005-001	0.32	—	0.23	0.25	—	Yes	NV
SVOA	Dichlorvos	mg/kg	—	16	2	12.5	0.016	0.018	C612	0.01	—	0.011	0.0155	—	Yes	NV
SVOA	Dieldrin	mg/kg	0.0019	16	0	0	—	—	—	0.01	—	0.0015	0.031	15	Yes	ASL
SVOA	Diethyl phthalate	mg/kg	0.061	23	2	8.7	0.47	0.5	S1	0.26	2	0.23	0.25	21	Yes	ASL
SVOA	Dimethoate	mg/kg	—	16	0	0	—	—	—	0.01	—	0.011	0.0155	—	Yes	NV
SVOA	Dimethyl phthalate	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	23	13	56.52	0.46	1.6	K001	0.65	—	0.235	0.25	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Docosane	mg/kg	—	16	8	50	0.004	0.046	S1	0.09	—	0.08	0.215	—	Yes	NV
SVOA	Dodecane	mg/kg	—	16	1	6.25	0.022	0.022	S1	0.16	—	0.075	0.245	—	Yes	NV
SVOA	Dotriacontane	mg/kg	—	16	10	62.5	0.009	0.092	C612	0.09	—	0.08	0.215	—	Yes	NV
SVOA	Eicosane	mg/kg	—	16	8	50	0.005	0.037	C612	0.09	—	0.08	0.215	—	Yes	NV
SVOA	Endosulfan I	mg/kg	0.0055	16	0	0	—	—	—	0.01	—	0.0015	0.031	15	Yes	ASL
SVOA	Endosulfan II	mg/kg	0.0055	16	0	0	—	—	—	0.01	—	0.0015	0.031	15	Yes	ASL
SVOA	Endosulfan sulfate	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Endrin	mg/kg	0.00222	16	0	0	—	—	—	0.01	—	0.0015	0.031	15	Yes	ASL
SVOA	Endrin aldehyde	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Ethion	mg/kg	—	16	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Famphur	mg/kg	—	16	0	0	—	—	—	0.03	—	0.0215	0.03	—	Yes	NV
SVOA	Fensulfothion	mg/kg	—	16	0	0	—	—	—	0.02	—	0.0195	0.0275	—	Yes	NV
SVOA	Fenthion	mg/kg	—	16	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	gamma-Chlordane	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Henicosane	mg/kg	—	16	9	56.25	0.005	0.068	S1	0.09	—	0.08	0.215	—	Yes	NV
SVOA	Heptachlor	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Heptachlor epoxide	mg/kg	0.0006	16	0	0	—	—	—	0.06	—	0.006	0.12	16	Yes	ASL
SVOA	heptacosane	mg/kg	—	16	15	93.75	0.054	1.2	S1	0.29	—	0.11	0.11	—	Yes	NV
SVOA	Heptadecane	mg/kg	—	16	12	75	0.007	0.6	S1	0.15	—	0.08	0.215	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	23	3	13.04	0.46	0.5	S1	0.27	—	0.23	0.25	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Hexacosane	mg/kg	—	16	11	68.75	0.01	0.097	S1	0.08	—	0.11	0.215	—	Yes	NV
SVOA	Hexadecane	mg/kg	—	16	7	43.75	0.005	0.045	S1	0.09	—	0.075	0.215	—	Yes	NV
SVOA	Isophorone	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Lindane	mg/kg	0.00094	16	1	6.25	0.002	0.002	K001	0.01	1	0.0015	0.031	15	Yes	ASL
SVOA	m,p-Cresol	mg/kg	—	8	0	0	—	—	—	0.23	—	0.23	0.245	—	Yes	NV
SVOA	Malathion	mg/kg	0.0067	16	0	0	—	—	—	0.02	—	0.013	0.018	16	Yes	ASL
SVOA	Methoxychlor	mg/kg	—	16	0	0	—	—	—	0.03	—	0.0029	0.06	—	Yes	NV
SVOA	Methyl parathion	mg/kg	—	16	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Mirex	mg/kg	—	16	0	0	—	—	—	0.01	—	0.0015	0.031	—	Yes	NV
SVOA	Mocap	mg/kg	—	16	1	6.25	0.0079	0.0079	C612	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	n-Hentriacontane	mg/kg	—	16	16	100	0.13	1.9	C612	0.78	—	—	—	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	N-Nitrosodimethylamine	mg/kg	—	16	2	12.5	0.47	0.5	S1	0.27	—	0.23	0.245	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	n-Octacosane	mg/kg	—	16	12	75	0.015	0.11	C612, K001, S1	0.09	—	0.11	0.215	—	Yes	NV
SVOA	Nonacosane	mg/kg	—	16	16	100	0.095	1.8	K001	0.81	—	—	—	—	Yes	NV
SVOA	Nonadecane	mg/kg	—	16	7	43.75	0.008	0.049	S1	0.1	—	0.08	0.245	—	Yes	NV
SVOA	n-Pentacosane	mg/kg	—	16	14	87.5	0.026	0.25	S1	0.11	—	0.11	0.16	—	Yes	NV

Table E2.5. Ecological Screening of Surface Sediment Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	n-Tetracosane	mg/kg	—	16	8	50	0.006	0.07	S1	0.09	—	0.08	0.215	—	Yes	NV
SVOA	n-Triacontane	mg/kg	—	16	13	81.25	0.013	0.13	S1	0.09	—	0.11	0.215	—	Yes	NV
SVOA	n-Tricosane	mg/kg	—	16	12	75	0.01	0.11	C612	0.08	—	0.11	0.215	—	Yes	NV
SVOA	n-Tritriacontane	mg/kg	—	16	16	100	0.034	0.68	C612	0.22	—	—	—	—	Yes	NV
SVOA	Octadecane	mg/kg	—	16	8	50	0.002	0.035	C612	0.09	—	0.08	0.215	—	Yes	NV
SVOA	Parathion	mg/kg	—	16	1	6.25	0.003	0.003	K001	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Pentachlorophenol	mg/kg	—	23	3	13.04	0.237	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Pentadecane	mg/kg	—	16	7	43.75	0.01	0.061	S1	0.09	—	0.075	0.215	—	Yes	NV
SVOA	Perylene	mg/kg	—	16	6	37.5	0.009	0.095	C612	0.04	—	0.016	0.045	—	Yes	NV
SVOA	Phenol	mg/kg	—	23	2	8.7	0.47	0.5	S1	0.26	—	0.23	0.25	—	Yes	NV
SVOA	Phorate	mg/kg	—	16	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Pyridine	mg/kg	—	18	3	16.67	0.46	0.5	S1	0.28	—	0.23	0.245	—	Yes	NV
SVOA	Tetradecane	mg/kg	—	16	3	18.75	0.011	0.036	S1	0.14	—	0.075	0.245	—	Yes	NV
SVOA	Tetratriacontane	mg/kg	—	16	2	12.5	0.017	0.027	S1	0.15	—	0.075	0.245	—	Yes	NV
SVOA	Toxaphene	mg/kg	0.0022	16	0	0	—	—	—	1.45	—	0.15	3.1	16	Yes	ASL
SVOA	Tridecane	mg/kg	—	16	3	18.75	0.006	0.028	S1	0.14	—	0.075	0.245	—	Yes	NV
SVOA	Undecane	mg/kg	—	16	1	6.25	0.016	0.016	S1	0.16	—	0.075	0.245	—	Yes	NV
SVOA	Acenaphthene	mg/kg	0.089	128	49	38.28	0.08	9.4	OF01B-14-01	0.41	48	0.0315	0.28	74	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	128	49	38.28	0.46	1.5	OF01B-14-01	0.34	—	0.0315	0.28	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	128	51	39.84	0.117	30	OF01B-14-01	0.63	51	0.0315	0.28	77	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	129	54	41.86	0.061	51	OF01B-14-01	0.85	54	0.045	0.28	75	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	129	54	41.86	0.064	130	OF01B-14-01	1.51	54	0.045	0.28	75	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	129	57	44.19	0.043	290	OF01B-14-01	2.86	57	0.045	0.28	72	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg	—	129	56	43.41	0.19	42	OF01B-14-01	0.73	—	0.045	0.28	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	129	51	39.53	0.055	29	OF01B-14-01	0.69	51	0.045	0.28	78	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	129	54	41.86	0.074	6.07	005-001	0.52	54	0.045	0.28	75	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	128	54	42.19	0.039	14	OF01B-14-01	0.44	54	0.0315	0.28	74	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	129	57	44.19	0.053	200	OF01B-14-01	2.24	56	0.045	0.28	71	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	128	51	39.84	0.056	7.6	OF01B-14-01	0.41	51	0.0315	0.28	77	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	129	54	41.86	0.04	54	OF01B-14-01	0.83	54	0.045	0.28	75	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	128	49	38.28	0.46	2.7	OF01B-14-01	0.34	49	0.0315	0.28	79	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	128	56	43.75	0.034	130	OF01B-14-01	1.55	55	0.045	0.28	72	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	129	55	42.64	0.038	46	OF01B-14-01	0.94	54	0.045	0.28	73	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	1043.27	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**101**	**26**	**25.74**	**0.005**	**0.005**	**OF01B-02-02, OF01B-04-01, OF01B-05-03, OF01B-05-04, OF01B-06-01, OF01B-06-02, OF01B-06-03, OF01B-07-04, OF01B-09-01, OF01B-10-02, OF01B-10-04, OF01B-11-01, OF01B-11-03, OF01B-12-01, OF01B-13-04, OF01B-14-03, OF01B-15-02, OF01B-16-03, OF01B-17-01, OF01B-17**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
VOA	1,2-Dichlorobenzene	mg/kg	0.033	23	2	8.7	0.47	0.5	S1	0.26	2	0.23	0.25	21	Yes	ASL
VOA	1,4-Dichlorobenzene	mg/kg	0.035	23	2	8.7	0.47	0.5	S1	0.26	2	0.23	0.25	21	Yes	ASL
VOA	2,6-Dimethylnaphthalene	mg/kg	—	16	1	6.25	0.029	0.029	S1	0.04	—	0.015	0.065	—	Yes	NV
VOA	Decane	mg/kg	—	16	0	0	—	—	—	0.17	—	0.075	0.245	—	Yes	NV
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**101**	**15**	**14.85**	**0.005**	**0.005**	**OF01B-02-02, OF01B-04-01, OF01B-05-03, OF01B-06-01, OF01B-06-02, OF01B-06-03, OF01B-07-04, OF01B-09-01, OF01B-13-04, OF01B-15-02, OF01B-16-03, OF01B-17-01, OF01B-17-03, OF01B-19-02, OF01B-19-03**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Wetchem	Total organic carbon	mg/kg	—	35	35	100	1965	24700	C612	7570.71	—	—	—	—	—	—

Notes:

ASL – Above screening value
BSL – Below screening value
BHC – Benzene hexachloride
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane

NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte

wet chem - wet chemistry
Bold – Indicates COPC has been eliminated
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Screening levels from DOE 2001
The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.6. Ecological Screening of Surface Soil Data – Outfall 001

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	Aluminum	mg/kg	5	10	10	100	4830	10200	006-002	7569.2	10	—	—	—	Yes	ASL
Metal	Antimony	mg/kg	1.9	10	4	40	20	20	006-001, 006-002, 006-003, NSD009	14	4	10	10	6	Yes	ASL
Metal	Arsenic	mg/kg	1	10	2	20	8.35	9.32	SYD009	3.77	2	2.5	2.5	8	Yes	ASL
Metal	Barium	mg/kg	20	10	10	100	44.9	119	NSD009	81.21	10	—	—	—	Yes	ASL
Metal	Beryllium	mg/kg	0.19	11	5	45.45	0.5	0.67	006-001	0.4	5	0.25	0.25	6	Yes	ASL
Metal	Cadmium	mg/kg	0.11	10	1	10	2	2	NSD009	1.1	1	1	1	9	Yes	ASL
Metal	Calcium	mg/kg	—	10	10	100	2390	42700	SYD012	12590	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	0.4	11	11	100	7.29	25	SYD001	13.45	11	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	2.5	10	9	90	3.54	6.96	SYD007	4.5	9	1.25	1.25	0	Yes	ASL
Metal	Copper	mg/kg	0.45	10	10	100	7.47	21.3	006-001	11	10	—	—	—	Yes	ASL
Metal	**Cyanide**	**mg/kg**	**5**	**3**	**0**	**0**	**—**	**—**		**0.5**	—	**0.5**	**0.5**	**0**	**No**	**BSL**
Metal	Iron	mg/kg	110	10	10	100	8340	17600	SYD007	12269	10	—	—	—	Yes	ASL
Metal	Lead	mg/kg	20	10	1	10	20	20	NSD009	11	1	10	10	0	Yes	ASL
Metal	Lithium	mg/kg	2	7	1	14.29	6.35	6.35	NSD009	5.19	1	5	5	6	Yes	ASL
Metal	Magnesium	mg/kg	—	10	10	100	758	3080	SYD001	1560.6	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	25	10	10	100	136	669	SYD007	383.8	10	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.1	11	0	0	—	—		0.1	—	0.1	0.1	11	Yes	ASL
Metal	Nickel	mg/kg	11	10	10	100	9.72	43.2	006-001	16.63	9	—	—	—	Yes	ASL
Metal	Potassium	mg/kg	—	3	3	100	347	578	006-001	495.33	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.21	10	2	20	1.2	1.3	SYD001	0.65	2	0.5	0.5	8	Yes	ASL
Metal	Silver	mg/kg	1	10	1	10	2.5	2.5	NSD009	2.05	1	2	2	9	Yes	ASL
Metal	Sodium	mg/kg	—	3	3	100	207	232	006-002	223.33	—	—	—	—	Yes	NV
Metal	Thallium	mg/kg	1	10	1	10	20	20	NSD009	10.25	1	7.5	10	9	Yes	ASL
Metal	Tin	mg/kg	5.6	7	1	14.29	100	100	NSD009	57.14	1	50	50	6	Yes	ASL
Metal	Uranium	mg/kg	5	8	1	12.5	943	943	JP-0151	199.12	1	50	100	7	Yes	ASL
Metal	Vanadium	mg/kg	2	10	10	100	14.7	27.9	SYD007	19.2	10	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	8.5	10	9	90	30	129	SYD008	61.22	9	10	10	1	Yes	ASL
PCB	PCB-1016	mg/kg	—	11	0	0	—	—	—	0.04	—	0.03	0.052	—	Yes	NV
PCB	PCB-1221	mg/kg	—	11	0	0	—	—	—	0.05	—	0.05	0.052	—	Yes	NV
PCB	PCB-1232	mg/kg	—	11	0	0	—	—	—	0.05	—	0.045	0.052	—	Yes	NV
PCB	PCB-1242	mg/kg	—	11	0	0	—	—	—	0.04	—	0.035	0.052	—	Yes	NV
PCB	PCB-1248	mg/kg	—	11	0	0	—	—	—	0.04	—	0.04	0.052	—	Yes	NV
PCB	PCB-1254	mg/kg	—	11	1	9.09	1.1	1.1	JP-0151	0.13	—	0.03	0.052	—	Yes	NV
PCB	PCB-1260	mg/kg	—	11	2	18.18	0.09	0.4	SYD008	0.08	—	0.045	0.052	—	Yes	NV
PCB	PCB-1268	mg/kg	—	8	0	0	—	—	—	0.05	—	0.05	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.02	8	3	37.5	0.09	1.1	JP-0151	0.23	3	0.05	0.05	5	Yes	ASL
Rads	**Actinium-228**	**pCi/g**	**1900**	**1**	**1**	**100**	**0.4963**	**0.4963**	**JP-0151**	**0.5**	**0**	—	—	—	**No**	**BSL**
Rads	**Activity of Uranium-235**	**pCi/g**	**1750**	**7**	**7**	**100**	**0.0355**	**0.11**	**SYD008**	**0.06**	**0**	—	—	—	**No**	**BSL**
Rads	Alpha activity	pCi/g	—	1	1	100	417.53	417.53	JP-0151	417.53	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**975**	**8**	**1**	**12.5**	**4.65**	**4.65**	**JP-0151**	**0.6**	**0**	**0.0161**	**0.03225**	**0**	**No**	**BSL**
Rads	Antimony-124	pCi/g	—	1	0	0	—	—	—	-0.00649	—	-0.00649	-0.00649	—	Yes	NV
Rads	**Antimony-125**	**pCi/g**	**12900**	**1**	**0**	**0**	—	—	—	**0.001**	—	**0.0012115**	**0.0012115**	**0**	**No**	**BSL**
Rads	Barium-133	pCi/g	—	1	0	0	—	—	—	0.005	—	0.005435	0.005435	—	Yes	NV
Rads	Barium-140	pCi/g	—	1	0	0	—	—	—	0.008	—	0.008055	0.008055	—	Yes	NV
Rads	Beta activity	pCi/g	—	1	1	100	866.99	866.99	JP-0151	866.99	—	—	—	—	Yes	NV
Rads	**Bismuth-211**	**pCi/g**	**258**	**1**	**1**	**100**	**1.542**	**1.542**	**JP-0151**	**1.54**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-212**	**pCi/g**	**154**	**1**	**0**	**0**	—	—	—	**0.17**	—	**0.17415**	**0.17415**	**0**	**No**	**BSL**
Rads	**Bismuth-214**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.5999**	**0.5999**	**JP-0151**	**0.6**	**0**	—	—	—	**No**	**BSL**
Rads	Cerium-139	pCi/g	—	1	0	0	—	—	—	0.02	—	0.024375	0.024375	—	Yes	NV
Rads	Cerium-141	pCi/g	—	1	0	0	—	—	—	0.34	—	0.33565	0.33565	—	Yes	NV
Rads	Cerium-144	pCi/g	—	1	0	0	—	—	—	0.18	—	0.1842	0.1842	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**825**	**8**	**1**	**12.5**	**-0.00476**	**-0.00476**	**JP-0151**	**-0.00166662**	**0**	**-0.00486**	**0.00154**	**0**	**No**	**BSL**
Rads	Cesium-136	pCi/g	—	1	0	0	—	—	—	-0.00671	—	-0.00671	-0.00671	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**1240**	**8**	**8**	**100**	**0.0429**	**0.393**	**JP-0151**	**0.14**	**0**	—	—	—	**No**	**BSL**
Rads	Chromium-51	pCi/g	—	1	0	0	—	—	—	-0.002385	—	-0.002385	-0.002385	—	Yes	NV

Table E2.6. Ecological Screening of Surface Soil Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	Cobalt-56	pCi/g	—	1	0	0	—	—	—	-0.01189	—	-0.01189	-0.01189	—	Yes	NV
Rads	Cobalt-57	pCi/g	—	1	0	0	—	—	—	-0.00022	—	-0.00022	-0.00022	—	Yes	NV
Rads	Cobalt-58	pCi/g	—	1	0	0	—	—	—	-0.0012745	—	-0.0012745	-0.0012745	—	Yes	NV
Rads	Cobalt-60	pCi/g	7860	8	1	12.5	0.00412	0.00412	JP-0151	0.0009	0	-0.0032	0.003355	0	No	BSL
Rads	Europium-152	pCi/g	—	1	0	0	—	—	—	-0.02483	—	-0.02483	-0.02483	—	Yes	NV
Rads	Europium-154	pCi/g	4340	1	0	0	—	—	—	-0.00764	—	-0.00764	-0.00764	0	No	BSL
Rads	Europium-155	pCi/g	26900	1	0	0	—	—	—	0.06	—	0.0608	0.0608	0	No	BSL
Rads	Iridium-192	pCi/g	—	1	0	0	—	—	—	-0.00138	—	-0.00138	-0.00138	—	Yes	NV
Rads	Iron-59	pCi/g	—	1	0	0	—	—	—	-0.00328	—	-0.00328	-0.00328	—	Yes	NV
Rads	Lead-210	pCi/g	4250	1	0	0	—	—	—	-2.392	—	-2.392	-2.392	0	No	BSL
Rads	Lead-211	pCi/g	258	1	1	100	1.542	1.542	JP-0151	1.54	0	—	—	—	No	BSL
Rads	Lead-212	pCi/g	154	1	1	100	0.3821	0.3821	JP-0151	0.38	0	—	—	—	No	BSL
Rads	Lead-214	pCi/g	16.1	1	1	100	0.5734	0.5734	JP-0151	0.57	0	—	—	—	No	BSL
Rads	Manganese-54	pCi/g	—	1	0	0	—	—	—	0.009	—	0.00902	0.00902	—	Yes	NV
Rads	Mercury-203	pCi/g	—	1	0	0	—	—	—	0.008	—	0.008095	0.008095	—	Yes	NV
Rads	Neodymium-147	pCi/g	—	1	0	0	—	—	—	18.8	—	18.8	18.8	—	Yes	NV
Rads	Neptunium-237	pCi/g	1680	8	1	12.5	0.0926	0.0926	NSD009	0.02	0	0.003505	0.02775	0	No	BSL
Rads	Neptunium-239	pCi/g	—	1	0	0	—	—	—	0.2	—	0.19805	0.19805	—	Yes	NV
Rads	Niobium-94	pCi/g	—	1	0	0	—	—	—	0.005	—	0.005205	0.005205	—	Yes	NV
Rads	Niobium-95	pCi/g	—	1	0	0	—	—	—	0.71	—	0.712	0.712	—	Yes	NV
Rads	Plutonium-238	pCi/g	1900	8	0	0	—	—	—	-0.00319938	—	-0.0148	0.003545	0	No	BSL
Rads	Plutonium-239/240	pCi/g	2020	8	2	25	0.0537	0.0786	NSD009	0.02	0	-0.0035	0.008	0	No	BSL
Rads	Potassium-40	pCi/g	1820	1	1	100	6.56	6.56	JP-0151	6.56	0	—	—	—	No	BSL
Rads	Promethium-146	pCi/g	—	1	0	0	—	—	—	-0.00832	—	-0.00832	-0.00832	—	Yes	NV
Rads	Protactinium-231	pCi/g	383	1	1	100	60.81	60.81	JP-0151	60.81	0	—	—	—	No	BSL
Rads	Protactinium-233	pCi/g	1680	1	0	0	—	—	—	0.03	—	0.02904	0.02904	0	No	BSL
Rads	Protactinium-234m	pCi/g	1060	1	1	100	312	312	JP-0151	312	0	—	—	—	No	BSL
Rads	Radium-223	pCi/g	258	1	0	0	—	—	—	0.04	—	0.0382	0.0382	0	No	BSL
Rads	Radium-226	pCi/g	16.1	1	1	100	0.537	0.537	JP-0151	0.54	0	—	—	—	No	BSL
Rads	Radium-228	pCi/g	1900	1	1	100	0.4447	0.4447	JP-0151	0.44	0	—	—	—	No	BSL
Rads	Radon-219	pCi/g	258	1	0	0	—	—	—	0.16	—	0.15715	0.15715	0	No	BSL
Rads	Ruthenium-106	pCi/g	1180	1	0	0	—	—	—	-0.028665	—	-0.028665	-0.028665	0	No	BSL
Rads	Silver-110m	pCi/g	—	1	0	0	—	—	—	-0.006795	—	-0.006795	-0.006795	—	Yes	NV
Rads	Sodium-22	pCi/g	—	1	0	0	—	—	—	-0.002605	—	-0.002605	-0.002605	—	Yes	NV
Rads	Strontium-90	pCi/g	882	1	0	0	—	—	—	-0.6	—	-0.6	-0.6	0	No	BSL
Rads	Technetium-99	pCi/g	6570	8	4	50	3.78	7.85	SYD012	2.85	0	0.1785	0.875	0	No	BSL
Rads	Thallium-208	pCi/g	55.3	1	1	100	0.1811	0.1811	JP-0151	0.18	0	—	—	—	No	BSL
Rads	Thorium-227	pCi/g	255	1	0	0	—	—	—	-0.07195	—	-0.07195	-0.07195	0	No	BSL
Rads	Thorium-228	pCi/g	154	8	8	100	0.257	0.522	SYD007	0.4	0	—	—	—	No	BSL
Rads	Thorium-229	pCi/g	21.7	1	0	0	—	—	—	0.1	—	0.09575	0.09575	0	No	BSL
Rads	Thorium-230	pCi/g	3990	8	8	100	0.385	2.06	NSD009	0.74	0	—	—	—	No	BSL
Rads	Thorium-232	pCi/g	1900	8	8	100	0.1782	0.519	SYD007	0.4	0	—	—	—	No	BSL
Rads	Thorium-234	pCi/g	1060	1	1	100	312	312	JP-0151	312	0	—	—	—	No	BSL
Rads	Tin-113	pCi/g	—	1	0	0	—	—	—	0.006	—	0.00556	0.00556	—	Yes	NV
Rads	Uranium-234	pCi/g	1990	8	2	25	1.14	19.2	JP-0151	2.96	0	0.295	1.07	0	No	BSL
Rads	Uranium-238	pCi/g	1060	8	8	100	1.19	317	JP-0151	41.21	0	—	—	—	No	BSL
Rads	Yttrium-88	pCi/g	—	1	0	0	—	—	—	0.009	—	0.009085	0.009085	—	Yes	NV
Rads	Zinc-65	pCi/g	8920	1	0	0	—	—	—	-0.007155	—	-0.007155	-0.007155	0	No	BSL
Rads	Zirconium-95	pCi/g	—	1	0	0	—	—	—	0.7	—	0.698	0.698	—	Yes	NV
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV
SVOA	2,4,5-Trichlorophenol	mg/kg	4	10	1	10	0.48	0.48	SYD008	0.27	0	0.235	0.25	0	No	BSL
SVOA	2,4,6-Trichlorophenol	mg/kg	10	10	1	10	0.48	0.48	SYD008	0.27	0	0.235	0.25	0	No	BSL
SVOA	2,4-Dichlorophenol	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV

Table E2.6. Ecological Screening of Surface Soil Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**2,4-Dinitrophenol**	**mg/kg**	**20**	**9**	**0**	**0**	—	—	—	**0.24**	—	**0.235**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dinitrotoluene	mg/kg	—	10	0	0	—	—	—	0.24	—	0.235	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	10	0	0	—	—	—	0.24	—	0.235	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	10	3	30	0.47	0.48	SYD001	0.32	—	0.24	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	**4-Nitrophenol**	**mg/kg**	**7**	**10**	**2**	**20**	**0.47**	**0.48**	**SYD008**	**0.29**	**0**	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	—	10	2	20	0.42	0.47	SYD009	0.28	—	0.24	0.25	—	Yes	NV
SVOA	Butyl benzyl phthalate	mg/kg	—	9	1	11.11	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	Carbazole	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	Dibenzofuran	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**Diethyl phthalate**	**mg/kg**	**100**	**3**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	**Dimethyl phthalate**	**mg/kg**	**200**	**3**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	**Di-n-butyl phthalate**	**mg/kg**	**200**	**3**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	Di-n-octylphthalate	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	0.0025	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
SVOA	Hexachlorobutadiene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**Hexachlorocyclopentadiene**	**mg/kg**	**10**	**10**	**3**	**30**	**0.47**	**0.48**	**SYD001**	**0.32**	**0**	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Hexachloroethane	mg/kg	—	10	0	0	—	—	—	0.24	—	0.235	0.25	—	Yes	NV
SVOA	Isophorone	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	**Nitrobenzene**	**mg/kg**	**40**	**10**	**1**	**10**	**0.47**	**0.47**	**SYD009**	**0.27**	**0**	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	10	1	10	0.47	0.47	SYD009	0.27	—	0.24	0.25	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**mg/kg**	**20**	**10**	**1**	**10**	**0.47**	**0.47**	**SYD009**	**0.27**	**0**	**0.24**	**0.25**	**0**	**No**	**BSL**
SVOA	Pentachlorophenol	mg/kg	0.002	10	2	20	0.48	0.49	SYD012	0.29	2	0.235	0.25	8	Yes	ASL
SVOA	Phenol	mg/kg	0.05	10	2	20	0.48	0.49	SYD012	0.29	2	0.235	0.25	8	Yes	ASL
SVOA	Pyridine	mg/kg	0.1	7	2	28.57	0.48	0.49	SYD012	0.31	2	0.235	0.245	5	Yes	ASL
SVOA	Total PAHs		—	—	—	—	—	—	—	—	—	—	—	—	—	—
SVOA	Acenaphthene	mg/kg	20	10	3	30	0.47	0.75	SYD012	0.34	0	0.24	0.25	0	Yes	BSL
SVOA	Acenaphthylene	mg/kg	—	10	2	20	0.47	0.48	SYD008	0.29	—	0.24	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.1	10	4	40	0.156	0.84	SYD012	0.34	4	0.24	0.25	6	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	—	9	3	33.33	0.255	3.1	SYD012	0.59	—	0.235	0.25	—	Yes	NV
SVOA	Benzo(a)pyrene	mg/kg	0.1	9	3	33.33	0.402	2.8	SYD012	0.57	3	0.235	0.25	6	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	—	9	3	33.33	0.48	3.9	SYD012	0.7	—	0.235	0.25	—	Yes	NV
SVOA	Benzo(ghi)perylene	mg/kg	—	9	5	55.56	0.124	0.76	SYD012	0.37	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	—	2	1	50	0.5	0.5	006-001	0.38	—	0.25	0.25	—	Yes	NV
SVOA	Chrysene	mg/kg	—	9	2	22.22	0.417	3.5	SYD012	0.62	—	0.235	0.25	—	Yes	NV
SVOA	Dibenz(a,h)anthracene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Fluoranthene	mg/kg	0.1	2	1	50	0.636	0.636	006-001	0.44	1	0.25	0.25	1	Yes	ASL
SVOA	Fluorene	mg/kg	—	10	2	20	0.47	0.59	SYD012	0.3	—	0.24	0.25	—	Yes	NV
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	—	9	3	33.33	0.138	1	SYD012	0.34	—	0.24	0.25	—	Yes	NV

Table E2.6. Ecological Screening of Surface Soil Data – Outfall 001 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Naphthalene	mg/kg	0.1	10	1	10	0.47	0.47	SYD009	0.27	1	0.24	0.25	9	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.1	10	3	30	0.461	5.2	SYD012	0.78	3	0.235	0.25	7	Yes	ASL
SVOA	Pyrene	mg/kg	0.1	9	3	33.33	0.65	6.4	SYD012	1.02	3	0.24	0.25	6	Yes	ASL
SVOA	Total PAHs	mg/kg	1	—	—	—	—	31.176	—	—	—	—	—	—	Yes	ASL
VOA	1,1,1-Trichloroethane	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,1,2,2-Tetrachloroethane	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,1,2-Trichloroethane	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,1-Dichloroethane	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,1-Dichloroethene	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,2-Dichlorobenzene	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV
VOA	**1,2-Dichloroethane**	**mg/kg**	**0.4**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD008**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**mg/kg**	**700**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD008**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,2-Dimethylbenzene	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	—	10	1	10	0.48	0.48	SYD008	0.27	—	0.235	0.25	—	Yes	NV
VOA	2-Butanone	mg/kg	—	7	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	2-Hexanone	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	4-Methyl-2-pentanone	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	Acetone	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD008	0.006	—	0.005	0.005	—	Yes	NV
VOA	**Benzene**	**mg/kg**	**0.05**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD008**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	Bromoform	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	Bromomethane	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	Carbon disulfide	mg/kg	—	7	1	14.29	0.01	0.01	SYD007	0.006	—	0.005	0.005	—	Yes	NV
VOA	**Carbon tetrachloride**	**mg/kg**	**160**	**7**	**1**	**14.29**	**0.01**	**0.01**	**SYD007**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**mg/kg**	**0.05**	**7**	**1**	**14.29**	**0.01**	**0.01**	**SYD007**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Ethylbenzene**	**mg/kg**	**0.05**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD008**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	m,p-Xylene	mg/kg	—	7	1	14.29	0.02	0.02	SYD007	0.01	—	0.01	0.01	—	Yes	NV
VOA	Methylene chloride	mg/kg	—	7	4	57.14	0.01	0.01	SYD001, SYD007, SYD009	0.008	—	0.005	0.005	—	Yes	NV
VOA	**Styrene**	**mg/kg**	**0.1**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD012**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Tetrachloroethene	mg/kg	0.01	7	2	28.57	0.01	0.01	SYD007, SYD012	0.006	2	0.005	0.005	0	Yes	ASL
VOA	**Toluene**	**mg/kg**	**0.05**	**7**	**2**	**28.57**	**0.01**	**0.01**	**SYD007, SYD012**	**0.006**	**0**	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD012	0.006	—	0.005	0.005	—	Yes	NV
VOA	trans-1,3-Dichloropropene	mg/kg	—	7	2	28.57	0.01	0.01	SYD007, SYD012	0.006	—	0.005	0.005	—	Yes	NV
VOA	Trichloroethene	mg/kg	0.001	7	2	28.57	0.01	0.01	SYD007, SYD012	0.006	2	0.005	0.005	5	Yes	ASL
Wetchem	Total organic carbon (TOC)	mg/kg	—	3	3	100	6100	11000	006-001, 006-003	9366.67	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001.

Table E2.7. Ecological Screening of Surface Water Data – Outfall 002

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	Std. unit	—	13	13	100	7.4	736	K002	63.68	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	14	13	92.86	0.267	3.25	K002	1.13	13	0	0.55	1.1	0.2	2.92	13	0.1	0.1	1	Yes	ASL
Metal	**Antimony**	**mg/L**	**0.16**	**8**	**1**	**12.5**	**0.005**	**0.005**	**K002**	**0.003**	**0**	**0**	**0.03**	**0.05**	**0.005**	**0.005**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	**Arsenic**	**mg/L**	**0.05**	**8**	**0**	**0**	—	—	—	**0.005**	—	**0**	**0.03**	**0.05**	—	—	—	**0.005**	**0.005**	**0**	**No**	**BSL**
Metal	Barium	mg/L	0.004	8	8	100	0.019	0.36	K002	0.07	8	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	8	0	0	—	—	—	0.0006	—	0	0	0.002	—	—	—	0.0005	0.001	1	Yes	ASL
Metal	Cadmium	mg/L	0.00142	14	0	0	—	—	—	0.004	—	0	0.01	0.02	0.001	0.001	0	0.0005	0.0125	5	Yes	ASL
Metal	Calcium	mg/L	—	8	8	100	15.2	32.1	K002	23.6	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	**Chromium**	**mg/L**	**0.04885**	**14**	**2**	**14.29**	**0.02**	**0.02**	**K002**	**0.01**	**0**	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	**Cobalt**	**mg/L**	**0.023**	**8**	**1**	**12.5**	**0.001**	**0.001**	**K002**	**0.0006**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0005**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	14	5	35.71	0.00892	0.028	K002	0.01	5	0	0.02	0.04	0.0052	0.038	8	0.0025	0.025	7	Yes	ASL
Metal	Cyanide	mg/L	0.0052	13	5	38.46	0.02	0.05	K002	0.02	5	0	0.02	0.03	—	—	—	0.01	0.025	8	Yes	ASL
Metal	Iron	mg/L	1	14	13	92.86	0.248	2.51	K002	0.75	3	0	0.98	1.95	0.488	2.6	5	0.1	0.1	0	Yes	ASL
Metal	Lead	mg/L	0.00132	14	0	0	—	—	—	0.04	—	0	0.06	0.13	—	—	—	0.0025	0.1	14	Yes	ASL
Metal	Magnesium	mg/L	—	8	8	100	1.93	4.57	K002	3.13	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	**Manganese**	**mg/L**	**0.12**	**8**	**8**	**100**	**0.00822**	**0.0244**	**K002**	**0.02**	**0**	**0**	**0.24**	**0.48**	**0.108**	**0.329**	**12**	—	—	—	**No**	**BSL**
Metal	Mercury	mg/L	0.000012	8	1	12.5	0.0002	0.0002	K002	0.0001	1	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	7	Yes	ASL
Metal	Nickel	mg/L	0.029	14	5	35.71	0.005	0.0747	K002	0.02	1	0	0.02	0.04	0.005	0.05	1	0.0025	0.025	0	Yes	ASL
Metal	Phosphorous	mg/L	—	14	14	100	0.13	0.3	K002	0.21	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Potassium	mg/L	—	8	8	100	1.44	3.2	K002	2.13	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	**Selenium**	**mg/L**	**0.005**	**8**	**0**	**0**	—	—	—	**0.002**	—	**0**	**0**	**0.006**	—	—	—	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	Silver	mg/L	0.000012	8	4	50	0.001	0.00143	K002	0.0009	4	0	0	0.007	0.001	0.001	1	0.0005	0.001	4	Yes	ASL
Metal	Sodium	mg/L	—	8	8	100	5.8	78	K002	19.38	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	Thallium	mg/L	0.004	8	4	50	0.01	0.01	K002	0.008	4	0	0.03	0.06	0.01	0.01	3	0.005	0.005	4	Yes	ASL
Metal	Uranium	mg/L	0.0026	18	3	16.67	0.00271	0.00957	K002	0.004	3	0	0	0.002	0.001	0.001	0	0.0004185	0.025	1	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**8**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.01**	**0**	**No**	**BSL**
Metal	**Zinc**	**mg/L**	**0.067**	**14**	**9**	**64.29**	**0.02**	**0.0711**	**K002**	**0.04**	**1**	**0**	**0.07**	**0.14**	**0.02**	**0.2**	**1**	**0.05**	**0.1**	**1**	**No**	**ASL**
PCB	**PCB-1016**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.17**	—	—	—	**0.08**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1221**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.09**	—	**0**	**0.09**	**0.18**	—	—	—	**0.085**	**0.09**	**20**	**No**	**ASL**
PCB	**PCB-1232**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.16**	—	—	—	**0.065**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1242**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.07**	**0.14**	—	—	—	**0.045**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1248**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.07**	—	**0**	**0.08**	**0.15**	—	—	—	**0.055**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1254**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.08**	**0.16**	**0.23**	**0.23**	**1**	**0.035**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1260**	**µg/L**	**0.014**	**20**	**0**	**0**	—	—	—	**0.04**	—	**0**	**0.06**	**0.13**	—	—	—	**0.025**	**0.085**	**20**	**No**	**ASL**
PCB	**PCB-1268**	**µg/L**	—	**20**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.07**	**0.14**	—	—	—	**0.04**	**0.085**	—	**No**	**NV**
PCB	**Polychlorinated biphenyl (Total PCBs)**	**µg/L**	**0.0014**	**20**	**0**	**0**	—	—	—	**0.09**	—	**0**	**0.09**	**0.19**	**0.23**	**0.23**	**1**	**0.085**	**0.09**	**20**	**No**	**ND**
Rads	Activity of Uranium-235	pCi/L	—	6	0	0	—	—	—	0.74	—	0	0.63	1.25	—	—	—	0	1.1	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**14**	**0**	**0**	—	—	—	**1.08**	—	**0**	**-3.81**	**-7.62398947**	—	—	—	**-15.95**	**16.8**	**0**	**No**	**BSL**
Rads	**Cesium-134**	**pCi/L**	**11000**	**14**	**0**	**0**	—	—	—	**-2.94425**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-8.5**	**-0.2015**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**14**	**0**	**0**	—	—	—	**-0.46182857**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-4.605**	**3.65**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**14**	**0**	**0**	—	—	—	**-0.57353571**	—	**0**	**-0.22**	**-0.43722632**	—	—	—	**-3.395**	**2.92**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**14**	**0**	**0**	—	—	—	**-0.04598214**	—	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.286**	**0.129**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**14**	**0**	**0**	—	—	—	**-0.00079**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.0488**	**0.04705**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**14**	**0**	**0**	—	—	—	**0.001**	—	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.01235**	**0.0237**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**14**	**0**	**0**	—	—	—	**-8.53189286**	—	**0**	**-23.74**	**-47.4747368**	—	—	—	**-106**	**42.5**	**0**	**No**	**BSL**
Rads	Suspended Alpha	pCi/L	—	11	1	9.09	1.48	1.48	K002	0.26	—	0	0.66	1.32	-2.29	7.68	—	-0.785	1.385	—	Yes	NV
Rads	Suspended Beta	pCi/L	—	12	0	0	—	—	—	1.14	—	0	0.17	0.34	-9.72	5.37	—	-1.625	2.88	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**14**	**3**	**21.43**	**15.3**	**31.7**	**K002**	**7.56**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-0.174**	**5.95**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**14**	**0**	**0**	—	—	—	**-0.02654429**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.262**	**0.02615**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**14**	**0**	**0**	—	—	—	**-0.08776179**	—	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-1.12**	**0.0975**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**14**	**0**	**0**	—	—	—	**-0.00970429**	—	**0**	**0**	**0.009**	—	—	—	**-0.115**	**0.02765**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	9	0	0	—	—	—	-8.03833333	—	0	-0.52	-1.035	—	—	—	-35.2	18.8	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**7**	**0**	**0**	—	—	—	**13.61**		**0**	**10.29**	**20.58**	—	—	—	**0.2535**	**20**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4550**	**9**	**7**	**77.78**	**0.377**	**1.45**	**K002**	**0.76**	**0**	**0**	**0.1**	**0.2**	—	—	—	**0**	**0**	**0**	**No**	**BSL**

Table E2.7. Ecological Screening of Surface Water Data – Outfall 002 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**6**	**0**	**0**	**—**	**—**	**—**	**2.5**	**—**	**0**	**—**	**—**	**—**	**—**	**—**	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	2-Propanol	µg/L	7.5	5	0	0	—	—	—	500	—	0	500	1000	—	—	—	500	500	5	Yes	ASL
VOA	**Acetone**	**µg/L**	**1500**	**5**	**0**	**0**	**—**	**—**	**—**	**500**	**—**	**0**	**500**	**1000**	**—**	**—**	**—**	**500**	**500**	**0**	**No**	**BSL**
VOA	**Trichloroethene**	**µg/L**	**47**	**20**	**0**	**0**	**—**	**—**	**—**	**0.5**	**—**	**0**	**0.5**	**1**	**—**	**—**	**—**	**0.5**	**0.5**	**0**	**No**	**BSL**
Wetchem	Hardness – total as CaCO$_3$	mg/L	—	14	14	100	53	275	K002	89.64	—	0	52.25	104.5	32	179	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
ND – Not detected
NV – No screening value
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
Bold – Indicates COPC has been eliminated
mg/L - milligrams/liter
ug/L - micrograms/liter
pCi/L - picocuries/liter
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.8. Ecological Screening of Surface Sediment Data – Outfall 002

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Aluminum**	**mg/kg**	**25500**	**36**	**36**	**100**	**1900**	**12100**	**OF02B-01-04**	**6719.17**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	36	28	77.78	8.8	9.97	OF02B-08-03	8.37	28	4.205	4.94	8	Yes	ASL
Metal	Arsenic	mg/kg	5.9	36	19	52.78	0.00304	6.64	OF02B-02-01	3.13	1	2.16	2.485	0	Yes	ASL
Metal	Barium	mg/kg	—	36	36	100	24.7	113	OF02B-05-04	63.43	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	36	9	25	0.421	0.546	OF02B-05-04	0.29	—	0.221	0.249	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	36	0	0	—	—	—	0.94	—	0.84	0.995	36	Yes	ASL
Metal	Calcium	mg/kg	—	36	36	100	1160	305000	OF02B-08-02	45617.78	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	36	36	100	6.21	232	OF02B-07-01	38.95	10	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	36	34	94.44	2.45	14.6	OF02B-03-04	4.3	—	1.2	1.225	—	Yes	NV
Metal	**Copper**	**mg/kg**	**30**	**36**	**32**	**88.89**	**3.12**	**16.6**	**OF02B-07-01**	**8.09**	**0**	**1.2**	**1.245**	**0**	**No**	**BSL**
Metal	Iron	mg/kg	2000	36	36	100	3320	13600	OF02B-02-01	9239.72	36	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	36	2	5.56	23.1	25.6	OF02B-07-01	10.2	2	8.4	9.95	0	Yes	ASL
Metal	Magnesium	mg/kg	—	36	36	100	365	28100	OF02B-02-04	2839.14	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	36	36	100	74.9	624	OF02B-06-04	254.77	1	—	—	—	Yes	ASL
Metal	**Mercury**	**mg/kg**	**0.16**	**36**	**0**	**0**	—	—	—	**0.04**	—	**0.0305**	**0.05**	**0**	**No**	**BSL**
Metal	Molybdenum	mg/kg	—	36	15	41.67	4.4	26.4	OF02B-07-01	5.53	—	1.05	2.49		Yes	NV
Metal	**Nickel**	**mg/kg**	**16**	**36**	**29**	**80.56**	**4.59**	**10.1**	**OF02B-02-01**	**5.78**	**0**	**2.21**	**2.49**	**0**	**No**	**BSL**
Metal	Potassium	mg/kg	—	36	36	100	116	1230	OF02B-05-03	602.81	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	36	6	16.67	16.8	17.9	OF02B-03-03, OF02B-03-04	10.82	6	8.8	9.95	30	Yes	ASL
Metal	Silver	mg/kg	0.00038	36	30	83.33	2.1	3.83	OF02B-08-01	2.19	30	1.125	1.245	6	Yes	ASL
Metal	Sodium	mg/kg	—	36	17	47.22	84.1	252	OF02B-06-03	104.94	—	44	494	—	Yes	NV
Metal	Thallium	mg/kg	—	36	0	0	—	—	—	9.37	—	8.4	9.95	—	Yes	NV
Metal	Uranium	mg/kg	—	72	53	73.61	0.718	9.35	OF02B-01-02	2.3	—	0.000452	1.23	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	36	36	100	7.06	27	OF02B-01-04	16.41	36	—		—	Yes	ASL
Metal	Zinc	mg/kg	4.7	36	36	100	31.8	179	OF02B-02-03	62.19	36	—		—	Yes	ASL
PCB	PCB-1016	mg/kg	—	261	0	0	—	—	—	0.05	—	0.045	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	261	0	0	—	—	—	0.06	—	0.055	0.065	—	Yes	NV
PCB	PCB-1232	mg/kg	—	261	0	0	—	—	—	0.05	—	0.045	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	261	0	0	—	—	—	0.03	—	0.025	0.03	—	Yes	NV
PCB	PCB-1248	mg/kg	—	261	1	0.38	0.18	0.18	OF02A-156	0.05	—	0.045	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	261	5	1.92	0.16	1.08	OF02A-029	0.05	—	0.04	0.045	—	Yes	NV
PCB	PCB-1260	mg/kg	—	261	31	11.88	0.1	2.35	OF02A-025	0.12	—	0.045	0.05	—	Yes	NV
PCB	PCB-1268	mg/kg	—	261	0	0	—	—	—	0.04	—	0.035	0.04	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	261	29	11.11	0.13	2.35	OF02A-025	0.14	29	0.055	0.065	232	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	36	9	25	0.0271	0.121	OF02B-01-02	0.02	—	0.001205	0.0138	—	Yes	NV
Rads	Alpha activity	pCi/g	—	36	30	83.33	2.29	10.9	OF02B-01-03	4.79	—	0.142	2.81	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**36**	**0**	**0**	—	—	—	**0.00006**	—	**-0.01305**	**0.01735**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	36	31	86.11	3.27	9.4	OF02B-06-03	5.11	—	1.285	1.955	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**36**	**21**	**58.33**	**0.0437**	**0.829**	**OF02B-07-01**	**0.16**	**0**	**-0.01015**	**0.0443**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**36**	**0**	**0**	—	—	—	**-0.00025899**	—	**-0.01895**	**0.02025**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**36**	**1**	**2.78**	**0.0532**	**0.0532**	**OF02B-01-02**	**0.004**	**0**	**-0.004655**	**0.02625**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**36**	**0**	**0**	—	—	—	**-0.00141411**	—	**-0.00515**	**0.00715**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**36**	**1**	**2.78**	**0.0289**	**0.0289**	**OF02B-06-03**	**-0.00221256**	**0**	**-0.0082**	**0.00935**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	36	15	41.67	3.47	7.73	OF02B-01-02	2.51	—	-1.13	1.85	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**36**	**32**	**88.89**	**0.0608**	**0.651**	**OF02B-07-03**	**0.28**	**0**	**0.0279**	**0.0795**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**36**	**28**	**77.78**	**0.21**	**1.05**	**OF02B-01-01**	**0.32**	**0**	**0.02605**	**0.098**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**36**	**36**	**100**	**0.0589**	**0.582**	**OF02B-07-04**	**0.3**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**36**	**36**	**100**	**0.119**	**2.08**	**OF02B-01-02**	**0.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**36**	**36**	**100**	**0.16**	**3.12**	**OF02B-01-02**	**0.66**	**0**	—	—	—	**No**	**BSL**
SVOA	Acenaphthene	mg/kg	0.089	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	22	0.24	0.25	14	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39		0.24	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	36	21	58.33	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	21	0.235	0.25	15	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01, OF02B-06-01	0.4	22	0.24	0.25	14	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	36	22	61.11	0.47	0.56	OF02B-01-01, OF02B-03-02, OF02B-04-01	0.4	22	0.24	0.25	14	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	36	20	55.56	0.47	1	OF02B-01-01	0.41	20	0.24	0.245	16	Yes	ASL

Table E2.8. Ecological Screening of Surface Sediment Data – Outfall 002 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Benzo(ghi)perylene	mg/kg	—	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	36	21	58.33	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	21	0.235	0.25	15	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	36	22	61.11	0.47	0.76	OF02B-01-01	0.4	22	0.24	0.25	14	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	36	21	58.33	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	21	0.235	0.25	15	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	36	20	55.56	0.47	1.6	OF02B-01-01	0.45	20	0.24	0.245	16	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	22	0.24	0.25	14	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	22	0.24	0.25	14	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	36	22	61.11	0.47	0.56	OF02B-03-02, OF02B-04-01	0.39	22	0.24	0.25	14	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	36	19	52.78	0.47	1	OF02B-06-01	0.39	19	0.24	0.25	17	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	36	19	52.78	0.47	1.1	OF02B-01-01, OF02B-06-01	0.41	19	0.24	0.245	17	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	11.62	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**36**	**8**	**22.22**	**0.005**	**0.005**	**OF02B-01-01, OF02B-01-01, OF02B-02-04, OF02B-03-01, OF02B-06-03, OF02B-07-04, OF02B-08-02, OF02B-08-03**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**36**	**8**	**22.22**	**0.005**	**0.005**	**OF02B-01-01, OF02B-01-01, OF02B-02-04, OF02B-03-01, OF02B-06-03, OF02B-07-04, OF02B-08-02, OF02B-08-03**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
ND – Not detected
NV – No screening value
PAHs - polyaromatic hydrocarbons
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001

The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.9. Ecological Screening of Surface Soil Data – Outfall 002

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Uranium**	**mg/kg**	**5**	**1**	**1**	**100**	**3.4**	**3.4**	**JP-0161**	**3.4**	**0**	—	—	—	**No**	**BSL**
Rads	**Actinium-228**	**pCi/g**	**1900**	**1**	**1**	**100**	**1.066**	**1.066**	**JP-0161**	**1.07**	**0**	—	—	—	**No**	**BSL**
Rads	Alpha activity	pCi/g	—	1	1	100	10.11	10.11	JP-0161	10.11	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**975**	**1**	**1**	**100**	**0.0124**	**0.0124**	**JP-0161**	**0.01**	**0**	—	—	—	**No**	**BSL**
Rads	Antimony-124	pCi/g	—	1	0	0	—	—	—	-0.0004998	—	-0.0004998	-0.0004998	—	Yes	NV
Rads	**Antimony-125**	**pCi/g**	**12900**	**1**	**0**	**0**	—	—	—	**-0.00964**	—	**-0.00964**	**-0.00964**	**0**	**No**	**BSL**
Rads	Barium-133	pCi/g	—	1	0	0	—	—	—	0.002	—	0.0022295	0.0022295	—	Yes	NV
Rads	Barium-140	pCi/g	—	1	0	0	—	—	—	-0.012955	—	-0.012955	-0.012955	—	Yes	NV
Rads	Beta activity	pCi/g	—	1	1	100	12.82	12.82	JP-0161	12.82	—	—	—	—	Yes	NV
Rads	**Bismuth-211**	**pCi/g**	**258**	**1**	**1**	**100**	**2.377**	**2.377**	**JP-0161**	**2.38**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-212**	**pCi/g**	**154**	**1**	**1**	**100**	**0.7818**	**0.7818**	**JP-0161**	**0.78**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-214**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.8436**	**0.8436**	**JP-0161**	**0.84**	**0**	—	—	—	**No**	**BSL**
Rads	Cerium-139	pCi/g	—	1	0	0	—	—	—	-0.011085	—	-0.011085	-0.011085	—	Yes	NV
Rads	Cerium-141	pCi/g	—	1	0	0	—	—	—	-0.002611	—	-0.002611	-0.002611	—	Yes	NV
Rads	Cerium-144	pCi/g	—	1	0	0	—	—	—	-0.0543	—	-0.0543	-0.0543	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**825**	**1**	**1**	**100**	**-0.0159**	**-0.0159**	**JP-0161**	**-0.0159**	**0**	—	—	—	**No**	**BSL**
Rads	Cesium-136	pCi/g	—	1	0	0	—	—	—	0.03	—	0.03031	0.03031	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**1240**	**1**	**1**	**100**	**0.415**	**0.415**	**JP-0161**	**0.42**	**0**	—	—	—	**No**	**BSL**
Rads	Chromium-51	pCi/g	—	1	0	0	—	—	—	0.02	—	0.01918	0.01918	—	Yes	NV
Rads	Cobalt-56	pCi/g	—	1	0	0	—	—	—	0.008	—	0.00806	0.00806	—	Yes	NV
Rads	Cobalt-57	pCi/g	—	1	0	0	—	—	—	0.00007	—	0.00007155	0.00007155	—	Yes	NV
Rads	Cobalt-58	pCi/g	—	1	0	0	—	—	—	-0.00905	—	-0.00905	-0.00905	—	Yes	NV
Rads	**Cobalt-60**	**pCi/g**	**7860**	**1**	**1**	**100**	**-0.0014**	**-0.0014**	**JP-0161**	**-0.0014**	**0**	—	—	—	**No**	**BSL**
Rads	Europium-152	pCi/g	—	1	0	0	—	—	—	0.01	—	0.00972	0.00972	—	Yes	NV
Rads	**Europium-154**	**pCi/g**	**4340**	**1**	**0**	**0**	—	—	—	**0.009**	—	**0.00865**	**0.00865**	**0**	**No**	**BSL**
Rads	**Europium-155**	**pCi/g**	**26900**	**1**	**0**	**0**	—	—	—	**0.04**	—	**0.04374**	**0.04374**	**0**	**No**	**BSL**
Rads	Iridium-192	pCi/g	—	1	0	0	—	—	—	0.005	—	0.00524	0.00524	—	Yes	NV
Rads	Iron-59	pCi/g	—	1	0	0	—	—	—	-0.003633	—	-0.003633	-0.003633	—	Yes	NV
Rads	**Lead-210**	**pCi/g**	**4250**	**1**	**1**	**100**	**2.923**	**2.923**	**JP-0161**	**2.92**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-211**	**pCi/g**	**258**	**1**	**1**	**100**	**2.377**	**2.377**	**JP-0161**	**2.38**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-212**	**pCi/g**	**154**	**1**	**1**	**100**	**0.9273**	**0.9273**	**JP-0161**	**0.93**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-214**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.8477**	**0.8477**	**JP-0161**	**0.85**	**0**	—	—	—	**No**	**BSL**
Rads	Manganese-54	pCi/g	—	1	0	0	—	—	—	0.006	—	0.00645	0.00645	—	Yes	NV
Rads	Mercury-203	pCi/g	—	1	0	0	—	—	—	0.001	—	0.00131	0.00131	—	Yes	NV
Rads	Neodymium-147	pCi/g	—	1	0	0	—	—	—	0.18	—	0.1771	0.1771	—	Yes	NV
Rads	**Neptunium-237**	**pCi/g**	**1680**	**1**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
Rads	Neptunium-239	pCi/g	—	1	0	0	—	—	—	0.27	—	0.2654	0.2654	—	Yes	NV
Rads	Niobium-94	pCi/g	—	1	0	0	—	—	—	-0.0005725	—	-0.0005725	-0.0005725	—	Yes	NV
Rads	Niobium-95	pCi/g	—	1	0	0	—	—	—	0.02	—	0.022155	0.022155	—	Yes	NV
Rads	**Plutonium-238**	**pCi/g**	**1900**	**1**	**0**	**0**	—	—	—	**-0.0035**	—	**-0.0035**	**-0.0035**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**2020**	**1**	**0**	**0**	—	—	—	**0.004**	—	**0.0035**	**0.0035**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**1820**	**1**	**1**	**100**	**9.78**	**9.78**	**JP-0161**	**9.78**	**0**	—	—	—	**No**	**BSL**
Rads	Promethium-146	pCi/g	—	1	0	0	—	—	—	0.001	—	0.0011425	0.0011425	—	Yes	NV
Rads	**Protactinium-231**	**pCi/g**	**383**	**1**	**1**	**100**	**0.5734**	**0.5734**	**JP-0161**	**0.57**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-233**	**pCi/g**	**1680**	**1**	**0**	**0**	—	—	—	**0.04**	—	**0.03681**	**0.03681**	**0**	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**1060**	**1**	**1**	**100**	**1.89**	**1.89**	**JP-0161**	**1.89**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-223**	**pCi/g**	**258**	**1**	**1**	**100**	**0.321**	**0.321**	**JP-0161**	**0.32**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-226**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.828**	**0.828**	**JP-0161**	**0.83**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-228**	**pCi/g**	**1900**	**1**	**1**	**100**	**1.027**	**1.027**	**JP-0161**	**1.03**	**0**	—	—	—	**No**	**BSL**
Rads	**Radon-219**	**pCi/g**	**258**	**1**	**1**	**100**	**0.358**	**0.358**	**JP-0161**	**0.36**	**0**	—	—	—	**No**	**BSL**
Rads	**Ruthenium-106**	**pCi/g**	**1180**	**1**	**0**	**0**	—	—	—	**0.06**	—	**0.05515**	**0.05515**	**0**	**No**	**BSL**
Rads	Silver-110m	pCi/g	—	1	0	0	—	—	—	0.005	—	0.005175	0.005175	—	Yes	NV
Rads	Sodium-22	pCi/g	—	1	0	0	—	—	—	0.01	—	0.014765	0.014765	—	Yes	NV
Rads	**Strontium-90**	**pCi/g**	**882**	**1**	**0**	**0**	—	—	—	**-0.38**	—	**-0.38**	**-0.38**	**0**	**No**	**BSL**
Rads	**Technetium-99**	**pCi/g**	**6570**	**1**	**1**	**100**	**0**	**0**	**JP-0161**	**0**	**0**	—	—	—	**No**	**BSL**
Rads	**Thallium-208**	**pCi/g**	**55.3**	**1**	**1**	**100**	**0.387**	**0.387**	**JP-0161**	**0.39**	**0**	—	—	—	**No**	**BSL**

Table E2.9. Ecological Screening of Surface Soil Data – Outfall 002 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Thorium-227**	**pCi/g**	**255**	**1**	**0**	**0**	**—**	**—**	**—**	**0.04**	**—**	**0.043125**	**0.043125**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/g**	**154**	**1**	**1**	**100**	**0.512**	**0.512**	**JP-0161**	**0.51**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Thorium-229**	**pCi/g**	**21.7**	**1**	**0**	**0**	**—**	**—**	**—**	**0.02**	**—**	**0.019335**	**0.019335**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**3990**	**1**	**1**	**100**	**0.369**	**0.369**	**JP-0161**	**0.37**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**1900**	**1**	**1**	**100**	**0.3687**	**0.3687**	**JP-0161**	**0.37**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**1060**	**1**	**1**	**100**	**2.06**	**2.06**	**JP-0161**	**2.06**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	Tin-113	pCi/g	—	1	0	0	—	—	—	-0.012675	—	-0.012675	-0.012675	—	Yes	NV
Rads	**Uranium-234**	**pCi/g**	**1990**	**1**	**1**	**100**	**0.96**	**0.96**	**JP-0161**	**0.96**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**1750**	**1**	**1**	**100**	**0.03**	**0.03**	**JP-0161**	**0.03**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**1060**	**1**	**1**	**100**	**1.1**	**1.1**	**JP-0161**	**1.1**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	Yttrium-88	pCi/g	—	1	0	0	—	—	—	-0.011385	—	-0.011385	-0.011385	—	Yes	NV
Rads	**Zinc-65**	**pCi/g**	**8920**	**1**	**0**	**0**	**—**	**—**	**—**	**-0.02692**	**—**	**-0.02692**	**-0.02692**	**0**	**No**	**BSL**
Rads	Zirconium-95	pCi/g	—	1	0	0	—	—	—	0.02	—	0.02017	0.02017	—	Yes	NV

Notes:

ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

Table E2.10. Ecological Screening of Surface Water Data – Outfall 008

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
eld paramet	pH	Std. unit	—	16	16	100	6.9	8	K016	7.37	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	17	11	64.71	0.2	1.53	K016	0.45	11	0	0.55	1.1	0.2	2.92	13	0.1	0.1	6	Yes	ASL
Metal	**Antimony**	**mg/L**	**0.16**	**4**	**1**	**25**	**0.005**	**0.005**	**K016**	**0.003**	**0**	**0**	**0.03**	**0.05**	**0.005**	**0.005**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	**Arsenic**	**mg/L**	**0.05**	**4**	**0**	**0**	—	—	—	**0.005**	—	**0**	**0.03**	**0.05**	—	—	—	**0.005**	**0.005**	**0**	**No**	**BSL**
Metal	Barium	mg/L	0.004	4	4	100	0.0292	0.0542	K016	0.04	4	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	4	0	0	—	—	—	0.0006	—	0	0	0.002	—	—	—	0.0005	0.001	1	Yes	ASL
Metal	Cadmium	mg/L	0.00142	17	0	0	—	—	—	0.007	—	0	0.01	0.02	0.001	0.001	0	0.0005	0.0125	11	Yes	ASL
Metal	Calcium	mg/L	—	4	4	100	25.7	43.6	K016	35.15	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	**Chromium**	**mg/L**	**0.04885**	**17**	**2**	**11.76**	**0.02**	**0.025**	**K004**	**0.01**	**0**	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	**Cobalt**	**mg/L**	**0.023**	**4**	**1**	**25**	**0.001**	**0.001**	**K016**	**0.0006**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0005**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	17	4	23.53	0.00709	0.025	K004	0.01	4	0	0.02	0.04	0.0052	0.038	8	0.0025	0.025	12	Yes	ASL
Metal	Cyanide	mg/L	0.0052	14	3	21.43	0.02	0.02	K016	0.01	3	0	0.02	0.03	—	—	—	0.01	0.01	11	Yes	ASL
Metal	Iron	mg/L	1	17	16	94.12	0.2	1.1	K016	0.39	1	0	0.98	1.95	0.488	2.6	5	0.1	0.1	0	Yes	ASL
Metal	Lead	mg/L	0.00132	17	0	0	—	—	—	0.07	—	0	0.06	0.13	—	—	—	0.0025	0.1	17	Yes	ASL
Metal	Magnesium	mg/L	—	4	4	100	2.86	4.58	K016	4.01	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	**Manganese**	**mg/L**	**0.12**	**4**	**4**	**100**	**0.00673**	**0.0114**	**K016**	**0.008**	**0**	**0**	**0.24**	**0.48**	**0.108**	**0.329**	**12**	—	—	—	**No**	**BSL**
Metal	Mercury	mg/L	0.000012	4	1	25	0.0002	0.0002	K016	0.0001	1	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	3	Yes	ASL
Metal	**Nickel**	**mg/L**	**0.029**	**17**	**3**	**17.65**	**0.005**	**0.01**	**K004**	**0.02**	**0**	**0**	**0.02**	**0.04**	**0.005**	**0.05**	**1**	**0.0025**	**0.025**	**0**	**No**	**BSL**
Metal	Phosphorous	mg/L	—	16	16	100	0.07	1.27	K004	0.51	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Potassium	mg/L	—	4	4	100	0.823	2.9	K016	2.02	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	**Selenium**	**mg/L**	**0.005**	**4**	**0**	**0**	—	—	—	**0.002**	—	**0**	**0**	**0.006**	—	—	—	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	Silver	mg/L	0.000012	4	1	25	0.001	0.001	K016	0.0008	1	0	0	0.007	0.001	0.001	1	0.0005	0.001	3	Yes	ASL
Metal	Sodium	mg/L	—	4	4	100	11.9	231	K016	66.97	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	Thallium	mg/L	0.004	4	2	50	0.01	0.01	K016	0.008	2	0	0.03	0.06	0.01	0.01	3	0.005	0.005	2	Yes	ASL
Metal	Uranium	mg/L	0.0026	12	5	41.67	0.004	0.065	K004	0.01	5	0	0	0.002	0.001	0.001	0	0.0025	0.025	2	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**4**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.01**	**0**	**No**	**BSL**
Metal	**Zinc**	**mg/L**	**0.067**	**17**	**5**	**29.41**	**0.02**	**0.06**	**K016**	**0.05**	**0**	**0**	**0.07**	**0.14**	**0.02**	**0.2**	**1**	**0.025**	**0.1**	**2**	**No**	**BSL**
PCB	PCB-1016	µg/L	0.014	17	0	0	—	—	—	0.08	—	0	0.08	0.17	—	—	—	0.085	0.085	17	Yes	ASL
PCB	PCB-1221	µg/L	0.014	17	0	0	—	—	—	0.08	—	0	0.09	0.18	—	—	—	0.085	0.085	17	Yes	ASL
PCB	PCB-1232	µg/L	0.014	17	0	0	—	—	—	0.08	—	0	0.08	0.16	—	—	—	0.085	0.085	17	Yes	ASL
PCB	PCB-1242	µg/L	0.014	17	0	0	—	—	—	0.07	—	0	0.07	0.14	—	—	—	0.045	0.085	17	Yes	ASL
PCB	PCB-1248	µg/L	0.014	17	0	0	—	—	—	0.08	—	0	0.08	0.15	—	—	—	0.06	0.085	17	Yes	ASL
PCB	PCB-1254	µg/L	0.014	17	0	0	—	—	—	0.08	—	0	0.08	0.16	0.23	0.23	1	0.05	0.085	17	Yes	ASL
PCB	PCB-1260	µg/L	0.014	17	1	5.88	0.367	0.367	K004	0.08	1	0	0.06	0.13	—	—	—	0.04	0.085	16	Yes	ASL
PCB	PCB-1268	µg/L	—	17	0	0	—	—	—	0.07	—	0	0.07	0.14	—	—	—	0.045	0.085	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	µg/L	0.0014	17	1	5.88	0.367	0.367	K004	0.1	1	0	0.09	0.19	0.23	0.23	1	0.085	0.085	16	Yes	ASL
Rads	Activity of U-235	pCi/L	—	3	1	33.33	19.3	19.3	K004	6.8	—	0	0.63	1.25	—	—	—	0	1.1	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**17**	**0**	**0**	—	—	—	**-3.58522353**	—	**0**	**-3.81**	**-7.62398947**	—	—	—	**-18.8**	**15.8**	**0**	**No**	**BSL**
Rads	**Cesium-134**	**pCi/L**	**11000**	**17**	**0**	**0**	—	—	—	**-2.90074706**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-12.85**	**2.86**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**17**	**0**	**0**	—	—	—	**0.79**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-3.45**	**3.81**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**17**	**0**	**0**	—	—	—	**0.13**	—	**0**	**-0.22**	**-0.43722632**	—	—	—	**-4.355**	**4.35**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**17**	**0**	**0**	—	—	—	**-0.04253824**	—	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.391**	**0.221**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**17**	**0**	**0**	—	—	—	**0.007**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.03125**	**0.0675**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**17**	**0**	**0**	—	—	—	**-0.00056294**	—	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.01325**	**0.0174**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**17**	**2**	**11.76**	**34.6**	**594**	**K004**	**26.71**	**0**	**0**	**-23.74**	**-47.47473684**	—	—	—	**-79**	**80.5**	**0**	**No**	**BSL**
Rads	Suspended Alpha	pCi/L	—	14	2	14.29	-1.19	5.66	K004	0.31	—	0	0.66	1.32	-2.29	7.68	—	-0.995	0.865	—	Yes	NV
Rads	Suspended Beta	pCi/L	—	15	4	26.67	9.94	162	K004	13.42	—	0	0.17	0.34	-9.72	5.37	—	-2.195	2.74	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**17**	**2**	**11.76**	**17.8**	**34**	**K004**	**5.48**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-2.85**	**8.1**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**17**	**0**	**0**	—	—	—	**0.007**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.02975**	**0.04775**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**17**	**1**	**5.88**	**0.641**	**0.641**	**K016**	**0.04**	**0**	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.1105**	**0.1085**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**17**	**0**	**0**	—	—	—	**-0.00196221**	—	**0**	**0**	**0.009**	—	—	—	**-0.059**	**0.02075**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	6	0	0	—	—	—	22.05	—	0	-0.52	-1.035	—	—	—	-63	163	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**4**	**0**	**0**	—	—	—	**49.88**	—	**0**	**10.29**	**20.58**	—	—	—	**15**	**149.5**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4550**	**7**	**3**	**42.86**	**0.508**	**0.753**	**K016**	**33.99**	**0**	**0**	**0.1**	**0.2**	—	—	—	**0**	**236**	**0**	**No**	**BSL**

Table E2.10. Ecological Screening of Surface Water Data – Outfall 008 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	2-Propanol	µg/L	7.5	11	0	0	—	—	—	500	—	0	500	1000	—	—	—	500	500	11	Yes	ASL
VOA	**Acetone**	**µg/L**	**1500**	**11**	**0**	**0**	—	—	—	**500**	—	**0**	**500**	**1000**	—	—	—	**500**	**500**	**0**	**No**	**BSL**
VOA	**Trichloroethene**	**µg/L**	**47**	**17**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
Wetchem	Hardness – Total as CaCO3	mg/L	—	17	17	100	57	161	K016	100.24	—	0	52.25	104.5	32	179	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/L - milligrams/liter
ug/L - micrograms/liter
pCi/L - picocuries/liter
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.11. Ecological Screening of Surface Sediment Data – Outfall 008

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	none	—	2	2	100	6.6	7.27	004-003	6.94	—	—	—	—	—	—
Metal	**Aluminum**	**mg/kg**	**25500**	**63**	**63**	**100**	**581**	**15500**	**OF08B-05-02**	**7224.78**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	63	56	88.89	2.1	20	004-003, 004-004	9.28	56	4.47	10	7	Yes	ASL
Metal	Arsenic	mg/kg	5.9	63	29	46.03	0.998	7.02	OF08B-14-02	3.27	3	2.13	2.5	0	Yes	ASL
Metal	Barium	mg/kg	—	63	63	100	12.4	135	OF08B-09-03	65.59	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	63	9	14.29	0.465	0.685	OF08B-01-03	0.28	—	0.213	0.25	—	Yes	NV
Metal	Boron	mg/kg	—	2	0	0	—	—	—	59.68	—	19.35	100	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	63	3	4.76	2.25	2.6	K008-2SE	1.02	3	0.85	1	60	Yes	ASL
Metal	Calcium	mg/kg	—	63	63	100	898	243000	OF08B-06-01	18042.19	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	63	62	98.41	5.54	90	K008-2SE	15.07	3	1.185	1.185	0	Yes	ASL
Metal	Cobalt	mg/kg	—	63	60	95.24	2.5	13.4	OF08B-10-03	4.74	—	1.16	1.185	—	Yes	NV
Metal	Copper	mg/kg	30	63	62	98.41	4.45	106	K008-2SE	13.9	3	1.185	1.185	0	Yes	ASL
Metal	Cyanide	mg/kg	—	2	0	0	—	—	—	0.5	—	0.5	0.5	—	Yes	NV
Metal	Iron	mg/kg	2000	63	63	100	2330	24100	K008-2SE	10624.92	63	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	63	13	20.63	20.2	121	K008-2SE	15.02	13	8.5	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	63	63	100	370	20300	OF08B-09-01	1965.33	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	63	63	100	49.3	982	OF08B-09-03	350.06	4	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	63	8	12.7	0.1	3.28	K008-2SE	0.18	6	0.0355	0.1	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	61	21	34.43	2	24.8	OF08B-01-01	5.02	—	2.13	2.5	—	Yes	NV
Metal	Nickel	mg/kg	16	63	51	80.95	4.54	129	OF08B-14-04	12.8	15	2.235	2.495	0	Yes	ASL
Metal	Potassium	mg/kg	—	63	63	100	156	1780	OF08B-05-02	547.51	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	63	1	1.59	2.3	2.3	K008-2SE	8.97	1	0.5	9.95	62	Yes	ASL
Metal	Silicon	mg/kg	—	1	1	100	420	420	K008-2SE	420	—	—	—	—	Yes	NV
Metal	Silver	mg/kg	0.00038	63	30	47.62	0.59	3.92	OF08B-05-02	1.79	30	1.12	2	33	Yes	ASL
Metal	Sodium	mg/kg	—	63	43	68.25	68.5	304	OF08B-02-04	105.08	—	46.15	150	—	Yes	NV
Metal	Thallium	mg/kg	—	63	0	0	—	—	—	9.32	—	0.95	10	—	Yes	NV
Metal	Uranium	mg/kg	—	118	107	90.68	0.618	208	OF08B-10-02	8.98	—	0.3165	0.97	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	63	63	100	5.18	38.9	OF08B-01-03	17.25	63	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	63	63	100	21.2	706	OF08B-14-04	70.14	63	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	534	1	0.19	0.1	0.1	OF08A-407	0.05	—	0.032	0.0525	—	Yes	NV
PCB	PCB-1221	mg/kg	—	534	1	0.19	0.13	0.13	OF08A-407	0.06	—	0.032	0.065	—	Yes	NV
PCB	PCB-1232	mg/kg	—	534	1	0.19	0.1	0.1	OF08A-407	0.05	—	0.032	0.0525	—	Yes	NV
PCB	PCB-1242	mg/kg	—	534	1	0.19	0.06	0.06	OF08A-407	0.03	—	0.025	0.0525	—	Yes	NV
PCB	PCB-1248	mg/kg	—	534	2	0.37	0.1	0.27	OF08A-197	0.05	—	0.032	0.0525	—	Yes	NV
PCB	PCB-1254	mg/kg	—	534	46	8.61	0.09	61.2	OF08A-337	0.26	—	0.032	0.0525	—	Yes	NV
PCB	PCB-1260	mg/kg	—	534	82	15.36	0.041	14.1	OF08AC-903	0.14	—	0.04	0.05	—	Yes	NV
PCB	PCB-1262	mg/kg	—	1	0	0	—	—	—	0.03	—	0.032	0.032	—	Yes	NV
PCB	PCB-1268	mg/kg	—	532	2	0.38	0.08	0.11	OF08A-417	0.04	—	0.03	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	531	90	16.95	0.1	61.2	OF08A-337	0.36	90	0.055	0.065	441	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	59	41	69.49	0.0275	2.58	OF08B-06-01	0.11	—	0.001955	0.0158	—	Yes	NV
Rads	Alpha activity	pCi/g	—	62	59	95.16	2.48	142	OF08B-11-04	13.4	—	1.03	1.58	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**62**	**8**	**12.9**	**0.0327**	**0.998**	**OF08B-08-04**	**0.03**	**0**	**-0.01835**	**0.0162**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g		62	61	98.39	3.46	87.7	OF08B-11-04	14.16	—	1.92	1.92	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**61**	**53**	**86.89**	**0.0646**	**1.27**	**OF08B-05-02**	**0.32**	**0**	**-0.0062**	**0.04805**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**61**	**2**	**3.28**	**0.71**	**0.93**	**004-003**	**0.03**	**0**	**-0.0185**	**0.02255**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**61**	**20**	**32.79**	**0.0376**	**0.663**	**OF08B-08-04**	**0.06**	**0**	**-0.00402**	**0.04475**	**0**	**No**	**BSL**
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**22300**	**1**	**1**	**100**	**0.6641**	**0.6641**	**K008-2SE**	**0.66**	**0**	—	—	—	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**60**	**2**	**3.33**	**0.0536**	**0.111**	**OF08B-08-04**	**0.001**	**0**	**-0.00505**	**0.00715**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**62**	**32**	**51.61**	**0.0239**	**9.05**	**OF08B-08-04**	**0.29**	**0**	**-0.00625**	**0.0241**	**0**	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**175000**	**3**	**3**	**100**	**27.74**	**120**	**004-003**	**80.58**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-226**	**pCi/g**	**2820**	**2**	**0**	**0**	—	—	—	**0.83**	—	**0.625**	**1.035**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	62	39	62.9	2.89	73.12	K008-2SE	4.96	—	0.1405	2.065	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**59**	**59**	**100**	**0.141**	**0.764**	**OF08B-08-04**	**0.35**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**59**	**58**	**98.31**	**0.226**	**84.1**	**OF08B-11-04**	**4.23**	**0**	**0.1005**	**0.1005**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**59**	**59**	**100**	**0.143**	**0.794**	**OF08B-08-04**	**0.36**	**0**	—	—	—	**No**	**BSL**

Table E2.11. Ecological Screening of Surface Sediment Data – Outfall 008 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Thorium-234**	**pCi/g**	**175000**	**3**	**2**	**66.67**	**14.8**	**15.63**	**K008-2SE**	**13.48**	**0**	**10**	**10**	**0**	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**62**	**62**	**100**	**0.155**	**42.1**	**OF08B-06-01**	**2**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**1**	**1**	**100**	**0.5584**	**0.5584**	**K008-2SE**	**0.56**	**0**	**—**	**—**	**—**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**62**	**62**	**100**	**0.203**	**19.3**	**004-003**	**2.43**	**0**	**—**	**—**	**—**	**No**	**BSL**
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	2	0	0	—	—	—	0.25	—	0.25	0.25	2	Yes	ASL
SVOA	2,4,5-Trichlorophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	1	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	2	0	0	—	—	—	0.25	—	0.25	0.25	2	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	1	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Carbazole	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Dibenzofuran	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Diethyl phthalate	mg/kg	0.061	2	0	0	—	—	—	0.25	—	0.25	0.25	2	Yes	ASL
SVOA	Dimethyl phthalate	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Isophorone	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Pentachlorophenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Phenol	mg/kg	—	2	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Total PAHs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SVOA	Acenaphthene	mg/kg	0.089	61	21	34.43	0.47	0.5	OF08B-01-01, OF08B-08-02, OF08B-08-04, OF08B-14-02, OF08B-11-04, OF08B-12-02	0.33	21	0.24	0.25	40	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	61	21	34.43	0.47	0.5	OF08B-01-01, OF08B-08-02, OF08B-08-04, OF08B-14-02, OF08B-11-04, OF08B-12-02	0.33	—	0.24	0.25	—	Yes	NV

Table E2.11. Ecological Screening of Surface Sediment Data – Outfall 008 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Anthracene	mg/kg	0.023	61	21	34.43	0.47	0.89	OF08B-13-03	0.34	21	0.24	0.25	40	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	61	20	32.79	0.47	3.6	OF08B-13-03	0.39	20	0.24	0.25	41	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	61	21	34.43	0.47	3	OF08B-13-03	0.39	21	0.24	0.25	40	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	61	28	45.9	0.47	6.4	OF08B-13-03	0.57	28	0.24	0.25	33	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg		61	20	32.79	0.47	1.2	OF08B-13-03	0.34	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	61	21	34.43	0.47	2.3	OF08B-13-03	0.37	21	0.24	0.25	40	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	61	24	39.34	0.47	4.5	OF08B-13-03	0.44	24	0.24	0.25	37	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	61	21	34.43	0.47	0.5	OF08B-01-01, OF08B-08-02, OF08B-08-04, OF08B-11-04, OF08B-12-02, OF08B-14-02	0.33	21	0.24	0.25	40	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	61	27	44.26	0.47	11	OF08B-13-03	0.62	27	0.24	0.25	34	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	61	21	34.43	0.47	0.5	OF08B-01-01, OF08B-08-02, OF08B-08-04, OF08B-11-04, OF08B-12-02, OF08B-14-02	0.33	21	0.24	0.25	40	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	61	21	34.43	0.47	1.5	OF08B-13-03	0.35	21	0.24	0.25	40	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	61	22	36.07	0.47	0.5	OF08B-01-01, OF08B-08-02, OF08B-08-04, OF08B-11-04, OF08B-12-02, OF08B-14-02	0.33	22	0.24	0.25	39	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	61	21	34.43	0.47	6.8	OF08B-13-03	0.46	21	0.24	0.25	40	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	61	26	42.62	0.47	7.6	OF08B-13-03	0.52	26	0.24	0.25	35	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	51.29	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**61**	**22**	**36.07**	**0.005**	**0.005**	**OF08B-01-03, OF08B-02-04, OF08B-03-02, OF08B-03-03, OF08B-04-01, OF08B-04-02, OF08B-04-04, OF08B-05-01, OF08B-05-04, OF08B-06-02, OF08B-06-03, OF08B-07-03, OF08B-08-01, OF08B-09-02, OF08B-10-02, OF08B-11-01, OF08B-11-03, OF08B-11-04, OF08B-12-01, OF08B-13**	**0.003**	**0**	**0.0025**	**0.005**	**0**	**No**	**BSL**
VOA	1,1,2,2-Tetrachloroethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**1,1,2-Trichloroethane**	**mg/kg**	**0.098**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**mg/kg**	**0.027**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,1-Dichloroethene	mg/kg	0.035	2	0	0	—	—	—	0.16	—	0.133	0.1895	2	Yes	ASL
VOA	1,2-Dichlorobenzene	mg/kg	0.033	2	0	0	—	—	—	0.25	—	0.25	0.25	2	Yes	ASL
VOA	**1,2-Dichloroethane**	**mg/kg**	**0.043**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,2-Dichloropropane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,2-Dimethylbenzene	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	0.035	2	0	0	—	—	—	0.25	—	0.25	0.25	2	Yes	ASL
VOA	2-Butanone	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	2-Hexanone	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	4-Methyl-2-pentanone	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Benzene**	**mg/kg**	**0.057**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromoform	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromomethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Carbon disulfide	mg/kg	0.00086	2	0	0	—	—	—	0.005	—	0.005	0.005	2	Yes	ASL
VOA	**Carbon tetrachloride**	**mg/kg**	**0.02**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Chlorobenzene	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Chloroethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Chloroform**	**mg/kg**	**0.096**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Chloromethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	cis-1,2-Dichloroethene	mg/kg	—	2	0	0	—	—	—	0.16	—	0.133	0.1895	—	Yes	NV
VOA	cis-1,3-Dichloropropene	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Dibromochloromethane	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Ethylbenzene**	**mg/kg**	**0.54**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	m,p-Xylene	mg/kg	—	2	0	0	—	—	—	0.01	—	0.01	0.01	—	Yes	NV
VOA	Methylene chloride	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Styrene	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Tetrachloroethene**	**mg/kg**	**0.032**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Toluene**	**mg/kg**	**0.5**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**

Table E2.11. Ecological Screening of Surface Sediment Data – Outfall 008 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	trans-1,2-Dichloroethene	mg/kg	—	2	0	0	—	—	—	0.16	—	0.133	0.1895	—	Yes	NV
VOA	trans-1,3-Dichloropropene	mg/kg	—	2	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**61**	**22**	**36.07**	**0.005**	**0.005**	**OF08B-01-03, OF08B-02-04, OF08B-03-02, OF08B-03-03, OF08B-04-01, OF08B-04-02, OF08B-04-04, OF08B-05-01, OF08B-05-04, OF08B-06-02, OF08B-06-03, OF08B-07-03, OF08B-08-01, OF08B-09-02, OF08B-10-02, OF08B-11-01, OF08B-11-03, OF08B-11-04, OF08B-12-01, OF08B-13**	**0.009**	**0**	**0.0025**	**0.1895**	**2**	**No**	**BSL**
VOA	Vinyl chloride	mg/kg	—	2	0	0	—	—	—	0.16	—	0.133	0.1895		Yes	NV
Wetchem	Total organic carbon	mg/kg	—	2	2	100	3400	4600	004-004	4000	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH - Polyaromatic hydrocarbons
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001

The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.12. Ecological Screening of Surface Soil Data – Outfall 008

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	Aluminum	mg/kg	5	5	5	100	5400	8450	K008-3SO	6132	5	—	—	—	Yes	ASL
Metal	**Antimony**	**mg/kg**	**1.9**	**5**	**2**	**40**	**0.53**	**1.1**	**K008-3SO**	**6.33**	**0**	**10**	**10**	**3**	**No**	**BSL**
Metal	Arsenic	mg/kg	1	5	3	60	3.1	6.58	K008-1SO	4.14	3	2.5	2.5	2	Yes	ASL
Metal	Barium	mg/kg	20	5	5	100	51.2	112	K008-3SO	82.9	5	—	—	—	Yes	ASL
Metal	Beryllium	mg/kg	0.19	6	2	33.33	0.34	0.56	K008-3SO	0.32	2	0.25	0.25	4	Yes	ASL
Metal	Boron	mg/kg	0.5	4	0	0	—	—	—	56.76	—	12.3	100	4	Yes	ASL
Metal	Cadmium	mg/kg	0.11	5	2	40	0.53	1.4	K008-3SO	0.99	2	1	1	3	Yes	ASL
Metal	Calcium	mg/kg	—	5	5	100	880	36100	K008-1SO	13282	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	0.4	6	6	100	8.45	32.5	K008-3SO	18.59	6	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	2.5	5	5	100	4.51	14.1	K008-4SO	8.48	5	—	—	—	Yes	ASL
Metal	Copper	mg/kg	0.45	5	5	100	7.5	49.2	K008-3SO	23.31	5	—	—	—	Yes	ASL
Metal	Iron	mg/kg	110	5	5	100	8280	18800	K008-4SO	14776	5	—	—	—	Yes	ASL
Metal	Lead	mg/kg	20	5	3	60	13.6	40.9	K008-3SO	20.88	2	10	10	0	Yes	ASL
Metal	Lithium	mg/kg	2	1	0	0	—	—	—	5	—	5	5	1	Yes	ASL
Metal	Magnesium	mg/kg	—	5	5	100	617	2550	K008-3SO	1212.2	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	25	5	5	100	135	2390	K008-4SO	927.4	5	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.1	6	4	66.67	0.08	0.98	JP-0060	0.42	3	0.1	0.1	2	Yes	ASL
Metal	**Molybdenum**	**mg/kg**	**2**	**4**	**1**	**25**	**1**	**1**	**K008-3SO**	**2.11**	**0**	**2.45**	**2.5**	**3**	**No**	**BSL**
Metal	Nickel	mg/kg	11	5	5	100	6.7	55.8	K008-1SO	26.5	3	—	—	—	Yes	ASL
Metal	Potassium	mg/kg	—	4	4	100	316	677	K008-3SO	438.75	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.21	5	2	40	1.7	1.87	C733001	0.98	2	0.305	0.5	3	Yes	ASL
Metal	Silicon	mg/kg	—	2	2	100	230	374	K008-3SO	302	—	—	—	—	Yes	NV
Metal	**Silver**	**mg/kg**	**1**	**5**	**1**	**20**	**0.8**	**0.8**	**K008-3SO**	**1.48**	**0**	**0.6**	**2**	**3**	**No**	**BSL**
Metal	Sodium	mg/kg	—	4	1	25	223	223	K008-3SO	207.5	—	150	307	—	Yes	NV
Metal	Thallium	mg/kg	1	5	0	0	—	—	—	6.27	—	0.6	10	3	Yes	ASL
Metal	Tin	mg/kg	5.6	1	0	0	—	—	—	50	—	50	50	1	Yes	ASL
Metal	Uranium	mg/kg	5	2	1	50	20	20	JP-0060	60	1	100	100	1	Yes	ASL
Metal	Vanadium	mg/kg	2	5	5	100	12.1	21.3	K008-3SO	17.04	5	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	8.5	5	5	100	24.9	212	K008-3SO	89.42	5	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1232	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1248	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1260	mg/kg	—	6	2	33.33	0.44	0.7	K008-1SO	0.22	—	0.0205	0.05	—	Yes	NV
PCB	PCB-1262	mg/kg	—	2	0	0	—	—	—	0.02	—	0.0205	0.0245	—	Yes	NV
PCB	PCB-1268	mg/kg	—	6	0	0	—	—	—	0.04	—	0.0205	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.02	4	1	25	0.7	0.7	K008-1SO	0.21	1	0.05	0.05	3	Yes	ASL
Rads	**Actinium-228**	**pCi/g**	**1900**	**1**	**1**	**100**	**0.1096**	**0.1096**	**JP-0060**	**0.11**	**0**	—	—	—	**No**	**BSL**
Rads	**Activity of Uranium-235**	**pCi/g**	**1750**	**1**	**1**	**100**	**0.047**	**0.047**	**C733001**	**0.05**	**0**	—	—	—	**No**	**BSL**
Rads	Alpha activity	pCi/g	—	3	3	100	18.62	22.93	JP-0060	21.42	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**975**	**7**	**2**	**28.57**	**0.0845**	**0.1666**	**K008-2SO**	**0.06**	**0**	**-0.0065**	**0.0715**	**0**	**No**	**BSL**
Rads	Antimony-124	pCi/g	—	1	0	0	—	—	—	-0.0010225	—	-0.0010225	-0.0010225	—	Yes	NV
Rads	**Antimony-125**	**pCi/g**	**12900**	**1**	**0**	**0**	—	—	—	**0.006**	—	**0.00552**	**0.00552**	**0**	**No**	**BSL**
Rads	Barium-133	pCi/g	—	1	0	0	—	—	—	0.004	—	0.0039525	0.0039525	—	Yes	NV
Rads	Barium-140	pCi/g	—	1	0	0	—	—	—	0.002	—	0.001549	0.001549	—	Yes	NV
Rads	Beta activity	pCi/g	—	3	3	100	5.6	48.03	K008-1SO	29.59	—	—	—	—	Yes	NV
Rads	**Bismuth-211**	**pCi/g**	**258**	**1**	**1**	**100**	**0.3416**	**0.3416**	**JP-0060**	**0.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-212**	**pCi/g**	**154**	**1**	**0**	**0**	—	—	—	**0.07**	—	**0.06975**	**0.06975**	**0**	**No**	**BSL**
Rads	**Bismuth-214**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.1122**	**0.1122**	**JP-0060**	**0.11**	**0**	—	—	—	**No**	**BSL**
Rads	Cerium-139	pCi/g	—	1	0	0	—	—	—	-0.00652	—	-0.00652	-0.00652	—	Yes	NV
Rads	Cerium-141	pCi/g	—	1	0	0	—	—	—	0.03	—	0.02959	0.02959	—	Yes	NV
Rads	Cerium-144	pCi/g	—	1	0	0	—	—	—	0.0003	—	0.0002951	0.0002951	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**825**	**2**	**1**	**50**	**-0.000451**	**-0.000451**	**JP-0060**	**-0.0015755**	**0**	**-0.0027**	**-0.0027**	**0**	**No**	**BSL**
Rads	Cesium-136	pCi/g	—	1	0	0	—	—	—	-0.00032585	—	-0.00032585	-0.00032585	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**1240**	**2**	**1**	**50**	**0.0471**	**0.0471**	**JP-0060**	**0.02**	**0**	**-0.00745**	**-0.00745**	**0**	**No**	**BSL**
Rads	Chromium-51	pCi/g	—	1	0	0	—	—	—	-0.00676	—	-0.00676	-0.00676	—	Yes	NV

Table E2.12. Ecological Screening of Surface Soil Data – Outfall 008 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	Cobalt-56	pCi/g	—	1	0	0	—	—	—	-0.003137	—	-0.003137	-0.003137	—	Yes	NV
Rads	Cobalt-57	pCi/g	—	1	0	0	—	—	—	-0.00002014	—	-0.000020145	-0.000020145	—	Yes	NV
Rads	Cobalt-58	pCi/g	—	1	0	0	—	—	—	0.005	—	0.004843	0.004843	—	Yes	NV
Rads	**Cobalt-60**	**pCi/g**	**7860**	**2**	**1**	**50**	**0.00897**	**0.00897**	**JP-0060**	**0.005**	**0**	**0.0004515**	**0.0004515**	**0**	**No**	**BSL**
Rads	Europium-152	pCi/g	—	1	0	0	—	—	—	0.004	—	0.004489	0.004489	—	Yes	NV
Rads	**Europium-154**	**pCi/g**	**4340**	**1**	**0**	**0**	—	—	—	**-0.0039375**	—	**-0.0039375**	**-0.0039375**	**0**	**No**	**BSL**
Rads	**Europium-155**	**pCi/g**	**26900**	**1**	**0**	**0**	—	—	—	**0.003**	—	**0.0026385**	**0.0026385**	**0**	**No**	**BSL**
Rads	Iridium-192	pCi/g	—	1	0	0	—	—	—	-0.002135	—	-0.002135	-0.002135	—	Yes	NV
Rads	Iron-59	pCi/g	—	1	0	0	—	—	—	-0.0020615	—	-0.0020615	-0.0020615	—	Yes	NV
Rads	**Lead-210**	**pCi/g**	**4250**	**1**	**0**	**0**	—	—	—	**0.11**	—	**0.1107**	**0.1107**	**0**	**No**	**BSL**
Rads	**Lead-211**	**pCi/g**	**258**	**1**	**1**	**100**	**0.3416**	**0.3416**	**JP-0060**	**0.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-212**	**pCi/g**	**154**	**1**	**1**	**100**	**0.09822**	**0.09822**	**JP-0060**	**0.1**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-214**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.1263**	**0.1263**	**JP-0060**	**0.13**	**0**	—	—	—	**No**	**BSL**
Rads	Manganese-54	pCi/g	—	1	0	0	—	—	—	0.003	—	0.0034445	0.0034445	—	Yes	NV
Rads	Mercury-203	pCi/g	—	1	0	0	—	—	—	-0.000953	—	-0.000953	-0.000953	—	Yes	NV
Rads	Neodymium-147	pCi/g	—	1	0	0	—	—	—	0.04	—	0.041645	0.041645	—	Yes	NV
Rads	**Neptunium-237**	**pCi/g**	**1680**	**2**	**1**	**50**	**0.053**	**0.053**	**JP-0060**	**0.03**	**0**	**0.01375**	**0.01375**	**0**	**No**	**BSL**
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**1680**	**5**	**4**	**80**	**0.1939**	**0.4217**	**K008-2SO**	**0.25**	**0**	**0.0007395**	**0.0007395**	**0**	**No**	**BSL**
Rads	Neptunium-239	pCi/g	—	1	0	0	—	—	—	-0.02213	—	-0.02213	-0.02213	—	Yes	NV
Rads	Niobium-94	pCi/g	—	1	0	0	—	—	—	0.002	—	0.002269	0.002269	—	Yes	NV
Rads	Niobium-95	pCi/g	—	1	0	0	—	—	—	0.01	—	0.013665	0.013665	—	Yes	NV
Rads	**Plutonium-238**	**pCi/g**	**1900**	**6**	**0**	**0**	—	—	—	**-0.0054545**	—	**-0.02845**	**0.003112**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**2020**	**7**	**4**	**57.14**	**0.2061**	**0.5717**	**K008-2SO**	**0.22**	**0**	**0.00291**	**0.00932**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**1820**	**1**	**1**	**100**	**1.06**	**1.06**	**JP-0060**	**1.06**	**0**	—	—	—	**No**	**BSL**
Rads	Promethium-146	pCi/g	—	1	0	0	—	—	—	-0.0005825	—	-0.0005825	-0.0005825	—	Yes	NV
Rads	**Protactinium-231**	**pCi/g**	**383**	**1**	**1**	**100**	**0.1972**	**0.1972**	**JP-0060**	**0.2**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-233**	**pCi/g**	**1680**	**1**	**1**	**100**	**0.07022**	**0.07022**	**JP-0060**	**0.07**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**1060**	**6**	**5**	**83.33**	**6.87**	**19.83**	**K008-2SO**	**9.85**	**0**	**2.3395**	**2.3395**	**0**	**No**	**BSL**
Rads	**Radium-223**	**pCi/g**	**258**	**1**	**0**	**0**	—	—	—	**0.01**	—	**0.01142**	**0.01142**	**0**	**No**	**BSL**
Rads	**Radium-226**	**pCi/g**	**16.1**	**1**	**1**	**100**	**0.128**	**0.128**	**JP-0060**	**0.13**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-228**	**pCi/g**	**1900**	**1**	**1**	**100**	**0.1096**	**0.1096**	**JP-0060**	**0.11**	**0**	—	—	—	**No**	**BSL**
Rads	**Radon-219**	**pCi/g**	**258**	**1**	**0**	**0**	—	—	—	**0.02**	—	**0.0183**	**0.0183**	**0**	**No**	**BSL**
Rads	**Ruthenium-106**	**pCi/g**	**1180**	**1**	**0**	**0**	—	—	—	**0.02**	—	**0.01952**	**0.01952**	**0**	**No**	**BSL**
Rads	Silver-110m	pCi/g	—	1	0	0	—	—	—	-0.00033075	—	-0.00033075	-0.00033075	—	Yes	NV
Rads	Sodium-22	pCi/g	—	1	0	0	—	—	—	-0.0018205	—	-0.0018205	-0.0018205	—	Yes	NV
Rads	**Strontium-90**	**pCi/g**	**882**	**1**	**0**	**0**	—	—	—	**0.08**	—	**0.075**	**0.075**	**0**	**No**	**BSL**
Rads	**Technetium-99**	**pCi/g**	**6570**	**7**	**7**	**100**	**1.64**	**48.18**	**K008-1SO**	**25.39**	**0**	—	—	—	**No**	**BSL**
Rads	**Thallium-208**	**pCi/g**	**55.3**	**1**	**1**	**100**	**0.02721**	**0.02721**	**JP-0060**	**0.03**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-227**	**pCi/g**	**255**	**1**	**0**	**0**	—	—	—	**0.03**	—	**0.033195**	**0.033195**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/g**	**154**	**2**	**2**	**100**	**0.0522**	**0.401**	**C733001**	**0.23**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-229**	**pCi/g**	**21.7**	**1**	**0**	**0**	—	—	—	**-0.007755**		**-0.007755**	**-0.007755**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**3990**	**2**	**2**	**100**	**0.423**	**1.02**	**JP-0060**	**0.72**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**1900**	**2**	**2**	**100**	**0.0218**	**0.437**	**C733001**	**0.23**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**1060**	**6**	**6**	**100**	**2.177**	**15.29**	**K008-2SO**	**8.58**	**0**	—	—	—	**No**	**BSL**
Rads	Tin-113	pCi/g	—	1	0	0	—	—	—	-0.004643	—	-0.004643	-0.004643	—	Yes	NV
Rads	**Uranium-234**	**pCi/g**	**1990**	**7**	**6**	**85.71**	**0.9761**	**10.37**	**K008-2SO**	**4.72**	**0**	**0.4745**	**0.4745**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**1750**	**6**	**6**	**100**	**0.05226**	**0.5698**	**K008-2SO**	**0.31**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**1060**	**7**	**7**	**100**	**0.973**	**13.72**	**K008-2SO**	**6.3**	**0**	—	—	—	**No**	**BSL**
Rads	Yttrium-88	pCi/g	—	1	0	0	—	—	—	-0.0042575	—	-0.0042575	-0.0042575	—	Yes	NV
Rads	**Zinc-65**	**pCi/g**	**8920**	**1**	**0**	**0**	—	—	—	**-0.024585**	—	**-0.024585**	**-0.024585**	**0**	**No**	**BSL**
Rads	Zirconium-95	pCi/g	—	1	0	0	—	—	—	0.01	—	0.01338	0.01338	—	Yes	NV

Notes:

ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PCB – Polychlorinated biphenyl
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram

Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

Table E2.13. Ecological Screening of Surface Water Data – Outfall 010

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	Std. unit	—	30	30	100	6.68	8.2	K010	7.38	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	28	22	78.57	0.2	3.1	L194	0.65	22	0	0.55	1.1	0.2	2.92	13	0.1	0.1	6	Yes	ASL
Metal	**Antimony**	**mg/L**	**0.16**	**10**	**3**	**30**	**0.005**	**0.005**	**L194, L194, L194**	**0.003**	**0**	**0**	**0.03**	**0.05**	**0.005**	**0.005**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	**Arsenic**	**mg/L**	**0.05**	**10**	**0**	**0**	—	—	—	**0.005**	—	**0**	**0.03**	**0.05**	—	—	—	**0.005**	**0.005**	**0**	**No**	**BSL**
Metal	Barium	mg/L	0.004	10	10	100	0.0273	0.0571	L194	0.04	10	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	10	0	0	—	—	—	0.0005	—	0	0	0.002	—	—	—	0.0005	0.001	1	Yes	ASL
Metal	Cadmium	mg/L	0.00142	28	0	0	—	—	—	0.006	—	0	0.01	0.02	0.001	0.001	0	0.0005	0.0125	16	Yes	ASL
Metal	Calcium	mg/L	—	10	10	100	19.9	27.6	L194	22.96	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	**Chromium**	**mg/L**	**0.04885**	**28**	**3**	**10.71**	**0.02**	**0.025**	**K010**	**0.01**	**0**	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	**Cobalt**	**mg/L**	**0.023**	**10**	**3**	**30**	**0.001**	**0.001**	**L194, L194, L194**	**0.0006**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0005**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	28	7	25	0.005	0.025	K010	0.01	5	0	0.02	0.04	0.0052	0.038	8	0.0025	0.025	18	Yes	ASL
Metal	Cyanide	mg/L	0.0052	18	1	5.56	0.02	0.02	L194	0.01	1	0	0.02	0.03	—	—	—	0.01	0.025	17	Yes	ASL
Metal	Iron	mg/L	1	28	28	100	0.2	2.09	L194	0.63	4	0	0.98	1.95	0.488	2.6	5	—	—	—	Yes	ASL
Metal	Lead	mg/L	0.00132	28	0	0	—	—	—	0.06	—	0	0.06	0.13	—	—	—	0.0025	0.1	28	Yes	ASL
Metal	Magnesium	mg/L	—	10	10	100	4.31	7.38	L194	5.83	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	**Manganese**	**mg/L**	**0.12**	**10**	**10**	**100**	**0.0191**	**0.0617**	**L194**	**0.04**	**0**	**0**	**0.24**	**0.48**	**0.108**	**0.329**	**12**	—	—	—	**No**	**BSL**
Metal	Mercury	mg/L	0.000012	10	1	10	0.0002	0.0002	L194	0.0001	1	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	9	Yes	ASL
Metal	Nickel	mg/L	0.029	28	6	21.43	0.005	0.05	L194, L194	0.02	2	0	0.02	0.04	0.005	0.05	1	0.0025	0.025	0	Yes	ASL
Metal	Phosphorous	mg/L	—	26	26	100	0.13	0.38	K010	0.23	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Potassium	mg/L	—	10	10	100	2.21	3.22	L194	2.69	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	**Selenium**	**mg/L**	**0.005**	**10**	**0**	**0**	—	—	—	**0.002**	—	**0**	**0**	**0.006**	—	—	—	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Metal	Silver	mg/L	0.000012	10	1	10	0.001	0.001	L194	0.0006	1	0	0	0.007	0.001	0.001	1	0.0005	0.001	9	Yes	ASL
Metal	Sodium	mg/L	—	10	10	100	17.6	60.3	L194	31.54	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	Thallium	mg/L	0.004	10	3	30	0.01	0.01	L194, L194, L194	0.007	3	0	0.03	0.06	0.01	0.01	3	0.005	0.005	7	Yes	ASL
Metal	Uranium	mg/L	0.0026	25	21	84	0.00598	0.052	K010	0.01	21	0	0	0.002	0.001	0.001	0	0.0025	0.025	2	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**10**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.01**	**0**	**No**	**BSL**
Metal	Zinc	mg/L	0.067	28	12	42.86	0.02	0.2	L194	0.06	1	0	0.07	0.14	0.02	0.2	1	0.01	0.1	7	Yes	ASL
PCB	**PCB-1016**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.17**	—	—	—	**0.06**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1221**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.11**	—	**0**	**0.09**	**0.18**	—	—	—	**0.085**	**0.47**	**30**	**No**	**ASL**
PCB	**PCB-1232**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.16**	—	—	—	**0.07**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1242**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.07**	—	**0**	**0.07**	**0.14**	—	—	—	**0.045**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1248**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.15**	—	—	—	**0.06**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1254**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.07**	—	**0**	**0.08**	**0.16**	**0.23**	**0.23**	**1**	**0.035**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1260**	**µg/L**	**0.014**	**30**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.06**	**0.13**	—	—	—	**0.025**	**0.085**	**30**	**No**	**ASL**
PCB	**PCB-1268**	**µg/L**	—	**30**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.07**	**0.14**	—	—	—	**0.035**	**0.085**	—	**No**	**NV**
PCB	**Polychlorinated biphenyl (Total PCBs)**	**µg/L**	**0.0014**	**30**	**0**	**0**	—	—	—	**0.11**	—	**0**	**0.09**	**0.19**	**0.23**	**0.23**	**1**	**0.085**	**0.47**	**30**	**No**	**ND**
Rads	Activity of Uranium-235	pCi/L	—	9	2	22.22	0.145	0.147	L194	0.53	—	0	0.63	1.25	—	—	—	0	1.1	—	Yes	NV
Rads	Alpha activity	pCi/L	—	2	2	100	0	2.37	K010	1.18	—	0	—	—	—	—	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**30**	**2**	**6.67**	**10.4**	**16.3**	**K010**	**-2.43990767**	**0**	**0**	**-3.81**	**-7.62398947**	—	—	—	**-16.3**	**8.2**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/L	—	2	2	100	8.42	15.71	K010	12.07	—	0	—	—	—	—	—	—	—	—	Yes	NV
Rads	**Cesium-134**	**pCi/L**	**11000**	**28**	**0**	**0**	—	—	—	**-1.73911946**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-8.75**	**4.195**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**28**	**0**	**0**	—	—	—	**-0.27605357**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-4.52**	**3.715**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**28**	**0**	**0**	—	—	—	**0.42**	—	**0**	**-0.22**	**-0.43722632**	—	—	—	**-2.55**	**7.5**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**30**	**4**	**13.33**	**-14**	**11.7**	**K010**	**-0.00703641**	**0**	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.395**	**0.1905**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**28**	**0**	**0**				**-0.01139696**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.063**	**0.03715**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**30**	**3**	**10**	**-0.0313**	**0.127**	**L194**	**0.001**	**0**	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.033**	**0.0447**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**28**	**1**	**3.57**	**616**	**616**	**L194**	**3.52**	**0**	**0**	**-23.74**	**-47.4747368**	—	—	—	**-130**	**88**	**0**	**No**	**BSL**
Rads	Suspended alpha	pCi/L	—	24	4	16.67	-2.36	5.58	L194	0.09	—	0	0.66	1.32	-2.29	7.68	—	-1.415	2.055	—	Yes	NV
Rads	Suspended beta	pCi/L	—	25	2	8	-1.77	0.792	L194	0.15	—	0	0.17	0.34	-9.72	5.37	—	-2.215	3.425	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**30**	**5**	**16.67**	**0.0562**	**29.2**	**L194**	**4.8**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-7.3**	**7.9**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**28**	**0**	**0**	—	—	—	**0.004**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.03195**	**0.0515**	**0**	**No**	**BSL**

Table E2.13. Ecological Screening of Surface Water Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Thorium-230**	**pCi/L**	**413**	**30**	**3**	**10**	**-0.361**	**0.221**	**L194**	**-0.00214025**	**0**	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.094**	**0.146**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**28**	**0**	**0**	—	—	—	**-0.00112289**	—	**0**	**0**	**0.009**	—	—	—	**-0.0154**	**0.0186**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	12	0	0	—	—	—	5.36	—	0	-0.52	-1.035	—	—	—	-57.5	154	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**9**	**3**	**33.33**	**0.691**	**1.47**	**L194**	**10.32**	**0**	**0**	**10.29**	**20.58**	—	—	—	**12.5**	**20**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/L**	**4370**	**2**	**0**	**0**	—	—	—	**1.1**	—	**0**	**-1.62**	—	—	—	—	**1.1**	**1.1**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4550**	**13**	**10**	**76.92**	**1.12**	**362**	**K010**	**49.37**	**0**	**0**	**0.1**	**0.2**	—	—	—	**0**	**243.5**	**0**	**No**	**BSL**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2,2-Tetrachloroethane**	**µg/L**	**240**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2-Trichloroethane**	**µg/L**	**940**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**µg/L**	**47**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethene**	**µg/L**	**303**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloroethane**	**µg/L**	**2000**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**µg/L**	**525**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**2-Butanone**	**µg/L**	**14000**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	2-Hexanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	2-Propanol	µg/L	7.5	15	0	0	—	—	—	500	—	0	500	1000	—	—	—	500	500	15	Yes	ASL
VOA	4-Methyl-2-pentanone	µg/L	—	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	—	Yes	NV
VOA	**Acetone**	**µg/L**	**1500**	**17**	**2**	**11.76**	**10**	**10**	**K010, K010**	**442.35**	**0**	**0**	**500**	**1000**	—	—	—	**500**	**500**	**0**	**No**	**BSL**
VOA	**Benzene**	**µg/L**	**53**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Bromoform**	**µg/L**	**29**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Carbon disulfide	µg/L	0.92	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
VOA	**Carbon tetrachloride**	**µg/L**	**352**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**µg/L**	**195**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloroethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Chloroform**	**µg/L**	**289**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloromethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,2-Dichloroethene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	cis-1,3-Dichloropropene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Dibromochloromethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Ethylbenzene**	**µg/L**	**453**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Methylene chloride**	**µg/L**	**1930**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	Styrene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Tetrachloroethene**	**µg/L**	**84**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Toluene**	**µg/L**	**175**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Total Xylene**	**µg/L**	**13**	**2**	**0**	**0**	—	—	—	**7.5**	—	**0**	—	—	—	—	—	**7.5**	**7.5**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	trans-1,3-Dichloropropene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Trichloroethene**	**µg/L**	**47**	**30**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
Wetchem	Hardness – Total as $CaCO_3$	mg/L	—	28	28	100	57	118	L194	81.75	—	0	52.25	104.5	32	179	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
ug/L - micrograms/liter
pCi/L - picocuries/liter
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.14. Ecological Screening of Surface Sediment Data – Outfall 010

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Aluminum**	**mg/kg**	**25500**	**52**	**52**	**100**	**1870**	**14800**	**OF10B-02-02**	**8016.54**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	51	31	60.78	1.1	20	K010	8.08	30	4.05	10	20	Yes	ASL
Metal	Arsenic	mg/kg	5.9	51	29	56.86	0.871	12.6	OF10B-10-02	4.47	13	2.11	10	1	Yes	ASL
Metal	Barium	mg/kg	—	51	51	100	29.9	140	OF10B-08-02	67.69	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	52	15	28.85	0.33	1.36	K010-1SE	0.34	—	0.2145	0.25	—	Yes	NV
Metal	Boron	mg/kg	—	5	0	0			—	67.53	—	13.5	100	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	51	6	11.76	0.58	2.73	K010-1SE	1.04	6	0.845	1	45	Yes	ASL
Metal	Calcium	mg/kg	—	52	52	100	94.3	314000	OF10B-08-02	45603.1	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	51	51	100	4.28	118	OF10B-04-04	18.99	3	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	52	50	96.15	2.36	19.4	OF10B-01-02	4.66	—	1.08	1.25	—	Yes	NV
Metal	Copper	mg/kg	30	51	48	94.12	2.16	59	K010	13	4	1.195	1.24	0	Yes	ASL
Metal	Iron	mg/kg	2000	51	51	100	1560	41900	K010-1SE	11771.37	50	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	51	14	27.45	9.6	75.2	OF10B-10-01	16.25	13	8.6	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	52	52	100	596	17400	OF10B-08-02	3248.48	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	52	52	100	44.9	736	OF10B-08-01	269.58	1	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	52	5	9.62	0.06	0.31	OF10B-10-04	0.06	1	0.0245	0.1	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	48	19	39.58	0.7	20	OF10B-08-01	4.78		2.11	2.5		Yes	NV
Metal	Nickel	mg/kg	16	52	46	88.46	4.62	52.5	OF10B-08-03	9.56	6	2.16	2.5	0	Yes	ASL
Metal	Potassium	mg/kg	—	52	52	100	239	2170	OF10B-10-03	721.23	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	51	0	0	—	—	—	8.18	—	0.335	10	51	Yes	ASL
Metal	Silicon	mg/kg	—	2	2	100	266	498	K010-2SE	382	—	—	—	—	Yes	NV
Metal	Silver	mg/kg	0.00038	52	2	3.85	2.39	2.42	OF10B-10-02	1.28	2	0.7	2	50	Yes	ASL
Metal	Sodium	mg/kg	—	51	41	80.39	60.6	332	OF10B-10-02	162.46	—	48.45	495	—	Yes	NV
Metal	Thallium	mg/kg	—	51	0	0	—	—	—	9.14	—	0.7	10	—	Yes	NV
Metal	Uranium	mg/kg	—	89	81	91.01	0.39	135	OF10B-06-04	15.31	—	0.2515	50	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	51	51	100	5.74	75.5	K010-1SE	21.3	51	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	51	51	100	27.1	1430	OF10B-06-04	120.84	51	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	378	2	0.53	0.09	0.1	OF10A-022	0.07	—	0.022	1.25	—	Yes	NV
PCB	PCB-1221	mg/kg	—	378	20	5.29	0.12	0.13	OF10A-022, OF10A-062, OF10A-068, OF10A-073, OF10A-074, OF10A-076, OF10A-077, OF10A-078, OF10A-115, OF10A-123, OF10A-131, OF10A-201	0.09	—	0.022	1.625	—	Yes	NV
PCB	PCB-1232	mg/kg	—	378	20	5.29	0.09	0.1	OF10A-022, OF10A-062, OF10A-063, OF10A-068, OF10A-073, OF10A-074, OF10A-076, OF10A-077, OF10A-078, OF10A-115, OF10A-123, OF10A-131, OF10A-200, OF10A-201, OF10A-202, OF10A-236, OF10A-236	0.07	—	0.022	1.25	—	Yes	NV
PCB	PCB-1242	mg/kg	—	378	21	5.56	0.05	0.2	K010	0.04	—	0.022	0.75	—	Yes	NV
PCB	PCB-1248	mg/kg	—	378	20	5.29	0.09	0.1	OF10A-022, OF10A-062, OF10A-063, OF10A-068, OF10A-073, OF10A-074, OF10A-076, OF10A-077, OF10A-078, OF10A-115, OF10A-123, OF10A-131, OF10A-200, OF10A-201, OF10A-202, OF10A-236, OF10A-236	0.07	—	0.022	1.25	—	Yes	NV
PCB	PCB-1254	mg/kg	—	378	30	7.94	0.08	2.53	OF10A-056	0.08	—	0.022	1.125	—	Yes	NV
PCB	PCB-1260	mg/kg	—	378	132	34.92	0.09	609	OF10AC-903	6.87	—	0.022	0.05	—	Yes	NV
PCB	PCB-1262	mg/kg	—	2	0	0	—	—	—	0.03	—	0.022	0.04	—	Yes	NV
PCB	PCB-1268	mg/kg	—	378	21	5.56	0.07	0.12	OF10A-197	0.06	—	0.022	1	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	376	121	32.18	0.12	609	OF10AC-903	6.94	121	0.05	0.065	255	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	43	33	76.74	0.0341	0.647	OF10B-07-03	0.12	—	0.002205	0.0169	—	Yes	NV
Rads	Alpha activity	pCi/g	—	50	44	88	2.27	38	OF10B-06-04	8.53	—	0.2905	2.555	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**49**	**1**	**2.04**	**0.12**	**0.12**	**OF10B-04-04**	**-0.00365392**	**0**	**-0.021565**	**0.0299**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	50	46	92	2.86	74.7	OF10B-05-04	14.03	—	-0.457	2.265	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**47**	**31**	**65.96**	**0.0194**	**1.04**	**OF10B-05-01**	**0.2**	**0**	**-0.01745**	**0.0615**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**47**	**0**	**0**	—	—	—	**0.001**	—	**-0.01945**	**0.02295**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**47**	**8**	**17.02**	**0.0321**	**0.743**	**OF10B-08-03**	**0.04**	**0**	**-0.0053**	**0.02935**	**0**	**No**	**BSL**

Table E2.14. Ecological Screening of Surface Sediment Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**22300**	**2**	**0**	**0**	—	—	—	**0.01**	—	**0.008725**	**0.018305**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**45**	**0**	**0**	—	—	—	**-0.00297722**	—	**-0.01269**	**0.005715**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**49**	**6**	**12.24**	**0.0259**	**0.109**	**OF10B-10-04**	**0.006**	**0**	**-0.03635**	**0.0102**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**31600**	**4**	**4**	**100**	**4.33**	**5.11**	**K010**	**4.88**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**175000**	**2**	**1**	**50**	**15.49**	**15.49**	**K010-2SE**	**7.3**	**0**	**-0.8825**	**-0.8825**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	49	27	55.1	0.175	84.3	OF10B-04-01	4.07	—	-1.27	1.33	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**43**	**42**	**97.67**	**0.0844**	**0.426**	**OF10B-03-03**	**0.25**	**0**	**-0.03105**	**-0.03105**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**47**	**40**	**85.11**	**0.198**	**0.821**	**OF10B-10-04**	**0.3**	**0**	**0.0575**	**0.1015**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**43**	**42**	**97.67**	**0.108**	**0.461**	**OF10B-02-03**	**0.26**	**0**	**-0.0125**	**-0.0125**	**0**	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**175000**	**2**	**2**	**100**	**2.136**	**10.06**	**K010-2SE**	**6.1**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**47**	**46**	**97.87**	**0.086**	**7.42**	**OF10B-10-03**	**1.35**	**0**	**0.0625**	**0.0625**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**4**	**4**	**100**	**0.005**	**0.1878**	**K010-2SE**	**0.08**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**47**	**46**	**97.87**	**0.13**	**28.7**	**OF10B-07-03**	**4.85**	**0**	**0.0885**	**0.0885**	**0**	**No**	**BSL**
SVOA	1,1-biphenyl	mg/kg	—	4	0	0	—	—	—	0.03	—	0.0165	0.0465	—	Yes	NV
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	1,2-Diphenylhydrazine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	4	0	0	—	—	—	0.24	—	0.24	0.245	4	Yes	ASL
SVOA	2,4,5-Trichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,4'-DDD	mg/kg	—	4	0	0	—	—	—	0.004	—	0.00115	0.0055	—	Yes	NV
SVOA	2,4'-DDE	mg/kg	—	4	0	0	—	—	—	0.004	—	0.00115	0.0055	—	Yes	NV
SVOA	2,4'-DDT	mg/kg	—	4	0	0	—	—	—	0.004	—	0.00115	0.0055	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,6,10,14-Tetramethylhexadecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.165	0.22	—	Yes	NV
SVOA	2,6,10,14-Tetramethylpentadecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.165	0.22	—	Yes	NV
SVOA	2,6-Dichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	5	0	0	—	—	—	0.2	—	0.0465	0.245	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4,4'-DDD	mg/kg	0.0033	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	4,4'-DDE	mg/kg	0.00142	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	4,4'-DDT	mg/kg	0.0036	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.24	0.24	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Aldrin	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	alpha-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	alpha-Chlordane	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Aniline	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Azinphos-methyl	mg/kg	—	4	0	0	—	—	—	0.06	—	0.055	0.075	—	Yes	NV
SVOA	Benzenemethanol	mg/kg	—	4	1	25	0.94	0.94	K010	0.42	—	0.24	0.245	—	Yes	NV

Table E2.14. Ecological Screening of Surface Sediment Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Benzidine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Benzo(e)pyrene	mg/kg	—	4	4	100	0.009	0.63	K010	0.21	—	—	—	—	Yes	NV
SVOA	Benzoic acid	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	beta-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	3	0	0	—	—	—	0.24	—	0.24	0.245	3	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Carbazole	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Chlordane	mg/kg	0.00028	4	0	0	—	—	—	0.16	—	0.06	0.215	4	Yes	ASL
SVOA	Co-Ral	mg/kg	—	4	0	0	—	—	—	0.01	—	0.0115	0.0155	—	Yes	NV
SVOA	delta-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	**Diazinon**	**mg/kg**	**0.019**	**4**	**0**	**0**	—	—	—	**0.006**	—	**0.0055**	**0.0075**	**0**	**No**	**BSL**
SVOA	Dibenzofuran	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Dichlorvos	mg/kg	—	4	1	25	0.012	0.012	K010	0.01	—	0.0125	0.0155	—	Yes	NV
SVOA	Dieldrin	mg/kg	0.0019	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	Diethyl phthalate	mg/kg	0.061	4	0	0	—	—	—	0.24	—	0.24	0.245	4	Yes	ASL
SVOA	Dimethoate	mg/kg	—	4	0	0	—	—	—	0.01	—	0.0115	0.0155	—	Yes	NV
SVOA	Dimethyl phthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	4	3	75	0.49	0.68	K010	0.51	—	0.24	0.24	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Docosane	mg/kg	—	4	2	50	0.011	0.014	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Dodecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.165	0.22	—	Yes	NV
SVOA	Dotriacontane	mg/kg	—	4	3	75	0.043	0.084	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Eicosane	mg/kg	—	4	2	50	0.009	0.013	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Endosulfan I	mg/kg	0.0055	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	Endosulfan II	mg/kg	0.0055	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	Endosulfan sulfate	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Endrin	mg/kg	0.00222	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	Endrin aldehyde	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Ethion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Famphur	mg/kg	—	4	0	0	—	—	—	0.03	—	0.0225	0.0295	—	Yes	NV
SVOA	Fensulfothion	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0205	0.027	—	Yes	NV
SVOA	Fenthion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	gamma-Chlordane	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Henicosane	mg/kg	—	4	2	50	0.016	0.02	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Heptachlor	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Heptachlor epoxide	mg/kg	0.0006	4	0	0	—	—	—	0.07	—	0.023	0.11	4	Yes	ASL
SVOA	heptacosane	mg/kg	—	4	4	100	0.042	0.42	K010	0.19	—	—	—	—	Yes	NV
SVOA	Heptadecane	mg/kg	—	4	3	75	0.068	0.79	K010	0.28	—	0.165	0.165	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Hexacosane	mg/kg	—	4	2	50	0.019	0.046	K010	0.1	—	0.165	0.165	—	Yes	NV
SVOA	Hexadecane	mg/kg	—	4	2	50	0.015	0.019	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Isophorone	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Lindane	mg/kg	0.00094	4	0	0	—	—	—	0.02	—	0.006	0.0285	4	Yes	ASL
SVOA	m,p-Cresol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.245	0.245	—	Yes	NV
SVOA	Malathion	mg/kg	0.0067	4	0	0	—	—	—	0.02	—	0.0135	0.018	4	Yes	ASL
SVOA	Methoxychlor	mg/kg	—	4	0	0	—	—	—	0.04	—	0.0115	0.055	—	Yes	NV
SVOA	Methyl parathion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Mirex	mg/kg	—	4	0	0	—	—	—	0.02	—	0.006	0.0285	—	Yes	NV
SVOA	Mocap	mg/kg	—	4	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV

Table E2.14. Ecological Screening of Surface Sediment Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	n-Hentriacontane	mg/kg	—	4	4	100	0.17	1.2	K010	0.68	—	—	—	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitrosodimethylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	n-Octacosane	mg/kg	—	4	2	50	0.049	0.098	K010	0.12	—	0.165	0.165	—	Yes	NV
SVOA	Nonacosane	mg/kg	—	4	4	100	0.12	1.8	K010	0.73	—	—	—	—	Yes	NV
SVOA	Nonadecane	mg/kg	—	4	2	50	0.013	0.014	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	n-Pentacosane	mg/kg	—	4	3	75	0.072	0.12	K010	0.11	—	0.165	0.165	—	Yes	NV
SVOA	n-Tetracosane	mg/kg	—	4	2	50	0.013	0.023	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	n-Triacontane	mg/kg	—	4	3	75	0.055	0.088	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	n-Tricosane	mg/kg	—	4	3	75	0.038	0.048	K010	0.07	—	0.165	0.165	—	Yes	NV
SVOA	n-Tritriacontane	mg/kg	—	4	4	100	0.058	0.43	K010	0.25	—	—	—	—	Yes	NV
SVOA	Octadecane	mg/kg	—	4	2	50	0.011	0.025	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Parathion	mg/kg	—	4	1	25	0.0024	0.0024	K010	0.006	—	0.006	0.0075	—	Yes	NV
SVOA	Pentachlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Pentadecane	mg/kg	—	4	3	75	0.051	0.067	K010	0.08	—	0.165	0.165	—	Yes	NV
SVOA	Perylene	mg/kg	—	4	3	75	0.024	0.087	K010	0.04	—	0.0165	0.0165	—	Yes	NV
SVOA	Phenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Phorate	mg/kg	—	4	0	0	—	—	—	0.006	—	0.0055	0.0075	—	Yes	NV
SVOA	Pyridine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.24	0.245	—	Yes	NV
SVOA	Tetradecane	mg/kg	—	4	2	50	0.007	0.008	K010	0.09	—	0.165	0.165	—	Yes	NV
SVOA	Tetratriacontane	mg/kg	—	4	1	25	0.017	0.017	K010	0.13	—	0.165	0.19	—	Yes	NV
SVOA	Toxaphene	mg/kg	0.0022	4	0	0	—	—	—	1.89	—	0.6	2.85	4	Yes	ASL
SVOA	Tridecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.165	0.22	—	Yes	NV
SVOA	Undecane	mg/kg	—	4	1	25	0.011	0.011	K010	0.14	—	0.165	0.22	—	Yes	NV
SVOA	Acenaphthene	mg/kg	0.089	48	22	45.83	0.032	0.73	OF10B-04-01	0.35	21	0.235	0.25	26	Yes	ASL
SVOA	Acenaphthylene	mg/kg		48	21	43.75	0.46	0.5	OF10B-03-01, OF10B-06-02, OF10B-07-01, OF10B-10-02	0.35	—	0.0465	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	48	21	43.75	0.051	0.84	OF10B-04-01	0.35	21	0.235	0.25	27	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	48	22	45.83	0.46	2.7	OF10B-04-01	0.49	22	0.23	0.25	26	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	48	21	43.75	0.33	2.3	OF10B-04-01	0.46	21	0.23	0.25	27	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	48	25	52.08	0.46	4	OF10B-04-01	0.67	25	0.235	0.25	23	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg	—	48	20	41.67	0.22	1.5	OF10B-04-01	0.37	—	0.235	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	48	21	43.75	0.31	1.5	OF10B-04-01	0.41	21	0.23	0.25	27	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	48	25	52.08	0.42	3.3	OF10B-04-01	0.54	25	0.23	0.25	23	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	48	23	47.92	0.034	0.5	OF10B-03-01, OF10B-06-02, OF10B-07-01, OF10B-10-02	0.35	23	0.235	0.25	25	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	48	27	56.25	0.46	8.8	OF10B-04-01	0.98	27	0.235	0.25	21	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	48	21	43.75	0.027	0.5	OF10B-03-01, OF10B-06-02, OF10B-07-01, OF10B-10-02	0.34	21	0.235	0.25	27	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	48	20	41.67	0.46	1.7	OF10B-04-01	0.39	20	0.18	0.25	28	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	48	20	41.67	0.46	0.5	OF10B-03-01, OF10B-06-02, OF10B-07-01, OF10B-10-02	0.34	20	0.0465	0.25	28	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	48	25	52.08	0.46	6.6	OF10B-04-01	0.7	25	0.23	0.25	23	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	48	27	56.25	0.46	5.9	OF10B-04-01	0.76	27	0.235	0.25	21	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	41.87	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**43**	**16**	**37.21**	**0.005**	**0.005**	**OF10B-01-01, OF10B-02-01, OF10B-02-02, OF10B-02-03, OF10B-03-01, OF10B-03-01, OF10B-03-02, OF10B-03-04, OF10B-05-04, OF10B-07-03, OF10B-08-02, OF10B-08-04, OF10B-09-01, OF10B-09-02, OF10B-10-02, OF10B-10-03**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
VOA	1,2-Dichlorobenzene	mg/kg	0.033	4	0	0	—	—	—	0.24	—	0.24	0.245	4	Yes	ASL

Table E2.14. Ecological Screening of Surface Sediment Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	1,4-Dichlorobenzene	mg/kg	0.035	4	0	0	—	—	—	0.24	—	0.24	0.245	4	Yes	ASL
VOA	2,6-Dimethylnaphthalene	mg/kg	—	4	0	0	—	—	—	0.03	—	0.0165	0.0465	—	Yes	NV
VOA	Decane	mg/kg	—	4	1	25	0.15	0.15	K010	0.18	—	0.165	0.22	—	Yes	NV
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**43**	**5**	**11.63**	**0.005**	**0.005**	**OF10B-03-02, OF10B-03-04, OF10B-05-04, OF10B-10-02, OF10B-10-03**	**0.003**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Wetchem	Total organic carbon	mg/kg	—	4	4	100	4225	16400	K010	11693.75	—	—	—	—	—	—

Notes:

ASL – Above screening value
BHC – Benzene hexachloride
BSL – Below screening value
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.15. Ecological Screening of Surface Soil Data – Outfall 010

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Dioxin/furan	1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/g	—	2	2	100	49.2	63.7	082-012	56.45	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/g	—	2	2	100	340	450	082-012	395	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/g	—	2	2	100	4.59	5.9	082-012	5.24	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,4,7,8-Hexachlorodibenzofuran	pg/g	—	2	2	100	6.84	8.56	082-012	7.7	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	pg/g	—	2	2	100	5.52	6.6	082-012	6.06	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,6,7,8-Hexachlorodibenzofuran	pg/g	—	2	2	100	3.34	4.39	082-012	3.86	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/g	—	2	2	100	15.5	18.2	082-012	16.85	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,7,8,9-Hexachlorodibenzofuran	pg/g	—	2	1	50	0.416	0.416	082-009	0.97	—	1.52	1.52	—	Yes	NV
Dioxin/furan	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/g	—	2	2	100	7.49	9.43	082-012	8.46	—	—	—	—	Yes	NV
Dioxin/furan	1,2,3,7,8-Pentachlorodibenzofuran	pg/g	—	2	1	50	1.61	1.61	082-009	1.11	—	0.61	0.61	—	Yes	NV
Dioxin/furan	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	pg/g	—	2	0	0	—	—	—	0.6	—	0.595	0.61	—	Yes	NV
Dioxin/furan	2,3,4,6,7,8-Hexachlorodibenzofuran	pg/g	—	2	1	50	2.8	2.8	082-009	2.16	—	1.52	1.52	—	Yes	NV
Dioxin/furan	2,3,4,7,8-Pentachlorodibenzofuran	pg/g	—	2	2	100	4.82	14.4	082-012	9.61	—	—	—	—	Yes	NV
Dioxin/furan	2,3,7,8-Tetrachlorodibenzofuran	pg/g	—	2	2	100	6.13	12	082-012	9.06	—	—	—	—	Yes	NV
Dioxin/furan	2,3,7,8-Tetrachlorodibenzo-p-dioxin	pg/g	—	2	0	0	—	—	—	0.6	—	0.595	0.61	—	Yes	NV
Dioxin/furan	Octachloro-dibenzo[b,e][1,4]dioxin	pg/g	—	2	2	100	12600	25300	082-012	18950	—	—	—	—	Yes	NV
Dioxin/furan	Octachlorodibenzofuran	pg/g	—	2	2	100	163	175	082-012	169	—	—	—	—	Yes	NV
Metal	Aluminum	mg/kg	5	7	7	100	3200	12900	099-031	7765.71	7	—	—	—	Yes	ASL
Metal	Antimony	mg/kg	1.9	7	1	14.29	20	20	099-031	11.43	1	10	10	6	Yes	ASL
Metal	Arsenic	mg/kg	1	7	4	57.14	5.55	8.04	099-016	4.86	4	2.5	2.5	3	Yes	ASL
Metal	Barium	mg/kg	20	7	7	100	20.8	104	099-015	59.66	7	—	—	—	Yes	ASL
Metal	Beryllium	mg/kg	0.19	7	3	42.86	0.52	0.89	099-016	0.42	3	0.25	0.25	4	Yes	ASL
Metal	Boron	mg/kg	0.5	7	1	14.29	100	100	099-004	71.43	1	50	100	6	Yes	ASL
Metal	Cadmium	mg/kg	0.11	7	0	0	—	—	—	1	—	1	1	7	Yes	ASL
Metal	Calcium	mg/kg	—	6	6	100	2600	260000	099-004	59586.67	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	0.4	7	7	100	7.67	45.7	099-016	21.17	7	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	2.5	7	7	100	1.7	5.56	099-016	3.95	6	—	—	—	Yes	ASL
Metal	Copper	mg/kg	0.45	7	7	100	5.38	20.7	K010-1SO	10.78	7	—	—	—	Yes	ASL
Metal	**Cyanide**	**mg/kg**	**5**	**5**	**0**	**0**	—	—	—	**0.5**	—	**0.5**	**0.5**	**0**	**No**	**BSL**
Metal	Iron	mg/kg	110	7	7	100	4210	23300	099-016	11461.43	7	—	—	—	Yes	ASL
Metal	**Lead**	**mg/kg**	**20**	**7**	**0**	**0**	—	—	—	**10**	—	**10**	**10**	**0**	**No**	**BSL**
Metal	Lithium	mg/kg	2	5	5	100	4.38	8.01	099-031	6.16	5	—	—	—	Yes	ASL
Metal	Magnesium	mg/kg	—	7	7	100	964	22200	099-004	4967.71	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	25	7	7	100	120	319	K010-2SO	230.71	7	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.1	7	0	0	—	—	—	0.1	—	0.1	0.1	7	Yes	ASL
Metal	Molybdenum	mg/kg	2	2	0	0	—	—	—	2.5	—	2.5	2.5	2	Yes	ASL
Metal	Nickel	mg/kg	11	7	6	85.71	6.95	20.1	099-004	9.94	2	2.5	2.5	0	Yes	ASL
Metal	Potassium	mg/kg	—	7	7	100	336	666	099-015	505.14	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.21	6	0	0	—	—	—	0.5	—	0.5	0.5	6	Yes	ASL
Metal	Silver	mg/kg	1	7	0	0	—	—	—	2	—	2	2	7	Yes	ASL
Metal	Sodium	mg/kg	—	7	4	57.14	200	315	099-031	189.43	—	100	150	—	Yes	NV
Metal	Strontium	mg/kg	—	5	5	100	25.1	234	099-004	93.94	—	—	—	—	Yes	NV
Metal	Thallium	mg/kg	1	7	0	0	—	—	—	8.21	—	7.5	10	7	Yes	ASL
Metal	Vanadium	mg/kg	2	7	7	100	7.02	31.9	099-016	18.37	7	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	8.5	7	7	100	41.1	124	099-004	71.41	7	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	14	1	7.14	1.87	1.87	082-014	3.43	—	0.0475	45.5	—	Yes	NV
PCB	PCB-1221	mg/kg	—	14	0	0	—	—	—	0.07	—	0.0455	0.2725	—	Yes	NV
PCB	PCB-1232	mg/kg	—	14	0	0	—	—	—	0.07	—	0.0455	0.2725	—	Yes	NV
PCB	PCB-1242	mg/kg	—	14	0	0	—	—	—	0.07	—	0.0455	0.2725	—	Yes	NV
PCB	PCB-1248	mg/kg	—	14	0	0	—	—	—	0.07	—	0.0455	0.2725	—	Yes	NV
PCB	PCB-1254	mg/kg	—	14	1	7.14	0.037	0.037	099-045	0.07	—	0.0475	0.2725	—	Yes	NV
PCB	PCB-1260	mg/kg	—	14	6	42.86	0.09	1.183	082-012	0.21	—	0.0455	0.2725	—	Yes	NV
PCB	PCB-1268	mg/kg	—	3	0	0	—	—	—	0.05	—	0.05	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.02	3	2	66.67	0.1	0.2	082-009	0.12	2	0.05	0.05	1	Yes	ASL
Rads	Alpha activity	pCi/g	—	14	12	85.71	6.61	142	082-014	36.31	—	0.765	0.93	—	Yes	NV

Table E2.15. Ecological Screening of Surface Soil Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Americium-241**	**pCi/g**	**975**	**14**	**7**	**50**	**1.5**	**9.5**	**099-031**	**4.32**	**0**	**0.025195**	**6.5**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	14	14	100	5.52	2730	082-014	247.64	—	—	—	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**1240**	**12**	**8**	**66.67**	**0.41**	**74**	**099-044**	**7.21**	**0**	**0.24**	**0.43**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**7860**	**12**	**7**	**58.33**	**0.56**	**4.6**	**099-015**	**1.29**	**0**	**0.115**	**0.6**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**1680**	**5**	**5**	**100**	**-0.0582**	**12.8**	**082-014**	**2.81**	**0**	—	—	—	**No**	**BSL**
Rads	**Neptunium-237/Protactinium-233**	**pCi/g**	**1680**	**2**	**0**	**0**	—	—	—	**0.01**	—	**0.007795**	**0.022005**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**1900**	**2**	**0**	**0**	—	—	—	**0.005**	—	**0.0035145**	**0.005975**	**0**	**No**	**BSL**
Rads	**Plutonium-239**	**pCi/g**	**2030**	**1**	**1**	**100**	**0.0275**	**0.0275**	**082-009**	**0.03**	**0**	—	—	—	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**2020**	**6**	**4**	**66.67**	**-0.01**	**0.57**	**082-014**	**0.13**	**0**	**0**	**0.0039835**	**0**	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**1060**	**14**	**8**	**57.14**	**8.132**	**500**	**099-003**	**144.14**	**0**	**4.8085**	**230**	**0**	**No**	**BSL**
Rads	**Technetium-99**	**pCi/g**	**6570**	**14**	**14**	**100**	**0**	**2650**	**082-014**	**195.62**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**1060**	**14**	**11**	**78.57**	**0.86**	**44.7**	**082-014**	**14.56**	**0**	**2.4**	**11**	**0**	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**1990**	**6**	**6**	**100**	**0.8939**	**16.4**	**082-014, 099-044**	**7.76**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**1750**	**12**	**7**	**58.33**	**0.06624**	**7.6**	**099-031**	**3.47**	**0**	**1.1**	**4.95**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**1060**	**6**	**6**	**100**	**1.738**	**51.7**	**082-014**	**22.2**	**0**	—	—	—	**No**	**BSL**
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**2,4,5-Trichlorophenol**	**mg/kg**	**4**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	**2,4,6-Trichlorophenol**	**mg/kg**	**10**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dichlorophenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**2,4-Dinitrophenol**	**mg/kg**	**20**	**1**	**0**	**0**	—	—	—	**0.24**	—	**0.24**	**0.24**	**0**	**No**	**BSL**
SVOA	2,4-Dinitrotoluene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**4-Nitrophenol**	**mg/kg**	**7**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25		Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	7	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Butyl benzyl phthalate	mg/kg	—	1	0	0	—	—	—	0.24	—	0.24	0.24	—	Yes	NV
SVOA	Carbazole	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Dibenzofuran	mg/kg	—	8	2	25	0.123	0.28	082-012	0.24	—	0.25	0.25	—	Yes	NV
SVOA	**Diethyl phthalate**	**mg/kg**	**100**	**8**	**1**	**12.5**	**0.26**	**0.26**	**082-003**	**0.25**	**0**	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	**Dimethyl phthalate**	**mg/kg**	**200**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	**Di-n-butyl phthalate**	**mg/kg**	**200**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	Di-n-octylphthalate	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	0.0025	8	0	0	—	—	—	0.25	—	0.25	0.25	8	Yes	ASL
SVOA	Hexachlorobutadiene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**Hexachlorocyclopentadiene**	**mg/kg**	**10**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	Hexachloroethane	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV

Table E2.15. Ecological Screening of Surface Soil Data – Outfall 010 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Isophorone	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**Nitrobenzene**	**mg/kg**	**40**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**mg/kg**	**20**	**8**	**0**	**0**	—	—	—	**0.25**	—	**0.25**	**0.25**	**0**	**No**	**BSL**
SVOA	Pentachlorophenol	mg/kg	0.002	8	0	0	—	—	—	0.25	—	0.25	0.25	8	Yes	ASL
SVOA	Phenol	mg/kg	0.05	8	0	0	—	—	—	0.25	—	0.25	0.25	8	Yes	ASL
SVOA	Pyridine	mg/kg	0.1	1	0	0	—	—	—	0.24	—	0.24	0.24	1	Yes	ASL
SVOA	Acenaphthene	mg/kg	20	8	2	25	0.3	0.35	082-012	0.27	0	0.24	0.25	0	Yes	BSL
SVOA	Acenaphthylene	mg/kg	—	8	0	0	—	—	—	0.25		0.24	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.1	8	4	50	0.12	0.51	082-012	0.29	4	0.24	0.25	4	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	—	8	4	50	0.21	1.3	082-012	0.51	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(a)pyrene	mg/kg	0.1	8	4	50	0.29	2.4	082-012	0.74	4	0.24	0.25	4	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	—	8	6	75	0.3	5	082-012	1.35	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(ghi)perylene	mg/kg	—	7	1	14.29	1.18	1.18	099-031	0.38	—	0.24	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	—	8	2	25	0.466	0.54	082-009	0.31	—	0.24	0.25	—	Yes	NV
SVOA	Chrysene	mg/kg	—	8	4	50	0.26	1.6	082-012	0.58	—	0.24	0.25	—	Yes	NV
SVOA	Dibenz(a,h)anthracene	mg/kg	—	8	1	12.5	0.1	0.1	082-009	0.23	—	0.25	0.25	—	Yes	NV
SVOA	Fluoranthene	mg/kg	0.1	8	6	75	0.14	2.66	099-031	0.88	6	0.25	0.25	2	Yes	ASL
SVOA	Fluorene	mg/kg	—	8	2	25	0.219	0.4	082-012	0.26	—	0.25	0.25	—	Yes	NV
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	—	8	2	25	1.05	1.3	082-012	0.48	—	0.24	0.25	—	Yes	NV
SVOA	Naphthalene	mg/kg	0.1	8	1	12.5	0.52	0.52	082-012	0.28	1	0.25	0.25	7	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.1	8	4	50	0.41	1.63	099-031	0.6	4	0.24	0.25	4	Yes	ASL
SVOA	Pyrene	mg/kg	0.1	8	6	75	0.13	2.25	099-031	0.78	6	0.25	0.25	2	Yes	ASL
SVOA	Total PAHs	mg/kg	1	—	—	—	—	21.99	—	—	—	—	—	—	Yes	ASL
VOA	1,1-Dichloroethene	mg/kg	—	2	0	0	—	—	—	0.12	—	0.099	0.132	—	Yes	NV
VOA	1,2-Dichlorobenzene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	—	8	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
VOA	cis-1,2-Dichloroethene	mg/kg	—	2	0	0	—	—	—	0.12	—	0.099	0.132	—	Yes	NV
VOA	trans-1,2-Dichloroethene	mg/kg	—	2	0	0	—	—	—	0.12	—	0.099	0.132	—	Yes	NV
VOA	Trichloroethene	mg/kg	0.001	2	0	0	—	—	—	0.12	—	0.099	0.132	2	Yes	ASL
VOA	Vinyl chloride	mg/kg	0.01	2	0	0	—	—	—	0.12	—	0.099	0.132	2	Yes	ASL

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligram/kilogram
pCi/g - picocuries/gram
pg/g - picogram/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

Table E2.16. Ecological Screening of Surface Water Data – Outfall 011

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	Std. unit	—	20	20	100	6.91	8.35	L55	7.48	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	20	19	95	0.2	3.91	L55	1.22	19	0	0.55	1.1	0.2	2.92	13	0.1	0.1	1	Yes	ASL
Metal	**Antimony**	**mg/L**	**0.16**	**8**	**2**	**25**	**0.005**	**0.005**	**L55**	**0.04**	**0**	**0**	**0.03**	**0.05**	**0.005**	**0.005**	**0**	**0.0025**	**0.1**	**0**	**No**	**BSL**
Metal	Arsenic	mg/L	0.05	8	0	0	—	—	—	0.04	—	0	0.03	0.05	—	—	—	0.005	0.1	3	Yes	ASL
Metal	Barium	mg/L	0.004	8	8	100	0.0586	0.146	L55	0.1	8	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	8	0	0	—	—	—	0.001	—	0	0	0.002	—	—	—	0.0005	0.0025	4	Yes	ASL
Metal	Cadmium	mg/L	0.00142	20	2	10	0.022	0.024	L55	0.009	2	0	0.01	0.02	0.001	0.001	0	0.0005	0.0125	12	Yes	ASL
Metal	Calcium	mg/L	—	5	5	100	11.5	36.6	L55	23.5	—	0	12.01	24.02	10.1	14.8	—	—	—	—	Yes	NV
Metal	**Chromium**	**mg/L**	**0.04885**	**20**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	**Cobalt**	**mg/L**	**0.023**	**8**	**1**	**12.5**	**0.001**	**0.001**	**L55**	**0.005**	**0**	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0005**	**0.0125**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	20	2	10	0.00652	0.0399	L55	0.01	2	0	0.02	0.04	0.0052	0.038	8	0.0025	0.025	15	Yes	ASL
Metal	Cyanide	mg/L	0.0052	10	1	10	0.02	0.02	K011	0.01	1	0	0.02	0.03	—	—	—	0.01	0.01	9	Yes	ASL
Metal	Iron	mg/L	1	20	19	95	0.262	2.37	L55	1.01	7	0	0.98	1.95	0.488	2.6	5	0.1	0.1	0	Yes	ASL
Metal	Lead	mg/L	0.00132	20	0	0	—	—	—	0.07	—	0	0.06	0.13	—	—	—	0.0025	0.1	20	Yes	ASL
Metal	Magnesium	mg/L	—	5	5	100	2.86	8.43	L55	5.7	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	Manganese	mg/L	0.12	8	8	100	0.0352	0.231	L55	0.1	2	0	0.24	0.48	0.108	0.329	12	—	—	—	Yes	ASL
Metal	Mercury	mg/L	0.000012	8	1	12.5	0.0002	0.0002	L55	0.0001	1	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	7	Yes	ASL
Metal	**Molybdenum**	**mg/L**	**0.37**	**3**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.0125**	**0.0125**	**0**	**No**	**BSL**
Metal	Nickel	mg/L	0.029	20	3	15	0.005	0.05	L55	0.02	1	0	0.02	0.04	0.005	0.05	1	0.0025	0.025	0	Yes	ASL
Metal	Phosphorous	mg/L	—	17	17	100	0.05	0.46	L55	0.17	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Potassium	mg/L	—	5	5	100	1.35	6.12	L55	2.62	—	0	2.63	5.26	1.93	4.87	—	—	—	—	Yes	NV
Metal	Selenium	mg/L	0.005	8	0	0	—	—	—	0.003	—	0	0	0.006	—	—	—	0.0025	0.005	3	Yes	ASL
Metal	Silver	mg/L	0.000012	8	1	12.5	0.001	0.001	L55	0.005	1	0	0	0.007	0.001	0.001	1	0.0005	0.0125	7	Yes	ASL
Metal	Sodium	mg/L	—	5	5	100	6.48	55.3	L55	29.04	—	0	9.64	19.28	5.74	13.2	—	—	—	—	Yes	NV
Metal	**Strontium**	**mg/L**	**1.5**	**3**	**3**	**100**	**0.298**	**0.909**	**L55**	**0.7**	**0**	**0**	**0.09**	**0.18**	**0.072**	**0.107**	**0**	—	—	—	**No**	**BSL**
Metal	Thallium	mg/L	0.004	8	2	25	0.01	0.01	L55	0.04	2	0	0.03	0.06	0.01	0.01	3	0.005	0.1	6	Yes	ASL
Metal	Uranium	mg/L	0.0026	48	25	52.08	0.003	0.37	K011	0.02	25	0	0	0.002	0.001	0.001	0	1.525E-05	0.007	6	Yes	ASL
Metal	**Vanadium**	**mg/L**	**0.02**	**8**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	Zinc	mg/L	0.067	20	6	30	0.02	0.2	L55	0.07	2	0	0.07	0.14	0.02	0.2	1	0.025	0.1	6	Yes	ASL
PCB	PCB-1016	µg/L	0.014	47	0	0	—	—	—	0.08	—	0	0.08	0.17	—	—	—	0.08	0.095	47	Yes	ASL
PCB	PCB-1221	µg/L	0.014	47	0	0	—	—	—	0.09	—	0	0.09	0.18	—	—	—	0.085	0.1	47	Yes	ASL
PCB	PCB-1232	µg/L	0.014	47	0	0	—	—	—	0.08	—	0	0.08	0.16	—	—	—	0.065	0.085	47	Yes	ASL
PCB	PCB-1242	µg/L	0.014	47	0	0	—	—	—	0.06	—	0	0.07	0.14	—	—	—	0.045	0.085	47	Yes	ASL
PCB	PCB-1248	µg/L	0.014	47	0	0	—	—	—	0.07	—	0	0.08	0.15	—	—	—	0.055	0.085	47	Yes	ASL
PCB	PCB-1254	µg/L	0.014	47	0	0	—	—	—	0.05	—	0	0.08	0.16	0.23	0.23	1	0.035	0.085	47	Yes	ASL
PCB	PCB-1260	µg/L	0.014	47	2	4.26	0.273	0.414	K011	0.05	2	0	0.06	0.13	—	—	—	0.025	0.085	45	Yes	ASL
PCB	PCB-1268	µg/L	—	47	0	0	—	—	—	0.05	—	0	0.07	0.14	—	—	—	0.04	0.085	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	µg/L	0.0014	47	2	4.26	0.273	0.414	K011	0.1	2	0	0.09	0.19	0.23	0.23	1	0.085	0.1	45	Yes	ASL
Rads	Activity of Uranium-235	pCi/L	—	3	0	0	—	—	—	0.73	—	0	0.63	1.25	—	—	—	0	1.1	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**20**	**0**	**0**	—	—	—	**-3.60012**	—	**0**	**-3.81**	**-7.62398947**	—	—	—	**-29.65**	**13.3**	**0**	**No**	**BSL**
Rads	**Cesium-134**	**pCi/L**	**11000**	**20**	**0**	**0**	—	—	—	**-1.1306**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-5.75**	**7.1**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**20**	**0**	**0**	—	—	—	**-0.881325**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-7.5**	**1.615**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**20**	**1**	**5**	**13.6**	**13.6**	**L55**	**0.32**	**0**	**0**	**-0.22**	**-0.43722632**	—	—	—	**-5.15**	**5.5**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**20**	**2**	**10**	**-0.287**	**-0.143**	**L55**	**-0.0791175**	**0**	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.3325**	**0.245**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**20**	**0**	**0**	—	—	—	**-0.01223**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.079**	**0.069**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**20**	**0**	**0**	—	—	—	**-0.00421275**	—	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.0277**	**0.02265**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**20**	**0**	**0**	—	—	—	**-11.81905**	—	**0**	**-23.74**	**-47.47473684**	—	—	—	**-117**	**56**	**0**	**No**	**BSL**
Rads	Suspended Alpha	pCi/L	—	18	2	11.11	-0.502	5.11	L55	0.75	—	0	0.66	1.32	-2.29	7.68	—	-0.58	1.95	—	Yes	NV
Rads	Suspended Beta	pCi/L	—	19	0	0	—	—	—	0.9	—	0	0.17	0.34	-9.72	5.37	—	-1.92	3.955	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**20**	**1**	**5**	**21.4**	**21.4**	**L55**	**3.23**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-4.685**	**7.35**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**20**	**0**	**0**	—	—	—	**0.005**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.01485**	**0.0258**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**20**	**1**	**5**	**0.724**	**0.724**	**L55**	**0.06**	**0**	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.114**	**0.302**	**0**	**No**	**BSL**

Table E2.16. Ecological Screening of Surface Water Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	**Thorium-232**	**pCi/L**	**478**	**20**	**0**	**0**	—	—	—	**-0.00053952**	—	**0**	**0**	**0.009**	—	—	—	**-0.096**	**0.0378**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	6	0	0	—	—	—	9.92	—	0	-0.52	-1.035	—	—	—	-29.85	157.5	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**4**	**0**	**0**	—	—	—	**16.25**	—	**0**	**10.29**	**20.58**	—	—	—	**15**	**20**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/L**	**4370**	**3**	**0**	**0**	—	—	—	**0.3**	—	**0**	**-1.62**	—	—	—	—	**-1.285**	**1.1**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4550**	**8**	**4**	**50**	**1.33**	**8.18**	**L55**	**2.2**	**0**	**0**	**0.1**	**0.2**	—	—	—	**0**	**0**	**0**	**No**	**BSL**
SVOA	1,1-biphenyl	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	2,4'-DDD	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	2,4'-DDE	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	2,4'-DDT	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	2-Methylnaphthalene	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	4,4'-DDD	µg/L	0.0064	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	4,4'-DDE	µg/L	0.01	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	4,4'-DDT	µg/L	0.001	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	**Aldrin**	**µg/L**	**0.3**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	**alpha-BHC**	**µg/L**	**500**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	alpha-Chlordane	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Azinphos-methyl	µg/L	—	3	0	0	—	—	—	1.25	—	0	1.25	2.5	—	—	—	1.25	1.25	—	Yes	NV
SVOA	Benzo(e)pyrene	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	**beta-BHC**	**µg/L**	**5000**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Chlordane	µg/L	0.0043	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	3	Yes	ASL
SVOA	Co-Ral	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	delta-BHC	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Diazinon	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Dibenzothiophene	µg/L	—	1	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	Dichlorvos	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Dieldrin	µg/L	0.0019	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	Dimethoate	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	**Endosulfan I**	**µg/L**	**0.056**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	**Endosulfan II**	**µg/L**	**0.056**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Endosulfan sulfate	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Endrin	µg/L	0.0023	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	Endrin aldehyde	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Ethion	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Famphur	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	Fensulfothion	µg/L	—	3	0	0	—	—	—	1.25	—	0	1.25	2.5	—	—	—	1.25	1.25	—	Yes	NV
SVOA	Fenthion	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	gamma-Chlordane	µg/L	—	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Heptachlor	µg/L	0.0038	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	Heptachlor epoxide	µg/L	0.0038	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	**Lindane**	**µg/L**	**0.08**	**3**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Malathion	µg/L	0.1	3	0	0	—	—	—	0.6	—	0	0.6	1.2	—	—	—	0.6	0.6	3	Yes	ASL
SVOA	Methoxychlor	µg/L	0.03	3	0	0	—	—	—	0.05	—	0	0.05	0.1	—	—	—	0.05	0.05	3	Yes	ASL
SVOA	Methyl parathion	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Mirex	µg/L	0.001	3	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	3	Yes	ASL
SVOA	Mocap	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Parathion	µg/L	0.013	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	3	Yes	ASL
SVOA	Perylene	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
SVOA	Phorate	µg/L	—	3	0	0	—	—	—	0.25	—	0	0.25	0.5	—	—	—	0.25	0.25	—	Yes	NV
SVOA	Toxaphene	µg/L	0.0002	3	0	0	—	—	—	2.5	—	0	2.5	5	—	—	—	2.5	2.5	3	Yes	ASL
SVOA	**Acenaphthene**	**µg/L**	**17**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
SVOA	**Acenaphthylene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Anthracene**	**µg/L**	**0.73**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
SVOA	**Benz(a)anthracene**	**µg/L**	**0.027**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**3**	**No**	**ASL**

Table E2.16. Ecological Screening of Surface Water Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**Benzo(a)pyrene**	**µg/L**	**0.014**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**3**	**No**	**ASL**
SVOA	**Benzo(b)fluoranthene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Benzo(ghi)perylene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Benzo(k)fluoranthene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Chrysene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Dibenz(a,h)anthracene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Fluoranthene**	**µg/L**	**39.8**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
SVOA	**Fluorene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Indeno(1,2,3-cd)pyrene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Naphthalene**	**µg/L**	**62**	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
SVOA	**Phenanthrene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Pyrene**	**µg/L**	—	**3**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	—	**No**	**NV**
SVOA	**Total PAHs**	**µg/L**	—				—	—	—	—	—	—	—	—	—	—	—	—	—	—	**No**	**ND**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**31**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	2,6-Dimethylnaphthalene	µg/L	—	3	0	0	—	—	—	0.5	—	0	0.5	1	—	—	—	0.5	0.5	—	Yes	NV
VOA	2-Propanol	µg/L	7.5	10	0	0	—	—	—	500	—	0	500	1000	—	—	—	500	500	10	Yes	ASL
VOA	**Acetone**	**µg/L**	**1500**	**10**	**0**	**0**	—	—	—	**500**	—	**0**	**500**	**1000**	—	—	—	**500**	**500**	**0**	**No**	**BSL**
VOA	Trichloroethene	µg/L	47	51	3	5.88	8	130	K011	3.86	1	0	0.5	1	—	—	—	0.5	0.5	0	Yes	ASL
Wetchem	Hardness – total as $CaCO_3$	mg/L	—	17	17	100	41	204	K011	106.12	—	0	52.25	104.5	32	179	—	—	—	—	—	—

Notes:
ASL – Above screening value
BHC – Benzene hexachloride
BSL – Below screening value
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
ND – Not detected
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chimistry
Bold – Indicates COPC has been eliminated

mg/L - milligrams/liter
pCi/L - picocuries/liter
ug/L - micrograms/liter
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.17. Ecological Screening of Surface Sediment Data – Outfall 011

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Aluminum**	**mg/kg**	**25500**	**15**	**14**	**93.33**	**4040**	**12000**	**OF11B-01-01**	**7211.33**	**0**	**3120**	**3120**	**0**	**No**	**BSL**
Metal	Antimony	mg/kg	2	14	4	28.57	10	20	S30	9.59	4	4.815	10	10	Yes	ASL
Metal	Arsenic	mg/kg	5.9	14	4	28.57	6.13	11.2	S30	4.5	4	2.41	10	1	Yes	ASL
Metal	Barium	mg/kg	—	14	14	100	39.2	103	OF11B-01-02	66.08	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	16	4	25	0.507	0.636	S30	0.32	—	0.241	0.25	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	14	2	14.29	2.71	3.64	OF11B-01-01	1.3	2	0.965	1	12	Yes	ASL
Metal	Calcium	mg/kg	—	15	15	100	727	20100	OF11B-01-01	4444.87	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	15	15	100	8.43	72.3	S30	31.3	5	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	15	15	100	2.93	15.7	OF11B-01-02	5.64	—	—	—	—	Yes	NV
Metal	Copper	mg/kg	30	14	12	85.71	4.08	202	OF11B-01-01	32.19	3	2.5	2.5	0	Yes	ASL
Metal	Iron	mg/kg	2000	14	14	100	5560	16300	OF11B-01-01	11187.86	14	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	14	2	14.29	45.8	62	OF11B-01-01	16.2	2	9.65	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	15	15	100	360	2740	OF11B-01-01	1014	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	15	15	100	59.2	851	OF11B-01-02	244.32	1	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	16	4	25	0.098	0.2	S30	0.1	1	0.0415	0.1	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	5	1	20	8.31	8.31	OF11B-01-01	3.6	—	2.41	2.47	—	Yes	NV
Metal	Nickel	mg/kg	16	15	10	66.67	4.97	17.1	OF11B-01-01	6.63	1	2.5	2.5	0	Yes	ASL
Metal	Potassium	mg/kg	—	15	15	100	172	1150	OF11B-01-01	407.07	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	12	0	0	—	—	—	7.5	—	0.5	10	12	Yes	ASL
Metal	Silver	mg/kg	0.00038	15	3	20	2.5	4	S30	1.74	3	1.205	2	12	Yes	ASL
Metal	Sodium	mg/kg	—	14	5	35.71	123	305	S30	131.26	—	48.15	125	—	Yes	NV
Metal	Thallium	mg/kg	—	14	0	0	—	—	—	9.9	—	9.65	10	—	Yes	NV
Metal	Uranium	mg/kg	—	21	15	71.43	1.14	611	OF11B-01-01	99.31	—	0.5	100	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	14	14	100	10.9	25.3	S30	19.79	14	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	14	14	100	20.1	764	OF11B-01-01	125.06	14	—	—	—	Yes	ASL
PCB	Demeton	mg/kg	—	1	0	0	—	—	—	0.006	—	0.0055	0.0055	—	Yes	NV
PCB	PCB-1016	mg/kg	—	58	0	0	—	—	—	0.05	—	0.03	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	58	0	0	—	—	—	0.06	—	0.05	0.065	—	Yes	NV
PCB	PCB-1232	mg/kg	—	58	0	0	—	—	—	0.05	—	0.045	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	58	1	1.72	0.2	0.2	S30	0.04	—	0.025	0.05	—	Yes	NV
PCB	PCB-1248	mg/kg	—	58	9	15.52	0.4	8.45	OF11A-004	0.53	—	0.04	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	58	17	29.31	0.1	4.98	OF11A-004	0.51	—	0.03	0.05	—	Yes	NV
PCB	PCB-1260	mg/kg	—	58	38	65.52	0.13	9.12	OF11B-01-01	1.31	—	0.045	0.05	—	Yes	NV
PCB	PCB-1268	mg/kg	—	58	1	1.72	1	1	OF11A-018	0.06	—	0.035	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	58	39	67.24	0.13	16.3	OF11A-004	2.29	39	0.05	0.065	19	Yes	ASL
Rads	**Actinium-228**	**pCi/g**	**5470**	**1**	**1**	**100**	**0.9794**	**0.9794**	**JP-0091**	**0.98**	**0**	—	—	—	**No**	**BSL**
Rads	Activity of Uranium-235	pCi/g	—	5	5	100	0.0322	0.116	OF11B-01-04	0.07	—	—	—	—	Yes	NV
Rads	Alpha activity	pCi/g	—	18	18	100	2.97973	105.47	K011	37.71	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**18**	**2**	**11.11**	**0.165**	**0.363**	**K011**	**0.03**	**0**	**-0.0333**	**0.028955**	**0**	**No**	**BSL**
Rads	Antimony-124	pCi/g	—	1	0	0	—	—	—	0.007	—	0.00654	0.00654	—	Yes	NV
Rads	**Antimony-125**	**pCi/g**	**12300**	**1**	**0**	**0**	—	—	—	**0.02**	—	**0.01803**	**0.01803**	**0**	**No**	**BSL**
Rads	Barium-133	pCi/g	—	1	0	0	—	—	—	0.002	—	0.0015895	0.0015895	—	Yes	NV
Rads	Barium-140	pCi/g	—	1	0	0	—	—	—	-0.00875	—	-0.00875	-0.00875	—	Yes	NV
Rads	Beta activity	pCi/g	—	18	18	100	3.14518	222	OF11B-01-03	76.35	—	—	—	—	Yes	NV
Rads	**Bismuth-211**	**pCi/g**	**12800**	**1**	**1**	**100**	**2.347**	**2.347**	**JP-0091**	**2.35**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-212**	**pCi/g**	**3310**	**1**	**1**	**100**	**0.8068**	**0.8068**	**JP-0091**	**0.81**	**0**	—	—	—	**No**	**BSL**
Rads	**Bismuth-214**	**pCi/g**	**2820**	**1**	**1**	**100**	**0.9238**	**0.9238**	**JP-0091**	**0.92**	**0**	—	—	—	**No**	**BSL**
Rads	Cerium-139	pCi/g	—	1	0	0	—	—	—	-0.009015	—	-0.009015	-0.009015	—	Yes	NV
Rads	Cerium-141	pCi/g	—	1	0	0	—	—	—	0.01	—	0.013345	0.013345	—	Yes	NV
Rads	Cerium-144	pCi/g	—	1	0	0	—	—	—	-0.0297	—	-0.0297	-0.0297	—	Yes	NV
Rads	**Cesium-134**	**pCi/g**	**3390**	**1**	**0**	**0**	—	—	—	**-0.0034735**	—	**-0.0034735**	**-0.0034735**	**0**	**No**	**BSL**
Rads	Cesium-136	pCi/g	—	1	0	0	—	—	—	0.009	—	0.009385	0.009385	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**18**	**10**	**55.56**	**0.014**	**0.586**	**OF11B-01-04**	**0.08**	**0**	**-0.01015**	**0.03045**	**0**	**No**	**BSL**
Rads	Chromium-51	pCi/g	—	1	0	0	—	—	—	-0.015385	—	-0.015385	-0.015385	—	Yes	NV

Table E2.17. Ecological Screening of Surface Sediment Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Rads	Cobalt-56	pCi/g	—	1	0	0	—	—	—	0.001	—	0.0010105	0.0010105	—	Yes	NV
Rads	Cobalt-57	pCi/g	—	1	0	0	—	—	—	0.004	—	0.0039075	0.0039075	—	Yes	NV
Rads	Cobalt-58	pCi/g	—	1	0	0	—	—	—	-0.0043145	—	-0.0043145	-0.0043145	—	Yes	NV
Rads	**Cobalt-60**	**pCi/g**	**2100**	**16**	**0**	**0**	—	—	—	**0.0009**	—	**-0.0123**	**0.0245**	**0**	**No**	**BSL**
Rads	Europium-152	pCi/g	—	1	0	0	—	—	—	-0.00417	—	-0.00417	-0.00417	—	Yes	NV
Rads	**Europium-154**	**pCi/g**	**4260**	**1**	**0**	**0**	—	—	—	**-0.00125**	—	**-0.00125**	**-0.00125**	**0**	**No**	**BSL**
Rads	**Europium-155**	**pCi/g**	**87200**	**1**	**0**	**0**	—	—	—	**0.05**	—	**0.04675**	**0.04675**	**0**	**No**	**BSL**
Rads	Iridium-192	pCi/g	—	1	0	0	—	—	—	-0.00523	—	-0.00523	-0.00523	—	Yes	NV
Rads	Iron-59	pCi/g	—	1	0	0	—	—	—	0.01	—	0.01317	0.01317	—	Yes	NV
Rads	**Lead-210**	**pCi/g**	**977000**	**1**	**0**	**0**	—	—	—	**0.5**	—	**0.5045**	**0.5045**	**0**	**No**	**BSL**
Rads	**Lead-211**	**pCi/g**	**12800**	**1**	**1**	**100**	**2.347**	**2.347**	**JP-0091**	**2.35**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-212**	**pCi/g**	**3310**	**1**	**1**	**100**	**0.7682**	**0.7682**	**JP-0091**	**0.77**	**0**	—	—	—	**No**	**BSL**
Rads	**Lead-214**	**pCi/g**	**2820**	**1**	**1**	**100**	**0.8645**	**0.8645**	**JP-0091**	**0.86**	**0**	—	—	—	**No**	**BSL**
Rads	Manganese-54	pCi/g	—	1	0	0	—	—	—	0.01	—	0.01477	0.01477	—	Yes	NV
Rads	Mercury-203	pCi/g	—	1	0	0	—	—	—	0.003	—	0.0028585	0.0028585	—	Yes	NV
Rads	Neodymium-147	pCi/g	—	1	0	0	—	—	—	0.26	—	0.2633	0.2633	—	Yes	NV
Rads	**Neptunium-237**	**pCi/g**	**22300**	**18**	**2**	**11.11**	**0.00546**	**0.0229**	**K011**	**0.006**	**0**	**-0.00725**	**0.01955**	**0**	**No**	**BSL**
Rads	Neptunium-239	pCi/g	—	1	0	0	—	—	—	-0.0103	—	-0.0103	-0.0103	—	Yes	NV
Rads	Niobium-94	pCi/g	—	1	0	0	—	—	—	0.005	—	0.00544	0.00544	—	Yes	NV
Rads	Niobium-95	pCi/g	—	1	0	0	—	—	—	0.02	—	0.01809	0.01809	—	Yes	NV
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**6**	**0**	**0**	—	—	—	**-0.00083592**	—	**-0.00545**	**0.0015**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**18**	**3**	**16.67**	**0.00817**	**0.0344**	**OF11B-01-04**	**0.004**	**0**	**-0.00159**	**0.0066**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**31600**	**11**	**11**	**100**	**1.55**	**4.35**	**S30**	**2.94**	**0**	—	—	—	**No**	**BSL**
Rads	Promethium-146	pCi/g	—	1	0	0	—	—	—	0.004	—	0.00419	0.00419	—	Yes	NV
Rads	**Protactinium-231**	**pCi/g**	**111000**	**1**	**1**	**100**	**0.4097**	**0.4097**	**JP-0091**	**0.41**	**0**	—	—	—	**No**	**BSL**
Rads	**Protactinium-233**	**pCi/g**	**22300**	**1**	**0**	**0**	—	—	—	**-0.01035**	—	**-0.01035**	**-0.01035**	**0**	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**175000**	**1**	**1**	**100**	**11.43**	**11.43**	**JP-0091**	**11.43**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-223**	**pCi/g**	**12800**	**1**	**0**	**0**	—	—	—	**0.03**	—	**0.034535**	**0.034535**	**0**	**No**	**BSL**
Rads	**Radium-226**	**pCi/g**	**2820**	**1**	**1**	**100**	**0.8181**	**0.8181**	**JP-0091**	**0.82**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-228**	**pCi/g**	**5470**	**1**	**1**	**100**	**1.127**	**1.127**	**JP-0091**	**1.13**	**0**	—	—	—	**No**	**BSL**
Rads	**Radon-219**	**pCi/g**	**12800**	**1**	**0**	**0**	—	—	—	**0.06**	—	**0.0575**	**0.0575**	**0**	**No**	**BSL**
Rads	**Ruthenium-106**	**pCi/g**	**8570**	**1**	**0**	**0**	—	—	—	**-0.00721**	—	**-0.00721**	**-0.00721**	**0**	**No**	**BSL**
Rads	Silver-110m	pCi/g	—	1	0	0	—	—	—	-0.005555	—	-0.005555	-0.005555	—	Yes	NV
Rads	Sodium-22	pCi/g	—	1	0	0	—	—	—	-0.0034875	—	-0.0034875	-0.0034875	—	Yes	NV
Rads	**Strontium-90**	**pCi/g**	**55700**	**1**	**0**	**0**	—	—	—	**-0.18**	—	**-0.18**	**-0.18**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g		18	14	77.78	0.176	10.3	OF11B-01-01	1.73	—	0	1.45	—	Yes	NV
Rads	**Thallium-208**	**pCi/g**	**1190**	**1**	**1**	**100**	**0.234**	**0.234**	**JP-0091**	**0.23**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-227**	**pCi/g**	**12600**	**1**	**0**	**0**	—	—	—	**0.06**	—	**0.0564**	**0.0564**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/g**	**3310**	**6**	**6**	**100**	**0.194**	**0.373**	**OF11B-01-04**	**0.32**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-229**	**pCi/g**	**18100**	**1**	**0**	**0**	—	—	—	**0.01**	—	**0.011265**	**0.011265**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**18**	**18**	**100**	**0.211**	**1.6**	**OF11B-01-01**	**0.38**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**6**	**6**	**100**	**0.1604**	**0.381**	**OF11B-01-04**	**0.28**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**175000**	**1**	**1**	**100**	**11.59**	**11.59**	**JP-0091**	**11.59**	**0**	—	—	—	**No**	**BSL**
Rads	Tin-113	pCi/g	—	1	0	0	—	—	—	-0.001957	—	-0.001957	-0.001957		Yes	NV
Rads	**Uranium-234**	**pCi/g**	**10000000**	**13**	**12**	**92.31**	**0.262**	**1.556**	**S30**	**0.71**	**0**	**0.1855**	**0.1855**	**0**	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**4**	**4**	**100**	**0.046**	**0.08967**	**S30**	**0.07**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**13**	**12**	**92.31**	**1.12**	**25.526**	**S30**	**7.55**	**0**	**2.765**	**2.765**	**0**	**No**	**BSL**
Rads	Yttrium-88	pCi/g	—	1	0	0	—	—	—	0.004	—	0.0042965	0.0042965	—	Yes	NV
Rads	**Zinc-65**	**pCi/g**	**9030**	**1**	**0**	**0**	—	—	—	**0.004**	—	**0.004352**	**0.004352**	**0**	**No**	**BSL**
Rads	Zirconium-95	pCi/g	—	1	0	0	—	—	—	0.02	—	0.017185	0.017185	—	Yes	NV
SVOA	1,1-biphenyl	mg/kg	—	5	0	0	—	—	—	0.02	—	0.014	0.0325	—	Yes	NV
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	1,2-Diphenylhydrazine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	5	2	40	0.47	0.48	S30	0.34	2	0.24	0.245	3	Yes	ASL

Table E2.17. Ecological Screening of Surface Sediment Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	2,4,5-Trichlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,4'-DDD	mg/kg	—	5	0	0	—	—	—	0.003	—	0.00105	0.0049	—	Yes	NV
SVOA	2,4'-DDE	mg/kg	—	5	1	20	0.015	0.015	S30	0.005	—	0.00105	0.0049	—	Yes	NV
SVOA	2,4'-DDT	mg/kg	—	5	0	0	—	—	—	0.003	—	0.00105	0.0049	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,6,10,14-Tetramethylhexadecane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	—	Yes	NV
SVOA	2,6,10,14-Tetramethylpentadecane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	—	Yes	NV
SVOA	2,6-Dichlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	7	1	14.29	0.48	0.48	S30	0.18	—	0.023	0.245	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4,4'-DDD	mg/kg	0.0033	5	2	40	0.0028	0.0035	S30	0.01	1	0.012	0.025	3	Yes	ASL
SVOA	4,4'-DDE	mg/kg	0.00142	5	3	60	0.0014	0.0062	S30	0.01	2	0.0225	0.025	2	Yes	ASL
SVOA	4,4'-DDT	mg/kg	0.0036	5	1	20	0.022	0.022	S30	0.01	1	0.0055	0.0225	4	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	3	1	33.33	0.48	0.48	S30	0.32	—	0.24	0.245	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Aldrin	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	alpha-BHC	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	alpha-Chlordane	mg/kg	—	5	2	40	0.0049	0.0049	S30	0.01	—	0.012	0.025	—	Yes	NV
SVOA	Aniline	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Azinphos-methyl	mg/kg	—	5	0	0	—	—	—	0.06	—	0.055	0.06	—	Yes	NV
SVOA	Benzenemethanol	mg/kg	—	5	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	Benzidine	mg/kg	—	5	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	Benzo(e)pyrene	mg/kg	—	5	5	100	0.021	0.14	S30	0.08	—	—	—	—	Yes	NV
SVOA	Benzoic acid	mg/kg	—	5	1	20	0.47	0.47	S30	0.29	—	0.24	0.245	—	Yes	NV
SVOA	beta-BHC	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	5	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	4	1	25	0.48	0.48	S30	0.3	1	0.235	0.245	3	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	5	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	Carbazole	mg/kg	—	5	3	60	0.47	0.49	S30	0.38	—	0.24	0.245	—	Yes	NV
SVOA	Chlordane	mg/kg	0.00028	5	0	0	—	—	—	0.12	—	0.055	0.19	5	Yes	ASL
SVOA	Co-Ral	mg/kg	—	5	0	0	—	—	—	0.01	—	0.011	0.0125	—	Yes	NV
SVOA	delta-BHC	mg/kg	—	5	2	40	0.0015	0.0075	S30	0.009	—	0.0055	0.0225	—	Yes	NV
SVOA	**Diazinon**	**mg/kg**	**0.019**	**5**	**0**	**0**	**—**	**—**	**—**	**0.006**	**—**	**0.0055**	**0.006**	**0**	**No**	**BSL**
SVOA	Dibenzofuran	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Dichlorvos	mg/kg	—	5	0	0	—	—	—	0.01	—	0.011	0.0125	—	Yes	NV

Table E2.17. Ecological Screening of Surface Sediment Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Dieldrin	mg/kg	0.0019	5	1	20	0.025	0.025	S30	0.01	1	0.0055	0.0225	4	Yes	ASL
SVOA	Diethyl phthalate	mg/kg	0.061	5	2	40	0.47	0.48	S30	0.34	2	0.24	0.245	3	Yes	ASL
SVOA	Dimethoate	mg/kg	—	5	0	0	—	—	—	0.01	—	0.011	0.0125	—	Yes	NV
SVOA	Dimethyl phthalate	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	5	4	80	0.49	1.3	S30	0.74	—	0.24	0.24	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Docosane	mg/kg	—	5	3	60	0.01	0.022	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Dodecane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	—	Yes	NV
SVOA	Dotriacontane	mg/kg	—	5	3	60	0.042	0.13	S30	0.12	—	0.16	0.16	—	Yes	NV
SVOA	Eicosane	mg/kg	—	5	3	60	0.004	0.01	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	**Endosulfan I**	**mg/kg**	**0.0055**	**5**	**1**	**20**	**0.0017**	**0.0017**	**S30**	**0.01**	**0**	**0.006**	**0.025**	**4**	**No**	**BSL**
SVOA	**Endosulfan II**	**mg/kg**	**0.0055**	**5**	**2**	**40**	**0.0019**	**0.0031**	**S30**	**0.01**	**0**	**0.012**	**0.025**	**3**	**No**	**BSL**
SVOA	Endosulfan sulfate	mg/kg	—	5	2	40	0.0065	0.01	S30	0.02	—	0.012	0.025	—	Yes	NV
SVOA	Endrin	mg/kg	0.00222	5	0	0	—	—	—	0.01	—	0.0055	0.025	5	Yes	ASL
SVOA	Endrin aldehyde	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	Ethion	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV
SVOA	Famphur	mg/kg	—	5	0	0	—	—	—	0.02	—	0.0215	0.0245	—	Yes	NV
SVOA	Fensulfothion	mg/kg	—	5	0	0	—	—	—	0.02	—	0.0195	0.022	—	Yes	NV
SVOA	Fenthion	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV
SVOA	gamma-Chlordane	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	Henicosane	mg/kg	—	5	3	60	0.007	0.019	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Heptachlor	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	Heptachlor epoxide	mg/kg	0.0006	5	0	0	—	—	—	0.06	—	0.0215	0.1	5	Yes	ASL
SVOA	heptacosane	mg/kg	—	5	5	100	0.087	1.1	S30	0.49	—	—	—	—	Yes	NV
SVOA	Heptadecane	mg/kg	—	5	3	60	0.009	0.02	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	5	3	60	0.47	0.49	S30	0.38	—	0.24	0.245	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Hexacosane	mg/kg	—	5	4	80	0.038	0.11	S30	0.08	—	0.16	0.16	—	Yes	NV
SVOA	Hexadecane	mg/kg	—	5	3	60	0.006	0.017	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Isophorone	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Lindane	mg/kg	0.00094	5	0	0	—	—	—	0.01	—	0.0055	0.025	5	Yes	ASL
SVOA	m,p-Cresol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	Malathion	mg/kg	0.0067	5	0	0	—	—	—	0.01	—	0.013	0.015	5	Yes	ASL
SVOA	Methoxychlor	mg/kg	—	5	0	0	—	—	—	0.03	—	0.0105	0.049	—	Yes	NV
SVOA	Methyl parathion	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV
SVOA	Mirex	mg/kg	—	5	0	0	—	—	—	0.01	—	0.0055	0.025	—	Yes	NV
SVOA	Mocap	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV
SVOA	n-Hentriacontane	mg/kg	—	5	5	100	0.42	3.9	S30	2.27	—	—	—	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitrosodimethylamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	n-Octacosane	mg/kg	—	5	5	100	0.037	0.18	S30	0.1	—	—	—	—	Yes	NV
SVOA	Nonacosane	mg/kg	—	5	5	100	0.38	3.6	S30	2.1	—	—	—	—	Yes	NV
SVOA	Nonadecane	mg/kg	—	5	3	60	0.006	0.025	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	n-Pentacosane	mg/kg	—	5	4	80	0.088	0.26	S30	0.15	—	0.16	0.16	—	Yes	NV
SVOA	n-Tetracosane	mg/kg	—	5	3	60	0.026	0.05	S30	0.09	—	0.16	0.16	—	Yes	NV
SVOA	n-Triacontane	mg/kg	—	5	4	80	0.052	0.26	S30	0.14	—	0.16	0.16	—	Yes	NV
SVOA	n-Tricosane	mg/kg	—	5	4	80	0.034	0.08	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	n-Tritriacontane	mg/kg	—	5	5	100	0.085	0.67	S30	0.36	—	—	—	—	Yes	NV
SVOA	Octadecane	mg/kg	—	5	3	60	0.007	0.014	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Parathion	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV

Table E2.17. Ecological Screening of Surface Sediment Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Pentachlorophenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Pentadecane	mg/kg	—	5	3	60	0.005	0.014	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Perylene	mg/kg	—	5	5	100	0.009	0.038	S30	0.02	—	—	—	—	Yes	NV
SVOA	Phenol	mg/kg	—	5	2	40	0.47	0.48	S30	0.34	—	0.24	0.245	—	Yes	NV
SVOA	Phorate	mg/kg	—	5	0	0	—	—	—	0.006	—	0.0055	0.006	—	Yes	NV
SVOA	Pyridine	mg/kg	—	5	3	60	0.47	0.49	S30	0.38	—	0.24	0.245	—	Yes	NV
SVOA	Tetradecane	mg/kg	—	5	3	60	0.006	0.011	S30	0.07	—	0.16	0.16	—	Yes	NV
SVOA	Tetratriacontane	mg/kg	—	5	1	20	0.009	0.009	S30	0.18	—	0.16	0.375	—	Yes	NV
SVOA	Toxaphene	mg/kg	0.0022	5	0	0	—	—	—	1.42	—	0.55	2.5	5	Yes	ASL
SVOA	Tridecane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	—	Yes	NV
SVOA	Undecane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	—	Yes	NV
SVOA	Acenaphthene	mg/kg	0.089	12	5	41.67	0.013	5.3	OF11B-01-01	0.87	4	0.023	0.245	5	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	12	3	25	0.46	0.56	OF11B-01-03	0.25	—	0.023	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	12	4	33.33	0.013	11	OF11B-01-01	1.58	3	0.023	0.28	8	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	12	7	58.33	0.08	39	OF11B-01-01	5.67	7	0.235	0.245	5	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	12	6	50	0.044	40	OF11B-01-01	5.86	6	0.235	0.245	6	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	12	6	50	0.13	67	OF11B-01-01	10.53	6	0.235	0.245	6	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg	—	12	4	33.33	0.028	18	OF11B-01-01	2.34	—	0.023	0.245	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	12	8	66.67	0.044	25	OF11B-01-01	3.75	8	0.235	0.245	4	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	12	8	66.67	0.053	41	OF11B-01-01	5.93	8	0.235	0.245	4	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	12	5	41.67	0.48	5.3	OF11B-01-01	0.86	5	0.023	0.245	7	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	12	8	66.67	0.16	52	OF11B-01-01	8.48	8	0.235	0.245	4	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	12	5	41.67	0.011	4.4	OF11B-01-01	0.77	5	0.023	0.245	7	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	12	8	66.67	0.038	20	OF11B-01-01	2.72	8	0.235	0.245	4	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	12	4	33.33	0.48	2.8	OF11B-01-01	0.5	4	0.023	0.245	8	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	12	8	66.67	0.1	53	OF11B-01-01	7.38	8	0.235	0.245	4	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	12	8	66.67	0.1	130	OF11B-01-01	16.5	8	0.235	0.245	4	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	514.36	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**5**	**3**	**60**	**0.005**	**0.005**	**OF11B-01-01, OF11B-01-02, OF11B-01-04**	**0.004**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
VOA	1,2-Dichlorobenzene	mg/kg	0.033	5	2	40	0.47	0.48	S30	0.34	2	0.24	0.245	3	Yes	ASL
VOA	1,4-Dichlorobenzene	mg/kg	0.035	5	2	40	0.47	0.48	S30	0.34	2	0.24	0.245	3	Yes	ASL
VOA	2,6-Dimethylnaphthalene	mg/kg	—	5	0	0	—	—	—	0.02	—	0.014	0.0325	**—**	Yes	NV
VOA	Decane	mg/kg	—	5	0	0	—	—	—	0.21	—	0.14	0.375	**—**	Yes	NV
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**5**	**3**	**60**	**0.005**	**0.005**	**OF11B-01-01, OF11B-01-02, OF11B-01-04**	**0.004**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Wetchem	Total organic carbon	mg/kg	—	8	8	100	730	10970	S30	5240	—	—	—	—	—	—

Notes:

ASL – Above screening value
BHC – Benzene hexachloride
L – Below screening value
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001
The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.18. Ecological Screening of Surface Soil Data – Outfall 011

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	Aluminum	mg/kg	5	2	2	100	7420	7800	BSN011-27	7610	2	—	—	—	Yes	ASL
Metal	Antimony	mg/kg	1.9	2	1	50	20	20	BSN011-27	15	1	10	10	1	Yes	ASL
Metal	Arsenic	mg/kg	1	2	1	50	21.1	21.1	BSN011-29	11.8	1	2.5	2.5	1	Yes	ASL
Metal	Barium	mg/kg	20	2	2	100	69.7	85.6	BSN011-29	77.65	2	—	—	—	Yes	ASL
Metal	Beryllium	mg/kg	0.19	2	1	50	1.54	1.54	BSN011-29	0.9	1	0.25	0.25	1	Yes	ASL
Metal	Cadmium	mg/kg	0.11	2	0	0	—	—	—	1	—	1	1	2	Yes	ASL
Metal	Calcium	mg/kg	—	2	2	100	2680	6010	BSN011-29	4345	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	0.4	2	2	100	9.3	149	BSN011-29	79.15	2	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	2.5	2	2	100	3.51	11.2	BSN011-29	7.36	2	—	—	—	Yes	ASL
Metal	Copper	mg/kg	0.45	2	2	100	8.37	33.8	BSN011-29	21.08	2	—	—	—	Yes	ASL
Metal	Iron	mg/kg	110	2	2	100	9210	32600	BSN011-29	20905	2	—	—	—	Yes	ASL
Metal	Lead	mg/kg	20	2	1	50	34.5	34.5	BSN011-29	22.25	1	10	10	0	Yes	ASL
Metal	Lithium	mg/kg	2	2	2	100	5.14	5.84	BSN011-27	5.49	2	—	—	—	Yes	ASL
Metal	Magnesium	mg/kg	—	2	2	100	890	1250	BSN011-29	1070	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	25	2	2	100	226	550	BSN011-29	388	2	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.1	2	0	0	—	—	—	0.1	—	0.1	0.1	2	Yes	ASL
Metal	Nickel	mg/kg	11	2	2	100	7.5	13.4	BSN011-29	10.45	1	—	—	—	Yes	ASL
Metal	Selenium	mg/kg	0.21	2	0	0	—	—	—	0.5	—	0.5	0.5	2	Yes	ASL
Metal	Silver	mg/kg	1	2	1	50	2.5	2.5	BSN011-29	1.88	1	1.25	1.25	1	Yes	ASL
Metal	Thallium	mg/kg	1	2	0	0	—	—	—	10	—	10	10	2	Yes	ASL
Metal	Tin	mg/kg	5.6	2	1	50	144	144	BSN011-27	97	1	50	50	1	Yes	ASL
Metal	Uranium	mg/kg	5	2	1	50	100	100	BSN011-27	75	1	50	50	1	Yes	ASL
Metal	Vanadium	mg/kg	2	2	2	100	17.2	67	BSN011-29	42.1	2	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	8.5	2	2	100	25.7	161	BSN011-29	93.35	2	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	2	0	0	—	—	—	0.03	—	0.03	0.03	—	Yes	NV
PCB	PCB-1221	mg/kg	—	2	0	0	—	—	—	0.05	—	0.05	0.05	—	Yes	NV
PCB	PCB-1232	mg/kg	—	2	0	0	—	—	—	0.04	—	0.045	0.045	—	Yes	NV
PCB	PCB-1242	mg/kg	—	2	0	0	—	—	—	0.04	—	0.035	0.035	—	Yes	NV
PCB	PCB-1248	mg/kg	—	2	0	0	—	—	—	0.04	—	0.04	0.04	—	Yes	NV
PCB	PCB-1254	mg/kg	—	2	0	0	—	—	—	0.03	—	0.03	0.03	—	Yes	NV
PCB	PCB-1260	mg/kg	—	2	1	50	0.7	0.7	BSN011-29	0.37	—	0.045	0.045	—	Yes	NV
PCB	PCB-1268	mg/kg	—	2	0	0	—	—	—	0.05	—	0.05	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.02	2	1	50	0.7	0.7	BSN011-29	0.38	1	0.05	0.05	1	Yes	ASL
Rads	**Activity of Uranium-235**	**pCi/g**	**1750**	**2**	**2**	**100**	**0.0525**	**0.281**	**BSN011-29**	**0.17**	**0**	—	—	—	**No**	**BSL**
Rads	**Americium-241**	**pCi/g**	**975**	**2**	**0**	**0**	—	—	—	**0.006**	—	**0.00161**	**0.0113**	**0**	**No**	**BSL**
Rads	**Cesium-134**	**pCi/g**	**825**	**2**	**0**	**0**	—	—	—	**0.002**	—	**0.00053**	**0.00325**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/g**	**1240**	**2**	**2**	**100**	**0.0455**	**0.0829**	**BSN011-27**	**0.06**	**0**	—	—	—	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**7860**	**2**	**0**	**0**	—	—	—	**-0.004785**	—	**-0.00875**	**-0.00082**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**1680**	**2**	**0**	**0**	—	—	—	**0.003**	—	**0.00305**	**0.003775**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**1900**	**2**	**0**	**0**	—	—	—	**0.002**	—	**-0.0132**	**0.01635**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**2020**	**2**	**0**	**0**	—	—	—	**-0.000665**	—	**-0.00319**	**0.00186**	**0**	**No**	**BSL**
Rads	**Technetium-99**	**pCi/g**	**6570**	**2**	**1**	**50**	**5.08**	**5.08**	**BSN011-29**	**3.16**	**0**	**1.23**	**1.23**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/g**	**154**	**2**	**2**	**100**	**0.43**	**0.637**	**BSN011-29**	**0.53**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**3990**	**2**	**2**	**100**	**0.42**	**0.73**	**BSN011-29**	**0.57**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**1900**	**2**	**2**	**100**	**0.45**	**0.693**	**BSN011-29**	**0.57**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**1990**	**2**	**1**	**50**	**3.14**	**3.14**	**BSN011-29**	**1.75**	**0**	**0.3645**	**0.3645**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**1060**	**2**	**2**	**100**	**1.99**	**18.9**	**BSN011-29**	**10.44**	**0**	—	—	—	**No**	**BSL**
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**2,4,5-Trichlorophenol**	**mg/kg**	**4**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	**2,4,6-Trichlorophenol**	**mg/kg**	**10**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dichlorophenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV

Table E2.18. Ecological Screening of Surface Soil Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	2,4-Dimethylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**2,4-Dinitrophenol**	**mg/kg**	**20**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	2,4-Dinitrotoluene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	2	1	50	0.65	0.65	BSN011-29	0.44	—	0.23	0.23	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**4-Nitrophenol**	**mg/kg**	**7**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Butyl benzyl phthalate	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Carbazole	mg/kg	—	2	1	50	7.3	7.3	BSN011-29	3.76	—	0.23	0.23	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**Hexachlorocyclopentadiene**	**mg/kg**	**10**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	Hexachloroethane	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Isophorone	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**Nitrobenzene**	**mg/kg**	**40**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**mg/kg**	**20**	**2**	**0**	**0**	—	—	—	**0.24**	—	**0.23**	**0.25**	**0**	**No**	**BSL**
SVOA	Pentachlorophenol	mg/kg	0.002	2	0	0	—	—	—	0.24	—	0.23	0.25	2	Yes	ASL
SVOA	Phenol	mg/kg	0.05	2	0	0	—	—	—	0.24	—	0.23	0.25	2	Yes	ASL
SVOA	Pyridine	mg/kg	0.1	2	0	0	—	—	—	0.24	—	0.23	0.25	2	Yes	ASL
SVOA	Acenaphthene	mg/kg	20	2	1	50	2.6	2.6	BSN011-29	1.42	0	0.23	0.23	0	Yes	BSL
SVOA	Acenaphthylene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.1	2	1	50	5.5	5.5	BSN011-29	2.86	1	0.23	0.23	1	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	—	2	1	50	13	13	BSN011-29	6.62	—	0.23	0.23	—	Yes	NV
SVOA	Benzo(a)pyrene	mg/kg	0.1	2	1	50	12	12	BSN011-29	6.12	1	0.23	0.23	1	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	—	2	1	50	17	17	BSN011-29	8.62	—	0.23	0.23	—	Yes	NV
SVOA	Benzo(ghi)perylene	mg/kg	—	2	1	50	3.2	3.2	BSN011-29	1.72	—	0.23	0.23	—	Yes	NV
SVOA	Chrysene	mg/kg	—	2	1	50	12	12	BSN011-29	6.12	—	0.23	0.23	—	Yes	NV
SVOA	Dibenz(a,h)anthracene	mg/kg	—	2	1	50	1.1	1.1	BSN011-29	0.66	—	0.23	0.23	—	Yes	NV
SVOA	Fluorene	mg/kg	—	2	1	50	3.3	3.3	BSN011-29	1.76	—	0.23	0.23	—	Yes	NV
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	—	2	1	50	4.3	4.3	BSN011-29	2.26	—	0.23	0.23	—	Yes	NV
SVOA	Naphthalene	mg/kg	0.1	2	1	50	0.63	0.63	BSN011-29	0.43	1	0.23	0.23	1	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.1	2	1	50	20	20	BSN011-29	10.12	1	0.23	0.23	1	Yes	ASL
SVOA	Pyrene	mg/kg	0.1	2	1	50	19	19	BSN011-29	9.62	1	0.23	0.23	1	Yes	ASL
SVOA	Total PAHs	mg/kg	1	—	—	—	—	113.88	—	—	—	—	—	—	Yes	ASL

Table E2.18. Ecological Screening of Surface Soil Data – Outfall 011 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	1,2-Dichlorobenzene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	—	2	0	0	—	—	—	0.24	—	0.23	0.25	—	Yes	NV

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
mg/kg - milligrams/kilogram
pCi/gram - picocuries/gram
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001

Table E2.19. Ecological Screening of Surface Water Data – Outfall 012

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	Std. unit	—	6	6	100	6.91	7.79	K012	7.36	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	6	4	66.67	0.2	0.727	K012	0.27	4	0	0.55	1.1	0.2	2.92	13	0.1	0.1	2	Yes	ASL
Metal	Cadmium	mg/L	0.00142	6	0	0	—	—	—	0.009	—	0	0.01	0.02	0.001	0.001	0	0.0005	0.0125	5	Yes	ASL
Metal	**Chromium**	**mg/L**	**0.04885**	**6**	**1**	**16.67**	**0.025**	**0.025**	**K012**	**0.01**	**0**	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.0125**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	6	1	16.67	0.025	0.025	K012	0.02	1	0	0.02	0.04	0.0052	0.038	8	0.01	0.025	5	Yes	ASL
Metal	Cyanide	mg/L	0.0052	4	0	0	—	—	—	0.01	—	0	0.02	0.03	—	—	—	0.01	0.01	4	Yes	ASL
Metal	Iron	mg/L	1	6	6	100	0.295	1.36	K012	0.8	3	0	0.98	1.95	0.488	2.6	5	—	—	—	Yes	ASL
Metal	Lead	mg/L	0.00132	6	0	0	—	—	—	0.08	—	0	0.06	0.13	—	—	—	0.0025	0.1	6	Yes	ASL
Metal	**Nickel**	**mg/L**	**0.029**	**6**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.04**	**0.005**	**0.05**	**1**	**0.005**	**0.025**	**0**	**No**	**BSL**
Metal	Phosphorous	mg/L	—	5	5	100	0.08	0.18	K012	0.13	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Uranium	mg/L	0.0026	10	3	30	0.00287	0.006	K012	0.005	3	0	0	0.002	0.001	0.001	0	0.0004025	0.025	1	Yes	ASL
Metal	Zinc	mg/L	0.067	6	0	0	—	—	—	0.05	—	0	0.07	0.14	0.02	0.2	1	0.025	0.1	1	Yes	ASL
PCB	**PCB-1016**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.17**	—	—	—	**0.08**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1221**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.09**	—	**0**	**0.09**	**0.18**	—	—	—	**0.085**	**0.09**	**12**	**No**	**ASL**
PCB	**PCB-1232**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.08**	—	**0**	**0.08**	**0.16**	—	—	—	**0.065**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1242**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.07**	**0.14**	—	—	—	**0.045**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1248**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.07**	—	**0**	**0.08**	**0.15**	—	—	—	**0.055**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1254**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.08**	**0.16**	**0.23**	**0.23**	**1**	**0.035**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1260**	**µg/L**	**0.014**	**12**	**0**	**0**	—	—	—	**0.05**	—	**0**	**0.06**	**0.13**	—	—	—	**0.025**	**0.085**	**12**	**No**	**ASL**
PCB	**PCB-1268**	**µg/L**	—	**12**	**0**	**0**	—	—	—	**0.06**	—	**0**	**0.07**	**0.14**	—	—	—	**0.04**	**0.085**	—	**No**	**NV**
PCB	**Polychlorinated biphenyl (Total PCBs)**	**µg/L**	**0.0014**	**12**	**0**	**0**	—	—	—	**0.09**	—	**0**	**0.09**	**0.19**	**0.23**	**0.23**	**1**	**0.085**	**0.09**	**12**	**No**	**ND**
Rads	Activity of Uranium-235	pCi/L	—	1	1	100	26.8	26.8	K012	26.8	—	0	0.63	1.25	—	—	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/L**	**1170**	**6**	**0**	**0**	—	—	—	**-6.215**	—	**0**	**-3.81**	**-7.62398947**	—	—	—	**-24.45**	**5.15**	**0**	**No**	**BSL**
Rads	**Cesium-134**	**pCi/L**	**11000**	**6**	**0**	**0**	—	—	—	**0.46**	—	**0**	**-2.56**	**-5.12518421**	—	—	—	**-3.575**	**2.985**	**0**	**No**	**BSL**
Rads	**Cesium-137**	**pCi/L**	**7720**	**6**	**0**	**0**	—	—	—	**0.07**	—	**0**	**-0.38**	**-0.75447368**	—	—	—	**-3.215**	**2.09**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/L**	**107000**	**6**	**0**	**0**	—	—	—	**0.64**	—	**0**	**-0.22**	**-0.43722632**	—	—	—	**-3.375**	**4.145**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/L**	**1340**	**6**	**0**	**0**	—	—	—	**-0.02380833**	—	**0**	**0.06**	**0.11**	**-0.358**	**0.584**	**0**	**-0.185**	**0.1905**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/L**	**1170**	**6**	**0**	**0**	—	—	—	**-0.004275**	—	**0**	**0**	**-0.00833632**	—	—	—	**-0.0434**	**0.03455**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/L**	**1240**	**6**	**0**	**0**	—	—	—	**-0.00758333**	—	**0**	**0.01**	**0.02**	**-0.0414**	**0.118**	**0**	**-0.02925**	**0.0123**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/L**	**761**	**6**	**1**	**16.67**	**293**	**293**	**K012**	**18.76**	**0**	**0**	**-23.74**	**-47.4747368**	—	—	—	**-93.5**	**5.3**	**0**	**No**	**BSL**
Rads	Suspended alpha	pCi/L	—	5	0	0	—	—	—	0.56	—	0	0.66	1.32	-2.29	7.68	—	-0.061	1.49	—	Yes	NV
Rads	Suspended beta	pCi/L	—	5	0	0	—	—	—	0.1	—	0	0.17	0.34	-9.72	5.37	—	-0.745	1.135	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**6**	**0**	**0**	—	—	—	**2.46**	—	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**-2.615**	**9.05**	**0**	**No**	**BSL**
Rads	**Thorium-228**	**pCi/L**	**60.1**	**6**	**0**	**0**	—	—	—	**0.002**	—	**0**	**0**	**-0.00135779**	—	—	—	**-0.02225**	**0.0099**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/L**	**413**	**6**	**0**	**0**	—	—	—	**-0.01054167**	—	**0**	**0.08**	**0.17**	**-0.0355**	**1**	**0**	**-0.0304**	**0.0202**	**0**	**No**	**BSL**
Rads	**Thorium-232**	**pCi/L**	**478**	**6**	**0**	**0**	—	—	—	**0.003**	—	**0**	**0**	**0.009**	—	—	—	**-0.01735**	**0.0186**	**0**	**No**	**BSL**
Rads	Thorium-234	pCi/L	—	1	0	0	—	—	—	94.5	—	0	-0.52	-1.035	—	—	—	94.5	94.5	—	Yes	NV
Rads	**Uranium-234**	**pCi/L**	**4040**	**1**	**0**	**0**	—	—	—	**210.5**	—	**0**	**10.29**	**20.58**	—	—	—	**210.5**	**210.5**	**0**	**No**	**BSL**
Rads	**Uranium-238**	**pCi/L**	**4550**	**2**	**0**	**0**	—	—	—	**155**	—	**0**	**0.1**	**0.2**	—	—	—	**0**	**310**	**0**	**No**	**BSL**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**6**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	2-Propanol	µg/L	7.5	5	0	0	—	—	—	500	—	0	500	1000	—	—	—	500	500	5	Yes	ASL
VOA	**Acetone**	**µg/L**	**1500**	**5**	**0**	**0**	—	—	—	**500**	—	**0**	**500**	**1000**	—	—	—	**500**	**500**	**0**	**No**	**BSL**
VOA	**Trichloroethene**	**µg/L**	**47**	**12**	**0**	**0**	—	—	—	**0.5**	—	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
Wetchem	Hardness – total as $CaCO_3$	mg/L	—	6	6	100	125	152	K012	142.83	—	0	52.25	104.5	32	179	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PCB – Polychlorinated biphenyl

Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry

mg/L - milligrams/liter
pCi/L - picocuries/liter
ug/L - micrograms/liter
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.20. Ecological Screening of Surface Sediment Data – Outfall 012

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Metal	**Aluminum**	**mg/kg**	**25500**	**9**	**9**	**100**	**4670**	**9350**	**OF12B-01-01**	**7191.11**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	8	6	75	9.34	20	K012	11.02	6	10	10	2	Yes	ASL
Metal	Arsenic	mg/kg	5.9	8	2	25	5	12.8	OF12B-01-03	4.99	1	2.335	10	1	Yes	ASL
Metal	Barium	mg/kg	—	8	8	100	50.2	126	OF12B-01-02	78.29	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	9	3	33.33	0.647	0.779	OF12B-01-03	0.41	—	0.2335	0.25	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	8	1	12.5	2.54	2.54	OF12B-01-03	1.17	1	0.935	1	7	Yes	ASL
Metal	Calcium	mg/kg	—	9	9	100	1520	19400	OF12B-01-04	4690	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	8	8	100	17.4	77.1	K012	32.98	1	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	9	9	100	3.63	6.93	OF12B-01-03	4.76	—	—	—	—	Yes	NV
Metal	Copper	mg/kg	30	8	8	100	8.5	67.6	K012	19.47	1	—	—	—	Yes	ASL
Metal	Iron	mg/kg	2000	8	8	100	8050	21800	OF12B-01-03	10953.75	8	—	—	—	Yes	ASL
Metal	**Lead**	**mg/kg**	**12**	**8**	**0**	**0**	—	—	—	**9.76**	—	**9.35**	**10**	**0**	**No**	**BSL**
Metal	Magnesium	mg/kg	—	9	9	100	760	1970	OF12B-01-04	1110.33	—	—	—	—	Yes	NV
Metal	**Manganese**	**mg/kg**	**614**	**9**	**9**	**100**	**59.4**	**453**	**OF12B-01-03**	**271.43**	**0**	—	—	—	**No**	**BSL**
Metal	**Mercury**	**mg/kg**	**0.16**	**9**	**0**	**0**	—	—	—	**0.07**	—	**0.03**	**0.1**	**0**	**No**	**BSL**
Metal	Molybdenum	mg/kg	—	5	1	20	7.75	7.75	OF12B-01-04	3.46	—	2.335	2.405	—	Yes	NV
Metal	**Nickel**	**mg/kg**	**16**	**9**	**8**	**88.89**	**5.02**	**11.3**	**K012**	**6.33**	**0**	**2.405**	**2.405**	**0**	**No**	**BSL**
Metal	Potassium	mg/kg	—	9	9	100	235	950	OF12B-01-02	475.22	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	8	0	0	—	—	—	7.39	—	0.5	10	8	Yes	ASL
Metal	Silver	mg/kg	0.00038	9	0	0	—	—	—	1.31	—	1.17	2	9	Yes	ASL
Metal	Sodium	mg/kg	—	8	2	25	327	414	K012	138.32	—	46.7	125	—	Yes	NV
Metal	Thallium	mg/kg	—	8	0	0	—	—	—	9.76	—	9.35	10	—	Yes	NV
Metal	Uranium	mg/kg	—	13	12	92.31	0.9	10.6	OF12B-01-01	8.75	—	50	50	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	8	8	100	12.8	35.6	OF12B-01-03	19.01	8	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	8	8	100	75.6	410	OF12B-01-04	159.02	8	—	—	—	Yes	ASL
PCB	PCB-1016	mg/kg	—	55	0	0	—	—	—	0.05	—	0.03	0.05	—	Yes	NV
PCB	PCB-1221	mg/kg	—	55	0	0	—	—	—	0.06	—	0.05	0.065	—	Yes	NV
PCB	PCB-1232	mg/kg	—	55	0	0	—	—	—	0.05	—	0.045	0.05	—	Yes	NV
PCB	PCB-1242	mg/kg	—	55	0	0	—	—	—	0.03	—	0.025	0.05	—	Yes	NV
PCB	PCB-1248	mg/kg	—	55	4	7.27	1.31	2.71	OF12A-032	0.18	—	0.04	0.05	—	Yes	NV
PCB	PCB-1254	mg/kg	—	55	12	21.82	0.13	10	OF12A-030	0.41	—	0.03	0.05	—	Yes	NV
PCB	PCB-1260	mg/kg	—	55	17	30.91	0.1	1.81	OF12A-037	0.17	—	0.045	0.05	—	Yes	NV
PCB	PCB-1268	mg/kg	—	55	0	0	—	—	—	0.04	—	0.035	0.05	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	mg/kg	0.032	55	22	40	0.13	11.1	OF12A-030	0.69	22	0.05	0.065	33	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	5	5	100	0.0402	0.0719	OF12B-01-01	0.05	—	—	—	—	Yes	NV
Rads	Alpha activity	pCi/g	—	9	9	100	2.27	7.32	K012	3.86	—	—	—	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**9**	**0**	**0**	—	—	—	**0.001**	—	**-0.01465**	**0.0345**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	9	9	100	2.65	9.64	OF12B-01-01	5.68	—	—	—	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**9**	**9**	**100**	**0.0413**	**0.695**	**OF12B-01-01**	**0.22**	**0**	—	—	—	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**9**	**0**	**0**	—	—	—	**0.0009**	—	**-0.01175**	**0.012**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**9**	**3**	**33.33**	**0.0767**	**0.235**	**OF12B-01-01**	**0.07**	**0**	**0.001625**	**0.068**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**5**	**0**	**0**	—	—	—	**-0.0019644**	—	**-0.003205**	**-0.000417**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**9**	**3**	**33.33**	**0.0598**	**0.131**	**K012**	**0.03**	**0**	**-0.003235**	**0.00655**	**0**	**No**	**BSL**
Rads	**Potassium-40**	**pCi/g**	**31600**	**4**	**4**	**100**	**3.55**	**5.85**	**K012**	**4.63**	**0**	—	—	—	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	9	5	55.56	0.446	6.81	OF12B-01-01	2.26	—	0.03915	1.425	—	Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**5**	**5**	**100**	**0.213**	**0.413**	**OF12B-01-02**	**0.34**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**9**	**9**	**100**	**0.235**	**0.393**	**OF12B-01-01**	**0.31**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**5**	**5**	**100**	**0.202**	**0.374**	**OF12B-01-02**	**0.31**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**7**	**7**	**100**	**0.111**	**1.01**	**OF12B-01-01**	**0.57**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-235**	**pCi/g**	**29600**	**2**	**2**	**100**	**0.007**	**0.01744**	**K012**	**0.01**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**7**	**7**	**100**	**0.301**	**3.56**	**OF12B-01-01**	**1.68**	**0**	—	—	—	**No**	**BSL**
SVOA	1,1-biphenyl	mg/kg	—	4	0	0	—	—	—	0.04	—	0.0315	0.05	—	Yes	NV
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	1,2-Diphenylhydrazine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	4	0	0	—	—	—	0.24	—	0.23	0.245	4	Yes	ASL

Table E2.20. Ecological Screening of Surface Sediment Data – Outfall 012 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	2,4,5-Trichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,4'-DDD	mg/kg	—	4	0	0	—	—	—	0.004	—	0.00265	0.0049	—	Yes	NV
SVOA	2,4'-DDE	mg/kg	—	4	1	25	0.012	0.012	K012	0.006	—	0.00265	0.0049	—	Yes	NV
SVOA	2,4'-DDT	mg/kg	—	4	0	0	—	—	—	0.004	—	0.00265	0.0049	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,6,10,14-Tetramethylhexadecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.155	0.24	—	Yes	NV
SVOA	2,6,10,14-Tetramethylpentadecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.155	0.24	—	Yes	NV
SVOA	2,6-Dichlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	5	0	0	—	—	—	0.2	—	0.05	0.245	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4,4'-DDD	mg/kg	0.0033	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL
SVOA	4,4'-DDE	mg/kg	0.00142	4	1	25	0.0038	0.0038	K012	0.02	1	0.0135	0.025	3	Yes	ASL
SVOA	4,4'-DDT	mg/kg	0.0036	4	1	25	0.0098	0.0098	K012	0.02	1	0.0135	0.024	3	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	2	0	0	—	—	—	0.24	—	0.235	0.245	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Aldrin	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	alpha-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	alpha-Chlordane	mg/kg	—	4	1	25	0.0098	0.0098	K012	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Aniline	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Azinphos-methyl	mg/kg	—	4	0	0	—	—	—	0.06	—	0.06	0.065	—	Yes	NV
SVOA	Benzenemethanol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Benzidine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Benzo(e)pyrene	mg/kg	—	4	4	100	0.21	1.5	K012	0.55	—	—	—	—	Yes	NV
SVOA	Benzoic acid	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	beta-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	4	0	0	—	—	—	0.24	—	0.23	0.245	4	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Carbazole	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Chlordane	mg/kg	0.00028	4	0	0	—	—	—	0.16	—	0.135	0.195	4	Yes	ASL
SVOA	Co-Ral	mg/kg	—	4	1	25	0.033	0.033	K012	0.02	—	0.012	0.0135	—	Yes	NV
SVOA	delta-BHC	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	**Diazinon**	**mg/kg**	**0.019**	**4**	**0**	**0**	—	—	—	**0.006**	—	**0.006**	**0.0065**	**0**	**No**	**BSL**
SVOA	Dibenzofuran	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Dichlorvos	mg/kg	—	4	0	0	—	—	—	0.01	—	0.012	0.0135	—	Yes	NV
SVOA	Dieldrin	mg/kg	0.0019	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL

Table E2.20. Ecological Screening of Surface Sediment Data – Outfall 012 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Diethyl phthalate	mg/kg	0.061	4	0	0	—	—	—	0.24	—	0.23	0.245	4	Yes	ASL
SVOA	Dimethoate	mg/kg	—	4	0	0	—	—	—	0.01	—	0.012	0.0135	—	Yes	NV
SVOA	Dimethyl phthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	4	3	75	0.53	0.77	K012	0.54	—	0.235	0.235	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Docosane	mg/kg	—	4	2	50	0.009	0.03	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	Dodecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.155	0.24	—	Yes	NV
SVOA	Dotriacontane	mg/kg	—	4	2	50	0.042	0.13	K012	0.12	—	0.155	0.16	—	Yes	NV
SVOA	Eicosane	mg/kg	—	4	2	50	0.009	0.017	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	Endosulfan I	mg/kg	0.0055	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL
SVOA	Endosulfan II	mg/kg	0.0055	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL
SVOA	Endosulfan sulfate	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Endrin	mg/kg	0.00222	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL
SVOA	Endrin aldehyde	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Ethion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.006	0.0065	—	Yes	NV
SVOA	Famphur	mg/kg	—	4	0	0	—	—	—	0.03	—	0.0235	0.0265	—	Yes	NV
SVOA	Fensulfothion	mg/kg	—	4	0	0	—	—	—	0.02	—	0.021	0.024	—	Yes	NV
SVOA	Fenthion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.006	0.0065	—	Yes	NV
SVOA	gamma-Chlordane	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Henicosane	mg/kg	—	4	2	50	0.01	0.04	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	Heptachlor	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Heptachlor epoxide	mg/kg	0.0006	4	0	0	—	—	—	0.08	—	0.055	0.1	4	Yes	ASL
SVOA	heptacosane	mg/kg	—	4	4	100	0.18	0.54	K012	0.3	—	—	—	—	Yes	NV
SVOA	Heptadecane	mg/kg	—	4	2	50	0.02	0.035	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Hexacosane	mg/kg	—	4	3	75	0.02	0.08	K012	0.08	—	0.155	0.155	—	Yes	NV
SVOA	Hexadecane	mg/kg	—	4	2	50	0.009	0.015	K012	0.08	—	0.155	0.16	—	Yes	NV
SVOA	Isophorone	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Lindane	mg/kg	0.00094	4	0	0	—	—	—	0.02	—	0.0135	0.025	4	Yes	ASL
SVOA	m,p-Cresol	mg/kg	—	2	0	0	—	—	—	0.23	—	0.23	0.235	—	Yes	NV
SVOA	Malathion	mg/kg	0.0067	4	0	0	—	—	—	0.02	—	0.014	0.016	4	Yes	ASL
SVOA	Methoxychlor	mg/kg	—	4	0	0	—	—	—	0.04	—	0.0265	0.049	—	Yes	NV
SVOA	Methyl parathion	mg/kg	—	4	1	25	0.009	0.009	K012	0.007	—	0.006	0.0065	—	Yes	NV
SVOA	Mirex	mg/kg	—	4	0	0	—	—	—	0.02	—	0.0135	0.025	—	Yes	NV
SVOA	Mocap	mg/kg	—	4	0	0	—	—	—	0.006	—	0.006	0.0065	—	Yes	NV
SVOA	n-Hentriacontane	mg/kg	—	4	4	100	0.64	3	K012	1.69	—	—	—	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	N-Nitrosodimethylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	n-Octacosane	mg/kg	—	4	4	100	0.05	0.17	K012	0.09	—	—	—	—	Yes	NV
SVOA	Nonacosane	mg/kg	—	4	4	100	0.7	2.9	K012	1.58	—	—	—	—	Yes	NV
SVOA	Nonadecane	mg/kg	—	4	2	50	0.011	0.021	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	n-Pentacosane	mg/kg	—	4	4	100	0.046	0.16	K012	0.08	—	—	—	—	Yes	NV
SVOA	n-Tetracosane	mg/kg	—	4	2	50	0.014	0.04	K012	0.09	—	0.155	0.16	—	Yes	NV
SVOA	n-Triacontane	mg/kg	—	4	4	100	0.051	0.22	K012	0.1	—	—	—	—	Yes	NV
SVOA	n-Tricosane	mg/kg	—	4	3	75	0.028	0.086	K012	0.08	—	0.155	0.155	—	Yes	NV
SVOA	n-Tritriacontane	mg/kg	—	4	4	100	0.2	0.85	K012	0.42	—	—		—	Yes	NV
SVOA	Octadecane	mg/kg	—	4	2	50	0.011	0.014	K012	0.08	—	0.155	0.16	—	Yes	NV
SVOA	Parathion	mg/kg	—	4	0	0	—	—	—	0.006	—	0.006	0.0065	—	Yes	NV
SVOA	Pentachlorophenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Pentadecane	mg/kg	—	4	1	25	0.006	0.006	K012	0.14	—	0.155	0.24	—	Yes	NV

Table E2.20. Ecological Screening of Surface Sediment Data – Outfall 012 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Perylene	mg/kg	—	4	4	100	0.08	0.46	K012	0.19	—	—	—	—	Yes	NV
SVOA	Phenol	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Phorate	mg/kg	—	4	0	0	—	—	—	0.006	—	0.006	0.0065	—	Yes	NV
SVOA	Pyridine	mg/kg	—	4	0	0	—	—	—	0.24	—	0.23	0.245	—	Yes	NV
SVOA	Tetradecane	mg/kg	—	4	1	25	0.008	0.008	K012	0.13	—	0.155	0.18	—	Yes	NV
SVOA	Tetratriacontane	mg/kg	—	4	1	25	0.048	0.048	K012	0.14	—	0.155	0.18	—	Yes	NV
SVOA	Toxaphene	mg/kg	0.0022	4	0	0	—	—	—	1.9	—	1.35	2.5	4	Yes	ASL
SVOA	Tridecane	mg/kg	—	4	1	25	0.006	0.006	K012	0.13	—	0.155	0.18	—	Yes	NV
SVOA	Undecane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.155	0.24	—	Yes	NV
SVOA	Acenaphthene	mg/kg	0.089	10	4	40	0.16	0.56	OF12B-01-01	0.32	4	0.23	0.28	6	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	10	4	40	0.48	0.56	OF12B-01-01, OF12B-01-04	0.34	—	0.05	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	10	4	40	0.16	0.56	OF12B-01-01	0.32	4	0.23	0.28	6	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	10	4	40	0.48	2	K012	0.68	4	0.23	0.46	6	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	10	5	50	0.48	1.2	OF12B-01-04	0.54	5	0.23	0.28	5	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	10	6	60	0.48	2.7	K012, OF12B-01-04	1.1	6	0.23	0.25	4	Yes	ASL
SVOA	Benzo(ghi)perylene	mg/kg	—	10	4	40	0.41	0.7	OF12B-01-04	0.36	—	0.23	0.28	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	10	5	50	0.48	1	K012, OF12B-01-01, OF12B-01-04	0.55	5	0.23	0.28	5	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	10	5	50	0.48	1.9	OF12B-01-04	0.7	5	0.23	0.28	5	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	10	5	50	0.1	0.56	OF12B-01-01, OF12B-01-04	0.35	5	0.23	0.25	5	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	10	6	60	0.48	4.3	OF12B-01-04	1.47	6	0.23	0.25	4	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	10	4	40	0.12	0.56	OF12B-01-01	0.32	4	0.23	0.28	6	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	10	5	50	0.48	0.9	K012	0.46	5	0.23	0.28	5	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	10	5	50	0.051	0.56	OF12B-01-01, OF12B-01-04	0.34	5	0.23	0.25	5	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	10	5	50	0.48	2.9	OF12B-01-04	0.87	5	0.23	0.28	5	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	10	6	60	0.48	3.1	OF12B-01-04	1.17	6	0.23	0.25	4	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	24.06	—	—	—		—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**5**	**2**	**40**	**0.005**	**0.005**	**OF12B-01-01, OF12B-01-02**	**0.004**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
VOA	1,2-Dichlorobenzene	mg/kg	0.033	4	0	0	—	—	—	0.24	—	0.23	0.245	4	Yes	ASL
VOA	1,4-Dichlorobenzene	mg/kg	0.035	4	0	0	—	—	—	0.24	—	0.23	0.245	4	Yes	ASL
VOA	2,6-Dimethylnaphthalene	mg/kg	—	4	0	0	—	—	—	0.04	—	0.0315	0.05	—	Yes	NV
VOA	Decane	mg/kg	—	4	0	0	—	—	—	0.18	—	0.155	0.24	—	Yes	NV
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**5**	**2**	**40**	**0.005**	**0.005**	**OF12B-01-01, OF12B-01-02**	**0.004**	**0**	**0.0025**	**0.0025**	**0**	**No**	**BSL**
Wetchem	Total organic carbon	mg/kg	—	4	4	100	9495	17400	K012	14648.75	—	—	—	—	—	—

Notes:
ASL – Above screening value
BHC – Benzene hexachloride
BSL – Below screening value
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001

The NFA value for silver is referenced in Appendix, E, Section E.6.7.

Table E2.21. Ecological Screening of Surface Water Data – Outfall 015

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Dioxin/furan	2,3,7,8-Tetrachlorodibenzo-p-dioxin	µg/L	0.0000014	2	0	0	—	—	—	0.00006	—	0	—	—	—	—	—	1.0586E-05	0.00011	2	Yes	ASL
Field parameters	pH	Std. unit	—	143	143	100	6.77	8.3	K015	7.56	—	0	7.08	14.16	6.24	8.2	—	—	—	—	—	—
Metal	Aluminum	mg/L	0.087	2	1	50	1.03	1.03	K015	0.57	1	0	0.55	1.1	0.2	2.92	13	0.1	0.1	1	Yes	ASL
Metal	**Antimony**	**mg/L**	**0.16**	**31**	**4**	**12.9**	**0.005**	**0.005**	**K015**	**0.05**	**0**	**0**	**0.03**	**0.05**	**0.005**	**0.005**	**0**	**0.0025**	**0.1**	**0**	**No**	**BSL**
Metal	Arsenic	mg/L	0.05	31	5	16.13	0.005	0.2	K015	0.05	4	0	0.03	0.05	—	—	—	0.0025	0.1	6	Yes	ASL
Metal	Barium	mg/L	0.004	2	2	100	0.031	0.059	K015	0.04	2	0	0.05	0.1	0.037	0.0645	13	—	—	—	Yes	ASL
Metal	Beryllium	mg/L	0.00053	31	1	3.23	0.005	0.005	K015	0.002	1	0	0	0.002	—	—	—	0.0005	0.005	18	Yes	ASL
Metal	Boron	mg/L	0.0016	2	0	0	—	—	—	1	—	0	—	—	—	—	—	1	1	2	Yes	ASL
Metal	**Cadmium**	**mg/L**	**0.00142**	**31**	**3**	**9.68**	**0.001**	**0.001**	**K015**	**0.005**	**0**	**0**	**0.01**	**0.02**	**0.001**	**0.001**	**0**	**0.0005**	**0.025**	**12**	**No**	**BSL**
Metal	**Chromium**	**mg/L**	**0.04885**	**31**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.02**	**0.03**	**0.02**	**0.05**	**1**	**0.01**	**0.025**	**0**	**No**	**BSL**
Metal	**Cobalt**	**mg/L**	**0.023**	**2**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0**	**0.007**	**0.001**	**0.00103**	**0**	**0.0125**	**0.0125**	**0**	**No**	**BSL**
Metal	Copper	mg/L	0.00516	31	8	25.81	0.0052	0.02	K015	0.01	8	0	0.02	0.04	0.0052	0.038	8	0.0025	0.05	18	Yes	ASL
Metal	Cyanide	mg/L	0.0052	2	0	0	—	—	—	0.01	—	0	0.02	0.03	—	—	—	0.01	0.01	2	Yes	ASL
Metal	Iron	mg/L	1	31	31	100	0.215	2.26	K015	1.03	16	0	0.98	1.95	0.488	2.6	5	—	—	—	Yes	ASL
Metal	Lead	mg/L	0.00132	31	1	3.23	0.005	0.005	K015	0.05	1	0	0.06	0.13	—	—	—	0.0025	0.125	30	Yes	ASL
Metal	Magnesium	mg/L	—	2	2	100	3.9	7.33	K015	5.62	—	0	2.99	5.98	2.49	3.43	—	—	—	—	Yes	NV
Metal	Manganese	mg/L	0.12	2	1	50	0.211	0.211	K015	0.11	1	0	0.24	0.48	0.108	0.329	12	0.0125	0.0125	0	Yes	ASL
Metal	Mercury	mg/L	0.000012	31	6	19.35	0.0002	0.0002	K015	0.0001	6	0	0	0.0002	0.0002	0.0002	1	0.0001	0.0001	25	Yes	ASL
Metal	**Molybdenum**	**mg/L**	**0.37**	**2**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.01**	**0.02**	—	—	—	**0.0125**	**0.0125**	**0**	**No**	**BSL**
Metal	Nickel	mg/L	0.029	31	12	38.71	0.005	0.05	K015	0.02	1	0	0.02	0.04	0.005	0.05	1	0.0025	0.05	2	Yes	ASL
Metal	Phosphorous	mg/L	—	3	3	100	0.12	0.56	K015	0.28	—	0	0.06	0.12	0.05	0.18	—	—	—	—	Yes	NV
Metal	Selenium	mg/L	0.005	31	2	6.45	0.005	0.005	K015	0.03	2	0	0	0.006	—	—	—	0.0025	0.1	14	Yes	ASL
Metal	Silver	mg/L	0.000012	31	10	32.26	0.001	0.025	K015	0.01	10	0	0	0.007	0.001	0.001	1	0.0005	0.025	21	Yes	ASL
Metal	Thallium	mg/L	0.004	31	5	16.13	0.01	0.2	K015	0.06	5	0	0.03	0.06	0.01	0.01	3	0.005	0.125	26	Yes	ASL
Metal	Tin	mg/L	0.073	2	0	0	—	—	—	0.5	—	0	—	—	—	—	—	0.5	0.5	2	Yes	ASL
Metal	Titanium	mg/L	—	2	0	0	—	—	—	0.01	—	0	—	—	—	—	—	0.0125	0.0125	—	Yes	NV
Metal	Total Metals	mg/L	—	28	3	10.71	0.593	5	K015	2.47	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
Metal	Uranium	mg/L	0.0026	29	29	100	0.012	0.58	K015	0.14	29	0	0	0.002	0.001	0.001	0	—	—	—	Yes	ASL
Metal	Zinc	mg/L	0.067	31	12	38.71	0.02	0.539	K015	0.07	1	0	0.07	0.14	0.02	0.2	1	0.01	0.1	11	Yes	ASL
PCB	Endrin ketone	µg/L	—	2	0	0	—	—	—	0.05	—	0	—	—	—	—	—	0.05	0.05	—	Yes	NV
PCB	PCB-1016	µg/L	0.014	80	0	0	—	—	—	0.08	—	0	0.08	0.17	—	—	—	0.08	0.085	80	Yes	ASL
PCB	PCB-1221	µg/L	0.014	80	0	0	—	—	—	0.09	—	0	0.09	0.18	—	—	—	0.085	0.09	80	Yes	ASL
PCB	PCB-1232	µg/L	0.014	80	0	0	—	—	—	0.08	—	0	0.08	0.16	—	—	—	0.065	0.085	80	Yes	ASL
PCB	PCB-1242	µg/L	0.014	80	0	0	—	—	—	0.07	—	0	0.07	0.14	—	—	—	0.045	0.085	80	Yes	ASL
PCB	PCB-1248	µg/L	0.014	80	0	0	—	—	—	0.08	—	0	0.08	0.15	—	—	—	0.055	0.085	80	Yes	ASL
PCB	PCB-1254	µg/L	0.014	80	1	1.25	0.075	0.075	K015	0.07	1	0	0.08	0.16	0.23	0.23	1	0.035	0.085	79	Yes	ASL
PCB	PCB-1260	µg/L	0.014	80	0	0	—	—	—	0.07	—	0	0.06	0.13	—	—	—	0.025	0.085	80	Yes	ASL
PCB	PCB-1268	µg/L	—	80	0	0	—	—	—	0.07	—	0	0.07	0.14	—	—	—	0.045	0.275	—	Yes	NV
PCB	Polychlorinated biphenyl (Total PCBs)	µg/L	0.0014	80	2	2.5	0.075	0.17	K015	0.09	2	0	0.09	0.19	0.23	0.23	1	0.085	0.09	78	Yes	ASL
Rads	Alpha activity	pCi/L	—	3	2	66.67	52.8	53.8	K015	35.53	—	0	—	—	—	—	—	0	0	—	Yes	NV
Rads	Beta activity	pCi/L	—	3	2	66.67	39.7	67.4	K015	42.37	—	0	—	—	—	—	—	20	20	—	Yes	NV
Rads	Radium	pCi/L	—	2	1	50	0.612	0.612	K015	0.2	—	0	—	—	—	—	—	-0.2135	-0.2135	—	Yes	NV
Rads	Suspended Alpha	pCi/L	—	29	9	31.03	-1.29	13.4	K015	2.16	—	0	0.66	1.32	-2.29	7.68	—	-0.575	2.51	—	Yes	NV
Rads	Suspended Beta	pCi/L	—	29	21	72.41	7.23	52.5	K015	14.01	—	0	0.17	0.34	-9.72	5.37	—	0.397	3.06	—	Yes	NV
Rads	**Technetium-99**	**pCi/L**	**1940000**	**29**	**18**	**62.07**	**19.5**	**89.7**	**K015**	**26.36**	**0**	**0**	**2.99**	**5.98**	**-3.17**	**20.8**	**0**	**0.245**	**7.25**	**0**	**No**	**BSL**
Rads	Tritium	pCi/L	—	9	0	0	—	—	—	-9.21777778	—	0	—	—	—	—	—	-129	81	—	Yes	NV
SVOA	**1,2,4-Trichlorobenzene**	**µg/L**	**44.9**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**1,2-Diphenylhydrazine**	**µg/L**	**2.7**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**1,3-Dichlorobenzene**	**µg/L**	**50.2**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**2,4,6-Trichlorophenol**	**µg/L**	**3.2**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**2,4-Dichlorophenol**	**µg/L**	**36.5**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**2,4-Dimethylphenol**	**µg/L**	**21.2**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrophenol**	**µg/L**	**6.2**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**2,4-Dinitrotoluene**	**µg/L**	**310**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**

Table E2.21. Ecological Screening of Surface Water Data – Outfall 015 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	2,6-Dinitrotoluene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	2-Chloronaphthalene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**2-Chlorophenol**	**µg/L**	**43.8**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	2-Methyl-4,6-dinitrophenol	µg/L	2.3	1	0	0	—	—	—	25	—	0	—	—	—	—	—	25	25	1	Yes	ASL
SVOA	**2-Nitrophenol**	**µg/L**	**3500**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	3,3'-Dichlorobenzidine	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	4,4'-DDD	µg/L	0.0064	2	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	2	Yes	ASL
SVOA	4,4'-DDE	µg/L	0.01	2	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	2	Yes	ASL
SVOA	4,4'-DDT	µg/L	0.001	2	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	2	Yes	ASL
SVOA	4-Bromophenyl phenyl ether	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**4-Nitrophenol**	**µg/L**	**82.8**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Aldrin**	**µg/L**	**0.3**	**2**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	**alpha-BHC**	**µg/L**	**500**	**2**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	alpha-Chlordane	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	**Benzidine**	**µg/L**	**25**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**beta-BHC**	**µg/L**	**5000**	**2**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Bis(2-chloroethoxy)methane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	µg/L	0.12	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
SVOA	**Butyl benzyl phthalate**	**µg/L**	**22**	**1**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	delta-BHC	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Dieldrin	µg/L	0.0019	2	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	2	Yes	ASL
SVOA	**Diethyl phthalate**	**µg/L**	**521**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Dimethyl phthalate**	**µg/L**	**330**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Di-n-butyl phthalate**	**µg/L**	**9.4**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Di-n-octylphthalate	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**Endosulfan I**	**µg/L**	**0.056**	**2**	**0**	**0**	—	—	—	**0.01**	—	**0**	**0.02**	**0.05**	—	—	—	**0**	**0.025**	**0**	**No**	**BSL**
SVOA	**Endosulfan II**	**µg/L**	**0.056**	**2**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0**	**0.05**	**0**	**No**	**BSL**
SVOA	Endosulfan sulfate	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0	0.05	—	Yes	NV
SVOA	Endrin	µg/L	0.0023	2	0	0	—	—	—	0.05	—	0	0.02	0.05	—	—	—	0.05	0.05	2	Yes	ASL
SVOA	Endrin aldehyde	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0	0.05	—	Yes	NV
SVOA	gamma-Chlordane	µg/L	—	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.025	0.025	—	Yes	NV
SVOA	Heptachlor	µg/L	0.0038	2	0	0	—	—	—	0.02	—	0	0.02	0.05	—	—	—	0.0065	0.025	2	Yes	ASL
SVOA	Heptachlor epoxide	µg/L	0.0038	2	0	0	—	—	—	0.01	—	0	0.02	0.05	—	—	—	0	0.025	1	Yes	ASL
SVOA	Hexachlorobenzene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	Hexachlorobutadiene	µg/L	0.93	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
SVOA	Hexachlorocyclopentadiene	µg/L	0.07	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	2	Yes	ASL
SVOA	**Hexachloroethane**	**µg/L**	**9.8**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Isophorone**	**µg/L**	**1170**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Lindane**	**µg/L**	**0.08**	**1**	**0**	**0**	—	—	—	**0.02**	—	**0**	**0.02**	**0.05**	—	—	—	**0.025**	**0.025**	**0**	**No**	**BSL**
SVOA	Methoxychlor	µg/L	0.03	2	0	0	—	—	—	0.25	—	0	0.05	0.1	—	—	—	0.25	0.25	2	Yes	ASL
SVOA	**Nitrobenzene**	**µg/L**	**270**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	N-Nitrosodimethylamine	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
SVOA	**N-Nitrosodiphenylamine**	**µg/L**	**58.5**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Pentachlorophenol**	**µg/L**	**14.9**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Phenol**	**µg/L**	**256**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	Toxaphene	µg/L	0.0002	2	0	0	—	—	—	2.5	—	0	2.5	5	—	—	—	2.5	2.5	2	Yes	ASL
SVOA	**Acenaphthene**	**µg/L**	**17**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Acenaphthylene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**		**No**	**NV**
SVOA	**Anthracene**	**µg/L**	**0.73**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**2**	**No**	**ASL**
SVOA	**Benz(a)anthracene**	**µg/L**	**0.027**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**2**	**No**	**ASL**
SVOA	**Benzo(a)pyrene**	**µg/L**	**0.014**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**2**	**No**	**ASL**

Table E2.21. Ecological Screening of Surface Water Data – Outfall 015 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Background count	Background average	Background average x 2	Background detect minimum	Background detect maximum	Background detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	**Benzo(b)fluoranthene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Benzo(ghi)perylene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Benzo(k)fluoranthene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Chrysene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Dibenz(a,h)anthracene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Fluoranthene**	**µg/L**	**39.8**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Fluorene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Indeno(1,2,3-cd)pyrene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Naphthalene**	**µg/L**	**62**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
SVOA	**Phenanthrene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Pyrene**	**µg/L**	—	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	**0.5**	**1**	—	—	—	**2.5**	**2.5**	—	**No**	**NV**
SVOA	**Total PAHs**	**µg/L**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**No**	**ND**
VOA	**1,1,1-Trichloroethane**	**µg/L**	**528**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2,2-Tetrachloroethane**	**µg/L**	**240**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1,2-Trichloroethane**	**µg/L**	**940**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**µg/L**	**47**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethene**	**µg/L**	**303**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichlorobenzene**	**µg/L**	**15.8**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloroethane**	**µg/L**	**2000**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,2-Dichloropropane**	**µg/L**	**525**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**1,4-Dichlorobenzene**	**µg/L**	**11.2**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**2-Chloroethyl vinyl ether**	**µg/L**	**3540**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	Acrolein	µg/L	2.1	2	0	0	—	—	—	5	—	0	—	—	—	—	—	5	5	2	Yes	ASL
VOA	**Acrylonitrile**	**µg/L**	**75.5**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**Benzene**	**µg/L**	**53**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Bromoform**	**µg/L**	**29**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Bromomethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Carbon tetrachloride**	**µg/L**	**352**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Chlorobenzene**	**µg/L**	**195**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloroethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Chloroform**	**µg/L**	**289**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	Chloromethane	µg/L	—	1	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	Dibromochloromethane	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Ethylbenzene**	**µg/L**	**453**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	MBAS	mg/L	—	3	0	0	—	—	—	0.04	—	0	—	—	—	—	—	0.04	0.04	—	Yes	NV
VOA	**Methylene chloride**	**µg/L**	**1930**	**2**	**0**	**0**	—	—	—	**5**	—	**0**	—	—	—	—	—	**5**	**5**	**0**	**No**	**BSL**
VOA	**Tetrachloroethene**	**µg/L**	**84**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	**Toluene**	**µg/L**	**175**	**2**	**0**	**0**	—	—	—	**2.5**	—	**0**	—	—	—	—	—	**2.5**	**2.5**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	trans-1,3-Dichloropropene	µg/L	—	2	0	0	—	—	—	2.5	—	0	—	—	—	—	—	2.5	2.5	—	Yes	NV
VOA	**Trichloroethene**	**µg/L**	**47**	**2**	**1**	**50**	**2**	**2**	**K015**	**1.25**	**0**	**0**	**0.5**	**1**	—	—	—	**0.5**	**0.5**	**0**	**No**	**BSL**
VOA	Vinyl chloride	µg/L	—	2	0	0	—	—	—	1.75	—	0	—	—	—	—	—	1	2.5	—	Yes	NV
Wetchem	Hardness – total as $CaCO_3$	mg/L	—	77	77	100	56	436	K015	161.62	—	0	52.25	104.5	32	179	—	—	—	—	—	—
Wetchem	Total organic carbon	mg/L	—	2	2	100	9.6	15	K015	12.3	—	0	—	—	—	—	—	—	—	—	—	—

Notes:

ASL – Above screening value
BHC – Benzene hexachloride
BSL – Below screening value
COPC – Chemical of potential concern
DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane

ND – Not detected
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte

VOA – Volatile organic analyte
wet chem - wet chemistry
mg/L - milligrams/liter
pCi/L - picocuries/liter
ug/L - micrograms/liter
Bold – Indicates COPC has been eliminated
Screening levels from DOE 2001
The background samples were collected from Massac Creek, located southeast of the PGDP.

Table E2.22. Ecological Screening of SurfaceSediment Data – Outfall 015

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
Field parameters	pH	None	—	3	3	100	6.62	7.81	004-002	7.34	—	—	—	—	—	—
Metal	**Aluminum**	**mg/kg**	**25500**	**48**	**48**	**100**	**2050**	**12900**	**004-001**	**5546.88**	**0**	—	—	—	**No**	**BSL**
Metal	Antimony	mg/kg	2	48	18	37.5	8.54	20	004-001, 004-002, 004-005	7.24	18	4.33	4.985	30	Yes	ASL
Metal	Arsenic	mg/kg	5.9	48	31	64.58	1.31	46.9	OF15B-08-03	6.9	15	2.165	2.5	0	Yes	ASL
Metal	Barium	mg/kg	—	48	48	100	24	148	004-001, OF15B-05-01	70.7	—	—	—	—	Yes	NV
Metal	Beryllium	mg/kg	—	48	14	29.17	0.489	2.42	OF15B-05-01	0.44	—	0.214	0.25	—	Yes	NV
Metal	Cadmium	mg/kg	0.27	48	5	10.42	2.09	3.27	OF15B-04-03	1.12	5	0.855	1	43	Yes	ASL
Metal	Calcium	mg/kg	—	48	48	100	937	245000	OF15B-06-02	20334.1	—	—	—	—	Yes	NV
Metal	Chromium	mg/kg	37.3	48	48	100	2.5	102	OF15B-03-03	14.68	1	—	—	—	Yes	ASL
Metal	Cobalt	mg/kg	—	48	43	89.58	2.74	15.3	OF15B-04-01	5	—	1.07	1.245	—	Yes	NV
Metal	Copper	mg/kg	30	48	47	97.92	2.24	66	OF15B-04-04	16.19	7	1.245	1.245	0	Yes	ASL
Metal	Cyanide	mg/kg	—	3	0	0	—	—	—	0.5	—	0.5	0.5	—	Yes	NV
Metal	Iron	mg/kg	2000	48	48	100	1700	41900	004-005	10393.75	47	—	—	—	Yes	ASL
Metal	Lead	mg/kg	12	48	18	37.5	19.6	303	OF15B-03-01	27.01	18	8.55	10	0	Yes	ASL
Metal	Magnesium	mg/kg	—	48	48	100	317	6400	OF15B-09-01	1467.52	—	—	—	—	Yes	NV
Metal	Manganese	mg/kg	614	48	48	100	35.8	1300	004-001	328.21	3	—	—	—	Yes	ASL
Metal	Mercury	mg/kg	0.16	48	13	27.08	0.062	0.45	004-005	0.08	5	0.0325	0.1	0	Yes	ASL
Metal	Molybdenum	mg/kg	—	45	6	13.33	4.99	18.4	OF15B-11-01	3.28	—	2.135	2.5	—	Yes	NV
Metal	Nickel	mg/kg	16	48	42	87.5	5.77	57.5	OF15B-03-03	17.12	19	2.345	2.495	0	Yes	ASL
Metal	Potassium	mg/kg	—	48	48	100	149	1090	OF15B-05-01	443.21	—	—	—	—	Yes	NV
Metal	Selenium	mg/kg	0.05	48	0	0	—	—	—	8.99		0.5	10	48	Yes	ASL
Metal	Silver	mg/kg	0.00038	48	15	31.25	2.13	2.5	OF15B-07-02, OF15B-07-04	1.62	15	1.08	2	33	Yes	ASL
Metal	Sodium	mg/kg	—	48	35	72.92	86.6	333	OF15B-04-04	118.06	—	44.8	100	—	Yes	NV
Metal	Thallium	mg/kg	—	48	0	0	—	—	—	9.43	—	7.5	10	—	Yes	NV
Metal	Uranium	mg/kg	—	90	84	93.33	1.09	920	OF15B-07-02	50.63	—	0.4045	2.49	—	Yes	NV
Metal	Vanadium	mg/kg	0.2	48	48	100	4.27	37.7	OF15B-05-01	16.45	48	—	—	—	Yes	ASL
Metal	Zinc	mg/kg	4.7	48	45	93.75	19.7	409	OF15B-01-04	67.09	45	9.4	9.95	3	Yes	ASL
PCB	PCB-1016	mg/kg	—	399	1	0.25	2.43	2.43	OF15A-190	0.06	—	0.04	0.12	—	Yes	NV
PCB	PCB-1221	mg/kg	—	399	1	0.25	3.16	3.16	OF15A-190	0.07	—	0.05	0.16	—	Yes	NV
PCB	PCB-1232	mg/kg	—	399	1	0.25	2.43	2.43	OF15A-190	0.06	—	0.04	0.12	—	Yes	NV
PCB	PCB-1242	mg/kg	—	399	1	0.25	1.46	1.46	OF15A-190	0.03	—	0.025	0.075	—	Yes	NV
PCB	PCB-1248	mg/kg	—	399	1	0.25	2.43	2.43	OF15A-190	0.06	—	0.04	0.12	—	Yes	NV
PCB	PCB-1254	mg/kg	—	399	130	32.58	0.09	5.43	OF15A-106	0.21	—	0.04	0.11	—	Yes	NV
PCB	PCB-1260	mg/kg	—	399	133	33.33	0.1	262	OF15A-190	0.8	—	0.04	0.12	—	Yes	NV
PCB	PCB-1268	mg/kg	—	397	2	0.5	0.16	1.95	OF15A-190	0.04	—	0.035	0.1	—	Yes	NV
PCB	Polychlorinated biphenyl (PCBs)	mg/kg	0.032	397	161	40.55	0.12	262	OF15A-190	0.98	161	0.05	0.065	236	Yes	ASL
Rads	Activity of Uranium-235	pCi/g	—	45	40	88.89	0.0189	3.11	OF15B-03-01	0.22	—	0.003985	0.0115	—	Yes	NV
Rads	Alpha activity	pCi/g	—	41	39	95.12	4.8	300	OF15B-03-01	48.31	—	3.58	4.12	—	Yes	NV
Rads	**Americium-241**	**pCi/g**	**167000**	**49**	**16**	**32.65**	**0.0343**	**2.28**	**K015**	**0.18**	**0**	**-0.00471**	**0.051**	**0**	**No**	**BSL**
Rads	Beta activity	pCi/g	—	49	48	97.96	5.52	611	OF15B-03-01	79.51	—	2.07	2.07	—	Yes	NV
Rads	**Cesium-137**	**pCi/g**	**9320**	**49**	**45**	**91.84**	**0.0618**	**181**	**004-005**	**7.27**	**0**	**0.0124**	**0.03785**	**0**	**No**	**BSL**
Rads	**Cobalt-60**	**pCi/g**	**2100**	**48**	**3**	**6.25**	**1**	**1.1**	**004-001**	**0.07**	**0**	**-0.0173**	**0.04125**	**0**	**No**	**BSL**
Rads	**Neptunium-237**	**pCi/g**	**22300**	**49**	**21**	**42.86**	**0.0382**	**1.01**	**OF15B-07-02**	**0.13**	**0**	**-0.00461**	**0.0835**	**0**	**No**	**BSL**
Rads	**Plutonium-238**	**pCi/g**	**9590000**	**45**	**3**	**6.67**	**0.166**	**0.383**	**OF15B-02-01**	**0.02**	**0**	**-0.00458**	**0.0202**	**0**	**No**	**BSL**
Rads	**Plutonium-239/240**	**pCi/g**	**10000000**	**49**	**36**	**73.47**	**0.0271**	**27.1**	**004-005**	**2.33**	**0**	**-0.004275**	**0.1085**	**0**	**No**	**BSL**
Rads	**Protactinium-234m**	**pCi/g**	**175000**	**3**	**3**	**100**	**480**	**500**	**004-001**	**490**	**0**	—	—	—	**No**	**BSL**
Rads	**Radium-226**	**pCi/g**	**2820**	**3**	**0**	**0**	—	—	—	**1.02**	—	**0.84**	**1.255**	**0**	**No**	**BSL**
Rads	Technetium-99	pCi/g	—	48	32	66.67	2.78	55.3	OF15B-07-02	9.21	—	0.61	1.485		Yes	NV
Rads	**Thorium-228**	**pCi/g**	**3310**	**45**	**44**	**97.78**	**0.208**	**0.867**	**OF15B-02-03**	**0.43**	**0**	**0.081**	**0.081**	**0**	**No**	**BSL**
Rads	**Thorium-230**	**pCi/g**	**11200000**	**46**	**46**	**100**	**0.338**	**78.2**	**OF15B-02-03**	**5.81**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-232**	**pCi/g**	**5470**	**45**	**45**	**100**	**0.16**	**1.09**	**OF15B-02-03**	**0.45**	**0**	—	—	—	**No**	**BSL**
Rads	**Thorium-234**	**pCi/g**	**175000**	**3**	**3**	**100**	**16**	**20.3**	**004-001**	**18.73**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-234**	**pCi/g**	**10000000**	**48**	**48**	**100**	**0.207**	**24.9**	**OF15B-03-01**	**2.99**	**0**	—	—	—	**No**	**BSL**
Rads	**Uranium-238**	**pCi/g**	**175000**	**48**	**48**	**100**	**0.27**	**132**	**OF15B-03-01**	**9.38**	**0**	—	—	—	**No**	**BSL**

Table E2.22. Ecological Screening of SurfaceSediment Data – Outfall 015 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	1,2,4-Trichlorobenzene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	1,3-Dichlorobenzene	mg/kg	0.17	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
SVOA	2,4,5-Trichlorophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4,6-Trichlorophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dichlorophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dimethylphenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,4-Dinitrophenol	mg/kg	—	1	0	0	—	—	—	0.23	—	0.23	0.23	—	Yes	NV
SVOA	2,4-Dinitrotoluene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2,6-Dinitrotoluene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chloronaphthalene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Chlorophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methyl-4,6-dinitrophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylnaphthalene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Methylphenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrobenzenamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	2-Nitrophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3,3'-Dichlorobenzidine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	3-Nitrobenzenamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Bromophenyl phenyl ether	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chloro-3-methylphenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorobenzenamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Chlorophenyl phenyl ether	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Methylphenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Nitrobenzenamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	4-Nitrophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroethoxy)methane	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroethyl) ether	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-chloroisopropyl) ether	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Bis(2-ethylhexyl)phthalate	mg/kg	0.018	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
SVOA	Butyl benzyl phthalate	mg/kg	—	1	0	0	—	—	—	0.23	—	0.23	0.23	—	Yes	NV
SVOA	Carbazole	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Dibenzofuran	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Diethyl phthalate	mg/kg	0.061	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
SVOA	Dimethyl phthalate	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Di-n-butyl phthalate	mg/kg	—	3	0	0	—	—	—	0.37	—	0.25	0.6	—	Yes	NV
SVOA	Di-n-octylphthalate	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorobenzene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorobutadiene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachlorocyclopentadiene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Hexachloroethane	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Isophorone	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Nitrobenzene	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	N-Nitroso-di-n-propylamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	N-Nitrosodiphenylamine	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Pentachlorophenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Phenol	mg/kg	—	3	0	0	—	—	—	0.25	—	0.25	0.25	—	Yes	NV
SVOA	Pyridine	mg/kg	—	1	0	0	—	—	—	0.23	—	0.23	0.23	—	Yes	NV
SVOA	Acenaphthene	mg/kg	0.089	48	31	64.58	0.46	0.5	OF15B-01-04, OF15B-04-01, OF15B-05-01, OF15B-06-01, OF15B-06-02, OF15B-06-03, OF15B-06-04, OF15B-11-01, OF15B-11-04	0.4	31	0.235	0.25	17	Yes	ASL
SVOA	Acenaphthylene	mg/kg	—	48	31	64.58	0.46	0.5	OF15B-01-04, OF15B-04-01, OF15B-05-01, OF15B-06-01,	0.4	—	0.235	0.25	—	Yes	NV
SVOA	Anthracene	mg/kg	0.023	48	29	60.42	0.46	0.63	OF15B-04-04	0.39	29	0.23	0.25	19	Yes	ASL
SVOA	Benz(a)anthracene	mg/kg	0.0317	48	31	64.58	0.46	1.5	OF15B-04-04	0.42	31	0.23	0.25	17	Yes	ASL
SVOA	Benzo(a)pyrene	mg/kg	0.0319	48	31	64.58	0.46	1.4	OF15B-04-04	0.42	31	0.23	0.25	17	Yes	ASL
SVOA	Benzo(b)fluoranthene	mg/kg	0.004	48	28	58.33	0.46	2.4	OF15B-04-04	0.43	28	0.23	0.25	20	Yes	ASL

Table E2.22. Ecological Screening of SurfaceSediment Data – Outfall 015 (Continued)

(ContinuedAnalysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
SVOA	Benzo(ghi)perylene	mg/kg	—	48	32	66.67	0.46	0.58	OF15B-04-04	0.41	—	0.235	0.25	—	Yes	NV
SVOA	Benzo(k)fluoranthene	mg/kg	0.004	48	31	64.58	0.46	0.84	OF15B-04-04	0.41	31	0.23	0.25	17	Yes	ASL
SVOA	Chrysene	mg/kg	0.033	48	30	62.5	0.46	1.9	OF15B-04-04	0.42	30	0.23	0.25	18	Yes	ASL
SVOA	Dibenz(a,h)anthracene	mg/kg	0.01	48	32	66.67	0.46	0.5	OF15B-01-04, OF15B-04-01, OF15B-05-01, OF15B-06-01, OF15B-06-02, OF15B-06-03, OF15B-06-04, OF15B-08-01, OF15B-11-01, OF15B-11-04	0.4	32	0.235	0.25	16	Yes	ASL
SVOA	Fluoranthene	mg/kg	0.054	48	23	47.92	0.47	4	OF15B-04-04	0.45	23	0.23	0.25	25	Yes	ASL
SVOA	Fluorene	mg/kg	0.01	48	31	64.58	0.46	0.5	OF15B-01-04, OF15B-04-01, OF15B-05-01, OF15B-06-01, OF15B-06-02, OF15B-06-03, OF15B-06-04, OF15B-11-01, OF15B-11-04	0.4	31	0.235	0.25	17	Yes	ASL
SVOA	Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	48	31	64.58	0.46	0.68	OF15B-04-04	0.4	31	0.23	0.25	17	Yes	ASL
SVOA	Naphthalene	mg/kg	0.01465	48	28	58.33	0.46	1.7	OF15B-04-04	0.41	28	0.23	0.25	20	Yes	ASL
SVOA	Phenanthrene	mg/kg	0.0419	48	25	52.08	0.46	3.6	OF15B-04-04	0.44	25	0.23	0.25	23	Yes	ASL
SVOA	Pyrene	mg/kg	0.053	48	27	56.25	0.47	2.9	OF15B-04-04	0.43	27	0.23	0.25	21	Yes	ASL
SVOA	Total PAHs	mg/kg	1.61	—	—	—	—	24.13	—	—	—	—	—	—	Yes	ASL
VOA	**1,1,1-Trichloroethane**	**mg/kg**	**0.096**	**48**	**25**	**52.08**	**0.005**	**0.005**	**OF15B-01-02, OF15B-01-03, OF15B-02-04, OF15B-03-01, OF15B-03-03, OF15B-03-04, OF15B-04-01, OF15B-04-02, OF15B-04-03, OF15B-04-04, OF15B-05-01, OF15B-05-01, OF15B-05-02, OF15B-05-04, OF15B-06-01, OF15B-06-03, OF15B-06-04, OF15B-07-01, OF15B-07-02, OF15B-07**	**0.004**	**0**	**0.0025**	**0.005**	**0**	**No**	**BSL**
VOA	1,1,2,2-Tetrachloroethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**1,1,2-Trichloroethane**	**mg/kg**	**0.098**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**1,1-Dichloroethane**	**mg/kg**	**0.027**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,1-Dichloroethene	mg/kg	0.035	3	0	0	—	—	—	0.19	—	0.158	0.254	3	Yes	ASL
VOA	1,2-Dichlorobenzene	mg/kg	0.033	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
VOA	**1,2-Dichloroethane**	**mg/kg**	**0.043**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	1,2-Dichloropropane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,2-Dimethylbenzene	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	1,4-Dichlorobenzene	mg/kg	0.035	3	0	0	—	—	—	0.25	—	0.25	0.25	3	Yes	ASL
VOA	2-Butanone	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	2-Hexanone	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	4-Methyl-2-pentanone	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Benzene**	**mg/kg**	**0.057**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Bromodichloromethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromoform	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Bromomethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Carbon disulfide	mg/kg	0.00086	3	0	0	—	—	—	0.005	—	0.005	0.005	3	Yes	ASL
VOA	**Carbon tetrachloride**	**mg/kg**	**0.02**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Chlorobenzene	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Chloroethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Chloroform**	**mg/kg**	**0.096**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	Chloromethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	cis-1,2-Dichloroethene	mg/kg	—	3	0	0	—	—	—	0.19	—	0.158	0.254	—	Yes	NV
VOA	cis-1,3-Dichloropropene	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Dibromochloromethane	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Ethylbenzene**	**mg/kg**	**0.54**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	m,p-Xylene	mg/kg	—	3	0	0	—	—	—	0.01	—	0.01	0.01	—	Yes	NV
VOA	Methylene chloride	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	Styrene	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV
VOA	**Tetrachloroethene**	**mg/kg**	**0.032**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	**Toluene**	**mg/kg**	**0.5**	**3**	**0**	**0**	—	—	—	**0.005**	—	**0.005**	**0.005**	**0**	**No**	**BSL**
VOA	trans-1,2-Dichloroethene	mg/kg	—	3	0	0	—	—	—	0.19	—	0.158	0.254	—	Yes	NV
VOA	trans-1,3-Dichloropropene	mg/kg	—	3	0	0	—	—	—	0.005	—	0.005	0.005	—	Yes	NV

Table E2.22. Ecological Screening of SurfaceSediment Data – Outfall 015 (Continued)

Analysis type	Chemical name	Units	Screening level	Total analyses	Total detects	Detect frequency	Detect minimum	Detect maximum	Detect maximum location	Average	Detect exceedances SL	Half detect limit minimum	Half detect limit maximum	Half detect limit exceedances SL	COPC	Rationale
VOA	**Trichloroethene**	**mg/kg**	**0.052**	**48**	**22**	**45.83**	**0.005**	**0.005**	**OF15B-01-02, OF15B-01-03, OF15B-02-04, OF15B-03-01, OF15B-03-03, OF15B-04-01, OF15B-04-02, OF15B-04-03, OF15B-04-04, OF15B-05-01, OF15B-05-01, OF15B-05-02, OF15B-05-04, OF15B-06-01, OF15B-06-03, OF15B-07-01, OF15B-07-02, OF15B-08-04, OF15B-10-04, OF15B-11**	**0.02**	**0**	**0.0025**	**0.254**	**3**	**No**	**BSL**
VOA	Vinyl chloride	mg/kg	—	3	0	0	—	—	—	0.19	—	0.158	0.254	—	Yes	NV
Wetchem	Total organic carbon	mg/kg	—	3	3	100	5900	13000	004-005	8766.67	—	—	—	—	—	—

Notes:
ASL – Above screening value
BSL – Below screening value
COPC – Chemical of potential concern
NV – No screening value
PAH – Polycyclic aromatic hydrocarbon
PCB – Polychlorinated biphenyl
Rads – Radionuclides
SL – Screening level
SVOA – Semivolatile organic analyte
VOA – Volatile organic analyte
wet chem - wet chemistry
mg/kg - milligrams/kilogram
pCi/g - picocuries/gram
Bold – Indicates COPC has been eliminated

Screening levels from DOE 2001

The NFA value for silver is referenced in Appendix, E, Section E.6.7.

ATTACHMENT E3

PCB FOOD WEB MODELS

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Table E3.1. Exposure Point Concentrations (EPCs)

	SW	SED	SS	Aquatic insect (WB)		Crayfish (WB)		Fish (WB)		Vegetation		Worm (WB)		Small mammal (WB)	
Area	mg/L	mg/kg	mg/kg	mg/kg	BSAF	mg/kg	BSAF	mg/kg	BSAF	mg/kg	BAF	mg/kg	BAF	mg/kg	BAF
NSDD	0.000470	28.9	20.0	63.58	2.2	34.68	1.2	21.96	0.76	0.016	0.0008	22.6000	1.13	8.00	0.40
OF 001	0.000460	0.52	0.40	1.14	2.2	0.62	1.2	0.40	0.76	0.000	0.0008	0.4520	1.13	0.16	0.40

SW, SED, and SS PCB concentrations are based on maximum detected concentrations of Total PCBs (per screening level ERA guidance)
Abiotic media concentrations for each area are based on maximums for the entire within-fence areas (not by individual EUs)

EU Data–Outfall 001	SW	SED	SS
EU 1	0.00026	0.17	0.4
EU 4	no data	0.065	0.4
EU 5	no data	0.52	0.4
EU 6	0.00046	0.13	0.4
EU 7	0.000085	0.27	0.4

SS data based on Ourfall 001, not by separate EUs

Section data–NSDD	SW	SED	SS
Section 3	No data	28.9	20.0
Section 4	No data	0.5	1.0
Section 5	0.00047	2.47	3.9

SW data unavailable for Sects. 3 and 4

BAF/BSAF Sources:

Aquatic insect	Sediment-to-insect BSAF based on mean (total PCB) sediment (dw) to midge (mean of larvae and adults, ww) as reported by Larsson 1984 in Eisler 1986 Sediment PCB concentrations ranged from 0.3 to 28 mg/kg dw, mean midge PCB concentrations ranged from 0.15 to 79.8 mg/kg ww
Crayfish	Sediment-to-crayfish BSAF based on mean (total PCB) sediment (dw) to midge larvae (ww) as reported by Larsson 1984 in Eisler 1986 Sediment PCB concentrations ranged from 0.3 to 28 mg/kg dw, midge larvae PCB concentrations ranged from 0.1 to 35.5 mg/kg ww Midge larvae representative of sediment-associated invertebrates, including crayfish
Fish	Water-to-fish BAF (230,000, Aroclor 1254) from Table C.1, Paducah Gaseous Diffusion Plant guidance (DOE/OR/07-1506/V2&D2) Sediment-to-water partition factor (302,000) from mean (total PCB) value for Allied Paper Inc./Portage Creek/Kalamazoo River BERA (2003) Sediment-to-fish BSAF = 230,000 / 302,000 = 0.76 BSAF of 0.76 supported by similarity to mean (total PCB) BSAF (0.88) derived for smallmouth bass at Allied Paper Inc./Portage Creek/Kalamazoo River BERA (2003)
Vegetation	Soil-to-plant BAF based on mean of co-located soil and tomato samples, Allied Paper Inc./Portage Creek/Kalamazoo River BERA (2003) Tomato representative of fruits, seeds, and berries (above-ground vegetation)
Worm	Soil-to-worm BAF based on BAF from Table C.1, Paducah Gaseous Diffusion Plant Guidance (DOE/OR/07-1506/V2&D2) Soil-to-worm BAF based on Aroclor 1254 because the BAF for Total PCBs (280) is two orders of magnitude higher than that for Aroclor 1254. Data from the Kalamazoo ERA better supports the BSAF of 1.13 (mean BSAF for worms at Kalamazoo River equalled approximately 0.1) Earthworm representative of soil-dwelling invertebrates
Small mammal	Soil-to-small mammal BAF based on mean of co-located soil and white-footed/deer mouse samples, Allied Paper Inc./Portage Creek/Kalamazoo River BERA (2003) White-footed/deer mouse representative of small terrestrial mammals

Notes:

BAFs and BSAFs are linked to either soil or sediment (not water) because preliminary remediation goals are based on, and back calculated from, soil or sediment.
Sediment and soil concentrations are dry weight, while all biota concentrations are wet weight.

Table E3.1 (continued)

Site area (acres/hectares)

Area	Acres	Hectares	Description	Length (ft)	Width (ft)	Area (ft)	Feet/acre
NSDD	7.71	19	NSDD	8,400	40	336,000	43,560
Outfall 001	5.99	15	Outfall 001 inside fence (EUs 1,4,5,6, and 7)	6,518	40	260,720	43,560

TRVs for food web model receptors

(mg/kg total Aroclor 1254, from Sample, Opresko, and Suter 1996)

	LOAEL	NOAEL
Shrew	0.668	0.067
Vole	0.511	0.051
Mink	0.69	0.14
Bat	0.795	0.079
Kestrel	1.8	0.18
Woodcock	1.8	0.18
Robin	1.8	0.18
Quail	1.8	0.18
Wren	1.8	0.18
Kingfisher	1.8	0.18

TRVs are based on Aroclor-1254 because dose-based TRVs are unavailable to Total PCBs
Aroclor-1254 is among the most toxic of Aroclors to birds and mammals
TRVs are the same for all birds because scaling is not appropriate for birds (Sample, Opresko, and Suter 1996)

Notes:

BAF – Bioaccumulation factor
BERA – Baseline ecological risk assessment
BSAF – Biota-sediment accumulation factor
dw – Dry weight
EPC – Exposure point concentration
EU – Exposure unit
ERA – Ecological Risk Assessment
NSDD – North-South Diversion Ditch
PCB – Polychlorinated biphenyl
SS – Surface soil
SED – Sediment
SW – Surface water
TRV – Toxicity reference value
ww – Wet weight

Table E3.2. Food Web Model for Total PCBs – North-South Diversion Ditch

		Food				Water			Soil/sediment																				
Soil-based receptors	**BW**	**IRww**	**NIRww**	**IRdw**	**NIRdw**	**IRww**	**NIRww**	**SW conc.**	**Soil conc.**	**DF soil**	**Worm BAF**	**Worm conc.**	**DF worm**	**Veg. BAF**	**Veg conc.**	**DF veg.**	**Mammal BAF**	**Mammal conc.**	**DF mammal**	**Site area**	**Foraging area**	**SFF**	**Dose**	**LOAEL**	**LOAEL HQ**	**NOAEL**	**NOAEL HQ**	**LOAEL PRG**	**NOAEL PRG**
	(kg)	(kg/d)	(kg/kgbw-d)	(kg/d)	(kg/kgbw-d)	(L/d)	(L/kgbw-d)	(mg/L)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ha)	(ha)	(ratio)	(mg/kg-d)	(mg/kg-d)	(ratio)	(mg/kg-d)	(ratio)	(mg/kg)	(mg/kg)
Short-tailed shrew	0.015	0.0255	1.7	0.0022	0.1451	0.0033	0.223	0.000470	20.000	0.02	1.13	22.600	0.89	0.0008	0.0160	0.11	—	—	0	19	0.39	1.0000	34.2549	0.668	**51.3**	0.067	**511**	0.390	0.0391
Meadow vole	0.020	0.0060	0.30	0.0034	0.1682	0.0035	0.175	0.000470	20.000	0.024	—	—	0	0.0008	0.0160	1.0	—	—	0	19	0.013	1.0000	0.0856	0.511	0.17	0.051	**1.7**	119	11.9
American kestrel	0.119	0.0357	0.30	0.0109	0.0916	0.0137	0.115	0.000470	20.000	0.01	1.13	22.600	0.25	—	—	0	0.4	8.000	0.75	19	154	0.1237	0.4347	1.8	0.24	0.18	**2.4**	82.8	8.28
American woodcock	0.15	0.1155	0.77	0.0282	0.1877	0.0150	0.10	0.000470	20.000	0.104	1.13	22.600	1.0	—	—	0	—	—	0	19	25	0.7621	13.5595	1.8	**7.5**	0.18	**75.3**	2.65	0.265
American robin	0.0773	0.0688	0.89	0.0160	0.2073	0.0108	0.14	0.000470	20.000	0.02	1.13	22.600	0.51	0.0008	0.0160	0.49	—	—	0	19	0.5	1.0000	10.3481	1.8	**5.7**	0.18	**57.5**	3.48	0.348
Bobwhite quail	0.16	0.0125	0.078	0.0136	0.0851	0.0176	0.11	0.000470	20.000	0.02	1.13	22.600	0.05	0.0008	0.0160	0.95	—	—	0	19	10	1.0000	0.1234	1.8	0.069	0.18	0.69	292	29.2
Surface water/sediment-based receptors	**BW**	**IRww**	**NIRww**	**IRdw**	**NIRdw**	**IRww**	**NIRww**	**SW conc.**	**Sed conc.**	**DF sed**	**Fish BSAF**	**Fish conc.**	**DF fish**	**Crayfish BSAF**	**Crayfish conc.**	**DF crayfish**	**Aq. insect BSAF**	**Aq. insect conc.**	**DF aq. insect**	**Site area**	**Foraging area**	**SFF**	**Dose**	**LOAEL**	**LOAEL HQ**	**NOAEL**	**NOAEL HQ**	**LOAEL PRG**	**NOAEL PRG**
	(kg)	(kg/d)	(kg/kgbw-d)	(kg/d)	(kg/kgbw-d)	(L/d)	(L/kgbw-d)	(mg/L)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ha)	(ha)	(ratio)	(mg/kg-d)	(mg/kg-d)	(ratio)	(mg/kg-d)	(ratio)	(mg/kg)	(mg/kg)
Mink	0.78	0.3588	0.46	0.0560	0.0718	0.0616	0.079	0.000470	28.900	0.02	0.76	21.964	0.85	1.2	34.680	0.15	—	—	0	19	320	0.0595	0.6563	0.69	**1.0**	0.14	**4.7**	30.39	6.165
Little brown bat	0.0075	0.0068	0.90	0.0012	0.1642	0.0015	0.2	0.000470	28.900	0.01	—	—	0	—	—	0	2.2	63.580	1.0	19	5	1.0000	57.2695	0.795	**72.0**	0.079	**725**	0.4012	0.03987
Marsh wren	0.0094	0.0063	0.67	0.0027	0.2844	0.0025	0.27	0.000470	28.900	0.01	—	—	0	—	—	0	2.2	63.580	1.0	19	0.12	1.0000	42.6809	1.8	**23.7**	0.18	**237**	1.219	0.1219
Belted kingfisher	0.136	0.0680	0.50	0.0120	0.0886	0.0150	0.11	0.000470	28.900	0.01	0.76	21.964	0.73	—	—	0	2.2	63.580	0.27	19	1.2	1.0000	16.6258	1.8	**9.2**	0.18	**92.4**	3.129	0.3129

Notes:

Input parameters from PGDP Guidance, Vol. II (DOE/OR/07-1506/V2&D2), supplemented by EPA Exposure Factors Handbook (EPA 1993)
Dietary fraction for soil or sediment from EPA 1993, or estimated
NOAELs/LOAELs for birds and mammals from Sample, Opresko, and Suter II 1996
IRdw (passerine) = (((BW * 1000)^0.85) * 0.398)/1000 (EPA 1993 equation 3-4)
IRdw (non-passerine) = (((BW * 1000)^0.751) * 0.301)/1000 (EPA 1993 equation 3-5)
IRdw (rodents) = (((BW * 1000)^0.564) * 0.621)/1000 (EPA 1993 equation 3-8)
IRdw (non-rodent mammals) = (((BW * 1000)^0.822) * 0.235)/1000 (EPA 1993 equation 3-7)
Dietary fraction values from EPA 1993 (mean of all studies or location representative of Kentucky)
Water IR from EPA 1993 or estimated (bat)
BAF = measured or estimated tissue conc / soil or sediment conc
Dose = SUM (Food NIRww * Conc Prey1…x * DFPrey1…x * SFF) + (NIRdw * Conc Soil or Sed * DFSoil or SED* SFF) + (Water NIRww * SW Con
HQ = Dose / LOAEL or Dose / NOAEL
PRG = LOAEL or NOAEL / SUM ((Food NIRww * BAFPrey1…x * DFPrey1…x * SFF) + (NIRdw * DFsoil or Sed * SFF
= (LOAEL or NOAEL / Dose) * Existing Soil or Sediment Concentration
Differences in PRGs for any given receptor are due to differences in SFF for each area

Acronyms:

BAF – Bioaccumulation factor
BSAF – Biota-sediment accumulation factor
BW – Body weight
Conc. – Concentration
DF – Dietary fraction
dw – Dry weight
HQ – Hazard quotient
IR – Ingestion rate
LOAEL – Lowest observed adverse effect leve
NIR – Normalized ingestion rate
NOAEL – No observed adverse effect level
PRG – Preliminary remediation goal
SED – Sediment
SFF – Site foraging factor
SW – Surface water
ww – Wet weight

Table E3.3. Food Web Model for Total PCBs – Outfall 001

		Food				Water			Soil/sediment																			
Soil-based receptors	**BW**	**IRww**	**NIRww**	**IRdw**	**NIRdw**	**IRww**	**NIRww**	**SW conc.**	**Soil conc.**	**DF soil**	**Worm BAF**	**Worm conc.**	**DF worm**	**Veg. BAF**	**Veg. conc.**	**DF veg.**	**Mammal BAF**	**Mammal conc.**	**DF mammal**	**Site area**	**Foraging area**	**SFF**	**Dose**	**LOAEL**	**LOAEL HQ**	**NOAEL**	**NOAEL HQ**	**LOAEL PRG**	**NOAEL PRG**
	(kg)	(kg/d)	(kg/kgbw-d)	(kg/d)	(kg/kgbw-d)	(L/d)	(L/kgbw-d)	(mg/L)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ha)	(ha)	(ratio)	(mg/kg-d)	(mg/kg-d)	(ratio)	(mg/kg-d)	(ratio)	(mg/kg)	(mg/kg)
Short-tailed shrew	0.015	0.0255	1.7	0.0022	0.1451	0.0033	0.223	0.000470	0.400	0.02	1.13	0.452	0.89	0.0008	0.0003	0.11	—	—	0	15	0.39	1.0000	0.6852	0.668	**1.0**	0.067	**10.2**	0.390	0.0391
Meadow vole	0.02	0.0060	0.30	0.0034	0.1682	0.0035	0.175	0.000470	0.400	0.024	—	—	0	0.0008	0.0003	1.0	—	—	0	15	0.013	1.0000	0.0018	0.511	0.0035	0.051	0.035	119	11.9
American kestrel	0.119	0.0357	0.30	0.0109	0.0916	0.0137	0.115	0.000470	0.400	0.01	1.13	0.452	0.25	—	—	0	0.4	0.160	0.75	15	154	0.0960	0.0068	1.8	0.0038	0.18	0.038	106.7	10.67
American woodcock	0.15	0.1155	0.77	0.0282	0.1877	0.0150	0.10	0.000470	0.400	0.104	1.13	0.452	1.0	—	—	0	—	—	0	15	25	0.5913	0.2105	1.8	0.12	0.18	**1.2**	3.42	0.342
American robin	0.0773	0.0688	0.89	0.0160	0.2073	0.0108	0.14	0.000470	0.400	0.02	1.13	0.452	0.51	0.0008	0.0003	0.49	—	—	0	15	0.5	1.0000	0.2070	1.8	0.12	0.18	**1.2**	3.48	0.348
Bobwhite quail	0.16	0.0125	0.078	0.0136	0.0851	0.0176	0.11	0.000470	0.400	0.02	1.13	0.452	0.05	0.0008	0.0003	0.95	—	—	0	15	10	1.0000	0.0025	1.8	0.0014	0.18	0.014	292	29.2
Surface water/sediment-based receptors	**BW**	**IRww**	**NIRww**	**IRdw**	**NIRdw**	**IRww**	**NIRww**	**SW conc.**	**Sed conc.**	**DF sed**	**Fish BSAF**	**Fish conc.**	**DF fish**	**Crayfish BSAF**	**Crayfish conc.**	**DF crayfish**	**Aq. insect BSAF**	**Aq. insect conc.**	**DF aq. insect**	**Site area**	**Foraging area**	**SFF**	**Dose**	**LOAEL**	**LOAEL HQ**	**NOAEL**	**NOAEL HQ**	**LOAEL PRG**	**NOAEL PRG**
	(kg)	(kg/d)	(kg/kgbw-d)	(kg/d)	(kg/kgbw-d)	(L/d)	(L/kgbw-d)	(mg/L)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ww/dw)	(mg/kg)	(fraction)	(ha)	(ha)	(ratio)	(mg/kg-d)	(mg/kg-d)	(ratio)	(mg/kg-d)	(ratio)	(mg/kg)	(mg/kg)
Mink	0.78	0.3588	0.46	0.0560	0.0718	0.0616	0.079	0.000470	0.520	0.02	0.76	0.395	0.85	1.2	0.624	0.15	—	—	0	15	320	0.0462	0.0092	0.69	0.013	0.14	0.065	39.16	7.945
Little brown bat	0.0075	0.0068	0.90	0.0012	0.1642	0.0015	0.2	0.000470	0.520	0.01	—	—	0	—	—	0	2.2	1.144	1.0	15	5	1.0000	1.0305	0.795	**1.3**	0.079	**13.0**	0.4012	0.03987
Marsh wren	0.0094	0.0063	0.67	0.0027	0.2844	0.0025	0.27	0.000470	0.520	0.01	—	—	0	—	—	0	2.2	1.144	1.0	15	0.12	1.0000	0.7681	1.8	0.43	0.18	**4.3**	1.219	0.1219
Belted kingfisher	0.136	0.0680	0.50	0.0120	0.0886	0.0150	0.11	0.000470	0.520	0.01	0.76	0.395	0.73	—	—	0	2.2	1.144	0.27	15	1.2	1.0000	0.2992	1.8	0.17	0.18	**1.7**	3.129	0.3129

Input parameters from PGDP Guidance, Vol. II (DOE/OR/07-1506/V2&D2), supplemented by EPA Exposure Factors Handbook (EPA 1993)
Dietary fraction for soil or sediment from EPA 1993, or estimated
NOAELs/LOAELs for birds and mammals from Sample, Opresko, and Suter II 1996
IRdw (passerine) = (((BW * 1000)^0.85) * 0.398)/1000 (EPA 1993 equation 3-4)
IRdw (non-passerine) = (((BW * 1000)^0.751) * 0.301)/1000 (EPA 1993 equation 3-5)
IRdw (rodents) = (((BW * 1000)^0.564) * 0.621)/1000 (EPA 1993 equation 3-8)
IRdw (non-rodent mammals) = (((BW * 1000)^0.822) * 0.235)/1000 (EPA 1993 equation 3-7)
Dietary fraction values from EPA 1993 (mean of all studies or location representative of Kentucky)
Water IR from EPA 1993 or estimated (bat)
BAF = measured or estimated tissue conc / soil or sediment conc
Dose = SUM (Food NIRww * Conc Prey1…x * DFPrey1…x * SFF) + (NIRdw * Conc Soil or Sed * DFSoil or SED* SFF) + (Water NIRww * SW Co
HQ = Dose / LOAEL or Dose / NOAEL
PRG = LOAEL or NOAEL / SUM ((Food NIRww * BAFPrey1…x * DFPrey1…x * SFF) + (NIRdw * DFsoil or Sed * SFF
= (LOAEL or NOAEL / Dose) * Existiing Soil or Sediment Concentration

Acronyms:

BAF	Bioaccumulation factor
BSAF	Biota-sediment accumulation factor
BW	Body weight
Conc.	Concentration
DF	Dietary fraction
dw	Dry weight
HQ	Hazard quotient
IR	Ingestion rate
LOAEL	Lowest observed adverse effect leve
NIR	Normalized ingestion rate
NOAEL	No observed adverse effect level
PRG	Preliminary remediation goal
SED	Sediment
SFF	Site foraging factor
SW	Surface water
ww	Wet weight

APPENDIX F

EVALUATION OF LABORATORY QUALIFIED DATA

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CONTENTS

TABLES

FIGURES

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ACRONYMS

EU	exposure unit
GC	gas chromatograph
mg/kg	milligram per kilogram
NSDD	North-South Diversion Ditch
OU	operable unit
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
QC	quality control

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F1. EVALUATION OF LABORATORY QUALIFIED DATA

Data quality ordinarily is evaluated on the basis of its uncertainty when compared with the expected end-use requirements. If the data are consistent and the uncertainty is adequate for the intended use, the data are considered to be of acceptable quality. The purpose of this appendix is to present information that allows for a better understanding of the uncertainties associated with the total polychlorinated biphenyl (Total PCB) results that exceeded the established calibration range or limit of linearity of the laboratory gas chromatographs (GC). This evaluation determines that the data quality of these Total PCB results is acceptable for decision making.

F1.1 BACKGROUND

The objective of Activity 1 sampling was to obtain data that would be used to identify "hot spots" in surface soil and sediment in each of the outfalls, in their associated internal ditches and areas, and in Sections 3, 4, and 5 of the North-South Diversion Ditch (NSDD). Activity 1 analyses included specific indicator analytes (cesium-137, uranium-238, and Total PCBs) that were used to determine the extent of contamination in these areas. Results of Total PCB analyses also were used to develop exposure point concentrations. The associated indicator levels used for Sections 3, 4, and 5 of the NSDD were 1 picocurie per gram (pCi/g) cesium-137, 10 pCi/g uranium-238, and 1 milligram per kilogram (mg/kg) Total PCBs. Associated indicator chemical levels used for the outfalls were 10 pCi/g cesium-137, 100 pCi/g uranium-238, and 20 mg/kg Total PCBs. A total of 2,575 samples [this includes base and contingency samples and their associated duplicates, but excludes the remainder of the field quality control (QC) samples] was collected for Total PCB analysis during Activity 1. Of the 2,575 Total PCB sample results, 173 Total PCB analyses exceeded the established calibration range or limit of linearity of the GCs and were assigned an "E" qualifier by the laboratory.

The objective of Activity 2 sampling was to obtain data that would be used to characterize contamination in soils and sediments in each of the outfalls, in their associated internal ditches and areas, and in Sections 3, 4, and 5 of the NSDD and to further delineate "hot spots." Activity 2 analyses consisted of a comprehensive suite of chemical and radiological parameters, including Total PCBs. The Activity 2 data were used to develop source terms to support transport modeling and were used to develop exposure point concentrations for each exposure unit (EU) to support the baseline human health risk assessment. There were 388 samples (this includes base and contingency samples and their associated duplicates, but excludes the remainder of the field QC samples) collected for Total PCB analysis during Activity 2. Of the 388 Total PCB sample results, 16 Total PCB analyses exceeded the established calibration range or limit of linearity of the laboratory GCs and were assigned an "E" qualifier by the laboratory.

F1.2 DISCUSSION

The data quality objectives for the Surface Water Operable Unit (OU) Site Investigation project required a laboratory reporting limit for Total PCBs of 0.1 mg/kg. This, in turn, set the upper calibration limit for Total PCBs at 0.7 mg/kg. The reporting limit was very low and assumed that all PCB concentrations would be environmental in nature (i.e., very low levels of Total PCBs). Of the 2,963 Activity 1 and Activity 2 samples, 189 samples from various EU locations contained Total PCB concentrations that exceeded the upper established calibration range or limit of linearity of the laboratory GCs. In some cases, laboratory dilutions were made in an attempt to reduce the Total PCB concentrations to the established GC calibration range (EPA 2005a). Some diluted samples still contained concentrations of PCBs that exceeded the established calibration range or limit of linearity of the laboratory GCs.

The assignment of an "E" qualifier by the laboratory indicates uncertainty in the reported concentration of the chemical (in this case Total PCBs), but not in its assigned identity; therefore, it can be stated that the "E" qualified data sets contain PCBs, and the data can be used in a similar manner as other positive or detectable data that do not have assigned laboratory qualifiers (EPA 1989). The uncertainty with "E" qualified data lies in determining the exact concentration of Total PCBs and, as a result, the data are considered estimated.

The following actions were taken in order to better understand the uncertainties associated with the "E" qualified data and to improve the decision making process:

- Conducted a review of the laboratory methodology (EPA 2005a; 2005b) and data validation (EPA 1999; 2005c), data usability, and risk assessment regulatory guidance documents (EPA 1989);
- Confirmed laboratory audit status and certifications;
- Interviewed laboratory personnel to review raw data sets, Quality Assurance/QC, and chromatograms associated with "E" qualified data;
- Reanalyzed a subset of the original samples that were "E" qualified within the calibration range to determine variability within data sets (see Attachment 1);
- Conducted a special analytical study that evaluated the error range of data sets analyzed outside of the calibration range (linearity and precision) (see Attachment 2); and
- Conferred with subject matter experts in areas of analytical methodology, data validation, data usability, and risk assessment.

This evaluation determined that, overall, the results that exceeded the calibration range for Total PCBs exhibited a low-bias. (For samples above the calibration range, all reported values were lower than the true values.) Recoveries from the analytical study ranged from approximately 80% at 5 mg/kg to approximately 60% at 50 mg/kg. A least-squares linear regression analysis of the results of the four linearity studies of the two available GCs yielded equations for calculation of the Aroclor 1016 and Aroclor 1260 concentrations for samples exceeding the calibration range of the GCs. The following equation assumes the definition of a straight line in an *x*- and *y*- coordinate system: $y = mx + b$

where

y = calculated value (approximate PCB concentration),

m = slope of the line,

x = given value (laboratory reported concentration), and

b = y-axis intercept (correction factor).

Both of the derived equations (for Aroclor 1016 and Aroclor 1260) have a small standard deviation ($R^2 = 0.9881$ and 0.9826, respectively) (i.e., high confidence of correlation).

For example:

Aroclor 1016 concentration = (1.73 x reported Aroclor 1016 Result) – 0.85

For an Aroclor 1016 reported result of 30 mg/kg, the approximate Aroclor 1016 result would be [(1.73 x 30) – 0.85] mg/kg = 51.05 mg/kg.

and

Aroclor 1260 concentration = (1.52 x reported Aroclor 1260 Result) – 0.59

For an Aroclor 1260 reported result of 30 mg/kg, the approximate Aroclor 1260 result would be [(1.52 x 30) – 0.59] mg/kg = 45.01 mg/kg.

In addition, precision studies indicate that the GCs used to perform PCB analysis are very stable above the calibration limits, with an instrument precision range of 0.0% to 0.6% and an associated error of 0.0 mg/kg to 0.37 mg/kg. This was confirmed through the reanalysis of a subset of the original samples that had exceeded the calibration range or limit of linearity of the laboratory GCs. Review of the laboratory methodology and data reporting protocol further indicated that the appropriate data qualifiers with the appropriate data references and narratives had been used to describe the quality of the data produced by the laboratory.

Data validation/data usability guidelines (EPA 1999; 2005c) confirmed that the data are of known quality and that the data should be treated as a positive result with the associated numerical value indicating an approximate or estimated concentration, and further qualified with a “J” qualifier. Risk assessment guidance states that the assignment of an “E” qualifier by the laboratory and a “J” qualifier during the validation process indicates uncertainty in the reported concentration of the chemical, but not in its assigned chemical identity; therefore, it can be used in a similar manner as other positive or detectable data that do not have assigned laboratory qualifiers and should be included as part of a quantitative risk assessment (EPA 1989).

F2. SUMMARY

Based on this evaluation, the uncertainty associated with the “E” qualified data is minimal and the qualified data sets are of known quality. The data are consistent and adequate for the intended use. As a result, the data are of acceptable quality for use in decision making. It should be noted that since the qualified data sets exhibit a low-bias, the data user will need to consider the low-bias when making decisions based on Total PCB results close to the removal action level (i.e., Outfall 001, EU13 and Outfall 011, EU1). Linearity tables can be used to estimate the concentrations of Total PCBs in the samples with “E” qualified results when making decisions.

F3. REFERENCES

EPA (U.S. Environmental Protection Agency) 1989. *Risk Assessment Guidance for Superfund (RAGS) Part A, EPA/540/1-89/002,* December.

EPA 1999. *Contract Laboratory Program National Functional Guidelines for Organic Data Review EPA-540/R-99-008,* October.

EPA 2005a. *SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Method; Chapter 1, Method 8000B, and Method 8082,* January.

EPA 2005b. Region 4 *Laboratory Operations and Quality Assurance Manual,* October.

EPA 2005c. *Contract Laboratory Program National Functional Guidelines for Organic Data Review, OSWER 9240.1-46, USEPA-540-R-04-009 (Final Draft),* January.

ATTACHMENT 1

REANALYZED DATA SET LABORATORY SUMMARY

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SUMMARY OF THE PADUCAH UNITED STATES ENRICHMENT CORPORATION ANALYTICAL LABORATORY
(E-MAIL DATED JUNE 21, 2006)

Nine Surface Water OU solid samples were reanalyzed to assess the "E"-qualified Total PCB results. The samples were extracted by SW-846 method 3540 and then diluted and analyzed by SW-846 method 8082. Samples were analyzed for Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, and Aroclor-1268. A Total PCB value then was derived by summing the individual Aroclor results. The laboratory analyzed a blank between each sample to demonstrate that there was no carryover between samples.

(Note that the samples had been stored in the sample management area of the laboratory and were transferred to the PCB laboratory for extraction and analysis. These samples had not been stored at the required temperature since the original analysis. The samples used in this reanalysis were well outside of the specified holding time for PCBs.)

Table F1.1 presents the data associated with the original analysis and the reanalysis, where the samples were diluted to Total PCB concentrations within the calibration range of the laboratory GCs.

Table F1.1. PCB Data: Original Results and Reanalysis Results

Laboratory Sample Number	Sample Number	Original Result (mg/kg)	Reanalyzed Dilution Result (mg/kg)
C052710065	OF08AC-903	36.9 E	33.3 D
C052300143	OF10A-300	7.59 E	13.1 D
C052300144	OF10A-308	1.23 E	1.57 D
C052410051	OF01A-444	8.77 E	13.9 D
C052520088	OF01A-397	12.6 E	11.1 D
C052450036	OF01A-404	16.2 E	15.0 D
C052710045	OF10AC-907	16.0 E	17.6 D
C052710031	OF01AC-903	13.9 E	18.6 D

Notes: "E" indicates that the result exceeded the calibration curve.
"D" indicates that the sample was diluted.

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ATTACHMENT 2

LABORATORY ANALYTICAL STUDY LINEARITY AND PRECISION

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SURFACE WATER OPERABLE UNIT
PCB DATA DISCUSSION SUMMARY

On July 14, 2006, discussions were held with representatives of the United States Enrichment Corporation Analytical Laboratory to further clarify the acceptability of the “E” qualified Total PCB data generated for the Surface Water OU Project. Four specific topics were presented and discussed.

1. The data validator’s concern that some chromatographic baselines were too “noisy” and prevented accurate quantitation (see excerpt provided on page F2-4).

2. What bias should be associated with results that were “E” qualified because their concentrations exceeded the GC calibration range?

3. What estimates for the actual values of “E” qualified data could be provided?

4. How stable were the chromatographic systems at levels above the calibration limits and what effect did this have on the results?

Discussion:

1. The chromatograms supplied with data packages for data validation do not represent the full capabilities of current instrumentation/software to identify, resolve, and accurately quantify the peaks of target analytes. Pages F2-4 through F2-6 are the validator’s comments and the data report and chromatogram from a data package. Pages F2-7 and F2-8 are examples of the laboratory’s capability to isolate and magnify specific portions of the chromatogram for evaluation of proper integration and any effect of interference. The data on page F2-9 evaluates the potential effect of background interference on the reported concentration. The peak at 19.6 minutes (see chromatogram on page F2-8), easily distinguishable from the baseline, was processed as if it had been included in the calculations. As shown, the reported concentrations would have been elevated a maximum of ~ 2% to 9%. The “noisy” baselines do not materially affect the accuracy of reported results at these levels.

2. Each Surface Water OU sample was analyzed using one or both of two calibration ranges on one of three GCs. Linearity studies using each calibration have been completed on two of these GCs. The third GC currently is being used to analyze samples and its study will be completed when the GC becomes available. Figure F2.1 through Figure F2.8 and Table F2.1 through Table F2.4 present the data and plots of the information. Above the calibration range, reported values were lower than true values. Recoveries ranged from ~ 80% at 5 mg/kg to ~ 60% at 50 mg/kg.

3. Table F2.1 through Table F2.4 can be used to estimate approximate values from “E” qualified data. For example, samples containing ~ 20 mg/kg Aroclor 1016 would have been reported as having from 12–14 mg/kg depending upon the instrument and calibration used.

4. Precision studies were performed for both GCs to determine their stability at concentration levels above the calibration ranges. Table F2.5 and Table F2.6 contain the data and results from the precision studies. Two data points for Aroclor-1260 on GC#2 were considered to be outliers and were not included in the calculations. Instrument precision ranged from 0.0%–0.6% and the associated error ranged from 0.0 mg/kg –0.37 mg/kg.

EXCERPT FROM DATA VALIDATION REPORT

The following is an excerpt from the data validation report.

> *The lines on the chromatogram are a representation of the calibration range and not the actual calibration range determined from the ICAL.*
>
> *Also please pay close attention to the scaling of the chromatograms as the response scale varies greatly from one detected sample to another.*
>
> *Sample OF15B-02-03 (K015A20102)*
>
> *From the chromatogram, you can see well defined peaks with very little or no interference from the other peaks. However, it can also be seen that the detected Aroclor results exceeded the calibration range; therefore, the amount reported is an estimated value, but could be close to what is actually present due to the fact that there is little interference present.*
>
> *Sample OF11B-01-01 and OF11B-01-01D (K011A201)*
>
> *There is more noise on these chromatograms. Several of the smaller peaks intersect with identified Aroclor peaks creating interferences and indicating the peak may not have returned to the baseline. This will affect the amount of Aroclor detected in the sample. It can also be seen that the amounts exceed the calibration range. It could not be ascertained to what degree this affects the results. As the amount of Aroclor present is so questionable, the results should not be used.*

Analy Meth:SW846-6020 QC Batch: Test:ST7108SWOU Rpt Basis:None Date Approved
Prep Meth: SW846-3051 Analyzed:09/08/05 08:01:15 A R HERNDON Approver: C D SCHNEIDER 09/09/05 12:36

Analyte Name	Result	+/-	Unit	Qual	Fn	LCR	Dilu	HT	CLF
Arsenic	4.94		mg/kg	U		4.94	5		
Uranium	611		mg/kg	B		49.4	50		

EPA Qualifiers:

* - Duplicate analysis not within control limits.
B - Applies when the analyte is found in the associated blank
N - Sample spike recovery not within control limits.
U - Analyte analyzed for but not detected at or below the lowest concentration reported.
X - Other specific flags and footnotes may be required to properly define the results

---

Analy Meth:SW846-8082 QC Batch: Test:OA-7100SWOU Rpt Basis:None Date Approved
Prep Meth: SW846-3540 Analyzed:08/23/05 17:40:00 C L MILLS Approver: T L BRAZELL 08/26/05 07:38

Analyte Name	Result	+/-	Unit	Qual	Fn	LCR	Dilu	HT	CLF
PCB, Total	7.56		mg/kg	E		0.12	1		
PCB-1016	0.09		mg/kg	U		0.09	1		
PCB-1221	0.12		mg/kg	U		0.12	1		
PCB-1232	0.09		mg/kg	U		0.09	1		
PCB-1242	0.05		mg/kg	U		0.05	1		
PCB-1248	0.09		mg/kg	U		0.09	1		
PCB-1254	0.08		mg/kg	U		0.08	1		
PCB-1260	7.56		mg/kg	E		0.09	1		
PCB-1268	0.07		mg/kg	U		0.07	1		

Analy Meth:SW846-3540 QC Batch: Test:OA-7102 Rpt Basis:None Date Approved
Prep Meth: Analyzed:08/15/05 00:00:00 C L MILLS Approver: C L MILLS 08/17/05 05:11

Analy Meth:SW846-8270 QC Batch: Test:OA-7301 Rpt Basis:None Date Approved
Prep Meth: SW846-3540 Analyzed:08/24/05 11:42:00 D J RUTHERFORD Approver: T L BRAZELL 09/07/05 14:03

Analyte Name	Result	+/-	Unit	Qual	Fn	LCR	Dilu	HT	CLF
Acenaphthene	5300		ug/kg	J		460	1		
Acenaphthylene	460		ug/kg	J		460	1		
Anthracene	11000		ug/kg	EJ		460	1		
Benzo(a)anthracene	39000		ug/kg	EJ		460	1		
Benzo(a)pyrene	40000		ug/kg	EJ		460	1		
Benzo(b)fluoranthene	67000		ug/kg	EJ		460	1		
Benzo(ghi)perylene	18000		ug/kg	EJ		460	1		
Benzo(k)fluoranthene	25000		ug/kg	EJ		460	1		
Chrysene	41000		ug/kg	EJ		460	1		
Dibenz(a,h)anthracene	5300		ug/kg	J		460	1		
Fluoranthene	52000		ug/kg	EJ		460	1		

```
                    Quantitation Report      (QT Reviewed)
Data File : J:\PCB\GC01\A050822\SMPL040.D\ECD1A.CH          Vial: 40
Acq On    : 23 Aug 2005    4:58 pm                      Operator: C.L. Mills
Sample    : OF11B-01-01D    C052240049                  Inst    : GC_01
Misc      : 10.9407-10mL                                Multiplr: 1.00
IntFile   : EVENTS.E

Data File : J:\PCB\GC01\A050822\SMPL040.D\ECD2B.CH          Vial: 40
Acq On    : 23 Aug 2005    5:40 pm                      Operator: C.L. Mills
Sample    : OF11B-01-01D    C052240049                  Inst    : GC_01
Misc      : 10.9407-10mL                                Multiplr: 1.00
IntFile   : EVENTS2.E
Quant Time: Aug 25 12:26 2005   Quant Results File: SOIL01.RES

Quant Method  : C:\HPCHEM\1\METHODS\SOIL01.M (Chemstation Integrator)
Title         : SW-846 Method 8082
Last Update   : Thu Aug 25 10:42:11 2005
Response via  : Multiple Level Calibration
DataAcq Meth  : SOIL01.M

Volume Inj.       :
Signal #1 Phase   :                  Signal #2 Phase:
Signal #1 Info    :                  Signal #2 Info :
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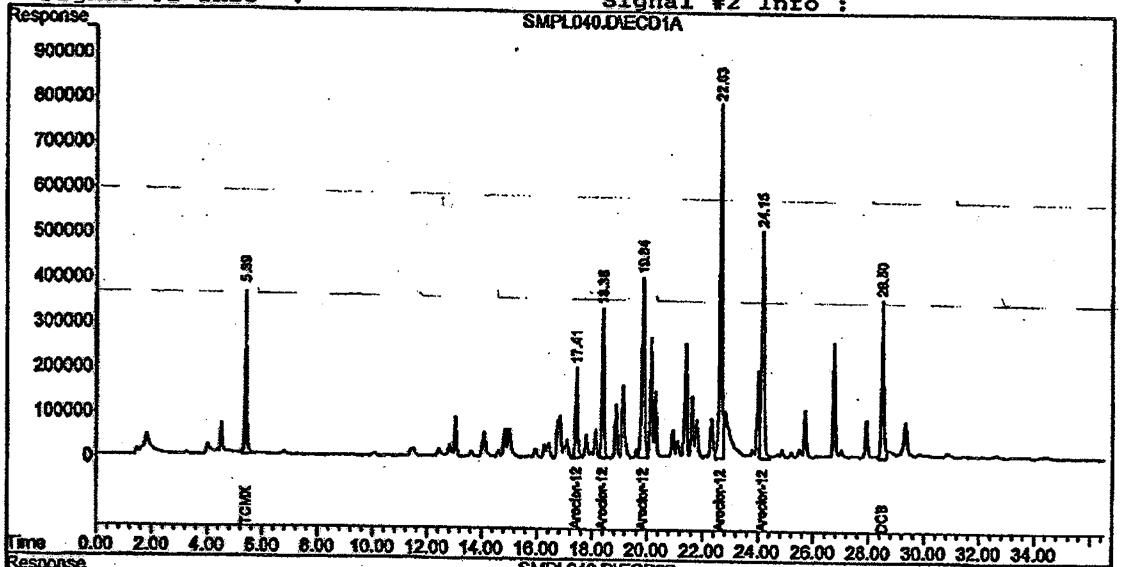

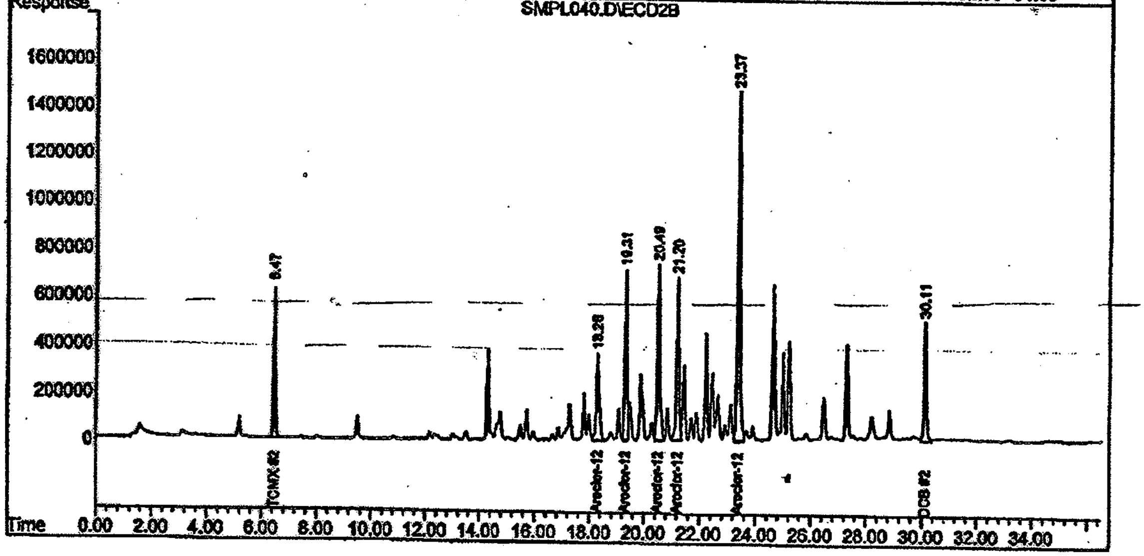

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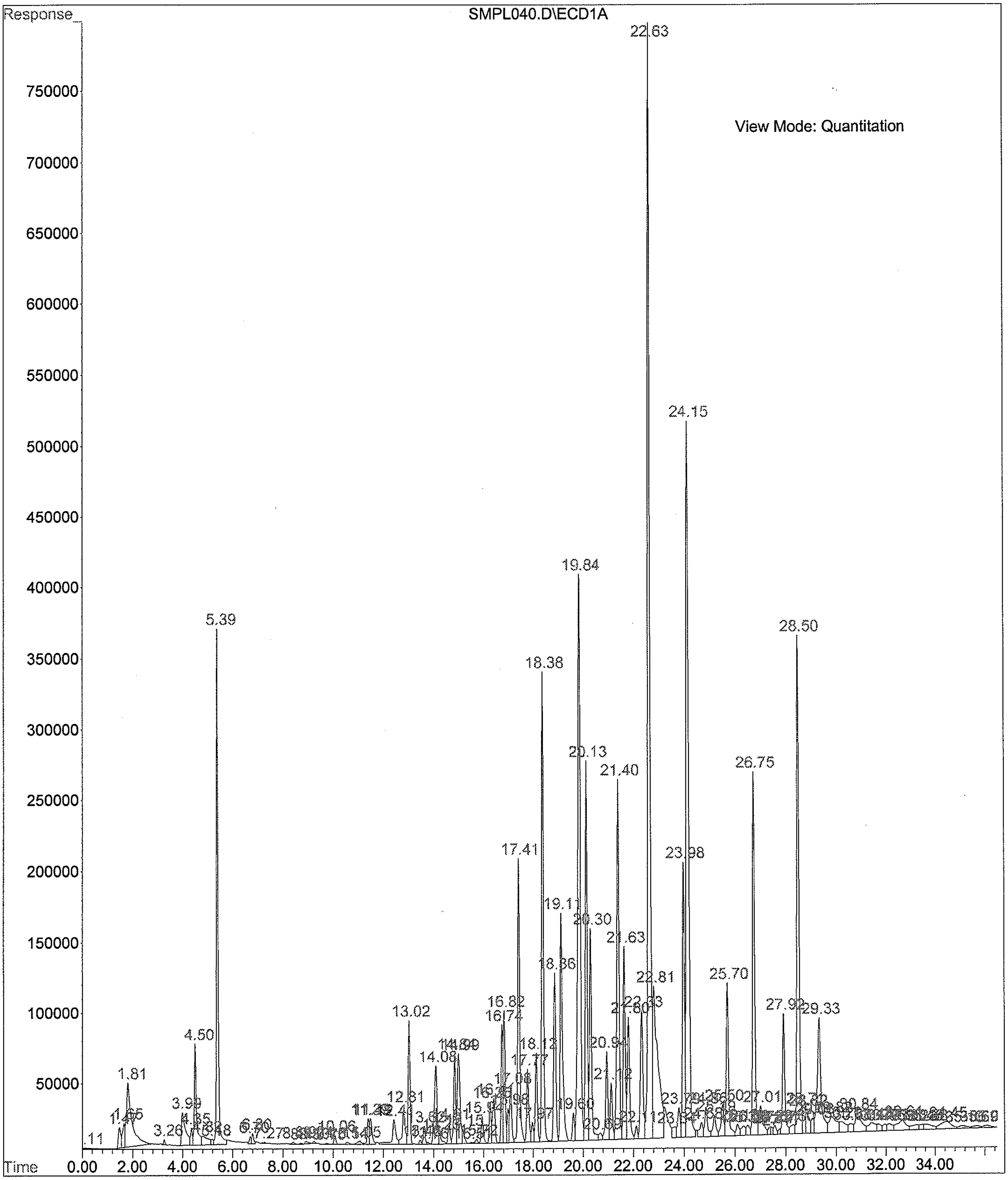
File        : J:\PCB\GC01\A050822\SMPL040.D
Operator    : C.L. Mills
Acquired    : 23 Aug 2005   4:58 pm using AcqMethod SOIL01.M
Instrument  :   GC_01
Sample Name: OF11B-01-01D   C052240049
Misc Info   : 10.9407-10mL
Vial Number: 40
```

Front Column



```
                         Quantitation Report (Qedit)

    Data File : J:\PCB\GC01\A050822\SMPL040.D\ECD1A.CH          Vial: 40
    Acq On    : 23 Aug 2005   4:58 pm                       Operator: C.L. Mills
    Sample    : OF11B-01-01D   C052240049                   Inst     : GC_01
    Misc      : 10.9407-10mL                                Multiplr: 1.00
    IntFile   : EVENTS.E

    Data File : J:\PCB\GC01\A050822\SMPL040.D\ECD2B.CH          Vial: 40
    Acq On    : 23 Aug 2005   5:40 pm                       Operator: C.L. Mills
    Sample    : OF11B-01-01D   C052240049                   Inst     : GC_01
    Misc      : 10.9407-10mL                                Multiplr: 1.00
    IntFile   : EVENTS2.E
    Quant Time: Aug 25 12:26 2005  Quant Results File: SOIL01.RES


    Method         : C:\HPCHEM\1\METHODS\SOIL01.M (Chemstation Integrator)
    Title          : SW-846 Method 8082
    Last Update    : Wed Jul 12 12:30:20 2006
    Response via   : Multiple Level Calibration
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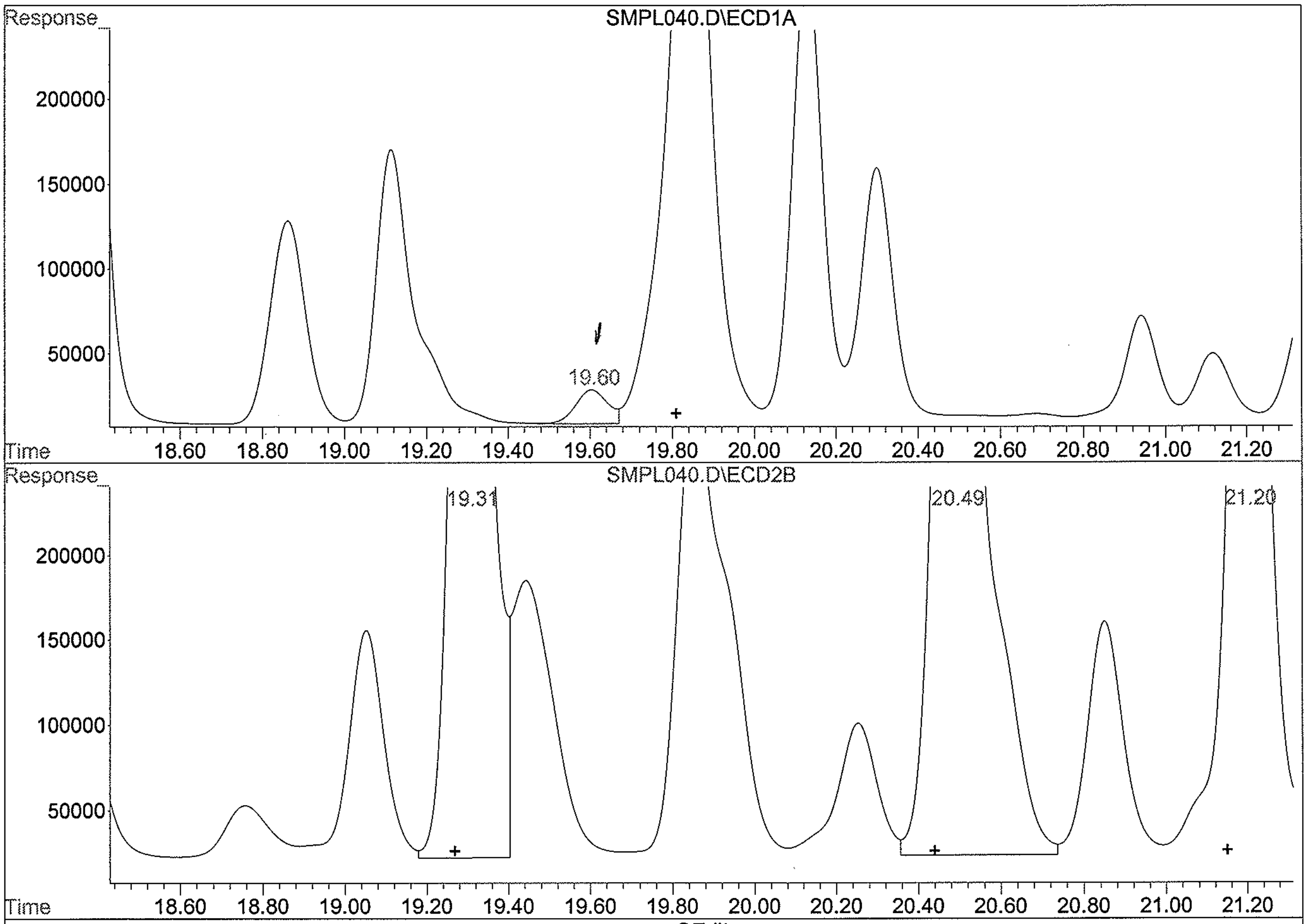

QEdit

```
(31) Aroclor-1260 #2 (L7)
  R.T.  Response  Conc
 17.41  11438656  6175.11
 18.38  17043455  6958.74
 19.60   1083015   296.92
 21.40  14695278  3484.15
 24.15  35963472  10281.61

(31) Aroclor-1260 #2 (L7)
  R.T.  Response  Conc
 18.28  27727827  6836.16
 19.31  40998881  7266.69
 20.49  51268308  7694.43
 21.20  40532007  9497.07
 23.37  94163816  10066.26
```

```
 (+) = Expected Retention Time
SMPL040.D  SOIL01.M       Thu Jul 13 13:57:26 2006
```

Effect of Background on Concentration

Sample Number	Reported Conc. (mg/kg)	Peak R.T (minutes)	Peak Area	Baseline Area	Interference (%)	Conc. From Interference (7.56 x %) (mg/kg)	Adjusted Concentration (mg/kg)
C052240049 OF11B-01-01D	7.56	17.41	11438656	1083015	9.4	.71	6.85
		18.38	17043455	1083015	6.3	.50	7.06
		19.84	28990750	1083015	3.7	.23	7.33
		22.62	48576860	1083015	2.2	.17	7.39
		24.15	35963472	1083015	3.0	.23	7.33

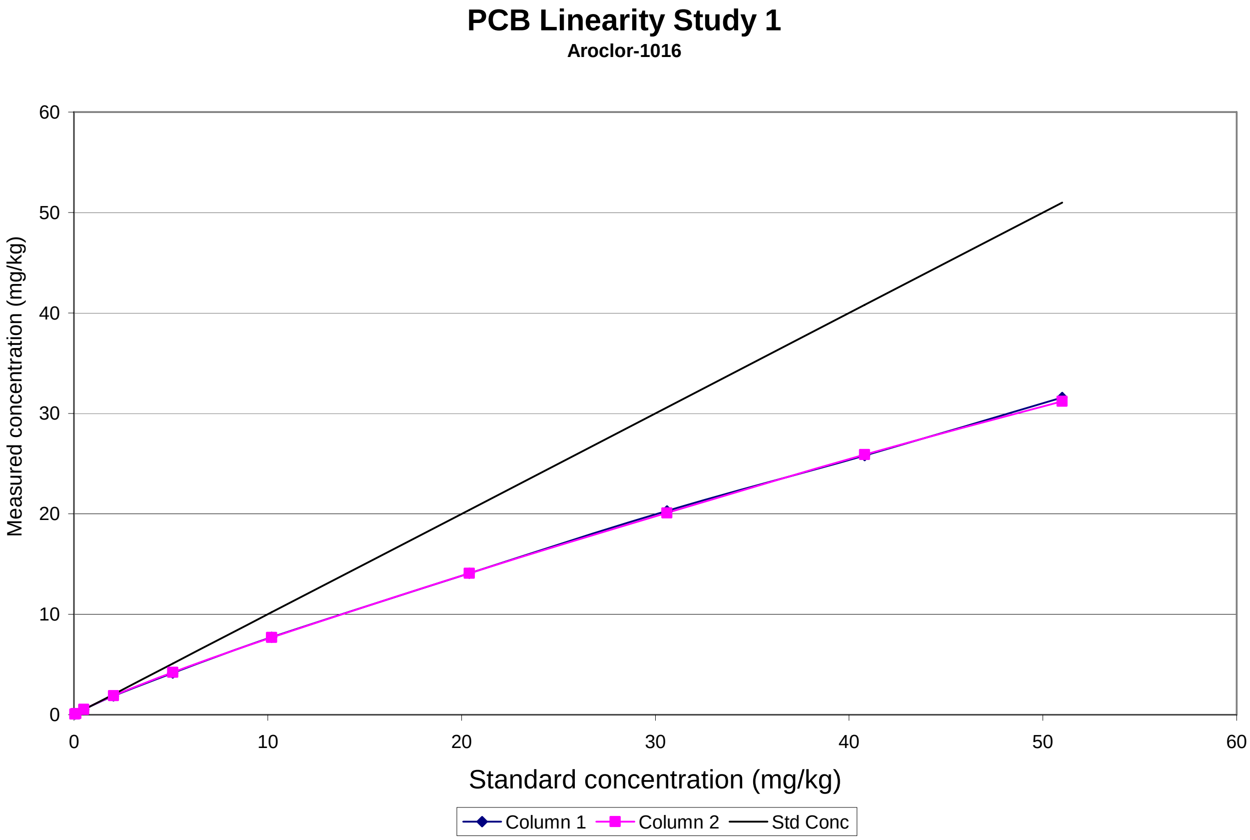

Figure F2.1. PCB Linearity Study 1—Aroclor-1016

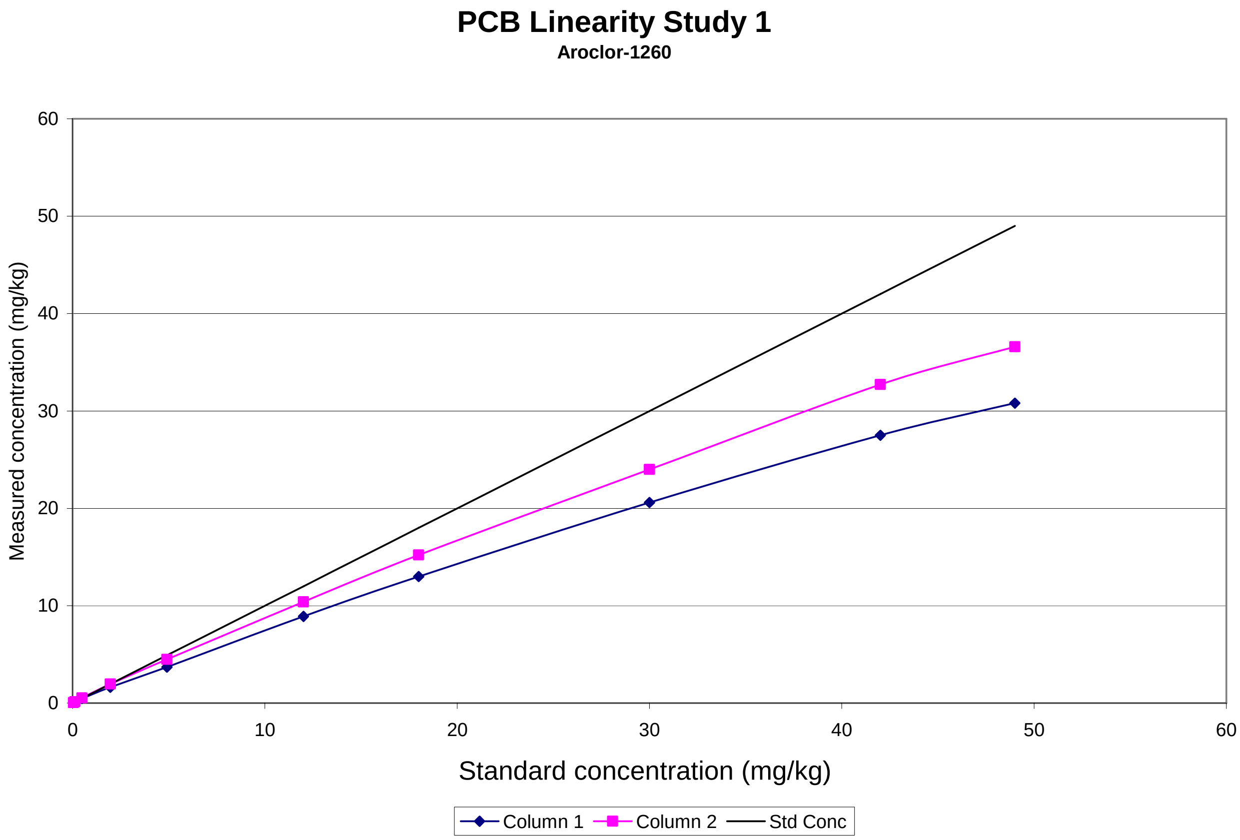

Figure F2.2. PCB Linearity Study 1—Aroclor-1260

Table F2.1. PCB Linearity Study—GC-03, 7/13/06 Calibration (0.54–5.0 mg/kg)

Column		Front		Back		
Std. #	Conc.	Result	%	Result	%	
Aroclor 1016		Column 1		Column 2		Std Conc
1	0.051	0.061	119.61	0.063	123.53	0.051
2	0.102	0.119	116.67	0.121	118.63	0.102
3	0.51	0.523	102.55	0.536	105.10	0.51
4	2.04	1.88	92.16	1.89	92.65	2.04
5	5.1	4.15	81.37	4.23	82.94	5.1
6	10.2	7.73	75.78	7.71	75.59	10.2
7	20.4	14.1	69.12	14.1	69.12	20.4
8	30.6	20.3	66.34	20.1	65.69	30.6
9	40.8	25.8	63.24	25.9	63.48	40.8
10	51	31.6	61.96	31.2	61.18	51
Aroclor 1260						
1	0.049	0.054	110.20	0.054	110.20	0.049
2	0.12	0.127	105.83	0.134	111.67	0.12
3	0.49	0.464	94.69	0.538	109.80	0.49
4	1.96	1.63	83.16	1.95	99.49	1.96
5	4.9	3.7	75.51	4.48	91.43	4.9
6	12	8.9	74.17	10.4	86.67	12
7	18	13	72.22	15.2	84.44	18
8	30	20.6	68.67	24	80.00	30
9	42	27.5	65.48	32.7	77.86	42
10	49	30.8	62.86	36.6	74.69	49

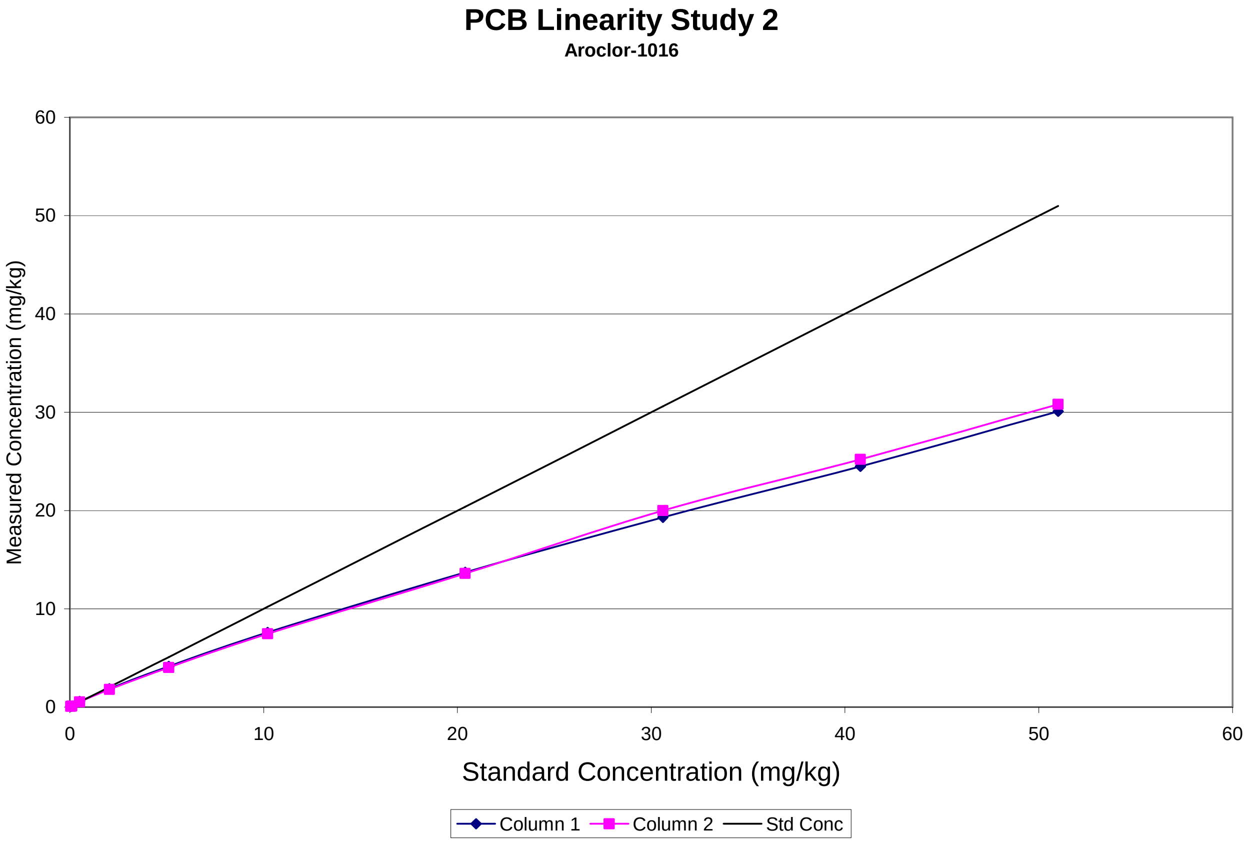

Figure F2.3. PCB Linearity Study 2—Aroclor-1016

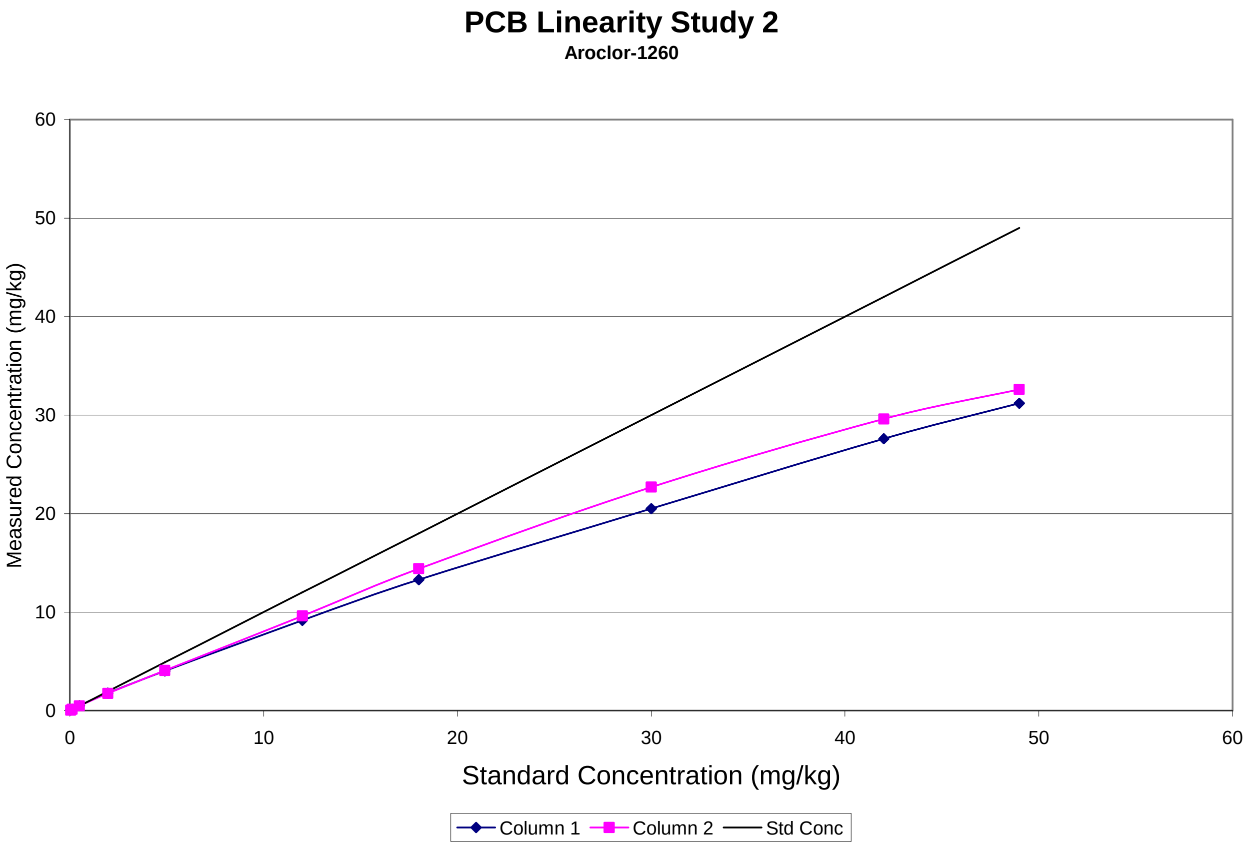

Figure F2.4. PCB Linearity Study 2—Aroclor-1260

Table F2.2. PCB Linearity Study 2—GC-03, 7/13/06 (0.54 to > 5.0 mg/kg)

Column		Front		Back		
Std. #	Conc.	Result	%	Result	%	
Aroclor 1016		Column 1		Column 2		Std Conc
1	0.051	0.063	123.5	0.062	121.57	0.051
2	0.102	0.118	115.7	0.118	115.69	0.102
3	0.510	0.569	111.6	0.533	104.51	0.510
4	2.04	1.86	91.2	1.8	88.24	2.04
5	5.10	4.15	81.4	4.04	79.22	5.10
6	10.20	7.61	74.6	7.47	73.24	10.20
7	20.40	13.7	67.2	13.6	66.67	20.40
8	30.60	19.3	63.1	20	65.36	30.60
9	40.80	24.5	60.0	25.2	61.76	40.80
10	51.00	30.1	59.0	30.8	60.39	51.00
Aroclor 1260						
1	0.049	0.058	118.4	0.054	110.20	0.049
2	0.123	0.143	116.6	0.132	107.67	0.123
3	0.490	0.513	104.7	0.491	100.20	0.490
4	1.96	1.77	90.3	1.76	89.80	1.96
5	4.90	4.03	82.2	4.07	83.06	4.90
6	12.00	9.16	76.3	9.61	80.08	12.00
7	18.00	13.3	73.9	14.4	80.00	18.00
8	30.00	20.5	68.3	22.7	75.67	30.00
9	42.00	27.6	65.7	29.6	70.48	42.00
10	49.00	31.2	63.7	32.6	66.53	49.00

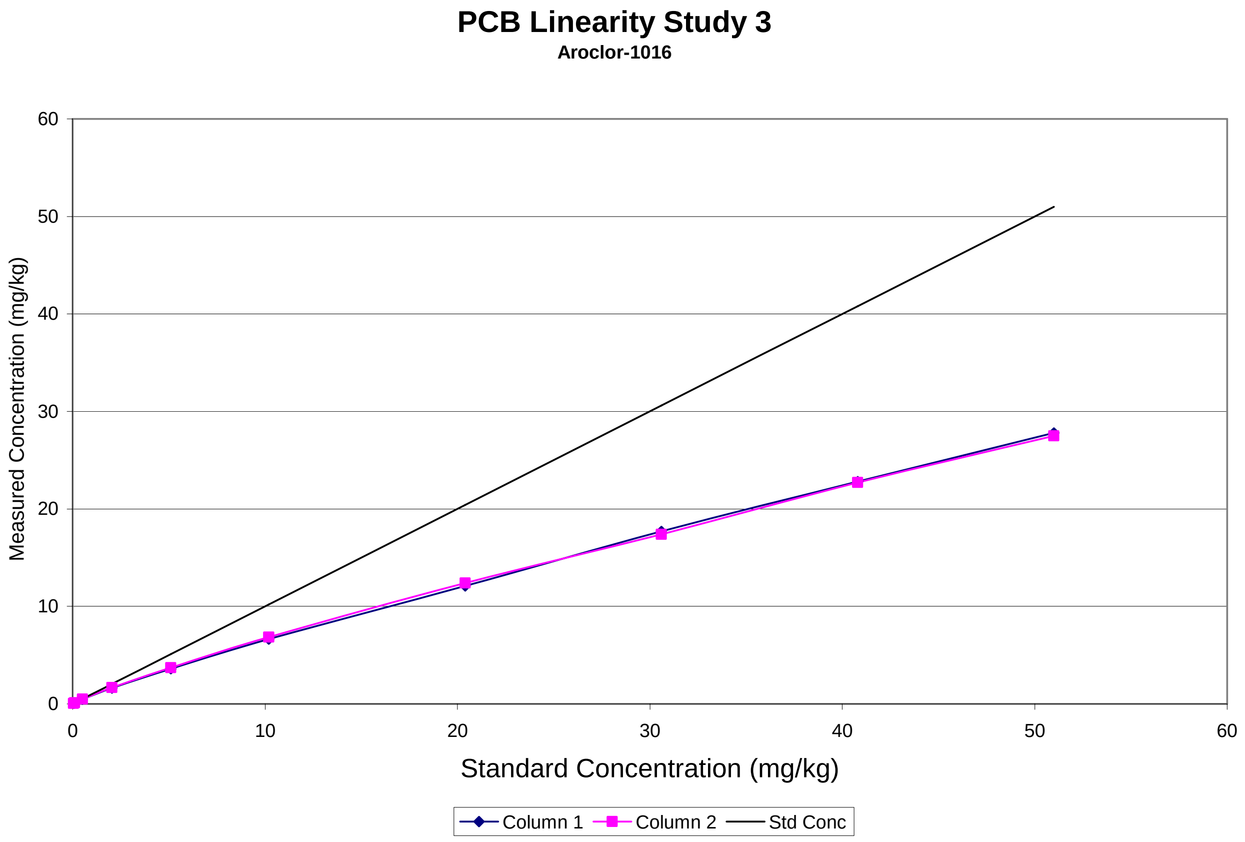

Figure F2.5. PCB Linearity Study 3—Aroclor-1016

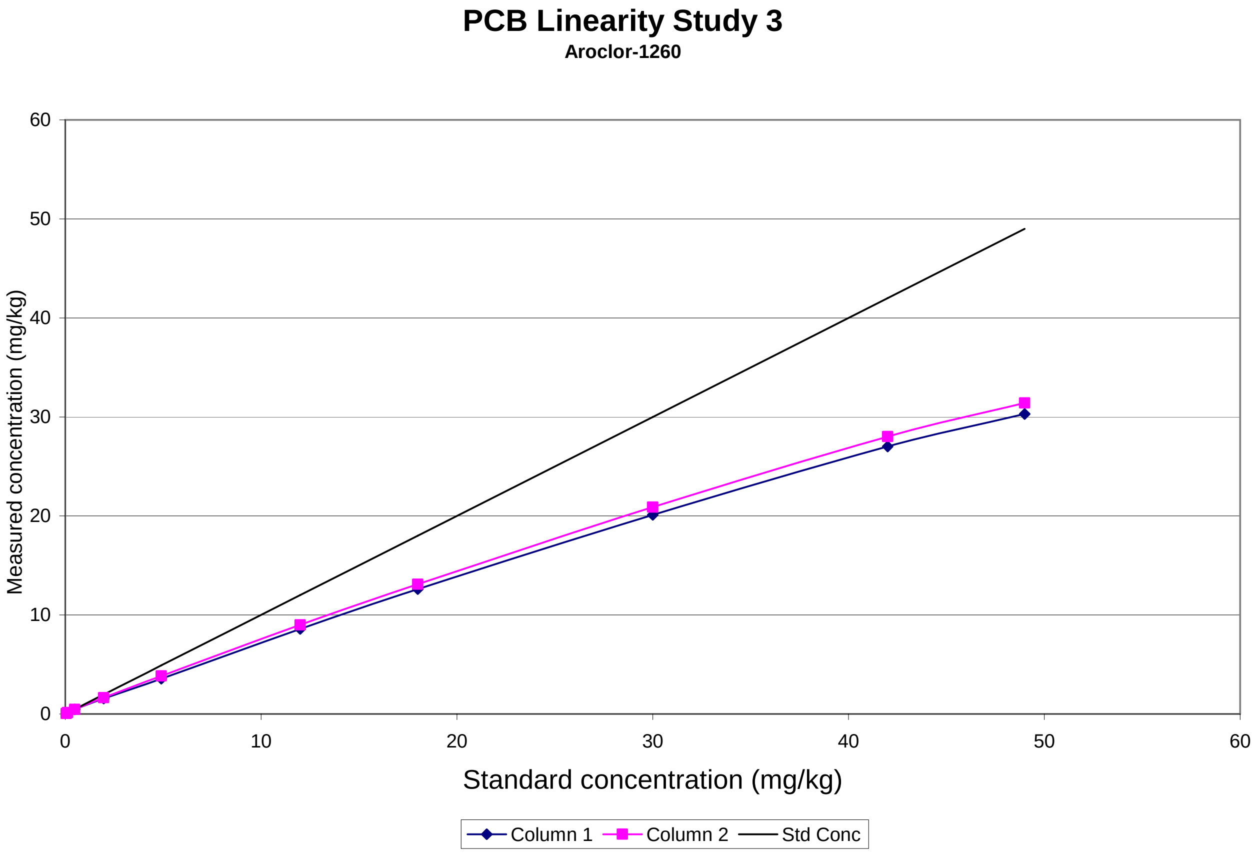

Figure F2.6. PCB Linearity Study 3—Aroclor-1260

Table F2.3. PCB Linearity Study 3—GC-01, 7/13/06 Calibration (0.1–0.7 mg/kg)

Column		Front		Back		
Std. #	Conc.	Result	%	Result	%	
Aroclor 1016		Column 1		Column 2		Std Conc
1	0.051	0.053	103.9	0.053	103.92	0.051
2	0.102	0.101	99.0	0.107	104.90	0.102
3	0.510	0.475	93.1	0.488	95.69	0.510
4	2.040	1.62	79.4	1.67	81.86	2.040
5	5.100	3.6	70.6	3.71	72.75	5.100
6	10.200	6.63	65.0	6.86	67.25	10.200
7	20.400	12.1	59.3	12.4	60.78	20.400
8	30.600	17.7	57.8	17.4	56.86	30.600
9	40.800	22.8	55.9	22.7	55.64	40.800
10	51.000	27.8	54.5	27.5	53.92	51.000
Aroclor 1260						
1	0.049	0.053	108.2	0.048	97.96	0.049
2	0.123	0.125	102.0	0.128	104.40	0.123
3	0.490	0.459	93.7	0.474	96.73	0.490
4	1.960	1.55	79.1	1.66	84.69	1.960
5	4.900	3.57	72.9	3.84	78.37	4.900
6	12.000	8.58	71.5	9	75.00	12.000
7	18.000	12.6	70.0	13.1	72.78	18.000
8	30.000	20.1	67.0	20.9	69.67	30.000
9	42.000	27	64.3	28	66.67	42.000
10	49.000	30.3	61.8	31.4	64.08	49.000

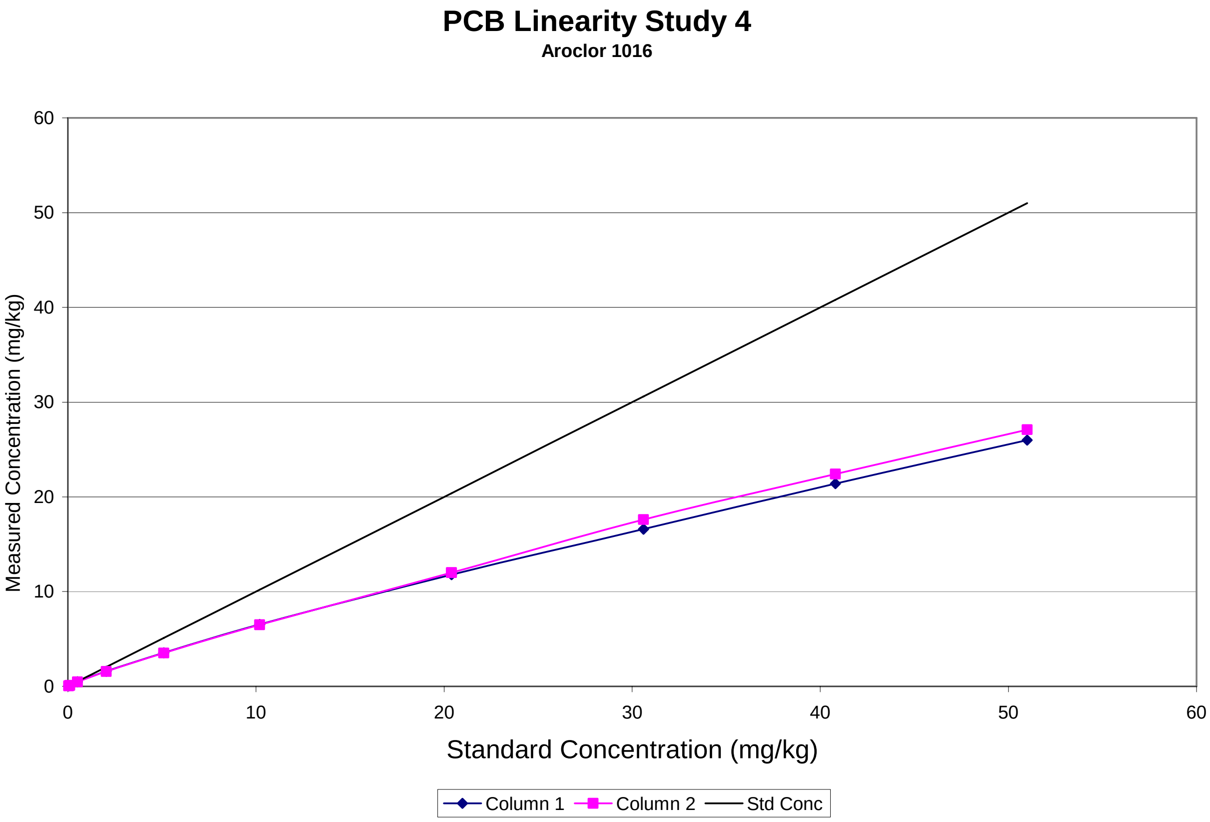

Figure F2.7. PCB Linearity Study 4—Aroclor 1016

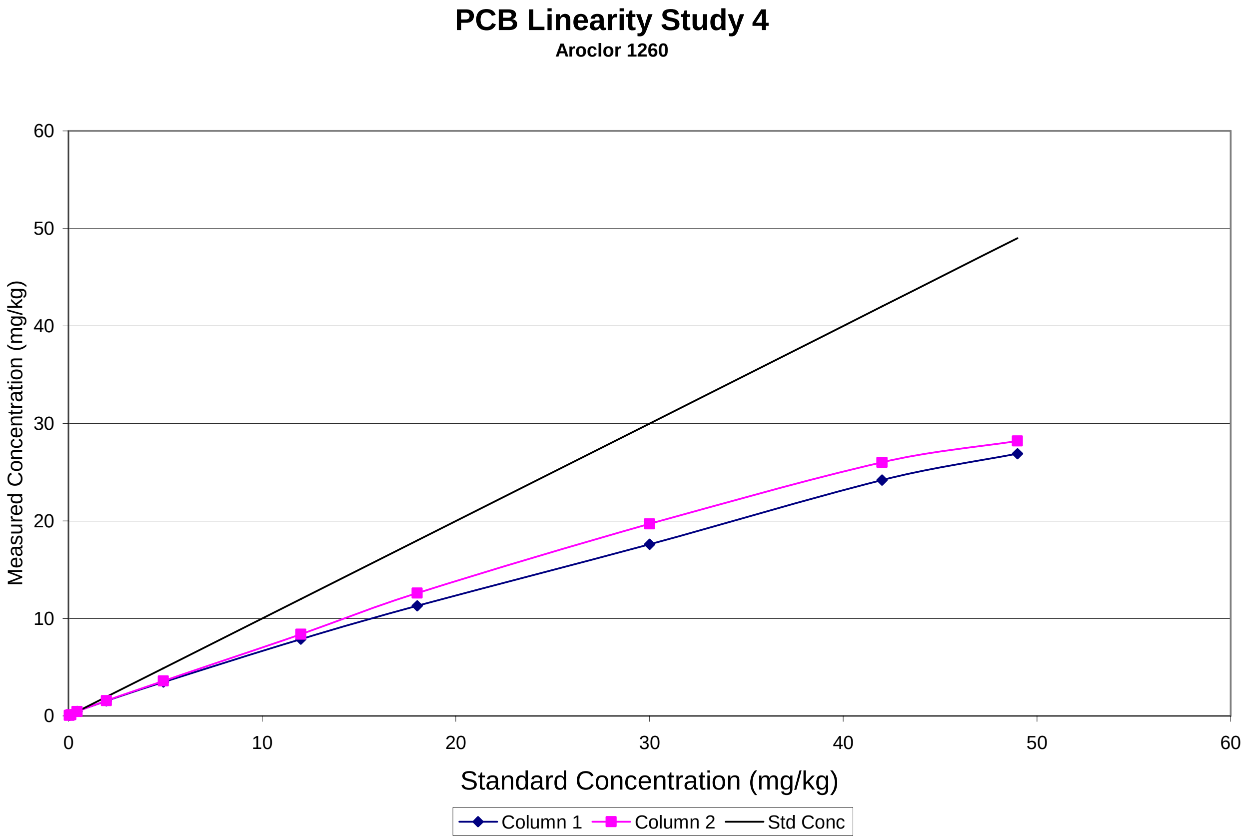

Figure F2.8. PCB Linearity Study 4—Aroclor 1260

Table F2.4. PCB Linearity Study 4—GC-03, 7/17/06 Calibration (0.1– 0.7 mg/kg)

Column		Front		Back		
Std. #	Conc.	Result	%	Result	%	
Aroclor 1016		Column 1		Column 2		Std Conc
1	0.051	0.054	105.9	0.055	107.84	0.051
2	0.102	0.101	99.0	0.104	101.96	0.102
3	0.510	0.482	94.5	0.467	91.57	0.510
4	2.04	1.6	78.4	1.57	76.96	2.04
5	5.10	3.55	69.6	3.52	69.02	5.10
6	10.20	6.55	64.2	6.5	63.73	10.20
7	20.40	11.8	57.8	12	58.82	20.40
8	30.60	16.6	54.2	17.6	57.52	30.60
9	40.80	21.4	52.5	22.4	54.90	40.80
10	51.00	26	51.0	27.1	53.14	51.00
Aroclor 1260						
1	0.049	0.053	108.2	0.052	106.12	0.049
2	0.130	0.125	96.2	0.12	92.31	0.130
3	0.446	0.459	102.9	0.449	100.67	0.446
4	1.96	1.53	78.1	1.56	79.59	1.96
5	4.90	3.46	70.6	3.58	73.06	4.90
6	12.00	7.87	65.6	8.38	69.83	12.00
7	18.00	11.3	62.8	12.6	70.00	18.00
8	30.00	17.6	58.7	19.7	65.67	30.00
9	42.00	24.2	57.6	26	61.90	42.00
10	49.00	26.9	54.9	28.2	57.55	49.00

Table F2.5. PCB Precision Study—GC #1
(10–50 ppm mg/kg)

Aroclor	1016	1016	1016	1016	1016		1260	1260	1260	1260	1260
Conc.	10.2	20.4	30.6	40.8	51		12.3	18.4	30.60	42.90	49.00
Value	6.69	12.1	17.7	22.8	27.4		8.68	12.6	20.1	27.2	30.0
	6.69	12.2	17.5	22.9	27.4		8.69	12.7	20.1	27.3	30.1
	6.7	12.2	17.5	**23.0**	27.5		8.75	12.7	20.0	**27.3**	30.1
	6.73	12.2	17.5	23.0	27.5		8.73	12.7	20.1	27.3	30.1
	6.72	12.2	17.7	22.9	27.5		8.74	12.7	20.1	27.3	30.0
	6.74	12.2	17.7	23.0	27.6		8.71	12.7	20.1	27.3	30.2
	6.81	12.2	17.5	23.0	27.6		8.74	12.7	20.1	27.4	30.2
	6.77	12.2	17.5	23.1	27.5		8.78	12.8	20.1	27.4	30.1
	6.63	12.1	17.5	23.2	27.7		8.58	12.6	20.1	27.5	30.2
mean	6.7	12.2	17.6	23.0	27.5		8.7	12.7	20.1	27.3	30.1
Std Dev	0.05	0.04	0.10	0.12	0.10		0.06	0.06	0.03	0.09	0.08
Precision (%)	0.77	0.36	0.57	0.51	0.35		0.67	0.47	0.17	0.32	0.26
Error, 99% +/-	0.16	0.13	0.30	0.35	0.29		0.17	0.18	0.10	0.26	0.23
Range	6.56 – 6.88	12.0 – 12.3	17.3 – 17.9	22.6 – 23.4	27.2 – 27.8		8.54 – 8.88	12.51 – 12.87	20.0 – 20.2	27.0 – 27.6	29.8 – 30.3

Table F2.6. PCB Precision Study—GC #2
(10–50 ppm mg/kg)

Aroclor	1016	1016	1016	1016	1016		1260	1260	1260	1260	1260
Conc.	10.2	20.4	30.6	40.8	51		12.3	18.4	30.60	42.90	49.00
Value	6.49	11.8	16.6	21.4	25.7		7.85	12.6	17.60	24.30	26.70
	6.58	11.8	16.6	21.4	25.7		7.97	12.7	17.70	24.30	26.70
	6.59	11.8	16.6	**24.8**	25.7		7.94	12.7	17.60	**28.40**	26.70
	6.59	11.8	16.7	21.3	25.7		7.94	12.7	17.90	24.20	26.70
	6.59	11.8	16.8	21.3	25.6		7.97	12.7	17.90	24.20	26.60
	6.58	11.8	16.7	21.3	25.7		7.95	12.7	17.80	24.50	26.70
	6.61	11.8	16.7	21.4	25.8		7.97	12.7	17.80	24.30	26.80
	6.58	11.8	16.7	21.3	25.7		7.95	12.8	17.80	24.30	26.80
	6.55	11.8	16.6	21.4	25.7		7.87	12.6	17.60	24.30	26.70
mean	6.57	11.80	16.67	21.73	25.70		7.93	12.69	17.74	24.76	26.71
Std Dev	0.04	0.00	0.07	1.15	0.05		0.04	0.06	0.12	1.37	0.06
Precision (%)	0.53	0.00	0.42	5.30	0.19		0.56	0.47	0.70	5.53	0.22
Error, 99% +/-	0.11	0.00	0.21	3.45	0.15		0.13	0.18	0.37	4.11	0.18
Range	6.46 – 6.68	11.8	16.5 – 16.9	18.3 – 25.2	25.6 – 25.8		7.80 – 8.06	12.51 – 12.87	17.4 – 18.1	20.7 – 28.9	26.5 – 26.9

Precision	0.25	Precision	0.38
Error	0.16	Error	0.28
Range	21.2- 21.5	Range	24.0-24.6

Bolded points are outliers.