PADUCAH
Remediation Services
A Portage Shaw Joint Venture Company

761 Veterans Ave.
Kevil, KY 42053

October 22, 2008

ENM-L-0904

Ms. Sandy Gruzesky, Director
Kentucky Department for Environmental Protection
Division of Water
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Gruzesky:

TRANSMITTAL OF THE PUBLISHED *PADUCAH SITE ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2006*, VOLUMES I AND II

Paducah Remediation Services, LLC, (PRS) is transmitting to the Kentucky Division of Water (KDOW), the published copy of the *Paducah Site Annual Site Environmental Report for Calendar Year 2006*, Volumes I and II.

During the Kentucky Pollutant Discharge Elimination System (KPDES) permit renewal process, KDOW requested a copy of the Annual Site Environmental Report, pursuant to the publication of the document. PRS is authorized, as co-permittee of the KPDES permit, to distribute this approved report.

Enclosed is a CD containing both volumes of this report. Volume I is comprised of a data summary of monitoring results, as well as informational text defining achievements and historical background of the site. Volume II is a data presentation of raw data, which was summarized within Volume I.

This document also may be viewed on the PRS Web Site at http://www.prs-llc.net under Public Documents.

If you have any questions or require additional information, please contact Tracey Duncan at (270) 441-5167.

Sincerely,

Russell Boyd, P.E., Site Manager
Paducah Remediation Services, LLC

In accordance with the requirements of Contract DE-AC30-06EW05001 and as acknowledged by the above signature, I hereby certify that the information provided in this transmittal has been prepared in accordance with all applicable requirements and the information is, to the best of my knowledge and belief, true, accurate, and complete.

RB:TLD:kjw

Enclosure
CD of the *Paducah Site Annual Site Environmental Report for Calendar Year 2006,* Volumes I and II

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PRS-ENM-0034
Volume I

PADUCAH SITE

Annual Site Environmental Report

2006

Fractions and Multiples of Units

Multiple	Decimal Equivalent	Prefix	Symbol	Engineering Format
10^{6}	1,000,000	mega-	M	E+06
10^{3}	1,000	kilo-	k	E+03
10^{2}	100	hecto-	h	E+02
10	10	deka-	da	E+01
10^{-1}	0.1	deci-	d	E-01
10^{-2}	0.01	centi-	c	E-02
10^{-3}	0.001	milli-	m	E-03
10^{-6}	0.000001	micro-	µ	E-06
10^{-9}	0.000000001	nano-	n	E-09
10^{-12}	0.000000000001	pico-	P	E-12
10^{-15}	0.000000000000001	femto-	F	E-15
10^{-18}	0.000000000000000001	atto-	a	E-18

This report is intended to fulfill the requirements of U. S. Department of Energy (DOE) Order 231.1 Change 2. The data and information contained in this report were collected in accordance with the Paducah Site Environmental Monitoring Plan (BJC 2005) approved by DOE. This report is not intended to provide the results of all sampling conducted at the Paducah Site. Additional data collected for other site purposes, such as environmental restoration, remedial investigation reports, and waste management characterization sampling, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or federal or state laws.

PRS-ENM-0034
Volume I

Paducah Site

Annual Site Environmental Report for Calendar Year 2006

September 2008

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

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06EW05001

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Tables

Acronyms and Abbreviations

ACO	Administrative Order by Consent
AIP	Agreement in Principle
^{241}Am	americium-241
AO	Agreed Order
AOC	Area of Concern
ASER	Annual Site Environmental Report
ASTM	American Society of Testing and Materials
BCHT	Blended Chemical Heat Treatment™
BJC	Bechtel Jacobs Company LLC
CAA	Clean Air Act
CAB	Paducah Citizens Advisory Board
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
Ci	curie
COE	U.S. Army Corps of Engineers
^{137}Cs	cesium-137
CSOU	comprehensive site operable unit
CWA	Clean Water Act
CX	categorical exclusion
CY	calendar year
D&D	decontamination and decommissioning
DCG	derived concentration guideline
DMSA	DOE Material Storage Area
DNAPL	dense nonaqueous-phase liquid
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	U. S. Department of Energy Consolidated Audit Program
DQO	data quality objective
DUF_6	depleted uranium hexafluoride
EA	environmental assessment
EDD	electronic data deliverable
EIC	Environmental Information Center
EIS	environmental impact statement
EM	environmental management
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EQADMP	Environmental Services Quality Assurance and Data Management Plan
FFA	Federal Facility Agreement
FFC Act	Federal Facility Compliance Act
FFCA	Federal Facility Compliance Agreement
FR	*Federal Register*
FS	feasibility study
ft	foot (feet)
FY	fiscal year
GDP	gaseous diffusion plant
gpy	gallons per year
HAP	hazardous air pollutant
HSWA	Hazardous and Solid Waste Amendments

ICRP	International Commission on Radiological Protection
IRA	interim remedial action
KAR	*Kentucky Administrative Regulations*
KCHFS	Kentucky Cabinet for Health and Family Services
KDAQ	Kentucky Division for Air Quality
KDEP	Kentucky Department for Environmental Protection
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
^{40}K	potassium-40
kg	kilogram(s)
km	kilometer(s)
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
KYREG	Kentucky regulations
L	liter(s)
LLW	low-level waste
LPAF	Liquid Pollution Abatement Facility
LRGA	Lower Regional Gravel Aquifer
LUC	land use control
LUCIP	Land Use Control Implementation Plan
MAM	Massac Creek Mile
m	meter(s)
MCL	maximum contaminant level
mHBI	modified Hilsenhoff Biotic Index
µg	microgram(s)
mg	milligrams(s)
MGD	million gallons per day
mR	milliRoentgen(s)
mrem	millirem(s)
MW	monitoring well
ND	not detected
NEPA	National Environmental Policy Act
NEPCS	Northeast Plume Containment System
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NOV	notice of violation
^{237}Np	neptunium-237
NPL	National Priorities List
NR	not reported
NRHP	National Register of Historic Places
NSDD	North-South Diversion Ditch
NWPGS	Northwest Plume Groundwater System
OREIS	Oak Ridge Environmental Information System
OS	outside
OU	operable unit
PCB	polychlorinated biphenyl
pCi	picocurie(s)
PEMS	Project Environmental Measurement Systems
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen-ion concentration
ppb	parts per billion
PPE	personal protective equipment

ppm	part per million
PRS	Paducah Remediation Services, LLC
^{239}Pu	plutonium-239
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RDSI	Remedial Design Support Investigation
RGA	Regional Gravel Aquifer
RHTAB	Radiation Health and Toxic Agents Branch
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SI	site investigation
SMCL	Secondary Maximum Contaminant Level
SMO	Sample Management Office
SMP	Site Management Plan
SOW	statement of work
^{90}Sr	strontium-90
STP	Site Treatment Plan
SVOA	semivolatile organic analyte
SWMU	solid waste management unit
^{99}Tc	technetium-99
TCE	trichloroethene
^{230}Th	thorium-230
TLD	thermoluminescent dosimeter
TSCA	Toxic Substances Control Act
TTL	Target Treatment Level
TVA	Tennessee Valley Authority
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
U_3O_8	triuranium octoxide
UCRS	Upper Continental Recharge System
UE	uranium enrichment
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
URGA	Upper Regional Gravel Aquifer
USEC	United States Enrichment Corporation
UST	underground storage tank
VOA	volatile organic analyte
VOC	volatile organic compound
WAG	waste area group
WFM	West Fork of Massac Creek Mile
WKWMA	West Kentucky Wildlife Management Area
WMP	Watershed Monitoring Program
WM/PP	waste minimization/pollution prevention

Request for Comments

The U.S. Department of Energy (DOE) requires an annual site environmental report from each of the sites operating under its authority. This report presents the results from the various environmental monitoring programs and activities carried out during the year. This *Paducah Site Annual Site Environmental Report for Calendar Year 2006* was prepared to fulfill DOE requirements. This report is a public document that is distributed to government regulators, businesses, special interest groups, and members of the public.

This report is based on thousands of environmental samples collected at or near the Paducah Site. Significant efforts were made to provide the data collected and details of the site environmental management programs in a clear and concise manner. The editors of this report encourage comments in order to better address the needs of our readers in future site environmental reports. Please send comments to the following address:

U.S. Department of Energy
Portsmouth/Paducah Project Office
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

1 Site Operation and Overview

Abstract

The Paducah Gaseous Diffusion Plant (PGDP), located in McCracken County, Kentucky, has been producing enriched uranium since 1952. In July 1993, the U.S. Department of Energy (DOE) leased the production areas of the site to the United States Enrichment Corporation (USEC), a private company. DOE maintains responsibility for the environmental restoration, legacy waste management, nonleased facilities management, uranium hexafluoride (UF_6) cylinder management, and decontamination and decommissioning (D&D)/DOE Material Storage Area (DMSA) programs. DOE also implements an environmental monitoring and management program to ensure protection of human health and the environment and compliance with all applicable regulatory requirements. This document summarizes calendar year (CY) 2006 environmental management (EM) activities, including effluent monitoring, environmental surveillance, and environmental compliance status. It also highlights significant site program efforts conducted by DOE and its contractors and subcontractors at the Paducah Site. ***This report does not include USEC environmental monitoring activities.***

Introduction

DOE requires that environmental monitoring be conducted and documented for all of its facilities under the purview of DOE Order 231.1 Change 1, *Environment, Safety, and Health Reporting*. Several other laws, regulations, and DOE directives require compliance with environmental standards. The purpose of this Annual Site Environmental Report (ASER) is to summarize CY 2006 EM activities at the Paducah Site, including effluent monitoring, environmental surveillance, and environmental compliance status, and to highlight significant site program efforts. Paducah Site programs were coordinated by DOE's remediation contractor, Paducah Remediation Services, LLC, (PRS) beginning April 24, 2006. From January 1 to April 23, 2006, Bechtel Jacobs Company LLC (BJC) was the managing and integrating contractor. References in this report to the Paducah Site generally mean the property, programs, and facilities at or near PGDP for which DOE has ultimate responsibility.

Environmental monitoring consists of the following two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the direct measurement or the collection and analysis of samples of liquid and gaseous discharges to the environment. Environmental surveillance is the direct measurement or the collection and analysis of samples consisting of ambient air, water, soil, biota, and other media. Environmental monitoring is performed to characterize and quantify contaminants, assess radiation exposure, demonstrate compliance with applicable standards and permit requirements, and detect and assess the

effects, if any, on the local population and environment. Multiple samples are collected throughout the year and are analyzed for radioactivity, chemical content, and various physical attributes.

The overall goals for DOE/EM are to protect site personnel, the environment, Paducah Site neighbors, and to maintain full compliance with all current environmental regulations. The current environmental strategy is to prevent non-compliance, to identify any current compliance issues, and to develop a system for resolution. The long-range goal of DOE/EM is to reduce exposures of the public, workers, and biota to harmful chemicals and radiation.

Background

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. During World War II, 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. In October 1950, as a result of joint recommendations from the DOD, Department of State, and the Atomic Energy Commission, President Truman directed the Atomic Energy Commission to expand further 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 complete until 1954, production of enriched uranium began in 1952.

The plant's mission of uranium enrichment has continued unchanged, and the original facilities still are in operation, albeit with substantial upgrading and refurbishment. Of the 7,566 acres acquired by the Atomic Energy Commission, 1,361 acres subsequently were transferred to the 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 [West Kentucky Wildlife Management Area (WKWMA)]. DOE's current holdings at the Paducah Site total 3,424 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 grams of plutonium-239 (^{239}Pu), 18,400 grams of neptunium-237 (^{237}Np), and 661,000 grams of technetium-99 (^{99}Tc). The majority of the ^{239}Pu and ^{237}Np was separated out during the initial chemical conversion to UF_6. Concentrations of transuranics (e.g., ^{239}Pu and ^{237}Np) and ^{99}Tc 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 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; the Legacy Waste Management Program, including all waste inventories predating July 1, 1993; and wastes generated by subsequent DOE activities. DOE and its managing contractors are responsible for Kentucky Pollutant Discharge Elimination System (KPDES) compliance at outfalls not leased to USEC. DOE also has retained responsibility 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 DOE and its contractor are co-operators for Resource Conservation and Recovery Act (RCRA)-permitted facilities and are responsible for compliance with the RCRA permit.

Description of Site Locale

Location

The Paducah Site is located in a generally rural area of McCracken County, Kentucky. The center of PGDP is about 10 miles west of Paducah, Kentucky, and 3 miles south of the Ohio River (Figure 1.1). The industrial portion of PGDP is situated within a fenced security area and constitutes about 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. Of the remaining 2,676 acres, a 689-acre "buffer zone" that surrounds PGDP has been designated as unsecured industrial land. There are no residences on DOE property at the Paducah Site.

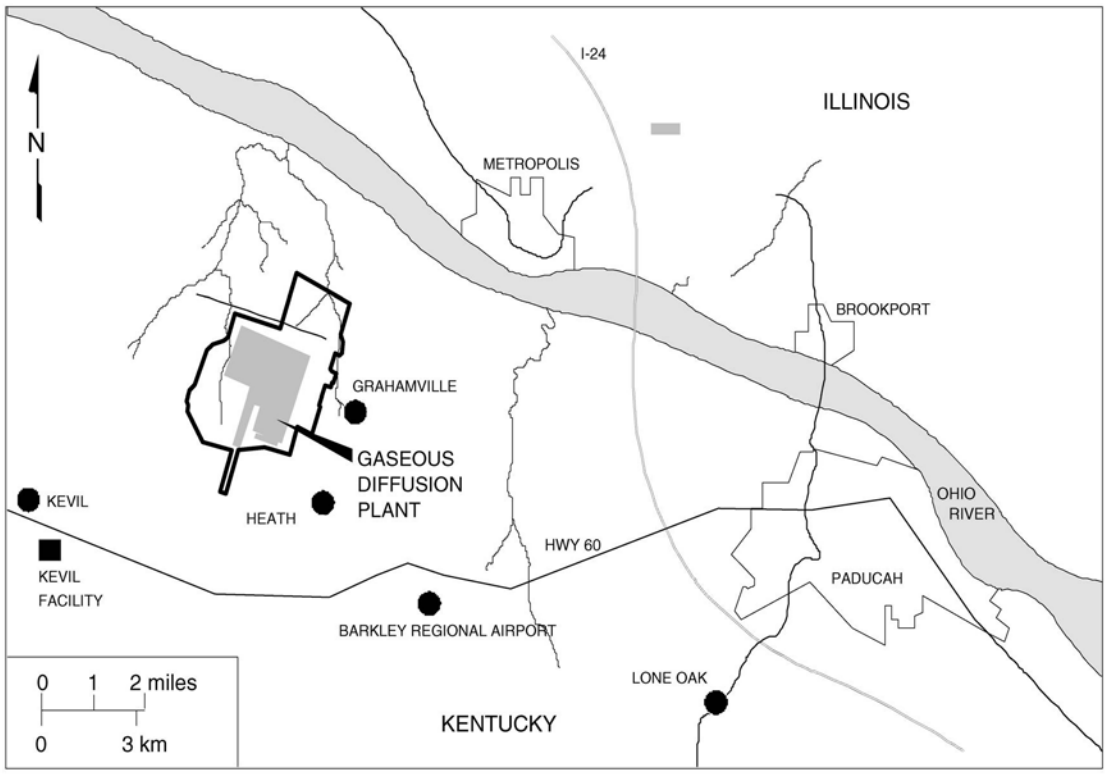

Figure 1.1. Location of the Paducah Site

Three small communities are located within 3 miles of the DOE property boundary at PGDP: Heath and Grahamville to the east, and Kevil to the southwest. The closest commercial airport is Barkley Regional Airport, approximately 5 miles to the southeast. The population within a 50-mile radius of PGDP is about 500,000. Within a 10-mile radius of PGDP, the population is about 66,000 (DOC 2000).

Climate

The Paducah Site is located in the humid continental zone where summers are warm (July averages 79 °F) and winters are moderately cold (January averages 35 °F). Yearly precipitation averages about 49 inches. The prevailing wind is from the south-southwest at approximately 10 miles per hour.

Surface Water Drainage

The Paducah Site is situated in the western part of the Ohio River basin. The confluence of the Ohio River with the Tennessee River is about 15 miles upstream of the site, and the confluence of the Ohio River with the Mississippi River is about 35 miles downstream. PGDP is located on a local drainage divide. Surface water from the east side of the plant flows east-northeast toward Little Bayou Creek, and surface water from the west side of the plant flows west-northwest toward Bayou Creek. Bayou Creek is a perennial stream that flows toward the Ohio River along a 9-mile course. Little Bayou Creek is an intermittent stream that flows north toward the Ohio River along a 7-mile course. The two creeks converge 3 miles north of the plant before emptying into the Ohio River.

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, but not within the industrialized area of PGDP. These 100-year floodplains range from approximately 340 to 380 feet (ft) above mean sea level. Plant elevations range from about 370 to 385 ft above mean sea level [U.S. Army Corps of Engineers (COE) 1994].

Wetlands

More than 1,100 separate wetlands, totaling over 1,600 acres, were found in a study area of about 12,000 acres in and around the Paducah Site (COE 1994; CDM 1994). More than 60 percent of the total wetland area is forested.

Soils and Hydrogeology

Soils of the area are predominantly silty loams that are poorly drained, acidic, and have little organic content.

The local groundwater flow system at the Paducah Site contains the following four major components (listed from shallowest to deepest): (1) the Terrace Gravel, (2) the Upper Continental Recharge System (UCRS), (3) the Regional Gravel Aquifer (RGA), and (4) the McNairy flow system.

The Terrace Gravel consists of shallow Pliocene gravel deposits in the southern portion of the plant site. These deposits usually lack sufficient thickness and saturation to constitute an aquifer, but may be an important source of groundwater recharge to the RGA.

The UCRS consists mainly of clay silt with interbedded sand and gravel in the upper continental deposits. The system is so named because of its characteristic recharge to the RGA.

The RGA consists of coarse-grained sediments at the base of the upper continental deposits, sand and gravel facies in the lower continental deposits, gravel and coarse sand portions of the upper McNairy that are directly adjacent to the lower continental deposits, and alluvium adjacent to the Ohio River. These deposits have an average thickness of 30 ft and can be more than 70-ft thick along an axis that trends east-west through the site. The RGA is the uppermost and primary aquifer, formerly used by private residences north of the Paducah Site.

The McNairy flow system is composed of interbedded and interlensing sand, silt, and clay. Near PGDP, the McNairy Formation can be subdivided into three members: (1) a 60-ft thick

sand-dominant lower member; (2) a 100- to 130-ft thick middle member, composed predominately of silty and clayey fine sand; and (3) a 30- to 50-ft thick upper member consisting of interbedded sands, silts, clays, and occasional gravel. Sand facies account for 40 to 50 percent of the total formation thickness of approximately 225 ft.

Groundwater flow originates south of the Paducah Site within Eocene sands and the Terrace Gravel. Groundwater within the Terrace Gravel discharges to local streams and recharges the RGA. Groundwater flow through the UCRS predominantly is downward, also recharging the RGA. From the plant site, groundwater generally flows northward in the RGA toward the Ohio River, which is the local base level for the system.

Ecological Resources

Vegetation

Much of the Paducah Site has been impacted by human activity. Vegetation communities on the reservation 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 mowed periodically 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 grama grass and Indian grass. Other species commonly cultivated for wildlife forage are corn, millet, milo, and soybean (CH2M Hill 1992a).

Field scrub-shrub communities consist of sun tolerant wooded species such as persimmon, maples, black locust, sumac, and oaks (CH2M Hill 1991a). The undergrowth varies depending on the location of the woodlands. Wooded areas near maintained grasslands have an undergrowth dominated by grasses. Other communities 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 (CH2M Hill 1991a). The undergrowth here varies, with limited undergrowth for more mature stands of trees, to dense undergrowth similar to that described for a scrub-shrub community.

Wildlife

Wildlife species indigenous to hardwood forests, scrub-shrub, and open grassland communities are present at the Paducah Site. A list of representative species is provided in the reference, CH2MHill 1991a, given in the reference section. Additionally, the Ohio River, which is 3 miles north of the Paducah Site, serves as a major flyway for migratory waterfowl (DOE 1995). Fish populations in Bayou Creek and Little Bayou Creek are dominated numerically by various species of sunfish. The Watershed Monitoring Report (PRS 2007b) provides a list of species present.

Threatened and Endangered Species

A threatened and endangered species investigation identified federally listed, proposed, or candidate species potentially occurring at or near the Paducah Site (COE 1994). Updated information is obtained on a regular basis from federal and state sources. Currently, potential habitat for seven species of federal concern exists in the study area (Section 2, Table 2.2). Six of these species are listed as "endangered" under the Endangered Species Act of 1973 and one is listed as "threatened." Of note, significant potential summer habitat exists at the Paducah Site for the Indiana bat, a federally listed endangered species; however, neither the Indiana bat, nor any other federally listed or candidate species, has been found on DOE property at the Paducah Site. Also, no property at the Paducah Site has been designated as "critical habitat" in accordance with the Endangered Species Act.

Site Program Missions

The following two major programs are operated by DOE at the Paducah Site: (1) EM and (2) Uranium Programs. Environmental Restoration, Waste Operations, and D&D are projects under the EM Program. The mission of the Environmental Restoration Project is to ensure that releases from past operations at the Paducah Site are investigated and that appropriate remedial action is taken for protection of human health and the environment in accordance with the Federal Facility Agreement (FFA) (DOE 1998a). The mission of the Waste Operations Project is to characterize and dispose of the legacy waste stored on-site, including DMSAs, in compliance with the October 2003 Agreed Order (AO) between DOE and the Kentucky Division of Waste Management (KDWM) and other regulatory requirements. The major missions of the D&D Project are to manage and characterize the areas and facilities in the program and prepare materials and/or waste for disposition. The major missions of the Uranium Program are to maintain safe, compliant storage of the DOE depleted UF_6 (DUF_6) inventory until final disposition and to manage facilities and grounds not leased to USEC. The environmental monitoring summarized in this report supports all DOE programs/projects.

2 Environmental Compliance

Abstract

The policy of DOE and its contractors and subcontractors at the Paducah Site is to conduct operations safely and minimize or eliminate the adverse impact of operations on the environment. Protection of the environment is considered a responsibility of paramount importance. The Paducah Site maintains an environmental compliance program aimed at satisfying all applicable requirements and protecting human health and the environment.

Introduction

State and federal agencies, including DOE, are responsible for enforcing the environmental regulations at the Paducah Site. Principal regulating agencies are the U.S. Environmental Protection Agency (EPA), Region 4, and the Kentucky Department for Environmental Protection (KDEP). These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable laws and regulations.

The EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards as directed by statutes passed by the U.S. Congress. In some instances, the EPA has delegated regulatory authority to KDEP when the Kentucky program meets or exceeds EPA requirements. Table 2.1 provides a summary of the Paducah Site environmental permits maintained by DOE in 2006.

Resource Conservation and Recovery Act

Regulatory standards for the characterization, treatment, storage, and disposal of solid and hazardous waste are established by RCRA. Waste generators must follow specific requirements outlined in RCRA regulations for handling solid and hazardous wastes. Owners and operators of hazardous waste treatment, storage, and disposal facilities are required to obtain operating and closure permits for waste treatment, storage, and disposal activities. The Paducah Site generates solid waste, hazardous waste, and mixed waste (i.e., hazardous waste mixed with radionuclides) and operates four permitted hazardous waste storage and treatment facilities. The closed C-404 Hazardous Waste Landfill also is managed under requirements of the RCRA regulations and permit.

Resource Conservation and Recovery Act Hazardous Waste Permit

Part A and Part B permit applications of RCRA for storage and treatment of hazardous wastes initially were submitted for the Paducah Site in the late 1980s. At that time, EPA had authorized the Commonwealth of Kentucky to administer exclusively the RCRA-based program for treatment, storage, and disposal units, but had not given the authorization to administer 1984 Hazardous and Solid Waste Amendments (HSWA) provisions.

Table 2.1. Permits, Agreements, and Agreed Orders Maintained by DOE for the Paducah Site for CY 2006

Permit Type	Issued By	Permit Number	Issued To
State Agency Interest ID# 3059			
Water			
KPDES	KDOW	KY0004049	DOE/PRS
Water Withdrawal Permit	KDOW	1345	DOE
Solid Waste			
Residential Landfill (closed)	KDWM	073-00014	DOE/PRS
Inert Landfill (closed)	KDWM	073-00015	DOE/PRS
Solid Waste Contained Landfill (construction/operation)	KDWM	073-00045	DOE/PRS
RCRA/Toxic Substances Control Act			
State Hazardous Waste Management Permit	KDWM	KY8-890-008-982	DOE/PRS*
Federal Facility Compliance Act Site Treatment Plan: Agreed Order	EPA	NA	DOE
FFA	EPA/KDWM	NA	DOE
TSCA FFCA	EPA	NA	DOE
DMSA Agreed Order DWM-31434-042, DAQ-31740-030, and DOW-26141-042	KDWM KDAQ KDOW	NA	DOE
DUF_6 Agreed Order DWM-32434-030	KDWM	NA	DOE

KDAQ – Kentucky Division for Air Quality
KDOW – Kentucky Division of Water
* Permit holder for Jan-April 2006 was DOE/BJC
FFCA – Federal Facility Compliance Agreement
NA – not analyzed
TSCA – Toxic Substances Control Act

A permit application was submitted to EPA and the KDWM for treatment and storage of hazardous wastes.

The current hazardous waste management facility permit was issued to DOE on September 30, 2004. The permit became effective on October 31, 2004, and is valid until October 31, 2014. The Part B permit application was modified on April 24, 2006, to identify PRS as an operator.

Resource Conservation and Recovery Act Notices of Violation

DOE received no RCRA notices of violation (NOVs) during 2006.

2003 Agreed Order with Commonwealth of Kentucky

The main accomplishments for the AO DWM-31434-042, DAQ-31740-030, DOW-2614-042, hereinafter referred to as the 2003 AO, are discussed briefly. The main program components in the 2003 AO pertained to RCRA-listed hazardous waste and DMSAs. Each DMSA was prioritized for removal based on the potential risk to plant workers and the environment, with "A" representing greatest potential risk, "B" representing medium potential risk, and "C" representing lowest potential risk. As required by the 2003 AO, all requirements for the highest priority DMSAs, Priority A, were met in 2004, and all of the requirements for the second-highest priority, priority B, were met in 2006.

- All Priority B DMSAs were characterized by September 30, 2006, in accordance with the AO. DOE continues to complete characterization of DMSAs in accordance with the schedule outlined in the AO.
- Twelve closure plans related to DMSAs were submitted to KDWM in 2006.

Modifications to the Resource Conservation and Recovery Act Hazardous Waste Permit

No modifications were made to this permit in 2006.

Federal Facility Compliance Act – Site Treatment Plan

The Federal Facility Compliance Act (FFC Act) was enacted in October 1992. This act waived the immunity from fines and penalties that had existed for federal facilities for violations of hazardous waste management as defined by RCRA. It also contained provisions for the development of site treatment plans for the treatment of DOE mixed waste and for the approval of such plans by the states. As a result of the complex issues and problems associated with the treatment of mixed chemical hazardous and radioactive waste (mixed waste), DOE and KDEP signed, after consideration of stakeholder input, an AO/Site Treatment Plan (STP) on September 10, 1997. The STP facilitates compliance with the FFC Act. A series of mixed waste treatment milestones are detailed in the STP. The STP also requires that DOE consider waste minimization in all projects and processes. The waste minimization program is discussed in Chapter 3.

Solid Waste Management

The PGDP disposes of a portion of its solid waste at its contained landfill facility, C-746-U. Construction of the C-746-U Landfill began in 1995 and was completed in 1996. The operation permit was received from KDWM in November 1996. Disposal of waste at the landfill began in February 1997. During 2006, the amount of waste disposed of in the landfill was 2,400 tons.

The office waste generated by DOE and its contractors at the plant site is taken off-site for disposal. Only office waste generated at the C-746-U Landfill itself is disposed at the landfill. Commercial Waste Incorporated in Mayfield, Kentucky, provides off-site disposal of the office waste. PGDP has a sitewide recycling program for office waste, which is described in Section 3.

In March of 2006, KDWM performed a site inspection of C-746-U Landfill and requested DOE conduct an evaluation of leachate collection capacities. Storage volume equal to 15 days peak production is required for the design of a landfill. DOE submitted the response in April 2006 which indicated that insufficient storage capacity was available for further operation at the landfill. Plans for correction were developed and sent to KDWM in the form of a permit modification request.

In addition, in 2006 free liquids were identified as having been found in waste disposed in the C-746-U Landfill. A NOV was issued in November of 2006. No NOVs were issued for the inactive C-746-S&T Landfill.

Underground Storage Tanks

Underground storage tank (UST) systems at the Paducah Site were used to store petroleum products such as gasoline, diesel fuel, and waste oil. These USTs are regulated under RCRA Subtitle I (40 *Code of Federal Regulations* (*CFR*) Part 280) and Kentucky UST regulations [401 *Kentucky Administrative Regulations* (*KAR*) Chapter 42].

DOE is responsible for 16 of the 18 site USTs that have been reported to KDWM; USEC is responsible for the other two. At the end of 2006, DOE had received regulatory approval for closure of all DOE USTs.

Comprehensive Environmental Response, Compensation, and Liability Act

DOE and EPA Region 4 entered into an Administrative Order by Consent (ACO) in August 1988 under Sections 104 and 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The ACO was in response to the off-site groundwater contamination detected at the Paducah Site in July 1988.

On May 31, 1994, the Paducah Site was placed on the EPA National Priorities List (NPL), which is a list of sites across the nation designated by EPA as having the highest priority for site remediation. The EPA uses the Hazard Ranking System to determine which sites should be included on the NPL.

Section 120 of CERCLA requires federal agencies with facilities on the NPL to enter into an FFA with the EPA. The FFA, which was signed February 13, 1998, by DOE, EPA, and KDEP, established a decision-making process for remediation of the Paducah Site and coordinates CERCLA remedial action requirements with RCRA corrective action requirements. The FFA parties, DOE, EPA, and KDEP, agreed to terminate the CERCLA ACO because those activities could be continued under the FFA. According to the FFA, DOE is required to submit an annual site management plan (SMP) to EPA and KDEP. The SMP summarizes the remediation work completed to date, outlines remedial priorities, and contains schedules for completing future work. The SMP is submitted to the regulators annually in November to update the enforceable milestones and to include any new strategic approaches.

Comprehensive Environmental Response, Compensation, and Liability Act Reportable Quantities

In 2006, there were no spills of CERCLA regulated substances above CERCLA reporting requirements.

National Environmental Policy Act

An evaluation of the potential environmental impact of certain proposed federal activities is required by the National Environmental Policy Act (NEPA). In addition, an examination of alternatives to certain proposed actions is required. Compliance with NEPA, as administered by DOE's NEPA Implementing Procedures (10 *CFR* § 1021) and the Council on Environmental Quality Regulations (40 *CFR* § 1500–1508), ensures that consideration is given to environmental values and factors in federal planning and decision making. In accordance with 10 *CFR* § 1021, the Paducah Site conducts NEPA reviews for proposed actions and determines if any proposal requires preparation of an environmental impact statement (EIS), an environmental assessment (EA), or is categorically excluded (CX) from preparation of either an EIS or an EA. The Paducah Site maintains records of all NEPA reviews.

Numerous minor activities were within the scope of the previously approved CXs for routine maintenance, small-scale facility modifications, and site characterization. The DOE Paducah Site Office and the PPPO NEPA compliance officer approve and monitor the internal applications of previously approved CX determinations.

In accordance with the 1994 DOE Secretarial Policy Statement on NEPA, preparation of separate NEPA documents for environmental restoration activities conducted under CERCLA no longer is required. Instead, DOE CERCLA documents incorporate "NEPA values," to the extent practical. The NEPA values are environmental issues that affect the quality of the human environment. Incorporation of NEPA values into CERCLA documents allows the decision makers to consider the potential effects of proposed actions on the human environment. Actions conducted under CERCLA are discussed in Section 3 of this report.

National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA) is the primary law governing a federal agency's responsibility for identifying and protecting historic properties [cultural resources included in or eligible for inclusion in the National Register of Historic Places, (NRHP)]. Historic properties include buildings of historic significance, and archeological sites. PGDP buildings were assessed in the *Cultural Resources Survey for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-688/R1, hereinafter referred to as the *Cultural Resources Plan*), March 2006. Archeological resources will be addressed as undisturbed land is developed for site use. To date, the only archeological assessment completed is in the EA for the C-746-U Landfill. This was conducted in 1993 by Archaeology Resources Consultant Services, Inc., of Louisville, Kentucky. The entire project area was approximately 40 acres located directly north of the C-746-S&T Landfill.

The *Cultural Resources Plan* identified an NRHP-eligible historic district at the facility. The PGDP Historic District contains 101 contributing properties and is eligible for the NRHP under

National Register Criterion A for its military significance during the Cold War and for its role in commercial nuclear power development. The PGDP historic district encompasses the area of the process buildings; the switchyards; the C-100 Administration Building; cooling towers and pump houses; security facilities; water treatment facilities; storage tanks; and the support, maintenance, and warehouse buildings. A map and the rationale for designating the area as such are included in the *Cultural Resource Plan.*

Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of endangered and threatened animals and plants. The act also serves to protect ecosystems on which such species depend. At the Paducah Site, proposed projects are reviewed, in conjunction with NEPA project reviews or the CERCLA process, to determine if activities have the potential to impact these species. If necessary, project-specific field surveys are performed to identify threatened and endangered species and their habitats, and mitigating measures are designed, as needed. When appropriate, DOE initiates consultation with the U.S. Fish and Wildlife Service and Kentucky Department for Fish and Wildlife Resources prior to implementing a proposed project.

Table 2.2 includes seven federally listed, proposed, or candidate species that have been identified as potentially occurring at or near the Paducah Site. No DOE project at the Paducah Site during 2006 impacted any of these seven species or their potential habitats.

Floodplain/Wetlands Environmental Review Requirements

Title 10 *CFR* Part 1022, establishes procedures for compliance with Executive Order 11988, "Floodplain Management," and Executive Order 11990, "Protection of Wetlands."

In 2006, no floodplain or wetlands assessments were prepared or approved. Also, no floodplain or wetlands notices of involvement were published in the *Federal Register* for the Paducah Site. In addition, DOE did not apply for any individual permits from COE or for any water quality certifications from the state. Some DOE projects were authorized through the COE nationwide permit program for activities involving waters of the United States. DOE activities did not result in significant impacts to floodplains or wetlands at the Paducah Site in 2006.

Table 2.2. Federally Listed, Proposed, and Candidate Species Potentially Occurring Within the Paducah Site Study Area in 2006[a]

Common Name	Scientific Name	Endangered Species Act Status
Indiana Bat[b]	*Myotis sodalis*	Listed Endangered
Interior Least Tern	*Sterna antillarum athalassos*	Listed Endangered
Pink Mucket	*Lampsilis abrupta*	Listed Endangered
Ring Pink	*Obovaria retusa*	Listed Endangered
Orangefoot Pimpleback	*Plethobasus cooperianus*	Listed Endangered
Fat Pocketbook	*Potamilus capax*	Listed Endangered
Bald Eagle	*Haliaeetus leucocephalus*	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 3 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 netted, identified, measured, and released on WKWMA property in 1991 and 1999.

Clean Water Act

The Clean Water Act (CWA) was established primarily through the passage of the Federal Water Pollution Control Act Amendments of 1972. The CWA established the following four major programs for control of water pollution:

(1) Regulating point-source discharges into waters of the United States;

(2) Controlling and preventing spills of oil and hazardous substances;

(3) Regulating discharges of dredge and fill materials into "waters of the United States"; and

(4) Providing financial assistance for construction of publicly owned sewage treatment works.

The Paducah Site is affected primarily by the regulations for point source discharges regulated under the KPDES permit.

Kentucky Pollutant Discharge Elimination System Permits

The CWA applies to all nonradiological DOE discharges to waters of the United States. At the Paducah Site, the regulations are applied through issuance of a KPDES permit for effluent discharges to Bayou Creek and Little Bayou Creek. The Kentucky Division of Water (KDOW) issued KPDES Permit No. KY0004049 to the Paducah Site. This permit became effective November 1, 2006, and is enforced by KDOW. This permit applies to the following four DOE outfalls: 001, 015, 017, and 019. The KPDES permit calls for chemical and biological monitoring as an indicator of discharge related effects in the receiving streams. The permit will expire on October 31, 2011. Following the issuance of the permit, several parties petitioned KDOW for a hearing on the permit. An Order to Mediate was issued by the Kentucky Environmental and Public Protection Cabinet. All new permit limitations were stayed with discharge limitations reverting to the April 1, 1998, permit. All monitoring requirements of the new permit were continued. Negotiations on an AO to settle all parties' disputes with the permit were not complete at the close of 2006. No exceedances of effluent permit limits occurred at Outfalls 001, 015, 017, or 019 in 2006.

Toxic Substances Control Act

In 1976, the Toxic Substances Control Act (TSCA) was enacted with a twofold purpose: (1) to ensure that information on the production, use, and environmental and health effects of chemical substances or mixtures is obtained by the EPA; and (2) to provide the means by which the EPA can regulate chemical substances/mixtures.

Polychlorinated Biphenyls

The Paducah Site complies with polychlorinated biphenyl (PCB) regulations (40 *CFR* § 761) and the Uranium Enrichment (UE) FFCA. The major activities performed in 2006 to ensure compliance included the following: maintaining compliant storage of PCB waste and PCB-contaminated wastewater; shipping PCB waste for treatment and disposal, treatment and discharge of PCB-contaminated wastewater; maintaining the troughing system; and reporting and record keeping.

The UE TSCA FFCA between EPA and DOE was signed in February 1992. Under this agreement, action plans have been developed and implemented for removal and disposal of large volumes of PCB material at the Paducah Site. Table 2.3 shows a summary of PCB equipment in service at the Paducah Site at the end of 2006. These items are utilized in USEC operations.

Table 2.3. Summary of PCB Equipment in Service at the End of 2006

Type	Number in Service	Volume (gal)	PCBs (kg)
PCB Transformers	66	95,040	279,346
PCB Contaminated Transformers	9	2,299	0.95
PCB Contaminated Electrical Equipment	7	2,094	1.14
PCB Capacitors	559	1,650	10,104

The PCB annual document, due July 1, provides details of facility activities associated with the management of PCB materials. The annual report provides details from the previous year on all PCB items that are in use, stored for reuse, generated as waste, stored for disposal, or shipped off-site for disposal. All Paducah Site UE TSCA FFCA milestones for 2006 were completed. In 2006, 49,900.1 kilograms (kg) of PCB waste was shipped off-site for disposal.

The facilities operated by USEC utilize equipment that contains PCB capacitors as well as transformers, electrical equipment, and other miscellaneous PCB equipment. Both radioactive and nonradioactive PCB wastes are stored on-site in units that meet TSCA and/or UE TSCA FFCA compliance requirements, as applicable. Nonradioactive PCBs are transported off-site to EPA-approved facilities for disposal.

Radioactively contaminated PCB wastes are authorized by the UE TSCA FFCA for long-term on-site storage at the Paducah Site (i.e., beyond two years). Technology for the treatment and/or disposal of radioactively contaminated PCB wastes is being evaluated.

Emergency Planning and Community Right-to-Know Act

Also referred to as Title III of the Superfund Amendments and Reauthorization Act, the Emergency Planning and Community Right-to-Know Act (EPCRA) requires reporting of emergency planning information, hazardous chemical inventories, and releases to the environment.

EPCRA's primary purpose is to inform communities and citizens of chemical hazards in their areas. In order to ensure proper and immediate responses to potential chemical hazards, EPCRA Section 304 requires facilities to notify State Emergency Response Commissions and Local Emergency Planning Committees of releases of hazardous substances and extremely hazardous substances when the release equals or exceeds the reportable quantity. Sections 311 and 312 of EPCRA require businesses to report the locations and quantities of chemicals stored on-site to state and local governments in order to help communities prepare to respond to chemical spills and similar emergencies. EPCRA Section 313 requires EPA and the States to collect data annually on releases and transfers of certain toxic chemicals from industrial facilities, and make the data available to the public.

The Paducah Site did not have any releases that were subject to EPCRA Section 304 notification requirements during 2006. No EPCRA Section 311 notifications were required in 2006. The EPCRA Section 312 Tier II report of inventories for 2006 included UF_6, uranium tetrafluoride (UF_4), iron filings, activated carbon pellets, magnesium fluoride, diesel fuel, acetylene, and PCBs associated with DOE activities. [UF_6 and UF_4 were reported even though radioactive materials are not subject to EPCRA Sections 311 and 312 (52 *FR* 38344-01).] The Paducah Site reported PCBs on the Section 313 report because DOE accepts legacy PCB material from USEC when disposal of electrical equipment is required.

Clean Air Act

Authority for enforcing compliance with the Clean Air Act (CAA) and subsequent amendments resides with EPA Region 4 and/or the Kentucky Division for Air Quality (KDAQ). The Paducah Site complies with federal and state rules by implementing the CAA and its amendments.

Clean Air Act Compliance Status

The Paducah Site had two air emission point sources in 2006. The Northwest Plume Groundwater System and the Northeast Plume Containment System. These systems are interim remedial actions (IRAs) under CERCLA that address the containment of groundwater contamination at the Paducah Site. These systems remove trichloroethene (TCE) contamination from the groundwater by air stripping. At the Northwest Plume Groundwater System, the TCE-laden groundwater passes through an air stripper to remove the TCE. The off-gas from the air stripper then passes through a carbon adsorption system to remove the TCE prior to atmospheric discharge. At the Northeast Plume Containment System, a cooling tower

system acts as an air stripper for TCE. Concentrations of TCE in the Northeast Plume are sufficiently low that a carbon adsorption system is not required to keep emission below regulatory threshold levels.

Asbestos Program

Numerous facilities at the Paducah Site contain asbestos materials. Compliance programs for asbestos management include identification of asbestos materials, monitoring, abatement, and disposal. Procedures and program plans are maintained that delineate scope, roles, and responsibilities for maintaining compliance, as applicable, with EPA, Occupational Safety and Health Administration, and Kentucky regulatory requirements. There were no noncompliances with environmental protection standards identified in 2006.

Radionuclide National Emission Standards for Hazardous Air Pollutants Program

Airborne emission of radionuclides from DOE facilities are regulated under 40 *CFR* § 61, Subpart H, the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. Potential radionuclide sources at the Paducah Site in 2006 were from scrap metal removal/handling, the Northwest Plume Groundwater System, C-410 D&D activities, and fugitive dust source emissions. The fugitive dust source emissions include piles of contaminated scrap metal, roads, and roofs. DOE utilized ambient air monitoring data to verify insignificant levels of radionuclides in off-site ambient air. The Radiation/ Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the Department for Public Health of the Kentucky Cabinet for Health Services conducted ambient air monitoring during 2006. Ambient air data were collected at 10 sites surrounding PGDP in order to measure radionuclides emitted from Paducah Site sources, including fugitive emissions. The calculated emissions for each monitored activity were less than the 40 *CFR* § 61, Subpart H, limit of 0.1 mrem dose to the maximally exposed individual. These results are discussed in further detail in Section 4.

Pollutants and Sources Subject to Regulation

Any stationary source emitting more than 10 tons/year of any hazardous air pollutant (HAP) or 25 tons/year of any combination of HAPs is considered a major source and is subject to regulation. Region 4 of the EPA must examine other sources for regulation under an "area source" program. The Paducah Site is not a major source by virtue of its individual or total HAP emissions.

Stratospheric Ozone Protection

The DOE refrigeration units contain less than 50 pounds of ozone-depleting substances; therefore, the only CAA Title VI provision that applies to the Paducah Site is the requirement to control refrigerants from leaking systems.

Clean Air Act Notices of Violation

The PGDP did not receive any CAA violations in 2006.

Kentucky/Department of Energy Agreement in Principle

The Kentucky/DOE Agreement in Principle (AIP) reflects the understanding and commitments between DOE and the Commonwealth of Kentucky regarding DOE's provision of technical and financial support to Kentucky for environmental oversight, surveillance, remediation, and emergency response activities. The goal of the AIP is to maintain an independent, impartial, and qualified assessment of the potential environmental impacts from present and future DOE activities at the Paducah Site. The AIP is intended to support nonregulated activities, whereas, the FFA covers regulated activities. The AIP includes a grant to support the Commonwealth of Kentucky in conducting independent monitoring and sampling, both on-site and off-site, and to provide support in a number of emergency response planning initiatives. Included are cooperative planning, conducting joint training exercises, and developing public information about preparedness activities.

Regulatory Inspections

Paducah Site programs are overseen by several organizations, both inside and outside the DOE complex. Each year, numerous appraisals, audits, and surveillances of various aspects of the environmental compliance program are conducted.

In 2006 the KDEP inspected the outfalls permitted under the KPDES program, the contained landfill, C-746-U, and RCRA container and tank storage facilities. All of the inspections showed that permit conditions are being met; no violations or exceedances were noted.

3 Environmental Program Information

Abstract

Environmental monitoring, environmental restoration, waste operations, facilities management, UF_6 cylinder management activities, D&D, and DMSA management occur at PGDP. Programs that support these activities are presented in this section to inform the public.

Environmental Monitoring Program

The Environmental Monitoring Program at PGDP consists of effluent monitoring and environmental surveillance. Requirements for routine environmental monitoring programs were established to measure and monitor effluents from DOE operations and maintain surveillance on the effects of those operations on the environment and public health through measurement, monitoring, and calculation. The Environmental Monitoring Program is documented in the *Paducah Site Environmental Monitoring Plan* (BJC 2005) in accordance with DOE Order 450.1, *Environmental Protection Program.* The results of this program are discussed in detail in subsequent sections of this ASER.

Before the DOE/USEC transition (described in Section 1), DOE's primary mission at the Paducah Site consisted of enriching uranium. Since the transition on July 1, 1993, DOE's mission at the site has been focused on environmental restoration, DUF_6 cylinder management, waste management, and D&D/DMSA management. This change in mission also changed the direction and emphasis of the Environmental Monitoring Program. In November 1995, the site Environmental Monitoring Plan (EMP) was reissued to address DOE operations exclusively. The environmental monitoring plan is reviewed annually and updated at least every three years. The October 2005 version of the *Paducah Site Environmental Monitoring Plan* addresses the sampling events in 2006 that are reported in this ASER.

Environmental Restoration Program

The goal of the Environmental Restoration Program is to ensure that releases from past operations and waste management activities are investigated and that the appropriate response action is taken for the protection of human health and the environment. In May 1994, PGDP was added to EPA's NPL. Two federal laws, RCRA and CERCLA, are the dominant regulatory drivers for monitoring and restoration activities at PGDP. RCRA sets the standards for managing hazardous waste and requires that permits be obtained for DOE facilities that treat, store, or dispose of hazardous waste and requires assessment and cleanup of hazardous waste releases at solid waste management units

(SWMUs). CERCLA addresses uncontrolled releases of hazardous substances and requires cleanup of inactive waste sites. As a result of PGDP being placed on the NPL, DOE, EPA, and KDEP entered into an FFA in 1998. The FFA coordinates compliance with both RCRA and CERCLA requirements.

The environmental restoration program supports investigations and environmental response actions, D&D of facilities no longer in use, projects designed to demonstrate or test advancements in remedial technologies, and other projects related to action for the protection of human health and the environment.

Background

In July 1988, the Kentucky Radiation Control Branch, in conjunction with the Purchase District Health Department, sampled several residential groundwater wells north of the plant in response to concerns from a local citizen regarding the quality of water in a private well. Subsequent analyses of these samples revealed elevated gross beta levels indicative of possible radionuclide contamination. On August 9, 1988, these results were reported to the Paducah Site, which responded by sampling several private groundwater wells adjacent to the site on August 10, 1988. Upon analysis, some of the samples collected contained elevated levels of both TCE and ^{99}Tc. In response, DOE immediately instituted the following actions:

- Provided a temporary alternate water supply to affected residences;
- Sampled surrounding residential wells to assess the extent of contamination;
- Began extension of a municipal water line to affected residences as a long-term source of water; and
- Began routine sampling of residential wells around the Paducah Site.

Following the initial response actions, DOE and EPA entered into an ACO in August 1988 under Sections 104 and 106 of CERCLA. The major requirements of the ACO include monitoring of residential wells potentially affected by contamination, providing alternative drinking water supplies to residents with contaminated wells, and investigating the nature and extent of off-site contamination.

Pursuant to the ACO, DOE continued routine sampling of residential wells and initiated a two-phase site investigation (SI) to identify the nature and extent of off-site contamination at the Paducah Site. Phase I of the SI, from summer 1989 to March 1991, evaluated the extent of off-site contamination through extensive groundwater monitoring and surface water sampling. Results of these activities are reported in *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1991a). Phase II of the SI, from November 1990 to October 1991, focused on identification and characterization of on-site sources contributing to off-site contamination. Phase II determined the level of risk to human health and the environment from exposure to contaminated media and biota and developed an initial list of remedial alternatives. Results are reported in *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1992b). Risks to human health and the environment from exposure to contamination originating at the Paducah Site were reported in *Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1992a). This report used data collected during the SI to quantitatively assess risks to human health and to qualitatively assess risks to the environment.

As part of the residential well sampling program that began when off-site contamination was discovered, DOE established a water policy in 1994. This policy provides that in the event contamination originating from the Paducah Site is detected above plant action levels a response would be initiated by the Paducah Site. These levels are established at the analytical laboratory detection limits of 25 picocuries per liter (pCi/L) for ^{99}Tc and 1 part per billion (ppb) for TCE. Accordingly, residents, as well as state and EPA officials, are notified immediately of sampling results above these levels, and alternative water supplies are provided to those residences through connection to the municipal water system, or, in the event of a time lapse between discovery and the ability to complete connections, bottled water is made available. In

accordance with the water policy of 1994, DOE pays installation cost of water systems and the monthly charges for water service to residences within the established water policy area.

DOE modified this water policy in 1994 to include provisions to extend a municipal water line to the entire area of the groundwater contamination originating from the Paducah Site. All residents within the defined area, regardless of whether their wells were contaminated, were given the option to receive municipal water at DOE's expense. DOE also provided municipal water to new residences and some new businesses in the area. A five-year review of the water policy was issued in 2003.

ACO activities identified two off-site groundwater contamination plumes, referred to as the Northwest and Northeast Plumes; identified several potential on-site source areas requiring additional investigation; and included the evaluation of alternatives and implementation of several interim activities. Upon signing the FFA in February 1998, the FFA parties declared that the ACO requirements were satisfied and terminated the ACO because the remaining cleanup would be continued under the authority of the FFA. A series of remedial investigations (RIs) and feasibility studies (FSs) were initiated under the FFA [e.g., Waste Area Groups (WAGs) 1, 3, 6, 7, 22, 23, 27, and 28], including the ongoing evaluation of all major contaminant sources impacting groundwater and surface water. In accordance with the ACO and FFA, DOE actions have focused primarily on reducing potential risks associated with off-site contamination. The following are examples of the significant actions and the dates they were completed so far (DOE 2006).

- Imposed land use controls (fencing and posting) to restrict public access to contaminated areas in certain outfall ditches and surface water areas (1993).
- Extended municipal water lines as a permanent source of drinking water to affected residents to eliminate exposure to contaminated groundwater (1995).
- Constructed and implemented groundwater treatment systems for both the Northwest and Northeast Plumes to reduce contaminant migration (1995 and 1997, respectively).
- Rerouted surface runoff away from highly contaminated portions of the North-South Diversion Ditch (NSDD) to reduce potential migration of surface contamination (1995).
- Excavated soil with high concentrations of PCBs in on-site areas to reduce off-site migration and potential direct-contact risks to plant workers (1998).
- Removed and disposed of "drum mountain," a contaminated scrap pile potentially contributing to surface water contamination so that a potential direct-contact risk to plant workers would be eliminated and an off-site migration risk would be reduced (2000).
- Applied *in situ* treatment of TCE-contaminated soil at the cylinder drop test site using innovative technology (i.e., the Lasagna™ technology) to eliminate a potential source of groundwater contamination (2002).
- Removed petroleum-contaminated soil from SWMU 193, the former McGraw Construction Yards, now the Southside Cylinder Yards, to eliminate a potential source of groundwater contamination (2002).
- Completed installation of a sediment control basin at Outfall 001 to control the potential migration of contaminated sediment (2002).
- Completed a treatability study that demonstrated the effectiveness of the six-phase heating technology for *in situ* treatment of dense nonaqueous-phase liquid (DNAPL) at C-400 (2003).
- Completed installation of a retention basin and excavation of the on-site portions of the NSDD, which removed a source of direct-contact risk to plant workers and a potential source of surface water contamination (2004).
- Investigated potential source areas contributing to the Southwest Plume, the results of which remain pending (2005).
- Completed D&D of the C-603 Nitrogen Facility (2005).

- Performed an SI near the C-746-S&T Landfills and determined that TCE groundwater contamination is from SWMU 145, the Residential/Inert Landfill and Borrow Area (2006).

- Disposed of approximately 30,500 tons of scrap metal, which eliminated a potential direct-contact risk to plant workers and a source of surface water contamination (2006).

- Completed D&D of the C-402 Limehouse (2006).

Operable Units

The National Contingency Plan states that owners of large, complex sites with multiple source areas, such as federal facilities, may choose to divide their sites into smaller areas to characterize them and to implement response actions, rather than conducting a single sitewide comprehensive action. These discrete actions, referred to as operable units (OUs), may address a geographic portion of the site, or specific site problems, or include a series of interim actions followed by final actions. The PGDP site cleanup strategy adopts this approach and includes a series of high-priority actions, ongoing site characterization activities to support future response action decisions, and eventual D&D of the currently operating PGDP after it ceases operation, followed by a Comprehensive Site Operable Unit (CSOU) evaluation. The timing and sequencing of these actions is based on a combination of factors, including risk, compliance, and technical considerations associated with PGDP operations and other criteria, as outlined in the Paducah SMP (DOE 2006a).

Groundwater is an example of an area that has unique technical factors that need special consideration in the sequencing and decision-making process. The strategy includes the following four phases:

(1) Preventing human exposure to contaminated groundwater;

(2) Preventing or minimizing further migration of the contaminant plume;

(3) Preventing or minimizing further migration of contaminants from source materials to groundwater; and

(4) Returning groundwater to beneficial uses wherever practicable.

Phases One and Two

The first phase of the ongoing Paducah groundwater strategy focuses on preventing human exposure to contaminated groundwater by providing an alternate drinking water supply to certain area residences. The first phase is commonly referred to as the "water policy." The second phase of the strategy, to prevent or minimize further migration of the contaminant plumes, is being implemented through the installation of the groundwater treatment systems in both the Northwest and Northeast Plumes.

Phase Three

The third phase of the groundwater strategy is focused on the prevention or minimization of contaminant migration from source areas. As part of this phase, the 60% Remedial Design Report was issued in 2006 that addressed electrical resistance heating remedial action for the C-400 area—the largest known DNAPL source of off-site contamination. A primary objective of this project is to contribute to the protection of off-site residences by addressing sources of groundwater contamination. The third phase also includes investigation of the Burial Grounds OU, which was initiated in 2006, and the Sitewide Soils OU to determine the presence of any additional groundwater contaminant sources and their contribution to the off-site plumes, if any. The third phase also will include a Groundwater OU project focused exclusively on the dissolved-phase plumes, including further assessment of the Northwest and Northeast Dissolved-Phased Plumes as well as the Southwest Dissolved-Phased Plume. The objective of this action will be to determine if any supplemental actions or modifications to existing actions for the plumes are needed prior to making a final remedial decision under the CSOU. The Groundwater OU Dissolved-Phase Project will be sequenced so that its planning can benefit from the preliminary results of the C-400 DNAPL remedial action and the Burial

Grounds OU and Soils OU remedy selections. By sequencing these projects after the C-400 project, the results of DNAPL source reduction at the C-400 area can be considered for any proposed groundwater actions associated with the Burial Grounds OU and Soils OU.

Phase Four

The fourth phase of the groundwater strategy is the evaluation of the technical practicability of returning groundwater to its expected beneficial use within a reasonable time frame. The evaluation will be conducted as part of the CSOU. Several technical factors must be considered in making a final decision for the groundwater, including the effectiveness of all source actions taken prior to the final one, the presence of any as yet unknown DNAPL source areas [including areas beneath the gaseous diffusion plant (GDP)] that might be contributing to groundwater contamination and require response action; and any effects that ceasing plant operations may have on groundwater flow. Each of these technical considerations is essential to effective remediation of the contaminants associated with the plumes. Some of these technical factors or data gaps cannot be completed until the plant ceases operations.

D&D

The scope of the D&D OU includes 17 currently inactive DOE facilities, those SMWUs and areas of concern (AOCs) associated with previous GDP operations, and the currently operating GDP. The 17 inactive DOE facilities are scheduled to undergo D&D before plant shutdown. The units associated with current GDP operations will be addressed during D&D of the GDP.

Final CSOU

The final CSOU evaluation will occur following completion of D&D of the GDP after plant shutdown. As part of the final CSOU evaluation, the land-use assumptions will be reassessed and modified, if necessary, to ensure consistency with the reasonably foreseeable land use, including any reuse initiatives that might be under consideration at that time. The final CSOU will include a sitewide baseline human health and ecological risk assessment to evaluate residual risks remaining and to identify any additional actions necessary to ensure long-term protectiveness.

2006 Response Activities

Significant accomplishments for the Environmental Restoration Program conducted in 2006 include, but were not limited to, the following:

- Completed the Southwest Plume SI Report.
- Completed the report for the investigation of the source groundwater contamination at the C-746-S&T Landfills.
- Continued operation of the Northwest and Northeast Plume groundwater treatment systems.
- Completed the Surface Water OU SI Report and began initial scoping of response actions.
- Began planning characterization and response actions (as required) for soil and rubble areas on Little Bayou and Bayou Creeks and in other areas of PGDP and Ballard County.
- Completed the Burial Grounds OU RI/FS Work Plan for the investigation of eight burial areas.
- Completed removal and disposal of approximately 30,500 tons of scrap metal to eliminate potential direct contact risk to plant workers and a source of surface water contamination.
- Initiated interim remedial action fieldwork, completed Remedial Design Site Investigation (RDSI), initiated remedial design, and initiated development of Remedial Action Work Plan for C-400 Interim Remedial Action for volatile organic contamination in soil and groundwater at the C-400 Cleaning Building.
- Completed D&D of the C-402 Limehouse Building.

C-400 Interim Removal Action for Volatile Organic Compound Contamination in Groundwater

In 2005, a Record of Decision (ROD) was approved by DOE and submitted to the regulators for selecting the IRA for the Groundwater OU volatile organic compounds (VOCs) source zone, comprised primarily of TCE, at the C-400 Cleaning Building at PGDP. The ROD includes discussion of the contribution that this IRA will make toward the final decision for the Groundwater OU at PGDP.

The IRA was developed to accomplish the following:

- Prevent potential exposure to contaminated groundwater to on-site industrial workers through institutional controls (e.g., excavation/penetration permit program); and
- Initiate remedial design for the C-400 groundwater action fieldwork. Reduce contamination comprised of TCE and other VOCs found in UCRS soil in the C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure.

The major components of the remedy would include the following:

- Reduce the concentration of TCE and other VOCs in the soils in the C-400 Cleaning Building area through removal and treatment using electrical resistance heating in both the UCRS and RGA;
- Collect post-action sampling results;
- Conduct an RDSI to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to ensure optimum placement of the remediation system; and
- Implement land use controls (LUCs) at the C-400 Cleaning Building area.

In 2006, the RDSI was completed and the results were used as input during the development of the remedial design for the IRA. In accordance with the FFA for Paducah, a phased approach to the design (30%, 60%, 90%, and Certified for Construction versions) is required. In 2006, the 30% and 60% designs were produced, as was the D2 Land Use Control Implementation Plan (LUCIP). The LUCIP currently is awaiting regulator approval.

Southwest Plume Site Investigation

In 2006, the *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2 (DOE 2006b), was submitted. The SI was conducted in accordance with the approved *Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2094&D2 (DOE 2004). The objectives of the current SI were to collect sufficient data to do the following:

- Determine which units are sources of contamination to the Southwest Groundwater Plume;
- Determine which units are not sources of contamination to the Southwest Groundwater Plume;
- Fill data gaps for risk assessment of the identified source areas; and
- Reduce uncertainties and increase the understanding of the Southwest Groundwater Plume and potential sources so that appropriate response actions can be identified, as necessary.

The investigation evaluated the following four potential source areas of contamination to the Southwest Groundwater Plume and profiled the level and distribution of VOCs and ^{99}Tc in the plume along the west plant boundary.

(1) C-747-C Oil Landfarm (SWMU 1)

(2) C-720 Building, specifically areas near the northeast and southeast corners of the building

(3) Storm sewer between the south side of the C-400 Building and Outfall 008 (a part of SWMU 102)

(4) C-747 Contaminated Burial Yard (SWMU 4)

Very little investigation previously has focused on the storm sewer as a potential source of groundwater contamination. Three of the four potential source areas and the dissolved-phase plume have been addressed in earlier investigations.

C-746-S&T Landfill Site Investigation

DOE completed an SI that focused on the vicinity of the C-746-S&T Landfill complex. The SI Report summarizes the results from fieldwork (primarily groundwater sampling) conducted in the area of the C-746-S Landfill, the C-746-T Landfill (commonly referred to as the C-746-S&T Landfills), and the C-746-P Landfill. The C-746-P Landfill underlies the C-746-S&T Landfills. This investigation determined that groundwater contamination by VOCs, principally TCE observed in landfill groundwater monitoring wells (MWs), is derived from the vicinity of the C-746-S&T Landfills and the C-746-P Landfill. It appears likely that the C-746-P Landfill is the source of the groundwater TCE contamination. Investigation results also established that the radionuclide ^{99}Tc found in the RGA is migrating to the vicinity of the C-746-S&T Landfills from an upgradient source.

Northwest Plume Groundwater System

The IRA for the Northwest Plume is documented in a ROD signed by DOE and EPA in July 1993. The KDEP concurred with the ROD. The results of the IRA led to the construction of the Northwest Plume Groundwater System (NWPGS). The NWPGS consists of two extraction well fields (each containing two extraction wells) transfer pipelines, and a fully enclosed treatment system. The NWPGS began operation August 28, 1995. The NWPGS, an interim action, is designed to contain the migration of TCE and ^{99}Tc in the high concentration portion of the Northwest Plume.

TCE is removed by an air stripping process. The TCE is volatilized in a low-profile air stripper by introducing a large volume of air into the contaminated groundwater. Activated carbon filtration beds then are used to remove the TCE from the off-gas generated by the air stripper before the air is discharged to the atmosphere. ^{99}Tc is removed from the groundwater by an ion exchange process.

The NWPGS has extracted and treated over a billion gallons of contaminated groundwater from startup in 1995 through the end of 2006. The NWPGS consistently has met the treatment goals documented in the ROD of 5 ppb TCE and 900 pCi/L of ^{99}Tc. The treated groundwater is released through KPDES-permitted Outfall 001. Radiological emissions from this facility are discussed in Section 4.

Northeast Plume Containment System

The IRA of the Northeast Plume was documented in a ROD signed by DOE and EPA in June 1995. The KDEP accepted the ROD and issued Hazardous Waste Permit Modification 8, dated June 26, 1995. The results of the IRA led to the construction of the Northeast Plume Containment System (NEPCS). The NEPCS consists of two extraction wells, an equalization tank, a transfer pump, a transfer pipeline, and instrumentation and controls. Characterization and construction activities were completed in December 1996. System startup and operational testing were conducted, and full operation began in February 1997.

System operation includes pumping groundwater contaminated with TCE from two extraction wells to the equalization tank. A transfer pump is used to pump the contaminated water from the equalization tank through a transfer pipeline (approximately 6,000 linear ft) to the top of the C-637-2A or C-637-2B Cooling Tower. C-637-2A is the primary destination; however, if C-637-2A is off-line, flow is transferred to the C-637-2B tower. The cooling tower acts as an air stripper and removes the TCE from the groundwater as it moves through the tower.

Through 2006, approximately 800 million gallons of contaminated groundwater have been

extracted and treated by the NEPCS. With the exception of July through September 1999, when the facility was taken off-line due to cooling tower maintenance, the system has been approximately 95 percent operational since startup.

Surface Water Operable Unit Site Investigation

Evaluation of the data collected during fieldwork of the on-site *Surface Water OU Site Investigation and Risk Assessment*, DOE/OR/07-2137&D2/R2 (DOE 2008), has continued through 2006. The objectives of the Surface Water OU Project included identification of hot spots in on-site ditches; selected storm sewers (4); Outfalls 001, 002, 008, 010, 011, 012, 015; and Sections 3, 4, and 5 of the NSDD. The SI scope also included an evaluation of whether additional sediment control measures and/or actions for potential legacy releases associated with the storm sewer system were needed. The results of the SI will be documented in an SI/ Baseline Risk Assessment Report and address the appropriateness of a non-time-critical removal action.

Soil and Rubble Areas Investigation and Removal Action

In November 2006, several soil and rubble areas were found outside the fence on DOE property. The areas will be characterized, data assessed, and evaluated to determine if an action is warranted. Efforts have been initiated to characterize the contaminant levels in other areas. Upon verification that any contamination exists above levels that pose a risk greater than that allowed by CERCLA in other soil or rubble areas, an action will be taken. Action at any of these areas will take into account any habitat of threatened or endangered species and disturbance of wetlands, and efforts will be taken to avoid the areas or minimize impacts. If excavated, soil and rubble will be disposed of in accordance with applicable regulations.

Burial Grounds Operable Unit Remedial Investigation/Risk Assessment

The *Work Plan for the Burial Grounds Operable Unit Remedial Investigation/ Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2179&D2/R1, was issued to the regulators on August 28, 2006, and was revised in November 2006. The goals for the Burial Grounds OU RI/FS are consistent with those established in the FFA and the Paducah SMP (DOE 2006) negotiated among DOE, EPA, and the KDEP. The goals of this RI/FS are as follows.

Goal 1: Characterize Nature of Source Zone—Characterize the nature of contaminant source materials by using existing data and, if required, by collecting additional data.

Goal 2: Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units—Define the nature, extent (vertical and lateral), and magnitude of contamination in soils, sediments, surface water, and groundwater by using existing data and, if required, by collecting additional data; determine the presence, general location (if practicable), and magnitude of any DNAPL zones as defined in the Paducah SMP (DOE 2006c).

Goal 3: Determine Surface and Subsurface Transport Mechanisms and Pathways—Gather existing quality data and, if necessary, collect additional adequate quality data to analyze contaminant transport mechanisms, evaluate risk, and support an FS.

Goal 4: Support Evaluation of Remedial Technologies—Determine if the existing data are sufficient to evaluate alternatives that will reduce risk to human health and the environment and/or control the migration of contaminants off-site.

Scrap Metal Removal

C-746-D Classified Scrap Yard

The last scrap metal from the C-746-D Classified Scrap Yard was shipped on February 20, 2006. During operations, the concrete floor of the yard became fractured in some areas and gravel was placed in the yard to provide a safe working area. After all scrap metal was removed, 36 shipments of soil and gravel also were packaged and disposed of at Nevada Test Site. The last shipments from the yard were

made on April 18, 2006. A total of 4,696.74 net tons of classified scrap metal and 678.84 net tons of classified soils was shipped on 343 truck shipments.

Northwest Corner Scrap Yards

Table 3.1 below summarizes each trainload of scrap in which scrap metal was sent for disposal.

Table 3.1. Northwest Corner Scrap Yard Shipments

Shipment	Date Released	Tonnage
1	January 20, 2006	629
2	February 17, 2006	1,366
3	April 19, 2006	1,654
4	May 31, 2006	3,270
5	June 23, 2006	3,231
6	October 12, 2006	4,075
7	December 16, 2006	1,849

Following the removal of all scrap material, the scrap yards were contoured to ensure proper drainage. Surface run-off was directed into the drainage system that was designed to flow into the C-613 Sedimentation Basin. The scrap yards were hydroseeded for erosion control.

As part of the Northwest Corner Scrap Yards Removal Action, the following activities also occurred:

- Removal of all subcontractor construction equipment,
- Removal of all temporary structures,
- Removal of excess construction equipment and materials, and
- Documentation of project activities

Waste Operations Program

The Paducah Site Waste Operations Program directs the safe treatment, storage, and disposal of waste generated before July 1, 1993, (i.e., legacy wastes) and waste from current DOE activities. Waste managed under the program is divided into the following eight categories.

(1) *Hazardous waste*—Waste that contains one or more of the wastes listed as hazardous under RCRA or that exhibits one or more of the four RCRA hazardous characteristics: (1) ignitability, (2) corrosivity, (3) reactivity, and (4) toxicity.

(2) *Mixed waste*—Waste containing both a hazardous component regulated under RCRA and a radioactive component regulated under the Atomic Energy Act.

(3) *Transuranic waste*—Waste that contains more than 100 nanocuries of alpha emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years.

(4) *Low-level radioactive waste (LLW)*—Radioactive waste not classified as high-level or transuranic.

(5) *PCB-containing and PCB-contaminated waste*—Waste containing or contaminated with PCBs.

(6) *Asbestos waste*—Asbestos-containing materials from renovation and demolition activities.

(7) *Solid waste*—Solid sanitary/industrial waste basically is refuse or industrial/construction debris and is disposed of in landfills.

(8) *PCB radioactive waste*—PCB waste or PCB items mixed with radioactive materials.

In addition to compliance with current regulations, DOE supplemental policies are enacted for management of radioactive, hazardous, PCB, PCB/radioactive, and mixed wastes. These policies include reducing the amount of wastes generated; characterizing and certifying waste before it is stored, processed, treated, or disposed of; and pursuing volume reduction and use of on-site storage, if safe and cost-effective, until a final disposal option is identified. In 2006, activities were focused on disposition of legacy waste—47,850 ft^3 of waste were disposed of. Some waste was disposed of

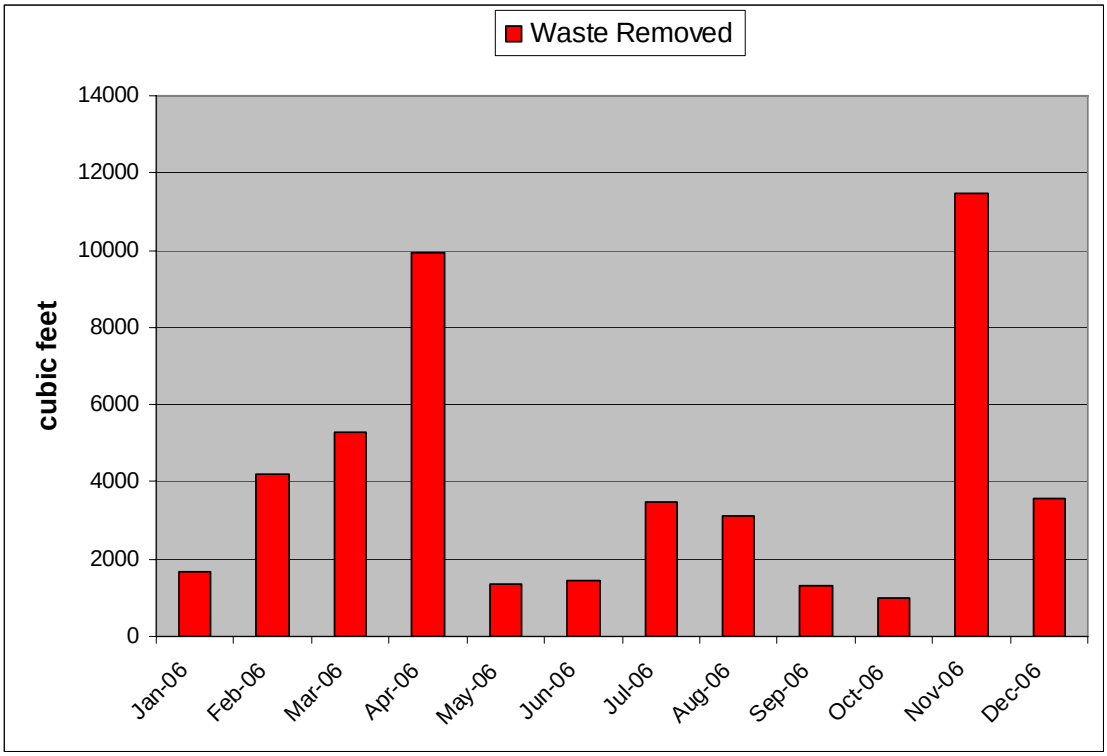

Figure 3.1. Legacy Waste Disposition During 2006

in the C-746-U Landfill and other waste in storage was prepared and shipped off-site. Figure 3.1 shows the legacy waste disposition quantities in 2006.

Waste Minimization/Pollution Prevention

The Waste Minimization/Pollution Prevention Program (WM/PP) at the Paducah Site provides guidance and objectives for minimizing waste generation. The program is set up to comply with RCRA and the Pollution Prevention Act, as well as applicable state and EPA rules, DOE Orders, Executive Orders, and the Site Treatment Plan (see Chapter 2). All PGDP projects are evaluated for WM/PP opportunities.

The program strives to minimize waste using the following strategies: source reduction, segregation, reuse of materials, recycling, and procurement of recycled-content products.

The program has the following goals and objectives:

- Reducing the quantity of wastes generated at their sources;
- Draining, drying, dewatering, evaporating, and otherwise removing liquid from wastes when possible;
- Segregating, sorting, consolidating, and reducing the volume of like wastes;
- Reusing or recycling spent materials;
- Reevaluating wastes determined to be hazardous or radioactive;
- Identifying waste reduction opportunities;
- Establishing site-specific goals for waste minimizing and recycling quantities;
- Establishing employee awareness of WM/PP principles;
- Integrating WM/PP technologies into ongoing projects;
- Coordinating recycling programs;
- Identifying WM/PP responsibilities and resource requirements; and
- Tracking and reporting results.

Accomplishments of the WM/PP Program in 2006 include the following:

(1) Segregated all wastes found and/or generated to reduce the amount of LLW, mixed, hazardous, and PCB-contaminated wastes.

(2) Implemented procedures that required employees to segregate individual items of personal protective equipment (PPE) according to the type of contaminants on them, and to place contaminated PPE into the waste containers that were the original contamination source of the PPE.

(3) Established collection areas for the recycling of certain items such as various types of batteries, fuses, and circuit boards.

(4) In 2006, recycled 1,175 lbs of batteries, 4,200 lbs of used oil, 2,020 lbs of paper, 3,020 lbs of scrap metal, and 1,812 lbs of tires.

(5) Reused 3,400 ft^3 of material rather than disposing of it as waste in 2006.

Depleted Uranium Hexafluoride Cylinder Program

A product of the UE process, DUF_6 is a solid at ambient temperatures and is stored in large metal cylinders. At the end of 2006, the Paducah Site managed an inventory of approximately 38,000 cylinders containing approximately 454,000 metric tons of UF_6 (most containing DUF_6) stored in outdoor facilities, commonly referred to as cylinder storage yards. The inventory varies from time to time as a result of DOE agreements to receive or market DUF_6.

Stored as a crystalline solid at less than atmospheric pressure, when DUF_6 is exposed to moisture in the atmosphere, hydrogen fluoride and uranyl fluoride form. The uranium byproducts form a hard crystalline solid that acts as a self-sealant within the storage cylinder. The acute hazard potential of DUF_6 primarily is chemical toxicity from any released hydrogen fluoride.

The mission of the DUF_6 Cylinder Program is to safely store the DOE-owned DUF_6 inventory until its ultimate disposition. DOE has an active cylinder management program that includes cylinder and cylinder yard maintenance, routine inspections, and other programmatic activities such as cylinder corrosion studies. The program maintains a cylinder inventory database that serves as a systematic repository for all cylinder inspection data.

On April 15, 1999, DOE issued the Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (DOE 1999). In 2002, DOE selected Uranium Disposition Services, LLC, to design, build, and operate facilities at Paducah, Kentucky, and Portsmouth, Ohio. The facilities would convert the inventory of DUF_6 to triuranium octoxide (U_3O_8), a more stable form of uranium that is suitable for disposal or reuse, and hydrofluoric acid that will be sold for commercial use. Consistent with Public Law 107-206, construction began in July 2004 and continued through 2006. Initial construction activities included site excavation, construction of a detention basin to control storm run-off, installation of underground utilities, and construction of a warehouse and administration building. In 2006, substantial progress was made on the construction of the conversion building. (Figure 3.2)

Figure 3.2. DUF_6 Facility Construction Activities

Decontamination and Decommissioning

D&D is conducted for inactive facilities and other structures contaminated with radiological and hazardous material. Facilities are accepted for D&D when they no longer are required to fulfill a site mission. Two major facilities comprising approximately 46,450 m^2 (500,000 ft^2) have been accepted for D&D at PGDP. These facilities are the C-340 Metal Reduction Plant complex, where UF_6 was converted to uranium metal and hydrogen fluoride, and the C-410 Feed Plant complex, where uranium trioxide was converted to UF_6. Contaminants at these facilities include depleted uranium, natural uranium and transuranic radionuclides, UF_4, PCBs, asbestos, and lead paint. Fifteen additional inactive facilities are included in the D&D program at Paducah.

Removal of the C-410 Complex infrastructure is being completed as a CERCLA non-time-critical removal action. Additional CERCLA documentation will be required for the C-410 Building demolition and for the C-340 Complex.

The following are D&D accomplishments in 2006.

- Completed D&D of the C-402 Limehouse Building.
- Submitted Removal Action Work Plan for the D&D of C-405 Incinerator and C-746-A West End Smelter.

Activities performed during the year at the C-340 Complex were limited to surveillance and maintenance of the structures to ensure containment of residual materials.

DOE Material Storage Areas

DMSAs are areas at PGDP containing uninventoried DOE material and equipment that require characterization. They are undergoing a characterization process consistent with requirements associated with nuclear criticality safety, RCRA, TSCA, and solid waste concerns. The 160 DMSAs originally were included with PGDP facilities leased to USEC. To facilitate Nuclear Regulatory Commission certification of PGDP, DMSAs were returned to DOE from USEC December 31, 1996. The DMSAs are located either in nonleased areas inside buildings leased to USEC or in nonleased outdoor areas.

The Kentucky Environmental and Public Protection Cabinet filed an administrative complaint in October 2001 regarding the enforcement of NOVs that alleged violations of Kentucky's hazardous waste management program. Most of these NOVs alleged the failure to characterize materials in the DMSAs at PGDP or the unpermitted storage of hazardous waste in the DMSAs.

In October 2003, an AO between DOE and the Commonwealth of Kentucky was signed that resolved the administrative complaint. The AO established regulatory deadlines for characterization and removal of hazardous waste from the DMSAs and also established requirements relating to RCRA closure for the DMSAs that are found to contain hazardous waste. A total of 330,000 ft^3 of DMSA material has been disposed of and 670,000 of 831,000 ft^3 has been characterized since the program's inception. Also, 18 outdoor DMSAs have been emptied since the program's inception.

According to the 2003 AO, all requirements for Priority B DMSAs were met in 2006. There were no requirements for Priority A or Priority C DMSAs in 2006. DMSAs that may contain hazardous waste have a higher priority than those without it. DOE notifies the Commonwealth of Kentucky when hazardous waste is identified during the DMSA project.

Public Awareness Program

A comprehensive Community Relations and Public Participation Program exists for DOE activities at the Paducah Site. The purpose of the program is to provide the public with opportunities to become involved in decisions affecting environmental issues at the site.

Community/Educational Outreach

DOE and PRS Public Affairs supported several educational and community outreach activities during 2006. DOE managers spoke with civic groups, business leaders, and residents at prearranged events and at the regular board and task force meetings of the PGDP Citizens Advisory Board (CAB).

Citizens Advisory Board

The PGDP CAB, a site-specific advisory board chartered by DOE under the Federal Advisory Committees Act, completed its tenth full year of operation in September 2006. During the year, the CAB held 11 regular board meetings and one retreat. The board includes three task forces and three subcommittees, which meet as necessary.

The task forces review issues for the following areas:

- Water Quality
- Waste Disposition
- Community Outreach
- Long-Range Strategy and Stewardship

All meetings are open to the public and all regular board meetings are publicly advertised. In addition to its voting members, the CAB also has liaison members representing DOE, Kentucky, and EPA.

In 2006, the CAB had nine voting members, four ex-officio members, a deputy-designated federal official, and a federal coordinator.

The Paducah CAB is made up of individuals with diverse backgrounds and interests. It meets monthly, except in December, to focus on early citizen participation in environmental cleanup priorities and related issues at the DOE facility. Additional information concerning the CAB may be obtained at www.pgdpcab.org.

End State Vision Document

The End State Vision Process for PGDP was initiated in 2004. The End State Vision Document was developed and issued in August 2005 as a planning tool for the site's future use. This process identifies the condition of the property after cleanup that would be protective of human health and the environment, while taking into account the future use of the property (e.g., industrial, recreational, or residential) and any potential contaminants and hazards. The process also identifies any variances between the currently planned end state and the potential alternative end state.

Environmental Information Center

The public has access to Administrative Records and programmatic documents at the DOE Environmental Information Center (EIC) in the Barkley Centre, 115 Memorial Drive, Paducah, Kentucky. The EIC is open Monday through Friday from 9 a.m. to 5 p.m. and by appointment. The EIC's phone number is (270) 554-6979.

Documents for public comment also are placed in the McCracken County Public Library (formerly the Paducah Public Library), 555 Washington Street, Paducah, Kentucky. The library is open Monday through Thursday from 9 a.m. to 9 p.m., Friday through Saturday from 9 a.m. to 6 p.m., and Sunday from 1 p.m. to 6 p.m.

The EIC and other public Web pages related to DOE work at the PGDP can be accessed at www.prs-llc.net.

4 Radiological Effluent Monitoring

Abstract

Releases to the atmosphere from the NWPGS, NEPCS, scrap metal removal projects, and the fluorine cell blasting project were estimated for 2006. The calculated emissions for each activity were less than the 40 CFR § 61, Subpart H, limit of 0.1 millirem (mrem) dose to the maximally exposed individual. Analyses of samples of liquid effluents from PGDP indicate that detectable levels of uranium and ^{99}Tc are at levels that are protective of human health. Dose to the public from airborne radionuclides is discussed in Section 6.

Introduction

PGDP effluents are monitored for radionuclides that are known to be present, either now or in the past. The monitoring program for radioactivity in liquid and airborne effluents is described fully in Paducah Site EMPs. In 2006, two separate EMPs defined the relationship of each element of the Environmental Monitoring Program. The fiscal year (FY) 2006 EMP (PRS 2006c) was in effect and covered data collected during the time frame of January 2006 to September 2006. The FY 2007 EMP was in effect and covered data collected during the time frame of October 2006 to December 2006. Dose calculations are provided in Section 6. The dose from all of DOE's emission sources described in this chapter and that from USEC is estimated to be 0.012 mrem, which is well below the 10 mrem limit of 40 *CFR* Part 61, Subpart H.

Airborne Effluents

In accordance with DOE Order 450.1, effluent monitoring is to be conducted to meet *General Environmental Protection Program Standards.* DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, sets dose standards for members of the public at 10 mrem per year from airborne releases and at 100 mrem per year through all exposure pathways resulting from routine DOE operations.

Radiological airborne releases from DOE facilities also are regulated under 40 *CFR* § 61, Subpart H, which governs radionuclide emissions, other than radon. This regulation was amended in 1989 to include specific sampling requirements for each emission point that has the potential to emit radionuclides at an effective dose equivalent of 0.1 mrem to the most potentially affected off-site resident. This refers to the resident who has the greatest chance of being affected by a release of airborne contaminants.

DOE had the sources described here of airborne radionuclides in 2006. DOE also had fugitive air sources that were measured by air monitoring stations around the site that are discussed in Chapter 5.

Northwest Plume Groundwater System

The CERCLA Interim Remedial Action ROD, signed July 22, 1993, established the NWPGS. Although administrative requirements (e.g., permits) of environmental regulations do not apply to projects conducted under CERCLA, DOE has continued to provide pertinent information about emissions to the regulators. The Operations and Maintenance Plan describes sampling and methodologies to be used at the NWPGS. The air emissions methodology is to sample the water stream influent and effluent to the air stripper. The difference in contaminant concentration then is used to calculate air emissions. The analysis of the air stripper influent and effluent water provides a more accurate measurement of airborne discharges than actual stack measurements due to the low, practically immeasurable, radionuclide airborne effluents associated with the facility.

On August 28, 1995, DOE began operation of the NWPGS. The facility is located just outside the northwest corner of the PGDP security area. The facility consists of an air stripper to remove volatile organics from water and an ion exchange unit for the removal of ^{99}Tc. The air stripper is located upstream of the ion exchange unit. The ^{99}Tc (radionuclide) concentration in the influent and effluent water of the air stripper and the quantity of the water passing through the air stripper were used to calculate total potential ^{99}Tc emissions from the facility in 2006. The emissions were used to calculate dose rates associated with this operation. In 2006, releases to the atmosphere from the NWPGS were estimated to be 8.2E-05 curies of ^{99}Tc.

Northeast Plume Containment System

The NEPCS is a CERCLA interim action to remediate contaminated groundwater. Although administrative requirements (e.g., permits) of environmental regulations do not apply to projects conducted under CERCLA, DOE has continued to provide pertinent information about emissions to the regulators. In 2006, ^{99}Tc was detected in small amounts in the groundwater that was extracted.

The wells and pumping facility are located northeast of the PGDP security area. The water is pumped to the C-637-A Cooling Tower where the contaminants evaporate from the extracted groundwater. The ^{99}Tc (radionuclide) concentration and the quantity of the water pumped to the cooling tower were used to calculate total potential ^{99}Tc emissions from the facility in 2006. The estimated emissions from the NEPCS were estimated to be 8.3E-06 curies of ^{99}Tc.

Scrap Yards Removal Projects

During 2006, the Scrap Metal Removal Project continued sorting, which involved characterizing, packaging, and off-site disposal of scrap yard material. Similar activities took place for DMSA Outside (OS)-12. Fugitive airborne radionuclide emissions may have resulted from dust created by removal, size reduction, and loading the scrap into transportation containers. Whenever necessary, the ground was sprayed with potable water to reduce fugitive emissions as much as practicable. Figure 4.1 shows loading of scrap metal into gondola boxes. The estimated emissions from the Scrap Metal Removal Projects were 1.0E-05 curies, and that for DMSA OS-12 was 6.1 x 10^{-5}.

Figure 4.1. Loading of Scrap Metal

C-410 Decontamination and Decommissioning Activities

Fluorine cells were removed and prepared for off-site shipment from the C-410 Facility. This preparation required removal of the paint on the exterior of the cells due to concerns about possible contaminants in the paint. The paint was removed by a sponge blasting process. A small amount of radionuclide contamination was present in the removed paint. The blasting occurred within a facility. Room ventilation was exhausted through a high efficiency particulate air filter. The amount of radionuclides released was estimated based on 40 *CFR* § 61,Subpart H, Appendix D, emission factors. The estimated emissions from the C-410 D&D Fluorine Cell Blasting project were 2.5E-08 curies.

C-402 Demolition

The C-402 Limehouse inactive facility was demolished during 2006. Fugitive airborne radionuclide emissions may have resulted from dust created by demolition and removal of the debris. The estimated emissions from the C-402 demolition were 1.5E-04 curies.

Table 4.1. Airborne Effluent Results Summary

Project	Releases to Atmosphere, curies
NWPGS	8.2×10^{-5}
NEPCS	8.3×10^{-6}
Scrap Metal Removal	1.0×10^{-5}
DMSA OS-12	6.1×10^{-5}
C-410 D&D Fluorine Blasting	2.5×10^{-8}
C-402 Demolition	1.5×10^{-4}

Liquid Effluents

The CWA for the Paducah Site is administered by KDOW through the KPDES Wastewater Discharge Permitting Program. The sitewide KPDES permit (KY0004049) became effective November 1, 2006. This permit was challenged by DOE, USEC, and UDS; consequently, the conditions of the previous permit remained in effect, for the 2006 reporting period, except for the monitoring requirements. In addition to nonradiological parameters on the KPDES permit, specific radionuclide analyses, in addition to gross alpha and beta activity analyses, are conducted on liquid effluent samples. Grab samples and composite samples collected at weekly or monthly monitoring frequencies are used to measure discharges.

DOE Orders 450.1 and 5400.5 establish effluent monitoring requirements to provide confidence that radiation exposure limits of 100 mrem per year are not exceeded. DOE Order 5400.5 sets guidelines for allowable concentrations of radionuclides in various effluents to protect public health and requires radiological monitoring. This protection is achieved at the Paducah Site by meeting derived concentration guidelines (DCGs), which are the concentrations of given radionuclides that would result in an effective dose equivalent of 100 mrem per year. The DCGs are based on the assumption that a member of the public has continuous, direct access to the liquid effluents. In reality, exposure is not continuous; therefore, the allowable concentrations for the DCGs are very conservative. Further information on DCGs is provided in Appendix B.

For monitoring purposes, the Paducah Site uses estimates of DCG levels and outfall flow characteristics (rainfall dependent) to determine sampling frequencies. Neither continuous monitoring nor continuous sampling is required by DOE Order 5400.5. Uranium and ^{99}Tc are the primary radionuclides of concern. Analyses also are performed routinely for dissolved alpha, suspended alpha, dissolved beta, and suspended beta concentrations. The KPDES permit requires additional sampling (two events in five years) for priority radiological pollutants at DOE outfalls. This sampling was conducted in 2000 and 2002. Radiological standards in liquid effluents were not exceeded in 2006.

Other radiological effluent monitoring is required by KDWM landfill permits 073-00014, 073-00015, and 073-00045 for the C-746-S, C-746-T, and C-746-U Landfills, respectively. Surface runoff is analyzed to determine if landfill constituents are being discharged into nearby receiving streams.

DOE Outfalls

DOE is responsible for a total of four outfalls, 001, 015, 017, and 019 (Figure 4.2). Outfall 001 is a continuous flow outfall that receives discharges from a variety of permitted units, including the following:

(1) USEC's C-616 Liquid Pollution Abatement Facility (LPAF), a once-through cooling water system, 0.8 million gallons per day (MGD);

(2) DOE's NWPGS, 0.3 MGD;

(3) C-752-A Waste Treatment and Storage facility, 100,000 gallons per year (gpy);

(4) C-752-C Decontamination Pad, 100,000 gpy; and

(5) Relatively small quantities of wastewater from several other sources.

DOE's NEPCS is treated through the C-637 Cooling Tower; the water from this is transferred to C-616 LPAF through a process known as blowdown. Next, the water is transferred by an underground pipeline to the C-616-F Full Flow Lagoon, and ultimately discharged into Outfall 001. In addition, surface-water runoff from the northwest scrap yards is collected in the C-613 Sedimentation Basin and then discharged into Outfall 001.

Outfall 015 receives surface-water runoff from the east-central sections of the plant. Outfall 017 receives surface-water runoff from the southeast section of the plant (primarily the cylinder storage yards). Outfall 019 receives surface-water runoff from C-746-U (DOE's operational nonhazardous, solid waste landfill). Radiological effluent data are presented in Section 1, Tables 1.1 through 1.4, of Volume II of this report.

Landfill Surface Runoff

Surface runoff from the closed C-746-S Residential Landfill and the C-746-T Inert Landfill is monitored quarterly. Due to their close proximity, the C-746-S&T Landfills are monitored as one landfill ("L" locations shown in Figure 4.2). Also, surface runoff is monitored from the operating C-746-U Contained Landfill. Surface runoff from these landfills is monitored for gross alpha and gross beta concentrations. Grab samples are taken from the landfill runoff, the receiving ditch upstream of the runoff discharge point, and the receiving ditch downstream of the runoff discharge point. Sampling is performed to comply with KDWM permit for landfill operations. Sampling data are presented in Section 1, Tables 1.5 through 1.10, of Volume II of this report. Results from landfill surface water runoff are consistent with levels seen in previous years' data.

Liquid Effluent Monitoring Results

Tables 4.2 and 4.3 indicate the minimum, maximum, and average concentrations of uranium and ^{99}Tc at each outfall monitoring location for CY 2006. Both radionuclides are compared with the corresponding DCG and are presented as a percentage of DCG. The sum of the percentages of the DCG is 0.42% of the allowable DCG. Technetium-99 averages for 2006 for all four outfalls were well below 0.1 percent of the DCG. Data for 2006 do not indicate a significant change in relation to DCG levels compared to data for the past five years.

Figures 4.3 and 4.4 show the five-year summary (CY 2002–CY 2006) of average concentrations of uranium and ^{99}Tc. Uranium concentrations for 2006 are well below the DCG of 600 pCi/L, established by DOE Order 5400.5 for the protection of human heath and the environment. Technetium-99 in 2006 is well below the DCG of 100,000 pCi/L, which is protective of human health as long as ^{99}Tc is the only radiological constituent to which the individual is exposed.

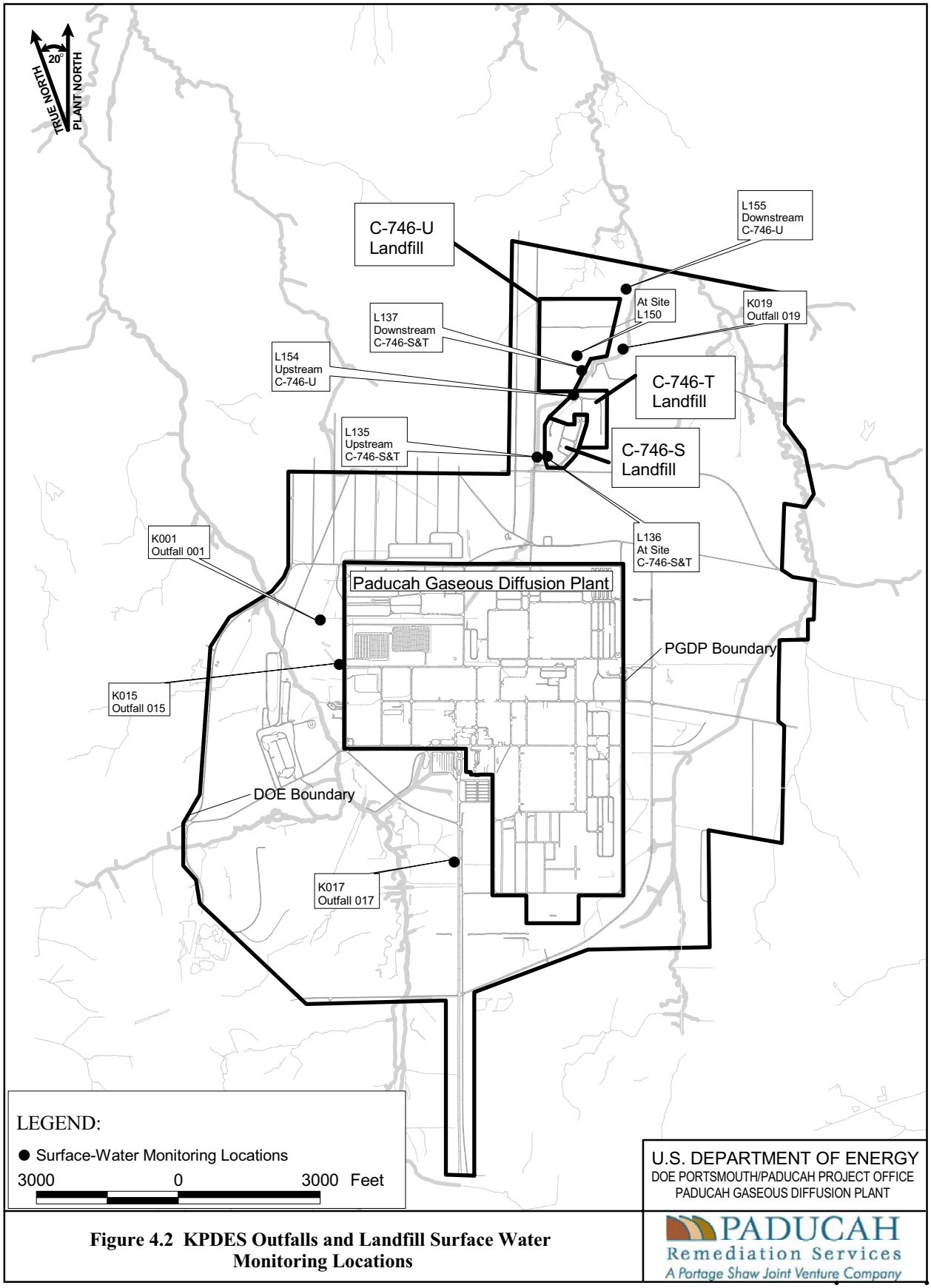

Figure 4.2 KPDES Outfalls and Landfill Surface Water Monitoring Locations

Table 4.2. Total Uranium Concentration in DOE Outfalls for 2006

Outfall	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Average (pCi/L)	% of ^{235}U	% of DCG[a]
001	5	0.002	0.02	0.0076	3.367	0.47[b]	0.56
015	6	0.025	0.15	0.076	32.17	0.29	5.36
017	6	0.0011	0.0029	0.0019	1.157	0.60[b]	0.19
019	3	< 0.001	< 0.001	< 0.001	0.695	0.76[c]	0.11

[a] DCG for uranium is 600 pCi/L.
[b] Insufficient uranium quantities to analyze for assay. Assay based on past data.
[c] Insufficient uranium quantities to analyze for assay. Natural uranium used as assay.

Table 4.3. Technetium-99 Activity in DOE Outfalls for 2006

Outfall	Number of Samples	Minimum (pCi/L)[a]	Maximum (pCi/L)[a]	Average (pCi/L)[a]	% of DCG[a]
001	7	-1.16	18.6	8.9	0.0089
015	5	0.547	24.2	13	0.013
017	6	-3.61	26.6	8.2	0.0082
019	4	2.35	14.9	5.6	0.0056

[a] DCG for ^{99}Tc is 100,000 pCi/L.

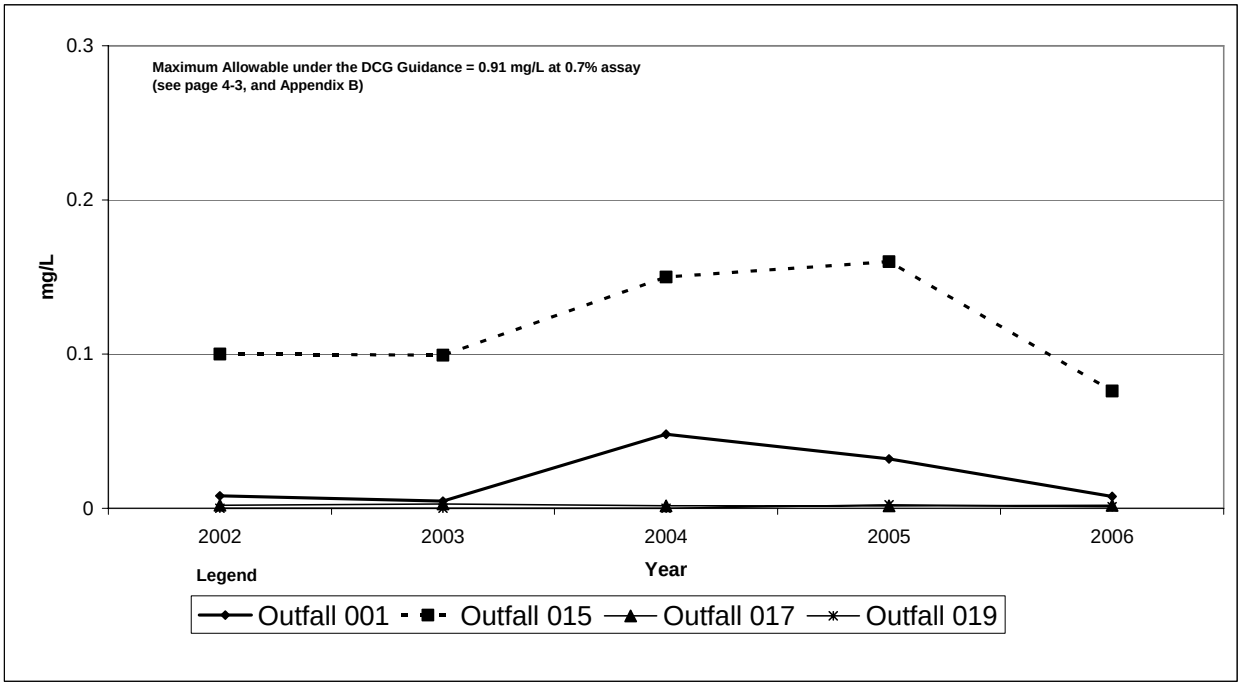

Figure 4.3. Uranium Concentration Discharged to Surface Water, 2002–2006

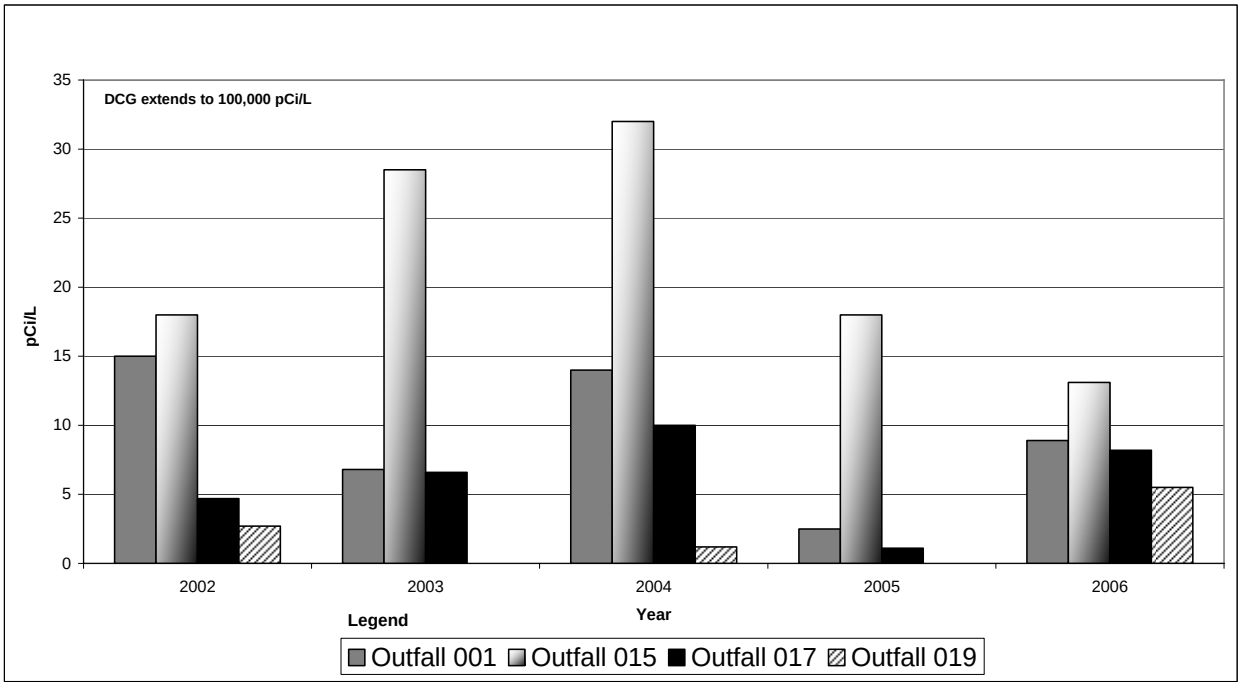

Figure 4.4. Technetium-99 Activity Discharged to Surface Water, 2002-2006

5 Radiological Environmental Surveillance

Abstract

The radiological environmental surveillance program assesses the effects of DOE's activities on the surrounding population and environment. Surveillance includes analyses of surface water, groundwater, sediment, terrestrial wildlife, direct radiation, and ambient air. Surveillance results from 2006 indicate that radionuclide concentrations in sampled media were within applicable DOE standards.

Introduction

The Radiological Environmental Surveillance Program at the Paducah Site is based on DOE Orders 450.1, *Environmental Protection Program,* and 5400.5, *Radiation Protection of the Public and the Environment.* These orders require that an environmental surveillance program be established at all DOE sites to monitor the radiological effects, if any, of DOE activities on the surrounding population and environment. Surveillance includes analyses of surface water, groundwater (Section 9), sediment, terrestrial wildlife, direct radiation, and ambient air. Surveillance results from 2006 indicate that radionuclide concentrations in sampled media were within applicable DOE standards.

Ambient Air

In accordance with the 1993 DOE/USEC lease agreement, USEC is responsible for their radionuclide airborne point-source discharges at PGDP, while DOE is responsible for the NWPGS, the NEPCS, the Scrap Metal Removal Project, C-402 Removal Activities, and C-410 D&D activities. Using Kentucky Cabinet for Health and Family Services (KCHFS)-operated air monitors, DOE monitors fugitive emission sources such as building roof tops, piles of contaminated scrap metal, roads, concrete rubble piles, and the decontamination of machinery and equipment used in remediation activities.

DOE utilized ambient air monitoring data to verify radionuclide levels in off-site ambient air. Ambient air samples are collected at 10 sites surrounding the plant (see Figure 5.1) in order to measure the radionuclides emitted from Paducah Site sources, including fugitive emissions. The Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch (RHTAB) of the KCHFS Department for Public Health conducted ambient air monitoring during 2006. Based on 2006 results, plant-derived radionuclides were not detected by the RHTAB's air monitoring network. The monitoring results for 2006 are listed in Section 2, Table 2.1 of Volume II, of this report.

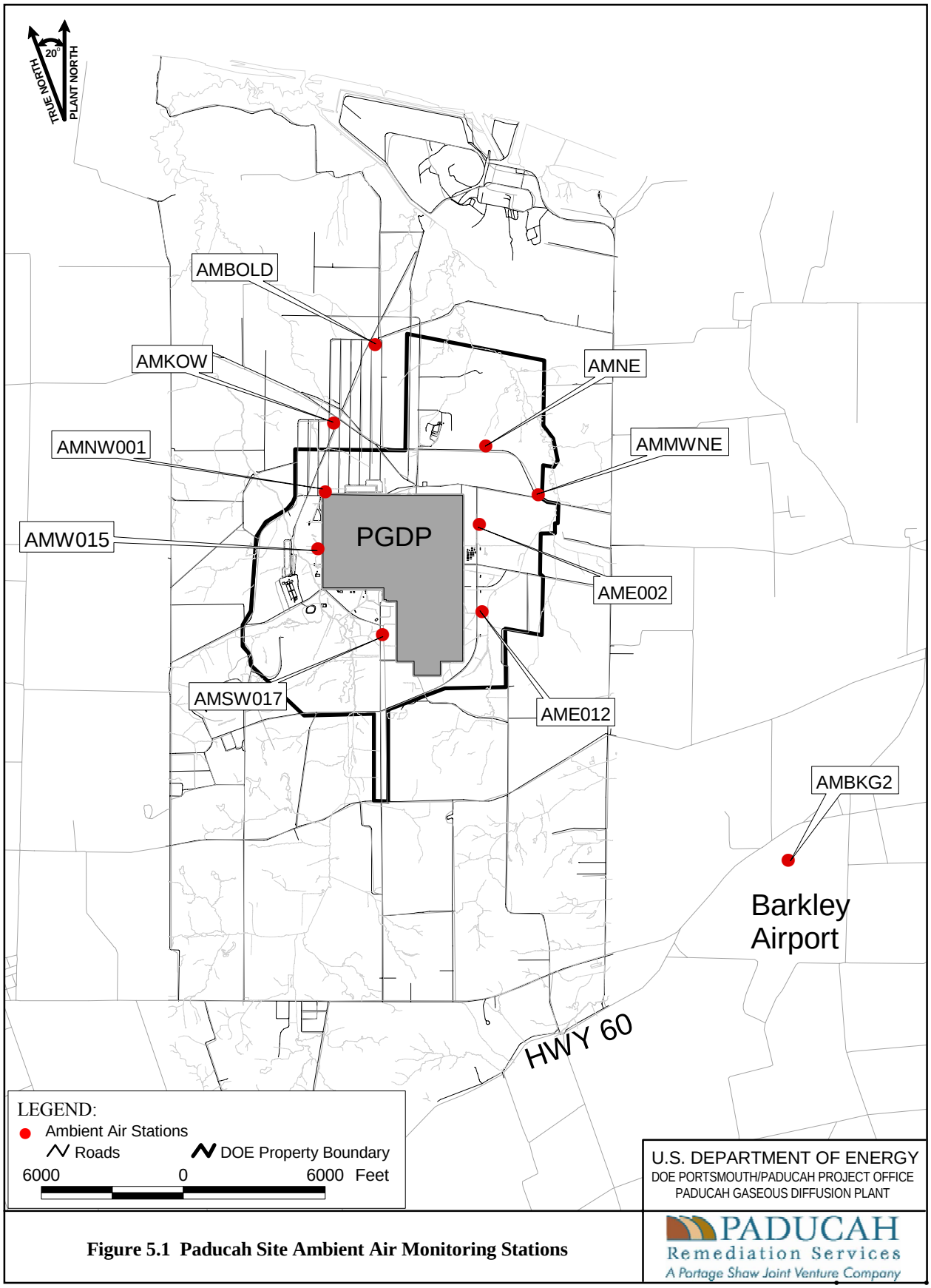

Figure 5.1 Paducah Site Ambient Air Monitoring Stations

Meteorological Monitoring

Computer-aided atmospheric-dispersion modeling uses emission and meteorological data to determine the impacts of plant operations to the community. Modeling is used at the Paducah Site to simulate the transport of air contaminants and predict the effects of abnormal airborne emissions from a given source. In addition, a multitude of emergency scenarios can be developed to estimate the effects of unplanned releases to employees and population centers downwind of the source.

Surface Water

Paducah Site surface water runoff is released through plant outfalls either to the west in Bayou Creek or to the east in Little Bayou Creek. These merge north of the site and discharge into the Ohio River. The net impact of the Paducah Site on surface waters is evaluated by comparing data from samples collected upstream of the site to data from samples collected downstream of the site or from ecologically similar waterways that have not been impacted by PGDP activities. Bayou Creek and Little Bayou Creek are not used as drinking water supplies; therefore, EPA safe-drinking-water standards do not apply. Radioactive effluents from PGDP are managed in accordance with DOE Order 5400.5.

Table 5.1 shows the radiological analytical parameters analyzed under the quarterly surveillance surface water sampling program. This table does not include the quarterly seep locations, which are upwellings of groundwater in the Little Bayou Creek bed. Similar to the groundwater sampling program, fewer radiological analytical parameters are collected than have been in the past because of the small changes seen in the last several years. The radiological contaminants of concern at PGDP are alpha, beta, and ^{99}Tc.

Table 5.1. Radiological Parameters for Surface Water Samples

Parameter
Americium-241 (^{241}Am)
Cesium-134 (^{134}Cs)
Cesium-137 (^{137}Cs)
Cobalt-60 (^{60}Co)
Dissolved Alpha
Dissolved Beta
Neptunium-237 (^{237}Np)
Plutonium-238 (^{238}Pu)
Plutonium-239/240 ($^{239/240}$Pu)
Potassium-40 (^{40}K)
Suspended Alpha
Suspended Beta
Technetium-99 (^{99}Tc)
Thorium-228 (^{228}Th)
Thorium-230 (^{230}Th)
Thorium-232 (^{232}Th)
Thorium-234 (^{234}Th)
Uranium (U)
Uranium-234 (^{234}U)
Uranium-235 (^{235}U)
Uranium-238 (^{238}U)

Figure 5.2 shows 21 surveillance surface water sampling and 2 seep locations. Radiological sampling is conducted at the following locations:

- Upstream Bayou Creek (L1);
- Bayou Creek near the plant site (C612, C616, K001UP, K015UP, S31, and L291);
- Downstream Bayou Creek (L5 and L6);
- Little Bayou Creek near the plant site (L10 and L194);
- Downstream Little Bayou Creek (L11, L12, and L241);
- Downstream Little Bayou Creek Seeps (LBCSP5 and LBCSP6);
- The convergence of Little and Bayou Creeks (L8);
- Upstream Ohio River (L29);
- Downstream Ohio River (L30);

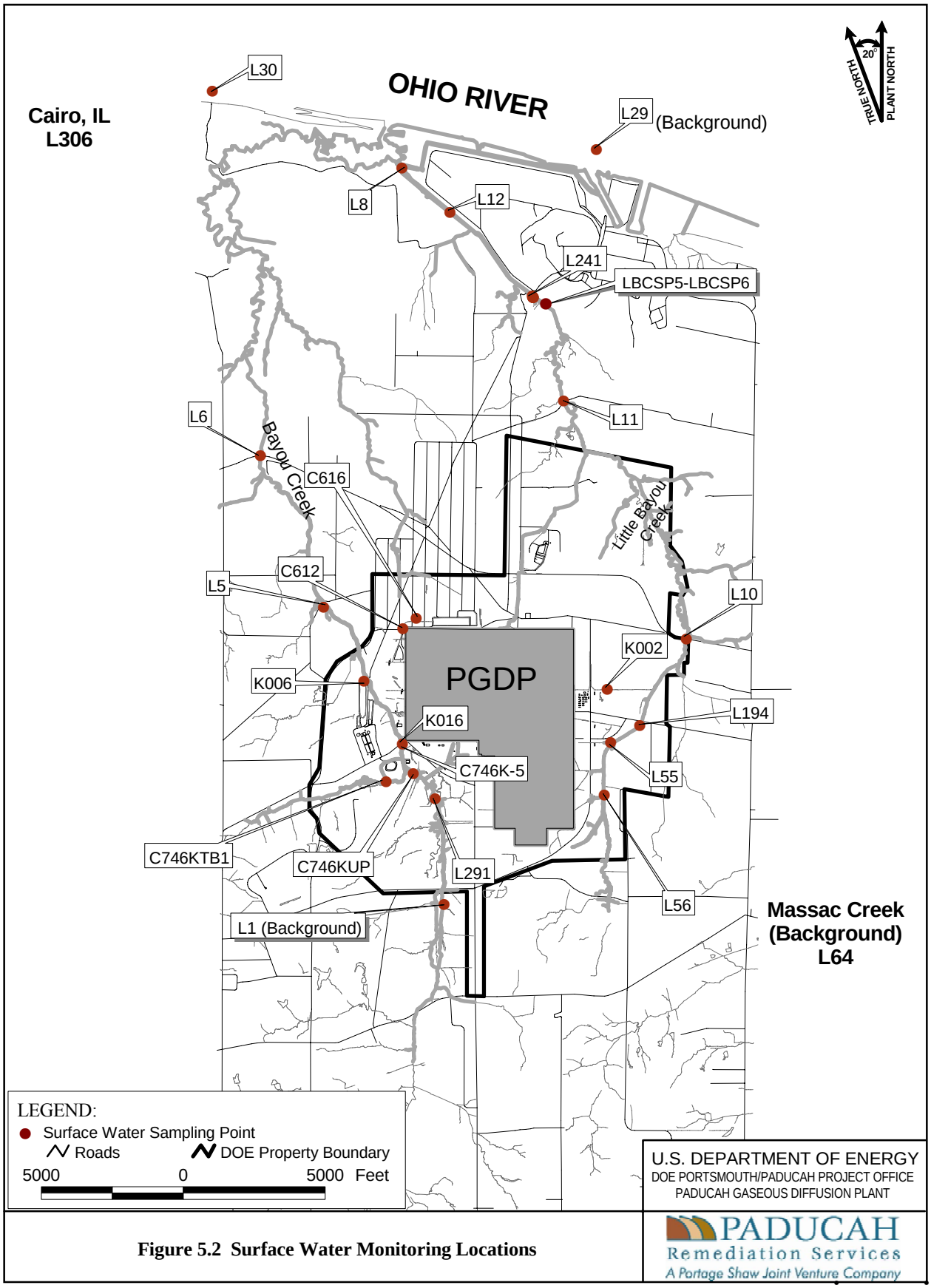

Figure 5.2 Surface Water Monitoring Locations

- Downstream Ohio River at the confluence with the Mississippi River (L306), which is the closest public drinking water supply source downstream of the plant;
- Background stream Massac Creek (L64); and
- From the C-746-K Landfill (C746K-5 and C746KTB1).

No sample point exists for upstream Little Bayou Creek because the flow in that part of the watershed is too low to monitor. Nearly all water in Little Bayou Creek is comprised of discharges from plant outfalls; therefore, reference water quality for Little Bayou Creek is based on Bayou Creek at station L1 (upstream Bayou Creek). Sampling locations L29 (Ohio River) and L64 (Massac Creek) are reference waterways that also are used for Little Bayou Creek.

Locations in Little Bayou Creek (LBCSP5 and LBCSP6), known as seeps, are upwellings of groundwater in the Little Bayou Creek bed. Two locations were chosen to sample each quarter to trend and observe changes in data. These seeps are located downstream of the plant site approximately halfway between the site and the Ohio River (Figure 5.2).

The surface water results are compared to the DCGs, which are the maximum levels that are considered protective of human health and the environment. These levels are given in DOE Order 5400.5. These values are maximum allowable concentrations calculated from the dose of 1 mrem from one isotope and one exposure pathway.

Surface Water Surveillance Results

Table 5.2 provides the average concentrations of radionuclides upstream and downstream of plant effluents in Bayou Creek, downstream of plant effluents in Little Bayou Creek; at the C-746-K Landfill; near the plant site in Bayou Creek and Little Bayou Creek; at the convergence of Bayou Creek and Little Bayou Creek; upstream and downstream in the Ohio River and at the confluence of the Mississippi River (Cairo, Illinois); and at the reference stream, Massac Creek.

Comparisons of downstream data to upstream data and/or reference data is one of the factors used to determine the impact of plant effluents on Little Bayou Creek or Bayou Creek. Concentrations of ^{99}Tc and other radionuclides were elevated near the plant site and in downstream creek locations, including the creek convergence, with the highest radionuclide concentrations found downstream of plant effluents in Little Bayou Creek (Figure 5.2). These concentrations are well below the Northwest Plume Interim Remedial Action target treatment level of 900 pCi/L and below the EPA maximum contaminant limit of 900 pCi/L. The level of radiological parameters seen at the C-746-K Landfill was similar to those found upstream of Bayou Creek. Suspended beta was detected at Massac Creek. Uranium-234 was found at L306 in Cairo, Illinois (the nearest public drinking water source). Concentrations of radionuclides in surface water effluents at the Paducah Site and downstream of it were far below DCGs.

Table 5.3 provides the average concentrations of radiological parameters at the seep locations. Results indicate that the concentration of ^{99}Tc is higher at both seeps than at other surface water locations on Little Bayou Creek; however, these concentrations are well below the Northwest Plume Interim Remedial Action target treatment level 900 pCi/L and below the EPA maximum contaminant limit of 900 pCi/L. Additional radiological surface water data are presented in Section 2, Tables 2.2 through 2.24 in Volume II of this report.

DCG levels established by DOE Order 5400.5 are screening values for the protection of human health and the environment. Radiological sample results for all surface water locations sampled in 2006 were less than DCG levels.

Table 5.2. 2006 Average Radiological Results for Surface Water Surveillance Samples[a]

Parameter (pCi/L) except where noted	DCG[b]	Up-stream Bayou[1]	Bayou near Site[2]	Down-stream Bayou[3]	Little Bayou near Site[4]	Down-stream Little Bayou[5]	Creek Conver-gence[6]	C-746-K Landfill[7]	Up-stream Ohio[8]	Down-stream Ohio[9]	Massac Creek[10]	Cairo, IL[11]
Dissolved Alpha	--	ND	23.66	ND	3.43	ND	ND	ND	ND	ND	ND	ND
Dissolved Beta	--	9.77	27	12	6.64	11.11	10.14	8.09	ND	ND	11.7	ND
Plutonium-239/40	--	ND	0.105	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40	7,000	38.7	48.07	ND	ND	ND	45.8	23	ND	ND	ND	ND
Suspended Beta	--	ND	15.84	ND	ND	ND	ND	ND	ND	ND	8.39	ND
Technetium-99	100,000	ND	22.25	18.3	ND	23.03	18.55	ND	ND	ND	ND	ND
Thorium-234	10,000	ND	52.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (mg/L)	--	ND	0.012	ND	0.011	0.0073	0.007	ND	ND	ND	ND	ND
Uranium	600	ND	18	1.72	4.53	2.87	ND	ND	ND	ND	ND	ND
Uranium-234	500	ND	5.18	0.806	0.90	0.57	1.03	ND	ND	ND	ND	0.29
Uranium-235	600	ND	0.43	0.16	0.11	0.081	ND	ND	ND	ND	ND	ND
Uranium-235(wt%)		ND	0.53	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-238	600	ND	7.38	0.77	2.9	1.3	1.15	ND	ND	ND	ND	ND

a = Average concentration for the seep locations (LBCSP5–LBCSP6) are found in Table 5.3.
b = Derived Concentration Guide (see Liquid Effluents section for definition, page 4-3).
c = Quantities of total uranium were found to be quite small or not detected; individual isotopes of uranium were not analyzed.
-- = DCGs for these radionuclides not provided.
ND=Not Detected
The following footnotes correspond with column titles in the above table. These are groupings of sampling locations in the area described in the title.

1 = L1 (Background)
2 = C612, C616, K001UP, K015UP, L291, S31
3 = L5, L6
4 = L10, L194,
5 = L11, L12, L241
6 = L8
7 = C746KTB1, C746K-5
8 = L29 (Background)
9 = L30
10 = L64 (Background)
11 = L306

Table 5.3. 2006 Average Radiological Sample Results for Surface Water Seeps in Little Bayou Creek

Parameter (pCi/L)	LBCSP5	LBCSP6	DCG
Alpha Activity	0.535	2.3825	--
Beta Activity	127.5	92.1	--
Technetium-99	169.5	172.1	100,000
Uranium	0.32605	0.46025	600

Sediment

Sediment is an important constituent of the aquatic environment. If a pollutant is a suspended solid or attached to suspended sediment, it can settle to the bottom (thus creating the need for sediment sampling), be taken up by certain organisms, or become attached to plant surfaces. Pollutants transported by water can adsorb on suspended organic and inorganic solids or be assimilated by plants and animals. Suspended solids, dead biota, and excreta settle to the bottom and become part of the organic substrata that support the bottom-dwelling community of organisms. Sediments can play a significant role in aquatic ecological impacts by serving as a repository for radioactive or chemical substances that pass via bottom-feeding biota to the higher trophic levels.

Sediment Surveillance Program

Because DOE retained responsibility for historic environmental issues, ditch sediments are sampled semiannually through a radiological environmental surveillance program. Table 5.4 shows the radiological analytical parameters. Sediment samples were taken from 14 locations (Figure 5.3).

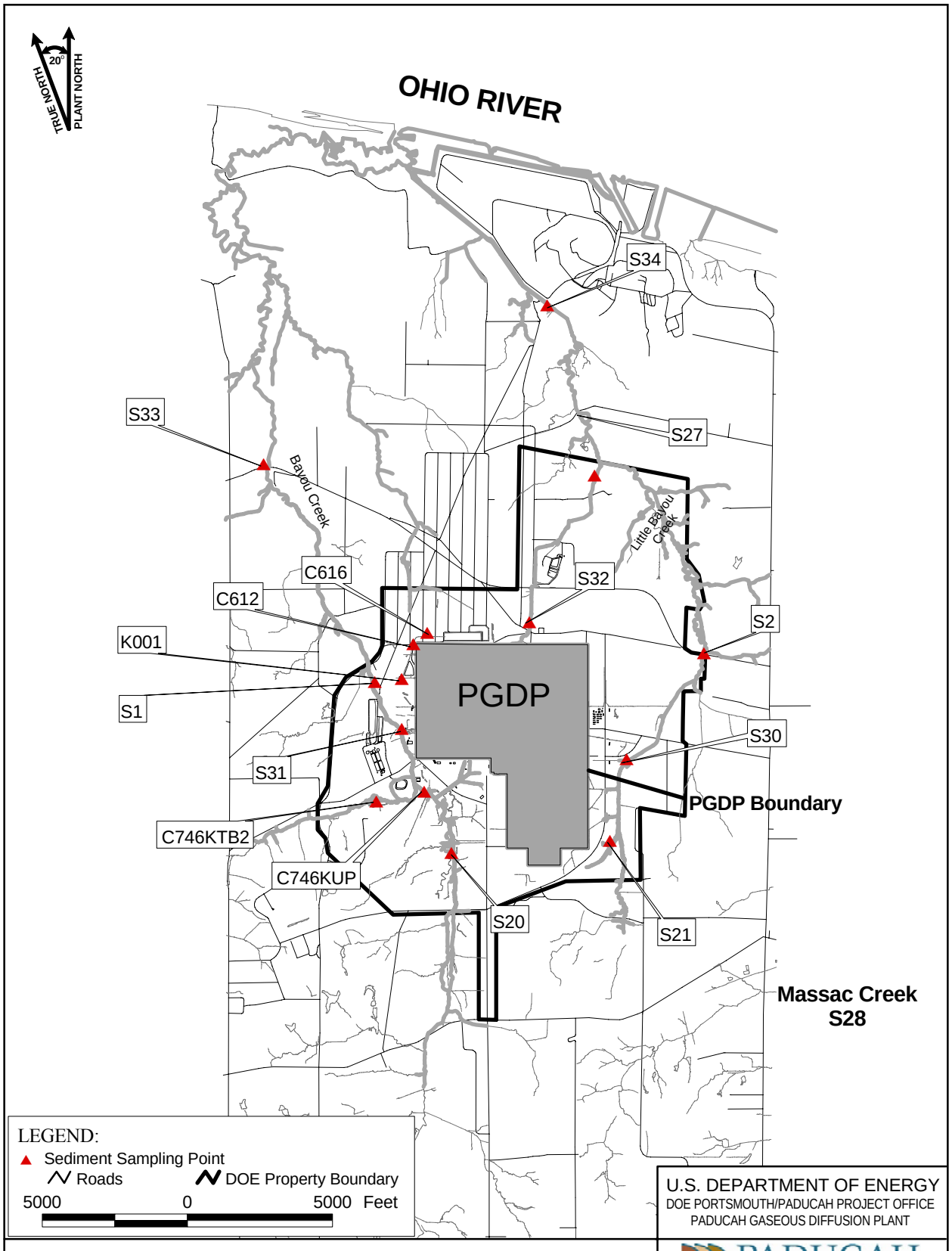

Figure 5.3 Sediment Monitoring Locations

Table 5.4. Radiological Parameters for Sediment Samples

Parameter
Alpha Activity
Americium-241 (^{241}Am)
Beta Activity
Cesium-137 (^{137}Cs)
Cobalt-60 (^{60}Cs)
Neptunium-237 (^{237}Np)
Plutonium-239/240 ($^{239/240}$Pu)
Potassium-40 (^{40}K)
Technetium-99 (^{99}Tc)
Thorium-230 (^{230}Th)
Uranium (U)
Uranium-234 (^{234}U)
Uranium-235 (^{235}U)
Uranium-238 (^{238}U)

Sediment Surveillance Results

Table 5.5 shows the concentrations of radionuclides in the sediments upstream and downstream of DOE. The locations are similar to those of the surface water surveillance program, except for the addition of NSDD, and the deletion of the Ohio and Mississippi Rivers from sediment surveillance (Figure 5.3).

In general, S32, within Section 3 of the NSDD, has the highest levels of most radionuclides. Section 3 is outside the security fence (Table 5.5), and access to this area is limited. This area will be the subject of a future CERCLA investigation, under the Surface Water OU, the results of which will determine if the levels of radionuclides pose an unacceptable risk to humans and/or the environment.

Uranium activity is elevated in Little Bayou Creek and Bayou Creek near the plant site and downstream. The downstream location (S34) on Little Bayou Creek corresponds with the surface water seep sites (LBCSP5 and LBCSP6) previously mentioned.

Other radionuclides, although present, are not significantly above background levels. Additional sediment data are presented in Tables 2.25 through 2.38 in Volume II, Section 2 of this report.

Areas that contain elevated radionuclide levels are controlled within the DOE property boundaries or are posted for protection of the public.

Annual Deer Harvest

In 2006, a total of five deer were harvested in the WKWMA as part of DOE's ongoing effort to monitor the effects of the Paducah Site on the ecology of the surrounding area. No reference deer were collected in 2006 due to the availability of sufficient historical data, which were used for comparison. Liver, muscle, and bone samples were analyzed for several radionuclides (^{137}Cs, ^{237}Np, ^{239}Pu, ^{99}Tc, ^{230}Th, ^{234}U, ^{235}U, and ^{238}U). In addition, thyroid samples were analyzed for ^{99}Tc. Because the liver and muscle tissues are considered consumable by humans, these tissues can be evaluated for radiological risks (dose) if analyses reveal detectable levels above background or levels found in reference deer. Bone and thyroid samples are used only as indicators of contamination.

In 2006, because the results of the site deer did not vary significantly from the reference deer, dose assessments concluded that there was no significant difference between the radiological dose from site deer and reference deer. Dose assessments indicate that deer muscle and liver are acceptable for consumption and levels are consistent with previous years' data.

Additional deer data are presented in Section 2, Tables 2.40 through 2.43 in Volume II of this report. Section 6 of this volume, discusses dose calculations associated with eating deer from the WKWMA.

Direct Radiation

A potential concern from DOE's operations at the Paducah Site is direct external radiation exposure. External radiation exposure is defined as exposure attributed to radioactive sources outside the body (e.g., cosmic gamma radiation). Sources of external radiation exposure at the Paducah Site

Table 5.5. 2006 Average[a] Radiological Results for Sediment Surveillance Samples

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	C-746-K Area[6]	NSDD[7]	Massac Creek[8]	Back-ground[b]
Alpha Activity (pCi/g)	4.9	17	2.5	9.1	5.5	2.5	110	4.5	--
Americium-241(pCi/g)	ND	0.032	ND	ND	0.04	ND	0.84	ND	--
Beta Activity (pCi/g)	2.6	28	3.06	11	6.2	3.5	110	2.8	--
Cesium-137 (pCi/g)	0.036	0.072	0.039	ND	0.068	ND	0.72	ND	0.49
Neptunium-237 (pCi/g)	ND	0.085	ND	ND	ND	ND	0.83	ND	0.1
Plutonium-239/240 (pCi/g)	ND	0.064	0.011	ND	0.16	ND	3.8	ND	0.025
Potassium-40 (pCi/g)	7.4	5.2	5.1	3.6	3.2	2.1	6.8	8.4	16
Technetium-99 (pCi/g)	0.58	6.4	0.40	0.74	1.1	0.42	6.6	4.7	2.5
Thorium-230 (pCi/g)	0.27	0.58	0.22	0.22	1.4	0.13	67	0.27	1.5
Uranium (pCi/kg)	222	7,500	809	7,400	2,500	ND	9,100	32	--
Uranium-234 (pCi/g)	0.11	4.4	0.38	1.2	0.58	0.098	3.8	0.13	2.5
Uranium-235 (pCi/g)	ND	0.21	0.019	0.11	0.049	ND	0.21	ND	0.14
Uranium-235 (wt%)	ND	1.00	0.68	0.28	0.42	ND	0.63	ND	--
Uranium-238 (pCi/g)	0.11	29	0.41	6.1	1.8	0.11	5.2	0.11	1.2

a = The average within each group of locations.
b = from Table A-12 of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D2, December, 2000.
ND = Not Detected

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title and are shown on Figure 5.3.

1 = S20
2 = C612, C616, K001, S1, S31
3 = S33
4 = S2, L194
5 = S27, S34
6 = C746KTB2
7 = S32
8 = S28

include the cylinder storage yards, the operations inside the cascade building, and small sources such as instrument check locations. Cylinder storage yards have the largest potential for a dose to the public because of their proximity to the PGDP security fence.

The Paducah Site EMP (BJC 2005) establishes DOE's program for monitoring external gamma radiation at areas accessible to members of the public. The External Radiation Exposure Monitoring Program has the following three objectives:

(1) To establish the potential radiation dose a member of the public may receive from direct exposure to DOE operations at the boundary of the DOE perimeter fence;

(2) To establish the potential dose a member of the public may receive while visiting or passing through accessible portions of the DOE Reservation; and

(3) To calculate the radiation dose equivalent for the maximally exposed individual member of the public.

In 2006, direct radiation was monitored by quarterly placement, collection, and analysis of environmental thermoluminescent dosimeters (TLDs). These monitoring locations are shown in Figure 5.4. Monitoring results indicate that 9 of 46 locations were consistently above background

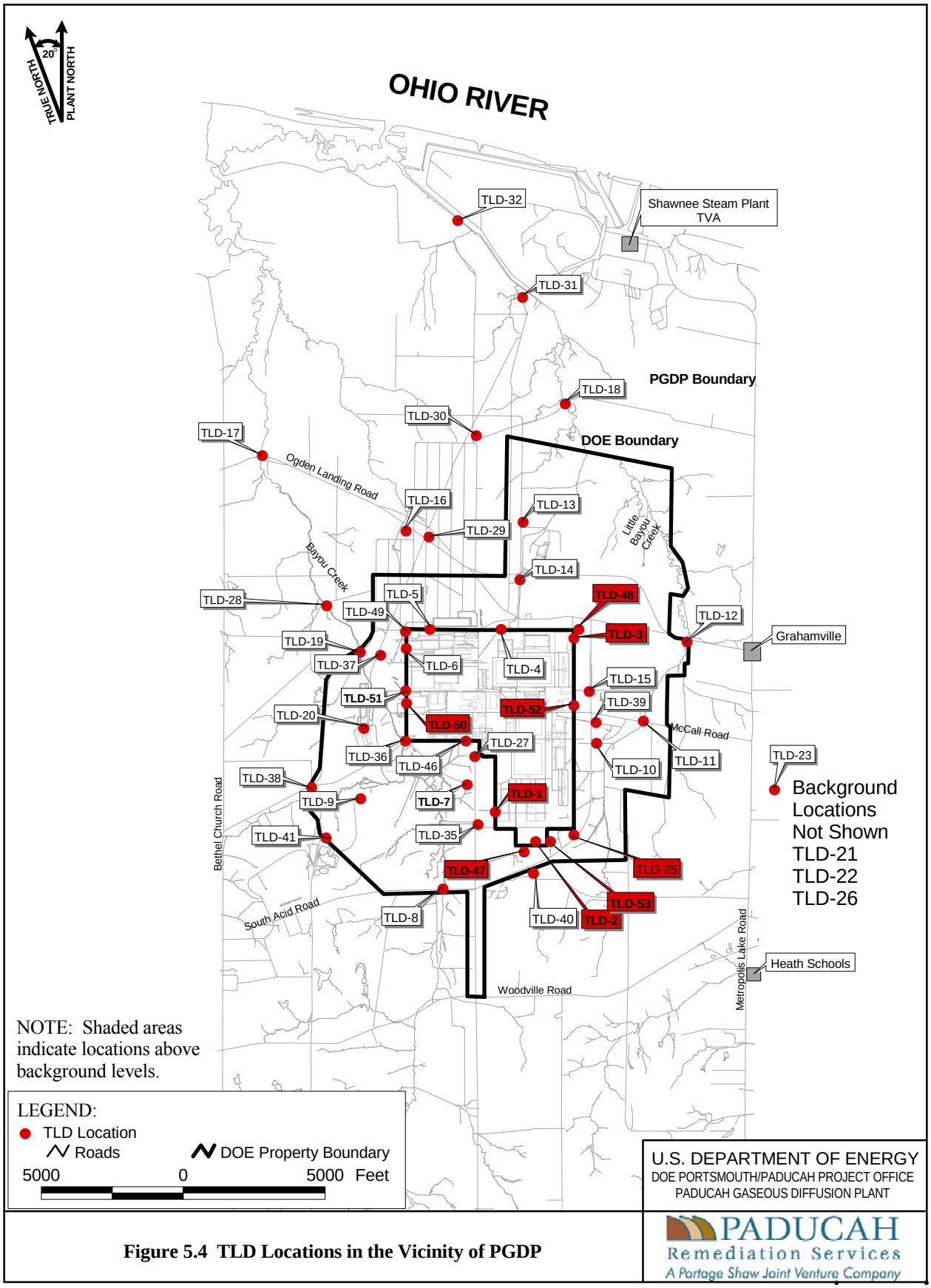

Figure 5.4 TLD Locations in the Vicinity of PGDP

levels (PRS 2007a). These locations were all at or near the PGDP security fence in the vicinity of UF_6 cylinder storage yards in areas not accessible to members of the public.

Annual dose rates for the background locations and nine locations above background were calculated. Based on the analysis of TLDs placed away from DOE property, the mean annual background exposure was determined to be zero milliRoentgen (mR) (PRS 2007a). For each location, the mean background exposure was subtracted from the annualized total exposure to obtain a net annual exposure. The net annual exposure represents the total exposure at that location for the entire CY 2006 attributed to the Paducah Site (Table 5.6). Exposure measured at these locations is assumed to result from DOE operations. Since the locations shown in Table 5.6 are in areas not accessible to the public, dose from direct radiation exposure to the maximally exposed individual member of the public from DOE operations is zero. Dose calculations associated with direct radiation exposure are discussed further in Section 6. Additional data are presented in Volume II, Section 2 of this report.

Table 5.6. Net Annual Exposure from Direct Radiation Attributed to the Paducah Site for 2006 (mR)

Location	TLD-1	TLD-2	TLD-3	TLD-25	TLD-47	TLD-48	TLD-50	TLD-52	TLD-53
Total annual exposure	1,214	960	257	103	337	129	107	93	408
Background[a]	87	87	87	87	87	87	87	87	87
Net annual exposure[b]	1,127	873	170	16	250	42	20	6	321

[a] Background is calculated based on the analysis of TLDs placed away from DOE property (PRS 2007a).
[b] Locations with net annual exposure from direct radiation above background levels are in areas not accessible to the public.

6 Radiological Dose Calculations

Abstract

For 2006, exposure pathways potentially contributing to radiological dose include ingestion of surface water, ingestion of sediments, ingestion of deer meat, direct radiation, and atmospheric releases. The highest estimated dose a maximally exposed individual might have received from all combined DOE exposure pathways (worst-case scenario) was 0.35 mrem per year. This dose is less than 1 percent of the applicable federal standard of 100 mrem per year.

Introduction

This section presents the calculated radiological doses to individuals and the surrounding population from atmospheric and liquid releases from the Paducah Site, as well as from direct radiation (Sections 4 and 5). In addition, potential doses from special-case exposure scenarios, such as deer meat consumption, were calculated based upon deer sample analyses. Doses from naturally occurring sources are discussed in Appendix A. The highest estimated dose that a maximally exposed individual might have received from all combined DOE exposure pathways (worst-case scenario) was 0.35 mrem per year. This dose is less than 1 percent of the applicable federal standard of 100 mrem per year.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, limits the dose to members of the public to less than 100 mrem per year total effective dose equivalent from all pathways resulting from operation of a DOE facility. Information on the demography and land use of the area surrounding the plant was used to develop exposure pathways of concern. On-site operations were used to determine which radionuclides to evaluate.

An early preliminary assessment of risk to public health from contaminants at the Paducah Site identified the following four primary exposure routes, each of which could contribute at least 1 percent to the total off-site dose: (1) groundwater ingestion, (2) sediment ingestion, (3) wildlife ingestion, and (4) exposure to direct radiation. Since that preliminary assessment, groundwater wells that supplied drinking water downgradient from PGDP have been replaced with public drinking water, resulting in the loss of that exposure route. Surface water is not used for drinking water in the PGDP area. Initiation of the NWPGS resulted in another airborne pathway that now is included in the dose calculations. In 2006, the DMSA OS-12 activities and C-402 demolition activities also were added to the airborne dose. A drinking water pathway for consumption of surface water at the nearest public drinking water source [Ohio River at Cairo, Illinois (L306)] now is included in dose calculations.

To assess fully the potential dose to the public, a hypothetical set of extreme characteristics was used to postulate an upper limit to any real dose. This is referred to as the worst-case scenario. The actual dose received is likely to be considerably less than the hypothetical dose calculated.

Terminology and Internal Dose Factors

Most of the human health consequences associated with radionuclides released to the environment are caused by interactions between human tissue and various types of radiation emitted by the radionuclides. These interactions involve the transfer of energy from radiation to tissue and can result in tissue damage. Radiation may come from radionuclides outside the body or from radionuclides deposited inside the body (by inhalation, ingestion, and, in a few cases, absorption through the skin). Exposures to radiation from radionuclides outside the body are called external exposures; exposures to radiation from radionuclides inside the body are called internal exposures. This distinction is important because external exposure occurs only as long as a person is near the radionuclide; simply leaving the area of the source will stop the exposure. Internal exposure continues as long as the radionuclide remains inside the body.

Damage associated with exposures to radiation results primarily from the deposition of radiant energy in tissue. The exposure is defined in terms of the amount of incident radiant energy absorbed by tissue and the biological consequences of that absorbed energy. These terms or quantities include the following:

- *Committed effective dose equivalent (CEDE)*—the total internal dose (measured in mrem) received over a 50-year period resulting from the intake of radionuclides in a one-year period. The CEDE is the product of the annual intake (pCi) and the dose conversion factor for each radionuclide (mrem/pCi).

- *Effective dose equivalent*—includes the CEDE from internal deposition of radionuclides and the dose from penetrating radiation from sources external to the body. This is a risk-equivalent value and can be used to estimate the health risk to the exposed individual.

- *Total effective dose equivalent*—includes the sum of the effective dose equivalent (for external exposures) and the CEDE (for internal exposures). For purposes of compliance, dose equivalent to the whole body may be used as the effective dose equivalent for external exposures.

The effect of an intake of a radionuclide by ingestion depends on the concentration of the radionuclide in food and drinking water and on the individual's consumption patterns. The estimated intake of a radionuclide is multiplied by the appropriate ingestion dose factor to provide the CEDE estimate resulting from the intake. Internal dose factors for several radionuclides of interest at the Paducah Site are included in Appendix A.

Landfill Authorized Limits

DOE Authorized Limits were established for the landfill in July 2003 under DOE Order 5400.5. The limits are based on conservative modeling to assure that the annual dose to workers will not exceed 2.1 mrem per year. Other users of the reservation area around the landfill site and members of the public will not receive more than 1 mrem of additional radiation per year as a result of landfill operations. The authorized limits apply to the disposal of soil, metal, and debris wastes into the C-746-U Landfill generated from construction, maintenance, environmental restoration, and D&D activities at the PGDP.

Direct Radiation

In 2006, DOE conducted continuous monitoring for direct external radiation exposure (Section 5). Access to PGDP is limited due to the increased boundary security implemented in September 2001. The monitoring results indicate that dose to the neighbor living closest to the PGDP security fence did not vary statistically from background because of the limited access of the public to radioactive material areas (PRS 2007a).

For 2006, an additional potential receptor was considered. In a conservative exposure scenario, this receptor is assumed to be exposed to the location at TLD-14 for 8.3 hours for the year. TLD-14 is near Harmony Cemetery located north of the plant security fence and south of Ogden Landing Road (Figure 5.4). The 8.3 hours-per-year assumption is based on an individual

driving past this location twice per day at 1 minute per trip, five days per week, 50 weeks per year. It is likely that actual exposure at this location is probably much less than that assumed because shielding from the receptor's vehicle was not considered. This location resulted in a calculated hypothetical external radiation exposure that is below background. Based on results from this location and other data obtained from all locations, the dose to the maximally exposed individual member of the public from DOE operations was 0 mrem/year.

Surface Water

The most common surface water exposure pathway is through drinking water containing radionuclides. Surface water pathway dose was calculated for an individual assumed to consume water from the public drinking water supply at Cairo, Illinois (L306). Cairo is the closest drinking water system (approximately 30 miles downstream) that uses water downstream of PGDP effluents. Cairo is located at the confluence of the Ohio and Upper Mississippi Rivers. The average concentrations of radionuclides that were detected near the surface water collection inlet at Cairo were used to calculate the exposure resulting from consumption of surface water. The radionuclide that was detected in Cairo was ^{234}U. Uranium-234 was detected only in one out of four sampling events at 0.222 pCi/L, which is well below the DCG for ^{234}U of 500 pCi/L, and the maximum contaminant level (MCL) for alpha activity of 15 pCi/L. The maximally exposed receptor was assumed to consume all of his/her daily required water, 8 glasses, each containing 8 ounces (a total of approximately 2 L), 365 days a year from the public drinking water supply. The maximum dose to an individual, without subtracting the background dose, was determined to be 0.055 mrem in 2006, which is significantly less than the 100 mrem allowed by DOE Order 5400.5.

Contaminated Sediment

Exposure to contaminated sediment in Bayou Creek and Little Bayou Creek could occur during fishing, hunting, or other recreational activities. Exposure is possible through incidental ingestion of contaminated sediment. The worst-case ingestion assumption is that an adult individual would splash around in one of the creeks every other day during the hunting season and ingest a small amount of sediment each visit (50 mg/day). A dose then is calculated based on the radionuclide concentrations and the amount of exposure via ingestion. Massac Creek samples are assumed to be background and are subtracted from downstream sample results to arrive at a dose associated with site releases. The downstream location with the maximum dose is assumed to represent the dose received from this pathway by the maximally exposed individual.

Doses are calculated for ingestion of sediments for both Bayou Creek and Little Bayou Creek. The worst-case dose was calculated to be at S32, the NSDD (Figure 5.3). The estimated worst case dose above background from sediment ingestion was 0.3 mrem in 2006. This exposure pathway is by far the major contributor to the worst-case combined exposure to the public, and it is significantly less than the DOE annual dose limit of 100 mrem/year. Dose results for all locations are provided in Table 6.1.

Ingestion of Deer

The effect of an intake of a radionuclide by ingestion depends on the concentration of the radionuclide in food and drinking water and on the individual's consumption patterns. The estimated intake of a radionuclide is multiplied by the appropriate ingestion dose factor to provide the CEDE estimate resulting from the intake.

Terrestrial wildlife, such as deer, can come into contact with contaminated soil, ingest contaminated plants through contaminant uptake or airborne deposition, or ingest contaminated water. Hunting is permitted in the WKWMA surrounding the Paducah Site, and the limit for deer harvest is two deer per person per season. Approximately 100 deer are harvested per year from WKWMA. The Paducah Site dose calculations assume that an individual kills two average-weight deer and consumes the edible portions of those deer during the year (approximately 100 pounds of meat and five pounds of liver). The dose is calculated for each deer sampled.

Table 6.1. 2006 Annual Dose Estimates for 2006 Incidental Ingestion of Sediment from Bayou Creek and Little Bayou Creek

Location	Committed Effective Dose Equivalent (mrem)										Total (mrem)
	^{241}Am	^{137}Cs	^{237}Np	$^{239/240}$Pu	^{40}K	^{99}Tc	^{230}Th	^{234}U	^{235}U	^{238}U	
S1	---	1.4E-05	.0021	0.00037	0.0003	2.2E-05	0.0007	0.0016	0.000064	0.0025	0.0083
S2	---	---	---	---	0.00034	6.6E-06	0.00054	0.0024	0.0004	0.0092	0.013
S20	---	9.6E-06	---	---	0.00075	4.0E-06	0.00077	0.00015	---	0.00015	0.0018
S27	0.0012	---	---	0.0057	0.00035	6.0E-06	0.005	0.00095	0.00051	0.0026	0.016
S28 (Background)	---	---	---	---	0.00084	3.2E-05	0.00076	0.00018	---	0.00015	0.002
S31	---	0.000023	0.0014	0.0032	0.0003	0.00001	0.0035	0.022	0.0024	0.0068	0.039
S32 (Maximum)	---	0.00019	---	0.17	0.086	0.000045	0.19	0.0052	0.00083	0.0063	0.3
S33	---	0.00001	---	0.00024	0.00052	2.7E-06	0.00062	0.00052	0.0009	0.0005	0.0033
S34	0.00056	0.000018	---	0.0013	0.00029	9.5E-06	0.0028	0.00066	0.00061	0.0018	0.0081
C612	---	0.0045	0.00089	0.0007	0.00062	0.00051	0.00097	0.0015	0.00092	0.0018	0.012
C616	0.00075	---	0.0033	0.0026	0.00078	0.000079	0.0022	0.004	0.0008	0.0049	0.02
C746KTB2	---	---	---	---	0.00021	2.9E-06	0.00037	0.00014	---	0.00013	0.00085
L194	---	---	---	---	0.00041	2.1E-06	0.00072	0.00092	0.00034	0.0056	0.008
K001	---	---	0.00066	0.00048	0.00063	0.000059	0.00089	0.0012	0.00077	0.0017	0.0064
	Net exposure from Paducah Site to maximally exposed individual[a] (S32 - S28) =										**0.3**

--- not detected
^{241}Am Americium-241
$^{239/240}$Pu Plutonium-239/240
^{40}K Potassium-40
[a]Maximum allowable exposure is 100 mrem/year for all contributing pathways (DOE Order 5400.5).

In 2006, five deer from the Paducah Site were sampled. Historical data were used for comparison. In 2006, the results of the site deer did not vary significantly from the historical reference deer radionuclide values. The site radiation dose contribution from ingestion of deer is essentially 0 mrem/year (Stanisich 2007).

Airborne Radionuclides

DOE had six radionuclide airborne point sources that contributed to the public dose in 2006. These sources were the NWPGS, the NEPCS, the Scrap Metal Removal Projects, the C-410 D&D Fluorine Cell Blasting Project, DMSA OS-12, and C-402. The six point sources were discussed in Section 4. These point-sources were reviewed or monitored to determine the extent to which the general public could be exposed and to demonstrate compliance with EPA regulations that are based on International Commission on Radiological Protection (ICRP) publications (ICRP 1980).

The 50-year CEDE (internal) from DOE air sources to the maximally exposed individual, who under most circumstances is the person living closest to the plant in the predominant wind direction, is calculated each year. EPA-supplied CAP-88 software was used to calculate the off-site dose from PGDP air emissions. This software provides a framework for developing dose and risk assessments for the purpose of demonstrating compliance with 40 *CFR* § 61.93(a). It assesses both collective populations and maximally exposed individuals. The dose to the maximally exposed individual from DOE radioactive air emissions was calculated to be 1.5E-05 mrem

from the NWPGS; 5.5E-07 mrem from the NEPCS; 3.0E-06 mrem from the Scrap Metal Removal Projects; and 1.4E-08 mrem from the C-410 D&D Activities; 9.8E-05 mrem from DMSA OS-12; and 1.6E-05 mrem from C-402 demolition. The maximally exposed individual to all of these sources received an estimated dose of 7.8E-05 mrem. The dose from both DOE and USEC emissions is estimated to be 0.012 mrem, which is well below the 10 mrem limit of 40 *CFR* Part 61, Subpart H.

Conclusions

Table 6.2 provides a summary of the radiological dose for 2006 from the Paducah Site that could be received by a member of the public assuming worst-case exposure from all major pathways. The largest contributor to the calculated dose is from ingestion of sediment. The groundwater pathway from DOE sources is assumed to contribute no dose to the population because all residents have been supplied with public water by DOE. The worst-case combined (internal and external) dose to an individual member of the public was calculated at 0.3 mrem. This level is well below the DOE annual dose limit of 100 mrem/year to members of the public and below the EPA limit of 10 mrem airborne dose to the public.

Estimates of radiation doses presented in this report were calculated using the dose factors provided by DOE and EPA guidance documents. These dose factors are based on ICRP Publication 30 (ICRP 1980). Figure 6.1 shows the potential (worst-case) annual dose as calculated for the past five years.

Table 6.2. Summary of Potential Radiological Dose from the Paducah Site for 2006 (Worst-Case Combined Exposure Pathways)

Pathway	**Dose[a] (mrem/year)**	**Percent of total**
Ingestion of surface water	5.5×10^{-2}	15
Ingestion of sediments	3.0×10^{-1}	85
Ingestion of deer meat	0	0
Direct radiation	0	0
Atmospheric releases [b]	7.8×10^{-5}	0
Total annual dose above background (all pathways)	**0.35**	**100**

[a] Maximum allowable exposure is 100 mrem/year (DOE Order 5400.5).
[b] DOE source emissions were from the NWPGS, the NEPCS, the Scrap Metal Removal Projects, C-410 D&D Fluorine Cell Blasting Activities, DMSA OS-12, and C-402 Demolition.

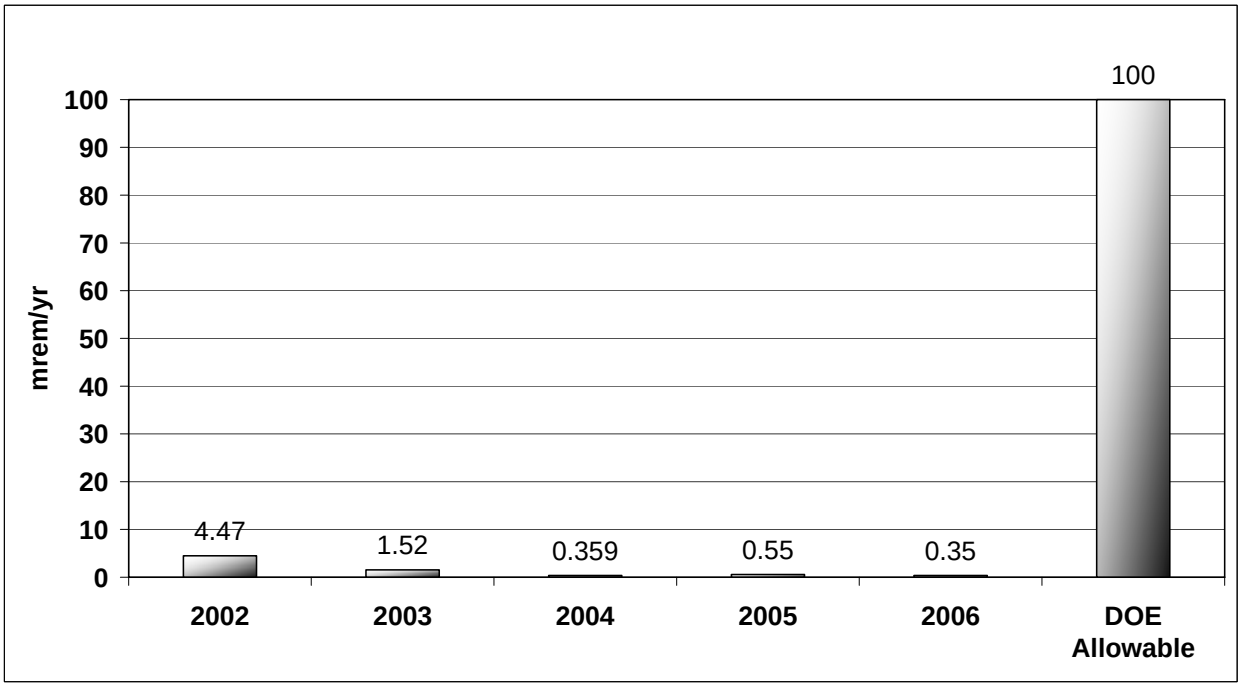

Figure 6.1. Potential Radiological Dose from DOE Activities at the Paducah Site, 2002–2006

7 Nonradiological Point Source Effluent Monitoring

Abstract

In 2006, none of the water samples from KPDES outfalls at the Paducah Site exceeded toxicity limits. DOE had two point sources and several fugitive sources for nonradiological air emissions. The combined emissions from these DOE sources were small; therefore, the Paducah Site is considered a minor source in accordance with the CAA.

Introduction

Responsibility for nearly all nonradioactive airborne emission sources at PGDP was turned over to USEC as a result of the 1993 lease agreement between USEC and DOE. Only a few fugitive sources, such as gravel roads, soil piles (resulting from construction excavation), metal scrap pile windage, and two point sources remained the responsibility of DOE in 2006. The small amount of emissions from DOE sources results in CAA classification of the Paducah Site as a minor air emissions source.

Monitoring of nonradiological parameters in liquid effluents is summarized in the Paducah Site EMP (BJC 2005) and is based on KPDES Permit KY0004049 and KDWM landfill permits 073-00014, 073-00015, and 073-00045. Effluents are monitored for nonradiological parameters listed on the permit governing the discharge.

Nonradiological Airborne Effluents

Airborne Effluent Applicable Regulations

The KDAQ administers much of the CAA at the Paducah Site. DOE has responsibility only for air emission sources under DOE program control; therefore, this report does not address emissions from the PGDP sources leased to USEC.

Airborne Effluent Monitoring Program

The point sources of air emissions other than radionuclides (Section 4) for the Paducah Site in 2006 were the NWPGS and the NEPCS. These systems combined removed approximately 1,180 pounds of TCE, which is a VOC and HAP, from approximately 183,000,000 gallons of groundwater. These facilities remove TCE contamination from the groundwater by air stripping. At the NWPGS, TCE-laden air passes through activated carbon to remove TCE. The air stream then is released to the atmosphere where any remaining TCE naturally breaks down. The NEPCS uses the existing C-637-2A Cooling Tower at PGDP for stripping the TCE from groundwater. The NWPGS and NEPCS

facilities operated in compliance with CERCLA decision documents during 2006.

Nonradiological Liquid Effluents

Liquid Effluent Applicable Regulations

At the Paducah Site, the CWA regulations are applied through issuance of a KPDES permit for effluent discharges to Bayou Creek and Little Bayou Creek. The KDOW issued KPDES Permit No. KY0004049 to the Paducah Site on September 29, 2006. This permit applies to the following four DOE outfalls: 001, 015, 017, and 019. The KPDES permit calls for chemical monitoring, biological monitoring (explained in Section 8), and toxicity monitoring as an indicator of discharge related effects in the receiving streams. The permit will expire on October 31, 2011. Following the issuance of the permit, several parties petitioned KDWM for a hearing on the permit. An Order to Mediate was issued by the Kentucky Environmental and Public Protection Cabinet. All new permit limitations were stayed with discharge limitations reverting to the April 1, 1998 permit. All monitoring requirements of the new permit were continued. Negotiations on an AO to settle all parties' disputes with the permit were not complete at the close of 2006.

The KDWM specifies in landfill permits 073-00014, 073-00015, and 073-00045 that surface runoff will be analyzed to ensure that landfill constituents are not discharging into nearby receiving streams.

Liquid Effluent Monitoring Program

DOE conducts nonradiological effluent monitoring for outfalls under its jurisdiction (Section 4, Figure 4.2). Outfalls 001, 015, 017, and 019 were monitored for KPDES permit parameters. The specific sample collection, preservation, and analytical methods acceptable for the types of constituents analyzed are listed in the permit and applicable regulations. The KPDES permit is available at the EIC, 115 Memorial Drive, in Paducah, Kentucky, for review by the public. Permit analytes and physical measurements are listed in Table 7.1.

Surface runoff from the closed C-746-S Residential Landfill, the closed C-746-T Inert Landfill, and the operating C-746-U Landfill was monitored quarterly. Grab samples were monitored for chemical oxygen demand, chloride, conductivity, dissolved oxygen, dissolved solids, flow rate, iron, hydrogen-ion concentration (pH), sodium, sulfate, suspended solids, temperature, total organic carbon, and total solids. Two sets of samples are collected; one set for the C-746-U and one set for the C-746 S&T Landfills, which are co-located. The samples taken include landfill runoff, the receiving ditch upstream of the runoff discharge point, and the receiving ditch downstream of the runoff discharge point (Section 4, Figure 4.2). Sampling was performed in compliance with the KDWM requirements for operation of the contained landfill.

Liquid Effluent Monitoring Results

Analytical results from the four DOE outfalls are reported to KDOW in monthly and quarterly discharge monitoring reports. There were no toxicity failures during 2006.

Data for the KPDES samples and the surface runoff samples from the landfills are presented in Section 3, Tables 3.1 through 3.10 of Volume II of this report.

Table 7.1. KPDES Permit Sampling Routine Nonradiological Maximum Detected Analyses for CY 2006

Parameter	Permit Discharge Limits During 2006	K001	K015	K017	K019
Alkalinity, mg/L	--	35	NR	NR	NR
Benz(a)anthracene, µg/L	--	0.039	0.044	0.053	ND
Benzidine, µg/L	--	ND	ND	0.052	ND
Benzo(a)pyrene, µg/L	--	0.029	0.032	0.042	ND
Benzo(k)fluoranthene, µg/L	--	0.036	0.04	0.046	ND
Beryllium, mg/L	--	ND	0.00103	ND	ND
Bis(2-ethylhexyl)phthalate, µg/L	--	0.31	0.42	0.36	ND
Cadmium, mg/L	--	0.001	0.001	0.001	ND
Chlorine, Total Residual, mg/L	Report	0.04	0.03	0.03	0.06
Chrysene, µg/L	--	ND	0.016	0.022	ND
Conductivity, umho/cm	--	1630	687	455	218
Copper, mg/L	--	0.0089	0.0111	0.0052	ND
Cyanide, mg/L	--	0.005	0.005	0.005	ND
Dibenz(a,h)anthracene, µg/L	--	ND	0.041	0.045	ND
Dissolved Oxygen, mg/L	--	1076	14.2	12.91	9.46
Flow Rate, mgd	Report	24.49	6.03	28.63	1.25
Hardness - Total as CaCO3, mg/L	Report	340	420	190	120
Heptachlor, µg/L	--	0.146	0.0055	0.00305	ND
Indeno(1,2,3-cd)pyrene, µg/L	--	ND	ND	0.038	ND
Iron, mg/L	--	1.27	1.27	1.5	4.54
Lead, mg/L	--	ND	0.00529	0.005	ND
Lindane, µg/L	--	ND	0.0074	ND	ND
Mercury, mg/L	--	0.0002	0.0002	0.0002	ND
Nickel, mg/L	--	0.0121	0.0229	ND	ND
pH, std unit	6.0≤pH≤9.0	8.66	8.31	8.31	8.84
Phosphorous, mg/L	1.0	0.49	ND	ND	ND
Selenium, mg/L	--	0.005	ND	ND	ND
Suspended Solids, mg/L	--	25	25	25	ND
Temperature, °F	89ºF	93.8	75.6	79.7	87.8
Total Metals, mg/L	report	1.29	1.38	1.53	4.63
Turbidity, NTU	--	42.3	182	146	38.9
Uranium, mg/L	report	0.02	0.15	0.00287	ND
Zinc, mg/L	--	ND	0.0521	0.195	ND

ND – not detected
NR – not reported/collected
-- - Not required by permit limits in effect during 2006; however, monitoring was required for these parameters.

8 Nonradiological Environmental Surveillance

Abstract

The nonradiological environmental surveillance program at the Paducah Site assesses the effects of DOE operations on the site and the surrounding environment. Surveillance includes analyses of air, surface water, groundwater (Section 9), sediment, soil, vegetation, terrestrial wildlife, fish, and other aquatic life. Surveillance results for 2006 were similar to results reported in previous ASERs.

Introduction

Nonradiological surveillance at the Paducah Site involves the sampling and analysis of surface water, groundwater (Section 9), sediment, soil, terrestrial wildlife, fish, and other aquatic life. This section discusses the nonradiological results of surveillance activities.

Ambient Air

As a result of the transfer of the operations of the plant to USEC in 1993, major air emission sources were transferred to USEC; therefore, DOE does not conduct ambient air monitoring for nonradiological parameters at the Paducah Site.

Surface Water

Surface water monitoring (except for biological monitoring) downstream of KPDES outfalls is not required by the KPDES permit; however, it is performed at the Paducah Site as part of the Environmental Surveillance Program. Figure 5.2 shows surveillance surface water sampling locations. Table 8.1 shows the analytical parameters that are analyzed on a quarterly or semiannual basis.

As described in Chapter 5, locations in Little Bayou Creek (LBCSP5 and LBCSP6) were added to the surface water sampling program in 2002. These locations, known as seeps, are upwellings of groundwater in the Little Bayou Creek bed. Two locations were chosen to sample each quarter to trend and observe changes in data. These locations are downstream of the plant site approximately halfway between the site and the Ohio River (Figure 5.2). Table 8.1 does not apply to the quarterly seep locations. A different list of analytical parameters is analyzed for the seeps, as presented in Table 8.2.

Surface Water Surveillance Results

Table 8.3 shows a water chemistry comparison between upstream and downstream locations associated with the plant by presenting the maximum average concentrations of selected parameters. Similar to 2005, the only result of significance in 2006 was TCE identified near the plant site and downstream in Little Bayou Creek. The downstream average concentration was 11 microgram per liter (µg/L), which is slightly lower than the same average for 2005. TCE also was detected in Bayou Creek upstream and downstream of the site at 2.2 and 1.7 µg/L, respectively.

Table 8.1. Nonradiological Parameters for Surface Water Samples

Parameters
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chloride
Chromium
Cobalt
Conductivity
Copper
Cyanide
Dissolved Oxygen
Flow Rate
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Nitrate/Nitrite as Nitrogen
Alkalinity
PCB Aroclors
pH
Phosphorous
Polychlorinated biphenyl, Total
Potassium
Selenium
Silver
Sodium
Suspended Solids
Temperature
Thallium
Trichloroethene
Ammonia
Turbidity
Uranium
Vanadium
Zinc

Table 8.2. Nonradiological Parameters for Surface Water Seep Sample Locations

Parameters
Chloride
Sulfate
Alkalinity
Conductivity
Dissolved Oxygen
pH
Temperature
Calcium
Magnesium
Manganese
Potassium
Sodium
Uranium
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
1,2-Dimethylbenzene
Benzene
Bromodichloromethane
Carbon tetrachloride
Chloroform
cis-1,2-Dichloroethene
Ethylbenzene
m,p-Xylene
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
Trichloroethene
Vinyl chloride

Table 8.3. Selected Routine Nonradiological Surface Water Surveillance Results (Average Concentrations) for 2006[a]

Parameter (mg/L) except where noted	Up-stream Bayou[1]	Bayou near Site[2]	Down-stream Bayou[3]	Little Bayou near Site[4]	Down-stream Little Bayou[5]	Creek Conver-gence[6]	C-746-K Landfill[7]	Up-stream Ohio[8]	Down-stream Ohio[9]	Massac Creek[10]	Cairo, IL[11]
Alkalinity	29.4	37	30	28	25	29	37	35	34	21	43
Aluminum	1.4	1.3	0.86	1.8	4.1	1.3	2.0	1.0	1.4	2.6	1.3
Ammonia	2.3	0.96	0.40	ND	0.48	ND	0.50	ND	ND	ND	ND
Barium	0.068	0.13	0.044	0.057	0.078	0.056	0.057	0.037	0.039	0.06	0.048
Calcium	17	130	36	21	23	32	19	29	29	12	38
Chloride	14	230	49	31	28	24	27	12	12	15	19
Chlorine, total residual	ND	0.030	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ND	0.0036	ND	ND	0.0010	0.0015		0.0020	0.0020	0.0021	0.0021
Conductivity (umho/cm)	210	1,200	600	370	240	360	270	250	240	140	370
Copper	ND	0.0097	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dissolved oxygen	9.0	8.8	9.0	7.8	9.3	9.0	8.9	8.8	6.9	8.8	10
Flow Rate, mgd	3.4	4.6	16	8.1	13	ND	2.3	ND	ND	14	ND
Hardness (CaCO3)	61	520	140	72	70	110	63	95	100	44	150
Iron	0.97	1.1	0.67	1.6	2.9	1.1	1.7	1.4	1.7	2.0	2.1
Magnesium	3.6	50	12	5.3	4.2	7.6	3.9	7.0	7.3	3.0	12
Manganese	0.13	0.12	0.075	0.078	0.11	0.23	0.059	0.12	0.14	0.26	0.13
Nickel	ND	0.014	ND	ND	ND	ND	ND	ND	0.0058	0.0053	0.0058
Nitrate as Nitrogen	1.8	4.4	1.6	0.60	0.76	0.86	1.1	0.65	0.67	0.60	1.5
pH	7.0	8.1	7.2	7.3	7.0	7.1	7.2	7.7	7.7	7.0	7.7
Phosphorous	0.29	0.36	0.19	0.27	0.39	0.18	0.14	0.16	0.17	0.20	0.24
Potassium	5.9	34	8.6	3.1	3.9	4.1	4.0	2.3	2.4	3.8	2.8
Sodium	14	260	56	31	19	26	22	10	10	9.1	13
Suspended Solids	NR	NR	NR	47	38	NR	NR	48	53	140	120
Temperature (°F)	58	73	68	68	65	64	66	63	64	61	62
Trichloroethene, µg/L	2.2	1.7	ND	ND	11	1.4	ND	ND	ND	ND	ND
Uranium	31	180	50	97	120	40	26	88	93	110	110
Zinc		0.012	0.0026	0.013	0.0080	0.007	0.0010	ND	ND	ND	ND

a = The results presented in the table are the average values for the locations within the area grouping using the highest value for each location in the average calculations.
ND = Not Detected
NR = Not Reported

The following footnotes correspond with column titles in the above table. These are groupings of sampling locations in the area described in the title. See Figure 5.2 for sampling locations.

1 = L1
2 = C612, C616, L291, S31, K001, K015
3 = L5, L6
4 = L10, L194
5 = L11, L12, L241
6 = L8
7 = C746K-5, C746KTB1
8 = L29
9 = L30
10 = L64
11 = L306

Table 8.4 presents the maximum average concentrations of selected parameters for the seep sampling locations. LBCSP5, had the highest maximum average for TCE at 360 µg/L, which is slightly lower than the 490 µg/L in 2005. TCE is the only parameter that had concentrations above background at the seep locations.

In 2006, there were no detections of PCBs in surface water. Additional data are presented in Section 4, Tables 4.1 through 4.23, of Volume II of this report. The 2006 surface water surveillance results are less than the limits of the corresponding KPDES-permitted levels.

Table 8.4. Selected Routine Nonradiological Surface Water Seep Sampling Surveillance Results (Average Concentrations) for CY 2006[a]

Parameter	LBCSP5	LBCSP6
Calcium (mg/L)	24	22
Magnesium (mg/L)	7.7	6.1
Manganese (mg/L)	0.015	0.041
Potassium (mg/L)	1.7	2.9
Sodium (mg/L)	31	21
Sulfate (mg/L)	17	17
Trichloroethene (µg/L)	360	340

a = The results presented in the table are the average values for the locations using the highest value for each location in the average calculations.

Seep sampling is representative of groundwater. Seep sampling results are compared to groundwater MCLs for evaluation. Sample results for TCE at a surface water location downstream of the seeps showed levels less than the KPDES permitted level of 81 µg/L.

Sediment

Sediment is an important constituent of the aquatic environment. If a pollutant is a suspended solid or is attached to suspended sediment, it can settle to the bottom (thus creating the need for sediment sampling), be taken up by certain organisms, or become attached to plant surfaces. Pollutants transported by water can adsorb either on organic and inorganic solids or be assimilated by plants and animals. Suspended solids, dead biota, and excreta settle to the bottom and become part of the organic substrata that supports the bottom dwelling community of organisms. Sediments can play a significant role in aquatic ecological impacts by serving as a repository for radioactive or chemical substances that pass via bottom-feeding biota to the higher trophic levels.

Sediment Surveillance Program

Creek and ditch sediments are sampled semiannually as part of a nonradiological environmental surveillance program. Sediment samples were taken from 14 locations in 2006 (Figure 5.3). Sediments were sampled for the parameters listed in Table 8.5.

Sediment Surveillance Results

Table 8.6 shows the average values for locations within the area group for specific parameters.

Only the parameters that had detected results are shown. The upstream (or background) and downstream results for detected parameters are compared to identify significant differences. Aluminum, barium, chromium, cobalt, copper, iron, magnesium, manganese, and vanadium were detected at all sites. The highest levels of metals were seen at the NSDD, Bayou Creek near the plant site, and Little Bayou Creek near the plant site. Chromium was identified in the NSDD at 43 mg/kg, and it was 27 mg/kg in 2005. Near the plant site on Little Bayou Creek, chromium was 27 mg/kg in 2006, an increase from 21 mg/kg in 2005. Chromium levels in Bayou Creek, the other sampling location where they are elevated, were 27 mg/kg in 2006 and were 28 mg/kg in 2005. Generally, contaminants are more abundant near the plant site and decrease downstream of the plant site.

PCBs were found in the NSDD and Bayou Creek near the plant site and Little Bayou near the plant site, with the highest levels seen at the NSDD. The aroclors present were PCB-1248, PCB-1254, and PCB-1260. Additional sediment data are presented in Section 4, Tables 4.24 through 4.37, of Volume II of this report. PCB results are consistent with levels seen in previous years' data. The PCB-contaminated areas either are within the DOE-controlled area or are posted for protection of the public.

Table 8.5. Semiannual Nonradiological Parameters for Sediment Samples

Parameter		
Aluminum	Lead	Vanadium
Antimony	Magnesium	Zinc
Arsenic	Manganese	PCB-1016
Barium	Mercury	PCB-1221
Beryllium	Nickel	PCB-1232
Cadmium	Potassium	PCB-1242
Calcium	Selenium	PCB-1248
Chromium	Silver	PCB-1254
Cobalt	Sodium	PCB-1260
Copper	Thallium	PCB-1268
Iron	Uranium	Polychlorinated Biphenyl

Table 8.6. Selected Routine Nonradiological Sediment Surveillance Results (Average Concentrations) for 2006[a]

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	C-746-K Area[6]	NSDD[7]	Massac Creek[8]
Aluminum (mg/kg)	4,200	4,700	3,200	4,800	3,000	2,200	5,800	4,100
Barium (mg/kg)	46	59	38	45	25	18	49	39
Beryllium (mg/kg)	ND	0.56	ND	ND	ND	ND	0.48	ND
Calcium (mg/kg)	390	2,500	480	920	340	380	1,900	800
Chromium (mg/kg)	6.3	27	9.3	27	19	6.5	43	7.6
Cobalt (mg/kg)	4.3	4.5	2.8	4.2	ND	2.4	3.5	4.0
Copper (mg/kg)	5.4	34	4.9	6.1	4.9	3.5	37	4.9
Iron (mg/kg)	6,300	8,800	5,000	6,700	3,400	4,700	9,400	5,900
Magnesium (mg/kg)	510	730	340	460	250	210	660	760
Manganese (mg/kg)	120	88	310	290	54	120	120	81
Mercury (mg/kg)	ND	0.26	ND	ND	ND	ND	0.16	ND
Nickel (mg/kg)	5.3	14	4.0	ND	ND	ND	23	6.3
PCB-1248 (µg/kg)	ND	ND	ND	490	ND	ND	ND	ND
PCB-1254 (µg/kg)	ND	220	ND	150	ND	ND	430	ND
PCB-1260 (µg/kg)	ND	300	ND	ND	ND	ND	280	ND
Polychlorinated biphenyl, total (µg/kg)	ND	410	ND	390	ND	ND	710	ND
Potassium (mg/kg)	260	430	210	220	290	150	450	400
Silver (mg/kg)	ND	ND	ND	ND	4.0	ND	ND	ND
Sodium (mg/kg)	370	250	140	ND	ND	ND	ND	130
Vanadium (mg/kg)	12	15	9.9	13	8.6	9.4	18	12
Zinc (mg/kg)	ND	110	ND	30	ND	ND	81	27

a = The results presented in the table are the average values for the locations within the area grouping using the highest value for each location in the average calculations.

ND = Not detected

The following footnotes correspond with column titles in the above table. These are groupings of sampling locations in the area described in the title. See Figure 5.3 for sampling locations.

1 = S20 (background location to 2 and 3)
2 = C612, C616, K001, S1, S31
3 = S33
4 = S2, L194
5 = S27, S34
6 = C746KTB2 (background location to 8 and 9)
7 = S32
8 = S28

Soil

The major source of soil contamination is deposition from air pathways. Because DOE no longer operates any major air emission sources, routine soil surveillance is not performed; however, surface soil contamination at the Paducah Site is being addressed by the Surface Soils OU (see Environmental Restoration Program in Section 3).

Vegetation

Because DOE no longer operates any major air emission sources, routine vegetation surveillance activities are not performed.

Terrestrial Wildlife

Annual Deer Harvest

The deer population in the WKWMA is sampled annually to determine levels of radionuclides (Section 5), PCBs, and inorganic elements that might be attributable to past plant practices. There were five deer harvested in 2006 from the WKWMA and one deer harvested in 2002 from the Stewart Island Habitat Reservation in Livingston County, Kentucky, to serve as a reference sample.

PCBs tend to accumulate in fat tissue. PCB-1268 was present in deer from the Paducah Site. Table 8.7 shows the maximum PCB results for any tissue or organ sampled. A risk assessment was conducted using the concentrations of PCBs found in deer, assuming 20 percent fat content and that a hunter would eat the two deer with the maximum concentrations of PCBs found in tissue samples. The risk assessment concluded that the risk to the hunter who eats 100 pounds of venison containing 20 percent fat and 5 pounds of liver from the deer would have an estimated increased cancer risk of 0.000028 or approximately 2.8 chances of cancer development (over a lifetime) per 100,000 people who eat the deer (Stanisich 2007). If the average concentration of deer tissue is ingested, the risk is 0.0000054 or approximately 5.4 chances of cancer development (over a lifetime) per one million people who eat the deer.

Table 8.7. Summary of PCB Detections in Deer for 2006[a]

Deer	Parameter	Type Fat Tissue	Fat
Deer 3	PCB-1268 (µg/kg)	Abdominal	50.3
Deer 3	PCB-1268 (µg/kg)	Rump	43
Deer 4	PCB-1268 (µg/kg)	Abdominal	43[b]
Deer 4	PCB-1268 (µg/kg)	Rump	89.8
Deer 5	PCB-1268 (µg/kg)	Abdominal	71.9
Deer 5	PCB-1268 (µg/kg)	Rump	86.6

µg/kg = part per billion
[a] Other PCB aroclors were analyzed, but not detected in any deer.
[b] The duplicate result for Deer 4 was 69.2 µg/kg.
Deer 1 and 2 did not have any detectable PCBs/

A comparison of the metals detected in the 2006 deer with the average chemical data from background deer collected over the past 10 years shows no chemicals significantly above background. Overall, evaluation of the results indicates that consumption of deer meat is not a threat to human health.

Additional deer data are presented in Section 4, Tables 4.38 through 4.41, of Volume II, of this report.

Fish and Other Aquatic Life

Aquatic monitoring was conducted, as required, by KPDES Permit KY0004049. The KPDES permit also requires toxicity monitoring of one continuous outfall and three intermittent outfalls on a quarterly basis (Section 7). Aquatic or biological monitoring of Bayou Creek and Little Bayou Creek has been conducted since 1987. The Watershed Monitoring Program (WMP) defines the boundaries and procedures for aquatic biological monitoring and is updated every three years. In part, these actions were initiated as a response to contamination found in Bayou and Little Bayou Creeks. Another response to these findings was posting warning signs along both creeks to warn members of the public about the possible risks posed by recreational contact with these waters, stream sediments, and fish caught in the creeks.

The objectives of the WMP are as follows:

- Determine whether discharges from the Paducah Site and its associated SWMUs are adversely affecting instream fauna;
- Assess the ecological health of Bayou Creek and Little Bayou Creek;
- Assess the degree to which abatement actions ecologically benefit Bayou Creek and Little Bayou Creek;
- Provide guidance for remediation;
- Provide an evaluation of changes in potential human health concerns; and
- Provide data that could be used to assess the impact of an inadvertent spill or fish kill.

Study Area and Methods

As specified in *Big Bayou Creek and Little Bayou Creek Revised Watershed Monitoring Program* (BJC 2003), the fish and benthic macroinvertebrate communities were sampled in June 2006 at eight locations, including locations in Massac Creek and in the West Fork of Massac Creek, both which serve as sources of reference fish [Massac Creek Mile (MAM) 8.6 and West Fork of Massac Mile (WFM) 0.5, respectively]. Figure 8.1 shows the eight locations, with the exception of MAM 8.6 and WFM 0.5, which are located several miles off-site.

Benthic macroinvertebrate samples were collected with a Surber square-foot bottom sampler from appropriate locations within a designated riffle at each site. Samplers selected locations within the reaches of the stream and samples were processed in a laboratory following EPA methods. The Modified Hilsenhoff-Biotic Index (mHBI) was used to evaluate the water quality of the sample locations based on the presence or absence of specific macroinvertebrates. Organisms were identified to the lowest practical taxon and counted. Instream and riparian habitat and water quality were assessed at each site following standard procedures outlined by the EPA. An analysis of the data includes general descriptive comparisons and parametric statistics to evaluate trends in temporal and spatial changes that could be associated with abatement activities or remedial actions. Metrics of the benthic macroinvertebrate community, are included in the analysis of the data presented in the *Watershed Monitoring Report for Calendar Year 2006, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS 2007b). Some of the metrics included are as follows:

- Total density;
- Total taxonomic richness;
- Taxonomic richness of the pollution-sensitive *Ephemeroptera, Plecoptera*, and *Trichoptera*;
- Percent community similarity index; and
- Dominants in common.

Quantitative samplings of the fish communities in the PGDP area were conducted by electrofishing. Block nets defined the sample reaches [8 to 120 m (26 to 394 ft)] of each site sampled. A three-pass depletion method was used in collecting the samples. Data from these samples were used to estimate species' richness, population size (numbers and biomass per unit area), and annual production. All fish sampling locations overlap locations used in the benthic macroinvertebrate community task. All field sampling was conducted according to standard operating procedures. The frequency of determining contaminant uptake in fauna, known as bioaccumulation monitoring, has been changed in the WMP to every two years.

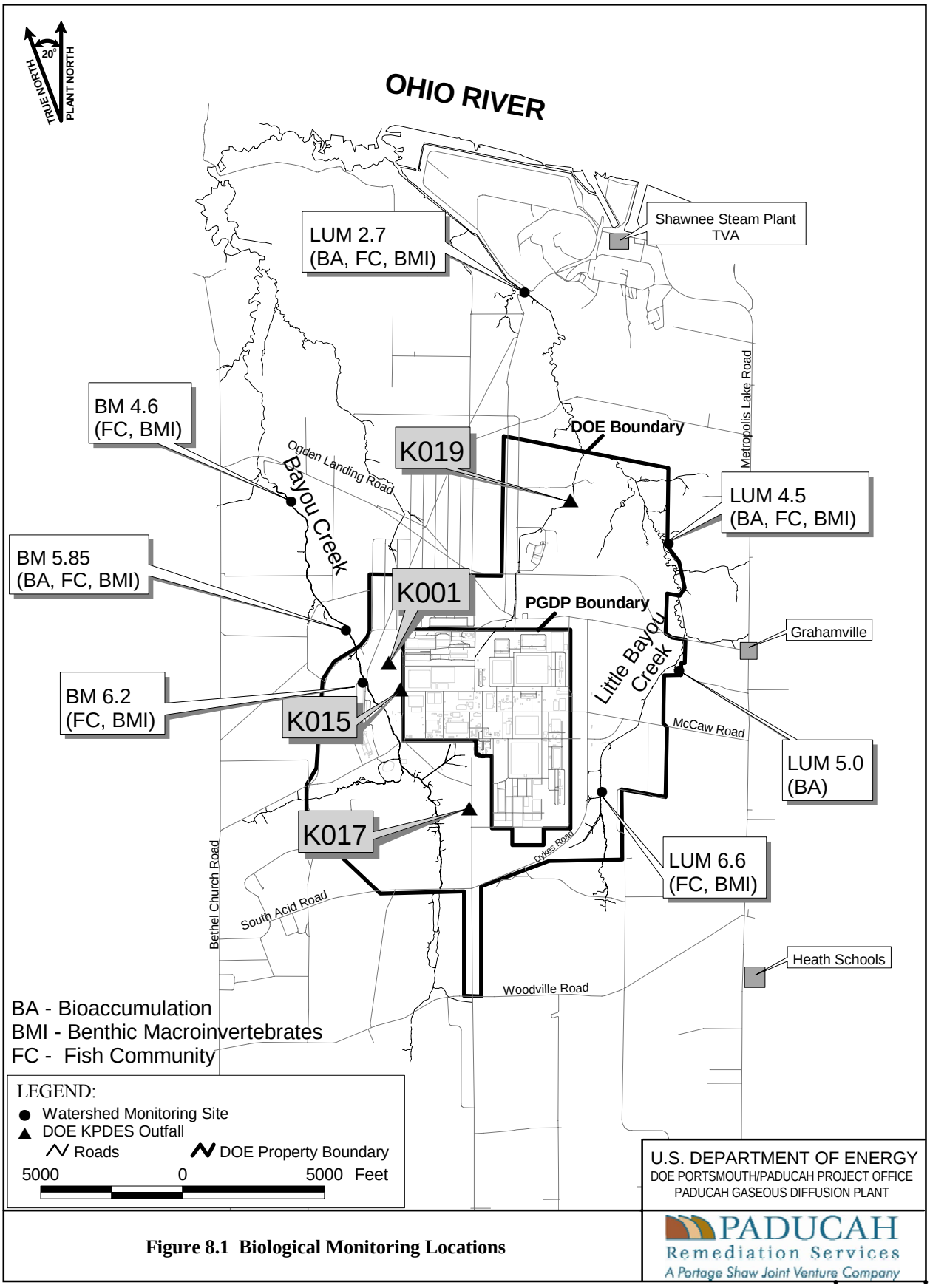

Figure 8.1 Biological Monitoring Locations

Watershed Monitoring

Results of watershed monitoring are reported to KDOW annually. The 2006 monitoring is reported in the *Watershed Monitoring Report for Calendar Year 2006, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS 2007b). Additional analysis of the data can be seen in this report, Sections 5 and 7. The watershed monitoring report conclusions, which meet the objectives of the WMP, are presented as follows.

Over the past years, conditions at all the eight study sites have fluctuated widely. Changes have been caused by the shifting substrates through the movement of gravel and varying flow levels due to beaver dams and natural events. Through this time, the macroinvertebrate populations Figure 8.1. Biological Monitoring Locations have changed in both density and composition based on the varying conditions. These changes are expected based on the characteristics of these streams.

The community metrics have fluctuated over the years making it difficult to map any clear population trends. The metric ratings over the years have ranged from poor to fairly poor water quality.

Values for the habitat evaluation for fish community conducted during 2006 for the Little Bayou Creek sites were scored as "not supporting," while the Bayou Creek sites scored "supporting, but threatened" (BM 6.2) and "not supporting" (BM 4.6 and BM 5.85). The reference sites, MAM 8.6 and WFM 0.5, scored "not supporting" and "partially supporting," respectively. The range in scores represented less variability of habitat characteristics than in 2005 (BJC 2005) among the streams that were sampled. Six out of eight sites (BM 4.6, BM 5.85, LUM 2.7, LUM 4.5, LUM 6.6, and reference site, MAM 8.6) were scored as "not supportive of biological integrity."

The fish communities examined in 2006 showed some changes in density, biomass, total numbers, and species richness. The changes noted for this year are not necessarily indicative of contaminant impacts, but possibly are indicative of changes in habitat and water level. As in past years, a factor in 2006 that may be affecting fluctuating levels of fish populations at several of the sites may be attributed to shifting stream-bed substrates, which affect changes in habitat within the streams sampled, by restructuring the size of runs, pools, riffles, and associated cover. All fish observed this year were found to be in good health having a condition factor of "good." Variability of the species assemblage of the streams in the vicinity of PGDP would appear to be related to the variable nature of the streams from year to year, as exemplified by periods of high water, shifting stream substrates, and changing habitat.

Bioaccumulation monitoring samples were analyzed for PCBs and metals, including mercury. Over the past several years, PCBs have varied. The Food and Drug Administration action limit for fish is 2 parts per million (ppm). In 2006, results for PCB-1260 and PCB Total were an average concentration of 1.4 ppm and 2.9 ppm, respectively, for fish collected near the plant site. In 2006, fish samples were analyzed for metals. Overall, metals for the Bayou Creek and Little Bayou Creek sites do not vary significantly from the fish collected from the reference locations.

Fish data are presented in Section 4, Tables 4.43 through 4.46 of Volume II of this report.

9 Groundwater

Abstract

The primary objectives of groundwater monitoring at the Paducah Site are to detect contamination and provide the basis for groundwater quality assessments, if contamination is detected. Monitoring includes the exit pathways at the perimeter of the plant and off-site water and monitoring wells. Primary off-site contaminants continue to be TCE, an industrial degreasing solvent, and ^{99}Tc, a fission by-product. Evidence suggests the presence of TCE as a DNAPL in groundwater beneath the site.

Introduction

Monitoring and protection of groundwater resources at the Paducah Site are required by federal and state regulations and by DOE orders. Groundwater is not used for on-site purposes and when off-site contamination from the Paducah Site was discovered in 1988, DOE provided an alternate water supply to affected residences.

A CERCLA/ACO SI, completed in 1991, determined the primary off-site contaminants in the RGA to be TCE and ^{99}Tc. TCE was used until 1993 as an industrial degreasing solvent and ^{99}Tc is a fission by-product contained in nuclear power reactor returns that were brought on-site through 1976 for reenrichment of ^{235}U. Such reactor returns no longer are used in the enrichment process; however, ^{99}Tc still is present in the system. Known or potential sources of TCE and ^{99}Tc include former test areas and other facilities, spills, leaks, buried waste, and leachate derived from contaminated scrap metal.

Investigations of the on-site source areas of TCE at the Paducah Site are ongoing. The main source of TCE contamination in the groundwater is near the C-400 Cleaning Building. TCE belongs to a class of contaminants called DNAPLs, which are characterized by higher density, relative to water, and low solubility. DNAPLs typically sink through the subsurface and may form pools of the contaminant above a less permeable layer, both within the subsurface and at the base of the aquifer. These DNAPL pools constitute a continuous source of dissolved-phase contamination (plumes) deep within the aquifer. Pools of DNAPL are extremely difficult to locate and remove. TCE is known to be pooled in the groundwater at C-400. The pump-and-treat system for the Northwest Plume is controlling the highest dissolved TCE concentrations and ^{99}Tc activities derived from C-400.

Continued groundwater monitoring serves to detect the extent of contamination, identify the fate of the contaminants, and determine the movement of groundwater near the plant. Figure 9.1 presents the latest maps (CY 2005) of the TCE

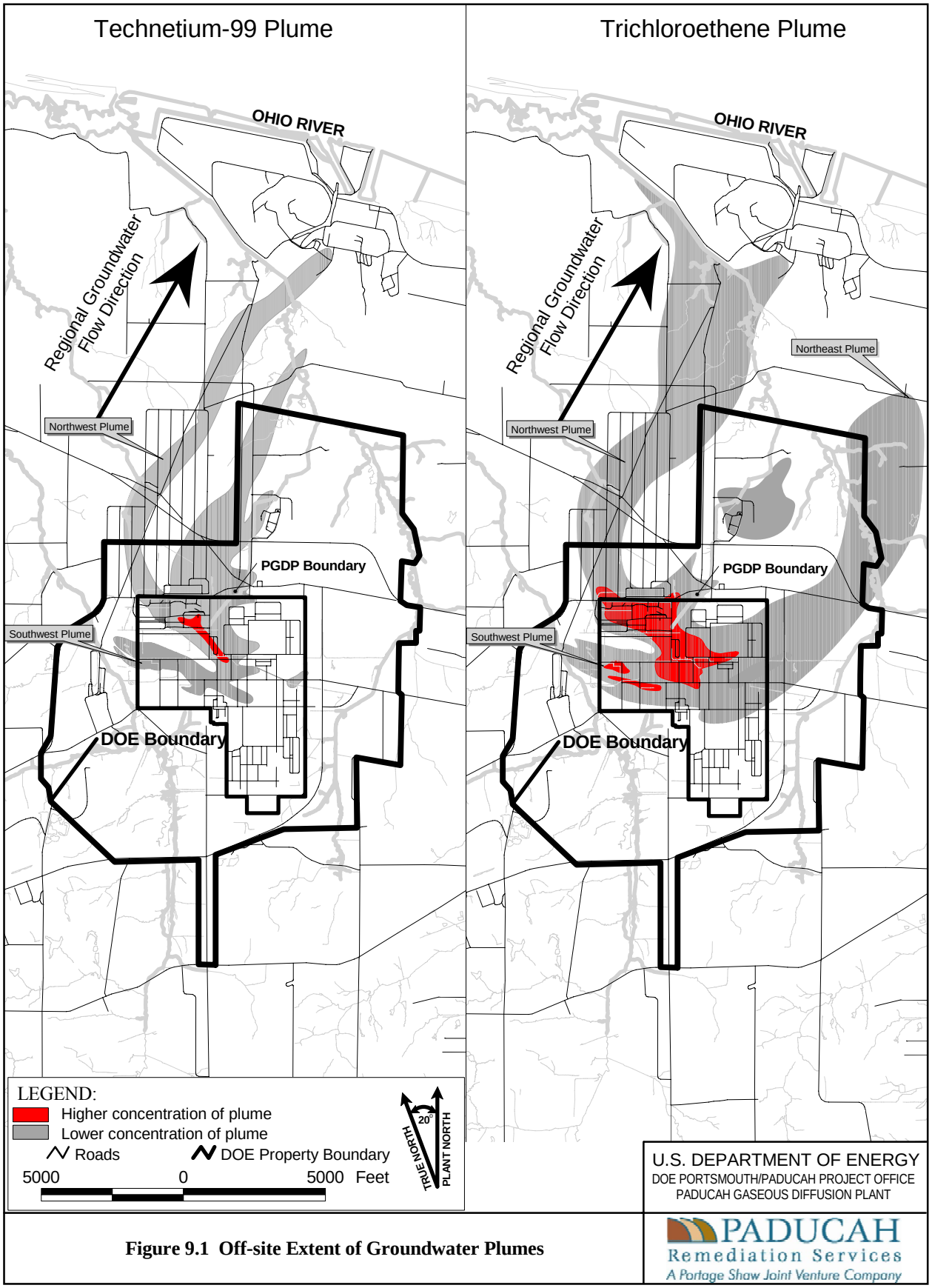

Figure 9.1 Off-site Extent of Groundwater Plumes

and ^{99}Tc plumes associated with PGDP.

Monitoring results indicate that TCE levels are decreasing overall in the core of the Northeast Plume, and both TCE and ^{99}Tc levels are decreasing in the core of the Northwest plume downgradient of the pump-and-treat wells (off-site).

Groundwater Hydrology

When rain falls to the ground, some of it flows across the surface eventually entering streams or lakes, some of it is used by plants, some evaporates and returns to the atmosphere, and some sinks into the ground. The water that sinks into the ground infiltrates the spaces between the particles of soil and rock. Groundwater is stored in and moves slowly through an aquifer. Aquifers typically consist of layers of sand and gravel or porous (sometimes fractured) rock. The speed that groundwater flows through the subsurface depends on the porosity of the soil or rock and how well the spaces are connected. Hydraulic conductivity is the physical property that describes the ease with which water can move through the pore spaces and fractures in soil, gravel, sand, and rock.

The area in the subsurface where water fills these pore spaces is called the saturated zone (Figure 9.2). The top of the saturated zone is the water table, which is the boundary between the unsaturated and saturated zones. This boundary generally gently mirrors the surface topography and is higher at natural exits such as springs, swamps, and beds of gaining streams and rivers. Groundwater can be brought to the surface naturally, either through discharge as a spring or as flow into lakes and streams, or it can be extracted through a well drilled into the aquifer. A well is a pipe/screen assembly in the ground that fills with groundwater, which then can be brought to the surface using a pump.

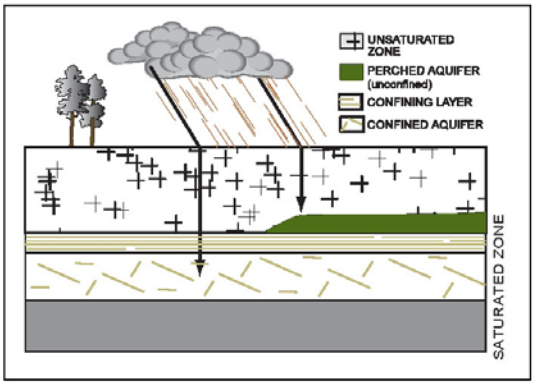

Figure 9.2. Typical Path for Rainwater Accumulation as Groundwater

Monitoring wells are used extensively at the Paducah Site to assess the effect of plant operations on groundwater quality. Wells positioned to sample groundwater flowing away from a site are called downgradient wells, and wells placed to sample groundwater flowing toward a site are called upgradient wells. Any contamination in the downgradient wells that is not present in the upgradient wells may be the result of that site.

Groundwater movement is determined by differences in the elevation of the top of the groundwater column at a specific location compared to the elevation elsewhere. This is called hydraulic head. Hydraulic head is considered to be the total energy in any water mass resulting from three components: pressure, velocity, and elevation. Water will rise in a well casing in response to the pressure of the water surrounding the well's screened zone. The depth to water in the well is measured and the elevation calculated to determine the hydraulic head of the water in the monitored zone (Figure 9.3). The hydraulic gradient measures the difference in hydraulic head over a specified distance. By

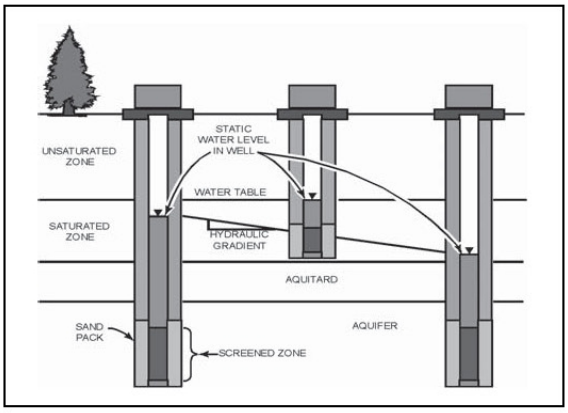

Figure 9.3. MW Construction Showing the Relationship between the Screened Zone and the Water Level in Wells Where Flow in the Aquifer is to the Right

comparing the water levels in adjacent wells screened in the same zone, a horizontal hydraulic gradient can be determined and the lateral direction of groundwater flow can be predicted.

Only wells screened in the same zones are considered when determining the horizontal gradient. Wells screened above and below an aquitard (a geologic unit that inhibits groundwater flow) can have different hydraulic heads, thus defining a vertical gradient. If the water levels in deeper wells are lower than those in shallower wells, then the flow is through the aquitard and primarily downward.

Groundwater aquifers are one of the primary pathways by which potentially hazardous substances can spread through the environment. Substances in the soil may migrate downward due to gravity or be dissolved in rainwater, which transports them downward through the unsaturated zone into the aquifer. The contaminated water then flows laterally downgradient toward the discharge point.

Geologic and Hydrogeologic Setting

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies near the northern boundary of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The Mississippi embayment is a large sedimentary trough oriented nearly north-south that received sediments during the Cretaceous and Tertiary geologic time periods.

During the Cretaceous Period, the PGDP area was a coastal marine environment. The derived sediments constitute a thick deposit of sand beneath PGDP (270 ft), with frequent lenses of silt and clay in the upper part that is called the McNairy Formation. A similar depositional environment continued into the early Paleocene Epoch. These sediments, indistinguishable in lithologic sample from the McNairy Formation, are named the Clayton Formation. (PGDP geologists commonly refer to the collective Cretaceous and lower Paleocene sediments as the McNairy Formation.)

Throughout most of the Mississippi Embayment and extending to under the south side of the PGDP, the Paleocene Porters Creek Clay overlies the McNairy/Clayton Formation. Locally, the Porters Creek Clay consists predominately of silt members with sand and clay interbeds that were deposited in marine and brackish water environments. Much later erosion, associated with formation of the ancestral Tennessee River basin, thinned the Porters Creek Clay to the north and completely removed it under most of the PGDP and adjacent area to the north. The McNairy and Clayton Formations and the Porters Creek Clay uniformly dip 30 to 35 ft per mile (5.7 to 6.6 m/km) to the south-southwest.

Pliocene-Pleistocene (the geologic age of these formations is uncertain) gravels (and lesser sands), representing a broad humic alluvial fan deposit that extended across all of the Jackson Purchase region at one time, overlie the Porters Creek Clay to the south. These gravels constitute the oldest member of the lower continental deposits. The ancestral Tennessee River cut through the PGDP area (close to the present course of the Ohio River) later in the Pleistocene, eroding through the Porters Creek Clay to form a wide valley. A subcrop of the Porters Creek Clay, buried in the sediments beneath the PGDP, marks the south side of the Tennessee River valley. Braided river deposits of sand and gravel, commonly 30-ft (9.1-m) thick, fill the lower portion of the ancestral Tennessee River valley. These sands and gravels form the youngest member of the lower continental deposits.

As sediments from retreating Pleistocene glaciers plugged tributaries to the Mississippi River, lakes formed in the ancestral Tennessee River valley. These lake deposits predominately consisted of silt. Intervals of common sand and gravel lenses within the silt beneath PGDP attest to minor periods of active erosion of the Pliocene-Pleistocene (the geologic age of these formations is uncertain) gravels to the south and redeposition within the valley. (The thick silt interval, with interbedded sand and gravel member, is collectively called the upper continental deposits). Finally, layers of loess, wind-blown silt derived from the receding

glaciers, blanketed the entire Jackson Purchase region. The combined thickness of upper continental deposits and loess at PGDP is commonly 60 ft (18.3 m) thick.

The local groundwater flow systems at the Paducah Site include the following (from shallowest to deepest): (1) the Terrace Gravel flow system, (2) UCRS, (3) RGA, and (4) the McNairy flow system. The Terrace Gravel consists of shallow Pliocene-Pleistocene (the geologic age of these formations is uncertain) gravel deposits in the southern portion of the Paducah Site. These deposits usually lack sufficient thickness and saturation to constitute an aquifer, but are a locally important source of groundwater recharge to the RGA.

The UCRS consists of the silts, with sand and gravel interbeds, of the upper continental deposits and overlying loess. Groundwater flow within the UCRS is predominately downward and is the primary recharge to the RGA. The RGA is the uppermost aquifer at the Paducah Site and was used formerly as a drinking water source by private residences north of the site. It consists primarily of the Lower Continental Deposits, a thick unit of sand and gravel formed by the ancestral Tennessee River, and includes contiguous sands and gravels of the Upper Continental Deposits, the McNairy Formation, and alluvium of the Ohio River. The Ohio River is the regional discharge/drainage feature for the area hydrologic system. Flow in the RGA and McNairy is northward to discharge into the Ohio River.

Uses of Groundwater in the Vicinity

The WKWMA and some lightly populated farmlands are in the immediate vicinity of the Paducah Site. Homes are sparsely located along rural roads in the vicinity of the site. Two communities, Grahamville and Heath, lie within 2 miles (3.2 km) east of the plant.

Groundwater was the primary source of water for residents and industries in the vicinity of the plant area, but it has been replaced by water from the West McCracken County Water District. The Paducah Site continues to provide municipal water to all residences within the area that are either known to be contaminated or are suspected of becoming contaminated in the future. The residential out-of-service wells are utilized by DOE for monitoring (per written agreements). Residential wells that no longer are sampled have been capped and locked.

PGDP uses surface water from the Ohio River for process waters and on-site drinking water. The nearest community downstream of Paducah using surface water for drinking water is Cairo, IL, which is located at the confluence of the Upper Mississippi and Ohio Rivers.

Groundwater Monitoring Program

The primary objectives of groundwater monitoring at the Paducah Site are early detection of any contamination resulting from past and/or present land disposal of wastes and provision of the basis for developing groundwater quality assessments, if contamination is detected. Additional objectives outlined in DOE Order 450.1, *Environmental Protection Program*, require implementation of a sitewide approach for groundwater monitoring.

The sitewide approach is outlined in the following three documents related to groundwater monitoring: (1) Groundwater Protection Management Program for CY 2006, (PRS 2006b); (2) Groundwater Protection Plan (BJC 2004); (3) and the Paducah Site EMP (BJC 2005). Approximately 170 MWs and residential wells are sampled in accordance with DOE orders and federal, state, and local requirements. Well sampling is included in several different monitoring programs, which are described as follows.

Resource Conservation and Recovery Act Permit Monitoring Programs

The only hazardous waste facility at the Paducah Site that requires groundwater monitoring is the C-404 Landfill (Figure 9.4). The C-404 Low-Level Radioactive Waste Burial Ground was used for the disposal of uranium-contaminated solid wastes until 1986 when it was determined that, of the wastes disposed there, gold dissolver

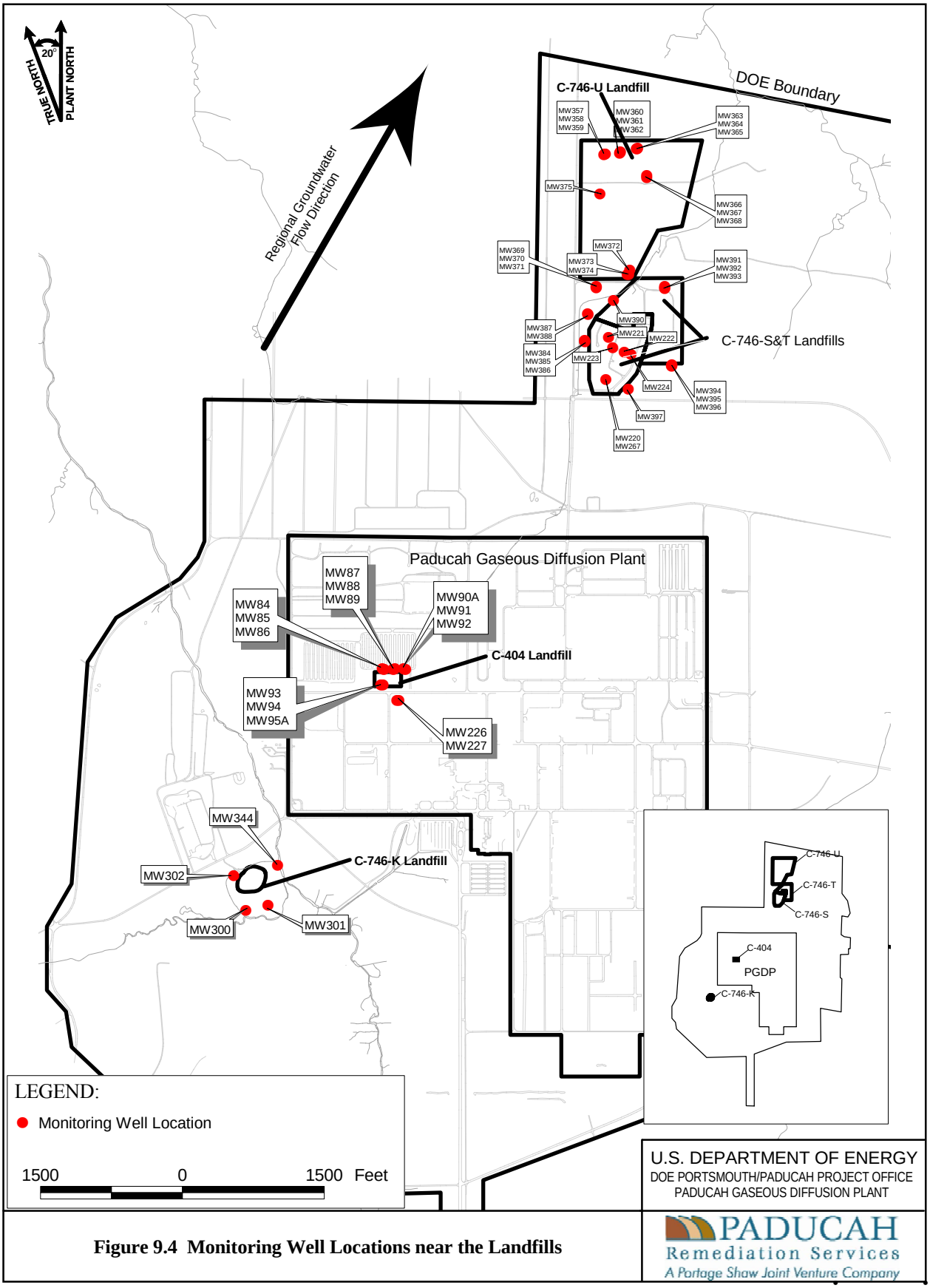

Figure 9.4 Monitoring Well Locations near the Landfills

precipitate was considered a hazardous waste under RCRA. The landfill was covered with a RCRA-compliant cap and was certified "closed" as a hazardous waste landfill in 1987.

The landfill now is monitored under post-closure monitoring requirements. According to the Kentucky C-404 Post-Closure Permit, 14 wells (MWs 84–95, 226, and 227) monitor groundwater quality of the UCRS (four wells) and the underlying RGA (10 wells) during the required postclosure monitoring on a semiannual basis.

During 2006, MWs at the C-404 Landfill were sampled and analyzed for total and dissolved chromium, arsenic, cadmium, lead, mercury, selenium, and uranium. Also monitored are TCE and ^{99}Tc. TCE exceeded the MCL in five upgradient RGA wells, and two downgradient RGA wells; however, this may be related to the underlying TCE plume and not C-404 itself. Remediation of the TCE plume will take place as a CERCLA action under the Groundwater OU. Chromium exceeded the MCL in two upgradient and one downgradient monitoring wells. No other parameters exceeded MCLs. Results are reported to KDWM semiannually. A summary of the detected maximum results for each of the wells is provided in Table 9.1. Parameters with no detections are not listed.

State Solid Waste Disposal Regulations

Post-closure groundwater monitoring continues for the C-746-S Residential Landfill. The landfill stopped receiving solid waste by July 1, 1995, and was certified closed on October 31, 1995, by an independent engineering firm. The groundwater monitoring system for the C-746-S Residential Landfill also encompasses the C-746-T Inert Landfill, which was certified closed in November 1992. No monitoring is done on the C-746-T Landfill because it had fulfilled the two years of post-closure environmental monitoring and maintenance requirements that were required as part of its closure.

The groundwater monitoring system for C-746-S&T consists of upgradient, sidegradient, and downgradient wells (Figure 9.4). The monitoring system is designed to monitor the UCRS, the upper portion of the RGA (URGA), and lower portion of the RGA (LRGA).

The MWs at C-746-S&T are sampled quarterly and in accordance with 401 *KAR* 48:300. The analytes are dictated by a KDWM-approved solid waste landfill permit modification.

During 2006, beta activity exceeded reference levels in sidegradient and downgradient wells. TCE exceeded reference levels in some upgradient and downgradient wells. The KDWM was notified of the exceedances. Results were reported to KDWM on a quarterly basis. A summary of the maximum results for upgradient, sidegradient, and downgradient wells in each of the monitored portions of the groundwater system is provided in Table 9.2.

The C-746-U Contained Landfill, a solid waste landfill at the Paducah Site, was completed in 1996 and operation was initiated in 1997. Solid waste regulations require groundwater monitoring of the landfill. Monitoring wells were installed in clusters of three. The three well clusters had wells in the UCRS, URGA, and LRGA (Figure 9.4).

During 2006, beta activity exceeded reference levels in two upgradient and two downgradient wells. Levels of PCB exceeded reference levels in one downgradient well. TCE exceeded reference levels in one upgradient well. The KDWM was notified of all exceedances and the results were reported to KDWM on a quarterly basis. A summary of the maximum results for upgradient, sidegradient, and downgradient wells in each of the monitored portions of the groundwater system at the C-746-U Landfill is provided in Table 9.3. Whether these exceedances are the result of releases from the C-746-S&T Landfills, which are upgradient of the C-746-U Landfill, was the subject of an RI.

Table 9.1. Summary of Maximum Groundwater Results from the RGA at C-404 Landfill for CY 2006

		Upgradient Wells						Downgradient Wells								
		RGA					UCRS	RGA					UCRS			
Chemical Name	**Units**	**MW 226**	**MW 227**	**MW 93**	**MW 95A**	**MW 94**	**MW 84**	**MW 86**	**MW 87**	**MW 89**	**MW 90A**	**MW 92**	**MW 85**	**MW 88**	**MW 91**	**Reference Value**
Arsenic	mg/L	0.0016	0.0013	0.0013	0.0010	ND	0.0013	0.0040	ND	ND	ND	ND	0.012	0.0042	0.0033	0.05
Arsenic, Dissolved	mg/L	ND	ND	ND	ND	0.0017	ND	ND	ND	ND	ND	ND	0.012	0.35	0.0016	--
Chromium	mg/L	**0.43**	**0.16**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.13**	0.1
Dissolved Oxygen	mg/L	0.92	8.1	1.6	1.2	1.3	2.5	2.1	2.4	2	2.0	1.5	3.7	1.5	2.8	--
Lead	mg/L	ND	0.017	ND	ND	0.0054	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05
Selenium	mg/L	0.0074	ND	ND	0.0052	0.0070	ND	ND	ND	ND	ND	ND	ND	ND	0.014	0.05
Selenium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0063	--
Uranium	mg/L	ND	ND	ND	ND	0.0043	ND	0.0017	ND	ND	ND	ND	0.0019	ND	ND	0.03
Uranium, Dissolved	mg/L	ND	ND	ND	ND	0.0038	ND	ND	ND	ND	ND	ND	0.0018	ND	ND	--
Activity of U-235	pCi/L	ND	ND	ND	3.2	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	--
Technetium-99	pCi/L	119	20	ND	29	316	22	19	23	ND	26	ND	168	33	865	900
Uranium-234	pCi/L	ND	ND	ND	55	1.3	ND	0.20	ND	3.35	ND	ND	0.25	ND	ND	--
Uranium-238	pCi/L	ND	ND	ND	7.9	1.4	ND	0.36	ND	0.522	ND	ND	0.72	ND	ND	--
Trichloro-ethene	µg/L	**550**	**61**	**390**	**290**	**7.4**	**370**	**300**	**72**	1.1	1			2.2	**71**	5

ND – not detected
-- – No reference value for this parameter
Bold – **Exceeds Criteria**

Table 9.2. Summary of Maximum Groundwater Results at C-746-S&T Landfills for CY 2006

		Lower RGA			Upper RGA			UCRS Wells				
	Parameter	**Up-gradient**	**Side-gradient**	**Down-gradient**	**Up-gradient**	**Side-gradient**	**Down-gradient**	**Up-gradient**	**Side-gradient**	**Down-gradient**	**Reference**	**Value**
ANION (mg/L)	Bromide	ND	ND	ND	ND	ND	ND	2.3	2.6	ND	--	
	Chloride	110	35	46	68	76	50	100	230	20	SMCL	250
	Fluoride	0.15	0.49	0.31	0.19	0.3	0.87	0.54	0.46	0.17	KYREG	4
	Nitrate as Nitrogen	2	1.3	1.6	1.9	1.5	3.7	ND	2.5	ND	KYREG	10
	Sulfate	12	27	23	13	22	30	19	26	8.9		
METAL (mg/L)	Aluminum	**0.4**	**0.302**	**0.267**	**0.308**	ND	**13**	**0.4**	**2.9**	ND	SMCL	0.2
	Arsenic	0.0017	0.00234	0.00368	0.00198	0.00734	0.00416	0.00378	0.00589	0.00304	KYREG	0.05
	Barium	0.29	0.231	0.30	0.29	0.213	0.72	0.398	0.50	0.112	KYREG	2
	Calcium	33	39	28	32.4	33.8	37.4	45.1	60.9	12.1	--	
	Chromium	ND	ND	ND	ND	ND	0.0296	ND	ND	ND	KYREG	0.1
	Cobalt	ND	0.009	0.00196	0.00825	0.00149	0.0472	0.00258	0.0083	ND	--	
	Iron	**0.335**	**5.41**	**4.17**	**0.44**	**1.48**	**11.3**	**5.16**	**5.83**	**5.01**	SMCL	0.3
	Magnesium	13.3	12.8	11.4	12.9	12.6	14.6	19.7	24.4	3.86	--	
	Manganese	ND	**0.859**	**1.25**	**0.0667**	**0.276**	**6.08**	**0.617**	**0.735**	0.0383	SMCL	0.05
	Molybdenum	0.00338	ND	ND	0.00481	ND	0.00902	ND	0.00292	ND	--	
	Nickel	ND	ND	ND	0.409	ND	0.06	ND	0.0562	ND	--	
	Potassium	2.1	1.98	1.97	7.92	1.49	5.24	1.36	1.01	0.57	--	
	Selenium	0.00872	0.00562	0.0073	0.0091	0.012	0.00103	0.013	0.0241	ND	KYREG	0.05
	Sodium	35	125	47	37.3	62.2	68.4	163	115	82.3	--	
	Uranium	ND	ND	0.0014	ND	ND	ND	ND	0.00127	ND	KYREG	0.03
	Zinc	ND	ND	ND	0.0562	ND	ND	ND	ND	ND	SMCL	5
METAL-D (mg/L)	Barium, Dissolved	0.275	0.215	0.3	0.289	0.201	0.65	0.378	0.467	0.113	--	
	Chromium, Dissolved	ND	ND	ND	ND	ND	0.0264	ND	ND	ND	--	
	Uranium, Dissolved	ND	0.00116	ND	ND	ND	ND	ND	ND	ND	--	
PHYSC (mg/L)	Dissolved Solids	226	**502**	223	233	308	298	**592**	**617**	261	SMCL	500
Pesticide/ PCB (µg/L)	PCB-1242	ND	ND	ND	ND	ND	0.11	ND	ND	ND	--	
RADS (pCi/L)	Alpha activity	ND	6.85	ND	ND	8.83	4.82	ND	4.85	ND	KYREG	15
	Beta activity	10.8	**154**	**118**	17.7	**332**	**176**	7.45	**58.5**	ND	KYREG	50
	Radium-226	ND	ND	ND	ND	0.352	ND	ND	ND	ND	KYREG	5
	Radium-228	ND	ND	ND	4.56	ND	3.14	**6.25**	ND	ND	KYREG	5
	Technetium-99	20.8	260	175	28.2	383	354	ND	102	ND	TTL	900
VOA	Trichloroethene	**8.7**	ND	**12**	**19**	1.2	**16**	ND	ND	ND	KYREG	5
WETCHEM	Chemical Oxygen Demand (mg/L)	NR	80	NR	NR	31	NR	34	54	26	--	
	Conductivity (umho/cm)	414	755	443	415	636	534	997	1060	484	--	
	Total Organic Carbon (mg/L)	NR	28.1	3	NR	12.3	1.5	9	20	5.7	--	
	Total Organic Halides (µg/L)	20.2	570	67	29.1	29.6	34.9	221	396	81.7	--	
	Turbidity (NTU)	**8.6**	**73.7**	**48**	**26.5**	**35.5**	**170**	**45.8**	**66.9**	**29**	MCL	5

ND – not detected
NR – not reported
Bold – **Exceeds Criteria**
-- – No reference value for this parameter
KYREG – Kentucky regulations
SMCL – Secondary MCL
TTL – Target treatment level for Northwest Plume
MCL – maximum contaminant level
SVOA – semivolatile organic analyte
VOA – volatile organic analyte

Table 9.3. Summary of Maximum Groundwater Results at C-746-U Landfill for CY 2006

		Lower RGA			Upper RGA			UCRS Wells			
	Parameter	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Down-gradient	Reference	Value
ANION (mg/L)	Chloride	130	35	31	55	40	28	130	15	SMCL	250
	Fluoride	0.19	0.21	0.26	0.25	0.33	0.27	0.31	0.42	KYREG	4
	Nitrate as Nitrogen	1.4	ND	ND	ND	ND	2.6	ND	2.3	KYREG	10
	Sulfate	230	28	120	150	41	85	100	59	--	
METAL (mg/L)	Aluminum	**0.218**	ND	ND	ND	**0.224**	**0.585**	ND	**10**	SMCL	0.2
	Arsenic	0.00209	0.00486	0.00244	0.0554	0.00586	0.00337	0.00363	0.0043	KYREG	0.05
	Barium	0.0203	0.191	0.0167	0.486	0.429	0.224	0.121	0.21	KYREG	2
	Boron	1.66	ND	0.306	1.13	ND	0.399	ND	ND	--	
	Calcium	73.4	37	44	59.6	24.8	37	29.7	32.6	--	
	Cobalt	0.00208	0.00193	0.00902	0.0666	0.0232	0.0193	0.00226	0.00224	--	
	Iron	0.21	**24.5**	**7.2**	**8.13**	**14.6**	**7.09**	**3.38**	**13**	SMCL	0.3
	Magnesium	31.8	11.5	18.1	23.8	10.8	14.1	10.9	15.6	--	
	Manganese	**0.0547**	**2.89**	**1.18**	**0.577**	**3.95**	**1.78**	**0.872**	**218**	SMCL	0.05
	Molybdenum	ND	ND	ND	ND	ND	ND	0.00355	0.00684	--	
	Nickel	0.00616	ND	0.00655	0.0146	0.00989	ND	ND	0.0111	--	
	Potassium	3.32	2.57	2.68	2.33	1.94	2.1	0.846	0.923	--	
	Selenium	0.0778	ND	0.0053	0.00587	0.0058	0.00504	0.0224	ND	KYREG	0.05
	Sodium	67.6	35.3	52.7	68.3	78.8	74.3	196	181	--	
	Uranium	0.00506	ND	ND	ND	ND	ND	0.0117	0.0149	KYREG	0.03
	Zinc	ND	0.0257	ND	ND	0.0377	ND	ND	ND	SMCL	5
METAL-D (mg/L)	Barium, Dissolved	0.202	0.196	0.245	0.46	0.39	0.211	0.172	0.189	--	
	Uranium, Dissolved	ND	ND	ND	ND	ND	ND	0.0118	0.0152	--	
PHYSC (mg/L)	Dissolved Solids	**579**	200	**333**	**419**	257	**272**	**526**	**659**	SMCL	500
Pesticide/ PCB (µg/L)	alpha-BHC	ND	ND	ND	ND	ND	ND	ND	0.0042	--	
	Heptachlor	ND	ND	ND	0.0059	ND	0.0217	ND	ND	MCL	0.4
	Heptachlor epoxide	ND	ND	ND	ND	ND	0.0084	ND	ND	MCL	0.2
	PCB-1016	ND	ND	ND	0.23	ND	0.79	ND	1.17	--	
	PCB-1242	ND	0.17	0.18	0.739	0.7	1.02	ND	1.34	--	
	PCB-1260	0.17	ND	ND	ND	ND	ND	0.07	ND	--	
	Polychlorinated biphenyl		0.17	0.18	0.39	**0.7**	**1.02**	ND	**1.34**	MCL	0.5
RADS (pCi/L)	Alpha activity	3.93	ND	ND	ND	ND	ND	10.2	ND	KYREG	15
	Beta activity	**64.4**	26.8	32.2	**130**	34.3	36.6	ND	6.54	KYREG	50
	Radium-228	ND	ND	4.52	ND	ND	4.76	ND	2.75	KYREG	5
	Technetium-99	99.7	32.9	44.9	179	51.6	50.8	24.6	ND	TTL	900
SVOA (µg/L)	1,4-Dioxane	ND	ND	17	ND	ND	ND	ND	ND	--	
VOA (µg/L)	Acetone	ND	ND	ND	ND	ND	ND	ND	1000	--	
	Carbon disulfide	ND	ND	5.8	ND	ND	ND	ND	7.8	--	
	Trichloroethene	**11**	ND	1.2	**11**	1.6	2.3	ND	ND	KYREG	5
WETCHEM	Chemical Oxygen Demand (mg/L)	ND	ND	200	ND	ND	ND	ND	190	--	
	Total Organic Carbon (mg/L)	ND	2	94.7	3.1	5.1	3.5	6.1	108.8	--	
	Total Organic Halides (µg/L)	19	13.8	15.6	51.6	116	34.2	146	65.7	--	
	Turbidity (NTU)	**24.1**	**9.3**	**35.1**	**68.7**	**24**	**64.9**	**51.5**	**405**	MCL	5

ND – not detected
NR – not reported
Bold – **Exceeds Criteria**
-- – No reference value for this parameter
KYREG – Kentucky regulations
SMCL – Secondary MCL
TTL – Target treatment level for Northwest Plume
MCL – maximum contaminant level
SVOA – semivolatile organic analyte
VOA – volatile organic analyte

C-746-K Sanitary Landfill Groundwater Monitoring

The C-746-K Sanitary Landfill was used at the PGDP between 1951 and 1981 primarily for the disposal of fly ash. Postclosure groundwater monitoring continues for the C-746-K Landfill on a quarterly basis. The UCRS and RGA are not present at the C-746-K site. Wells at the landfill are installed to monitor groundwater in the Terrace Gravel (Figure 9.4). A summary of the maximum results for each of the wells is provided in Table 9.4. Degradation compounds and TCE, at concentrations above their respective regulatory criterion, were identified in wells around the C-746-K site. Beta activity also was found above regulatory criteria. No metals were found above the MCL criteria. This site was included in the Burial Grounds OU RI that was described in Chapter 3.

Residential (Federal Facility Agreement) Monitoring

DOE conducts sampling of residential wells potentially affected by the contaminant plume (DOE 1998). Currently, only two residential wells (R294 and R302) are sampled monthly. Seventeen other residential wells are monitored annually. All residential wells were analyzed for alpha and beta activity, TCE, and ^{99}Tc. As stated previously, the hydrologic unit in which residential wells are screened is uncertain; however, most are believed to be RGA wells. Table 9.5 provides a summary of the eight residential wells that had detected results. Eleven wells had no detections of any alpha, beta, TCE, or ^{99}Tc.

For one residential well, R424, DOE has provided the residents with a carbon filter treatment system to allow them to have safe drinking water. These filters are replaced semiannually, and the groundwater is sampled before and after filter replacement. Before treatment, the groundwater in the well contains TCE above levels established by the EPA Safe Drinking Water Act (SDWA); however, after treatment, the concentrations are below those levels. The location of the well relative to PGDP makes it highly improbable that the contaminants migrated from the Paducah Site. All residents whose wells were sampled were notified by mail of the results.

Environmental Surveillance Monitoring

Environmental surveillance monitoring is defined as perimeter-exit-pathway (off-site exposure) monitoring and off-site water well monitoring. Environmental surveillance monitoring is conducted in support of DOE Orders and other laws and regulations as addressed in the Paducah Site EMP (BJC 2005).

During 2006, surveillance wells located on and off DOE property were sampled for VOCs, metals, radionuclides, alpha and beta activity, carbonaceous biochemical oxygen demand, hardness, and suspended solids. Table 9.6 provides a summary of the maximum detected results for each hydrogeologic unit sampled for the surveillance program. The maximum TCE value reported (from routine monitoring program wells) in the RGA is 1,300,000 µg/L. TCE also was detected in the McNairy at 32 µg/L. The contamination in the RGA is being addressed by CERCLA actions for the Groundwater OU, see Chapter 3.

During 2006, the maximum reported ^{99}Tc activity in the RGA was 9,150 pCi/L, which exceeded the MCL.

Three wells have been installed penetrating the Rubble Zone, which is the formation underlying the McNairy. No TCE or ^{99}Tc detections were observed in 2006.

Monitoring Well Rehabilitation

In 2006, DOE continued a preventive maintenance MW rehabilitation program at the Paducah Site; 30 wells were rehabilitated. The rehabilitation process utilized Blended Chemical Heat Treatment™ (BCHT). The BCHT method consists of three phases designed to remove the accumulated biofilm and blocking materials from the well screen, well bore, and surrounding aquifer. The shock phase uses heated chemicals, which are jetted into the screen and allowed to remain overnight. The disrupt phase continuously applies heated chemicals via jetting. The removal of biofilm and blocking material redevelops the MW using surging and airlift pumping techniques.

Table 9.4. Summary of Maximum Groundwater Results at C-746-K Landfill for CY 2006

	Parameter	MW300	MW301	MW302	MW344	Reference	Value
ANION (mg/L)	Chloride	16	58	11	22	SMCL	250
	Sulfate	1,600	2,000	140	180	--	
METAL (mg/L)	Aluminum	**0.334**	**0.76**	**0.418**	**4.32**	SMCL	0.2
	Arsenic	0.00396	0.00171	0.00162	0.00541	KYREG	0.05
	Barium	0.0161	0.0237	0.0755	0.0782	KYREG	2
	Beryllium	0.00105	ND	ND	ND	MCL	0.004
	Calcium	373	577	49	65.6	--	
	Iron	**161**	**295**	**1.02**	**6.79**	SMCL	0.3
	Iron (2+)	3	2.96	4	2.67	--	
	Lead	0.00216	ND	ND	0.00144	KYREG	0.05
	Magnesium	79.9	109	27.4	21.7	--	
	Manganese	**16.5**	**20.9**	**0.99**	**0.472**	SMCL	0.05
	Nickel	0.0666	0.0171	0.0109	0.00597	--	
	Potassium	19.5	43.2	0.527	1.85	--	
	Sodium	22.2	66.4	86.7	31.4	--	
	Uranium	ND	0.00249	ND	ND	KYREG	0.03
METAL-D (mg/L)	Arsenic, Dissolved	0.00222	0.00208	ND	0.00395	--	
	Barium, Dissolved	0.0162	0.0644	0.0714	0.0651	--	
	Beryllium, Dissolved	0.00126	ND	ND	ND	--	
	Lead, Dissolved	0.00225	ND	ND	ND	--	
	Uranium, Dissolved	ND	0.00659	ND	ND	--	
RADS (pCi/L)	Beta activity	ND	**62**	ND	ND	KYREG	50
VOA (µg/L)	1,1-Dichloroethane	77	5.8	ND	ND	--	
	1,1-Dichloroethene	**120**	5.9	ND	ND	KYREG	7
	cis-1,2-Dichloroethene	**960**	**72**	ND	ND	SMCL	70
	Trichloroethene	**26**	ND	ND	ND	KYREG	5
	Vinyl chloride	**130**	**4.4**	ND	ND	KYREG	2

VOA – volatile organic analyte
ND – not detected
NR – not reported
-- – No reference value for this parameter
Bold – Exceeds Criteria
KYREG – Kentucky regulations
MCL – maximum contaminant level
SMCL – Secondary MCL

Table 9.5. Summary of Maximum Groundwater Results from Residential Monitoring for CY 2006

Well Number	Alpha activity, pCi/L	Beta activity, pCi/L	^{99}Tc, pCi/L	TCE, µg/L	Type monitoring
R2	ND	19.6	34	**61**	annually
R12	ND	8.53	ND	ND	annually
R23	13.1	20.8	ND	ND	annually
R72	ND	6.53	ND	ND	annually
R82	ND	7.55	ND	ND	annually
R294	2.21	3.54	12.2	1	monthly
R302	**21**	**140**	13.3	1.1	monthly
R392	ND	4.02	ND	ND	annually
	MCL = 15	MCL = 50	MCL=NA	MCL = 5	

NA – not applicable
ND – not detected
MCL – maximum contaminant level (for reference only)
Bold – Exceeds Criteria

Table 9.6. Summary of Maximum Groundwater Results from Environmental Surveillance Monitoring for 2006

	Parameter	Eocene	McNairy	RGA	Rubble Zone	UCRS	Reference	Value
ANION (mg/L)	Chloride	NA	NA	91	NA	58	SMCL	250
	Fluoride	NA	NA	0.23	NA	0.23	MCL	4
	Nitrate as Nitrogen	NA	NA	**24**	NA	3.2	MCL	10
	Sulfate	NA	NA	72	NA	120	--	
METAL (mg/L)	Aluminum	NA	NA	**1.36**	NA	**3.66**	SMCL	0.2
	Arsenic	NA	NA	0.00591	NA	0.00241	MCL	0.05
	Barium	NA	NA	0.465	NA	0.338	MCL	2
	Calcium	NA	NA	47.8	NA	38.9	--	
	Chromium	NA	NA	**0.284**	NA	**0.195**	MCL	0.1
	Cobalt	NA	NA	0.0256	NA	0.0107	--	
	Iron	NA	NA	**8.5**	NA	**10.2**	SMCL	0.3
	Iron (2+)	NA	NA	1.73	NA	22	--	
	Lead	NA	NA	ND	NA	0.00179	SDWA	0.015
	Magnesium	NA	NA	19	NA	15.1	--	
	Manganese	NA	NA	**3.86**	NA	**1.99**	SMCL	0.05
	Molybdenum	NA	NA	0.0139	NA	0.00201	--	
	Nickel	NA	NA	0.408	NA	0.233	--	
	Potassium	NA	NA	8	NA	2.89	--	
	Selenium	NA	NA	0.00964	NA	0.00626	MCL	0.05
	Sodium	NA	NA	69.6	NA	60.8	--	
	Uranium	0.00109	ND	0.00451	NA	**0.102**	MCL	0.02
	Zinc	NA	NA	0.0252	NA	ND	SMCL	5
METAL-D (mg/L)	Arsenic, Dissolved	NA	NA	0.00505	NA	ND	--	
	Barium, Dissolved	NA	NA	0.463	NA	0.286	--	
	Calcium, Dissolved	NA	NA	47.6	NA	39.1	--	
	Cobalt, Dissolved	NA	NA	0.0192	NA	0.00568	--	
	Iron, Dissolved	NA	NA	3.09	NA	ND	--	
	Magnesium, Dissolved	NA	NA	19.3	NA	15.3	--	
	Manganese, Dissolved	NA	NA	3.8	NA	1.66	--	
	Molybdenum, Dissolved	NA	NA	0.00455	NA	ND	--	
	Nickel, Dissolved	NA	NA	0.403	NA	0.297	--	
	Potassium, Dissolved	NA	NA	7.81	NA	2.87	--	
	Selenium, Dissolved	NA	NA	0.00576	NA	ND	--	
	Sodium, Dissolved	NA	NA	70	NA	62.2	--	
	Zinc, Dissolved	NA	NA	0.0201	NA	ND	--	
PHYSC	Temperature (deg F)	63.4	63.9	83.1	64.5	76.8	--	
	Depth to Water (ft)	9.73	59.63	61.43	60.05	62.89	--	
	Dissolved Oxygen (mg/L)	1.96	3.53	7.99	0.47	6.94	--	
	Dissolved Solids (mg/L)	NA	NA	392	NA	328	SMCL	500
	Redox (mV)	142	258	376	13	292	--	
	pH (Std Unit)	7	6.35	7.9	6.91	7	SMCL	8.5
RADS (pCi/L)	Uranium	ND	ND	ND	ND	**0.1**	MCL	0.02
	Alpha activity	ND	ND	**40.7**	ND	**60.4**	MCL	15
	Beta activity	ND	8.68	**6,260**	11.1	**471**	MCL	50
	Technetium-99	ND	ND	**9,150**	ND	725	TTL	900
VOA (µg/L)	1,1-Dichloroethane	ND	ND	18	NA	NA	--	
	1,1-Dichloroethene	ND	ND	**29**	NA	**9.8**	MCL	7
	Carbon tetrachloride	ND	ND	**77**	NA	NA	MCL	5
	cis-1,2-Dichloroethene	ND	ND	**84,000**	NA	18	SMCL	70
	Methane	ND	ND	1,300	NA	NA	--	
	Trichloroethene	ND	**32**	**1,300,000**	NA	**20,000**	MCL	5
	Vinyl chloride	ND	ND	**810**	NA	NA	MCL	2
WETCHEM	Alkalinity (mg/L)	NA	NA	70	NA	65	--	
	Chlorine, Total Residual (mg/L)	NA	NA	35	NA	NA	--	
	Silica (mg/L)	NA	NA	28	NA	23	--	
	Total Organic Carbon (mg/L)	NA	NA	1.6	NA	1	--	
	Turbidity (NTU)	**161**	**54.5**	**247**	**31.6**	**2,000**	MCL	5
	Conductivity (umho/cm)	604	508	1,458	769	899	--	

NA = no analysis; ND = not detected; -- = No reference value for this parameter; TTL – Target treatment level for Northwest Plume; VOA – volatile organic analyte; **Bold – Exceeds Criteria**

Environmental Restoration Activities

Northwest Plume Monitoring

The NWPGS started operation in 1995 to initiate control of the highest TCE concentration portion (greater than 1,000 ppb) of the Northwest Plume. Two extraction well fields, each containing two extraction wells, were installed. Each set of extraction wells is surrounded by monitoring wells (Figure 9.5). The network is used for monitoring groundwater quality and water levels to determine the effectiveness of the interim action.

There were no significant TCE concentrations changes in the CY 2006 monitoring well data. All monitoring wells indicate that the highest TCE concentration portion of the plume is being controlled. Likewise, ^{99}Tc concentrations in CY 2006 were similar to those measured in CY 2005.

Summaries of the program's monitoring results are listed in Table 9.7. The data for this program are reported in the FFA Semiannual Progress Report.

Northeast Plume Monitoring

The EPA approved an Interim ROD for treatment of the Northeast Plume in June of 1995. The treatment system was completed in 1996 and operation began in 1997 and included two extraction wells, several MWs (Figure 9.6), and facilities required to transfer the TCE-contaminated water to the USEC C-637 Cooling Towers for treatment. Groundwater quality and water-level information obtained from the MWs is used to evaluate the effectiveness of the remedial action. The upgradient MWs also are used to measure ^{99}Tc contamination within the plume before it reaches the extraction wells.

Monitoring well data for the Northeast Plume well field and most upgradient locations within the Northeast Plume (wells MW255, MW258, MW288, and MW292) continued to document a trend of declining TCE levels. MW data from CY 2006 indicated the upward trend of ^{99}Tc in certain upgradient locations, as reported in CY 2005, was ongoing.

A summary of the program's monitoring results is listed in Table 9.8. The data for this program are reported in the FFA Semiannual Progress Report.

Groundwater Monitoring Results

The major objectives of groundwater monitoring at the Paducah Site are being met by the monitoring programs. Contamination has been detected in groundwater off-site, including the Tennessee Valley Authority (TVA) Shawnee Fossil Plant. Because of this, DOE collects monitoring well purge water from TVA and treats it in the PGDP Northwest Plume Treatment Facility. Through the monitoring program, in conjunction with RIs, a footprint of the groundwater contamination has been mapped and is updated periodically. The program is modified each year to delineate the boundaries of the contaminant plume over time and to identify source locations for contaminants. Monitoring wells upgradient and downgradient from individual underground waste disposal facilities are sampled and analyzed for contaminants of concern. Contaminants identified by the monitoring program are evaluated by technical assessment and statistical analysis as required by permit, legal agreements, and other standard environmental practices to determine if the source of the contaminants could be from the disposal site being monitored. Beta activity, TCE, and ^{99}Tc are found in the off-site and on-site contamination plumes. Groundwater monitoring results from all sampling efforts conducted by the Paducah Site are compiled in the Paducah Oak Ridge Environmental Information System (OREIS) database. A complete listing of analytical results is available upon request from the PRS Public Affairs Department.

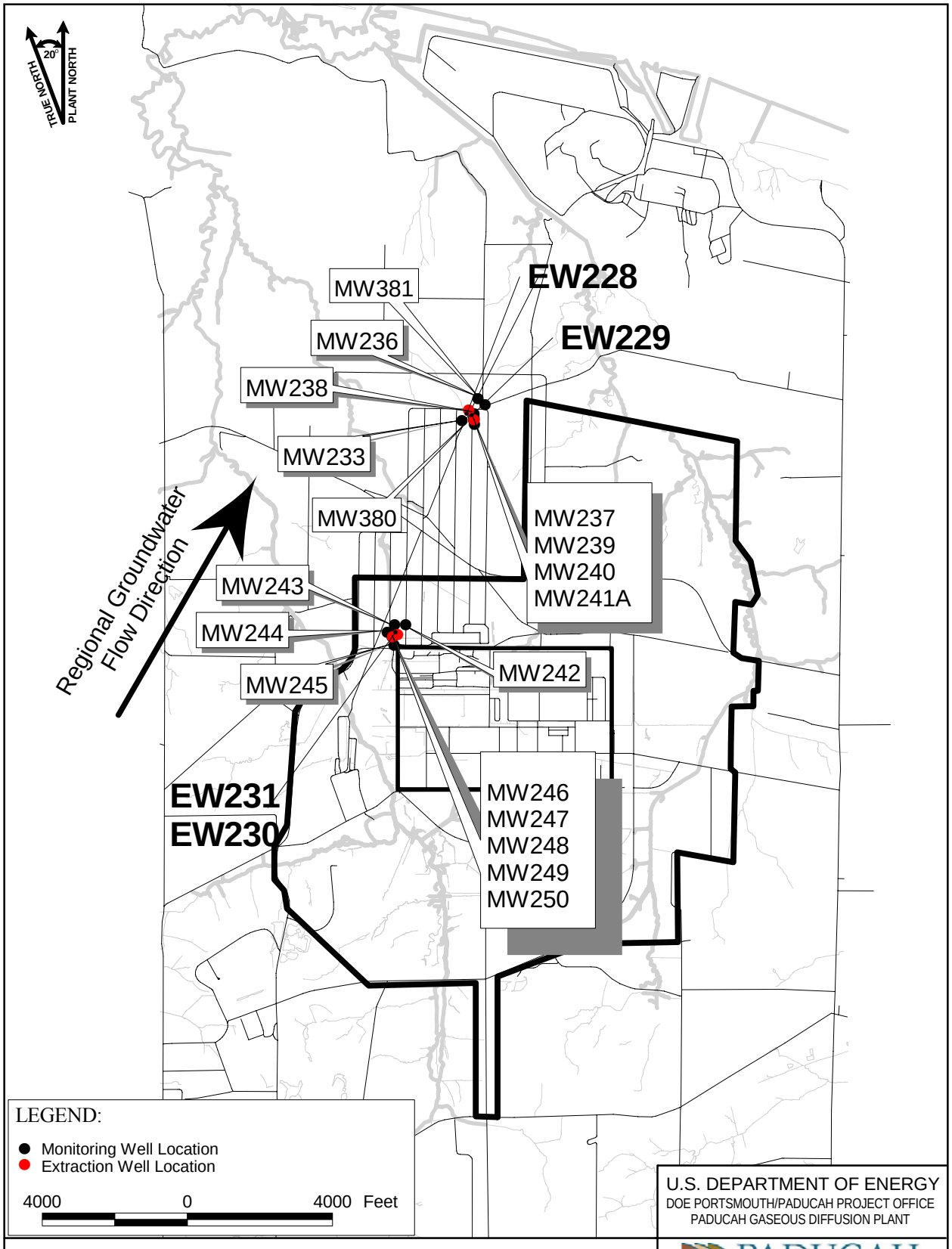

Figure 9.5 Northwest Plume Monitoring Wells

Table 9.7. Summary of Maximum Groundwater Results from the Northwest Plume Groundwater Monitoring for 2006

	Parameter	MW 233	MW 236	MW 238	MW 240	MW 242	MW 243	MW 244	MW 245	MW 248	MW 250	MW 380	MW 381	Reference/ Value	
ANION (mg/L)	Chloride	NA	NA	NA	NA	61	25	NA	NA	NA	NA	NA	37	SMCL	250
	Fluoride	NA	NA	NA	NA	0.14	0.11	NA	NA	NA	NA	NA	0.16	MCL	4
	Nitrate as Nitrogen	NA	NA	NA	NA	ND	1.5	NA	NA	NA	NA	NA	1.5	MCL	10
	Sulfate	NA	NA	NA	NA	12	15	NA	NA	NA	NA	NA	23	--	
METAL (mg/L)	Arsenic	NA	NA	NA	NA	0.0098	ND	NA	NA	NA	NA	NA	ND	MCL	0.05
	Barium	NA	NA	NA	NA	0.261	0.104	NA	NA	NA	NA	NA	0.152	MCL	2
	Calcium	NA	NA	NA	NA	20.4	19.2	NA	NA	NA	NA	NA	25	--	
	Chromium	NA	NA	NA	NA	0.0179	ND	NA	NA	NA	NA	NA	ND	MCL	0.1
	Cobalt	NA	NA	NA	NA	0.0127	ND	NA	NA	NA	NA	NA	ND	--	
	Iron	NA	NA	NA	NA	**10.4**	ND	NA	NA	NA	NA	NA	ND	SMCL	0.3
	Iron (2+)	NA	NA	NA	NA	0.04	0.02	NA	NA	NA	NA	NA	0.03	--	
	Magnesium	NA	NA	NA	NA	9.17	7.81	NA	NA	NA	NA	NA	10.1	--	
	Manganese	NA	NA	NA	NA	**0.811**	0.0052	NA	NA	NA	NA	NA	0.0051	SMCL	0.05
	Molybdenum	NA	NA	NA	NA	0.0041	0.0011	NA	NA	NA	NA	NA	ND	--	
	Nickel	NA	NA	NA	NA	0.0235	ND	NA	NA	NA	NA	NA	ND	--	
	Potassium	NA	NA	NA	NA	0.717	1.08	NA	NA	NA	NA	NA	1.53	--	
	Sodium	NA	NA	NA	NA	22.7	22.4	NA	NA	NA	NA	NA	31.7	--	
	Zinc	NA	NA	NA	NA	0.0305	ND	NA	NA	NA	NA	NA	ND	SMCL	5
METAL-D (mg/L)	Arsenic, Dissolved	NA	NA	NA	NA	0.0097	ND	NA	NA	NA	NA	NA	ND	--	
	Barium, Dissolved	NA	NA	NA	NA	0.258	0.105	NA	NA	NA	NA	NA	0.154	--	
	Calcium, Dissolved	NA	NA	NA	NA	20.4	18.7	NA	NA	NA	NA	NA	24.9	--	
	Cobalt, Dissolved	NA	NA	NA	NA	0.0129	ND	NA	NA	NA	NA	NA	ND	--	
	Iron, Dissolved	NA	NA	NA	NA	10.9	ND	NA	NA	NA	NA	NA	ND	--	
	Magnesium, Dissolved	NA	NA	NA	NA	9.29	7.77	NA	NA	NA	NA	NA	10.3	--	
	Manganese, Dissolved	NA	NA	NA	NA	0.821	ND	NA	NA	NA	NA	NA	ND	--	
	Molybdenum, Dissolved	NA	NA	NA	NA	0.0023	0.001	NA	NA	NA	NA	NA	ND	--	
	Nickel, Dissolved	NA	NA	NA	NA	0.0181	ND	NA	NA	NA	NA	NA	ND	--	
	Potassium, Dissolved	NA	NA	NA	NA	0.556	0.862	NA	NA	NA	NA	NA	1.43	--	
	Sodium, Dissolved	NA	NA	NA	NA	23.5	21.7	NA	NA	NA	NA	NA	31.5	--	
	Zinc, Dissolved	NA	NA	NA	NA	0.0271	ND	NA	NA	NA	NA	NA	ND	--	
PHYSC	Depth to Water (ft)	47.06	46.35	47.52	47.06	44.79	43.09	40.98	44.28	43.69	43.09	45.9	46.8	--	
	Dissolved Oxygen (mg/L)	4.35	413	4.37	4.38	4.5	4.95	3.57	1.91	3.89	4.62	3.55	4.11	--	
	Dissolved Solids (mg/L)	NA	NA	NA	NA	210	168	NA	NA	NA	NA	NA	231	SMCL	500
	pH (Std Units)	6.98	6.64	6.62	6.62	5.9	6.08	6.33	6.2	6.2	6.2	6.58	6.64	SMCL	8.5
	Redox (mV)	242	254	239	269	186	210	126	28	175	213	257	238	--	
	Temperature (deg F)	57.7	60.4	59.2	59.3	64.4	60.7	65.7	64.5	61.4	64.6	60.4	59.7	--	
RADS (pCi/L)	Alpha activity	ND	ND	ND	ND	ND	3.8	ND	ND	ND	ND	3.53	ND	MCL	15
	Beta activity	6.99	27.5	10.5	4.47	**71.9**	**153**	7.31	ND	**63.6**	9.64	23.4	**65.3**	MCL	50
	Radon	ND	ND	ND	ND	117	138	ND	177	163	145	ND	ND	--	
	Technetium-99	ND	37	18.2	ND	111	193	ND	17.4	90.6	ND	35.1	90	TTL	900
VOA (µg/L)	*cis*-1,2-Dichloroethene	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	ND	ND	SMCL	70
	Trichloroethene	**7.3**	**90**	**27**	**5.8**	**120**	**580**	**5.3**	**140**	**550**	**8.8**	**69**	**260**	MCL	5
WETCHEM	Alkalinity (mg/L)	NA	NA	NA	NA	40	30	NA	NA	NA	NA	NA	26	--	
	Conductivity	343	332	321	321	406	316	280	379	290	295	324	371	--	
	Silica (mg/L)	NA	NA	NA	NA	16	15	NA	NA	NA	NA	NA	16	--	
	Total Organic Carbon (mg/L)	NA	NA	NA	NA	1.1	ND	NA	NA	NA	NA	NA	NA	--	
	Turbidity (NTU)	**17**	3.3	**9.7**	**7.6**	**147**	**5.7**	3.9	**121**	3.1	**16.1**	**10.2**	**6.2**	MCL	5

NA – not analyzed
ND – not detected
MCL – maximum contaminant level
SMCL – Secondary MCL
TTL – Target treatment level for Northwest Plume
VOA – volatile organic analyte
-- – No reference value for this parameter
Bold – Exceeds Criteria

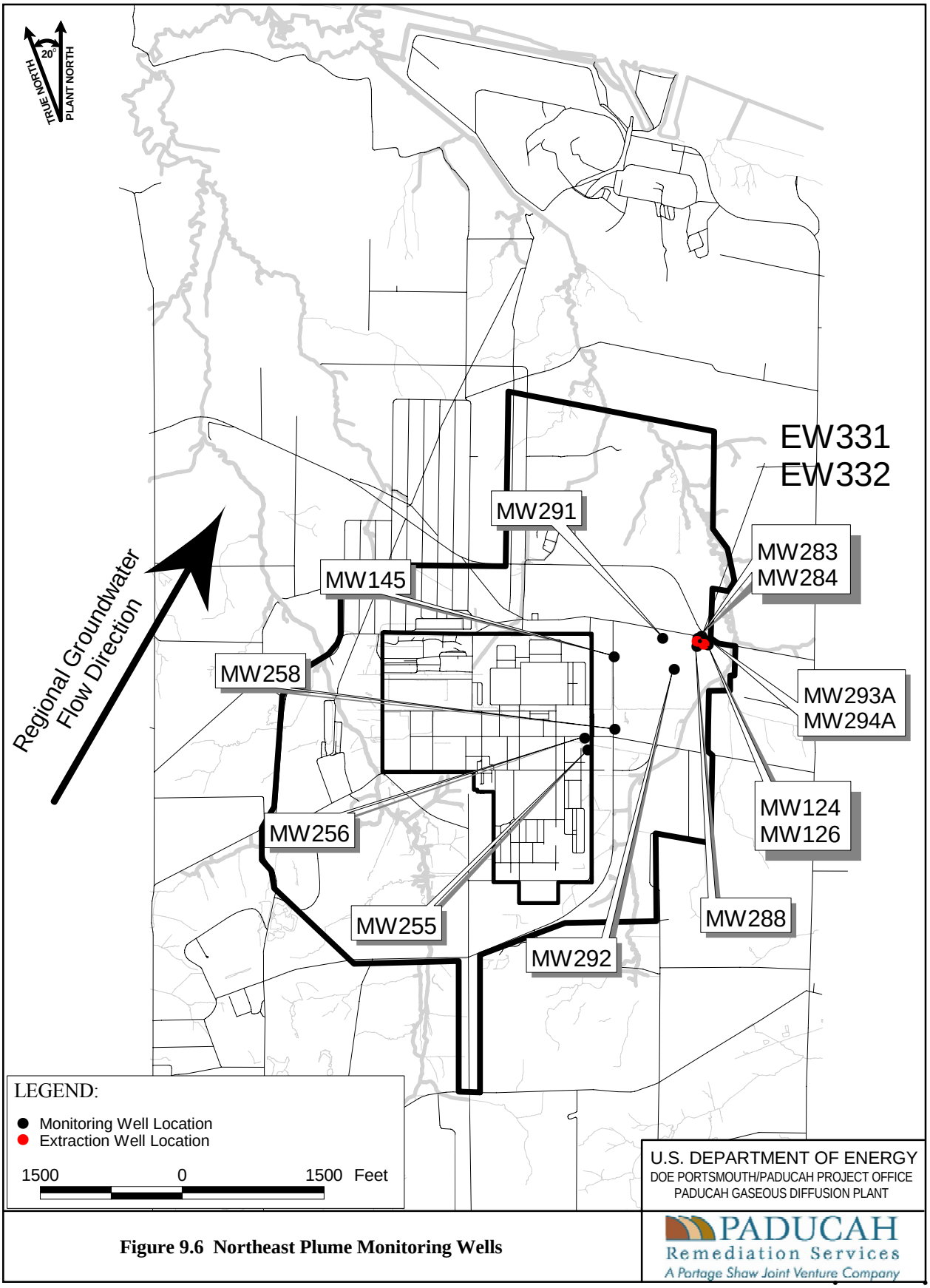

Figure 9.6 Northeast Plume Monitoring Wells

Table 9.8. Summary of Maximum Groundwater Results from the Northeast Plume Groundwater Monitoring for 2006

	Parameter	MW 124	MW 126	MW 145	MW 255	MW 256	MW 258	MW 283	MW 288	MW 291	MW 292	MW 293A	Reference/ Value	
ANION (mg/L)	Chloride	NA	NA	86	61	56	44	NA	68	59	58	NA	SMCL	250
	Fluoride	NA	NA	0.18	0.25	0.24	0.23	NA	0.15	0.14	0.18	NA	MCL	4
	Nitrate as Nitrogen	NA	NA	1	ND	ND	1.1	NA	1.1	1.3	1.2	NA	MCL	10
	Sulfate	NA	NA	98	39	25	27	NA	19	6.5	19	NA	--	
METAL (mg/L)	Aluminum	NA	NA	ND	**2.06**	ND	ND	NA	ND	**0.293**	ND	NA	SMCL	0.2
	Arsenic	NA	NA	ND	0.0026	0.0015	0.0014	NA	0.0013	0.0014	0.0011	NA	MCL	0.05
	Barium	NA	NA	0.0592	0.175	0.189	0.157	NA	0.258	0.214	0.213	NA	MCL	2
	Calcium	NA	NA	47.8	29.9	27.9	23.9	NA	31.2	21.9	27.5	NA	--	
	Chromium	NA	NA	0.0238	0.0108	ND	0.0117	NA	1.44	0.0252	ND	NA	MCL	0.1
	Cobalt	NA	NA	ND	0.007	0.0048	ND	NA	ND	ND	ND	NA	--	
	Copper	NA	NA	ND	ND	ND	ND	NA	0.0253	ND	ND	NA	SMCL	1.3
	Iron	NA	NA	**0.353**	**2.4**	0.107	0.179	NA	**9.1**	0.258	ND	NA	SMCL	0.3
	Iron (2+)	NA	NA	0.02	0.56	0	0	NA	0.3	0.03	0.01	NA	--	
	Magnesium	NA	NA	19	11.9	10.9	9.15	NA	12.5	8.84	11	NA	--	
	Manganese	NA	NA	ND	**1.71**	**0.247**	ND	NA	ND	0.0153	ND	NA	SMCL	0.05
	Molybdenum	NA	NA	ND	0.002	0.0017	ND	NA	0.124	0.0022	ND	NA	--	
	Nickel	NA	NA	0.0056	ND	ND	ND	NA	0.0765	0.0083	ND	NA	--	
	Potassium	NA	NA	5.72	2.06	1.97	1.93	NA	1.87	1.6	1.85	NA	--	
	Selenium	NA	NA	0.0054	0.0084	0.0064	0.0096	NA	0.0071	0.0078	0.0097	NA	MCL	0.05
	Sodium	NA	NA	68.7	85.7	64.9	63.8	NA	44.9	36.4	51.5	NA	--	
	Zinc	NA	NA	ND	ND	ND	ND	NA	0.0235	ND	ND	NA	SMCL	5
METAL-D (mg/L)	Arsenic, Dissolved	NA	NA	ND	0.0012	0.0011	ND	NA	ND	ND	ND	NA	--	
	Barium, Dissolved	NA	NA	0.0584	0.155	0.19	0.154	NA	0.248	0.215	0.214	NA	--	
	Calcium, Dissolved	NA	NA	45.6	30.2	28.2	23.8	NA	31.5	21.8	28.2	NA	--	
	Cobalt, Dissolved	NA	NA	ND	0.0061	0.0047	ND	NA	ND	ND	ND	NA	--	
	Iron, Dissolved	NA	NA	ND	0.678	ND	ND	NA	ND	ND	ND	NA	--	
	Magnesium, Dissolved	NA	NA	18.3	11.7	11.3	9.19	NA	12.8	8.9	11.3	NA	--	
	Manganese, Dissolved	NA	NA	ND	1.76	0.237	ND	NA	ND	0.0166	ND	NA	--	
	Molybdenum, Dissolved	NA	NA	ND	0.0013	ND	ND	NA	0.0064	ND	ND	NA	--	
	Nickel, Dissolved	NA	NA	ND	ND	ND	ND	NA	0.0184	ND	ND	NA	--	
	Potassium, Dissolved	NA	NA	5.38	1.69	1.79	1.76	NA	1.9	1.38	1.72	NA	--	
	Selenium, Dissolved	NA	NA	ND	0.0053	ND	0.0075	NA	0.0066	0.0051	0.0079	NA	--	
	Sodium, Dissolved	NA	NA	66.6	88.3	66.6	64.7	NA	45.3	36.9	53.5	NA	--	
PHYSC	Depth to Water (ft)	41.71	41.14	56.04	61.18	62.25	60.83	46.49	49.32	46.84	53.58	43.02	--	
	Dissolved Oxygen (mg/L)	2.87	2.91	2.21	1.3	1.4	2.07	3.71	3.4	5.01	2.65	3.6	--	
	Dissolved Solids (mg/L)	ND	ND	417	377	304	274	ND	275	219	273	ND	SMCL	500
	pH (Std Units)	6.6	6.6	6.42	6.39	6.52	6.6	6.4	6.12	6	6.3	6.01	SMCL	8.5
	Redox (mV)	221	236	263	210	280	270	260	266	263	265	213	--	
	Temperature (deg F)	59.1	59.3	63.9	66.8	68.9	63.2	61.5	62.1	59.4	65	60.9	--	
RADS (pCi/L)	Beta activity	4.85	ND	24.5	6.33	**124**	6.99	5.77	35.2	6.43	40.7	4.55	MCL	50
	Technetium-99	ND	ND	33.5	152	169	20.6	ND	55.1	18	54.6	19.5	TTL	900
VOA (µg/L)	1,1-Dichloroethene	ND	ND	ND	ND	**130**	ND	ND	**21**	ND	**34**	ND	MCL	7
	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	5.3	ND	ND	ND	ND	SMCL	70
	Trichloroethene	**52**	3.4	**75**	**500**	**740**	**400**	**120**	**240**	**97**	**370**	**440**	MCL	5
WET-CHEM	Alkalinity (mg/L)	NA	NA	50	40	24	32		70	50	40	NA	--	
	Conductivity (umho/cm)	415	391	768	673	561	514	470	504	393	498	369	--	
	Silica (mg/L)	NA	NA	15	13	14	14	NA	15	14	14	NA	--	
	Total Organic Carbon (mg/L)	NA	NA	1.1	1.2	1	NA	NA	NA	NA	NA	NA	--	
	Turbidity (NTU)	**66.5**	**40.8**	**24.9**	**65.7**	**11.6**	**8**	**12**	**103**	**12.6**	3.1	2.9	MCL	5

MCL – maximum contaminant level
NA – not analyzed
ND – not detected
SMCL – Secondary MCL
TTL – Target treatment level for Northwest Plume
VOA – volatile organic analyte
-- – No reference value for this parameter
Bold – **Exceeds Criteria**

10 Quality Assurance

Abstract

The Paducah Site maintains a Quality Assurance/Quality Control (QA/QC) Program to verify the integrity of data generated within the Environmental Monitoring Program. Sampling methods, instruments, locations, schedules, and other sampling and monitoring criteria are based on applicable guidelines from various established authorities.

Introduction

The Paducah Site maintains a QA/QC Program to verify the integrity of data generated within the Environmental Monitoring Program. Each aspect of the monitoring program, from sample collection to data reporting, must comply with quality requirements and assessment standards. Requirements and guidelines for the QA/QC Program at the Paducah Site are established by DOE Order 414.1C, *Quality Assurance;* state and federal regulations; and guidance from the EPA, the American National Standards Institute, the American Society of Mechanical Engineers, the American Society of Testing and Materials (ASTM), and the American Society for Quality Control. The QA/QC Program specifies organizational and programmatic elements to control equipment, design, documents, data, nonconformances, and records. Emphasis is placed on planning, implementing, and assessing activities. Program requirements are specified in project and subcontract documents to ensure that requirements are included in project-specific QA plans and other planning documents.

In 2006, two separate EMPs defined the relationship of each element of the Environmental Monitoring Program. The FY 2006 EMP was in effect and covered data collected during the time frame of January 2006 to September 2006. The FY 2007 EMP was in effect and covered data collected during the time frame of October 2006 to December 2006. In 2006, two separate QA plans defined the relationship of each element of the Environmental Monitoring Program to key quality and data management requirements. The *Environmental Monitoring Quality Assurance and Data Management Plan* (EQADMP) in the FY 2006 EMP was in effect and covered data collected during the time frame of January through September 2006. The EQADMP in the FY 2007 EMP covered October through December 2006. Training requirements, sample custody, procedures, instrument calibration and maintenance, and data review are a few of the subjects discussed in the two QA plans.

Field Sampling Quality Control

Data Quality Objectives and Sample Planning

From the start of any sampling program, data quality objectives (DQOs) play an important role. The number of samples, location of sampling sites, sampling methods, sampling schedules, and coordination of sampling and analytical resources to meet critical completion times are documented in the Paducah Site EMP (PRS 2006c).

Each sampling location and sample collected is assigned a unique identification number. Each segment of the identification number sequence is used to designate information concerning the location from which a sample is collected. To progress from planning to implementing the DQOs, an analytical statement of work (SOW) for the analytical laboratory is generated from a system within the Paducah Integrated Data System. From this system, the Project Environmental Measurements System (PEMS), an electronic database used for managing and streamlining field-generated and laboratory-generated data, is populated with sample identification numbers, sampling locations, sampling methods, analytical parameters, analytical methods, and sample container and preservative requirements. This information is used to produce sample bottle labels and chain-of-custody forms for each sampling event.

Field Measurements

Field measurements for the groundwater and surface water monitoring program are collected in the field and include water level measurements, pH, conductivity, flow rate, turbidity, temperature, dissolved oxygen, total residual chlorine, and barometric pressure. Environmental conditions, such as ambient temperature and weather, also are recorded. Field measurements are collected and are downloaded electronically, recorded on appropriate field forms or recorded in logbooks, and input into PEMS.

Sampling Procedures

Samples are collected using media-specific procedures, which are written according to EPA-approved sampling methods. Sample media consist of surface water, groundwater, sediment, and biota, such as fish and deer. Sample information recorded during a sampling event consists of the sample identification number, station (or location), date collected, time collected, and person who performed the sampling, etc. This information is documented in a logbook, on a chain-of-custody form, and on the sample container label, which then is input directly into PEMS. Chain-of-custody forms are maintained from the point of sampling, and the samples are protected properly until they are placed in the custody of an analytical laboratory.

Field Quality Control Samples

The QC program for both groundwater and environmental monitoring activities specifies a minimum target rate of 5 percent, or one per 20 environmental samples, for field QC samples. Table 10.1 shows the types of field QC samples collected and analyzed. Analytical results of field QC samples are evaluated to determine if the sampling event had any effect on the sample results.

Table 10.1. Types of QC Samples

Field QC Samples	Laboratory QC Samples
Field blanks[a]	Laboratory duplicates
Field duplicates	Reagent blanks
Trip blanks[a]	Matrix spikes[b]
Equipment rinseates	Matrix spike duplicates
	Surrogates
	Performance evaluations
	Laboratory control samples

[a] Blanks–Samples of deionized water used to assess potential contamination from a source other than the media being sampled.

[b] Spikes–Samples that have been mixed with a known quantity of a chemical to measure instrument effectiveness during the analysis process.

Analytical Laboratory Quality Control

Analytical Procedures

When available and appropriate for the sample matrix, EPA-approved SW-846 methods are used for sample analysis. When SW-846 methods are not available, other nationally recognized methods, such as those developed by DOE and ASTM, are used. Analytical methods are identified in a SOW for laboratory services. Using guidance from EPA, laboratories document the steps in sample handling, analysis, reporting results, and follow chain-of-custody procedures.

Laboratory Quality Control Samples

Laboratory QC samples are prepared and analyzed as required by the analytical methods used. Typical laboratory QC samples are identified in Table 10.1. If acceptance criteria are not met for the QC samples, then appropriate action, as denoted by the analytical method, is taken or the analytical data are qualified appropriately.

Independent Quality Control

The Paducah Site is required by DOE and EPA to participate in independent QC programs. The site also participates in voluntary independent programs to improve analytical QC. These programs generate data that readily are recognized as objective measures that allow participating laboratories and government agencies a periodic review of their performance. Results that exceed acceptable limits are investigated and documented according to formal procedures. Although participation in certain programs is mandatory, the degree of participation is voluntary, so that each laboratory can select parameters of particular interest to that facility. These programs are conducted by EPA, DOE, and commercial laboratories. The laboratories supporting the Paducah DOE KPDES program participate in a Discharge Monitoring Report QA Study conducted annually by EPA. During 2006, the laboratories provided acceptable results on all requested parameters, with the exception of Total Suspended Solids. A corrective action report was submitted to EPA in December 2006.

Laboratory Audits/Sample Management Office

Laboratory audits are performed annually by the DOE Consolidated Audit Program (DOECAP) to ensure that the laboratories are in compliance with regulations, methods, and procedures. The audited laboratories are included on the DOECAP-approved listing for use by the Sample Management Office (SMO). Findings are documented and addressed by the audited laboratory through corrective actions.

Data Management

Project Environmental Measurements System

The data generated from sampling events are stored in PEMS, a consolidated site data system for tracking and managing data. The system is used to manage field-generated data, import laboratory generated data, input data qualifiers identified during the data review process, and transfer data to the Paducah OREIS database for reporting. PEMS uses a variety of references and code lists to ensure consistency and standardization of the data.

Paducah OREIS

Paducah OREIS is the database used to consolidate data generated by the EM Program. Data consolidation consists of the activities necessary to prepare the evaluated data for the users. The PEMS files containing the assessed data are transferred from PEMS to Paducah OREIS for future use. The data manager is responsible for notifying the project team and other data users of the available data. Data used in reports distributed to external agencies (e.g., the quarterly landfill reports, the ASER, and the Biological Monitoring Program reports) are obtained from Paducah OREIS and have been through the data review process. (The data review process is documented in *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management*

and Enrichment Facilities, DOE/OR/07-1595&D2, Section 8.4 (DOE 1998b).

Electronic Data Deliverables

A "results only" Electronic Data Deliverable (EDD) is requested for all samples analyzed by each laboratory. The results and qualifier information from the EDD are checked in addition to the format of all fields provided. Discrepancies are reported immediately to the laboratory so corrections can be made or new EDDs can be issued. Approximately 10 percent of the EDDs are randomly checked to verify that the laboratory continues to provide adequate EDDs.

Data Packages

A "forms only" Level III data package is requested from the laboratory when data validation is to be performed on a specific sampling event or media. All data packages received from the fixed base laboratory are tracked, reviewed, and maintained in a secure environment. The following information is tracked: sample delivery group number, date received, number of samples, sample analyses, receipt of any EDD, and comments. The contents of the data package and the chain-of-custody forms are compared and discrepancies identified. Discrepancies are reported immediately to the laboratory and data validators. All data packages are forwarded to the PGDP Document Management Center for permanent storage.

Laboratory Contractual Screening

Laboratory contractual screening is the process of evaluating a set of data against the requirements specified in the analytical SOW to ensure that all requested information is received. The contractual screening includes, but is not limited to, the chain-of-custody form, number of samples, analytes requested, total number of analyses, method used, QC samples analyzed, EDDs, units, holding times, and reporting limits achieved. The contractual screening is conducted electronically upon receipt of data from the analytical laboratory. Any exception to the SOW is identified and documented.

Data Verification, Validation, and Assessment

Data verification is the process for comparing a data set against a set standard or contractual requirement. Verification is performed electronically, manually, or by a combination of both. Data verification includes contractual screening and other criteria specific to the data. Data are flagged as necessary. Verification qualifiers are stored in PEMS and transferred with the data to Paducah OREIS.

Data validation is the process performed by a qualified individual for a data set, independent from sampling, laboratory, project management, or other decision-making personnel. Data validation evaluates the laboratory adherence to analytical method requirements. Validation qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Data from routine sampling events are validated programmatically at a frequency of 5 percent of the total data packages. Each of the selected data packages, which make up 5 percent of the total number of data packages, is validated 100 percent.

Data assessment is the process for assuring that the type, quality, and quantity of data are appropriate for their intended use. It allows for the determination that a decision (or estimate) can be made with the desired level of confidence, given the quality of the data set. Data assessment follows data verification and data validation (if applicable) and must be performed at a rate of 100 percent to ensure data are useable. The data assessment is conducted by trained technical personnel in conjunction with other project team members. Assessment qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Data are made available for reporting from Paducah OREIS upon completion of the data assessment, and associated documentation is filed with the project files.

The EPA and KDOW require, as part of their QA program, a laboratory QA study. Each laboratory performing analyses to demonstrate KPDES permit compliance is required to participate. Two laboratories and one sampling organization participated in the study in 2006. Final

results for the Discharge Monitoring Report QA Study Number 26 were "acceptable," with the exception of Total Suspended Solids. A corrective action report was submitted to EPA in December 2006. The Discharge Monitoring Report QA Study results were provided to KDOW and EPA, as required.

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Glossary

absorption – The process by which the number and energy of particles or photons entering a body of matter is reduced by interaction with the matter.

adsorption – The accumulation of gases, liquids, or solutes on the surface of a solid or liquid.

activity – See radioactivity.

air stripping – The process of bubbling air through water to remove volatile organic compounds from the water.

alpha particle – A positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (two protons and two neutrons).

ambient air – The atmosphere around people, plants, and structures.

analyte – A constituent or parameter being analyzed.

analytical detection limit – The lowest reasonably accurate concentration of an analyte that can be detected; this value varies depending on the method, instrument, and dilution used.

aquifer – A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

aquitard – A geologic unit that inhibits the flow of water.

assimilate – To take up or absorb.

atom – Smallest particle of an element capable of entering into a chemical reaction.

beta particle – A negatively charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

biota – The animal and plant life of a particular region considered as a total ecological entity.

CERCLA-reportable release – A release to the environment that exceeds reportable quantities as defined by the Comprehensive Environmental Response, Compensation, and Liability Act.

chain-of-custody form – A form that documents sample collection, transport, analysis, and disposal.

closure – Formal shutdown of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

compliance – Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

concentration – The amount of a substance contained in a unit volume or mass of a sample.

conductivity – A measure of a material's capacity to convey an electric current. For water, this property is related to the total concentration of the ionized substances in water and the temperature at which the measurement is made.

confluence – The point at which two or more streams meet; the point where a tributary joins the main stream.

congener – Any particular member of a class of chemical substances. A specific congener is denoted by a unique chemical structure.

contained landfill – A solid waste site or facility that accepts disposal of solid waste. The technical requirements for contained landfills are found in 401 *KAR* 47:080, 48:050, and 48:070 to 48:090.

contamination – Deposition of unwanted material on the surfaces of dissolved into structures, areas, objects, or personnel.

cosmic radiation – Ionizing radiation with very high energies that originates outside the earth's atmosphere. Cosmic radiation is one contributor to natural background radiation.

curie (Ci) – A unit of radioactivity. One curie is defined as 3.7 x 10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are used commonly:

- **kilocurie (kCi)** – 10^{3} Ci, one thousand curies; 3.7 x 10^{13} disintegrations per second.
- **millicurie (mCi)** – 10^{-3} Ci, one-thousandth of a curie; 3.7 x 10^{7} disintegrations per second.
- **microcurie (µCi)** – 10^{-6} Ci, one-millionth of a curie; 3.7 x 10^{4} disintegrations per second.
- **picocurie (pCi)** – 10^{-12} Ci, one-trillionth of a curie; 3.7 x 10^{-2} disintegrations per second.

daughter – A nuclide formed by the radioactive decay of a parent nuclide.

decay, radioactive – The spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide or into a different energy state of the same radionuclide.

dense nonaqueous-phase liquid (DNAPL) – The liquid phase of chlorinated organic solvents. These liquids are denser than water and include commonly used industrial compounds such as tetrachloroethylene and trichloroethylene.

derived concentration guide (DCG) – The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and the lens of the eye. The guidelines for radionuclides in air and water are given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

disintegration, nuclear – A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

dose – The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

- **absorbed dose** – The quantity of radiation energy absorbed by an organ divided by the organ's mass. Absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 Gy).
- **dose equivalent** – The product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 Sv).
- **committed dose equivalent** – The calculated total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. Contributions from external dose are not included. Committed dose equivalent is expressed in units of rem (or sievert).
- **committed effective dose equivalent** – The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).
- **effective dose equivalent** – The sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body.
- **collective dose equivalent/collective effective dose equivalent** – The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within a 50-mile (80-km) radius expressed in units of person-rem (or person-

sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or DOE program activities.

downgradient – In the direction of decreasing hydrostatic head.

downgradient well – A well that is installed hydraulically downgradient of a site and that may be capable of detecting migration of contaminants from a site.

drinking water standards (DWS) – Federal primary drinking water standards, both proposed and final, as set forth by the EPA in 40 *CFR* § 141 and 40 *CFR* § 143.

effluent – A liquid or gaseous waste discharge to the environment.

effluent monitoring – The collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying the release of contaminants, assessing radiation exposures to members of the public, and demonstrating compliance with applicable standards.

Environmental Restoration – A DOE program that directs the assessment and cleanup of its sites (remediation) and facilities (decontamination and decommissioning) contaminated with waste as a result of nuclear-related activities.

exposure (radiation) – The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is that exposure to ionizing radiation received at a person's workplace. Population exposure is the exposure to the total number of persons who inhabit an area.

external radiation – Exposure to ionizing radiation when the radiation source is located outside the body.

fauna – The population of animals in a given area, environment, formation, or time span.

flora – The population of plants in a given area, environment, formation, or time span.

formation – A mappable unit of consolidated or unconsolidated geologic material of a characteristic lithology or assemblage of lithologies.

gamma ray – High-energy, short-wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma rays are identical to X-rays except for the source of the emission.

Gaussian puff/plume model – A computer-simulated atmospheric dispersion of a release using a Gaussian (normal) statistical distribution to determine concentrations in air.

grab sample – A sample collected instantaneously with a glass or plastic bottle placed below the water surface to collect surface-water samples (also called dip samples).

groundwater, unconfined – Water that is in direct contact with the atmosphere through open spaces in permeable material.

half-life, radiological – The time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

hardness – The amount of calcium carbonate dissolved in water, usually expressed as part of calcium carbonate per million parts of water.

high-level waste - High-level radioactive waste or HLW means: (1) Irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

hydrogeology – Hydraulic aspects of site geology.

hydrology – The science dealing with the properties, distribution, and circulation of natural water systems.

in situ – In its original place; field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

internal dose factor – A factor used to convert intakes of radionuclides to dose equivalents.

internal radiation – Occurs when natural radionuclides enter the body by ingestion of foods or liquids or by inhalation. Radon is the major contributor to the annual dose equivalent for internal radionuclides.

ion – An atom or compound that carries an electrical charge.

irradiation – Exposure to radiation.

isotopes – Forms of an element having the same number of protons but differing numbers of neutrons in their nuclei.

- **long-lived isotope** – A radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).

- **short-lived isotope** – A radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

lower limit of detection – The smallest concentration or amount of analyte that can be reliably detected in a sample at a 95 percent confidence level.

maximally exposed individual – A hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

migration – The transfer or movement of a material through air, soil, or groundwater.

milliroentgen (mR) – A measure of X-ray or gamma radiation. The unit is one-thousandth of a roentgen.

minimum detectable concentration – The smallest amount or concentration of a radionuclide that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level.

monitoring – Process whereby the quantity and quality of factors that can affect the environment or human health are measured periodically to regulate and control potential impacts.

mrem – The dose equivalent that is one-thousandth of a rem.

natural radiation – Radiation from cosmic and other naturally occurring radionuclide (such as radon) sources in the environment.

nuclide – An atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

outfall – The point of conveyance (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

part per billion (ppb) – A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or mg/mL.

part per million (ppm) – A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

pathogen – A disease-producing agent; usually refers to living organisms.

person-rem – Collective dose to a population group. For example, a dose of 1 rem to 10 individuals results in a collective dose of 10 person-rem.

pH – A measure of the hydrogen-ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 6, neutral solutions have a pH equal to 7, and basic solutions have a pH greater than 7.

piezometer – An instrument used to measure the hydraulic potential of groundwater at a given point; also, a well designed for this purpose.

polychlorinated biphenyl (PCB) - Any chemical substance that is limited to the biphenyl molecule and that has been chlorinated to varying degrees.

polynuclear aromatic hydrocarbon (PAH) – Any organic compound composed of more than one benzene ring.

process water – Water used within a system process.

purge – To remove water before sampling, generally by pumping or bailing.

quality assurance (QA) – Any action in environmental monitoring to ensure the reliability of monitoring and measurement data.

quality control (QC) – The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes.

quality factor – The factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage to exposed persons. A quality factor is used because some types of radiation, such as alpha particles, are more biologically damaging than others.

rad – An acronym for Radiation Absorbed Dose. The rad is a basic unit of absorbed radiation dose. (This is being replaced by the "gray," which is equivalent to 100 rad.)

radiation detection instruments – Devices that detect and record the characteristics of ionizing radiation.

radioactivity – The spontaneous emission of radiation, generally alpha or beta particles or gamma rays, from the nucleus of an unstable isotope.

radioisotopes – Radioactive isotopes.

radionuclide – An unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

reference material – A material or substance with one or more properties that is sufficiently well established and used to calibrate an apparatus, to assess a measurement method, or to assign values to materials.

release – Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem – The unit of dose equivalent (absorbed dose in rads multiplied by the radiation quality factor). Dose equivalent is frequently reported in units of millirem (mrem), which is one-thousandth of a rem.

remediation – The correction of a problem. See Environmental Restoration.

Resource Conservation and Recovery Act (RCRA) – Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes.

RFI Program – RCRA Facility Investigation Program; EPA-regulated investigation of a solid waste management unit with regard to its potential impact on the environment.

roentgen – A unit of exposure from X-rays or gamma rays. One roentgen equals 2.58×10^{4} coulombs per kilogram of air.

screen zone – In well construction, the section of a formation that contains the screen, or perforated pipe, that allows water to enter the well.

semivolatile organic analyte (SVOA) – Any organic compound with a high boiling point which will volatilize upon heating.

sievert (Sv) – The SI (International System of Units) unit of dose equivalent; 1 Sv = 100 rem.

slurry – A suspension of solid particles (sludge) in water.

source – A point or object from which radiation or contamination emanates.

specific conductance – The ability of water to conduct electricity; this ability varies in proportion to the amount of ionized minerals in the water.

stable – Not radioactive or not easily decomposed or otherwise modified chemically.

storm-water runoff – Surface streams that appear after precipitation.

strata – Beds, layers, or zones of rocks.

substrate – The substance, base, surface, or medium in which an organism lives and grows.

surface water – All water on the surface of the earth, as distinguished from groundwater.

suspended solids – Mixture of fine, nonsettling particles of any solid within a liquid or gas.

terrestrial radiation – Ionizing radiation emitted from radioactive materials, primarily ^{40}K, thorium, and uranium, in the earth's soils. Terrestrial radiation contributes to natural background radiation.

thermoluminescent dosimeter (TLD) – A device used to measure external gamma radiation.

total activity – The total quantity of radioactive decay particles that are emitted from a sample.

total solids – The sum of total dissolved solids and suspended solids.

total suspended particulates – Refers to the concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

transuranic element (TRU) – An element above uranium in the Periodic Table, that is, with an atomic number greater than 92. All 11 TRUs are produced artificially and are radioactive. They are neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium.

troughing system – A collection and containment system designed to collect leaks of oil that have been contaminated with PCBs.

turbidity – A measure of the concentration of sediment or suspended particles in solution.

upgradient – In the direction of increasing hydrostatic head.

vadose zone – Soil zone located above the water table.

volatile organic compound (VOC) – Any organic compound which has a low boiling point and readily volatilizes into air (e.g., trichloroethane, tetrachloroethylene, and trichloroethylene).

watershed – The region draining into a river, river system, or body of water.

wetland – A lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted to life in saturated soils.

Appendix A: Radiation

This appendix provides basic information about radiation. This information is intended to be a basis for understanding normal radiation dose from sources unassociated with the Paducah Site. People are constantly exposed to radiation. For example, radon in air; potassium in food and water; and uranium, thorium, and radium in the earth's crust are all sources of radiation. The following discussion describes important aspects of radiation, including atoms and isotopes; types, sources, and pathways of radiation; radiation measurement; and dose information.

ATOMS AND ISOTOPES

All matter is made up of **atoms**. The atom is thought to consist of a dense central nucleus surrounded by a cloud of electrons. The nucleus is composed of protons and neutrons. Table A.1 summarizes the basic components of an atom. In an electrically neutral atom, the number of protons equals the number of electrons. Atoms can lose or gain electrons through ionization. The number of protons in the nucleus determines an element's atomic number, or chemical identity. With the exception of hydrogen, the nucleus of each type of atom also contains at least one neutron. Unlike protons, the number of neutrons may vary among atoms of the same element. The number of neutrons and protons determines the atomic weight of the atom.

Atoms of the same element with a different number of neutrons are called **isotopes**. Isotopes have the same chemical properties but different atomic weights. Figure A.1 depicts isotopes of the element hydrogen. Uranium, which has 92 protons, is another example of an element that has isotopes. All isotopes of uranium have 92 protons; however, each uranium isotope has a different number of neutrons. Uranium-234 has 92 protons and 142 neutrons; ^{235}U has 92 protons and 143 neutrons; and ^{238}U has 92 protons and 146 neutrons.

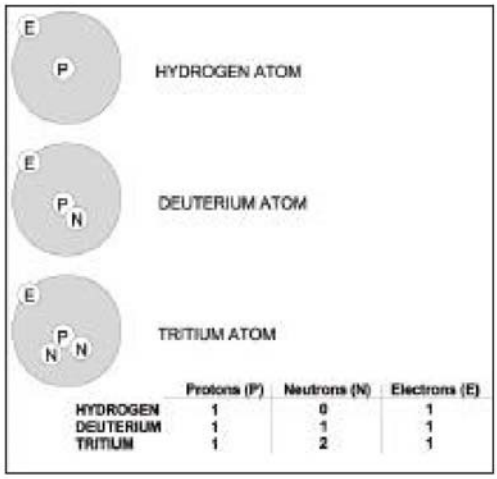

Figure A.1.Isotopes of the Element Hydrogen

Table A.1. Summary of the Basic Parts of an Atom

Particle	Location	Charge	Comments
Protons	Nucleus	+ positive	The number of protons determines the element. If the number of protons changes, the element changes.
Neutrons	Nucleus	No charge	Atoms of the same element have the same number of protons, but can have a different number of neutrons. This is called an isotope.
Electrons	Orbit nucleus	– negative	This negative charge is equal in magnitude to the proton's positive charge.

Source: Bechtel Jacobs Company LLC. Radiological Worker I and II Academics Training, Student Handbook, Revision 2.

BASIC INFORMATION ABOUT RADIATION

Radioactivity was discovered in 1896 by the French physicist Antoine Henri Becquerel when he observed that the element uranium can blacken a photographic plate, even when separated from the plate by glass or black paper. In 1898, the French chemists Marie Curie and Pierre Curie concluded that radioactivity is a phenomenon associated with atoms, independent of their physical or chemical state. The Curies measured the heat associated with the decay of radium and established that 1 g (0.035 oz) of radium gives off about 100 cal of energy every hour. This release of energy continues hour after hour and year after year, whereas the complete combustion of a gram of coal results in the production of a total of only about 8,000 cal of energy. Radioactivity attracted the attention of scientists throughout the world, following these early discoveries. In the ensuing decades, many aspects of the phenomenon were thoroughly investigated (Encarta 2002a).

Radiation is energy in the form of waves or particles moving through space. Radiation occurs because unstable atoms give off excess energy to become stable. **Ionization** is the process of removing electrons from neutral atoms. NOTE: Ionization should not be confused with radiation. Ionization is a result of the interaction of radiation with an atom and is what allows the radiation to be detected. **Ionizing radiation** is energy (particles or rays) emitted from radioactive atoms that can cause ionization. Ionizing radiation is capable of displacing electrons and changing the chemical state of matter and, subsequently, causing biological damage; therefore, ionizing radiation is potentially harmful to human health. Examples of ionizing radiation include alpha, beta, and gamma radiation. **Nonionizing radiation** bounces off or passes through matter without displacing electrons. Nonionizing radiation does not have enough energy to ionize an atom. It is unclear whether nonionizing radiation is harmful to human health. Examples include visible light, radar waves, microwaves, and radio waves. **Radioactivity** is the process of unstable or radioactive atoms becoming stable by emitting radiant energy. Radioactivity that occurs over a period of time is called **radioactive decay**. The discovery that radium decays to produce radon proved conclusively that radioactive decay is accompanied by a change in the chemical nature of the decaying element. A **disintegration** is a single atom undergoing radioactive decay. **Radioactive half-life** is the time it takes for one-half of the radioactive atoms present to decay.

TYPES, SOURCES, AND PATHWAYS OF RADIATION

Visible light, heat, radio waves, and alpha particles are examples of radiation. When people feel warmth from the sunlight, they actually are absorbing the radiant energy emitted by the sun. Electromagnetic radiation is radiation in the form of electromagnetic waves; examples include gamma rays, ultraviolet light, and radio waves. Particulate radiation is radiation in the form of particles; examples include alpha and beta particles. The spectrum of particle and electromagnetic radiations ranges from the extremely short wavelengths of cosmic rays and electrons to very long radio waves that are hundreds of kilometers in length. Figure A.2 shows the difference between a longer wavelength and a shorter wavelength. Figure A.3 illustrates the wavelengths of several types of radiation along with an example of something that is approximately the same dimension in length.

The radiation's ability to penetrate material is an important consideration in protecting human health. Adequate shielding decreases the power of radiation by absorbing part or all of it. Figure A.4 shows the different penetrating power of alpha, beta, and gamma rays. Alpha rays are stopped by the thickness of a few sheets of paper or a rubber glove. A few centimeters of wood or a thin sheet of copper stops beta rays. Gamma rays and X-rays require thick shielding of a heavy material, such as iron, lead, or concrete (Encarta 2002b).

Radiation is everywhere. Most occurs naturally, but a small percentage is from humanmade sources. Naturally occurring radiation is

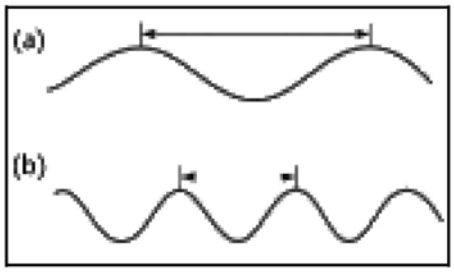

Figure A.2. Comparison between Longer (a) and Shorter (b) Wavelengths[1]

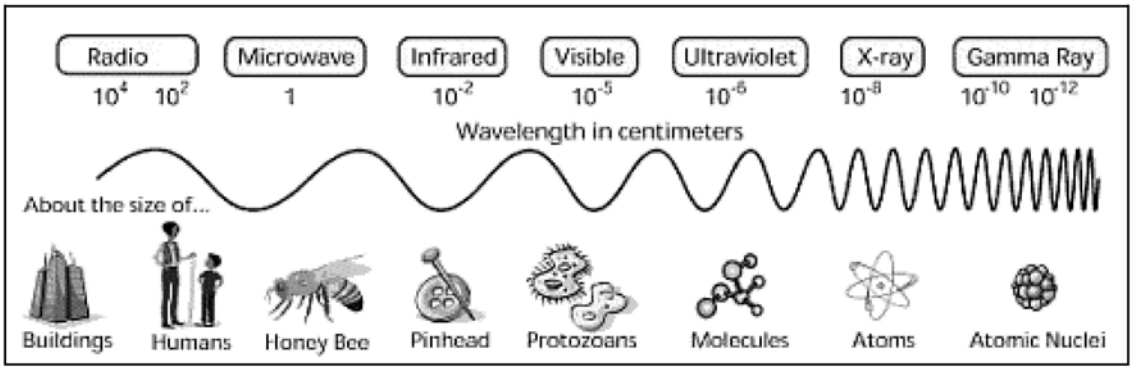

Figure A.3. The Approximate Wavelengths of the Various Regions of the Electromagnetic Spectrum and an Example of Something That Is Approximately the Same Size[2]

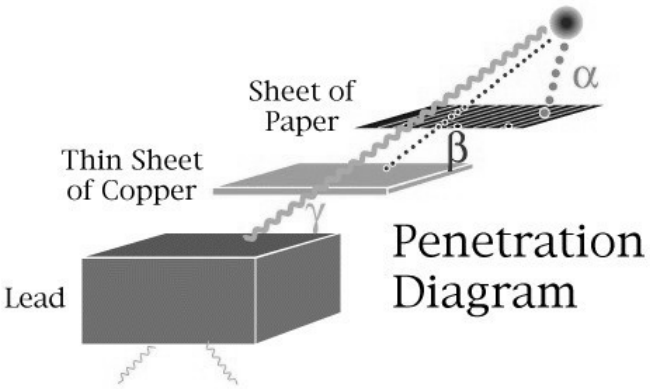

Figure A.4. The Penetrating Potential of the Three Types of Ionizing Radiation: Alpha (α), Beta (β), and Gamma (γ)[3]

[1] ("Electromagnetic…" 2002, Appendix A references)
[2] ("Exploring …" 2002, Appendix A references)
[3] ("Experiment…" 2002, Appendix A references)

identical to the radiation resulting from human-made sources.

Naturally occurring radiation is known as **background radiation**. In fact, this naturally occurring radiation is the major source of radiation in the environment. People have little control over the amount of background radiation to which they are exposed. Background radiation remains relatively constant over time. The amount of background radiation present in the environment today is much the same as it was hundreds of years ago. Sources of background radiation include uranium in the earth, radon in the air, and potassium in food. Depending on its origin, background radiation is categorized as cosmic, terrestrial, or internal. **Cosmic radiation** comes from the sun and outer space and is made up of energetically charged particles from that continuously hit the earth's atmosphere. Because the atmosphere provides some shielding against cosmic radiation, the intensity of cosmic radiation increases with altitude above sea level. Therefore, a person in Denver, Colorado, is exposed to more cosmic radiation than a person in Paducah, Kentucky. **Terrestrial radiation** refers to radiation emitted from radioactive materials in the earth's rocks, soils, and minerals. Radon (Rn); radon progeny, the relatively short-lived decay products of radium-235 (^{235}Ra); potassium (^{40}K); isotopes of thorium (Th); and isotopes of uranium (U) are the elements responsible for most terrestrial radiation. **Internal radiation** is radiation that is inside the body and is in close contact with body tissue. Internal radiation can deposit large amounts of energy in a small amount of tissue. Radioactive material in the environment enters the body through the air people breathe, the food they eat, and even through an open wound. Natural radionuclides in the body include isotopes of U, Th, Ra, Rn, Pu, bismuth (Bi), and lead in the ^{238}U and ^{212}Th decay series.

In addition, the body contains isotopes of sodium-24 (^{24}Na), ^{40}K, rubidium (Rb), and carbon-14 (^{14}C). Most of our internal exposure comes from ^{40}K. In addition to background radiation, there are human-made sources of radiation to which most people are exposed. Examples include consumer products, medical sources, and other sources. Some **consumer products** are sources of radiation. In some of these products, such as smoke detectors and airport X-ray baggage inspection systems, the radiation is essential to the performance of the device. In other products, such as televisions and tobacco products, the radiation occurs incidentally to the product function. **Medical sources** of radiation account for the majority of the exposure people receive from human-made radiation. Radiation is an important tool of diagnostic medicine and treatment. Exposure is deliberate and directly beneficial to the patients exposed. Generally, diagnostic or therapeutic medical exposures result from X-ray beams directed to specific areas of the body. Thus, all body organs generally are not irradiated uniformly.

Radiation and radioactive materials are also used in a wide variety of pharmaceuticals and in the preparation of medical instruments, including the sterilization of heat-sensitive products such as plastic heart valves. Nuclear medical examinations and treatment involve the internal administration of radioactive compounds, or radiopharmaceuticals, by injection, inhalation, consumption, or insertion. Even then, radionuclides are not distributed uniformly throughout the body. **Other sources** of radiation include fallout from atmospheric atomic weapons tests; emissions of radioactive materials from nuclear facilities such as uranium mines, fuel processing plants, and nuclear power plants; emissions from mineral extraction facilities; and transportation of radioactive materials. Atmospheric testing of atomic weapons has been suspended. About one-half of 1 percent of the United States population performs work in which radiation in some form is present. Radiation and radioactive material in the environment can reach people through many routes. Potential routes for radiation are referred to as **pathways**. Several radiation pathways are shown in Figure A.5. For example, radioactive material in the air could fall on a pasture. Cows could then eat the grass, and the radioactive material on the grass would show up in the cow's milk. People drinking the milk would thus be exposed to this radiation, or people could simply inhale the radioactive material in the air. The same events could occur with radioactive material in water. Fish living in the water would

be exposed. People eating the fish would then be exposed to the radiation in the fish, or people swimming in the water would be exposed.

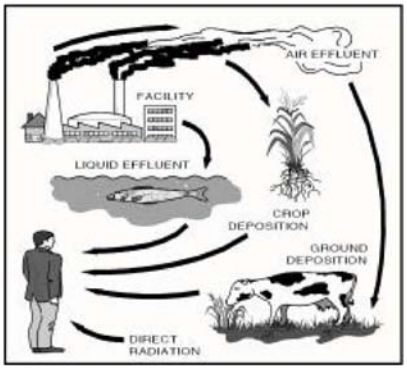

Figure A.5. Possible Radiation Pathways

MEASURING RADIATION

To determine the possible effects of radiation on the environment and the health of people, the radiation must be measured. More precisely, its potential to cause damage must be determined. When measuring the amount of radiation in the environment, what actually is being measured is the rate of radioactive decay, or **activity**. The rate of decay varies widely among the various radioisotopes. For that reason, 1 g of one radioactive substance may contain the same amount of activity as several tons of another substance. Activity is measured by the number of disintegrations a radioactive material undergoes in a certain period of time. In the United States, activity is expressed in a unit of measure known as a **curie (Ci)**. In the international system of units, activity is expressed in a unit of measure known as a **becquerel (Bq)**. One disintegration per second (dps) equals one becquerel (Bq). One curie equals:

- 37,000,000,000 atom disintegrations per second ($3.7x10^{10}$ dps)
- 37,000,000,000 becquerels ($3.7x10^{10}$ Bq)
- 1,000,000 microcuries ($1x10^{6}$ µCi)

DOSE INFORMATION

The total amount of energy absorbed per unit mass as a result of exposure to radiation is expressed in a unit of measure known as a **radiation absorbed dose (rad)**. In the international system of units, 100 rad = 1 gray. However, in terms of human health, it is the effect of the absorbed energy that is important because some forms of radiation are more harmful than others. The unit, rad, does not take into account the potential effects that different types of radiation have on the body. The measure of potential biological damage caused by exposure to and subsequent absorption of radiation is expressed in a unit of measure known as a **roentgen equivalent man (rem)**. One rem of any type of radiation has the same total damaging effect and pertains to the human body. Dose is expressed in millirems (mrem), because a rem represents a fairly large dose. One millirem is equal to 1/1000 rem. The International System of Units uses the **Sievert (Sv)**, l00 rem = 1 Sievert (Sv), 100 mrem = 1 millisievert (mSv).

Many terms are used to report dose, as listed in Table A.2. Several factors are taken into account, including the amount of radiation absorbed, the organ absorbing the radiation, and the effect of the radiation over a 50-year period. The term "dose," in this report, includes the committed effective dose equivalent (EDE) and the EDE attributable to penetrating radiation from sources external to the body.

Determining dose is an involved process using complex mathematical equations based on several factors, including the type of radiation, the rate of exposure, weather conditions, and typical diet. Basically, radiant energy is generated from radioactive decay or activity. People absorb some of the energy to which they are exposed. This absorbed energy is calculated as part of an individual's dose. Whether radiation is natural or human made, its effects on people are the same.

A comparison of some dose levels is presented in Table A.3. Included is an example of the type of exposure that may cause such a dose or the special significance of such a dose. This information is intended to help the reader become familiar with the type of doses individuals may receive. The average annual

dose received by residents of the United States

Table A.2. Dose Terminology

Term	Description
absorbed dose	Quantity of radiation energy absorbed by an organ divided by an organ's mass
dose equivalent	Absorbed dose to an organ multiplied by a quality factor
effective dose equivalent	Single weighted sum of combined dose equivalent received by all organs
committed dose equivalent	Effective dose equivalent to an organ over a 50-year period following intake
committed effective dose equivalent	Total effective dose equivalent to all organs in the human body over a 50-year period following intake
collective effective dose equivalent	Sum of effective dose equivalents of all members of a given population
quality factor	A modifying factor used to adjust for the effect of the type of radiation, for example, alpha particles or gamma rays, on tissue
weighting factor	Tissue-specific modifying factor representing the fraction of the total health risk from uniform, whole-body exposure

Table A.3. Comparison and Description of Various Dose Levels

Dose Level	Description
1 mrem (0.01 mSv)	Approximate daily dose from natural background radiation, including radon.
2.5 mrem (0.025 mSv)	Cosmic dose to a person on a one-way airplane flight from New York to Los Angeles.
10 mrem (0.10 mSv)	Annual exposure limit, set by the EPA for exposures from airborne emissions from operations of nuclear fuel cycle facilities, including power plants and uranium mines and mills.
45 mrem (0.45 mSv)	Average yearly dose from cosmic radiation received by people in the Paducah area.
46 mrem (0.46 mSv)	Estimate of the largest dose any off-site person could have received from the March 28, 1979, Three Mile Island nuclear power plant accident.
66 mrem (0.66 mSv)	Average yearly dose to people in the U.S. from human-made sources.
100 mrem (1.00 mSv)	Annual limit of dose from all DOE facilities to a member of the public who is not a radiation worker.
110 mrem (1.10 mSv)	Average occupational dose received by U.S. commercial radiation workers in 1980.
244 mrem (2.44 mSv)	Average dose from an upper gastrointestinal diagnostic X-ray series.
300 mrem (3.00 mSv)	Average yearly dose to people in the U.S. from all sources of natural background radiation.
1-5 rem (0.01-0.05 Sv)	EPA protective action guidelines state that public officials should take emergency action when the dose to a member of the public from a nuclear accident will likely reach this range.
5 rem (0.05 Sv)	Annual limit for occupational exposure of radiation workers set by NRC and DOE.
10 rem (0. 10 Sv)	The BEIR V report estimated that an acute dose at this level would result in a lifetime excess risk of death from cancer, caused by the radiation, of 0.8%.
25 rem (0.25 Sv)	EPA guideline for voluntary maximum dose to emergency workers for non-lifesaving work during an emergency.
75 rem (0.75 Sv)	EPA guideline for maximum dose to emergency workers volunteering for lifesaving work.
50-600 rem (0.50-6.00 Sv)	Doses in this range received over a short period of time will produce radiation sickness in varying degrees. At the lower end of this range, people are expected to recover completely, given proper medical attention. At the top of this range, most people would die within 60 days.

Adapted from *Savannah River Site Environmental Report for 1993* (SRS 1994).

dose received by residents of the United States from cosmic radiation is about 27 mrem (0.27 mSv) (NCRP 1987). The average annual dose from cosmic radiation received by residents in the Paducah area is about 45 mrem (0.45 mSv). The average annual dose received from terrestrial gamma radiation in the United States is about 28 mrem (0.28 mSv). The terrestrial dose varies geographically across the country (NCRP 1987); typical reported values are 16 mrem (0.16 mSv) at the Atlantic and Gulf coastal plains and 63 mrem (0.63 mSv) at the eastern slopes of the Rocky Mountains. In the Paducah area, background levels of radionuclides in soils are within typical levels indicating that the dose received from terrestrial gamma radiation is within the range of typical reported values (DOE 1998). The major contributors to the annual dose equivalent for internal radionuclides are the short-lived decay products of radon, mostly Rn-222. They contribute an average dose of about 200 mrem (2.00 mSv) per year. This dose estimate is based on an average radon concentration of about 1 pCi/L (0.037 Bq/L) (NCRP 1987). The average dose from other internal radionuclides is about 39 mrem (0.39 mSv) per year, most of which can be attributed to the naturally occurring isotope of potassium, ^{40}K. The concentration of radioactive potassium in human tissues is similar in all parts of the world. Table A.4 presents the internal dose factors for an adult. The United States average annual dose received by an individual from consumer products is about 10 mrem (0.10 mSv) (NCRP 1987). The dose from medical sources includes nuclear medicine examinations, which involve the internal administration of radiopharmaceuticals and generally account for the largest portion of the dose received from humanmade sources; however, the radionuclides used in specific tests are not distributed uniformly throughout the body. In these cases, comparisons are made using the concept of EDE, which relates exposure of organs or body parts to one effective whole-body dose. The average annual EDE from medical examinations is 53 mrem (0.53 mSv), including 39 mrem (0.39 mSv) for diagnostic X-rays and 14 mrem (0.14mSv) for nuclear medicine procedures (NCRP 1989). The actual doses received by individuals who complete such medical exams are much higher than these values, but not everyone receives such exams each year (NCRP 1989). The dose from other sources include small doses received by individuals that occur as a result of radioactive fallout from atmospheric atomic weapons tests, emissions of radioactive materials from nuclear facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials. The combination of these sources contributes less than 1 mrem (0.01 mSv) per year to the average dose to an individual (NCRP 1987). A comprehensive EPA report of 1984 projected the average occupational dose to monitored radiation workers in medicine, industry, the nuclear fuel cycle, government, and miscellaneous industries to be 105 mrem (1.05 mSv) per year for 1985, down slightly from 110 mrem (1.10 mSv) per year in 1980 (EPA 1984).

Table A.4. Internal Dose Factors for an Adult

Isotope	Half-life (years)	Intake[a] (mrem/pCi)			
		Inhalation (soluble)	**Inhalation (slightly soluble)**	**Inhalation (insoluble)**	**Ingestion**
^{237}Np	2,100,000	NA	0.49	NA	0.0039
^{239}Pu	24,000	NA	0.51	0.33	0.0043
^{99}Tc	210,000	0.00000084	0.0000075	0.12	0.0000013
^{230}Th	75,000	NA	0.32	0.26	0.00053
^{234}U	240,000	0.0027	0.0071	0.13	0.00026
^{235}U	710,000,000	0.0025	0.0067	0.12	0.00025
^{238}U	4,500,000,000	0.0024	0.0062	0.12	0.00023

[a]Source: U.S. DOE. July 1988. *Internal Dose Conversion Factors for Calculations of Dose to the Public*, DOE/EH-0071.
NA = not available in the above-referenced document

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Appendix B: Radionuclide and Chemical Nomenclature

Table B.1. Half-Life and Derived Concentration Guide for Selected Radionuclides

Radionuclide	Symbol	Half-life	Ingested Water DCG (µCi/ml)
Americium-241	^{241}Am	432 years	3E-08
Bismuth-210	^{210}Bi	5.01 days	2E-05
Cesium-137	^{137}Cs	30.2 years	3E-06
Cobalt-60	^{60}Co	5.3 years	1E-05
Lead-206	^{206}Pb	Stable	None
Lead-210	^{210}Pb	21 years	3E-08
Lead-214	^{214}Pb	26.8 minutes	2E-04
Neptunium-237	^{237}Np	2,140,000 years	3E-08
Plutonium-239	^{239}Pu	24,110 years	3E-08
Polonium-210	^{210}Po	138.9 days	8E-08
Polonium-214	^{214}Po	164 microseconds	None
Polonium-218	^{218}Po	3.05 minutes	None
Potassium-40	^{40}K	1,260,000,000 years	7E-06
Protactinium-234m	^{234m}Pa	1.17 minutes	None
Radium-226	^{226}Ra	1,602 years	1E-07
Radon-222	^{222}Rn	3.821 days	None
Technetium-99	^{99}Tc	212,000 years	1E-04
Thorium-230	^{230}Th	80,000 years	3E-07
Thorium-231	^{231}Th	25.5 hours	1E-04
Thorium-234	^{234}Th	24.1 days	1E-05
Uranium-234	^{234}U	247,000 years	5E-07
Uranium-235	^{235}U	710,000,000 years	6E-07
Uranium-236	^{236}U	23,900,000 years	5E-07
Uranium-238	^{238}U	4,510,000,000 years	6E-07

Derived Concentration Guide (DCG) is the concentration of a radionuclide in air or water that would result in an effective dose equivalent of 100 mrem under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation). DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.

Table B.2. Nomenclature for Elements and Chemical Compounds

Constituent	Symbol	Constituent	Symbol
Aluminum	Al	Manganese	Mn
Ammonia	NH3	Mercury	Hg
Antimony	Sb	Nickel	Ni
Arsenic	As	Nitrate	NO3 -
Barium	Ba	Nitrite	NO2 -
Beryllium	Be	Nitrogen	N
Cadmium	Cd	Oxygen	O
Calcium	Ca	Ozone	O3
Calcium carbonate	CaCO3	Phosphate	PO4 3-
Carbon	C	Phosphorus	P
Chlorine	Cl	Potassium	K
Chromium	Cr	Radium	Ra
Chromium, hexavalent	Cr6+	Radon	Rn
Cobalt	Co	Selenium	Se
Copper	Cu	Silver	Ag
Fluorine	F	Sodium	Na
Hydrogen fluoride	HF	Sulfate	SO4 2-
Iron	Fe	Sulfur dioxide	SO2
Lead	Pb	Thorium	Th
Lithium	Li	Uranium	U
Magnesium	Mg	Zinc	Zn

Units of Radiation Measure

Current System	System International	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7 x 1010 Bq
rad (radiation absorbed dose)	gray (Gy)	1 rad = 0.01 Gy
rem (roentgen equivalent man)	sievert (Sv)	1 rem = 0.01 Sv

Conversions

Multiply	***by***	***to obtain***	***Multiply***	***by***	***to obtain***
in	2.54	centimeters	centimeters	0.394	in
ft	0.305	m	m	3.28	ft
mile	1.61	km	km	0.621	mile
lb	0.4538	kg	kg	2.205	lb
gal	3.785	L	L	0.264	gal
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
acres	0.40468	hectares	hectares	2.471	acres
dpm	0.45	pCi	pCi	2.22	dpm
pCi	10-6	µCi	µCi	106	pCi
pCi/L (water)	10-9	µCi/mL (water)	µCi/mL (water)	109	pCi/L (water)
pCi/m3 (air)	10-12	µCi/mL (air)	µCi/mL (air)	1012	pCi/m3 (air)

Paducah Annual Site Environmental Report 2006

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Volume II

PADUCAH SITE

Annual Site Environmental Report
Environmental Monitoring Results

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Notes:

1. "ND" means the parameter was not detected. Detection limits are available in the Paducah OREIS database. The count detects column represents the number of times the contaminant was detected when sampled during the year.

2. Monitoring programs often include measurement of extremely low concentrations of radionuclides, below the detection limit of the counting instruments. Less-than-detectable data will produce numerical measurements with values below the detection limit and sometimes negative values. All of the actual values, including those that are negative, are included in the statistical analyses in accordance with DOE's *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991).

3. For non-radiological data, average values are calculated using the actual result values from the OREIS database. Where analytical result values were below the detection level, half of the detection limit was used to calculate average concentration. For radiological data, the average concentration was calculated by using the actual result given for both detectable and non-detectable results.

4. Reference Criteria for Sections 1 and 2 are used for comparison of results to Derived Concentration Guide (DCG) levels or site action limits that have been defined by the Environmental Programs.

5. The following data volume includes monitoring results for surface water, sediment, air, and animal tissue. Groundwater results are not presented in this data volume because more significant detail and data tables are presented in the Annual Site Environmental Report, Volume I.

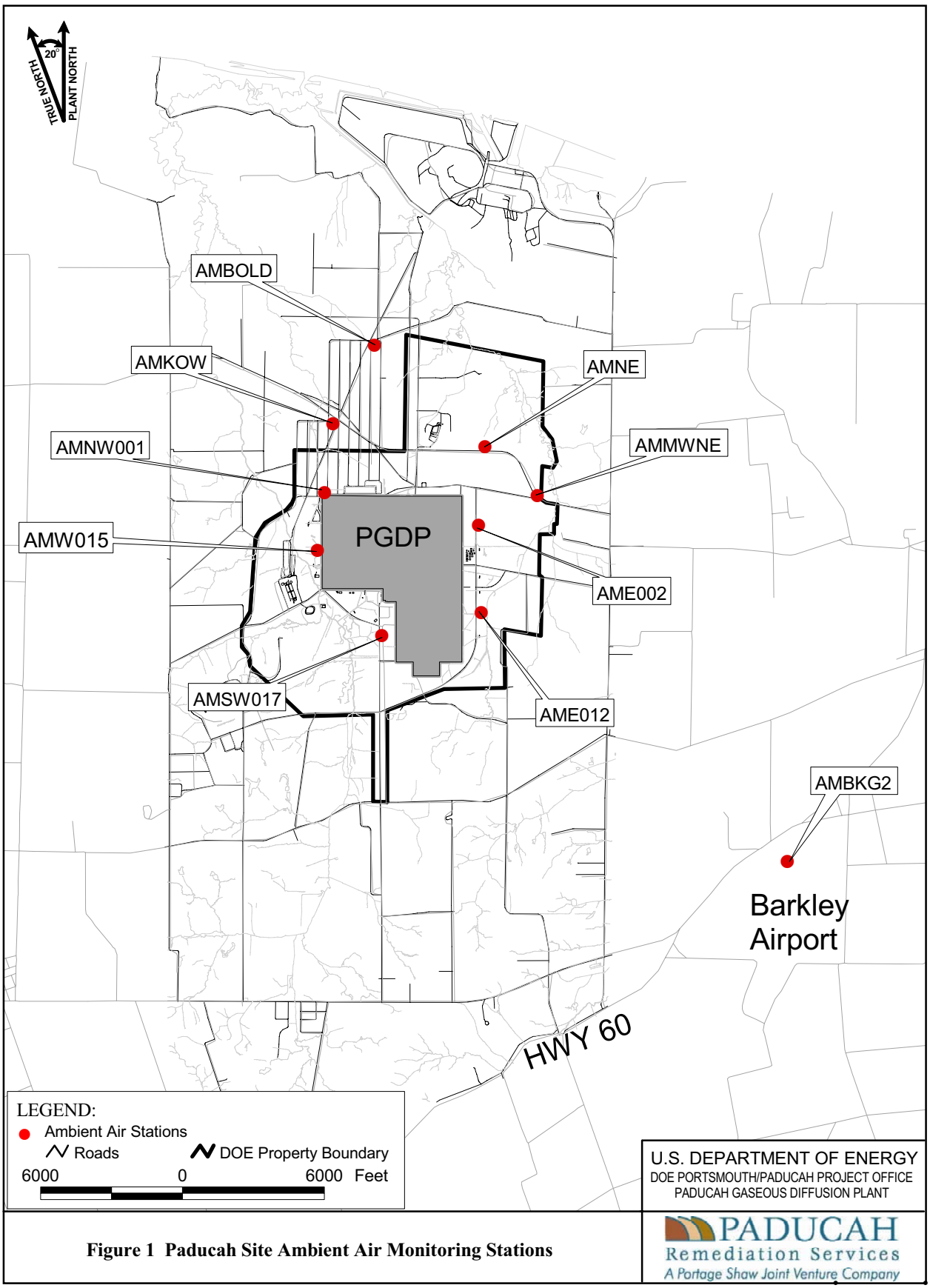

Figure 1 Paducah Site Ambient Air Monitoring Stations

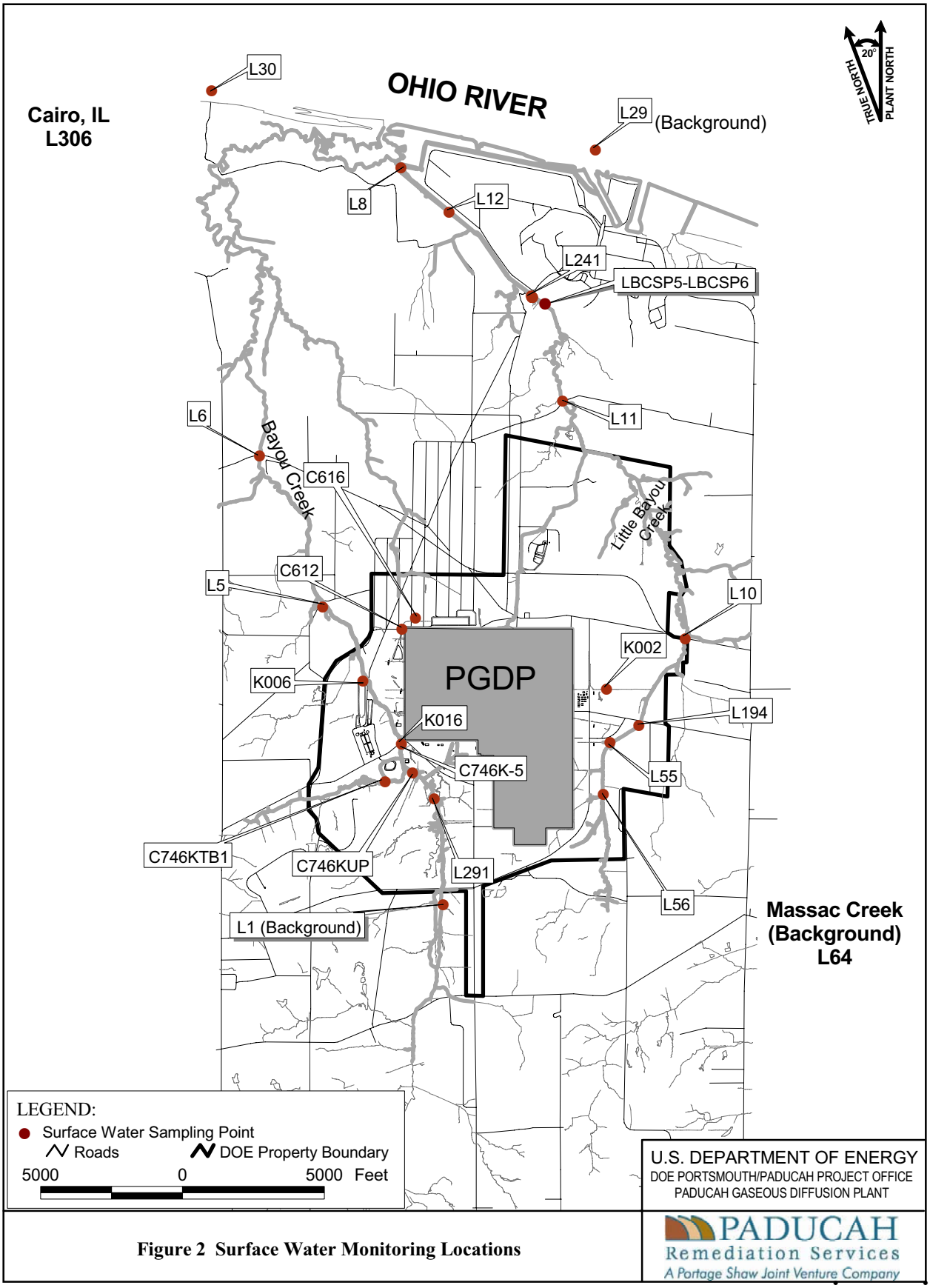

Figure 2 Surface Water Monitoring Locations

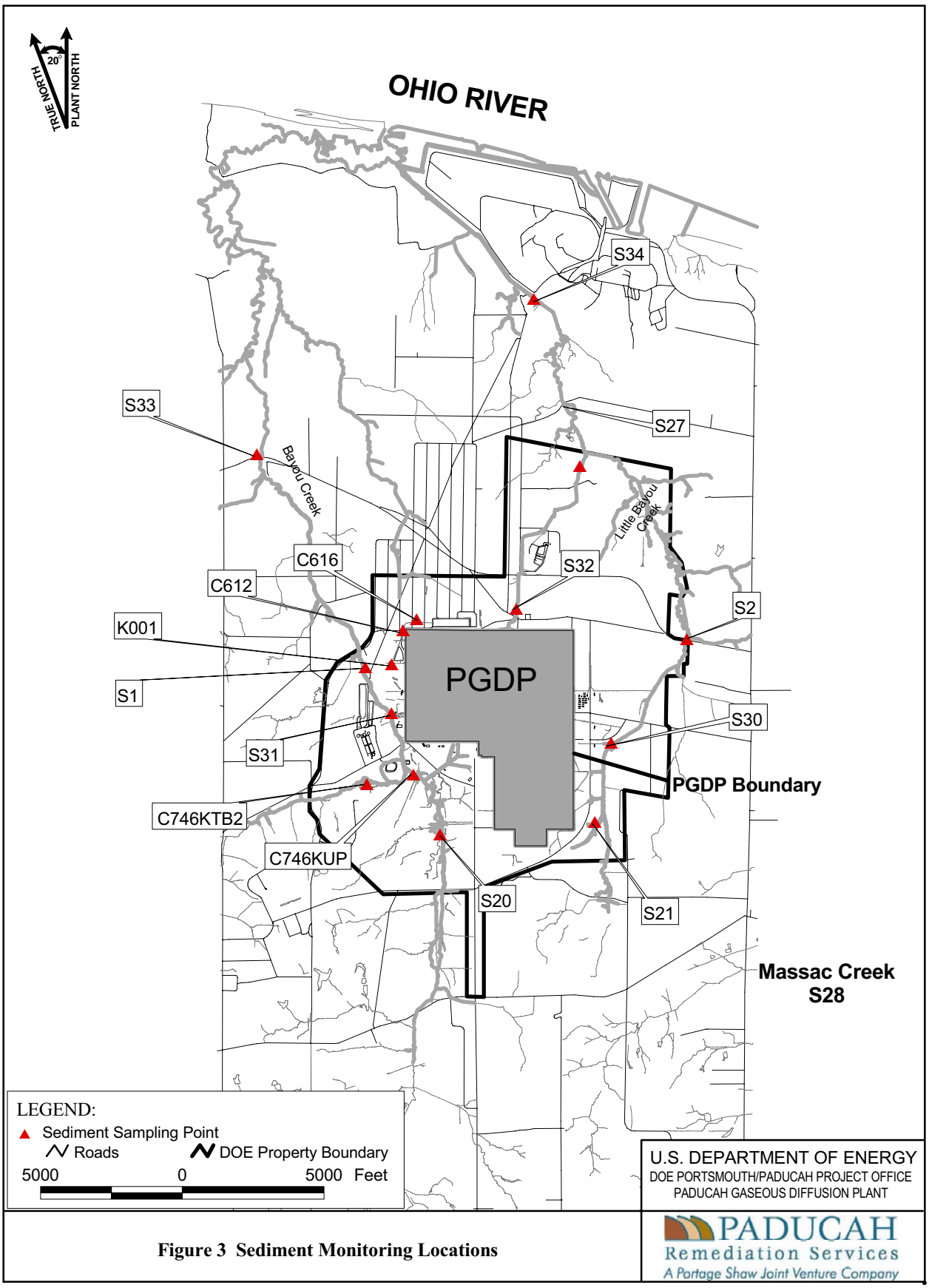

Figure 3 Sediment Monitoring Locations

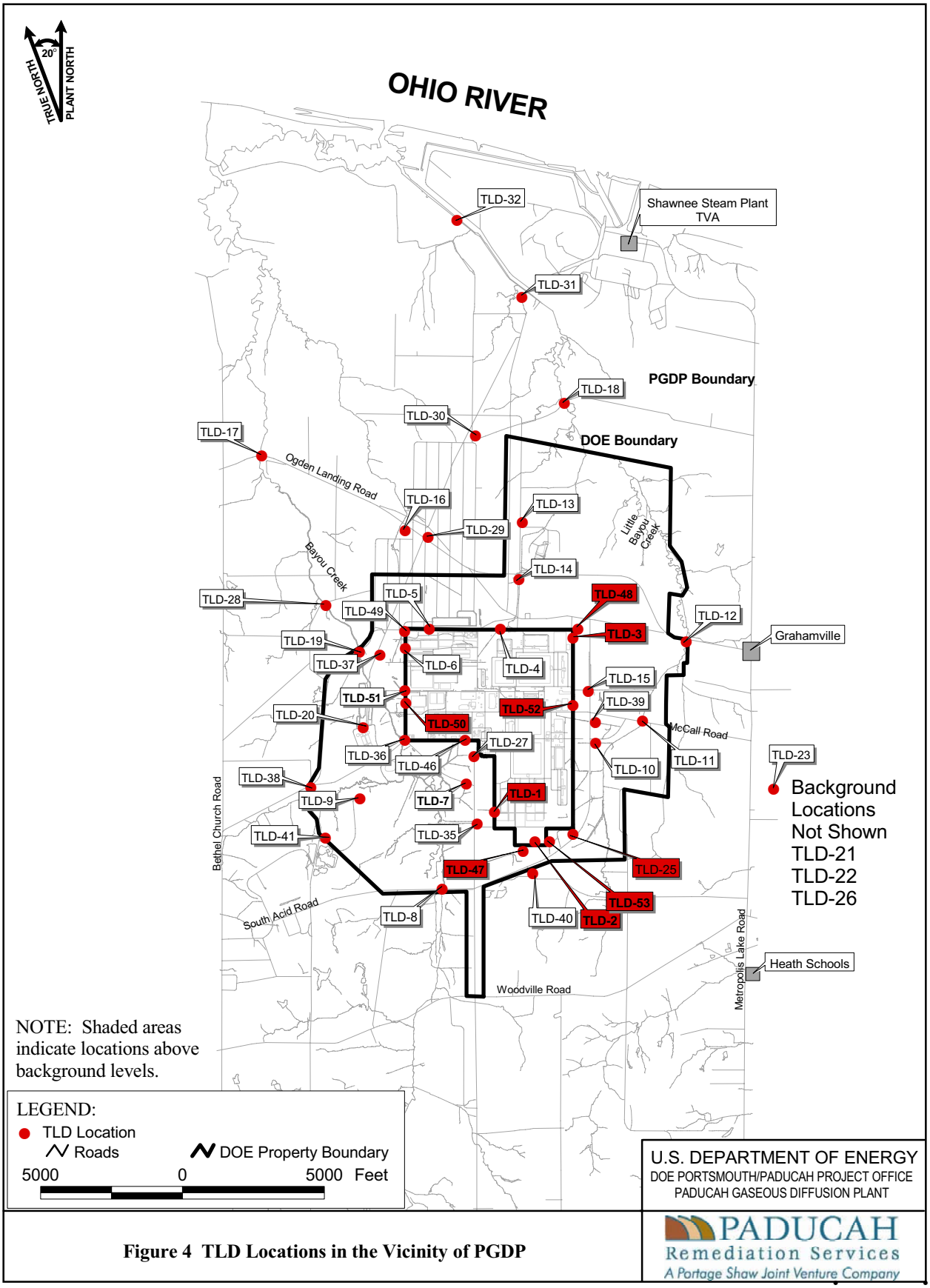

Figure 4 TLD Locations in the Vicinity of PGDP

1. RADIOLOGICAL EFFLUENT DATA

KPDES Radiological Data

Table 1.1 Radiological Effluent Data for Outfall 001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-5.9	8.6	1.8	0	8		
Beta activity	pCi/L	25	41	32	8	8		
Dissolved Alpha	pCi/L	-4.5	1.1	-1.1	0	6		
Dissolved Beta	pCi/L	21	34	27	6	6		
Suspended Alpha	pCi/L	-0.3	0.8	0.26	0	6		
Suspended Beta	pCi/L	-3.1	12	2.8	1	6		
Technetium-99	pCi/L	-1.2	19	8.9	0	7	ActionLimit	900

Table 1.2 Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	34	73	54	3	3		
Beta activity	pCi/L	18	70	46	3	3		
Dissolved Alpha	pCi/L	5.9	14	11	4	4		
Dissolved Beta	pCi/L	14	29	22	4	4		
Suspended Alpha	pCi/L	-0.17	2.6	1.6	0	4		
Suspended Beta	pCi/L	6.7	16	10	4	4		
Technetium-99	pCi/L	0.55	24	13	1	5	ActionLimit	900

Table 1.3 Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	1.4	1.5	1.4	0	3		
Beta activity	pCi/L	8.8	12	10	3	3		
Dissolved Alpha	pCi/L	0.47	1.9	1.2	0	5		
Dissolved Beta	pCi/L	3.7	8.3	6.5	2	5		
Suspended Alpha	pCi/L	-0.28	2.1	0.81	0	5		
Suspended Beta	pCi/L	-0.71	4	1.2	0	5		
Technetium-99	pCi/L	-3.6	27	8.2	1	6	ActionLimit	900

Table 1.4 Radiological Effluent Data for Outfall 019

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	-0.22	2.7	1.1	0	4		
Dissolved Beta	pCi/L	5.1	10	6.6	1	4		
Suspended Alpha	pCi/L	-0.63	1	0.16	0	4		
Suspended Beta	pCi/L	1.6	2.1	1.9	0	4		
Technetium-99	pCi/L	2.3	15	5.6	0	4	ActionLimit	900

Surface Water Radiological Data

Table 1.5 Radiological Effluent Data for Landfill Surface Water Location L135

Upstream of the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	2	8.8	4.1	2	5		
Beta activity	pCi/L	14	41	27	5	5		

Table 1.6 Radiological Effluent Data for Landfill Surface Water Location L136

At the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	0.12	1.8	1.1	0	4		
Beta activity	pCi/L	2.3	16	8.1	2	4		

Table 1.7 Radiological Effluent Data for Landfill Surface Water Location L137

Downstream of the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	0.34	5	2.9	1	4		
Beta activity	pCi/L	6	18	12	3	4		

Table 1.8 Radiological Effluent Data for Landfill Surface Water Location L150

At the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	0.17	3.4	1.4	1	5		
Beta activity	pCi/L	5.2	9.7	7	5	5		

Table 1.9 Radiological Effluent Data for Landfill Surface Water Location L154

Upstream of the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-0.38	1.9	0.86	0	4		
Beta activity	pCi/L	12	20	15	4	4		

Table 1.10 Radiological Effluent Data for Landfill Surface Water Location L155

Downstream of the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	4.1	15	9.7	4	4		
Beta activity	pCi/L	8.7	17	13	4	4		

2. RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA

Ambient Air Data

Table 2.1 Kentucky Radiation Health and Toxics Branch Air Monitoring[1,2]

		Ambient Air Station									
		AMSW017	AMW015	AMNW001	AMNE	AME002	AME012	AMBKG2	AMBOLD	AMKOW	AMMWNE
Quarter	Nuclide	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3	Ci/m^3
1	^{241}Am	1.14E-17	1.46E-18	4.53E-18	9.53E-18	1.55E-17	9.45E-18	9.26E-18	-1.28E-22	1.65E-22	6.00E-18
	^{237}Np	2.11E-16	-1.22E-16	-1.46E-16	-1.15E-16	9.23E-19	-3.34E-16	-1.87E-16	4.47E-16	-1.09E-16	-1.86E-16
	^{99}Tc	7.62E-16	7.35E-16	4.97E-16	4.32E-16	4.16E-16	3.08E-16	7.84E-16	6.18E-16	2.62E-16	2.79E-16
	^{238}U/^{234}Th	1.35E-16	1.31E-16	1.88E-16	1.29E-16	-4.30E-16	1.41E-16	1.36E-16	1.49E-16	1.57E-16	1.52E-16
2	^{241}Am	3.44E-16	-1.61E-16	-1.78E-16	-2.43E-16	3.90E-17	-4.51E-17	-2.05E-16	3.04E-17	2.77E-16	2.42E-16
	^{237}Np	7.23E-17	2.46E-16	-9.03E-18	1.07E-16	-2.82E-16	1.21E-16	1.30E-16	-1.91E-16	-4.31E-16	3.84E-16
	^{99}Tc	7.58E-16	3.43E-16	5.93E-16	7.90E-16	5.31E-16	3.13E-16	2.82E-16	5.07E-16	6.22E-16	5.66E-16
	^{238}U/^{234}Th	1.70E-16	1.81E-16	2.57E-16	2.04E-16	1.78E-16	1.82E-16	1.55E-16	1.79E-16	1.85E-16	1.70E-16
3	^{241}Am	1.48E-16	-1.58E-18	2.56E-16	1.40E-16	-2.04E-16	1.61E-16	-3.06E-17	2.33E-16	1.79E-16	-2.35E-16
	^{237}Np	-1.99E-17	1.12E-16	-1.39E-16	1.93E-16	-2.42E-17	-3.82E-17	-2.18E-16	-4.02E-16	2.25E-16	1.12E-16
	^{99}Tc	4.61E-16	4.69E-16	3.58E-17	3.59E-17	-2.27E-16	-2.25E-16	2.70E-16	3.50E-16	9.59E-17	2.11E-16
	^{238}U/^{234}Th	1.85E-16	2.04E-16	2.59E-16	1.92E-16	2.20E-16	1.72E-16	1.80E-16	3.07E-16	2.00E-16	1.92E-16
4	^{241}Am	-6.31E-16	-1.47E-16	-1.34E-16	-5.77E-16	-1.16E-15	-2.01E-16	-2.00E-16	-4.05E-16	-1.97E-16	-1.23E-15
	^{237}Np	-1.40E-16	2.64E-16	-2.63E-16	-8.28E-18	3.49E-16	-1.19E-16	4.40E-16	7.07E-17	2.61E-16	-4.55E-16
	^{99}Tc	9.20E-16	1.94E-16	6.73E-16	5.39E-16	3.98E-16	4.28E-16	7.12E-16	5.94E-16	9.39E-16	5.23E-16
	^{238}U/^{234}Th	1.22E-16	1.82E-16	2.11E-16	1.97E-16	1.51E-16	1.51E-16	1.63E-16	1.93E-16	1.91E-16	1.53E-16

[1] All results were considered non-detect.
[2] 40 CFR 61, Appendix E, Table 2 Limit Values (Ci/m^3): ^{241}Am 1.94E-15, ^{237}Np 1.2E-15, ^{99}Tc 1.4E-13, and ^{238}U/^{234}Th 8.3E-15.

Surface Water Radiological Data

Table 2.2 Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.018	0.017	-0.0024	0	5		
Americium-241	pCi/L	-0.013	0.026	0.0045	0	5	10%DCG	3
Cesium-134	pCi/L	-1.7	1.7	-0.046	0	5		
Cesium-137	pCi/L	-0.96	0.34	-0.062	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.85	0.49	-0.062	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-1.8	0.9	-0.038	0	5		
Dissolved Beta	pCi/L	-1.3	9.8	4	1	5		
Neptunium-237	pCi/L	-0.038	0.021	-0.0062	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.013	0.041	0.012	0	5		
Plutonium-239/240	pCi/L	0.01	0.017	0.012	0	5	10%DCG	3
Potassium-40	pCi/L	-38	39	1	1	5		
Suspended Alpha	pCi/L	-0.4	0.74	-0.069	0	5		
Suspended Beta	pCi/L	-0.95	3.1	0.51	0	5		
Technetium-99	pCi/L	-3.1	11	5.3	0	5	ActionLimit	900
Thorium-228	pCi/L	0.026	0.098	0.057	0	5		
Thorium-230	pCi/L	-0.0031	0.11	0.044	0	5	10%DCG	30
Thorium-232	pCi/L	-0.068	0.023	-0.016	0	5		
Thorium-234	pCi/L	-50	-10	-22	0	5		
Uranium	mg/L	0.005	0.005	0.005	0	5	10%DCG	0.0901
Uranium	pCi/L	-0.05	0.2	0.06	0	5	10%DCG	60
Uranium-234	pCi/L	-0.036	0.077	0.028	0	5	10%DCG	50
Uranium-238	pCi/L	-0.0029	0.12	0.034	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.3 Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0092	0.033	0.016	0	4		
Americium-241	pCi/L	-0.029	0.048	0.003	0	4	10%DCG	3
Cesium-134	pCi/L	-1.1	0.3	-0.25	0	4		
Cesium-137	pCi/L	-0.6	0.91	0.2	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.64	1.6	0.39	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	0.5	5.4	2.4	0	4		
Dissolved Beta	pCi/L	7.3	14	12	3	4		
Neptunium-237	pCi/L	-0.0087	0.033	0.011	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0034	0.018	0.0075	0	4		
Plutonium-239/240	pCi/L	-0.016	0.05	0.0094	0	4	10%DCG	3
Potassium-40	pCi/L	-25	13	-8.2	0	4		
Suspended Alpha	pCi/L	-0.59	3.1	0.94	0	4		
Suspended Beta	pCi/L	-0.81	2.5	1.4	0	4		
Technetium-99	pCi/L	2	8.4	5.2	0	4	ActionLimit	900
Thorium-228	pCi/L	0.068	0.13	0.11	0	4		
Thorium-230	pCi/L	-0.039	0.13	0.03	0	4	10%DCG	30
Thorium-232	pCi/L	0.013	0.046	0.03	0	4		
Thorium-234	pCi/L	-19	52	9.4	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.2	1.7	1.1	0	4	10%DCG	60
Uranium-234	pCi/L	0.11	0.85	0.54	2	4	10%DCG	50
Uranium-238	pCi/L	0.11	0.81	0.54	3	4	10%DCG	60

Surface Water Radiological Data

Table 2.4 Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.01	0.16	0.05	1	4		
Americium-241	pCi/L	-0.015	0.019	-0.0038	0	4	10%DCG	3
Cesium-134	pCi/L	-0.25	0.38	0.17	0	4		
Cesium-137	pCi/L	-0.52	0.89	-0.024	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.31	3.5	1.5	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.4	1.8	0.88	0	4		
Dissolved Beta	pCi/L	8.1	12	10	3	4		
Neptunium-237	pCi/L	-0.01	0.079	0.022	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.014	0.015	-0.0021	0	4		
Plutonium-239/240	pCi/L	-0.0036	0.018	0.0092	0	4	10%DCG	3
Potassium-40	pCi/L	-16	37	1.1	0	4		
Suspended Alpha	pCi/L	-1.8	1.1	-0.32	0	4		
Suspended Beta	pCi/L	-4	3	0.83	0	4		
Technetium-99	pCi/L	-8.9	18	6.9	1	4	ActionLimit	900
Thorium-228	pCi/L	0.042	0.17	0.087	0	4		
Thorium-230	pCi/L	-0.014	0.1	0.063	0	4	10%DCG	30
Thorium-232	pCi/L	-0.011	0.04	0.013	0	4		
Thorium-234	pCi/L	-48	52	-11	1	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	1	1.9	1.6	1	4	10%DCG	60
Uranium-234	pCi/L	0.45	1	0.67	2	4	10%DCG	50
Uranium-238	pCi/L	0.55	0.93	0.83	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.5 Radiological Monitoring Data for Surface Water Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.03	0.42	0.22	2	4		
Americium-241	pCi/L	-0.029	0.0073	-0.012	0	4	10%DCG	3
Cesium-134	pCi/L	-0.59	-0.021	-0.31	0	4		
Cesium-137	pCi/L	-1.2	0.0084	-0.51	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.7	-0.43	-0.93	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	2.3	7.4	5.4	0	4		
Dissolved Beta	pCi/L	24	46	32	4	4		
Neptunium-237	pCi/L	0.014	0.029	0.023	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0024	0.0048	0.0016	0	4		
Plutonium-239/240	pCi/L	-0.0091	0.038	0.0082	0	4	10%DCG	3
Potassium-40	pCi/L	5.4	46	32	2	4		
Suspended Alpha	pCi/L	-1.6	2	0.21	0	4		
Suspended Beta	pCi/L	-1.3	9.5	2.9	1	4		
Technetium-99	pCi/L	0.28	14	5.8	0	4	ActionLimit	900
Thorium-228	pCi/L	0.052	0.14	0.087	0	4		
Thorium-230	pCi/L	0.039	0.11	0.069	0	4	10%DCG	30
Thorium-232	pCi/L	-0.017	0.051	0.011	0	4		
Thorium-234	pCi/L	-1.8	57	19	0	4		
Uranium	pCi/L	0.95	18	9.5	2	4	10%DCG	60
Uranium-234	pCi/L	0.3	6.9	3.4	3	4	10%DCG	50
Uranium-238	pCi/L	0.62	11	5.9	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.6 Radiological Monitoring Data for Surface Water Location K015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.18	1	0.52	4	4		
Americium-241	pCi/L	-0.029	0.02	0.00067	0	4	10%DCG	3
Cesium-134	pCi/L	-0.47	0.71	0.3	0	4		
Cesium-137	pCi/L	-1	0.79	0.025	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.8	1.4	0.081	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	2.6	69	22	3	4		
Dissolved Beta	pCi/L	9.4	55	25	4	4		
Neptunium-237	pCi/L	0.031	0.083	0.054	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0022	0.021	0.008	0	4		
Plutonium-239/240	pCi/L	0.02	0.1	0.052	1	4	10%DCG	3
Potassium-40	pCi/L	-16	45	3.5	0	4		
Suspended Alpha	pCi/L	0.51	3.4	1.9	0	4		
Suspended Beta	pCi/L	7.2	21	11	4	4		
Technetium-99	pCi/L	14	27	19	2	4	ActionLimit	900
Thorium-228	pCi/L	0.027	0.16	0.065	0	4		
Thorium-230	pCi/L	0.00077	0.16	0.082	0	4	10%DCG	30
Thorium-232	pCi/L	-0.056	0.069	0.0036	0	4		
Thorium-234	pCi/L	-18	37	-2.4	0	4		
Uranium	pCi/L	11	68	29	4	4	10%DCG	60
Uranium-234	pCi/L	2.7	16	6.8	4	4	10%DCG	50
Uranium-238	pCi/L	8.3	50	22	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.7 Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.011	0.0093	0.0035	0	4		
Americium-241	pCi/L	-0.0049	0.15	0.047	0	4	10%DCG	3
Cesium-134	pCi/L	-1.3	0.6	-0.49	0	4		
Cesium-137	pCi/L	-0.94	-0.011	-0.56	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.3	0.48	-0.11	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.4	0.48	0.14	0	4		
Dissolved Beta	pCi/L	-1.8	9	5.2	1	4		
Neptunium-237	pCi/L	-0.009	0.019	0.0025	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0061	0.029	0.0089	0	4		
Plutonium-239/240	pCi/L	-0.0099	0.018	0.0058	0	4	10%DCG	3
Potassium-40	pCi/L	-47	12	-6.9	0	4		
Suspended Alpha	pCi/L	0.023	1.7	0.64	0	4		
Suspended Beta	pCi/L	-2	0.37	-0.82	0	4		
Technetium-99	pCi/L	2.9	14	6.4	0	4	ActionLimit	900
Thorium-228	pCi/L	0.036	0.22	0.097	0	4		
Thorium-230	pCi/L	0.014	0.35	0.12	0	4	10%DCG	30
Thorium-232	pCi/L	-0.019	0.0067	-0.0043	0	4		
Thorium-234	pCi/L	-14	18	2.6	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	-0.038	0.41	0.18	0	4	10%DCG	60
Uranium-234	pCi/L	-0.03	0.21	0.11	0	4	10%DCG	50
Uranium-238	pCi/L	0.0026	0.19	0.071	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.8 Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.022	0.071	0.042	0	4		
Americium-241	pCi/L	-0.0098	0.0024	-0.0046	0	4	10%DCG	3
Cesium-134	pCi/L	-0.49	1.7	0.68	0	4		
Cesium-137	pCi/L	-0.96	-0.26	-0.47	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.44	0.91	0.4	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-2.1	5.2	1.3	0	4		
Dissolved Beta	pCi/L	-10	45	25	3	4		
Neptunium-237	pCi/L	0.03	0.14	0.084	0	4	10%DCG	3
Plutonium-238	pCi/L	0.0046	0.031	0.014	0	4		
Plutonium-239/240	pCi/L	0.019	0.043	0.031	0	4	10%DCG	3
Potassium-40	pCi/L	38	64	52	3	4		
Suspended Alpha	pCi/L	-6.4	1.1	-1.4	0	4		
Suspended Beta	pCi/L	-3.1	32	7.7	1	4		
Technetium-99	pCi/L	0.17	16	7.7	0	4	ActionLimit	900
Thorium-228	pCi/L	0.064	0.13	0.098	0	4		
Thorium-230	pCi/L	0.031	0.052	0.044	0	4	10%DCG	30
Thorium-232	pCi/L	-0.045	0.034	0.0022	0	4		
Thorium-234	pCi/L	-33	9.5	-15	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.67	1.6	1.2	1	4	10%DCG	60
Uranium-234	pCi/L	0.37	0.73	0.59	2	4	10%DCG	50
Uranium-238	pCi/L	0.27	0.9	0.61	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.9 Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0046	0.013	0.00028	0	4		
Americium-241	pCi/L	-0.011	0.031	0.012	0	4	10%DCG	3
Cesium-134	pCi/L	-0.2	0.49	0.047	0	4		
Cesium-137	pCi/L	-0.51	0.91	0.45	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.3	0.99	-0.46	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.45	2.2	0.38	0	4		
Dissolved Beta	pCi/L	0.41	13	5.4	1	4		
Neptunium-237	pCi/L	-0.016	0.0035	-0.0049	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.012	0.0048	-0.0013	0	4		
Plutonium-239/240	pCi/L	-0.0067	0.035	0.013	0	4	10%DCG	3
Potassium-40	pCi/L	-22	42	6.1	1	4		
Suspended Alpha	pCi/L	0.029	2.5	1.3	0	4		
Suspended Beta	pCi/L	-0.94	3.1	0.57	0	4		
Technetium-99	pCi/L	-14	4.2	-2.6	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.026	0.085	0.039	0	4		
Thorium-230	pCi/L	0.0049	0.097	0.04	0	4	10%DCG	30
Thorium-232	pCi/L	-0.018	0.09	0.022	0	4		
Thorium-234	pCi/L	-32	3.5	-13	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.0086	0.79	0.28	0	4	10%DCG	60
Uranium-234	pCi/L	0.018	0.49	0.16	1	4	10%DCG	50
Uranium-238	pCi/L	-0.0047	0.28	0.11	1	4	10%DCG	60

Surface Water Radiological Data

Table 2.10 Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.004	0.097	0.065	2	4		
Americium-241	pCi/L	-0.035	0.025	0.0027	0	4	10%DCG	3
Cesium-134	pCi/L	-0.63	0.46	-0.023	0	4		
Cesium-137	pCi/L	-1	1.5	0.34	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.24	1.5	0.25	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.6	2.4	1.3	0	4		
Dissolved Beta	pCi/L	2.2	7.1	3.8	0	4		
Neptunium-237	pCi/L	-0.017	0.024	0.0029	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0028	0.016	0.0079	0	4		
Plutonium-239/240	pCi/L	-0.0076	0.028	0.0086	0	4	10%DCG	3
Potassium-40	pCi/L	-28	24	-6.5	0	4		
Suspended Alpha	pCi/L	-1.1	0.41	-0.36	0	4		
Suspended Beta	pCi/L	0.27	1.9	1.1	0	4		
Technetium-99	pCi/L	-13	9.5	-0.076	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.014	0.14	0.038	0	4		
Thorium-230	pCi/L	-0.015	0.1	0.049	0	4	10%DCG	30
Thorium-232	pCi/L	-0.024	0.058	0.0051	0	4		
Thorium-234	pCi/L	-28	31	-9.1	0	4		
Uranium	mg/L	0.005	0.011	0.0088	4	4	10%DCG	0.0901
Uranium	pCi/L	1.8	4.6	3.5	3	4	10%DCG	60
Uranium-234	pCi/L	0.3	1.2	0.74	3	4	10%DCG	50
Uranium-238	pCi/L	1.5	3.8	2.7	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.11 Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.011	0.16	0.073	1	4		
Americium-241	pCi/L	-0.011	0.02	0.0033	0	4	10%DCG	3
Cesium-134	pCi/L	-0.7	-0.038	-0.42	0	4		
Cesium-137	pCi/L	-1	0.26	-0.21	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.52	2.8	0.87	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	1.1	4.3	3	1	4		
Dissolved Beta	pCi/L	4.5	8.8	6.2	2	4		
Neptunium-237	pCi/L	-0.0022	0.046	0.024	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0059	0.03	0.012	0	4		
Plutonium-239/240	pCi/L	-0.0013	0.016	0.005	0	4	10%DCG	3
Potassium-40	pCi/L	-24	-3.8	-15	0	4		
Suspended Alpha	pCi/L	-0.21	1.7	0.48	0	4		
Suspended Beta	pCi/L	0.15	2.2	0.96	0	4		
Technetium-99	pCi/L	-6	7.5	1.7	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0012	0.12	0.05	0	4		
Thorium-230	pCi/L	0.0019	0.046	0.027	0	4	10%DCG	30
Thorium-232	pCi/L	-0.022	0.02	-0.0037	0	4		
Thorium-234	pCi/L	-17	1.5	-9.3	0	4		
Uranium	mg/L	0.005	0.018	0.011	3	4	10%DCG	0.0901
Uranium	pCi/L	0.97	7.7	4	3	4	10%DCG	60
Uranium-234	pCi/L	0.17	1.5	0.73	3	4	10%DCG	50
Uranium-238	pCi/L	0.79	6	3.2	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.12 Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0029	0.081	0.043	1	5		
Americium-241	pCi/L	-0.035	0.017	-0.0033	0	5	10%DCG	3
Cesium-134	pCi/L	-0.95	0.086	-0.38	0	5		
Cesium-137	pCi/L	-1.3	0.67	-0.37	0	5	10%DCG	300
Cobalt-60	pCi/L	-1.3	1.2	-0.067	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-0.54	1.1	0.3	0	5		
Dissolved Beta	pCi/L	4.1	8.4	6.3	1	5		
Neptunium-237	pCi/L	-0.031	0.087	0.0083	0	5	10%DCG	3
Plutonium-238	pCi/L	0.000018	0.016	0.0077	0	5		
Plutonium-239/240	pCi/L	-0.0076	0.017	0.0014	0	5	10%DCG	3
Potassium-40	pCi/L	-16	2	-9.6	0	5		
Suspended Alpha	pCi/L	-0.039	2.4	1.5	0	5		
Suspended Beta	pCi/L	0.94	3.6	2.2	0	5		
Technetium-99	pCi/L	-6.9	6.3	0.59	0	5	ActionLimit	900
Thorium-228	pCi/L	0.015	0.19	0.093	0	5		
Thorium-230	pCi/L	0.00099	0.075	0.043	0	5	10%DCG	30
Thorium-232	pCi/L	0.0008	0.16	0.041	0	5		
Thorium-234	pCi/L	-28	17	-12	0	5		
Uranium	mg/L	0.005	0.007	0.0062	3	5	10%DCG	0.0901
Uranium	pCi/L	1.4	2.9	2.1	1	5	10%DCG	60
Uranium-234	pCi/L	0.29	0.58	0.43	2	5	10%DCG	50
Uranium-238	pCi/L	0.93	2.2	1.6	5	5	10%DCG	60

Surface Water Radiological Data

Table 2.13 Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0046	0.068	0.02	0	4		
Americium-241	pCi/L	-0.029	0.012	-0.0056	0	4	10%DCG	3
Cesium-134	pCi/L	-0.76	0.34	-0.13	0	4		
Cesium-137	pCi/L	0.058	0.83	0.36	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.6	1.6	0.2	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.1	0.79	-0.22	0	4		
Dissolved Beta	pCi/L	4.1	11	7.6	2	4		
Neptunium-237	pCi/L	-0.014	0.032	0.0061	0	4	10%DCG	3
Plutonium-238	pCi/L	0.0039	0.013	0.0091	0	4		
Plutonium-239/240	pCi/L	-0.0017	0.019	0.0065	0	4	10%DCG	3
Potassium-40	pCi/L	-27	31	-6	0	4		
Suspended Alpha	pCi/L	-0.056	1	0.49	0	4		
Suspended Beta	pCi/L	0.49	4.2	1.9	0	4		
Technetium-99	pCi/L	4.9	21	9.9	1	4	ActionLimit	900
Thorium-228	pCi/L	0.078	0.19	0.11	0	4		
Thorium-230	pCi/L	-0.0066	0.19	0.061	0	4	10%DCG	30
Thorium-232	pCi/L	-0.022	0.043	0.015	0	4		
Thorium-234	pCi/L	-30	12	-8.4	0	4		
Uranium	mg/L	0.005	0.007	0.0055	1	4	10%DCG	0.0901
Uranium	pCi/L	0.7	2.8	1.4	1	4	10%DCG	60
Uranium-234	pCi/L	0.18	0.56	0.29	1	4	10%DCG	50
Uranium-238	pCi/L	0.46	2.2	1.1	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.14 Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.026	0.035	0.013	0	5		
Americium-241	pCi/L	-0.0041	0.024	0.013	0	5	10%DCG	3
Cesium-134	pCi/L	-0.68	1.7	0.4	0	5		
Cesium-137	pCi/L	-1.7	0.24	-0.33	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.57	1.4	0.23	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	0.66	3.4	1.6	0	5		
Dissolved Beta	pCi/L	6.9	15	11	4	5		
Neptunium-237	pCi/L	0.0052	0.064	0.029	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0077	0.014	0.0027	0	5		
Plutonium-239/240	pCi/L	-0.0068	0.04	0.013	0	5	10%DCG	3
Potassium-40	pCi/L	-29	34	-6	0	5		
Suspended Alpha	pCi/L	-1.3	1	-0.38	0	5		
Suspended Beta	pCi/L	-0.41	3.2	1.9	0	5		
Technetium-99	pCi/L	2.8	29	12	2	5	ActionLimit	900
Thorium-228	pCi/L	0.048	0.1	0.081	0	5		
Thorium-230	pCi/L	-0.000091	0.14	0.075	0	5	10%DCG	30
Thorium-232	pCi/L	-0.095	0.025	-0.011	0	5		
Thorium-234	pCi/L	-30	1.7	-13	0	5		
Uranium	mg/L	0.005	0.011	0.0062	2	5	10%DCG	0.0901
Uranium	pCi/L	0.54	3.5	1.4	0	5	10%DCG	60
Uranium-234	pCi/L	0.084	0.59	0.23	1	5	10%DCG	50
Uranium-238	pCi/L	0.48	2.9	1.2	5	5	10%DCG	60

Surface Water Radiological Data

Table 2.15 Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0033	0.028	0.014	0	5		
Americium-241	pCi/L	-0.016	0.035	0.0015	0	5	10%DCG	3
Cesium-134	pCi/L	-0.73	0.59	-0.025	0	5		
Cesium-137	pCi/L	-1.2	1.6	0.18	0	5	10%DCG	300
Cobalt-60	pCi/L	-1.5	1.1	0.037	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-1.3	1	-0.16	0	5		
Dissolved Beta	pCi/L	-1.6	8.1	4.1	1	5		
Neptunium-237	pCi/L	-0.0089	0.014	0.0073	0	5	10%DCG	3
Plutonium-238	pCi/L	0.0058	0.032	0.017	0	5		
Plutonium-239/240	pCi/L	-0.014	0.03	0.0024	0	5	10%DCG	3
Potassium-40	pCi/L	-34	27	3.4	0	5		
Suspended Alpha	pCi/L	-0.38	0.55	0.013	0	5		
Suspended Beta	pCi/L	-3.4	2.8	-0.85	0	5		
Technetium-99	pCi/L	-8.3	9.8	-0.14	0	5	ActionLimit	900
Thorium-228	pCi/L	0.035	0.09	0.056	0	5		
Thorium-230	pCi/L	0.026	0.053	0.04	0	5	10%DCG	30
Thorium-232	pCi/L	-0.02	0.013	0.0011	0	5		
Thorium-234	pCi/L	-16	29	0.044	0	5		
Uranium	mg/L	0.005	0.005	0.005	0	5	10%DCG	0.0901
Uranium	pCi/L	0.065	0.29	0.15	0	5	10%DCG	60
Uranium-234	pCi/L	-0.035	0.11	0.044	0	5	10%DCG	50
Uranium-238	pCi/L	0.039	0.19	0.097	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.16 Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.019	0.013	-0.0015	0	4		
Americium-241	pCi/L	-0.0092	0.041	0.0098	0	4	10%DCG	3
Cesium-134	pCi/L	-0.65	0.69	0.18	0	4		
Cesium-137	pCi/L	-0.76	0.56	0.029	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.7	0.93	-0.26	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.1	0.66	-0.35	0	4		
Dissolved Beta	pCi/L	3.2	5	4.1	0	4		
Neptunium-237	pCi/L	-0.026	0.026	-0.00071	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0064	0.016	0.0071	0	4		
Plutonium-239/240	pCi/L	-0.0014	0.017	0.0063	0	4	10%DCG	3
Potassium-40	pCi/L	-26	23	7.7	1	4		
Suspended Alpha	pCi/L	-2.1	0.97	-0.43	0	4		
Suspended Beta	pCi/L	-2.6	3.2	-0.11	0	4		
Technetium-99	pCi/L	-1.9	9.5	3.1	0	4	ActionLimit	900
Thorium-228	pCi/L	0.023	0.12	0.07	0	4		
Thorium-230	pCi/L	-0.0062	0.052	0.032	0	4	10%DCG	30
Thorium-232	pCi/L	-0.027	0.034	-0.00025	0	4		
Thorium-234	pCi/L	-33	24	-11	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	-0.022	0.088	0.011	0	4	10%DCG	60
Uranium-234	pCi/L	-0.032	0.06	0.0014	0	4	10%DCG	50
Uranium-238	pCi/L	-0.0034	0.038	0.012	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.17 Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.15	0.74	0.35	4	4		
Americium-241	pCi/L	-0.017	0.013	0.00064	0	4	10%DCG	3
Cesium-134	pCi/L	-0.53	1.3	0.34	0	4		
Cesium-137	pCi/L	-1	0.15	-0.26	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.2	0.52	-0.61	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	2.4	23	9.1	2	4		
Dissolved Beta	pCi/L	4.3	25	13	2	4		
Neptunium-237	pCi/L	-0.0033	0.084	0.028	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0077	0.017	0.0053	0	4		
Plutonium-239/240	pCi/L	-0.0034	0.035	0.024	0	4	10%DCG	3
Potassium-40	pCi/L	-32	-7.4	-15	0	4		
Suspended Alpha	pCi/L	-0.71	2.5	1.2	0	4		
Suspended Beta	pCi/L	3.6	22	12	2	4		
Technetium-99	pCi/L	-1.1	12	6.4	0	4	ActionLimit	900
Thorium-228	pCi/L	0.014	0.1	0.058	0	4		
Thorium-230	pCi/L	0.031	0.14	0.071	0	4	10%DCG	30
Thorium-232	pCi/L	-0.035	0.037	0.0095	0	4		
Thorium-234	pCi/L	-4.2	16	6.2	0	4		
Uranium	mg/L	0.005	0.022	0.01	3	4	10%DCG	0.0901
Uranium	pCi/L	3.9	22	11	4	4	10%DCG	60
Uranium-234	pCi/L	2.8	15	7.6	4	4	10%DCG	50
Uranium-238	pCi/L	0.95	6.6	2.9	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.18 Radiological Monitoring Data for Surface Water Location L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.023	0.073	0.043	0	4		
Americium-241	pCi/L	-0.024	0.022	-0.0059	0	4	10%DCG	3
Cesium-134	pCi/L	0.19	1.1	0.57	0	4		
Cesium-137	pCi/L	-0.85	1.1	0.28	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.4	0.74	-0.02	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.3	3.5	1.1	0	4		
Dissolved Beta	pCi/L	6	11	9.1	3	4		
Neptunium-237	pCi/L	-0.028	0.035	0.0083	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.013	0.017	0.0073	0	4		
Plutonium-239/240	pCi/L	-0.0014	0.02	0.0084	0	4	10%DCG	3
Potassium-40	pCi/L	-35	46	3.8	1	4		
Suspended Alpha	pCi/L	-0.33	2.7	1	0	4		
Suspended Beta	pCi/L	-0.41	4.2	1.9	0	4		
Technetium-99	pCi/L	-12	20	9.7	2	4	ActionLimit	900
Thorium-228	pCi/L	0.005	0.12	0.052	0	4		
Thorium-230	pCi/L	0.032	0.1	0.062	0	4	10%DCG	30
Thorium-232	pCi/L	-0.015	0.021	0.00052	0	4		
Thorium-234	pCi/L	-30	-12	-18	0	4		
Uranium	mg/L	0.005	0.007	0.0055	1	4	10%DCG	0.0901
Uranium	pCi/L	0.58	3.5	1.6	0	4	10%DCG	60
Uranium-234	pCi/L	0.13	1	0.45	1	4	10%DCG	50
Uranium-238	pCi/L	0.34	2.4	1.2	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.19 Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.011	0.01	0.00052	0	4		
Americium-241	pCi/L	-0.03	-0.0007	-0.011	0	4	10%DCG	3
Cesium-134	pCi/L	-0.25	1.2	0.41	0	4		
Cesium-137	pCi/L	-0.68	-0.14	-0.36	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.84	1.3	-0.092	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.17	1.1	0.54	0	4		
Dissolved Beta	pCi/L	-1.8	3.8	1.7	0	4		
Neptunium-237	pCi/L	-0.0072	0.039	0.012	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.015	0.0054	-0.0048	0	4		
Plutonium-239/240	pCi/L	-0.016	0.029	0.011	0	4	10%DCG	3
Potassium-40	pCi/L	-29	19	-2.2	0	4		
Suspended Alpha	pCi/L	-0.48	1.4	0.2	0	4		
Suspended Beta	pCi/L	-1.5	2.2	-0.17	0	4		
Technetium-99	pCi/L	-7.6	11	1.5	0	4	ActionLimit	900
Thorium-228	pCi/L	0.024	0.097	0.072	0	4		
Thorium-230	pCi/L	0.019	0.2	0.083	0	4	10%DCG	30
Thorium-232	pCi/L	-0.027	0.029	-0.0012	0	4		
Thorium-234	pCi/L	-30	23	-12	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.17	0.29	0.24	0	4	10%DCG	60
Uranium-234	pCi/L	0.1	0.15	0.13	0	4	10%DCG	50
Uranium-238	pCi/L	0.077	0.15	0.11	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.20 Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.004	0.014	0.0028	0	4		
Americium-241	pCi/L	-0.017	0.012	-0.0053	0	4	10%DCG	3
Cesium-134	pCi/L	-0.6	1.1	0.24	0	4		
Cesium-137	pCi/L	-0.84	0.63	-0.17	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.1	1	-0.002	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.89	1.9	0.37	0	4		
Dissolved Beta	pCi/L	1.8	5.2	3	0	4		
Neptunium-237	pCi/L	-0.021	0.029	0.0011	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.015	0.0047	-0.0075	0	4		
Plutonium-239/240	pCi/L	-0.0013	0.024	0.012	0	4	10%DCG	3
Potassium-40	pCi/L	-40	6.8	-8.7	0	4		
Suspended Alpha	pCi/L	-1.6	1.1	-0.56	0	4		
Suspended Beta	pCi/L	-2.4	3.1	-0.01	0	4		
Technetium-99	pCi/L	-22	8.6	-2.5	0	4	ActionLimit	900
Thorium-228	pCi/L	0.019	0.089	0.049	0	4		
Thorium-230	pCi/L	0.0099	0.56	0.17	0	4	10%DCG	30
Thorium-232	pCi/L	0.00078	0.012	0.0055	0	4		
Thorium-234	pCi/L	-36	24	-17	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.096	0.29	0.17	0	4	10%DCG	60
Uranium-234	pCi/L	0.028	0.17	0.083	0	4	10%DCG	50
Uranium-238	pCi/L	0.05	0.12	0.083	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.21 Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0049	0.023	0.0073	0	4		
Americium-241	pCi/L	-0.031	-0.0009	-0.014	0	4	10%DCG	3
Cesium-134	pCi/L	-0.33	0.39	0.075	0	4		
Cesium-137	pCi/L	-0.83	0.76	-0.2	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.1	1.1	0.16	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-2.3	2.7	0.83	0	4		
Dissolved Beta	pCi/L	-0.87	4.8	1.8	0	4		
Neptunium-237	pCi/L	-0.0039	0.033	0.0095	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0029	0.034	0.017	0	4		
Plutonium-239/240	pCi/L	0.017	0.025	0.02	0	4	10%DCG	3
Potassium-40	pCi/L	-29	18	-7.9	0	4		
Suspended Alpha	pCi/L	-0.62	0.35	-0.18	0	4		
Suspended Beta	pCi/L	-1.1	2	0.17	0	4		
Technetium-99	pCi/L	-16	8.2	-0.16	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0067	0.1	0.052	0	4		
Thorium-230	pCi/L	-0.0078	0.13	0.045	0	4	10%DCG	30
Thorium-232	pCi/L	-0.012	0.048	0.0072	0	4		
Thorium-234	pCi/L	-39	-17	-28	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.25	0.46	0.36	0	4	10%DCG	60
Uranium-234	pCi/L	0.11	0.29	0.2	1	4	10%DCG	50
Uranium-238	pCi/L	0.093	0.19	0.15	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.22 Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.012	0.014	-0.0014	0	4		
Americium-241	pCi/L	0.0096	0.02	0.014	0	4	10%DCG	3
Cesium-134	pCi/L	-0.14	1.1	0.32	0	4		
Cesium-137	pCi/L	-1.4	0.44	-0.36	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.63	-0.3	-0.45	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.45	1.3	0.58	0	4		
Dissolved Beta	pCi/L	0.86	12	5.1	1	4		
Neptunium-237	pCi/L	-0.015	0.014	-0.0013	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0062	0.008	0.0025	0	4		
Plutonium-239/240	pCi/L	-0.0016	0.013	0.0081	0	4	10%DCG	3
Potassium-40	pCi/L	-23	4.3	-12	0	4		
Suspended Alpha	pCi/L	-0.74	2.8	0.67	0	4		
Suspended Beta	pCi/L	-2.9	8.4	1.7	1	4		
Technetium-99	pCi/L	-3.7	12	2.7	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0021	0.1	0.055	0	4		
Thorium-230	pCi/L	-0.013	0.095	0.032	0	4	10%DCG	30
Thorium-232	pCi/L	0.00026	0.03	0.013	0	4		
Thorium-234	pCi/L	-27	4.6	-9.7	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	-0.034	0.33	0.072	0	4	10%DCG	60
Uranium-234	pCi/L	-0.015	0.19	0.04	0	4	10%DCG	50
Uranium-238	pCi/L	-0.015	0.12	0.033	0	4	10%DCG	60

Table 2.23 Radiological Monitoring Data for Surface Water Seep Location LBCSP5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-5.2	3.3	0.54	1	4		
Beta activity	pCi/L	120	140	130	4	4		
Technetium-99	pCi/L	150	200	170	4	4	ActionLimit	900
Uranium	pCi/L	0.0042	0.71	0.33	0	4	10%DCG	60

Table 2.24 Radiological Monitoring Data for Surface Water Seep Location LBCSP6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-1.1	5.5	2.4	2	4		
Beta activity	pCi/L	10	170	92	4	4		
Technetium-99	pCi/L	20	260	170	4	4	ActionLimit	900
Uranium	pCi/L	0.18	0.79	0.46	0	4	10%DCG	60

Sediment Radiological Data

Table 2.25 Radiological Data for Sediment Location S20

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0063	0.0078	0.0071	0	3		
Alpha activity	pCi/g	4.8	5	4.9	3	3		
Americium-241	pCi/g	0.0024	0.0066	0.0044	0	3		
Beta activity	pCi/g	2.1	3	2.6	3	3		
Cesium-137	pCi/g	-0.0027	0.036	0.011	1	3		
Cobalt-60	pCi/g	0.0048	0.013	0.0095	0	3		
Neptunium-237	pCi/g	0.0014	0.0032	0.0023	0	3		
Plutonium-239/240	pCi/g	0.0013	0.0039	0.0028	0	3		
Potassium-40	pCi/g	6.9	8.1	7.4	3	3		
Technetium-99	pCi/g	0.23	1.2	0.58	3	3		
Thorium-230	pCi/g	0.24	0.33	0.27	3	3		
Uranium	pCi/kg	200	240	230	2	3		
Uranium-234	pCi/g	0.1	0.11	0.11	3	3		
Uranium-238	pCi/g	0.094	0.12	0.11	3	3		

Table 2.26 Radiological Data for Sediment Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.047	0.095	0.071	2	2		
Alpha activity	pCi/g	3.5	8.3	5.9	2	2		
Americium-241	pCi/g	0.0041	0.015	0.0094	0	2		
Beta activity	pCi/g	12	22	17	2	2		
Cesium-137	pCi/g	0.036	0.084	0.06	1	2		
Cobalt-60	pCi/g	-0.0088	0.0025	-0.0031	0	2		
Neptunium-237	pCi/g	0.035	0.052	0.043	2	2		
Plutonium-239/240	pCi/g	0.021	0.041	0.031	2	2		
Potassium-40	pCi/g	5.5	6.9	6.2	2	2		
Technetium-99	pCi/g	5.9	8.8	7.4	2	2		
Thorium-230	pCi/g	0.33	0.36	0.34	2	2		
Uranium	pCi/kg	2000	3200	2600	2	2		
Uranium-234	pCi/g	0.81	1.3	1.1	2	2		
Uranium-238	pCi/g	1.1	1.8	1.5	2	2		

Sediment Radiological Data

Table 2.27 Radiological Data for Sediment Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.14	0.17	0.16	2	2		
Alpha activity	pCi/g	10	21	16	2	2		
Americium-241	pCi/g	0.016	0.032	0.024	1	2		
Beta activity	pCi/g	34	48	41	2	2		
Cesium-137	pCi/g	0.0015	0.029	0.015	0	2		
Cobalt-60	pCi/g	-0.003	-0.0013	-0.0022	0	2		
Neptunium-237	pCi/g	0.082	0.24	0.16	2	2		
Plutonium-239/240	pCi/g	0.093	0.14	0.11	2	2		
Potassium-40	pCi/g	6.3	9.2	7.7	2	2		
Technetium-99	pCi/g	8.6	14	11	2	2		
Thorium-230	pCi/g	0.62	0.96	0.79	2	2		
Uranium	pCi/kg	6700	7600	7100	2	2		
Uranium-234	pCi/g	2.8	3	2.9	2	2		
Uranium-238	pCi/g	3.7	4.4	4	2	2		

Table 2.28 Radiological Data for Sediment Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.047	0.061	0.054	2	2		
Alpha activity	pCi/g	5	5.6	5.3	2	2		
Americium-241	pCi/g	0.0031	0.0065	0.0048	0	2		
Beta activity	pCi/g	11	12	11	2	2		
Cesium-137	pCi/g	0.026	0.041	0.034	0	2		
Cobalt-60	pCi/g	-0.0056	0.0047	-0.00046	0	2		
Neptunium-237	pCi/g	0.0097	0.032	0.021	1	2		
Plutonium-239/240	pCi/g	0.018	0.024	0.021	2	2		
Potassium-40	pCi/g	5.5	7	6.3	2	2		
Technetium-99	pCi/g	2.7	14	8.5	2	2		
Thorium-230	pCi/g	0.31	0.32	0.32	2	2		
Uranium	pCi/kg	2100	2600	2300	2	2		
Uranium-234	pCi/g	0.77	0.96	0.87	2	2		
Uranium-238	pCi/g	1.3	1.5	1.4	2	2		

Sediment Radiological Data

Table 2.29 Radiological Data for Sediment Location S1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.037	0.087	0.062	2	2		
Alpha activity	pCi/g	3.1	10	6.8	2	2		
Americium-241	pCi/g	0.0038	0.006	0.0049	0	2		
Beta activity	pCi/g	5	30	17	2	2		
Cesium-137	pCi/g	0.05	0.056	0.053	2	2		
Cobalt-60	pCi/g	0.0013	0.007	0.0042	0	2		
Neptunium-237	pCi/g	0.021	0.1	0.062	1	2		
Plutonium-239/240	pCi/g	0.015	0.018	0.016	2	2		
Potassium-40	pCi/g	2.4	3.6	3	2	2		
Technetium-99	pCi/g	0.37	6.1	3.2	2	2		
Thorium-230	pCi/g	0.22	0.28	0.25	2	2		
Uranium	pCi/kg	1700	4800	3300	2	2		
Uranium-234	pCi/g	0.6	1.7	1.1	2	2		
Uranium-238	pCi/g	1.1	3	2.1	2	2		

Table 2.30 Radiological Data for Sediment Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.31	1	0.68	2	2		
Alpha activity	pCi/g	40	64	52	2	2		
Americium-241	pCi/g	0.02	0.023	0.022	0	2		
Beta activity	pCi/g	27	80	53	2	2		
Cesium-137	pCi/g	0.081	0.09	0.086	2	2		
Cobalt-60	pCi/g	0.0034	0.013	0.0082	0	2		
Neptunium-237	pCi/g	0.067	0.071	0.069	2	2		
Plutonium-239/240	pCi/g	0.13	0.15	0.14	2	2		
Potassium-40	pCi/g	2.6	3.3	3	2	2		
Technetium-99	pCi/g	0.28	2.7	1.5	2	2		
Thorium-230	pCi/g	1	1.4	1.2	2	2		
Uranium	pCi/kg	11000	33000	22000	2	2		
Uranium-234	pCi/g	7.8	24	16	2	2		
Uranium-238	pCi/g	2.7	8.5	5.6	2	2		

Sediment Radiological Data

Table 2.31 Radiological Data for Sediment Location S33

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.017	0.022	0.019	2	2		
Alpha activity	pCi/g	2	2.9	2.5	2	2		
Americium-241	pCi/g	0.0031	0.0092	0.0061	0	2		
Beta activity	pCi/g	2.7	3.4	3.1	2	2		
Cesium-137	pCi/g	0.036	0.041	0.039	2	2		
Cobalt-60	pCi/g	-0.015	0.0076	-0.0034	0	2		
Neptunium-237	pCi/g	0.0021	0.003	0.0026	0	2		
Plutonium-239/240	pCi/g	0.0083	0.011	0.0095	1	2		
Potassium-40	pCi/g	4.8	5.4	5.1	2	2		
Technetium-99	pCi/g	0.026	0.4	0.21	1	2		
Thorium-230	pCi/g	0.2	0.24	0.22	2	2		
Uranium	pCi/kg	800	820	810	2	2		
Uranium-234	pCi/g	0.34	0.42	0.38	2	2		
Uranium-238	pCi/g	0.35	0.47	0.41	2	2		

Table 2.32 Radiological Data for Sediment Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.051	0.093	0.072	2	2		
Alpha activity	pCi/g	6	9.8	7.9	2	2		
Americium-241	pCi/g	0.0019	0.003	0.0025	0	2		
Beta activity	pCi/g	6.5	13	9.7	2	2		
Cesium-137	pCi/g	-0.0085	0.00079	-0.0038	0	2		
Cobalt-60	pCi/g	0.01	0.02	0.015	0	2		
Neptunium-237	pCi/g	0.0046	0.0073	0.0059	0	2		
Plutonium-239/240	pCi/g	0.0026	0.0032	0.0029	0	2		
Potassium-40	pCi/g	3.7	4.5	4.1	2	2		
Technetium-99	pCi/g	0.15	0.31	0.23	1	2		
Thorium-230	pCi/g	0.21	0.3	0.26	2	2		
Uranium	pCi/kg	3200	7400	5300	2	2		
Uranium-234	pCi/g	0.48	0.86	0.67	2	2		
Uranium-238	pCi/g	2.6	6.5	4.6	2	2		

Sediment Radiological Data

Table 2.33 Radiological Data for Sediment Location S2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.14	0.14	0.14	2	2		
Alpha activity	pCi/g	9.4	11	10	2	2		
Americium-241	pCi/g	0.0024	0.0036	0.003	0	2		
Beta activity	pCi/g	12	12	12	2	2		
Cesium-137	pCi/g	0.0081	0.025	0.017	0	2		
Cobalt-60	pCi/g	-0.0058	0.0078	0.001	0	2		
Neptunium-237	pCi/g	0.0035	0.012	0.0077	0	2		
Plutonium-239/240	pCi/g	0.0018	0.0028	0.0023	0	2		
Potassium-40	pCi/g	2.8	3.3	3.1	2	2		
Technetium-99	pCi/g	0.27	1.6	0.95	2	2		
Thorium-230	pCi/g	0.19	0.19	0.19	2	2		
Uranium	pCi/kg	8500	10000	9500	2	2		
Uranium-234	pCi/g	1.4	2.2	1.8	2	2		
Uranium-238	pCi/g	6.2	9	7.6	2	2		

Table 2.34 Radiological Data for Sediment Location S27

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.045	0.06	0.053	2	2		
Alpha activity	pCi/g	5.7	5.7	5.7	2	2		
Americium-241	pCi/g	0.046	0.051	0.049	2	2		
Beta activity	pCi/g	6.6	6.6	6.6	2	2		
Cesium-137	pCi/g	0.0082	0.025	0.017	0	2		
Cobalt-60	pCi/g	-0.012	-0.0053	-0.0084	0	2		
Neptunium-237	pCi/g	0.022	0.025	0.024	0	2		
Plutonium-239/240	pCi/g	0.14	0.37	0.25	2	2		
Potassium-40	pCi/g	2.5	4.4	3.4	2	2		
Technetium-99	pCi/g	0.74	1	0.87	2	2		
Thorium-230	pCi/g	1.7	1.9	1.8	2	2		
Uranium	pCi/kg	2700	3100	2900	2	2		
Uranium-234	pCi/g	0.69	0.69	0.69	2	2		
Uranium-238	pCi/g	1.9	2.3	2.1	2	2		

Sediment Radiological Data

Table 2.35 Radiological Data for Sediment Location S34

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.043	0.046	0.045	2	2		
Alpha activity	pCi/g	5.3	5.3	5.3	2	2		
Americium-241	pCi/g	0.017	0.023	0.02	1	2		
Beta activity	pCi/g	4.9	6.9	5.9	2	2		
Cesium-137	pCi/g	0.024	0.068	0.046	1	2		
Cobalt-60	pCi/g	0.004	0.0098	0.0069	0	2		
Neptunium-237	pCi/g	0.01	0.014	0.012	0	2		
Plutonium-239/240	pCi/g	0.052	0.07	0.061	2	2		
Potassium-40	pCi/g	2.7	3.1	2.9	2	2		
Technetium-99	pCi/g	0.86	1.9	1.4	2	2		
Thorium-230	pCi/g	0.9	1.1	0.98	2	2		
Uranium	pCi/kg	1900	2200	2000	2	2		
Uranium-234	pCi/g	0.43	0.52	0.48	2	2		
Uranium-238	pCi/g	1.4	1.6	1.5	2	2		

Table 2.36 Radiological Data for Sediment Location C746KTB2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0026	0.0059	0.0043	0	2		
Alpha activity	pCi/g	0.95	4	2.5	2	2		
Americium-241	pCi/g	0.00058	0.0032	0.0019	0	2		
Beta activity	pCi/g	0.73	3.4	2.1	1	2		
Cesium-137	pCi/g	-0.014	0.02	0.0029	0	2		
Cobalt-60	pCi/g	-0.0031	0.0042	0.00052	0	2		
Neptunium-237	pCi/g	0.0012	0.0032	0.0022	0	2		
Plutonium-239/240	pCi/g	0.000099	0.0031	0.0016	0	2		
Potassium-40	pCi/g	1.6	2.6	2.1	2	2		
Technetium-99	pCi/g	0.16	0.42	0.29	1	2		
Thorium-230	pCi/g	0.12	0.15	0.13	2	2		
Uranium	pCi/kg	160	260	210	0	2		
Uranium-234	pCi/g	0.078	0.12	0.098	2	2		
Uranium-238	pCi/g	0.071	0.14	0.11	2	2		

Sediment Radiological Data

Table 2.37 Radiological Data for Sediment Location S32

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.12	0.31	0.21	2	2		
Alpha activity	pCi/g	88	140	110	2	2		
Americium-241	pCi/g	0.68	0.99	0.84	2	2		
Beta activity	pCi/g	68	160	110	2	2		
Cesium-137	pCi/g	0.61	0.83	0.72	2	2		
Cobalt-60	pCi/g	-0.0023	-5E-05	-0.0012	0	2		
Neptunium-237	pCi/g	0.68	0.98	0.83	2	2		
Plutonium-239/240	pCi/g	3.2	4.4	3.8	2	2		
Potassium-40	pCi/g	6.7	6.8	6.8	2	2		
Technetium-99	pCi/g	5.4	7.7	6.6	2	2		
Thorium-230	pCi/g	59	75	67	2	2		
Uranium	pCi/kg	5100	13000	9100	2	2		
Uranium-234	pCi/g	2.1	5.4	3.8	2	2		
Uranium-238	pCi/g	2.8	7.5	5.2	2	2		

Table 2.38 Radiological Data for Sediment Location S28

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0038	0.011	0.007	0	3		
Alpha activity	pCi/g	2.5	5.7	4.5	3	3		
Americium-241	pCi/g	0.0019	0.012	0.0071	0	3		
Beta activity	pCi/g	1.3	3.7	2.8	3	3		
Cesium-137	pCi/g	-0.021	-0.009	-0.013	0	3		
Cobalt-60	pCi/g	-0.0078	0.0087	-0.00094	0	3		
Neptunium-237	pCi/g	-0.00046	0.0047	0.0021	0	3		
Plutonium-239/240	pCi/g	0.0013	0.0045	0.0031	0	3		
Potassium-40	pCi/g	3.1	11	8.4	3	3		
Technetium-99	pCi/g	0.18	9.1	3.2	2	3		
Thorium-230	pCi/g	0.12	0.39	0.27	3	3		
Uranium	pCi/kg	150	320	250	1	3		
Uranium-234	pCi/g	0.08	0.17	0.13	3	3		
Uranium-238	pCi/g	0.071	0.14	0.11	3	3		

Direct Gamma Radiation (TLD) Data

Table 2.39 Radiological Exposure Due to Gamma Radiation (mrem)

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annualized[1]
TLD-1	270	403	246	335	1214
TLD-2	218	336	182	258	960
TLD-3	43	57	49	117	257
TLD-4	21	20	17	25	80
TLD-5	22	23	16	24	82
TLD-6	18	21	14	19	70
TLD-7	22	26	18	27	90
TLD-8	17	18	12	20	65
TLD-9	NA	20	14	21	73
TLD-10	19	21	14	22	74
TLD-11	20	21	16	23	77
TLD-12	19	20	14	21	72
TLD-13	24	25	17	26	90
TLD-14	19	19	13	20	69
TLD-15	17	17	12	19	63
TLD-16	23	22	16	24	82
TLD-17	19	19	14	20	70
TLD-18	18	19	14	19	68
TLD-19	18	NA	14	22	71
TLD-20	20	23	15	22	77
TLD-25	25	32	20	29	103
TLD-27	18	22	15	22	75
TLD-28	20	19	15	22	74
TLD-29	19	19	13	20	69
TLD-30	19	21	14	21	73
TLD-31	22	25	18	25	88
TLD-32	24	25	18	26	90
TLD-35	18	23	15	25	78
TLD-36	17	18	13	20	66
TLD-37	19	20	15	20	72
TLD-38	19	19	13	20	69
TLD-39	17	16	12	18	61
TLD-40	23	25	17	26	88
TLD-41	16	18	13	19	64
TLD-46	18	20	14	21	71
TLD-47	70	104	66	97	326
TLD-48	29	36	27	42	129
TLD-49	18	22	14	21	73
TLD-50	25	31	22	32	107
TLD-51	22	24	16	26	85
TLD-52	23	28	18	27	93
TLD-53	100	122	80	118	408
TLD-21	21	25	17	27	87
TLD-22	24	23	17	26	91
TLD-23	23	24	18	25	87
TLD-26	19	22	15	22	81

[1]Note: Annualized results represent a summation of the quarters adjusted to ensure that there is a correlation between the results and 1 year (365 days). TLDs may not have been collected on the last day of each quarter so this accounts for varying number of days.

NA – TLD Missing upon collection.

Deer Radiological Data

Table 2.40 Radiological Analysis of Deer Bone Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.0075	0.0065	-0.0012	0	6		
Plutonium-238	pCi/g	0.0029	0.011	0.0069	0	6		
Plutonium-239/240	pCi/g	-0.0032	0.0038	0.0001	0	6		
Technetium-99	pCi/g	-0.13	0.027	-0.033	0	6		
Thorium-230	pCi/g	0.000031	0.038	0.016	0	6		
Uranium-233/234	pCi/g	-0.0029	0.37	0.076	2	6		
Uranium-235	pCi/g	-0.0045	0.01	0.0027	0	6		
Uranium-238	pCi/g	-0.0036	0.34	0.071	2	6		

Table 2.41 Radiological Analysis of Deer Thyroid Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Technetium-99	pCi/g	-2.4	1.4	0.095	0	6		

Table 2.42 Radiological Analysis of Deer Muscle Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.0048	0.0018	-0.0011	0	6		
Plutonium-238	pCi/g	-0.0026	0.004	0.0015	0	6		
Plutonium-239/240	pCi/g	-0.018	0.001	-0.0039	0	6		
Technetium-99	pCi/g	0.0042	0.18	0.066	0	6		
Thorium-230	pCi/g	-0.0027	0.023	0.012	0	6		
Uranium-233/234	pCi/g	-0.0073	0.039	0.014	3	6		
Uranium-235	pCi/g	-0.0033	0.0044	0.00077	0	6		
Uranium-236	pCi/g	0	0	0	0	1		
Uranium-238	pCi/g	-0.0054	0.013	0.00033	1	6		

Table 2.43 Radiological Analysis of Deer Liver Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.0037	0.0025	-0.00092	0	6		
Plutonium-238	pCi/g	0	0.011	0.005	0	6		
Plutonium-239/240	pCi/g	-0.0052	0.0029	-0.00027	0	6		
Technetium-99	pCi/g	-0.0097	0.15	0.084	0	6		
Thorium-230	pCi/g	0.004	0.016	0.012	0	6		
Uranium-233/234	pCi/g	0.017	0.62	0.13	4	6		
Uranium-235	pCi/g	0	0.037	0.0084	1	6		
Uranium-236	pCi/g	0	0	0	0	2		
Uranium-238	pCi/g	0.0000025	0.65	0.11	3	6		

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3. NON-RADIOLOGICAL EFFLUENT DATA

KPDES Outfall Non-Radiological Data

Table 3.1 Non-Radiological Effluent Data for Outfall 001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	0	1
1,1-Dichloroethene	ug/L	ND	ND	ND	0	1
1,2-Diphenylhydrazine	ug/L	ND	ND	ND	0	1
2,4,6-Trichlorophenol	ug/L	ND	ND	ND	0	1
2,4-Dinitrotoluene	ug/L	ND	ND	ND	0	1
3,3'-Dichlorobenzidine	ug/L	ND	ND	ND	0	1
4,4'-DDD	ug/L	ND	ND	ND	0	1
4,4'-DDE	ug/L	ND	ND	ND	0	1
4,4'-DDT	ug/L	ND	ND	ND	0	1
Acrylonitrile	ug/L	ND	ND	ND	0	1
Aldrin	ug/L	ND	ND	ND	0	1
Alkalinity	mg/L	35	35	35	2	2
alpha-BHC	ug/L	ND	ND	ND	0	1
alpha-Chlordane	ug/L	ND	ND	ND	0	1
Antimony	mg/L	ND	ND	ND	0	6
Arsenic	mg/L	ND	ND	ND	0	6
Benz(a)anthracene	ug/L	0.039	0.039	0.039	1	1
Benzidine	ug/L	ND	ND	ND	0	1
Benzo(a)pyrene	ug/L	0.029	0.029	0.029	1	1
Benzo(k)fluoranthene	ug/L	0.036	0.036	0.036	1	1
Beryllium	mg/L	ND	ND	ND	0	6
beta-BHC	ug/L	ND	ND	ND	0	1
Bis(2-ethylhexyl)phthalate	ug/L	0.31	0.31	0.31	1	1
Cadmium	mg/L	ND	0.001	0.0004	1	7
Carbon tetrachloride	ug/L	ND	ND	ND	0	1
Chlorine, Total Residual	mg/L	0.03	0.04	0.03	83	83
Chromium	mg/L	ND	ND	ND	0	6
Chrysene	ug/L	ND	ND	ND	0	1
Conductivity	umho/cm	150	1600	1000	83	83
Copper	mg/L	0.0052	0.0089	0.0069	7	7
Cyanide	mg/L	0.005	0.005	0.005	1	1
Dibenz(a,h)anthracene	ug/L	ND	ND	ND	0	1
Dieldrin	ug/L	ND	ND	ND	0	1
Dissolved Oxygen	mg/L	5.2	1100	31	83	83
Endosulfan I	ug/L	ND	ND	ND	0	1
Endosulfan II	ug/L	ND	ND	ND	0	1
Endrin	ug/L	ND	ND	ND	0	1
Flow Rate	mgd	0.9	24	3.1	83	83
gamma-Chlordane	ug/L	ND	ND	ND	0	1
Hardness - Total as CaCO3	mg/L	110	340	270	13	13
Heptachlor	ug/L	0.15	0.15	0.15	1	1
Heptachlor epoxide	ug/L	ND	ND	ND	0	1
Hexachlorobenzene	ug/L	ND	ND	ND	0	1
Hexachloroethane	ug/L	ND	ND	ND	0	1
Indeno(1,2,3-cd)pyrene	ug/L	ND	ND	ND	0	1
Iron	mg/L	ND	1.3	0.55	5	6
Lead	mg/L	ND	ND	ND	0	7
Lindane	ug/L	ND	ND	ND	0	1

KPDES Outfall Non-Radiological Data

Table 3.1 Non-Radiological Effluent Data for Outfall 001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Mercury	mg/L	ND	0.0002	0.0000	1	7
Nickel	mg/L	ND	0.012	0.0079	5	6
N-Nitrosodimethylamine	ug/L	ND	ND	ND	0	1
N-Nitroso-di-n-propylamine	ug/L	ND	ND	ND	0	1
N-Nitrosodiphenylamine/Diphenylamine	ug/L	ND	ND	ND	0	1
Oil and Grease	mg/L	ND	ND	ND	0	52
PCB-1016	ug/L	ND	ND	ND	0	20
PCB-1221	ug/L	ND	ND	ND	0	20
PCB-1232	ug/L	ND	ND	ND	0	20
PCB-1242	ug/L	ND	ND	ND	0	20
PCB-1248	ug/L	ND	ND	ND	0	20
PCB-1254	ug/L	ND	ND	ND	0	20
PCB-1260	ug/L	ND	ND	ND	0	20
PCB-1268	ug/L	ND	ND	ND	0	20
Pentachlorophenol	ug/L	ND	ND	ND	0	1
pH	Std Unit	6.9	8.7	7.5	83	83
Phosphorous	mg/L	ND	0.49	0.21	51	52
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	20
Selenium	mg/L	ND	0.005	0.0028	1	7
Silver	mg/L	ND	ND	ND	0	7
Suspended Solids	mg/L	ND	25	8.6	2	8
Temperature	deg F	48	94	67	83	83
Tetrachloroethene	ug/L	ND	ND	ND	0	1
Thallium	mg/L	ND	ND	ND	0	7
Total Metals	mg/L	ND	1.3	0.6	5	6
Trichloroethene	ug/L	ND	ND	ND	0	20
Turbidity	NTU	8	42	21	10	10
Uranium	mg/L	0.0021	0.02	0.0076	14	14
Zinc	mg/L	ND	ND	ND	0	6

KPDES Outfall Non-Radiological Data

Table 3.2 Non-Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	0	1
1,1-Dichloroethene	ug/L	ND	ND	ND	0	1
1,2-Diphenylhydrazine	ug/L	ND	ND	ND	0	1
2,4,6-Trichlorophenol	ug/L	ND	ND	ND	0	1
2,4-Dinitrotoluene	ug/L	ND	ND	ND	0	1
3,3'-Dichlorobenzidine	ug/L	ND	ND	ND	0	1
4,4'-DDD	ug/L	ND	ND	ND	0	1
4,4'-DDE	ug/L	ND	ND	ND	0	1
4,4'-DDT	ug/L	ND	ND	ND	0	1
Acrylonitrile	ug/L	ND	ND	ND	0	1
Aldrin	ug/L	ND	ND	ND	0	1
alpha-BHC	ug/L	ND	ND	ND	0	1
alpha-Chlordane	ug/L	ND	ND	ND	0	1
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Benz(a)anthracene	ug/L	0.044	0.044	0.044	1	1
Benzidine	ug/L	ND	ND	ND	0	1
Benzo(a)pyrene	ug/L	0.032	0.032	0.032	1	1
Benzo(k)fluoranthene	ug/L	0.04	0.04	0.04	1	1
Beryllium	mg/L	ND	0.001	0.0006	1	4
beta-BHC	ug/L	ND	ND	ND	0	1
Bis(2-ethylhexyl)phthalate	ug/L	0.42	0.42	0.42	1	1
Cadmium	mg/L	ND	0.001	0.0004	1	5
Carbon tetrachloride	ug/L	ND	ND	ND	0	1
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	4	4
Chromium	mg/L	ND	ND	ND	0	4
Chrysene	ug/L	0.016	0.016	0.016	1	1
Conductivity	umho/cm	1.7	690	340	24	24
Copper	mg/L	ND	0.011	0.0061	3	5
Cyanide	mg/L	0.005	0.005	0.005	1	1
Dibenz(a,h)anthracene	ug/L	0.041	0.041	0.041	1	1
Dieldrin	ug/L	ND	ND	ND	0	1
Dissolved Oxygen	mg/L	6.3	14	9.3	24	24
Endosulfan I	ug/L	ND	ND	ND	0	1
Endosulfan II	ug/L	ND	ND	ND	0	1
Endrin	ug/L	ND	ND	ND	0	1
Flow Rate	mgd	0.0029	6	0.73	24	24
gamma-Chlordane	ug/L	ND	ND	ND	0	1
Hardness - Total as CaCO3	mg/L	110	420	210	10	10
Heptachlor	ug/L	0.0055	0.0055	0.0055	1	1
Heptachlor epoxide	ug/L	ND	ND	ND	0	1
Hexachlorobenzene	ug/L	ND	ND	ND	0	1
Hexachloroethane	ug/L	ND	ND	ND	0	1
Indeno(1,2,3-cd)pyrene	ug/L	ND	ND	ND	0	1
Iron	mg/L	0.52	1.3	0.74	5	5
Lead	mg/L	ND	0.0053	0.0028	2	5
Lindane	ug/L	0.0074	0.0074	0.0074	1	1
Mercury	mg/L	ND	0.0002	0.0000	1	5
Nickel	mg/L	ND	0.023	0.011	3	4
N-Nitrosodimethylamine	ug/L	ND	ND	ND	0	1

KPDES Outfall Non-Radiological Data

Table 3.2 Non-Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
N-Nitroso-di-n-propylamine	ug/L	ND	ND	ND	0	1
N-Nitrosodiphenylamine/Diphenylamine	ug/L	ND	ND	ND	0	1
Oil and Grease	mg/L	ND	ND	ND	0	12
PCB-1016	ug/L	ND	ND	ND	0	12
PCB-1221	ug/L	ND	ND	ND	0	12
PCB-1232	ug/L	ND	ND	ND	0	12
PCB-1242	ug/L	ND	ND	ND	0	12
PCB-1248	ug/L	ND	ND	ND	0	12
PCB-1254	ug/L	ND	ND	ND	0	12
PCB-1260	ug/L	ND	ND	ND	0	12
PCB-1268	ug/L	ND	ND	ND	0	12
Pentachlorophenol	ug/L	ND	ND	ND	0	1
pH	Std Unit	7.3	8.3	7.7	24	24
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	12
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Suspended Solids	mg/L	ND	25	12	1	3
Temperature	deg F	38	76	57	24	24
Tetrachloroethene	ug/L	ND	ND	ND	0	1
Thallium	mg/L	ND	ND	ND	0	5
Total Metals	mg/L	0.57	1.4	0.81	4	4
Turbidity	NTU	34	180	120	4	4
Uranium	mg/L	0.025	0.15	0.076	7	7
Zinc	mg/L	ND	0.052	0.029	2	4

KPDES Outfall Non-Radiological Data

Table 3.3 Non-Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	0	1
1,1-Dichloroethene	ug/L	ND	ND	ND	0	1
1,2-Diphenylhydrazine	ug/L	ND	ND	ND	0	1
2,4,6-Trichlorophenol	ug/L	ND	ND	ND	0	1
2,4-Dinitrotoluene	ug/L	ND	ND	ND	0	1
3,3'-Dichlorobenzidine	ug/L	ND	ND	ND	0	1
4,4'-DDD	ug/L	ND	ND	ND	0	1
4,4'-DDE	ug/L	ND	ND	ND	0	1
4,4'-DDT	ug/L	ND	ND	ND	0	1
Acrylonitrile	ug/L	ND	ND	ND	0	1
Aldrin	ug/L	ND	ND	ND	0	1
alpha-BHC	ug/L	ND	ND	ND	0	1
alpha-Chlordane	ug/L	ND	ND	ND	0	1
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Benz(a)anthracene	ug/L	0.053	0.053	0.053	1	1
Benzidine	ug/L	0.052	0.052	0.052	1	1
Benzo(a)pyrene	ug/L	0.042	0.042	0.042	1	1
Benzo(k)fluoranthene	ug/L	0.046	0.046	0.046	1	1
Beryllium	mg/L	ND	ND	ND	0	5
beta-BHC	ug/L	ND	ND	ND	0	1
Bis(2-ethylhexyl)phthalate	ug/L	0.36	0.36	0.36	1	1
Cadmium	mg/L	ND	0.001	0.0004	1	6
Carbon tetrachloride	ug/L	ND	ND	ND	0	1
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	4	4
Chromium	mg/L	ND	ND	ND	0	5
Chrysene	ug/L	0.022	0.022	0.022	1	1
Conductivity	umho/cm	1	460	230	27	27
Copper	mg/L	ND	0.0052	0.0026	1	6
Cyanide	mg/L	0.005	0.005	0.005	1	1
Dibenz(a,h)anthracene	ug/L	0.045	0.045	0.045	1	1
Dieldrin	ug/L	ND	ND	ND	0	1
Dissolved Oxygen	mg/L	6.1	13	9.2	27	27
Endosulfan I	ug/L	ND	ND	ND	0	1
Endosulfan II	ug/L	ND	ND	ND	0	1
Endrin	ug/L	ND	ND	ND	0	1
Flow Rate	mgd	0.05	29	2.8	27	27
gamma-Chlordane	ug/L	ND	ND	ND	0	1
Hardness - Total as CaCO3	mg/L	58	190	120	10	10
Heptachlor	ug/L	0.0031	0.0031	0.0031	1	1
Heptachlor epoxide	ug/L	ND	ND	ND	0	1
Hexachlorobenzene	ug/L	ND	ND	ND	0	1
Hexachloroethane	ug/L	ND	ND	ND	0	1
Indeno(1,2,3-cd)pyrene	ug/L	0.038	0.038	0.038	1	1
Iron	mg/L	0.32	1.5	0.98	5	5
Lead	mg/L	ND	0.005	0.0024	1	6
Lindane	ug/L	ND	ND	ND	0	1
Mercury	mg/L	ND	0.0002	0.0000	1	6
Nickel	mg/L	ND	ND	ND	0	5
N-Nitrosodimethylamine	ug/L	ND	ND	ND	0	1

KPDES Outfall Non-Radiological Data

Table 3.3 Non-Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
N-Nitroso-di-n-propylamine	ug/L	ND	ND	ND	0	1
N-Nitrosodiphenylamine/Diphenylamine	ug/L	ND	ND	ND	0	1
Oil and Grease	mg/L	ND	ND	ND	0	12
PCB-1016	ug/L	ND	ND	ND	0	12
PCB-1221	ug/L	ND	ND	ND	0	12
PCB-1232	ug/L	ND	ND	ND	0	12
PCB-1242	ug/L	ND	ND	ND	0	12
PCB-1248	ug/L	ND	ND	ND	0	12
PCB-1254	ug/L	ND	ND	ND	0	12
PCB-1260	ug/L	ND	ND	ND	0	12
PCB-1268	ug/L	ND	ND	ND	0	12
Pentachlorophenol	ug/L	ND	ND	ND	0	1
pH	Std Unit	7.5	8.3	7.8	27	27
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	12
Selenium	mg/L	ND	ND	ND	0	6
Silver	mg/L	ND	ND	ND	0	6
Suspended Solids	mg/L	ND	25	13	1	3
Temperature	deg F	42	80	58	28	28
Tetrachloroethene	ug/L	ND	ND	ND	0	1
Thallium	mg/L	ND	ND	ND	0	6
Total Metals	mg/L	0.47	1.5	1.1	5	5
Turbidity	NTU	0	150	91	8	8
Uranium	mg/L	0.0011	0.0029	0.0019	8	8
Zinc	mg/L	0.034	0.2	0.11	8	8

KPDES Outfall Non-Radiological Data

Table 3.4 Non-Radiological Effluent Data for Outfall 019

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Chlorine, Total Residual	mg/L	0.03	0.06	0.039	7	7
Chromium	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	130	220	170	13	13
Copper	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.5	9.5	7.9	13	13
Flow Rate	mgd	0.43	1.2	0.73	13	13
Hardness - Total as CaCO3	mg/L	74	120	91	4	4
Iron	mg/L	0.81	4.5	1.9	4	4
Lead	mg/L	ND	ND	ND	0	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Oil and Grease	mg/L	ND	ND	ND	0	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.5	8.8	8.4	13	13
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	51	88	74	13	13
Thallium	mg/L	ND	ND	ND	0	4
Total Metals	mg/L	0.81	4.6	1.9	4	4
Turbidity	mg/L	12	12	12	3	3
Turbidity	NTU	25	39	32	6	6
Uranium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 3.5 Non-Radiological Effluent Data for Landfill Surface Water Location L135

Upstream of the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	33	52	42	5	5
Chloride	mg/L	ND	7.3	5	4	5
Conductivity	umho/cm	72	170	130	5	5
Dissolved Oxygen	mg/L	7.6	12	9.1	5	5
Dissolved Solids	mg/L	77	140	110	5	5
Flow Rate	mgd	0.86	18	5.8	5	5
Iron	mg/L	0.7	2.3	1.1	5	5
pH	Std Unit	6.9	7.5	7.3	5	5
Sodium	mg/L	ND	10	3	4	5
Sulfate	mg/L	2.7	11	7.5	5	5
Suspended Solids	mg/L	ND	50	25	1	5
Temperature	deg F	42	74	57	5	5
Total Organic Carbon (TOC)	mg/L	14	21	19	5	5
Total Solids	mg/L	110	180	160	5	5
Uranium	mg/L	0.002	0.0057	0.0039	5	5

Table 3.6 Non-Radiological Effluent Data for Landfill Surface Water Location L136

At the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	30	40	35	4	4
Chloride	mg/L	ND	7.1	3.4	2	4
Conductivity	umho/cm	95	300	200	4	4
Dissolved Oxygen	mg/L	6.7	11	8.2	4	4
Dissolved Solids	mg/L	90	220	160	4	4
Flow Rate	mgd	0.16	0.83	0.38	4	4
Iron	mg/L	0.39	0.57	0.47	4	4
pH	Std Unit	7.4	8.2	7.8	4	4
Sodium	mg/L	ND	10	2.6	2	4
Sulfate	mg/L	3.8	27	15	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	42	75	59	4	4
Total Organic Carbon (TOC)	mg/L	12	18	14	4	4
Total Solids	mg/L	100	240	180	4	4
Uranium	mg/L	ND	0.0024	0.0011	2	4

Surface Water Non-Radiological Data

Table 3.7 Non-Radiological Effluent Data for Landfill Surface Water Location L137

Downstream of the C-746-S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	50	33	3	4
Chloride	mg/L	ND	8	4.3	2	4
Conductivity	umho/cm	0.06	140	77	4	4
Dissolved Oxygen	mg/L	7.8	12	9.7	4	4
Dissolved Solids	mg/L	ND	280	110	3	4
Flow Rate	mgd	1.2	24	7.4	4	4
Iron	mg/L	1.5	3.1	2	4	4
pH	Std Unit	7	7.5	7.3	4	4
Sodium	mg/L	ND	10	2.1	2	4
Sulfate	mg/L	2.5	13	6.2	4	4
Suspended Solids	mg/L	ND	360	120	2	4
Temperature	deg F	43	74	58	4	4
Total Organic Carbon (TOC)	mg/L	12	24	16	4	4
Total Solids	mg/L	150	480	260	4	4
Uranium	mg/L	ND	0.004	0.0017	2	4

Table 3.8 Non-Radiological Effluent Data for Landfill Surface Water Location L150

At the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	27	20	3	5
Chloride	mg/L	ND	4.7	2.5	3	5
Conductivity	umho/cm	100	200	150	5	5
Dissolved Oxygen	mg/L	7.9	12	9.8	5	5
Dissolved Solids	mg/L	ND	300	130	4	5
Flow Rate	mgd	0.04	1.5	0.35	5	5
Iron	mg/L	2	9.3	5.3	5	5
pH	Std Unit	8	8.6	8.1	5	5
Sodium	mg/L	ND	10	2.2	4	5
Sulfate	mg/L	7.5	25	17	5	5
Suspended Solids	mg/L	ND	250	110	4	5
Temperature	deg F	41	77	58	5	5
Total Organic Carbon (TOC)	mg/L	6.5	12	9	5	5
Total Solids	mg/L	180	420	260	5	5
Uranium	mg/L	ND	0.0014	0.0008	2	5

Surface Water Non-Radiological Data

Table 3.9 Non-Radiological Effluent Data for Landfill Surface Water Location L154

Upstream of the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	29	45	36	4	4
Chloride	mg/L	ND	15	6.2	2	4
Conductivity	umho/cm	0.064	150	88	4	4
Dissolved Oxygen	mg/L	7.4	14	9.6	4	4
Dissolved Solids	mg/L	64	160	120	4	4
Flow Rate	mgd	2.2	14	6.7	4	4
Iron	mg/L	0.66	2.1	1.2	4	4
pH	Std Unit	6.9	7.5	7.4	4	4
Sodium	mg/L	ND	10	2.2	2	4
Sulfate	mg/L	2.4	16	8.9	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	42	74	58	4	4
Total Organic Carbon (TOC)	mg/L	13	22	17	4	4
Total Solids	mg/L	100	180	150	4	4
Uranium	mg/L	0.0011	0.0016	0.0014	4	4

Table 3.10 Non-Radiological Effluent Data for Landfill Surface Water Location L155

Downstream of the C-746-U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	40	22	2	4
Chloride	mg/L	ND	26	10	3	4
Conductivity	umho/cm	53	320	160	4	4
Dissolved Oxygen	mg/L	7.3	10	8.6	4	4
Dissolved Solids	mg/L	ND	190	110	2	4
Flow Rate	mgd	17	590	310	2	2
Iron	mg/L	2.4	22	9.8	4	4
pH	Std Unit	6.4	7.8	7.2	4	4
Sodium	mg/L	1.7	26	11	4	4
Sulfate	mg/L	4.1	56	23	4	4
Suspended Solids	mg/L	260	1800	730	4	4
Temperature	deg F	45	74	59	4	4
Total Organic Carbon (TOC)	mg/L	6.2	14	9.7	4	4
Total Solids	mg/L	450	1800	920	4	4
Uranium	mg/L	0.0085	0.028	0.016	4	4

4. NON-RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA

Surface Water Non-Radiological Data

Table 4.1 Non-Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	15	35	29	5	5
Aluminum	mg/L	ND	1.9	1.2	4	5
Ammonia as Nitrogen	mg/L	ND	2.3	0.54	1	5
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Barium	mg/L	0.048	0.11	0.068	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	14	26	17	5	5
Chloride	mg/L	8.5	22	14	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	140	300	210	5	5
Copper	mg/L	ND	ND	ND	0	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	6.7	13	9	5	5
Flow Rate	mgd	0.31	6.2	3.4	5	5
Hardness - Total as CaCO3	mg/L	50	88	61	5	5
Iron	mg/L	0.29	1.4	0.97	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.1	5.1	3.6	5	5
Manganese	mg/L	0.064	0.18	0.13	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.34	6.9	1.8	5	5
PCB-1016	ug/L	ND	ND	ND	0	5
PCB-1221	ug/L	ND	ND	ND	0	5
PCB-1232	ug/L	ND	ND	ND	0	5
PCB-1242	ug/L	ND	ND	ND	0	5
PCB-1248	ug/L	ND	ND	ND	0	5
PCB-1254	ug/L	ND	ND	ND	0	5
PCB-1260	ug/L	ND	ND	ND	0	5
PCB-1268	ug/L	ND	ND	ND	0	5
pH	Std Unit	6.8	7.5	7	5	5
Phosphorous	mg/L	ND	0.62	0.24	4	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.7	12	5.9	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	7.1	32	14	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	37	73	58	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	3.1	1.9	4	5
Turbidity	NTU	26	33	31	4	4

Surface Water Non-Radiological Data

Table 4.1 Non-Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Uranium	mg/L	ND	ND	ND	0	10
Vanadium	mg/L	ND	ND	ND	0	5
Zinc	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.2 Non-Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	19	37	30	4	4
Aluminum	mg/L	ND	1.1	0.48	2	4
Ammonia as Nitrogen	mg/L	ND	0.4	0.17	1	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.029	0.05	0.038	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	27	45	36	4	4
Chloride	mg/L	29	66	49	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	420	780	600	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4	9.9	7.2	4	4
Flow Rate	mgd	8.9	23	13	4	4
Hardness - Total as CaCO3	mg/L	100	170	140	4	4
Iron	mg/L	ND	1.2	0.53	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	8.1	15	12	4	4
Manganese	mg/L	0.031	0.056	0.039	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.96	2.3	1.6	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.9	7.5	7.1	4	4
Phosphorous	mg/L	0.11	0.24	0.16	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	7.4	9.6	8.5	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	ND	83	42	3	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	53	85	68	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	16	120	50	3	3
Uranium	mg/L	ND	0.005	0.0026	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.2 Non-Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.3 Non-Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	35	25	4	4
Aluminum	mg/L	ND	1.2	0.41	2	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.036	0.049	0.044	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	23	44	35	4	4
Chloride	mg/L	26	66	48	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	370	760	600	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	7.3	10	9	4	4
Flow Rate	mgd	4.7	45	16	4	4
Hardness - Total as CaCO3	mg/L	96	170	130	4	4
Iron	mg/L	ND	1.1	0.46	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	7.5	14	12	4	4
Manganese	mg/L	0.058	0.11	0.075	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.76	1.9	1.4	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7	7.5	7.2	4	4
Phosphorous	mg/L	ND	0.29	0.16	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	7.2	9.6	8.3	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	ND	79	41	3	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	53	88	68	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	19	28	23	3	3
Uranium	mg/L	ND	0.005	0.0024	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.3 Non-Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.4 Non-Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	16	30	21	4	4
Aluminum	mg/L	ND	0.33	0.16	1	4
Ammonia as Nitrogen	mg/L	ND	0.34	0.16	1	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.032	0.046	0.039	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	100	150	130	4	4
Chloride	mg/L	200	260	230	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	0.0013	0.0052	0.0036	4	4
Conductivity	umho/cm	210	2500	1200	4	4
Copper	mg/L	0.0082	0.012	0.0097	4	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.5	10	8.6	4	4
Flow Rate	mgd	1.5	6	3.3	4	4
Hardness - Total as CaCO3	mg/L	440	580	520	4	4
Iron	mg/L	0.21	1.1	0.6	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	42	58	50	4	4
Manganese	mg/L	0.047	0.16	0.12	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	0.0095	0.016	0.014	4	4
Nitrate/Nitrite as Nitrogen	mg/L	2.8	6.1	4.4	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.8	8.4	7.3	4	4
Phosphorous	mg/L	0.19	0.38	0.25	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	ND	40	25	3	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	ND	300	190	3	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	50	88	68	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	8.4	44	23	3	3
Uranium	mg/L	ND	0.005	0.0024	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.4 Non-Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.013	1	4

Table 4.5 Non-Radiological Monitoring Data for Surface Water Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	35	40	37	3	3
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	1	1
Conductivity	umho/cm	180	1300	710	4	4
Dissolved Oxygen	mg/L	5.8	10	7.1	4	4
Flow Rate	mgd	2	2.6	2.3	4	4
pH	Std Unit	7.3	7.7	7.6	4	4
Temperature	deg F	39	80	62	4	4
Turbidity	NTU	12	22	17	2	2

Table 4.6 Non-Radiological Monitoring Data for Surface Water Location K015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	26	26	2	2
Conductivity	umho/cm	140	650	370	4	4
Dissolved Oxygen	mg/L	2.7	9.9	7.3	4	4
Flow Rate	mgd	0.0068	5.3	1.5	4	4
pH	Std Unit	7.4	8.2	7.7	4	4
Temperature	deg F	47	75	60	4	4
Turbidity	NTU	24	340	180	2	2

Surface Water Non-Radiological Data

Table 4.7 Non-Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	20	27	25	4	4
Aluminum	mg/L	ND	ND	ND	0	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.13	0.14	0.13	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	22	25	24	4	4
Chloride	mg/L	38	41	40	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	320	370	350	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.9	9.4	7.7	4	4
Hardness - Total as CaCO3	mg/L	90	99	94	4	4
Iron	mg/L	ND	ND	ND	0	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	9.2	11	9.8	4	4
Manganese	mg/L	ND	ND	ND	0	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	1.4	1.9	1.7	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.9	8.3	8.1	4	4
Phosphorous	mg/L	ND	ND	ND	0	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.1	1.2	1.2	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	27	30	28	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	58	69	63	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	1	3	1.7	4	4
Turbidity	NTU	2.5	8.5	5.8	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.8 Non-Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	14	35	23	4	4
Aluminum	mg/L	ND	1.8	0.99	3	4
Ammonia as Nitrogen	mg/L	ND	0.96	0.31	1	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.037	0.087	0.057	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	14	26	19	4	4
Chloride	mg/L	7.3	21	16	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	130	280	220	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.4	12	8.8	4	4
Flow Rate	mgd	0.63	15	4.6	4	4
Hardness - Total as CaCO3	mg/L	45	82	60	4	4
Iron	mg/L	ND	1.5	0.85	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.8	4.5	3.5	4	4
Manganese	mg/L	0.068	0.098	0.081	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	11	3.1	3	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7	7.5	7.3	4	4
Phosphorous	mg/L	ND	0.37	0.17	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.6	9.9	5.1	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	7.5	29	15	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	38	80	60	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	1.7	0.93	2	4
Turbidity	NTU	13	110	57	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.8 Non-Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.9 Non-Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	38	28	4	4
Aluminum	mg/L	0.31	3.8	1.8	4	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.04	0.071	0.057	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	18	21	20	4	4
Chloride	mg/L	20	63	31	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	150	360	260	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4.7	9.4	6.8	4	4
Flow Rate	mgd	3.9	17	8.1	4	4
Hardness - Total as CaCO3	mg/L	65	72	68	4	4
Iron	mg/L	0.38	3.2	1.6	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	3.3	5.1	4.5	4	4
Manganese	mg/L	0.056	0.097	0.078	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.38	0.92	0.56	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.1	7.2	7.2	4	4
Phosphorous	mg/L	0.16	0.26	0.22	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.3	3.8	3.1	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	23	34	28	4	4
Suspended Solids	mg/L	ND	45	22	1	4
Temperature	deg F	41	82	61	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	14	130	58	3	3
Uranium	mg/L	0.005	0.011	0.0089	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.9 Non-Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.10 Non-Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	15	35	24	4	4
Aluminum	mg/L	0.21	4.2	1.6	4	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.025	0.074	0.047	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	16	26	21	4	4
Chloride	mg/L	22	39	28	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	290	500	370	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4.8	10	7.8	4	4
Flow Rate	mgd	2.6	5.8	4.1	4	4
Hardness - Total as CaCO3	mg/L	53	88	72	4	4
Iron	mg/L	0.28	3.9	1.6	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.9	7.2	5.3	4	4
Manganese	mg/L	0.018	0.068	0.041	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.27	1.3	0.59	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.1	7.4	7.3	4	4
Phosphorous	mg/L	0.2	0.32	0.27	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.2	3.6	2.8	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	16	37	31	4	4
Suspended Solids	mg/L	ND	54	39	3	4
Temperature	deg F	48	86	68	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	16	190	97	3	3
Uranium	mg/L	ND	0.018	0.011	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.10 Non-Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.036	0.016	1	4

Surface Water Non-Radiological Data

Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	12	30	18	5	5
Aluminum	mg/L	0.2	6.1	4	5	5
Ammonia as Nitrogen	mg/L	ND	0.48	0.18	1	5
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Barium	mg/L	0.064	0.083	0.072	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	12	21	16	5	5
Chloride	mg/L	7.4	46	28	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	130	360	240	5	5
Copper	mg/L	ND	ND	ND	0	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	6.8	12	9.3	5	5
Flow Rate	mgd	1	18	13	5	5
Hardness - Total as CaCO3	mg/L	45	73	56	5	5
Iron	mg/L	0.55	3.7	2.9	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	2.8	5.9	3.6	5	5
Manganese	mg/L	0.073	0.1	0.085	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.12	0.59	0.3	5	5
PCB-1016	ug/L	ND	ND	ND	0	5
PCB-1221	ug/L	ND	ND	ND	0	5
PCB-1232	ug/L	ND	ND	ND	0	5
PCB-1242	ug/L	ND	ND	ND	0	5
PCB-1248	ug/L	ND	ND	ND	0	5
PCB-1254	ug/L	ND	ND	ND	0	5
PCB-1260	ug/L	ND	ND	ND	0	5
PCB-1268	ug/L	ND	ND	ND	0	5
pH	Std Unit	6.7	7.1	7	5	5
Phosphorous	mg/L	0.11	0.94	0.39	5	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.4	6.3	3.9	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	5.7	43	19	5	5
Suspended Solids	mg/L	ND	50	24	2	5
Temperature	deg F	43	80	59	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
Turbidity	NTU	72	170	120	4	4
Uranium	mg/L	ND	0.0077	0.0056	5	10
Vanadium	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.024	0.015	2	5

Surface Water Non-Radiological Data

Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	12	30	22	4	4
Aluminum	mg/L	ND	4.7	3.1	3	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.065	0.074	0.068	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	15	39	23	4	4
Chloride	mg/L	6	35	18	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.001	0.00063	1	4
Conductivity	umho/cm	140	360	240	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	8	9.6	9	4	4
Flow Rate	mgd	2.1	21	12	4	4
Hardness - Total as CaCO3	mg/L	50	100	70	4	4
Iron	mg/L	ND	3	2.2	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.7	6.1	3.9	4	4
Manganese	mg/L	0.088	0.14	0.11	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.31	1.2	0.76	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.6	7.1	6.8	4	4
Phosphorous	mg/L	0.1	0.37	0.27	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.8	5.1	3.8	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	5.3	27	14	4	4
Suspended Solids	mg/L	ND	40	21	1	4
Temperature	deg F	43	76	61	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	2.2	1.3	3	4
Turbidity	NTU	53	140	110	3	3
Uranium	mg/L	ND	0.0075	0.0037	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	33	25	5	5
Aluminum	mg/L	ND	5.4	2.1	4	5
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	5
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Barium	mg/L	0.066	0.1	0.078	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	11	24	16	5	5
Chloride	mg/L	5.7	29	14	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	120	320	190	5	5
Copper	mg/L	ND	ND	ND	0	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	7.1	10	8.6	5	5
Flow Rate	mgd	5.2	23	11	5	5
Hardness - Total as CaCO3	mg/L	39	81	58	5	5
Iron	mg/L	0.32	3.4	1.9	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	2.5	6.6	4.2	5	5
Manganese	mg/L	0.023	0.094	0.064	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.17	1	0.63	5	5
PCB-1016	ug/L	ND	ND	ND	0	5
PCB-1221	ug/L	ND	ND	ND	0	5
PCB-1232	ug/L	ND	ND	ND	0	5
PCB-1242	ug/L	ND	ND	ND	0	5
PCB-1248	ug/L	ND	ND	ND	0	5
PCB-1254	ug/L	ND	ND	ND	0	5
PCB-1260	ug/L	ND	ND	ND	0	5
PCB-1268	ug/L	ND	ND	ND	0	5
pH	Std Unit	6.5	7	6.7	5	5
Phosphorous	mg/L	ND	0.4	0.25	4	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.4	5.2	3.5	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	5.2	35	16	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	51	74	65	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	2.8	21	11	5	5
Turbidity	NTU	18	130	88	4	4
Uranium	mg/L	ND	0.011	0.0045	5	10
Vanadium	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.14 Non-Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	14	37	27	5	5
Aluminum	mg/L	ND	0.94	0.47	3	5
Ammonia as Nitrogen	mg/L	ND	0.5	0.18	1	5
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Barium	mg/L	0.036	0.064	0.046	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	16	23	19	5	5
Chloride	mg/L	8.3	76	27	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	150	430	270	5	5
Copper	mg/L	ND	ND	ND	0	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	6.5	13	8.9	5	5
Flow Rate	mgd	0.58	7.4	2.3	5	5
Hardness - Total as CaCO3	mg/L	51	75	63	5	5
Iron	mg/L	0.26	1.1	0.66	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.1	4.4	3.9	5	5
Manganese	mg/L	0.04	0.083	0.059	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	ND	3.3	0.92	4	5
PCB-1016	ug/L	ND	ND	ND	0	5
PCB-1221	ug/L	ND	ND	ND	0	5
PCB-1232	ug/L	ND	ND	ND	0	5
PCB-1242	ug/L	ND	ND	ND	0	5
PCB-1248	ug/L	ND	ND	ND	0	5
PCB-1254	ug/L	ND	ND	ND	0	5
PCB-1260	ug/L	ND	ND	ND	0	5
PCB-1268	ug/L	ND	ND	ND	0	5
pH	Std Unit	6.9	7.6	7.2	5	5
Phosphorous	mg/L	ND	0.21	0.1	3	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.4	6.9	4	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	8.6	38	22	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	42	81	66	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
Turbidity	NTU	18	36	26	3	3
Uranium	mg/L	ND	0.005	0.0016	1	10
Vanadium	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.14 Non-Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.15 Non-Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	25	20	4	4
Aluminum	mg/L	ND	ND	ND	0	4
Ammonia as Nitrogen	mg/L	ND	0.77	0.35	2	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.0083	0.027	0.016	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	15	26	19	4	4
Chloride	mg/L	18	25	22	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	290	370	330	4	4
Copper	mg/L	ND	0.0076	0.0048	2	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4.5	8.2	6.4	4	4
Flow Rate	mgd	0.75	4.6	1.9	4	4
Hardness - Total as CaCO3	mg/L	50	90	68	4	4
Iron	mg/L	ND	0.33	0.23	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.6	6.2	5.6	4	4
Manganese	mg/L	0.012	0.025	0.018	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.8	2.1	1.3	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7	7.3	7.1	4	4
Phosphorous	mg/L	0.2	0.51	0.35	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	3	4.9	3.7	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	27	43	34	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	58	88	73	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	10	100	68	3	3
Uranium	mg/L	ND	0.023	0.0095	4	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.15 Non-Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.013	1	4

Surface Water Non-Radiological Data

Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	30	53	37	4	4
Aluminum	mg/L	ND	2.6	1	2	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.053	0.062	0.057	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	9.5	14	12	4	4
Chloride	mg/L	8.6	21	14	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	120	250	190	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4.2	12	7.7	4	4
Flow Rate	mgd	0.5	2.2	1.5	4	4
Hardness - Total as CaCO3	mg/L	39	47	44	4	4
Iron	mg/L	ND	2.2	0.89	2	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2	3.3	2.8	4	4
Manganese	mg/L	0.0072	0.051	0.025	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.33	1.2	0.73	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.6	7.3	7	4	4
Phosphorous	mg/L	ND	0.17	0.11	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.2	5	3.8	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	6.6	32	18	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	38	78	59	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	12	20	15	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.17 Non-Radiological Monitoring Data for Surface Water Location L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	20	45	29	4	4
Aluminum	mg/L	ND	2.4	1	3	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.048	0.063	0.056	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	25	36	32	4	4
Chloride	mg/L	14	40	24	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.0015	0.00076	1	4
Conductivity	umho/cm	260	480	370	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.6	13	9	4	4
Hardness - Total as CaCO3	mg/L	83	120	110	4	4
Iron	mg/L	0.31	1.8	1.1	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.8	9.3	7.6	4	4
Manganese	mg/L	0.11	0.48	0.23	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.54	1.2	0.85	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.5	7.5	7.1	4	4
Phosphorous	mg/L	ND	0.22	0.14	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	3	5.3	4.1	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	14	46	26	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	51	78	64	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	1.4	0.72	1	4
Turbidity	NTU	5.4	94	40	3	3
Uranium	mg/L	ND	0.0073	0.0036	4	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.18 Non-Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	19	65	34	4	4
Aluminum	mg/L	0.27	2.2	1	4	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.029	0.044	0.037	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	23	36	28	4	4
Chloride	mg/L	8.7	15	12	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.0019	0.00086	1	4
Conductivity	umho/cm	200	290	250	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.8	11	8.8	4	4
Hardness - Total as CaCO3	mg/L	79	120	95	4	4
Iron	mg/L	0.39	2.6	1.4	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.7	9	7	4	4
Manganese	mg/L	0.088	0.19	0.12	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.24	1	0.65	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.5	7.9	7.7	4	4
Phosphorous	mg/L	ND	0.17	0.13	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.8	3	2.3	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	7.6	12	10	4	4
Suspended Solids	mg/L	ND	64	34	2	4
Temperature	deg F	44	86	63	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	17	190	88	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.19 Non-Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	20	55	34	4	4
Aluminum	mg/L	0.29	3.3	1.4	4	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.027	0.051	0.039	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	23	36	29	4	4
Chloride	mg/L	8.5	15	12	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.0029	0.0012	2	4
Conductivity	umho/cm	200	290	240	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	1.2	11	6.9	4	4
Hardness - Total as CaCO3	mg/L	77	140	100	4	4
Iron	mg/L	0.43	3.9	1.7	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	5.4	9.3	7.3	4	4
Manganese	mg/L	0.057	0.29	0.14	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.0058	0.0033	1	4
Nitrate/Nitrite as Nitrogen	mg/L	0.24	1	0.67	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.5	7.8	7.7	4	4
Phosphorous	mg/L	ND	0.2	0.14	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.8	3.2	2.4	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	8.3	12	10	4	4
Suspended Solids	mg/L	ND	85	37	2	4
Temperature	deg F	46	87	64	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	15	190	93	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.20 Non-Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	75	43	4	4
Aluminum	mg/L	0.36	2.1	1.3	4	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.043	0.054	0.048	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	31	47	38	4	4
Chloride	mg/L	15	22	19	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.0026	0.0013	2	4
Conductivity	umho/cm	320	410	370	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	8.7	12	10	4	4
Hardness - Total as CaCO3	mg/L	110	170	150	4	4
Iron	mg/L	0.59	3.7	2.1	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	8.6	14	12	4	4
Manganese	mg/L	0.062	0.24	0.13	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.0058	0.0033	1	4
Nitrate/Nitrite as Nitrogen	mg/L	0.43	2.2	1.5	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	7.1	8.1	7.7	4	4
Phosphorous	mg/L	ND	0.29	0.19	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.5	3.1	2.8	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	8.3	16	13	4	4
Suspended Solids	mg/L	ND	160	69	2	4
Temperature	deg F	41	88	62	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	22	210	110	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	16	30	21	4	4
Aluminum	mg/L	ND	4.5	1.4	2	4
Ammonia as Nitrogen	mg/L	ND	ND	ND	0	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.045	0.1	0.063	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	11	14	12	4	4
Chloride	mg/L	8.9	26	15	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.0021	0.00089	1	4
Conductivity	umho/cm	130	150	140	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.5	12	8.8	4	4
Flow Rate	mgd	1.2	34	14	4	4
Hardness - Total as CaCO3	mg/L	39	54	44	4	4
Iron	mg/L	0.63	5.5	2	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.6	3.5	3	4	4
Manganese	mg/L	0.14	0.39	0.26	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.0053	0.0032	1	4
Nitrate/Nitrite as Nitrogen	mg/L	0.26	0.91	0.59	4	4
PCB-1016	ug/L	ND	ND	ND	0	4
PCB-1221	ug/L	ND	ND	ND	0	4
PCB-1232	ug/L	ND	ND	ND	0	4
PCB-1242	ug/L	ND	ND	ND	0	4
PCB-1248	ug/L	ND	ND	ND	0	4
PCB-1254	ug/L	ND	ND	ND	0	4
PCB-1260	ug/L	ND	ND	ND	0	4
PCB-1268	ug/L	ND	ND	ND	0	4
pH	Std Unit	6.8	7.3	7	4	4
Phosphorous	mg/L	ND	0.43	0.16	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.1	6.6	3.8	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	4.8	14	9.1	4	4
Suspended Solids	mg/L	ND	140	43	1	4
Temperature	deg F	44	74	61	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Turbidity	NTU	22	240	110	3	3
Uranium	mg/L	ND	ND	ND	0	8
Vanadium	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.013	1	4

Table 4.22 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,1-Trichloroethane	ug/L	ND	ND	ND	0	4
1,1,2-Trichloroethane	ug/L	ND	ND	ND	0	4
1,1-Dichloroethane	ug/L	ND	ND	ND	0	4
1,1-Dichloroethene	ug/L	ND	ND	ND	0	4
1,2-Dichloroethane	ug/L	ND	ND	ND	0	4
1,2-Dimethylbenzene	ug/L	ND	ND	ND	0	4
Alkalinity	mg/L	19	35	27	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	23	25	24	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	30	31	31	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	340	370	350	4	4
Dissolved Oxygen	mg/L	2.9	5	3.9	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	7.2	8.1	7.7	4	4
Manganese	mg/L	ND	0.015	0.0057	1	4
pH	Std Unit	6.1	6.2	6.2	4	4
Potassium	mg/L	1.6	1.8	1.7	4	4
Sodium	mg/L	26	34	31	4	4
Sulfate	mg/L	17	17	17	4	4
Temperature	deg F	54	59	58	4	4
Tetrachloroethene	ug/L	ND	ND	ND	0	4
Toluene	ug/L	ND	ND	ND	0	4
trans-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Trichloroethene	ug/L	340	370	360	4	4
Turbidity	NTU	6.7	180	68	3	3
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.23 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,1-Trichloroethane	ug/L	ND	ND	ND	0	4
1,1,2-Trichloroethane	ug/L	ND	ND	ND	0	4
1,1-Dichloroethane	ug/L	ND	ND	ND	0	4
1,1-Dichloroethene	ug/L	ND	ND	ND	0	4
1,2-Dichloroethane	ug/L	ND	ND	ND	0	4
1,2-Dimethylbenzene	ug/L	ND	ND	ND	0	4
Alkalinity	mg/L	19	40	30	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	21	26	23	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	5.7	33	26	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	190	360	300	4	4
Dissolved Oxygen	mg/L	4.3	9.8	5.8	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	3.8	7.8	6.1	4	4
Manganese	mg/L	0.029	0.059	0.041	4	4
pH	Std Unit	6.1	7.1	6.4	4	4
Potassium	mg/L	1.5	6.1	2.9	4	4
Sodium	mg/L	3.5	31	21	4	4
Sulfate	mg/L	14	24	17	4	4
Temperature	deg F	48	63	56	4	4
Tetrachloroethene	ug/L	ND	ND	ND	0	4
Toluene	ug/L	ND	ND	ND	0	4
trans-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Trichloroethene	ug/L	34	520	340	4	4
Turbidity	NTU	17	39	28	2	2
Vinyl chloride	ug/L	ND	ND	ND	0	4

Sediment Non-Radiological Data

Table 4.24 Non-Radiological Data for Sediment Location S20

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3400	5600	4200	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	ND	ND	ND	0	3
Barium	mg/kg	41	55	46	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Calcium	mg/kg	370	410	390	3	3
Chromium	mg/kg	5.5	7.6	6.3	3	3
Cobalt	mg/kg	3.6	4.7	4.3	3	3
Copper	mg/kg	4.9	5.7	5.4	3	3
Iron	mg/kg	5900	6700	6300	3	3
Lead	mg/kg	ND	ND	ND	0	3
Magnesium	mg/kg	410	660	510	3	3
Manganese	mg/kg	100	130	120	3	3
Mercury	mg/kg	ND	ND	ND	0	3
Nickel	mg/kg	5.1	5.6	5.3	3	3
PCB-1016	ug/kg	ND	ND	ND	0	3
PCB-1221	ug/kg	ND	ND	ND	0	3
PCB-1232	ug/kg	ND	ND	ND	0	3
PCB-1242	ug/kg	ND	ND	ND	0	3
PCB-1248	ug/kg	ND	ND	ND	0	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	ND	ND	ND	0	3
PCB-1268	ug/kg	ND	ND	ND	0	3
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	3
Potassium	mg/kg	200	370	260	3	3
Selenium	mg/kg	ND	ND	ND	0	3
Silver	mg/kg	ND	ND	ND	0	3
Sodium	mg/kg	ND	370	170	1	3
Thallium	mg/kg	ND	ND	ND	0	3
Uranium	mg/kg	ND	ND	ND	0	3
Vanadium	mg/kg	12	12	12	3	3
Zinc	mg/kg	ND	ND	ND	0	3

Sediment Non-Radiological Data

Table 4.25 Non-Radiological Data for Sediment Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2600	3400	3000	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	34	40	37	2	2
Beryllium	mg/kg	ND	0.56	0.4	1	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1200	1300	1200	2	2
Chromium	mg/kg	11	12	11	2	2
Cobalt	mg/kg	3.2	5.2	4.2	2	2
Copper	mg/kg	18	19	19	2	2
Iron	mg/kg	5100	7300	6200	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	520	550	540	2	2
Manganese	mg/kg	34	55	45	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	6.4	7.5	7	2	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	290	350	320	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	240	170	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	6.4	15	11	2	2
Zinc	mg/kg	37	38	38	2	2

Sediment Non-Radiological Data

Table 4.26 Non-Radiological Data for Sediment Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2900	6500	4700	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	44	74	59	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1000	1100	1100	2	2
Chromium	mg/kg	21	32	27	2	2
Cobalt	mg/kg	3.4	5.4	4.4	2	2
Copper	mg/kg	15	21	18	2	2
Iron	mg/kg	6200	11000	8800	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	490	740	620	2	2
Manganese	mg/kg	30	120	74	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	8.9	9.7	9.3	2	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	310	540	430	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	220	270	250	2	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	9.2	21	15	2	2
Zinc	mg/kg	27	30	28	2	2

Sediment Non-Radiological Data

Table 4.27 Non-Radiological Data for Sediment Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3100	3800	3400	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	32	39	36	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1000	1100	1100	2	2
Chromium	mg/kg	8.8	9	8.9	2	2
Cobalt	mg/kg	4.2	4.8	4.5	2	2
Copper	mg/kg	13	16	15	2	2
Iron	mg/kg	4200	7300	5700	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	550	640	590	2	2
Manganese	mg/kg	29	45	37	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	5.8	7.4	6.6	2	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	330	340	340	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	180	200	190	2	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	6.1	14	10	2	2
Zinc	mg/kg	32	35	33	2	2

Sediment Non-Radiological Data

Table 4.28 Non-Radiological Data for Sediment Location S1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2700	5400	4100	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	20	25	23	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	620	720	670	2	2
Chromium	mg/kg	10	11	10	2	2
Cobalt	mg/kg	2.5	3.7	3.1	2	2
Copper	mg/kg	6.1	6.2	6.1	2	2
Iron	mg/kg	5600	8300	6900	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	300	320	310	2	2
Manganese	mg/kg	68	110	88	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	6.2	4.3	1	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	190	290	240	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	190	110	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	11	14	13	2	2
Zinc	mg/kg	ND	19	14	1	2

Sediment Non-Radiological Data

Table 4.29 Non-Radiological Data for Sediment Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2000	2500	2200	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	26	26	26	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	2100	2900	2500	2	2
Chromium	mg/kg	11	13	12	2	2
Cobalt	mg/kg	ND	ND	ND	0	2
Copper	mg/kg	33	36	34	2	2
Iron	mg/kg	3600	4500	4100	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	690	760	730	2	2
Manganese	mg/kg	21	25	23	2	2
Mercury	mg/kg	0.13	0.39	0.26	2	2
Nickel	mg/kg	13	16	14	2	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	220	130	1	2
PCB-1260	ug/kg	260	340	300	2	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	260	560	410	2	2
Potassium	mg/kg	200	230	210	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	180	94	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	4.4	5.7	5.1	2	2
Zinc	mg/kg	100	120	110	2	2

Sediment Non-Radiological Data

Table 4.30 Non-Radiological Data for Sediment Location S33

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3100	3400	3200	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	36	39	38	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	400	560	480	2	2
Chromium	mg/kg	9.2	9.4	9.3	2	2
Cobalt	mg/kg	2.5	3	2.8	2	2
Copper	mg/kg	3.5	6.4	4.9	2	2
Iron	mg/kg	4800	5100	5000	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	340	340	340	2	2
Manganese	mg/kg	300	320	310	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	4.9	3.2	1	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	190	230	210	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	71	210	140	2	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	9.6	10	9.9	2	2
Zinc	mg/kg	ND	ND	ND	0	2

Sediment Non-Radiological Data

Table 4.31 Non-Radiological Data for Sediment Location S2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2500	2800	2600	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	30	41	36	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	820	1000	920	2	2
Chromium	mg/kg	23	32	27	2	2
Cobalt	mg/kg	3.2	5.2	4.2	2	2
Copper	mg/kg	5.1	7.1	6.1	2	2
Iron	mg/kg	4700	8400	6500	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	280	280	280	2	2
Manganese	mg/kg	160	420	290	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	ND	ND	0	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	490	260	1	2
PCB-1254	ug/kg	90	200	140	2	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	90	690	390	2	2
Potassium	mg/kg	140	150	140	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	9.5	15	12	2	2
Zinc	mg/kg	26	35	30	2	2

Sediment Non-Radiological Data

Table 4.32 Non-Radiological Data for Sediment Location S27

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1300	4700	3000	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	14	26	20	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	190	330	260	2	2
Chromium	mg/kg	14	23	18	2	2
Cobalt	mg/kg	ND	ND	ND	0	2
Copper	mg/kg	4.4	5.4	4.9	2	2
Iron	mg/kg	2300	3900	3100	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	110	360	240	2	2
Manganese	mg/kg	38	70	54	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	ND	ND	0	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	ND	290	170	1	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	4	2.6	1	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	5.3	10	7.9	2	2
Zinc	mg/kg	ND	ND	ND	0	2

Sediment Non-Radiological Data

Table 4.33 Non-Radiological Data for Sediment Location S34

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1900	4100	3000	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	18	33	25	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	240	440	340	2	2
Chromium	mg/kg	13	21	17	2	2
Cobalt	mg/kg	ND	ND	ND	0	2
Copper	mg/kg	3.7	5.1	4.4	2	2
Iron	mg/kg	3000	3800	3400	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	170	330	250	2	2
Manganese	mg/kg	46	56	51	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	ND	ND	0	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	120	300	210	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	6.5	11	8.6	2	2
Zinc	mg/kg	ND	ND	ND	0	2

Sediment Non-Radiological Data

Table 4.34 Non-Radiological Data for Sediment Location C746KTB2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1600	2700	2200	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	15	21	18	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	250	510	380	2	2
Chromium	mg/kg	5.9	7.1	6.5	2	2
Cobalt	mg/kg	ND	2.4	1.8	1	2
Copper	mg/kg	3.1	3.8	3.5	2	2
Iron	mg/kg	4600	4700	4700	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	150	270	210	2	2
Manganese	mg/kg	110	140	120	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	ND	ND	0	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	2
Potassium	mg/kg	99	190	150	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	8.6	10	9.4	2	2
Zinc	mg/kg	ND	ND	ND	0	2

Sediment Non-Radiological Data

Table 4.35 Non-Radiological Data for Sediment Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4700	5000	4800	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	42	48	45	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	740	870	800	2	2
Chromium	mg/kg	10	14	12	2	2
Cobalt	mg/kg	3.6	4.2	3.9	2	2
Copper	mg/kg	5.4	6.7	6	2	2
Iron	mg/kg	6400	7000	6700	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	410	520	460	2	2
Manganese	mg/kg	150	220	190	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Nickel	mg/kg	ND	ND	ND	0	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	140	92	1	2
PCB-1254	ug/kg	ND	80	55	1	2
PCB-1260	ug/kg	ND	ND	ND	0	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	210	140	1	2
Potassium	mg/kg	210	240	220	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	12	13	13	2	2
Zinc	mg/kg	18	26	22	2	2

Sediment Non-Radiological Data

Table 4.36 Non-Radiological Data for Sediment Location S32

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	5000	6700	5800	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	38	60	49	2	2
Beryllium	mg/kg	ND	0.49	0.36	1	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1400	2400	1900	2	2
Chromium	mg/kg	33	53	43	2	2
Cobalt	mg/kg	2.6	4.4	3.5	2	2
Copper	mg/kg	26	48	37	2	2
Iron	mg/kg	8300	10000	9400	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	530	800	660	2	2
Manganese	mg/kg	84	160	120	2	2
Mercury	mg/kg	0.11	0.2	0.15	2	2
Nickel	mg/kg	17	29	23	2	2
PCB-1016	ug/kg	ND	ND	ND	0	2
PCB-1221	ug/kg	ND	ND	ND	0	2
PCB-1232	ug/kg	ND	ND	ND	0	2
PCB-1242	ug/kg	ND	ND	ND	0	2
PCB-1248	ug/kg	ND	ND	ND	0	2
PCB-1254	ug/kg	370	490	430	2	2
PCB-1260	ug/kg	200	360	280	2	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	570	850	710	2	2
Potassium	mg/kg	360	550	450	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	16	21	19	2	2
Zinc	mg/kg	50	110	81	2	2

Sediment Non-Radiological Data

Table 4.37 Non-Radiological Data for Sediment Location S28

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2900	5600	4100	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	ND	ND	ND	0	3
Barium	mg/kg	28	50	39	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Calcium	mg/kg	250	1300	800	3	3
Chromium	mg/kg	4.6	11	7.6	3	3
Cobalt	mg/kg	ND	4.1	3.1	2	3
Copper	mg/kg	2.9	6.1	4.9	3	3
Iron	mg/kg	3600	8800	5900	3	3
Lead	mg/kg	ND	ND	ND	0	3
Magnesium	mg/kg	260	1400	760	3	3
Manganese	mg/kg	74	92	81	3	3
Mercury	mg/kg	ND	ND	ND	0	3
Nickel	mg/kg	ND	7.9	5	2	3
PCB-1016	ug/kg	ND	ND	ND	0	3
PCB-1221	ug/kg	ND	ND	ND	0	3
PCB-1232	ug/kg	ND	ND	ND	0	3
PCB-1242	ug/kg	ND	ND	ND	0	3
PCB-1248	ug/kg	ND	ND	ND	0	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	ND	ND	ND	0	3
PCB-1268	ug/kg	ND	ND	ND	0	3
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	3
Potassium	mg/kg	240	610	400	3	3
Selenium	mg/kg	ND	ND	ND	0	3
Silver	mg/kg	ND	ND	ND	0	3
Sodium	mg/kg	ND	180	110	1	3
Thallium	mg/kg	ND	ND	ND	0	3
Uranium	mg/kg	ND	ND	ND	0	3
Vanadium	mg/kg	8.2	17	12	3	3
Zinc	mg/kg	ND	27	15	1	3

Deer Non-Radiological Data

Table 4.38 Non-Radiological Analysis of Deer Liver Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1.3	3.1	2	6	6
Antimony	mg/kg	ND	ND	ND	0	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	0.09	0.17	0.13	6	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	0.16	0.36	0.25	6	6
Chromium	mg/kg	ND	0.23	0.15	3	6
Cobalt	mg/kg	ND	0.13	0.068	1	6
Copper	mg/kg	17	72	44	6	6
Iron	mg/kg	43	82	61	6	6
Lead	mg/kg	ND	ND	ND	0	6
Lipids	%	5.8	7.1	6.5	6	6
Manganese	mg/kg	3	4.2	3.5	6	6
Mercury	mg/kg	ND	ND	ND	0	6
Nickel	mg/kg	ND	ND	ND	0	6
PCB-1016	ug/kg	ND	ND	ND	0	6
PCB-1221	ug/kg	ND	ND	ND	0	6
PCB-1232	ug/kg	ND	ND	ND	0	6
PCB-1242	ug/kg	ND	ND	ND	0	6
PCB-1248	ug/kg	ND	ND	ND	0	6
PCB-1254	ug/kg	ND	ND	ND	0	6
PCB-1260	ug/kg	ND	ND	ND	0	6
PCB-1268	ug/kg	ND	ND	ND	0	6
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	6
Selenium	mg/kg	ND	0.47	0.29	4	6
Silver	mg/kg	ND	ND	ND	0	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	25	36	30	6	6

Deer Non-Radiological Data

Table 4.39 Non-Radiological Analysis of Deer Muscle Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1.5	3	2.3	6	6
Antimony	mg/kg	ND	ND	ND	0	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	ND	ND	ND	0	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	ND	0.18	0.088	2	6
Chromium	mg/kg	ND	0.19	0.095	1	6
Cobalt	mg/kg	ND	ND	ND	0	6
Copper	mg/kg	0.9	1.6	1.3	6	6
Iron	mg/kg	28	47	39	6	6
Lead	mg/kg	ND	ND	ND	0	6
Manganese	mg/kg	0.11	0.27	0.19	6	6
Mercury	mg/kg	ND	ND	ND	0	6
Nickel	mg/kg	ND	ND	ND	0	6
Selenium	mg/kg	ND	ND	ND	0	6
Silver	mg/kg	ND	ND	ND	0	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	17	42	31	6	6

Table 4.40 Non-Radiological Analysis of Deer Kidney Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1.2	2.8	1.6	6	6
Antimony	mg/kg	ND	ND	ND	0	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	0.31	0.64	0.47	6	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	1.2	7.4	2.7	6	6
Chromium	mg/kg	ND	0.18	0.086	1	6
Cobalt	mg/kg	ND	0.12	0.061	1	6
Copper	mg/kg	3.3	4.6	3.9	6	6
Iron	mg/kg	50	76	59	6	6
Lead	mg/kg	ND	ND	ND	0	6
Manganese	mg/kg	1.3	2.3	1.7	6	6
Mercury	mg/kg	ND	ND	ND	0	6
Nickel	mg/kg	ND	ND	ND	0	6
Selenium	mg/kg	0.4	0.92	0.72	6	6
Silver	mg/kg	ND	ND	ND	0	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	20	33	27	6	6

Deer Non-Radiological Data

Table 4.41 Non-Radiological Analysis of Deer Fat Tissue for 2006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Lipids	%	61	85	74	7	7
PCB-1016	ug/kg	ND	ND	ND	0	7
PCB-1221	ug/kg	ND	ND	ND	0	7
PCB-1232	ug/kg	ND	ND	ND	0	7
PCB-1242	ug/kg	ND	ND	ND	0	7
PCB-1248	ug/kg	ND	ND	ND	0	7
PCB-1254	ug/kg	ND	ND	ND	0	7
PCB-1260	ug/kg	ND	ND	ND	0	7
PCB-1268	ug/kg	43	90	65	7	7
Polychlorinated biphenyl	ug/kg	43	90	65	7	7

Fish Non-Radiological Data

Table 4.42 Non-Radiological Analysis of Fish Tissue for 2006 for BM6.2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3.1	3.1	3.1	1	1
Antimony	mg/kg	ND	ND	ND	0	1
Arsenic	mg/kg	0.063	0.063	0.063	1	1
Barium	mg/kg	2.9	2.9	2.9	1	1
Beryllium	mg/kg	ND	ND	ND	0	1
Cadmium	mg/kg	0.032	0.032	0.032	1	1
Chromium	mg/kg	ND	ND	ND	0	1
Cobalt	mg/kg	ND	ND	ND	0	1
Copper	mg/kg	1.5	1.5	1.5	1	1
Iron	mg/kg	20	20	20	1	1
Lead	mg/kg	ND	ND	ND	0	1
Lipids	%	6.8	6.8	6.8	1	1
Manganese	mg/kg	3.5	3.5	3.5	1	1
Mercury	mg/kg	0.05	0.05	0.05	1	1
Nickel	mg/kg	ND	ND	ND	0	1
PCB-1016	ug/kg	ND	ND	ND	0	1
PCB-1221	ug/kg	ND	ND	ND	0	1
PCB-1232	ug/kg	ND	ND	ND	0	1
PCB-1242	ug/kg	ND	ND	ND	0	1
PCB-1248	ug/kg	290	290	290	1	1
PCB-1254	ug/kg	ND	ND	ND	0	1
PCB-1260	ug/kg	600	600	600	1	1
PCB-1268	ug/kg	ND	ND	ND	0	1
pH	Std Unit	7.2	7.2	7.2	1	1
Polychlorinated biphenyl	ug/kg	880	880	880	1	1
Selenium	mg/kg	0.59	0.59	0.59	1	1
Silver	mg/kg	ND	ND	ND	0	1
Temperature	deg F	71	71	71	1	1
Thallium	mg/kg	ND	ND	ND	0	1
Vanadium	mg/kg	ND	ND	ND	0	1
Zinc	mg/kg	40	40	40	1	1

Fish Non-Radiological Data

Table 4.43 Non-Radiological Analysis of Fish Tissue for 2006 for LUM2.7

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	6.5	12	9.1	4	4
Antimony	mg/kg	ND	ND	ND	0	4
Arsenic	mg/kg	0.029	0.055	0.042	4	4
Barium	mg/kg	1.5	2.3	1.9	4	4
Beryllium	mg/kg	ND	ND	ND	0	4
Cadmium	mg/kg	0.017	0.035	0.02	3	4
Chromium	mg/kg	ND	ND	ND	0	4
Cobalt	mg/kg	0.24	0.24	0.15	1	4
Copper	mg/kg	0.82	2.1	1.4	4	4
Iron	mg/kg	19	38	27	4	4
Lead	mg/kg	ND	ND	ND	0	4
Lipids	%	4.1	5.6	5.1	4	4
Manganese	mg/kg	6.2	16	9.4	4	4
Mercury	mg/kg	0.05	0.079	0.06	4	4
Nickel	mg/kg	ND	ND	ND	0	4
PCB-1016	ug/kg	ND	ND	ND	0	4
PCB-1221	ug/kg	ND	ND	ND	0	4
PCB-1232	ug/kg	ND	ND	ND	0	4
PCB-1242	ug/kg	ND	ND	ND	0	4
PCB-1248	ug/kg	260	400	330	4	4
PCB-1254	ug/kg	ND	ND	ND	0	4
PCB-1260	ug/kg	300	450	390	4	4
PCB-1268	ug/kg	ND	ND	ND	0	4
pH	Std Unit	6.7	6.7	6.7	4	4
Polychlorinated biphenyl	ug/kg	560	820	710	4	4
Selenium	mg/kg	1	1.3	1.2	4	4
Silver	mg/kg	ND	ND	ND	0	4
Temperature	deg F	67	67	67	4	4
Thallium	mg/kg	ND	ND	ND	0	4
Vanadium	mg/kg	ND	ND	ND	0	4
Zinc	mg/kg	18	38	27	4	4

Fish Non-Radiological Data

Table 4.44 Non-Radiological Analysis of Fish Tissue for 2006 for LUM4.5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1.4	1.6	1	2	5
Antimony	mg/kg	ND	ND	ND	0	5
Arsenic	mg/kg	0.018	0.046	0.035	5	5
Barium	mg/kg	0.096	0.28	0.14	4	5
Beryllium	mg/kg	ND	ND	ND	0	5
Cadmium	mg/kg	ND	ND	ND	0	5
Chromium	mg/kg	ND	ND	ND	0	5
Cobalt	mg/kg	ND	ND	ND	0	5
Copper	mg/kg	0.65	3.1	1.6	5	5
Iron	mg/kg	4.2	6.1	5	5	5
Lead	mg/kg	ND	ND	ND	0	5
Lipids	%	1.1	3.2	1.6	6	6
Manganese	mg/kg	0.6	1.9	0.99	5	5
Mercury	mg/kg	0.065	0.091	0.076	5	5
Nickel	mg/kg	0.47	0.47	0.19	1	5
PCB-1016	ug/kg	ND	ND	ND	0	6
PCB-1221	ug/kg	ND	ND	ND	0	6
PCB-1232	ug/kg	ND	ND	ND	0	6
PCB-1242	ug/kg	ND	ND	ND	0	6
PCB-1248	ug/kg	280	1000	490	6	6
PCB-1254	ug/kg	ND	ND	ND	0	6
PCB-1260	ug/kg	200	720	370	6	6
PCB-1268	ug/kg	ND	ND	ND	0	6
pH	Std Unit	7.4	7.4	7.4	6	6
Polychlorinated biphenyl	ug/kg	480	1800	850	6	6
Selenium	mg/kg	0.83	1.3	1	5	5
Silver	mg/kg	ND	ND	ND	0	5
Temperature	deg F	73	73	73	6	6
Thallium	mg/kg	ND	ND	ND	0	5
Vanadium	mg/kg	ND	ND	ND	0	5
Zinc	mg/kg	5.1	8	6.7	5	5

Fish Non-Radiological Data

Table 4.45 Non-Radiological Analysis of Fish Tissue for 2006 for LUM5.0

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	7.5	14	9.8	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	0.025	0.057	0.036	3	3
Barium	mg/kg	0.91	2	1.4	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	0.012	0.018	0.012	2	3
Chromium	mg/kg	0.77	0.83	0.5	1	3
Cobalt	mg/kg	0.32	0.32	0.18	1	3
Copper	mg/kg	0.86	3.3	1.8	3	3
Iron	mg/kg	21	27	24	3	3
Lead	mg/kg	ND	ND	ND	0	3
Lipids	%	3.3	5.7	4.6	3	3
Manganese	mg/kg	7.4	10	8.9	3	3
Mercury	mg/kg	0.042	0.061	0.051	3	3
Nickel	mg/kg	0.3	0.3	0.18	1	3
PCB-1016	ug/kg	ND	ND	ND	0	3
PCB-1221	ug/kg	ND	ND	ND	0	3
PCB-1232	ug/kg	ND	ND	ND	0	3
PCB-1242	ug/kg	ND	ND	ND	0	3
PCB-1248	ug/kg	620	2800	1500	3	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	770	2100	1500	3	3
PCB-1268	ug/kg	94	480	140	1	3
Polychlorinated biphenyl	ug/kg	2600	4900	2800	2	3
Selenium	mg/kg	1.1	1.4	1.3	3	3
Silver	mg/kg	ND	ND	ND	0	3
Thallium	mg/kg	ND	ND	ND	0	3
Vanadium	mg/kg	ND	ND	ND	0	3
Zinc	mg/kg	22	31	27	3	3

Fish Non-Radiological Data

Table 4.46 Non-Radiological Analysis of Fish Tissue for 2006 for MAM8.6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	ND	ND	0	1
Antimony	mg/kg	ND	ND	ND	0	1
Arsenic	mg/kg	0.039	0.039	0.039	1	1
Barium	mg/kg	7.4	7.4	7.4	1	1
Beryllium	mg/kg	ND	ND	ND	0	1
Cadmium	mg/kg	0.021	0.021	0.021	1	1
Chromium	mg/kg	ND	ND	ND	0	1
Cobalt	mg/kg	ND	ND	ND	0	1
Copper	mg/kg	1.5	1.5	1.5	1	1
Iron	mg/kg	20	20	20	1	1
Lead	mg/kg	ND	ND	ND	0	1
Lipids	%	4.7	4.7	4.7	1	1
Manganese	mg/kg	14	14	14	1	1
Mercury	mg/kg	0.043	0.043	0.043	1	1
Nickel	mg/kg	ND	ND	ND	0	1
PCB-1016	ug/kg	ND	ND	ND	0	1
PCB-1221	ug/kg	ND	ND	ND	0	1
PCB-1232	ug/kg	ND	ND	ND	0	1
PCB-1242	ug/kg	ND	ND	ND	0	1
PCB-1248	ug/kg	18	18	18	1	1
PCB-1254	ug/kg	ND	ND	ND	0	1
PCB-1260	ug/kg	ND	ND	ND	0	1
PCB-1268	ug/kg	ND	ND	ND	0	1
pH	Std Unit	6.9	6.9	6.9	1	1
Polychlorinated biphenyl	ug/kg	18	18	18	1	1
Selenium	mg/kg	0.53	0.53	0.53	1	1
Silver	mg/kg	ND	ND	ND	0	1
Temperature	deg F	67	67	67	1	1
Thallium	mg/kg	ND	ND	ND	0	1
Vanadium	mg/kg	ND	ND	ND	0	1
Zinc	mg/kg	32	32	32	1	1

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