DOE/OR/07-2233/V1
Volume I

PADUCAH SITE

Annual Site Environmental Report

2004

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 DOE O 231.1 Chg 2. The data and information contained in this report were collected in accordance with the Paducah Site Environmental Monitoring Plan (BJC 2003a) 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 laws.

Units of Radiation Measure

Current System	Système International	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7 x 10^{10} 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	10^6	pCi
pCi/L (water)	10^{-9}	µCi/mL (water)	µCi/mL (water)	10^9	pCi/L (water)
pCi/m^3 (air)	10^{-12}	µCi/mL (air)	µCi/mL (air)	10^{12}	pCi/m^3 (air)

DOE/OR/07-2233/V1 Paducah Site Annual Site Environmental Report for Calendar Year 2004

Paducah Annual Site Environmental Report 2004

DOE/OR/07-2233/V1

Paducah Site

Annual Site Environmental Report for Calendar Year 2004

April
2006

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

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-03OR22980

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Acronyms and Abbreviations

ACO	Administrative Order by Consent
AIP	KDEP Agreement in Principle
AO	Agreed Order
AOC	Area of Concern
ASER	Annual Site Environmental Report
ASTM	American Society of Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
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
C.F.R.	Code of Federal Regulations
Ci	Curie
COE	U.S. Army Corps of Engineers
^{137}Cs	cesium-137
CSOU	comprehensive site-wide operable unit
CWA	Clean Water Act
CX	categorical exclusion
CY	calendar year
D&D	decontamination and decommissioning
DCG	derived concentration guide
DMSA	DOE Material Storage Area
DNAPL	dense, nonaqueous-phase liquid
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	data quality objective
DUF_6	depleted uranium hexafluoride

EA	environmental assessment
EDD	electronic data deliverable
EIC	DOE Environmental Information Center
EIS	environmental impact statement
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EQADMP	Environmental Services Quality Assurance and Data Management Plan
FDA	Food and Drug Administration
FFA	Federal Facility Agreement
FFC Act	Federal Facility Compliance Act
FFCA	Federal Facility Compliance Agreement
ft	foot (feet)
HAP	hazardous air pollutant
HSWA	Hazardous and Solid Waste Amendments
ICRP	International Commission on Radiological Protection
IRA	interim remedial action
K.A.R.	Kentucky Administrative Regulation
KCHS	Kentucky Cabinet for Health Services
KDAQ	Kentucky Division for Air Quality
KDEP	Kentucky Department for Environmental Protection
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
kg	kilogram(s)
km	kilometer(s)
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
L	liter(s)
LLW	low-level waste

LRGA	Lower Regional Gravel Aquifer
m	meter(s)
MCL	maximum contaminant level
mHBI	modified Hilsenhoff Biotic Index
μg	microgram(s)
mg	milligrams(s)
mR	milliRoentgen(s)
mrem	millirem(s)
MLLW	mixed low-level waste
mt	metric ton(s)
MW	monitoring well
ND	not detected
NEPA	National Environmental Policy Act
NEPCS	Northeast Plume Containment System
NHPA	National Historic Preservation Act
NOV	notice of violation
^{237}Np	neptunium-237
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NTS	Nevada Test Site
NWPGS	Northwest Plume Groundwater System
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PCB	polychlorinated biphenyl
pCi	picoCurie(s)
PEMS	Project Environmental Measurement Systems
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen-ion concentration
PHA	public health assessment
ppb	parts per billion

ppm	part per million
PP/WM	Pollution Prevention/Waste Minimization
^{239}Pu	plutonium-239
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RD/RAWP	Remedial Design/Remedial Action Work Plan
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SI	site investigation
SMO	Sample Management Office
SMP	Site Management Plan
SOW	statement of work
^{90}Sr	strontium-90
STP	Site Treatment Plan
SWMU	solid waste management unit
^{99}Tc	technetium-99
TCE	trichloroethene
^{230}Th	thorium-230
TLD	thermoluminescent dosimeter
TRE	Toxicity Reduction Evaluation
TSCA	Toxic Substances Control Act
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
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
VOC	volatile organic compound
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area
WMP	Watershed Monitoring Program

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 2004* was prepared to fulfill DOE requirements. This report is a public document, 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 your 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. The DOE maintains responsibility for the environmental restoration, legacy waste management, non-leased facilities management, uranium hexafluoride (UF_6) cylinder management, and decontamination and decommissioning (D&D)/DOE Material Storage Area (DMSA) programs. The 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) 2004 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

The DOE requires that environmental monitoring be conducted and documented for all of its facilities under the purview of DOE Order 231.1 Change 2, *Environment, Safety and Health Reporting* (DOE 1996). 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 2004 environmental management activities at the Paducah Site, including effluent monitoring, environmental surveillance, and environmental compliance status, and to highlight significant site program efforts. Environmental management activities for CY 2005 will be reported in the next ASER. Since April 1, 1998, Paducah Site programs have been coordinated by DOE's managing and integrating contractor, Bechtel Jacobs Company LLC (BJC). 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 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 goal for EM is to protect site personnel, the environment, and the Paducah Site's neighbors, and to maintain full compliance with all current environmental regulations. The current environmental strategy is to prevent future compliance issues, to identify any current compliance issues, and to develop a system for resolution. The long-range goal of environmental management 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 was subsequently 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 were initially 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 further expand production of atomic weapons. One of the principle 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 are still in operation, albeit with substantial upgrading and refurbishment. Of the 7566 acres acquired by the Atomic Energy Commission, 1361 acres were subsequently transferred to the Tennessee Valley Authority (Shawnee Steam Plant site) and 2781 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 3423 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; and the Legacy Waste Management Program, including all waste inventories predating July 1, 1993, and wastes generated by subsequent DOE activities. The DOE is responsible for Kentucky Pollutant Discharge Elimination System (KPDES) compliance at outfalls not leased to USEC. The DOE has also retained manager and co-operator status of facilities not leased to USEC. The 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. The DOE is the owner, and BJC with DOE 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 (Figure 1.2, the C-720 building is an example of a support facility). Of the remaining 2675 acres, there is a 689 acre "buffer zone" that surrounds PGDP and it is designated as unsecured industrial land. There are no residences on DOE property at the Paducah Site.

Three small communities are located within 5 kilometers (km) (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 an 50-mile radius of PGDP is about 500,000. Within a 10-mile radius of PGDP, the population is about 66,000 (DOC 1994).

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 (commonly referred to as "Big 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. 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 1100 separate wetlands, totaling over 1600 acres, were found in a study area of about 12,000 acres in and around the Paducah Site (COE 1994 and CDM 1994). These wetlands have been classified into 16 cover types. More than 60 percent of the total wetland area is forested.

Soils and Hydrogeology

Soils of the area are predominantly silt loams that are poorly drained, acidic, and have little organic content. Of the six primary soil types associated with the Paducah Site, five commonly have the characteristics necessary to be considered prime farmland by the Natural Resources Conservation Service, formerly the Soil Conservation Service (Humphrey 1976).

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

The terrace gravels consist 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.

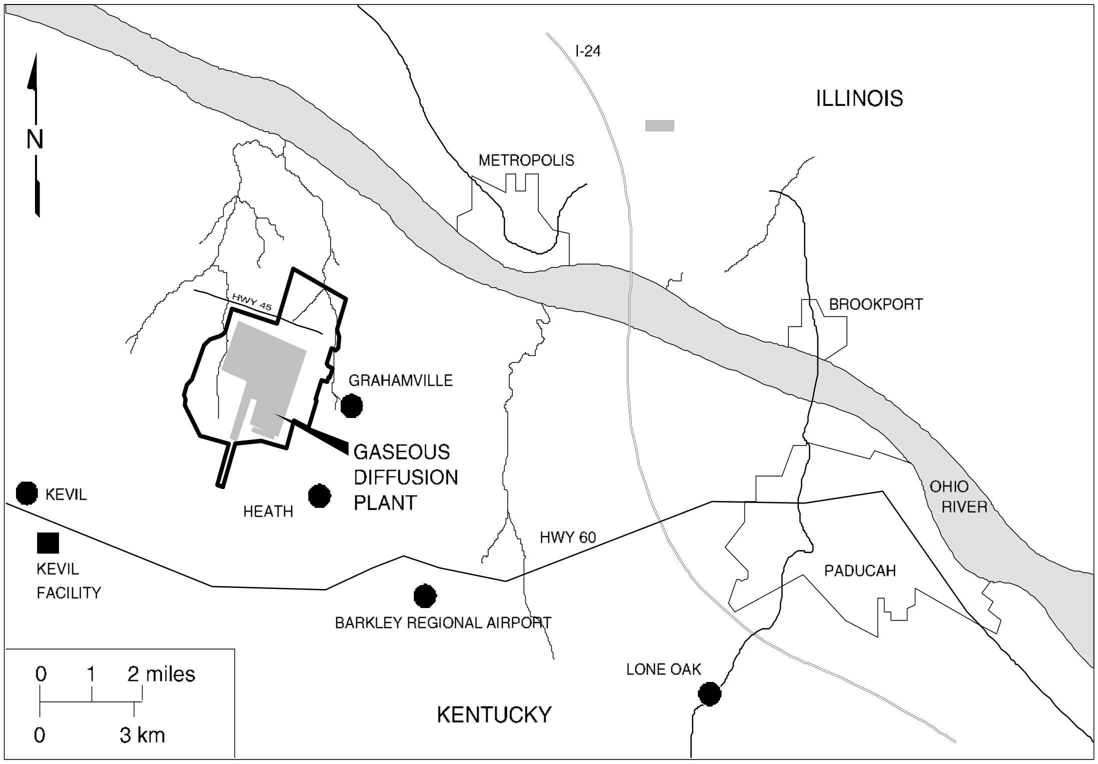

Figure 1.1 Location of the Paducah Site

Figure 1.2 C-720 Maintenance Shop at the PGDP

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 accessory, 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 gravels. Groundwater within the terrace gravels either discharges to local streams or recharges the RGA, although the flow regime of the terrace gravels is not fully understood. Groundwater flow through the UCRS is predominantly 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 periodically mowed or burned to maintain early successional vegetation, which is dominated by members of the compositae family and various grasses. Management practices on the WKWMA encourage re-establishment of once common native grasses such as eastern gama 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 vary 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). Undergrowth vary from open, with limited vegetation 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. Grassy fields are frequented by rabbits, mice, songbirds, and a variety of other small mammals and birds. Redwing blackbirds, killdeer, cardinals, mourning doves, bobwhite quail, meadowlarks, warblers, sparrows, and red-tailed hawks have been observed in such areas. Scrub-shrub communities support a variety of wildlife including opossums, voles, moles, raccoons, gray squirrels, killdeer, bluejays, redwing blackbirds, bluebirds, cardinals, mourning doves, shrike, warblers, turkeys, and meadowlarks. Deer, squirrels, raccoons, turkeys, songbirds, and great horned owls are found within the mature woodlands of the DOE reservation (CH2M Hill 1991a). In addition, the Ohio River serves as a major flyway for migratory birds, which are occasionally seen on the Paducah Site (DOE 1995).

Amphibians and reptiles are common throughout the Paducah Site. Amphibians likely to inhabit the area include the American and Woodhouse toads. Reptiles include the eastern box turtle and several species of snakes. Also, fish populations in Bayou Creek and Little Bayou Creek are numerically dominated by various species of sunfish (DOE 1995).

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 2.3). 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 have 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 (Figure 1.3). The mission of the Environmental Restoration Program is to ensure that releases from past operations at the Paducah Site are investigated and that appropriate remedial action is taken for protection to human health and the environment in accordance with the Federal Facility Agreement (FFA) (DOE 1998). The mission of the Waste Operations Program is to characterize and dispose of the legacy waste stored onsite, including DMSAs, in compliance with the October 2003 Agreed Order (AO) between DOE and the Kentucky Division of Waste Management (KDWM) and other agreements. The primary mission of the D&D Program is to manage and characterize the areas and facilities in the program and prepare materials and/or waste for disposition. The primary 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.

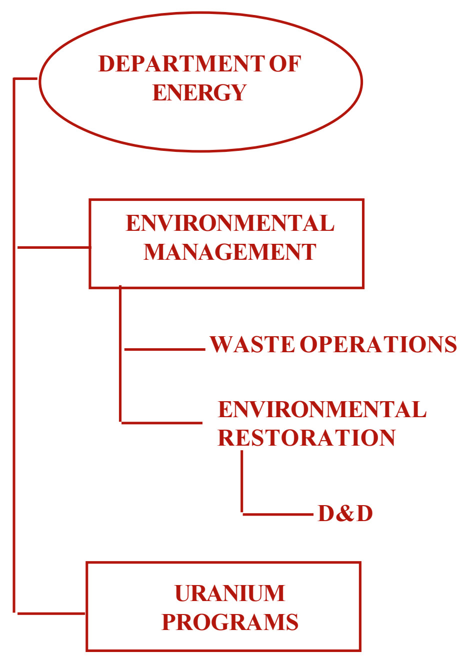

Figure 1.3 Paducah Site programs/projects

2 Environmental Compliance

Abstract

The policy of DOE and its contractors and subcontractors at the Paducah Site is to conduct operations safely and minimize 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 minimizing impacts. In 2004, DOE received a new hazardous waste management permit and a new C-746-U Landfill operating permit.

Introduction

State and federal agencies, including DOE, are responsible for enforcing the environmental regulations at the Paducah Site. Principle 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 2004.

Table 2.1 Environmental permit and compliance agreement summary

Permit Type	Issued By	Permit Number	Issued To
State Agency Interest ID# 3059			
Water			
KPDES	KDOW	KY0004049	DOE
Solid Waste			
Residential Landfill (closed)	KDWM	073-00014	DOE
Inert Landfill (closed)	KDWM	073-00015	DOE
Solid Waste Contained Landfill (construction/operation)	KDWM	073-00045	DOE
RCRA/Toxic Substances Control Act			
State Hazardous Waste Management Permit	KDWM	KY8-890-008-982	DOE/BJC
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
KDOW – Kentucky Division of Water KDWM – Kentucky Division of Waste Management			

Compliance Activities

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, disposal, and recycling facilities are required to obtain operating and closure permits for waste treatment, storage, disposal, and recycling activities. The Paducah Site generates solid, hazardous waste, and mixed waste (i.e., hazardous waste mixed with radionuclides) and operates four permitted hazardous waste storage and treatment facilities.

Resource Conservation and Recovery Act Hazardous Waste Permit

Part A and Part B permit applications of RCRA for storage and treatment of hazardous wastes were initially submitted for the Paducah Site in the late 1980s. At that time, EPA had authorized the Commonwealth of Kentucky to exclusively administer 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. Therefore, a permit application was submitted to EPA and the KDWM for treatment and storage of hazardous wastes.

On July 16, 1991, KDWM and EPA issued a 10-year RCRA permit (No. KY8890008982) to DOE as owner and operator and to DOE's prime contractor (currently BJC) as co-operator. This RCRA permit consisted of the following two individual permits: (1) a hazardous waste management permit administered by the Commonwealth of Kentucky and (2) a HSWA permit administered by EPA. The hazardous waste management permit contained regulatory provisions for the treatment, storage, and disposal activities at PGDP, as authorized under the RCRA-based program (pre-HSWA), as well as HSWA provisions. The HSWA permit addressed only the provisions of the HSWA, which include corrective actions for solid waste management units (SWMUs), and the land disposal restrictions. In 1996, Kentucky received authorization to administer the HSWA provisions in lieu of EPA.

On February 21, 2001, DOE submitted a RCRA permit renewal application to KDWM. On September 28, 2001, KDWM requested additional information. DOE submitted a revised permit application in February 2002. Additional revisions to the application were required. The revised Part A and Part B permit applications were submitted to KDWM on April 13, 2004. The new 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.

Modifications to the Resource Conservation and Recovery Act Hazardous Waste Permit

There were no modifications to this permit in 2004.

Resource Conservation and Recovery Act Hazardous Waste Facilities Closure Activities

In 2004, DOE submitted closure plans to KDWM for 14 DMSAs.

Resource Conservation and Recovery Act Notices of Violation

The DOE did not receive any RCRA notices of violation (NOVs) during 2004.

2003 Agreed Order with Commonwealth of Kentucky

October 2003 AO requirements were met in 2004. Seventeen SWMU Assessment Reports were revised in accordance with the AO to identify newly discovered hazardous waste in DMSAs. Part A of the RCRA Permit was revised to include fifteen of these DMSAs.

All Priority A DMSAs were characterized by September 30, 2004 in accordance with the AO. Material from 12 of the Priority A DMSAs was dispositioned from the DMSA. Three Priority A DMSAs were turned over for re-use and six were characterized for waste material.

Land Disposal Restrictions

Hazardous waste is subject to land disposal restrictions and storage prohibitions that permit storage only for accumulation of sufficient quantities of hazardous waste to facilitate proper treatment, recycling, or disposal. Typically, hazardous wastes are not to be stored for more than one year. The Paducah Site generates mostly mixed waste, which is a combination of hazardous and radioactive waste. Nationally, there are limited opportunities for treatment and disposal of mixed waste. Therefore, the Paducah Site stores some of its mixed waste for longer than one year. If not for the radioactive constituents, this waste would not pose a compliance problem for the site because there would be treatment and disposal options readily available. On June 30, 1992, DOE entered into an FFCA with EPA Region 4 to regulate the treatment and storage of land-disposal restricted mixed waste at the Paducah Site. On April 13, 1998, EPA Region 4 released DOE from the FFCA.

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 would facilitate compliance with the FFC Act. A series of mixed waste treatment milestones are detailed in the STP. DOE's implementation of and progress under the STP is documented annually to KDEP in March. Since inception of the STP, approximately 33,000 cubic ft of mixed waste have been treated either onsite or shipped offsite for treatment to commercial or other DOE facilities.

Solid Waste Management

The PGDP disposes a portion of its solid waste at its on-site 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. In November 1999, waste acceptance activities at the C-746-U Landfill were suspended for all waste streams with the exception of wastes classified as no-rad-added (not contaminated with radioactivity). The DOE completed an *Environmental Assessment (EA) for the Implementation of the Authorized Limits Process for Waste Acceptance at the C-746-U Landfill, Paducah, Kentucky* (DOE/EA-1414), in September

2000 that resulted in a finding of no significant impact (FONSI) on August 6, 2002, and the suspension thereafter was lifted. The DOE received the latest C-746-U Landfill operating permit on July 14, 2004, which has an expiration date of November 4, 2006.

In late 2000, potential corrosion problems were discovered in the monitoring wells (MWs) surrounding the C-746-U Landfill. On August 10, 2001, KDWM issued a letter ordering DOE to cease the placement of waste in the landfill until the MW network could be replaced. As a result, a long-term cover was installed. The KDWM required two sampling events, no less than 30 days apart, prior to authorizing the reopening of the landfill. Activities were initiated to replace MWs at the landfill in late 2001 and completed in 2002. After completion of the EA in August 2002 and installation and sampling of the new MWs, the landfill resumed disposal operations in November 2002. From November 2002 through December 2002, 142 tons (129 metric tons) of waste were disposed. During 2003 and 2004, the amount of waste disposed of in the landfill was 9151 tons and 35,000 tons (8302 and 31,773 metric tons), respectively.

In lieu of disposing of office waste at the C-746-U Landfill, office waste generated by DOE and its contractors at the plant site is taken offsite for disposal. Only office waste generated at the C-746-U Landfill itself was disposed at the landfill. Commercial Waste Incorporated in Mayfield, Kentucky, provides off-site disposal of the office waste. A site-wide recycling program exists for office waste (see Section 3 for details).

The DOE did not receive any NOVs during 2004 for the active C-746-U and inactive C-746-S & T landfills.

Underground Storage Tanks

Underground storage tank (UST) systems at the Paducah Site have been 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 (C.F.R.) Part 280] and Kentucky UST regulations [401 Kentucky Administrative Regulations (K.A.R.) Chapter 42].

The DOE is responsible for 16 of the 18 site USTs that have been reported to KDWM. Of DOE's 16 USTs, none are currently in use. Six were removed from the ground (including C-746-A1 in 2003), seven were filled in place with inert material, one (C-611-1) was "clean closed in place," and two were determined not to exist. Table 2.2 provides a current list of DOE USTs and their status.

At the end of 2004, one DOE UST (C-746-A1) had been "clean closed" but regulatory approval of the closure had not yet been received by DOE.

Comprehensive Environmental Response, Compensation, and Liability Act

The 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 facilities on the NPL to enter into an FFA with the appropriate regulatory agencies. The FFA, which was signed February 13, 1998, established a decision-making process for remediation of the Paducah Site, and coordinates CERCLA remedial action requirements with RCRA corrective action requirements. Under the FFA, the parties 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.

The Agency for Toxic Substances and Disease Registry (ATSDR), based in Atlanta, Georgia, is part of the U.S. Public Health Service. As required by CERCLA, this agency conducts

Table 2.2 Summary of USTs

UST	State ID	Date Installed	Operational Status	Regulatory Status
C-750-A	0001	1955	Removed from ground 3/91	Closure complete per KDWM letter of 3/25/99
C-750-B	0002	1955	Removed from ground 3/91	Closure complete per KDWM letter of 3/25/99
C-750-C	0003	1957 (Estimated)	Removed from ground 10/93	Clean closed under RCRA Subtitle C
C-750-D	0004	1957	Rinsed with trichloroethene and emptied 6/79, filled with cement 10/97	Closure complete per KDWM letter of 11/23/99
C-746-A1	0005	1960	Emptied 9/88, filled with cement 10/97, removed from ground 4/03	Final closure awaits approval from KDWM
C-710-B	0006	1956 (Estimated)	Emptied 7/85, filled with cement 10/97	Closure complete per KDWM letter of 2/19/02
C-200-A	0007	1956 (Estimated)	Filled with grout in 1977	Closure complete per KDWM letter of 11/23/99
C-746-A2	0008	—	Determined during Waste Area Group 15 site investigation not to exist	Documented during Waste Area Group 15 site investigation not to exist
C-751-W	0009	1992	In use by USEC	In use by USEC
C-751-E	0010	1992	In use by USEC	In use by USEC
C-611-1	0011	1943 (Estimated)	Last used before 1975	Clean closed in place per KDWM letter of 12/6/96
C-611-3	0012	1953	Last used before 1975, filled with cement 9/97	Clean closed in place per KDWM letter of 12/6/96
C-611-2	0013	—	Determined not to exist	No further action required per state correspondence of 12/6/96
C-611-4	0014	1943 (Estimated)	Last used before 1975, filled with sand	Clean closed in place per KDWM letter of 12/6/96
C-611-5	0015	Unknown	Filled with grout before 1975	Clean closed in place per KDWM letter of 12/6/96
C-200-B	0016	1967	Filled with concrete in 1981	Closure complete per KDWM letter of 2/19/02
C-745-K	0017	1951 (Estimated)	Removed from ground 2/02	Closure complete per KDWM letter of 12/4/02
C-746-K	0018	1951 (Estimated)	Removed from ground 4/02	Closure complete per KDWM letter of 12/4/02

public health assessments (PHAs) of hazardous waste sites listed on or proposed for the NPL. Representatives from the ATSDR made their initial site visit to Paducah in May 1994 to assign a ranking to the site for priority in scheduling the health assessment. The ATSDR is informed of the actions the site has taken since 1988 to address the risks from the potential use of contaminated water. In 1995, the ATSDR visited the Paducah Site to initiate a PHA. The PHA report was issued in May 2002. This document is available on the Internet at http://www.atsdr.cdc.gov/HAC/PHA/paducah2/pgd_toc.html.

Comprehensive Environmental Response, Compensation, and Liability Act Reportable Quantities

On June 11, 2004 a track hoe leaked approximately 30 gallons of hydraulic fluid within the operating cell of the C-746-U Landfill. The Kentucky spill reportable quantity is 25 gallons of oil. A notification of the spill was submitted to the state. Hydraulic oil spills are not a federal agency reportable event. The spill was cleaned in accordance with site procedures.

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 C.F.R. 1021) and the Council on Environmental Quality Regulations (40 C.F.R. 1500–1508), ensures that consideration is given to environmental values and factors in federal planning and decision making. In accordance with 10 C.F.R. 1021, the Paducah Site conducts NEPA reviews for proposed actions and determines if any proposal requires preparation of an environmental impact statement (EIS), an EA, or is categorically excluded (CX) from preparation of either an EIS or an EA. The Paducah Site maintains records of all NEPA reviews.

The DOE issued a record of decision (ROD) on July 27, 2004 for *Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, KY, Site* (DOE/EIS-0359). The facility will convert the stored inventory of DUF_6 into a more stable uranium oxide for reuse or disposal. The DOE also approved two CXs for refurbishing the C-745-F cylinder storage yard and repair of the access road to the C-745-C cylinder storage yard.

In addition, 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 DOE Oak Ridge Operations Office 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 is no longer 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).

The *Cultural Resources Survey for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-688/R1), March 2006, 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.

A Phase I archaeological reconnaissance was conducted in 1993 in McCracken County, Kentucky, by Archaeology Resources Consultant Services Inc. of Louisville, Kentucky. The reconnaissance was part of an Environmental Assessment by Martin Marietta Energy Systems, Inc., which was proposing to design and construct a solid waste landfill at PGDP. The entire project area was approximately 40 acres located directly north of the C-746-S&T landfill. The reconnaissance identified two historic sites.

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, 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 2.3 includes seven federally listed, proposed, or candidate species that have been identified as potentially occurring at or near the Paducah Site. Project NEPA reviews and

Table 2.3 Federally listed, proposed, and candidate species potentially occurring within the Paducah Site study area in 2004[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 three miles north of the DOE reservation. None of these species have been reported as sighted on the DOE reservation, although potential summer habitat exists there for the Indiana bat. No critical habitat for any of these species has been designated anywhere in the study area.

[b] Specimens of the Indiana bat were collected from WKWMA property in 1991 and 1999.

associated field surveys indicated that in 2004, DOE projects at the Paducah Site did not impact any of these seven species. Potential habitats of these species also were not impacted.

Floodplain/Wetlands Environmental Review Requirements

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

In 2004, 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 2004.

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) a permit program regulating point-source discharges into waters of the United States, (2) a program to control and prevent spills of oil and hazardous substances, (3) a program to regulate discharges of dredge and fill materials into "waters of the United States," and (4) a program to provide financial assistance for construction of publicly owned sewage treatment works. The Paducah Site is primarily affected by the regulations for point-source discharges regulated under the KPDES permit.

Kentucky Pollutant Discharge Elimination System Permits

The CWA applies to all non-radiological 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

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 April 1, 1998, 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 was set to expire at the end of March 2003, but by regulation, it is automatically extended until the regulators issue a final decision on the DOE renewal application. A permit renewal application was submitted to KDOW in September 2002 and a minor revision to the application was submitted in May 2003. As of the end of 2003, KDOW had not approved or denied the application; therefore, KPDES Permit No. KY0004049 remained in effect throughout 2004 and into 2005.

In correspondence dated March 17, 2003, from the Enforcement Branch of KDOW, an NOV was received for alleged violations of Kentucky Revised Statute (KRS) 224, 401 K.A.R. 5:065 1(1). Specifically, Paducah KPDES Outfall 001 allegedly exceeded the permit limit for chronic toxicity in samples collected in October, November, and December 2002. A Toxicity Reduction Evaluation (TRE) Plan was prepared and submitted to KDOW on March 21, 2003; approved on April 14, 2003; and immediately implemented. Implementation has included monthly compliance monitoring for chronic toxicity at Outfall 001, additional testing to determine the cause of the toxicity, and quarterly update reporting to KDOW. One apparent failure for chronic toxicity occurred at Outfall 001 in April 2004. No direct impacts on the receiving stream (Bayou Creek) have been noted. No permit exceedances for other parameters occurred at Outfall 001 in 2004.

On July 9, 2004, DOE and BJC received an NOV dated July 6, 2004, from the KDOW. The NOV cited two alleged KPDES permit noncompliances. The first alleged noncompliance cited was a recurrence of failure for chronic toxicity at PGDP KDPES Outfall 001 for the April 18–23, 2004, sampling event. The DOE/BJC was conducting the monthly sampling of Outfall 001 in accordance with the TRE Plan approved by the KDOW in April 2003. The NOV required continuation of the monthly sampling and other measures in the TRE Plan, and these efforts were ongoing at the end of 2004.

The second NOV alleged failure to follow the EPA test method regarding chilling and maintaining samples at 4° Celsius (39° Fahrenheit) until the samples reach the testing laboratory. The temperatures cited in the NOV correspond to the temperatures measured directly in the receiving stream flow at Outfall 001 and recorded by sampling personnel. The temperature values cited in the NOV do not reflect either the composite sampler temperature or the temperature recorded by the laboratory at the time of sample receipt. Temperatures recorded at the receiving laboratory indicate that the samples were chilled and shipped at the proper temperature in accordance with the permit requirements. No additional concerns were identified by KDOW.

On September 16, 2004, DOE and BJC received an NOV dated September 14, 2004, from the KDOW. The NOV cited three KPDES permit noncompliances. The first noncompliance cited an alleged violation of the acute toxicity limit at KPDES Outfall 017 (discussed below). The second KDOW allegation contends that samples collected at Outfall 001 during the June 2004 sampling event were improperly collected in accordance with KPDES permit sample temperature requirements (same issue as discussed above). The KDOW states in the third alleged violation cited on the NOV that DOE and BJC did not conduct a monthly PGDP chronic toxicity test at Outfall 001 as required based on the test being invalid due to the alleged sampling temperature violations. The DOE evaluated the sampling process and no additional concerns have been identified by KDOW.

Acute toxicity exceedances were reported to KDOW for Outfall 017 in April 2004, based on samples collected on April 12 and April 22. The KDOW issued an NOV for this on May 21. The NOV required that acute toxicity testing frequency be increased from the routine quarterly testing to monthly testing, and that a TRE Plan be submitted. Formal monthly testing was initiated in June and the plan was submitted to KDOW on June 22.

On May 10, prior to receipt of the May 21 NOV and initiation of required monthly sampling, an additional acute toxicity sample was collected from Outfall 017. This sample showed lower toxicity than in April, but still above the regulatory limit. This sample was reported to the KDOW in the quarterly Discharge Monitoring Report in July 2004.

The September 14, 2004, NOV cites the acute toxicity exceedance identified on the voluntary May sample from Outfall 017, and states that Paducah must continue monthly sampling and other measures in the TRE Plan, submit quarterly progress reports, and comply with the toxicity limit by June 1, 2005. These efforts were ongoing at the end of 2004 and there were no additional toxicity failures in 2004 at Outfall 017 after May 10. No direct impacts on the receiving stream (Bayou Creek) have been noted. No permit exceedances for other parameters occurred at Outfall 017 in 2004.

No exceedances of effluent permit limits occurred at Outfalls 015 or 019 in 2004.

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 are 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 C.F.R. 761) and the Uranium Enrichment (UE) FFCA. The major activities performed in 2004 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, maintenance to the troughing system, and reporting and record keeping.

The UE TSCA FFCA between EPA and DOE was signed in February 1992. To meet the compliance goals at the Paducah Site, the UE TSCA FFCA is occasionally revised and updated. 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 2.4 shows a summary of PCB items in service at the Paducah Site at the end of 2004. These items are utilized in USEC operations.

Table 2.4 Summary of PCBs and PCB items in service at the end of 2004

Type	Number in Service	Volume (gal)	PCBs (kg)
PCB Transformers	66**	95,148	277,421
PCB-Contaminated Transformers	9	2,299	0.95
PCB-Contaminated Electrical Equipment	7	2,094	1.13
PCB Capacitors	682	2,042*	12,528.6
PCB Open Systems	3	235	7.02

** 1 replacement transformer is awaiting installation

* assumed 540,000 parts per million (ppm) PCB, 13.5 lbs/gal

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 offsite for disposal. All Paducah Site UE TSCA FFCA milestones for 2004 were completed.

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 non-radioactive PCB wastes are stored onsite in units that meet TSCA and/or UE TSCA FFCA compliance requirements, as applicable. Upon approval, nonradioactive PCBs are transported offsite to EPA-approved facilities for disposal.

Radioactive-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. Reports under EPCRA are submitted to federal, state, and local authorities. Executive Order 12856, signed in August 1993, subjects all federal agencies to EPCRA.

The Paducah Site did not have any releases that were subject to Section 304 notification requirements during 2004. No Section 311 notifications were required in 2004. The Section 312 Tier II report of inventories for 2004 included UF_6, uranium tetrafluoride (UF_4), iron filings, activated carbon pellets, magnesium fluoride, diesel fuel, and PCBs associated with DOE activities. 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 2004. 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 atmosphere discharge. At the Northeast Plume Containment System, a cooling tower system acts as an air stripper for TCE.

Asbesto ogram

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 Region 4, Occupational Safety and Health Administration, and Kentucky regulatory requirements. There were no noncompliances with environmental protection standards identified in 2004.

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 2004 arose 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. The 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 2004. Ambient air data were collected at 11 sites surrounding the plant in order to measure radionuclides emitted from Paducah Site sources, including fugitive emissions. These results are discussed 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 2004.

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 non-regulated 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 onsite and offsite, 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 EM 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. Table 2.5 summarizes the regulatory inspections conducted in 2004.

Table 2.5 State and federal regulatory inspections at the Paducah Site in 2004

Date	Agency	Description
January	KDWM	C-746-U Landfill Inspection RCRA Inspection
February	None	None
March	None	None
April	KDWM	Requested No Further Action SWMUs C-746-U Landfill Inspections
May	KDOW KDWM	Outfall Inspection North-South Diversion Ditch Project
June	None	None
July	None	None
August	KDWM	C-746-U Landfill Inspections
September	None	None
October	KDWM	C-746-U Landfill Inspection
November	KDWM	C-746-U Landfill Inspection
December	KDWM	C-746-K Landfill Wells Split Sampling

3 Environmental Program Information

Abstract

Environmental monitoring, environmental restoration, waste operations, facilities management, UF_6 cylinder management activities, and D&D/DMSA management occur at the PGDP. Several programs are conducted; therefore, they are presented in this section to inform the public.

Environmental Monitoring Program

The environmental monitoring program at the 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 2003a) 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. However, 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 has changed the direction and emphasis of the environmental monitoring program. In November 1995, the site environmental monitoring plan was reissued to address DOE operations exclusively. The environmental monitoring plan is reviewed annually and updated at least every three years. The December 2003 version of the *Paducah Site Environmental Monitoring Plan* addresses the sampling events in 2004 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 remedial 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 EM and restoration activities at PGDP. The RCRA sets the standards for managing hazardous waste and requires permits to be obtained for DOE facilities that treat, store, or dispose of hazardous waste and require assessment and cleanup of hazardous waste releases at SWMUs. The CERCLA addresses uncontrolled releases of hazardous substances and requires cleanup of inactive waste sites. As a result of the PGDP being placed on the NPL and having RCRA permits, the 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 remedial investigations (RIs) 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 remedial 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 investigation of 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 1991b). Phase II of the site investigation, 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 1992a). 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 1992b). 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. 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 would be notified immediately if sampling results were above these levels, and alternative water supplies would be provided to such residents 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 would be made available. The DOE pays installation cost of water systems and the monthly charges for water service to residents with contaminated wells.

The 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 or not their wells were contaminated, were given the option to receive municipal water at DOE's expense. The DOE also provided municipal water to new residents and some new businesses in the area. A five-year review of the water policy was issued in 2003.

The ACO activities identified two off-site groundwater contamination plumes, referred to as the Northwest and Northeast plumes and identified several potential on-site source areas that required additional investigation. The activities also included the evaluation of alternatives and implementation of several interim activities. Upon signature of the FFA in February 1998, the FFA parties declared that the ACO requirements were satisfied and terminated the ACO. The remaining cleanup is being continued under the authority of the FFA. A series of RI/ 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 FFA, DOE actions have primarily focused on reducing potential risks associated with off-site contamination. Examples of the significant actions initiated and completed include, but are not limited to, the following (BJC 2004):

- 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).
- Constructed hard-piping to reroute surface runoff around 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," which is a contaminated scrap pile potentially contributing to surface-water contamination, to eliminate potential direct-contact risks to plant workers and reduce off-site migration (2000).
- Applied *in situ* treatment of TCE-contaminated soil at the cylinder drop test site with innovative technology (i.e., the LASAGNA™ technology) to eliminate a potential source of groundwater contamination (2002).
- Removed petroleum-contaminated soil from SWMU 193 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 contamination during scrap removal, and initiated removal and disposal of approximately 54,000 tons of scrap metal to eliminate potential direct-contact risks to plant workers and a source of surface-water contamination (2002).
- Completed hard-piping and installation of a retention basin and completed excavation of the on-site portions of the NSDD, which removed a source of potential direct-

contact risk to plant workers and surface-water contamination (2003).

- Completed two key groundwater technology studies, including a successful treatability study to evaluate the effectiveness of the Six-Phase Heating (SPH) technology for *in situ* treatment of dense, nonaqueous-phase liquid (DNAPL) at C-400 and a field demonstration to evaluate the technical constructability of a permeable treatment zone, which identified several installation concerns (BJC 2004).

Operable Units

The National Contingency Plan (NCP) states that owners of large, complex sites with multiple source areas, such as federal facilities, may choose to divide their sites into smaller areas for characterization and implementing response actions, as opposed to conducting a single site-wide 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 the OU approach and includes a series of prioritized actions, ongoing site characterization activities to support future response action decisions, and D&D of the currently operating PGDP once it ceases operation, followed by a Comprehensive Sitewide Operable Unit (CSOU) evaluation. The timing and sequencing for implementation 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 Section XVIII.A of the FFA (BJC 2004).

The OUs were established by developing a site conceptual risk model for each source area [SWMU/area of concern (AOC)]. This process included a qualitative evaluation of contaminant types and concentration, release mechanisms, exposure pathways, points of exposure, and receptors based on current and reasonably foreseeable future land use. The source areas were initially grouped into media-specific OUs as follows:

- Groundwater OU
- Surface-Water OU
- Soils OU
- Burial Grounds OU
- D&D OU
- CSOU

Sources and areas of contamination suspected of being primary risk contributors to off-site residents via the groundwater pathway were grouped under the Groundwater OU. Similarly, the Surface-Water OU contains sources and areas of contamination that could potentially impact creeks and streams. The soils, Burial Grounds, and D&D OUs contain the sources posing potential risks to on-site industrial workers via direct contact. The objective of grouping the sources and areas of contamination into media-specific OUs is to provide a more comprehensive framework to assess site-wide risks, identify and prioritize response actions, and develop integrated cleanup solutions that will reduce risk across the primary exposure pathways.

To further support implementation of this strategy, the source areas and affected media within each OU were then subjected to a screening process using existing data and process knowledge to further segregate the source areas into various categories. These include areas for accelerated action, areas requiring additional characterization/ risk evaluation, and areas in which investigation and/ or remediation needs to be coordinated with D&D of the PGDP once it ceases operation. Criteria used to designate areas as warranting an accelerated action included the following:

- Actions necessary to prevent and/or mitigate human exposure to on- and/or off-site contamination posing near-term unacceptable risk,
- Actions necessary to ensure safe conditions for current industrial workers, and
- Actions providing the greatest opportunity for risk reduction.

The accelerated actions are focused on reducing threats associated with the major risk contributors for the primary exposure/migration pathways (e.g., groundwater, surface water, soil). Units not included as part of the currently planned accelerated actions will undergo additional investigation and/or risk evaluation to support future response action decisions. Certain investigation activities have been planned to focus on characterizing specific site conditions/pathways. These include the Southwest Dissolved-Phase

Plume/Sources Project and the Surface-Water Project (onsite). Other investigations will be completed under the CSOU. This OU will address the data gaps for the remaining units and will include a multimedia evaluation as appropriate (e.g., groundwater, surface water). The RI for the CSOU will also evaluate the Northwest and Northeast Dissolved-Phase Groundwater Plumes and serve to identify hot-spot soil contamination that will be addressed through a removal action coordinated with the RI (BJC 2004).

Groundwater is an example of an area that has unique technical factors that need special consideration in the sequencing and decision-making process. The cleanup strategy for groundwater contamination includes preventing human exposure to contaminated groundwater, addressing source areas posing the off-site risks, and selecting and implementing final actions for the dissolved-phase plumes. As part of executing this strategy, alternate drinking water has been provided to potentially affected residents to prevent human exposure, and groundwater treatment systems have been installed in both the Northwest and Northeast plumes to reduce further off-site migration. Additionally, source-reduction actions are currently being proposed for the C-400 area, which is the largest DNAPL source of off-site contamination. Additionally, a site investigation for the Southwest Dissolved-Phase Plume/Sources will evaluate the need for additional groundwater actions for that plume before plant shutdown.

However, before a final decision for off-site dissolved-phase plumes can be reached, several technical factors must be considered, including the effectiveness of the DNAPL source actions at the C-400 area, whether additional DNAPL source areas exist beneath the operating PGDP, and the hydrogeologic effects that ceasing plant operations will have on groundwater flow directions. Each of these technical considerations, which will be further evaluated under the Site-Wide Soils OU, is essential to understanding remediation time frames and the fate/transport characteristics of the contaminants associated with the dissolved-phase plumes.

The scope of the D&D OU includes 17 currently inactive DOE facilities. The 17 inactive DOE facilities are scheduled to undergo D&D before plant shutdown. The units associated with PGDP operations will be prioritized and sequenced with D&D of the PGDP.

The final CSOU evaluation will occur following completion of D&D of the PGDP after plant shutdown. The scope of the final CSOU will include a site-wide baseline human health and ecological risk assessment to evaluate residual risks remaining and will identify any necessary additional actions to ensure long-term protectiveness (BJC 2004).

Site Priorities

The DOE uses a combination of factors to prioritize work being implemented under the EM program at PGDP. These factors include risk-based criteria, compliance with other programs, technical operational considerations, mortgage reduction, and demonstrated progress toward completing the EM mission.

2004 Remedial Activities

Significant accomplishments for the environmental restoration program conducted in 2004 include, but were not limited to, the following:

- Submitted a ROD for the C-400 groundwater action.
- Completed the Southwest Plume Site Investigation.
- Completed the C-746-S&T Landfill Site Investigation
- Continued operation of the Northwest and Northeast Plume groundwater treatment systems.
- Issued for regulatory review the Surface-Water OU Sampling and Analysis Plan.
- Completed the NSDD Section 2 remediation.
- Continued characterization, removal, and disposal of scrap metal.

C-400 Record of Decision

In 2004, a ROD was developed by DOE and submitted to the regulators for selecting the interim remedial action (IRA) for the Groundwater OU volatile organic compound (VOCs) source zone, comprised primarily of TCE, at the C-400 Cleaning Building at PGDP, and includes discussion of the contribution that this IRA will make toward the final decision for the Groundwater OU at the PGDP.

The IRA would accomplish the following:

- Prevent potential exposure to contaminated groundwater to on-site industrial workers through institutional controls (e.g., excavation/penetration permit program); and
- 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 point 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 a remedial design investigation to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to conclude optimum placement of the remediation system; and
- Implement Land Use Controls (LUCs) at the C-400 Cleaning Building area.

Southwest Plume Site Investigation

In 2004, an 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). The investigation evaluated the following four potential source areas of contamination to the Southwest Groundwater Plume and profiled the current level and distribution of VOCs and ^{99}Tc in the plume along the west plant boundary.

1. C-747-C Oil Landfarm,
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, and
4. C-747 Contaminated Burial Yard.

The objectives of the current SI were to collect sufficient data in order to:

- 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 *Site Investigation Report for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2180&D1) was issued in early 2005. The results will be utilized to determine future remedial actions for the Southwest Groundwater Plume.

C-746-S&T Landfill Site Investigation

The DOE completed an SI that focused on the vicinity of the C-746-S&T Landfill complex. The C-746-S&T Landfill complex covers approximately 36 acres and consists of closed sanitary and industrial landfills (C-746-S and C-746-T, respectively) that are permitted by KDWM. Temporary borings were used to collect groundwater samples from the top and base (approximately 50 ft to 100 ft below ground surface, respectively) of the RGA and every 10 ft within the RGA. The investigation determined that the groundwater contamination by VOCs, principally TCE observed in landfill groundwater MWs is derived from the vicinity of the C-746-P Area.

Northwest Plume Groundwater System

The IRA of the Northwest Plume is documented in a ROD signed by DOE and EPA in July 1993. The KDEP also 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.

Trichloroethene 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 are then used to remove the TCE from the off-gas generated by the air stripper before the air is discharged to the atmosphere. Lastly, ^{99}Tc is removed from the groundwater by an ion-exchange process.

The NWPGS has extracted and treated approximately 951,267 million gallons of contaminated groundwater from startup in 1995 through the end of 2004. The treatment system has exceeded the online goal of 85 percent since its startup. The NWPGS has consistently 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 the 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 operations 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 6000 linear feet) 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 2004, approximately 636,666 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

The Surface-Water OU Project includes a site investigation to identify hot spots in onsite ditches, selected storm sewers (4), and outfalls 001, 002, 008, 010, 011, 012, 015, including sections 3, 4, and 5 of the NSDD. The SI scope also includes an evaluation of whether additional sediment control measures and/or actions for potential legacy releases associated with the storm sewer system are needed. The results of the SI will be documented in an SI/Baseline Risk Assessment Report and non-time-critical removal action documentation, as appropriate. In 2004, DOE continued to negotiate the requirements with KDWM for the *Sampling and Analysis Plan of the Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2137&D2/R2).

North-South Diversion Ditch

On August 21, 2002, the *Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1948&D2) was approved by EPA and concurrence was received by the Commonwealth of Kentucky. The DOE signed the ROD on September 25, 2002. The IRA is addressed by sections 1 and 2 of the NSDD (i.e., SWMU 59). This portion of the NSDD is located inside the main security fence surrounding the industrialized portion of PGDP.

The IRA's objectives are documented in the ROD as follows:

- Prevent future discharge of process water to the NSDD;

- Reduce the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water; and
- Prevent future on-site runoff from being transported offsite (i.e., outside the existing security fence) via the NSDD.

The major components of the selected remedy include a two-phased approach. Phase I of the selected remedy includes the following components:

- Installation of piping to route process discharges, which currently go to the NSDD, directly to the C-616 Water Treatment Facility;
- Installation of storm-water runoff controls in the NSDD downstream of section 2, prior to excavation of a surge basin during Phase I (existing culverts at the downgradient end of Section 2 will be plugged and filled with controlled low-strength material as an initial step in surge basin construction and existing sediment controls inside the security fence will remain in place to control runoff);
- Excavation of a surge basin to contain storm-water runoff until it can be treated through the C-616 facility; and
- Installation of a plug in the NSDD at the PGDP security fence, and in three other ditches within the watershed, to prevent discharge of storm-water runoff to sections of the NSDD outside the PGDP security fence.

Phase II of the selected remedy includes the following components:

- Excavation of contaminated soils/sediments along sections 1 and 2 of the NSDD to achieve specified cleanup levels. Sections of the NSDD located inside the PGDP security-fence area (sections 1 and 2) will be excavated to remove contaminated soils/sediments, and a clay cover will be installed at the base of the excavation. The clay cover will provide an extra layer of protection in the elimination of the surface-exposure pathway.
- Contaminated materials excavated will be staged and disposed appropriately. Nonhazardous waste generated as a result of the NSDD remedial action will be disposed of in the C-746-U Landfill.
- Sections 1 and 2 of the NSDD will be restored to grade with 2 ft of clay cover, approximately 2 ft of clean soil, and vegetation following completion of excavation activities. The clay cover will provide an extra layer of protection in the elimination of the surface-exposure pathway. If excavation achieves or exceeds the specified cleanup levels for sections 1 and 2, long-term maintenance of the clay cover would not be required.

On September 26, 2002, DOE issued the Remedial Design/Remedial Action Work Plan (RD/RAWP) for the *North-South Diversion Ditch Piping and Pump Modifications at the Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1967&D2). The Commonwealth of Kentucky and EPA approved the RD/RAWP for the Piping and Pump Modifications on October 15, 2002. On October 21, 2002, field activities began on Phase I construction activities. Phase I field activities were completed in 2003. Phase II construction activities began in 2003, with the completion of section 2 excavation in 2004. Staged waste from this excavation was disposed at the C-746-U Landfill. Excavation of section 1 and final disposal of excavation material for both sections 1 and 2 was completed in 2004. A completion report on these activities will be submitted in 2005.

Scrap Metal Removal

The Paducah Site had an estimated 54,000 tons of scrap metal in ten scrap yards, most of which are adjacent to each other and located in the northwestern portion of the plant's fenced area. An Engineering Evaluation/Cost Analysis for S*crap Metal Disposition at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1880&D2/R1), which analyzed alternatives for handling the scrap, was issued by DOE and approved by EPA and the Commonwealth of Kentucky in March 2001. The activities included in the removal action are as follows:

- Construct staging areas to provide the scrap metal disposition with water, septic systems, electricity, and communications;
- Control surface-water and sediment runoff by constructing a storm-water control basin;

- Remove all of the scrap materials down to the level of surface soil;
- Characterize, process, and package scrap materials to meet RCRA, TSCA, appropriate disposal facility waste acceptance criteria, and U.S. Department of Transportation shipping requirements; and
- Transport and dispose of the materials removed.

During 2002, DOE completed construction of a storm-water control basin to support the removal action. In 2003, removal of scrap metal was initiated. The removal scope for the scrap metal project at Paducah consists of the following three major tasks:

1. Removal action to dispose of the Northwest corner scrap yards;
2. Removal action to dispose of the C-746-D Classified Scrap Metal Yard; and
3. Operations and maintenance of scrap metal infrastructure, including trailers and the C-613 storm-water collection basin that was constructed in 2002.

At the end of 2004, approximately 7000 tons of scrap had been removed from the Paducah Site. Figure 3.1 shows the disposition of scrap by month during 2004.

In September 2004, shipment of waste to off-site disposal facilities was placed on-hold due to issues that were identified with some shipments leaving the Paducah Site. Corrective actions were developed and implemented in order to resume shipments.

The C-613 basin that collects storm water from the northwest corner of the scrap yards operated under normal conditions in 2004. The basin is routinely sampled, and then discharged to Outfall 001.

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. *Low-level radioactive waste*—radioactive waste not classified as high-level or transuranic.
2. *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,

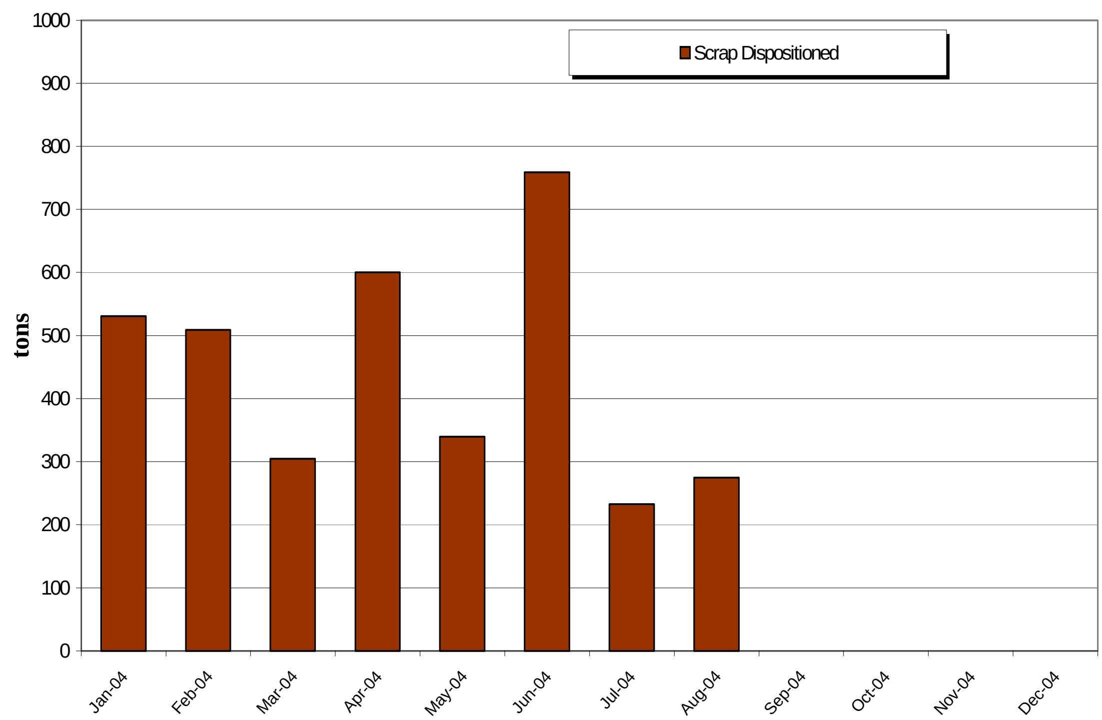

Figure 3.1 Scrap Metal Removal Project disposition during 2004

(2) corrosivity, (3) reactivity, and (4) toxicity.

3. *Mixed waste*—waste containing both a hazardous component regulated under RCRA and a radioactive component regulated under the Atomic Energy Act.
4. *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.
5. *PCB and PCB-contaminated waste*—waste containing or contaminated with PCBs.
6. *Asbestos waste*—asbestos-containing materials from renovation and demolition activities.
7. *Solid*—solid sanitary/industrial waste is basically refuse or industrial/construction debris and is disposed in landfills.
8. *PCB/radioactive waste*—PCB waste or PCB items mixed with radioactive materials.

In addition to compliance with current regulations, 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; and pursuing volume reduction and use of on-site storage, if safe and cost-effective, until a final disposal option is identified. In 2004, activities were focused on disposition of legacy waste—31,880 tons of waste were disposed in the C-746-U Landfill. Other waste in storage was prepared and shipped offsite. Figure 3.2 shows legacy waste disposition. Table 3.1 shows the legacy waste activities during 2004. Figure 3.3 shows the legacy waste disposition quantities in 2004.

Pollution Prevention/Waste Minimization

The Pollution Prevention/Waste Minimization (PP/WM) Program 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, and Executive Orders.

Figure 3.2 Legacy waste disposition

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 objectives:

- Identify waste reduction opportunities,
- Establish site-specific goals,
- Establish employee awareness of PP/WM principles,
- Integrate PP/WM technologies into ongoing projects,
- Coordinate recycling programs,
- Identify PP/WM responsibilities and resource requirements, and
- Track and report results.

Recycling efforts in 2004 included 10.1 metric tons (mt) (22,400 pounds) of office paper; 0.25 mt (550 pounds) of aluminum cans; 0.85 mt (1900 pounds) of telephone books; 0.41 mt (816 pounds) of printer and fax toner cartridges; 4.0 mt (8780 pounds) of carbon used in the NWPGS; spent motor oil; plastic bottles; and reuse of liners from a temporary sedimentation basin. Additional accomplishments of the PP/WM Program included transfer of ownership of 54 out-of-service fluorine cells (147 mt) and 28 drums of oil (5.5 mt) to offsite organizations for reuse. Efforts are also ongoing to reduce waste generation and expand recycling/reuse opportunities.

Table 3.1 Legacy waste disposition activities for 2004

<u>Jan 2004</u> Completed sorting and repackaging of 23 of 600 cubic meters of low-level waste (LLW). Shipped 11.3 cubic meters of mixed low-level waste (MLLW) soft solids to the TSCA Incinerator. Shipped 24.5 cubic meters of MLLW to Perma-Fix for disposition.
<u>March 2004</u> Shipped 38.4 cubic meters of MLLW to Perma-Fix for disposition. Discharge 12,000 gallons of wastewater generated by repackaging 1250 cubic meters.
<u>April 2004</u> Shipped 10.9 cubic meters of MLLW to Envirocare for treatment and disposal. Shipped 140 cubic meters of PCB/radioactive waste (280 cubic meters) to Envirocare for disposal. Shipped 12 cubic meters of MLLW combustible to the TSCA Incinerator. Shipped 24 cubic meters of MLLW to Perma-Fix for treatment and disposal.
<u>May 2004</u> Shipped 679 cubic meters of LLW debris to Envirocare of Utah for disposal. Shipped 29 cubic meters of MLLW to Perma-Fix for treatment/disposal. Discharged 2825 gallons waste water generated from the LLW task.
<u>June 2004</u> Completed the shipments of 285 cubic meters of PCB/radioactive waste to Envirocare for disposal. Shipped 17.4 cubic meters of solid MLLW to the TSCA Incinerator.
<u>July 2004</u> Shipped 11.5 cubic meters of MLLW to Envirocare of Utah for disposal.
<u>Aug 2004</u> Shipped 116 cubic meters AO waste to Envirocare of Utah. Shipped 360 cubic meters of classified scrap metal to the Nevada Test Site (NTS) for disposal.

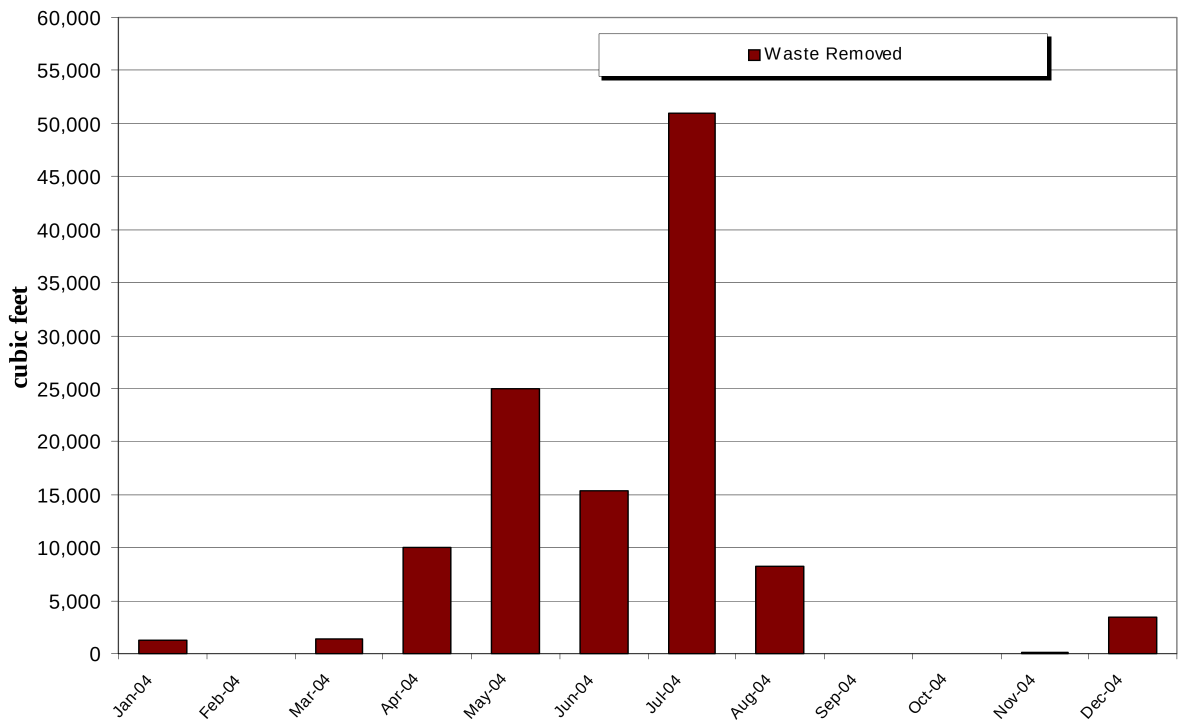

Figure 3.3 Legacy waste disposition during 2004

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 2003, the Paducah Site managed an inventory of approximately 38,000 cylinders containing approximately 454,000 mt of UF_6 (most containing DUF_6) stored in outdoor facilities, commonly referred to as cylinder storage yards. Additional cylinders are added to the DOE inventory annually as a result of formal agreements with the USEC.

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

The mission of the DUF_6 Cylinder Program is to safely store the DOE-owned DUF_6 inventory until its ultimate disposition. The DOE has an active cylinder management program that includes cylinder and cylinder yard maintenance, routine inspections, cylinder yard construction and improvement, 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*, in response to the Defense Nuclear Facility Safety Board's request to analyze alternative chemical forms for the storage of DUF_6. 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. Consistent with Public Law 107-206, construction began in July 2004. Initial construction activities included site excavation, construction of a detention basin to control storm run-off, and installation of underground utilities (Figure 3.4).

Figure 3.4 DUF_6 facility construction activities

DOE also entered into an AO in October 2003 with the Commonwealth of Kentucky that included a Cylinder Management Plan for continued activities associated with cylinder management at Paducah.

Decontamination and Decommissioning

D&D is conducted for facilities and other structures contaminated with radiological and hazardous material. Facilities are accepted for D&D when they are no longer required to fulfill a site mission. Two major facilities comprising approximately 46,450 square meters (m^2) (500,000 square feet) 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.

CERCLA documentation for removal of the C-410 Complex Infrastructure has been completed as a non-time critical removal action. Additional documentation will be required for the C-410 building demolition and for the C-340 complex. Actual D&D of the C-410/C-420 complex has been initiated. In 2004, D&D accomplishments in 2004 at the C-410/C-420 complex included the following:

- Completed sorting and repackaging of over 100 B-25 boxes of compactible wastes from the C-410 complex for offsite disposal;

- Completed isolation of steam, air, nitrogen, and steam condensate lines that enter the C-410 complex;
- Completed removal of support facilities around hydrofluoric acid tanks and shipped 11 hydrofluoric tanks to NTS for disposition (see Figure 3.5);
- Shipped hydrofluoric acid tank residuals to Envirocare;
- Completed removal of potentially fissile material in the C-410 complex;
- Demolished the C-410-A Hydrogen Holder tank;
- Installed temporary power to allow for D&D activities in the C-410 complex; and
- Shipped fluorince cells off-site for disposal.

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.

Figure 3.5 Disposition of the Hydrogen Fluoride Tank at NTS

DOE Material Storage Areas

DOE Material Storage Areas are areas at PGDP containing material and equipment. They are undergoing a characterization process consistent with requirements associated with Nuclear Criticality Safety, RCRA, TSCA, and solid waste concerns. The 160 DMSAs were originally included with PGDP facilities leased to USEC. To facilitate Nuclear Regulatory Commission certification of the PGDP, the DMSAs were returned to DOE from USEC December 31, 1996. The DMSAs are located either in non-leased areas inside buildings leased to USEC or in non-leased outdoor areas.

The Kentucky Natural Resources and Environmental 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 158,000 cubic feet of DMSA material have been disposed and 625,000 of 865,000 cubic feet have been characterized. Fourteen outdoor DMSAs have been emptied. The three remaining active outdoor DMSAs have been fully characterized and plans are underway to complete material disposition of those areas.

As described in Chapter 2, the AO commitments for Priority A DMSAs have been met. Fieldwork gives priority to DMSAs located outside or those that may contain hazardous waste. The 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 on DOE activities exists 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. The program uses proactive public involvement to foster a spirit of openness and credibility among local citizens and various segments of the public.

Community/Educational Outreach

The DOE and BJC Public Affairs supported several educational and community outreach activities during 2004. The DOE site manager spoke with civic groups, business leaders, and residents at pre-arranged events.

Citizens Advisory Board

The PGDP Citizens Advisory Board (CAB), a Site-Specific Advisory Board chartered by DOE under the Federal Advisory Committees Act, completed its eighth full year of operation in September 2004. 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:

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

All meetings are open to the public and all regular board meetings are publicly advertised.

In 2004, the CAB had 13 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 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.oakridge.doe.gov/pgdpssab.

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 are also 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.bechteljacobs.com/pad_eic/shtml.

4 Radiological Effluent Monitoring

Abstract

Environmental Monitoring at the Paducah Site, as required by DOE Order 5400.1, consists of two components: (1) effluent monitoring and (2) environmental surveillance monitoring. Effluent monitoring is initiated to demonstrate compliance with one or more federal or state regulations. Radiological liquid effluent monitoring was performed at the four outfalls under the jurisdiction of DOE at the Paducah Site during 2004. Three of the four outfalls retained by DOE discharge only rainfall runoff. A fourth outfall is a continuous-flow outfall. The outfalls were monitored for radionuclides historically known to be present at the site. Surface-water runoff from landfills at the Paducah Site was also monitored. Concentrations of the radionuclides measured (uranium and ^{99}Tc) for DOE outfalls were within acceptable limits set by DOE and federal standards. The DOE-operated point source areas for radionuclides in airborne effluents during 2004 were the NWPGS, the Scrap Yards Removal Projects, and the C-410 D&D Fluorine Cell Blasting Project.

Introduction

Effluents are monitored for radionuclides known to be emitted or to have been present at the Paducah Site. Monitoring of radioactivity in liquid and airborne effluents is described fully in the *Paducah Site Environmental Monitoring Plan* (BJC 2003a). Dose calculations are provided in Section 6.

Airborne Effluents

In accordance with DOE Order 5400.1, 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 millirem (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 are also regulated under 40 C.F.R. 61, Subpart H, which governs radionuclide emissions, other than radon. 40 C.F.R. 61 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.

The DOE had three sources of airborne radionuclides in 2004. These sources were the NWPGS, the Scrap Yards Removal Projects, and the C-410 D&D Fluorine Cell Blasting Project. The DOE also had fugitive air sources that are measured by air monitoring stations around the site.

Northwest Plume Groundwater System

The CERCLA 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 originally approved by EPA in March 1995 (since revised and approved), 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 is then 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 of 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 ^{99}Tc emissions from the facility in 2004. The emissions are then used to calculate dose rates associated with these operations.

Scrap Yards Removal Projects

During 2004, the Scrap Metal Removal Project continued sorting and characterizing materials contained within the scrap yards. Packaging materials for off-site shipment began, but was placed on-hold in September 2004 due to site shipment stand-down that required corrective actions to be taken by all projects shipping waste off-site for disposal. There are approximately 54,000 tons of scrap materials in the scrap yards. Most of the metal is iron, nickel, or aluminum. The most common contaminant is uranium. Approximately 7000 tons of scrap were removed from the site at the end of 2004.

C-410 Decontamination and Decommissioning Activities

Fluorine cells were removed and prepared for off-site shipment. 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; however, room ventilation was exhausted through a high-efficiency particulate air filter. The amount of radionuclides released was estimated based on 40 *CFR* Subpart H Appendix D emission factors. Figure 4.1 shows a fluorine cell.

Figure 4.1 Fluorine cell

Airborne Effluent Results Summary

In 2004, releases to the atmosphere from the NWPGS were calculated to be 9.85 x 10^{-5} Curies of ^{99}Tc. The estimated emissions from the scrap metal removal projects were 5.86 x 10^{-4} Curies. The estimated emissions from the fluorine cell blasting project were 1.9 x 10^{-7} Curies. The calculated emissions for each activity was less than the 40 CFR 61 Subpart H limit of 0.1 mrem dose to the maximally exposed individual. Dose to the public from airborne radionuclides is discussed in Section 6.

Liquid Effluents

The CWA for the Paducah Site is administered by KDOW through the KPDES Wastewater Discharge Permitting Program. The site-wide KPDES permit (KY0004049) became effective April 1, 1998. A renewal permit application has been submitted to KDOW. This permit contains discharge limits based on water quality criteria for a zero-flow receiving stream.

In addition to nonradiological parameters on the KPDES permit, specific radionuclide analyses and indicator-gross-activity analyses are conducted on liquid effluent samples. Grab samples and composite samples at various frequencies are used to measure discharges.

DOE Orders 5400.1 and 5400.5 establish effluent monitoring requirements to provide confidence that radiation exposure limits are not exceeded. DOE Order 5400.5 sets guidelines for allowable concentrations of radionuclides in various effluents and requires radiological monitoring to protect public health. This protection is achieved at the Paducah Site by meeting DOE Order 5400.5-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. This conservative exposure scenario is very unlikely to exist. Because exposure is not continuous, this results in conservatively low concentrations for the DCGs. 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 are required by DOE Order 5400.5. Uranium and ^{99}Tc are the primary radionuclides of concern. Analyses are also routinely performed for dissolved alpha, suspended alpha, dissolved beta, and suspended beta concentrations. The KPDES permit requires additional sampling (two events in five years) for priority pollutants at the DOE outfalls. This sampling was conducted in 2000 and 2002. Radiological standards in liquid effluents were not exceeded in 2004.

Other 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

The DOE was responsible for a total of four outfalls in 2004 (Figure 4.2). Under KPDES permit number KY0004049, Outfall 001 is a continuous-flow outfall that received discharges from USEC's Phosphate Reduction Facility, a once-through cooling water system, and DOE's NWPGS. The DOE's NEPCS is treated through the C-637 cooling tower system at PGDP. The cooling tower basin water is then transferred to C-616 through a process known as blowdown. Next, the water is transferred by an underground pipeline to C-616, a water treatment facility, and ultimately discharged into Outfall 001. In addition, surface-water runoff from the northeast side of the plant is collected in a 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 landfill). Data are presented in Section 1, Tables 1.1 through 1.4, of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

Landfill Surface Runoff

Surface runoff from the closed C-746-S Residential Landfill and the C-746-T Inert Landfill

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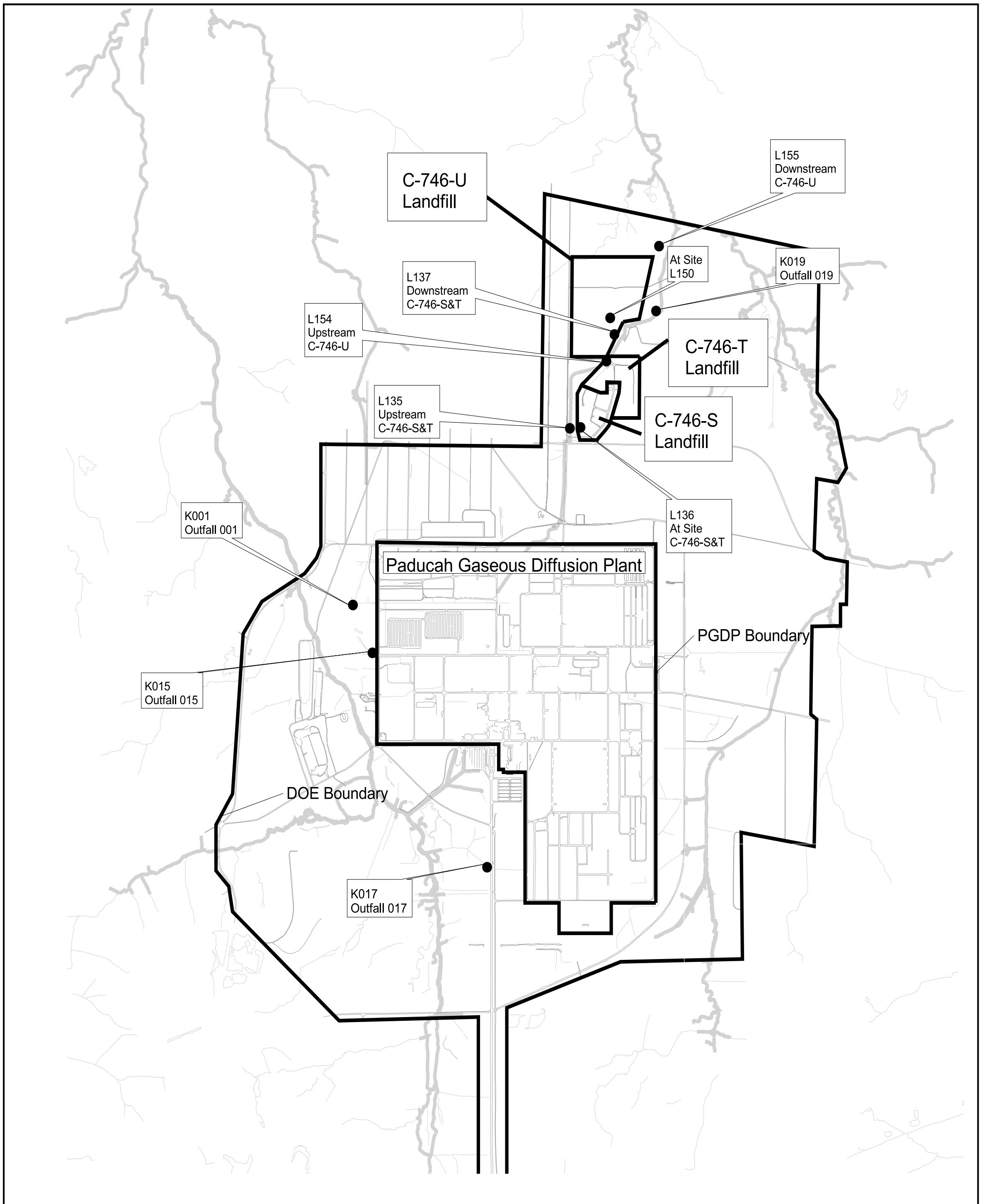

LEGEND:

● Surface-Water Monitoring Locations

900 0 900 1800 Feet

TRUE NORTH 20° PLANT NORTH

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

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Figure 4.2 KPDES outfalls and landfill surface-water monitoring locations

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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. Data are presented in Section 1, Tables 1.5 through 1.10, of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

Results are consistent with levels seen in previous years' data. These areas are within DOE-controlled areas and, therefore, pose no threat to human health and the environment.

Liquid Effluent Monitoring Results

Tables 4.1 and 4.2 include the yearly minimum, maximum, and average concentrations of uranium and ^{99}Tc at each outfall monitoring location. Each radionuclide is compared with the corresponding DCG and is presented as a percentage of DCG. The combined average concentrations at all outfalls were small percentages of the corresponding DCG. The average concentration of uranium being discharged to Outfall 015 was 15 percent of the DCG. The average concentration of uranium being discharged to Outfall 001 was 3.8 percent of the DCG. The average concentration of uranium being discharged to Outfalls 017 and 019 was less than 1 percent of the DCG. Outfall 015 received runoff from the uranium burial ground with small quantities of surface contamination from uranium compounds. Runoff from the burial ground is suspected to be responsible for the elevated uranium concentrations associated with Outfall 015. Technetium-99 averages for 2004 for all four outfalls were well below 0.1 percent of the DCG. Data for 2004 do not indicate a significant change in relation to DCG levels for any radionuclide compared to data for the past five years.

Figures 4.3 and 4.4 show the five-year summary of average concentrations of uranium and ^{99}Tc. Uranium concentrations were slightly higher in 2004 at Outfalls 001 and 015 versus 2003 levels. Uranium concentrations for 2004 are well below the DCG of 600 pCi/L, established by DOE Order 5400.5 for the protection of members of the public and the environment. Activities for ^{99}Tc are slightly higher than those seen in 2003. Activities for ^{99}Tc in 2004 are well below the DCG of 100,000 pCi/L.

Table 4.1 Total uranium concentration in DOE outfalls for 2004

Outfall	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Average (pCi/L)	% of ^{235}U	% of DCG[a]
001	5	0.0033	0.22	0.048	23	0.53[b]	3.8
015	3	0.046	0.21	0.15	91	0.30	15
017	5	<0.001	0.0025	0.0016	1.0	0.60[b]	0.17
019	3	<0.001	<0.001	<0.001	0.7	0.76[c]	0.12

[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 4.2 Technetium-99 activity in DOE outfalls for 2004

Outfall	Number of Samples	Minimum (pCi/L)[a]	Maximum (pCi/L)[a]	Average (pCi/L)[a]	% of DCG[a]
001	6	2.1	35	14	0.014
015	3	4.0	58	32	0.032
017	5	3.8	18	10	0.01
019	3	-7.8	5.8	1.2	0.0012

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

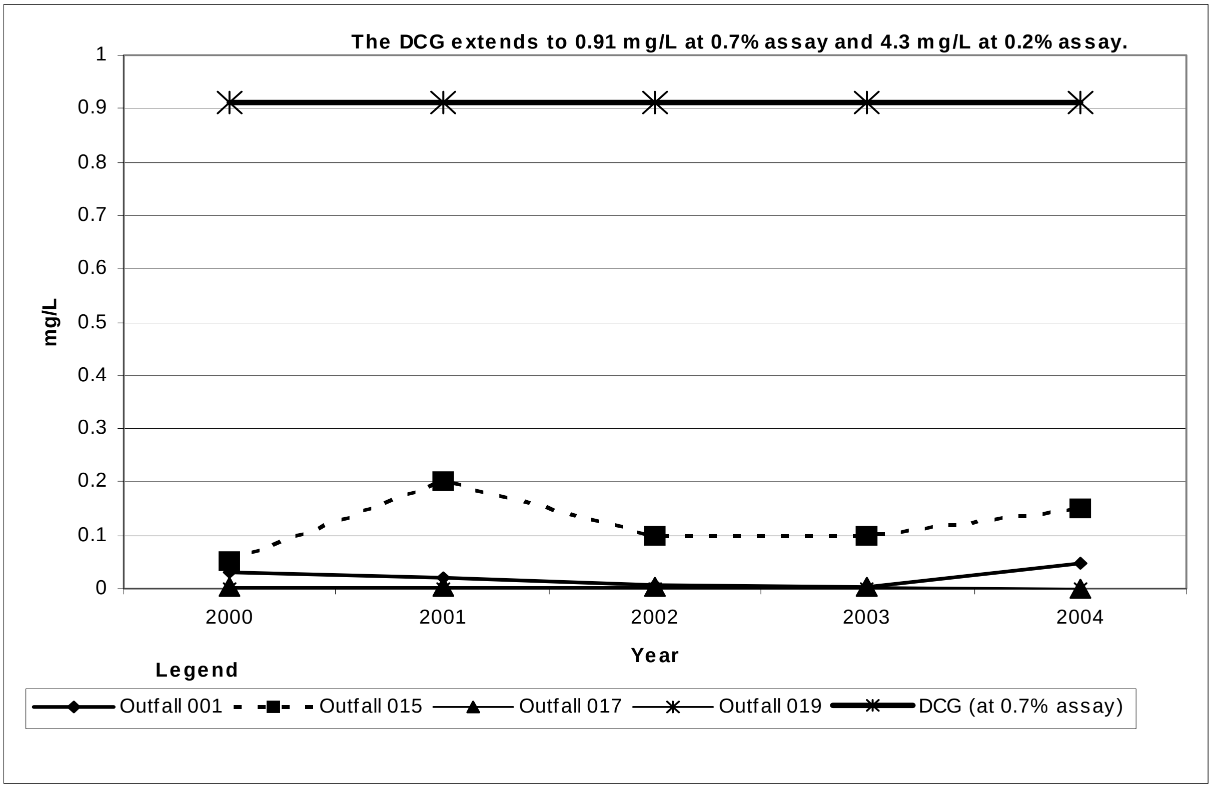

Figure 4.3 Uranium concentrations discharged to surface water, 2000–2004

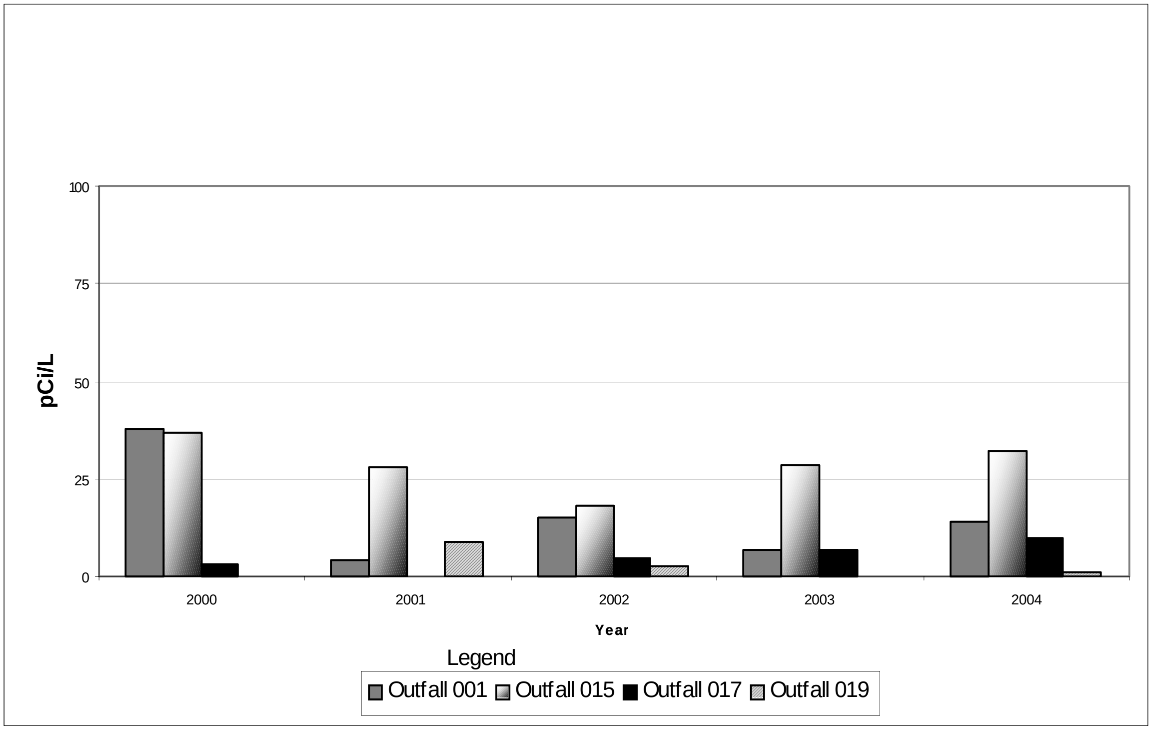

Figure 4.4 Technetium-99 activity discharged to surface water, 2000–2004

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 2004 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 2004 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 the existing radionuclide airborne point-source discharges at PGDP, with the exception of DOE's NWPGS, the Scrap Metal Removal Project, and C-410 D&D activities. The DOE monitors fugitive emission sources [using Kentucky Cabinet for Health Services (KCHS)-operated air monitors] including building roof tops, piles of contaminated scrap metal, roads, and concrete rubble piles. A potential fugitive or diffuse source of radionuclides could result from the decontamination of machinery and equipment used in remediation activities, such as well drilling. Machinery and equipment are washed with high-power sprayers to remove any contaminants originating from the soil and from groundwater. The concentrations of radionuclides on the equipment are so small that, under most circumstances, contamination levels cannot be distinguished from background levels.

The DOE utilized ambient-air-monitoring data to verify radionuclide levels in off-site ambient air. The radionuclide levels were determined to be insignificant. Ambient air samples are collected at ten 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 of the KCHS Department for Public Health conducted ambient air monitoring during 2004. Based on 2004 results, plant-derived radionuclides were not detected by the Radiation Health and Toxic Agents Branch's air monitoring network. The monitoring results for 2004 are listed in Section 2, Table 2.1, of

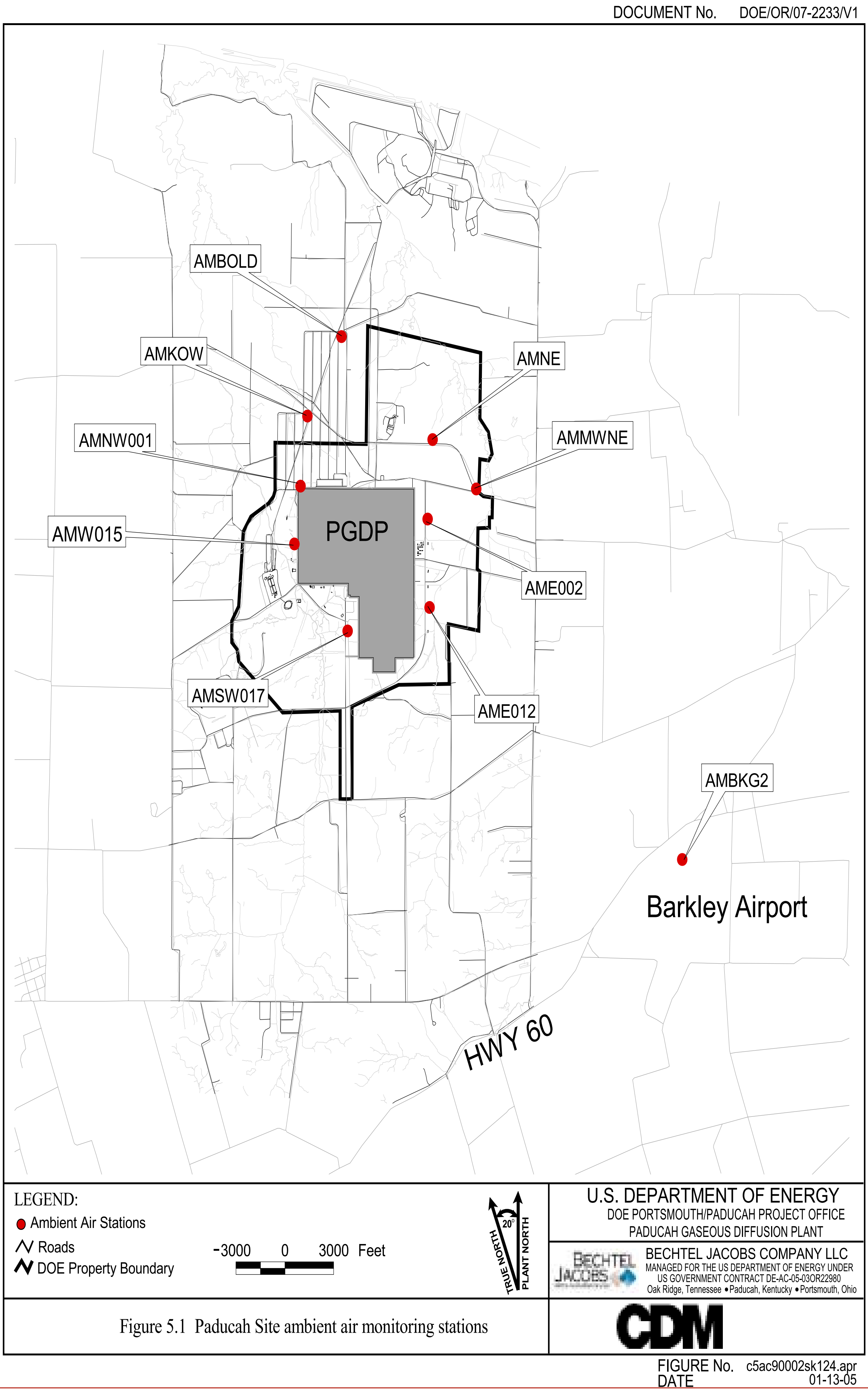

Figure 5.1 Paducah Site ambient air monitoring stations

the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II). Airborne radionuclides emitted from the Paducah Site (including both DOE and USEC emissions) were at or below background as measured by the ambient air monitors (KCHS 2005).

Meteorological Monitoring

U.S. Department of Energy Order 5400.1 requires that DOE facilities collect representative meteorological data in support of environmental monitoring activities. This information is used to characterize atmospheric transport and diffusion conditions in the vicinity of the Paducah Site.

Historic on-site meteorological data are used as input to calculate radiation dose to the public (Section 6). Additional meteorological data from Barkley Regional Airport are used by some groups for inputs into reporting. For example, the Environmental Restoration Program uses these data to correlate precipitation with groundwater flow.

Computer-aided atmospheric-dispersion modeling uses emission and meteorological data to determine the impacts of plant operations to the community. Modeling is used 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 with data from samples collected downstream of the site or from background waterways. Bayou Creek and Little Bayou Creek are not used as drinking water supplies, and EPA safe-drinking-water standards do not apply. Radioactive effluents 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, alpha activity, beta activity, and ^{99}Tc are collected.

Figure 5.2 shows 23 surveillance surface-water sampling and 6 seep locations. Radiological sampling is conducted at upstream Bayou Creek (L1); downstream Bayou Creek (L5 and L6), downstream Little Bayou Creek (L11, L12, and L241); the convergence of both creeks (L8), upstream Ohio River (L29), downstream Ohio River (L30); downstream Ohio River at the confluence with the Mississippi River (L306), which is the closest public drinking water supply source downstream of the plant; and background stream Massac Creek (L64). Samples were also collected near the plant from Bayou Creek (C612, C616, K006, and L291), Little Bayou Creek (K002, L10, L55, L56, and L194), and at the C-746-K Landfill (C746K-5, C746KTB1, and C746KUP). No sample point exists for upstream Little Bayou Creek because the watershed is insufficient to develop adequate flow to monitor. Nearly all water in Little Bayou Creek is comprised of discharges from plant outfalls. Therefore, background water quality for Little Bayou Creek is based on L1 (upstream Bayou Creek). Sampling locations L29 (Ohio River) and L64 (Massac Creek) are background waterways which are also used for comparison with data from Little Bayou Creek. Locations C746KTB2, K011, and K016, were sampled during 2003, but were not sampled in 2004 due to changes in the Environmental Monitoring Program. L55 was sampled during 2004 but was later removed from the sampling program due to safety concerns with accessing the location.

Locations in Little Bayou Creek (LBCSP1 through 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. Six 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).

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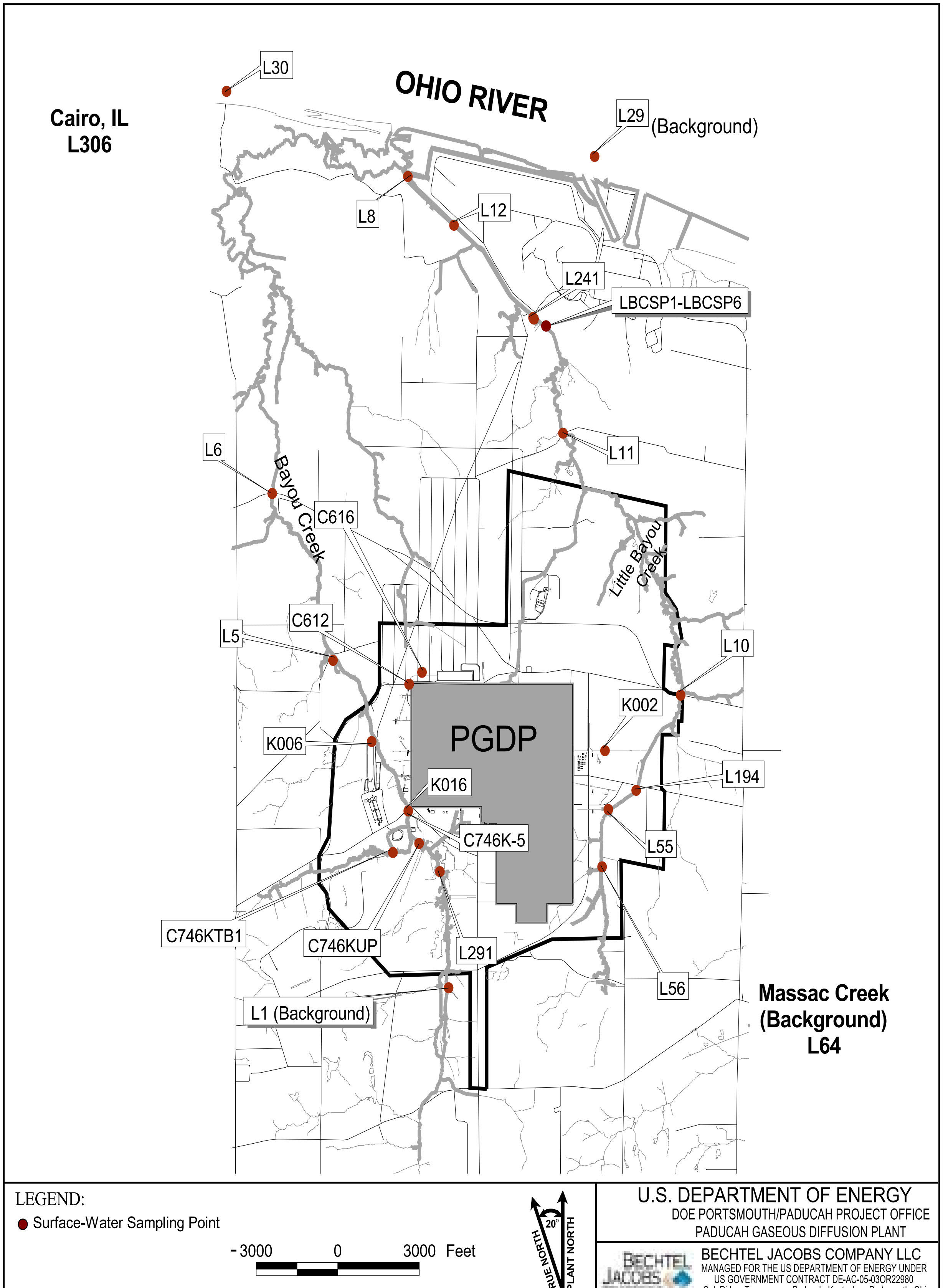

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Figure 5.2 Surface-water monitoring locations

CDM

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Table 5.1 Radiological parameters for surface-water samples

Parameter
Alpha Activity
Americium-241
Beta Activity
Cesium-134
Cesium-137
Cobalt-60
Dissolved Alpha
Dissolved Beta
Neptunium-237
Plutonium-238
Plutonium-239/240
Potassium-40
Suspended Alpha
Suspended Beta
Technetium-99
Thorium-228
Thorium-230
Thorium-232
Thorium-234
Uranium
Uranium-234
Uranium-235
Uranium-238

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 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 background stream, Massac Creek. Comparisons of downstream data with upstream data and background waterways can be made to determine the influence of plant effluents on these waterways.

Concentrations of ^{99}Tc were elevated near the plant site and in downstream creek locations, including the creek convergence, with the highest concentrations found downstream of plant effluents in Little Bayou Creek (Figure 5.2). These concentrations are well below the plant release criteria of 900 pCi/L. Higher concentrations of radionuclides were detected downstream of Bayou Creek, with locations in both creeks near the plant site at similar levels. The level of radiological parameters seen at the C-746-K Landfill was similar to those found upstream of Bayou Creek. Radionuclides were not detected at Massac Creek, upstream or downstream of the Ohio River, or at L306 in Cairo, Illinois (the nearest public drinking water source). Concentrations of radionuclides in effluents at the Paducah Site were far below DCGs and did not pose a health risk. Appendix B provides the DCGs.

Table 5.3 provides the average concentrations of radiological parameters at the seep locations. Results indicate that higher levels of alpha and beta activity and ^{99}Tc were seen at LBCSP5 than at other surface-water locations on Little Bayou Creek; however, these concentrations are well below the plant release criteria of 900 pCi/L and below the DCGs. Additional surface-water data are presented in Tables 2.2 through 2.30 in Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

When compared to the DCGs, established by DOE Order 5400.5 for the protection of members of the public and the environment, radiological parameters were not found in significant concentrations at any sampled location in 2004.

Sediment

Sediment is an important constituent of the aquatic environment. If a pollutant is a suspended solid or attached to suspended sediment, it can either 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 play a significant role in aquatic ecology 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

Table 5.2 Average radiological parameter concentrations for surface-water surveillance samples[a]

Parameter	DCG[b]	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	Creek Convergence[6]	C-746-K Landfill Area[7]	Upstream Ohio River[8]	Downstream Ohio River[9]	Massac Creek[10]	Cairo, IL [11]
Americium-241 (pCi/L)	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-134 (pCi/L)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137 (pCi/L)	3000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt-60 (pCi/L)	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dissolved Alpha (pCi/L)	--	ND	ND	**11.86**	ND	ND	ND	ND	ND	ND	ND	ND
Dissolved Beta (pCi/L)	--	ND	10.87	**21.36**	6.54	15.70	ND	ND	ND	ND	ND	ND
Neptunium-237 (pCi/L)	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium-238 (pCi/L)	--	**0.03**	0.01	ND	ND	ND	ND	0.02	ND	ND	ND	ND
Plutonium-239/240 (pCi/L)	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40 (pCi/L)	7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Suspended Alpha (pCi/L)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Suspended Beta (pCi/L)	--	ND	ND	**5.86**	ND	ND	ND	ND	ND	ND	ND	ND
Technetium-99 (pCi/L)	100,000	ND	4.03	10.21	7.76	**23.78**	10.52	ND	ND	ND	ND	ND
Thorium-228 (pCi/L)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-230 (pCi/L)	300	ND	**0.33**	ND	-0.01	ND	ND	ND	ND	ND	ND	ND
Thorium-232 (pCi/L)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-234 (pCi/L)	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (mg/L)	--	ND	ND	**0.04**	0.01	0.01	ND	ND	ND	ND	ND	ND
Uranium (pCi/L)	600	ND	ND	**97.14**	24.44	ND	ND	ND	ND	ND	ND	ND
Uranium-234 (pCi/L)	500	ND	19.53	**90.23**	21.38	ND	ND	ND	ND	ND	ND	ND
Uranium-235 (pCi/L)	600	ND	ND	**6.78**	1.71	ND	ND	ND	ND	ND	ND	ND
Uranium-235 (wt %)	--	c	c	**0.52**	0.26	0.25	c	1.96	c	c	c	c
Uranium-238 (pCi/L)	600	ND	0.35	**11.39**	1.89	1.71	0.68	0.40	ND	ND	ND	ND

a = Average concentration for the seep locations (LBCSP1–LBCSP6) are found in Table 5.3.
b = Derived Concentration Guide (see Liquid Effluents section for definition).
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
Bold values indicate the highest radionuclide concentrations for the parameter specified.

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title.
1 = L1 (Background)
2 = C612, C616, K006, L291
3 = L5, L6
4 = K002, L10, L55, L56, L194
5 = L11, L12, L241
6 = L8
7 = C746K-5, C746KTB1, C746KUP
8 = L29 (Background)
9 = L30
10 = L64
11 = L306

Table 5.3 Average radiological concentrations for seep locations in Little Bayou Creek

Parameter	LBCSP1	LBCSP2	LBCSP3	LBCSP4	LBCSP5	LBCSP6
Alpha activity (pCi/L)	2.4	1.3	1.3	2.1	**4.4**	1.9
Beta activity (pCi/L)	6	10	19	14	**201**	117
Technetium-99 (pCi/L)	6	15	22	18	**247**	123
Uranium (mg/L)	0.005	0.005	0.005	0.005	0.005	0.005
Uranium (pCi/L)	**27.90**	27.67	27.57	27.55	27.54	27.56

Bold values indicate the highest radionuclide concentrations for the parameter specified.

environmental surveillance program. Table 5.4 shows the radiological analytical parameters. Sediment samples were taken from 16 locations (Figure 5.3).

Table 5.4 Radiological parameters for sediment samples

Parameter
Activity of U-235
Alpha activity
Americium-241
Beta activity
Cesium-134
Cesium-137
Cobalt-60
Neptunium-237
Plutonium-239/240
Potassium-40
Technetium-99
Thorium-230
Uranium
Uranium-234
Uranium-235
Uranium-238

Sediment Surveillance Results

Table 5.5 shows the upstream concentrations of radionuclides in the sediments compared with concentrations downstream of all DOE outfalls for 2004. Locations S27, S33, and S34 are downstream of plant effluents. Locations S20, S21, and S28 are considered reference, or background sites, and can be compared with downstream data. Locations S20 and S21 at Bayou Creek and Little Bayou Creek, respectively, are upstream of plant discharges, whereas S28 is located in a similar, off-site stream (Massac Creek) and provides a regional reference site. Locations K001, C616, C612, S1, S2, S30, S31, and S32 are near the plant site and are downstream of certain plant discharges, but not downstream all discharges (Figure 5.3).

In general, the location with the highest readings for most radionuclides is the NSDD (Table 5.5). Remediation activities of the NSDD are in progress. Access to this area is limited.

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 previously mentioned.

Figure 5.4 shows uranium concentrations in sediment over the past five years. An increase of uranium concentration was seen in Bayou Creek at the plant site. Uranium concentrations downstream of Bayou Creek decreased slightly. Uranium concentrations at Little Bayou Creek near the plant site and downstream decreased significantly. New locations were added in 2001; therefore, no data are shown in Figure 5.4 for the new locations for the year 2000.

Figure 5.5 shows no change in ^{99}Tc activity in sediment in 2004 as compared to 2003 for Little Bayou Creek, both downstream and near the plant site, and downstream of Bayou Creek. An increase in ^{99}Tc was seen at Bayou Creek near the plant site. New locations added in 2001 are also shown as previously noted; therefore, no data are shown in Figure 5.5 for the year 2000. Other radionuclides, although present, are not significantly above background levels. Additional sediment data are presented in tables 2.31 through 2.46 in Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

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

Terrestrial Wildlife

Annual Deer Harvest

In 2004, 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 2004 due to sufficient historical references information available; therefore, 2002 data were used for comparison. Liver, muscle, and bone samples were analyzed for several radionuclides [cesium-137 (^{137}Cs), ^{237}Np, ^{239}Pu, ^{99}Tc, thorium-230 (^{230}Th), uranium-234 (^{234}U), uranium-235 (^{235}U), uranium-238 (^{238}U), and strontium-90 (^{90}Sr) (bone samples only)]. 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.

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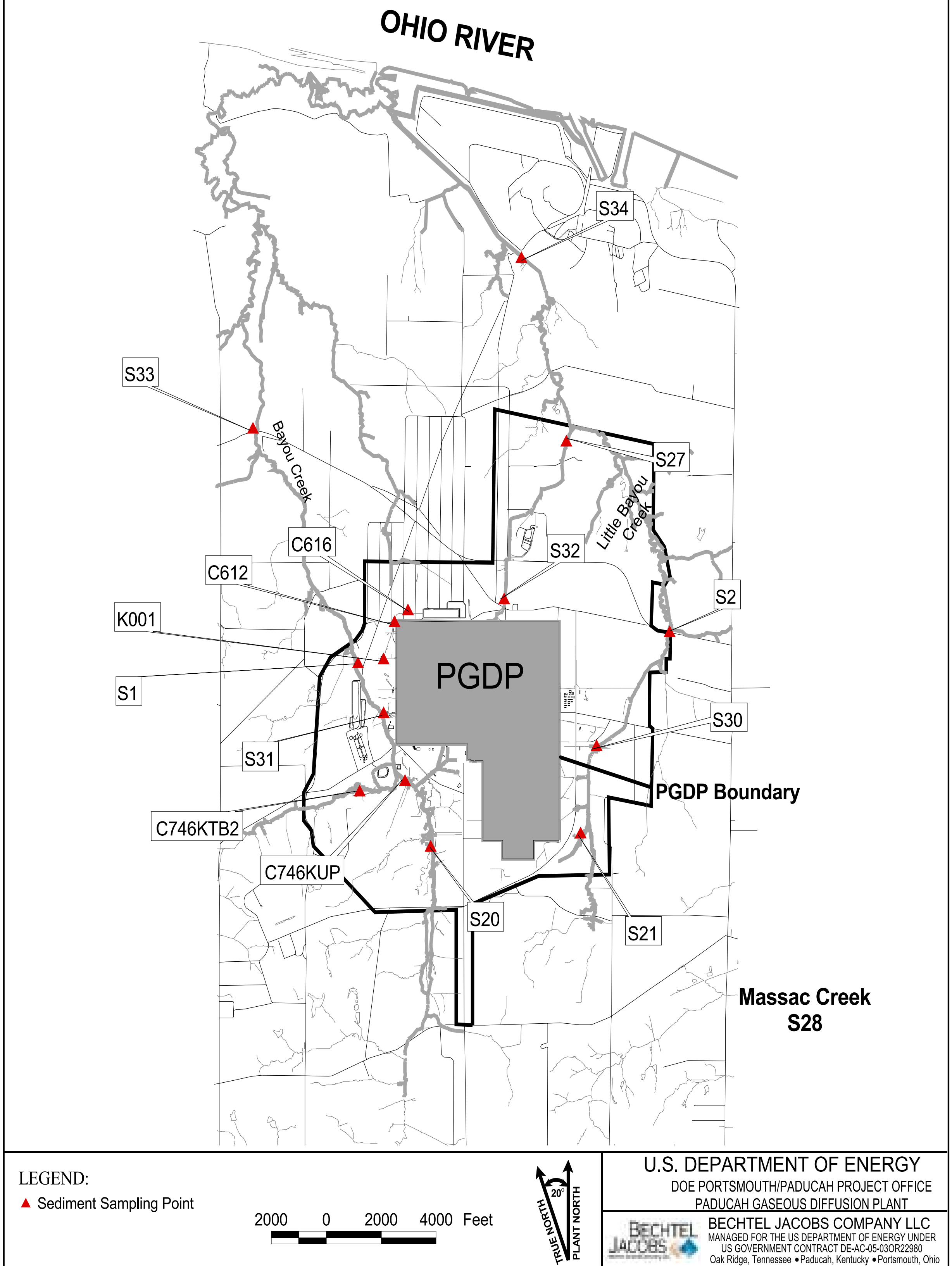

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-03OR22980
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Figure 5.3 Sediment monitoring locations

CDM

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Table 5.5 Average[a] radiological parameter concentrations for sediment surveillance samples

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Upstream Little Bayou[4]	Little Bayou Near Site[5]	Downstream Little Bayou[6]	C-746-K Area[7]	NSDD[8]	Massac Creek[9]
Activity of U-235 (pCi/g)	ND	0.112	0.029	ND	0.188	0.050	0.011	**0.196**	ND
Alpha activity (pCi/g)	2.21	10.94	3.35	3.54	12.67	9.11	2.45	**86.05**	1.55
Americium-241(pCi/g)	ND	0.07	ND	ND	ND	0.12	ND	**1.16**	ND
Beta activity (pCi/g)	2.15	29.51	3.67	2.31	18.42	8.91	2.18	**93.90**	1.81
Cesium-134 (pCi/g)	b	0.023	b	b	b	b	b	b	b
Cesium-137 (pCi/g)	0.021	0.065	0.033	ND	0.027	0.040	0.022	**0.998**	ND
Cobalt-60 (pCi/g)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Neptunium-237 (pCi/g)	ND	0.13	ND	ND	ND	0.01	ND	**1.22**	ND
Plutonium-239/240 (pCi/g)	ND	0.05	ND	ND	ND	0.09	0.00	**3.83**	ND
Potassium-40 (pCi/g)	3.84	5.75	5.84	3.98	4.31	4.16	4.23	**7.17**	3.79
Technetium-99 (pCi/g)	ND	9.50	0.30	0.12	0.17	1.21	0.25	**40.75**	ND
Thorium-230 (pCi/g)	0.18	0.55	0.25	0.34	0.23	1.70	0.21	**69.95**	0.16
Uranium (pCi/kg)	ND	4405	1060	ND	**13200**	2325	383	6680	ND
Uranium (ug/g)	ND	9.48	ND	ND	ND	ND	ND	**36.20**	ND
Uranium-234 (pCi/g)	0.10	2.75	0.48	0.14	1.30	0.50	0.18	**5.25**	0.08
Uranium-235 (pCi/g)	c	0.300	c	c	c	c	c	**0.416**	c
Uranium-235 (wt%)	c	0.723	**0.732**	c	0.248	0.437	0.688	0.645	c
Uranium-238 (pCi/g)	0.092	3.750	0.546	0.174	**11.800**	1.775	0.195	7.790	0.077

a = The average within each group of locations.
b = Cesium-134 was not requested but was reported during one sampling event.
c = Quantities of total uranium were found to be quite small or not detected; individual isotopes of uranium were not analyzed.
Bold values indicate the highest radionuclide concentrations for the parameter specified.
NSDD = North-South Diversion Ditch
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.
1 = S20
2 = C612, C616, K001, S1, S31
3 = S33
4 = S21
5 = S2, S30
6 = S27, S34
7 = C746KTB2, C746KUP
8 = S32
9 = S28

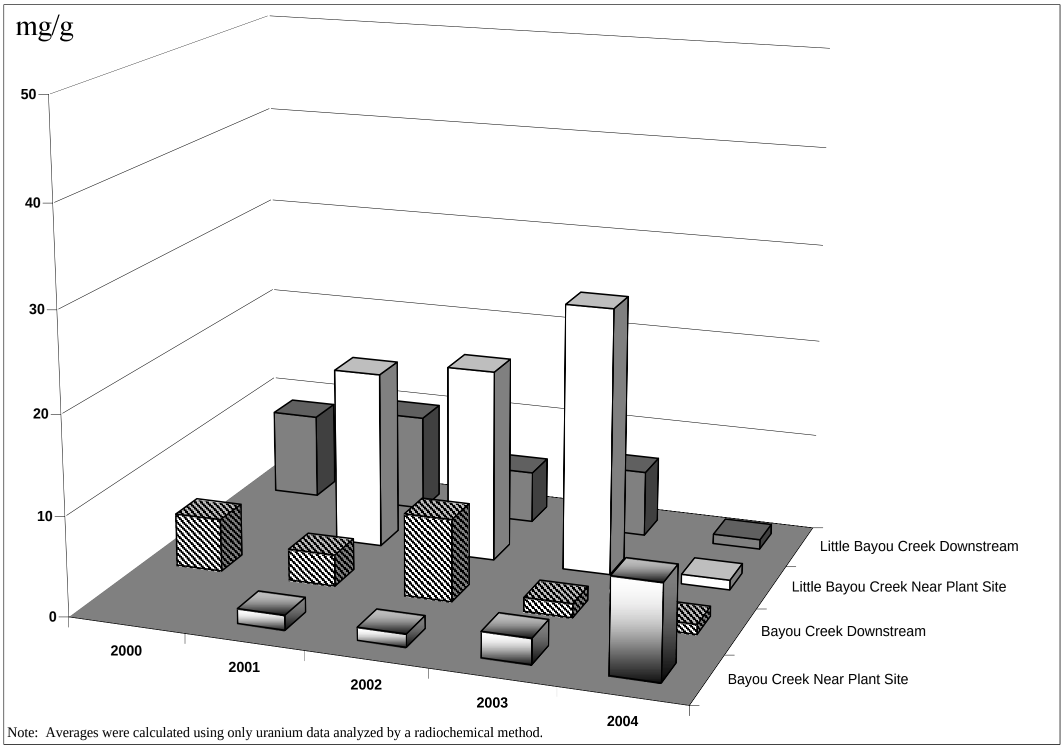

Figure 5.4 Five-year uranium concentration in sediment

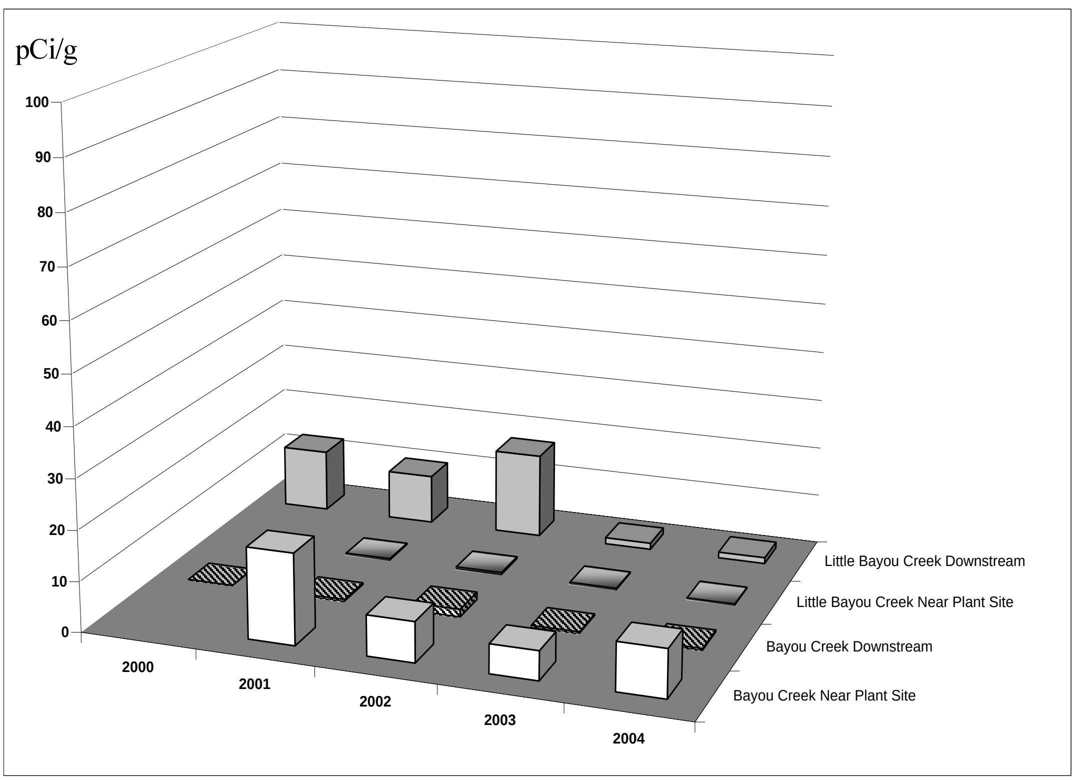

Figure 5.5 Five-year ^{99}Tc activity in sediment

Table 5.6 lists the radionuclides detected in deer tissue for 2004. In deer muscle, which is normally considered to be consumable by humans, concentrations of ^{230}Th were detected at low levels in WKWMA deer. In deer bone, ^{230}Th was found at or above detectable levels in WKWMA deer. In deer liver, uranium-233/234 was detected. No ^{99}Tc, ^{230}Th, and ^{235}U were detected in background deer. Dose assessments indicate that deer are acceptable for consumption and levels are consistent with previous years' data.

The thyroid and bone are not considered edible portions of deer, but rather as indicators of the presence of target radionuclides. Specifically, ^{90}Sr accumulates in the bone and ^{99}Tc accumulates to some lesser degree in the thyroid. In 2004, all results were less than the analytical detection limit for ^{90}Sr in the bone and ^{99}Tc in the thyroid for both WKWMA deer and in 2002 for background deer from Stewart Island.

Additional deer data are presented in Tables 2.48 through 2.51 in Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II). Section 6 discusses dose calculations associated with eating deer from the WKWMA.

Table 5.6 CY2004 radiological parameters detected in deer tissue

Parameter[a] (pCi/L)	Deer 1	Deer 2	Deer 3	Deer 4	Deer 5	Deer (Background)[b]
Technetium-99 (Liver)	ND	ND	ND	ND	ND	ND
Thorium-230 (Bone)	0.03708	ND	ND	ND	ND	ND
Thorium-230 (Liver)	ND	ND	ND	ND	ND	ND
Thorium-230 (Muscle)	ND	ND	0.05355	ND	ND	0.0757
Uranium-233/234 (Liver)	ND	ND	ND	0.04025	ND	ND
Uranium-235 (Liver)	ND	ND	ND	ND	ND	ND

ND – Not detected

[a] Other radionuclides were analyzed but not detected in any deer.

[b] Background deer were collected during 2002 from Stewart Island Habitat Restoration in Livingston County, Kentucky.

Direct Radiation

A primary concern of 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 include the cylinder storage yards, the cascade system, 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 Environmental Monitoring Plan* (BJC 2003a) 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 2004, monitoring consisted of quarterly placement, collection, and analysis of environmental thermoluminescent dosimeters (TLDs). These monitoring locations are shown in Figure 5.6. Monitoring results indicate that 9 of 46 locations were consistently above background levels (BJC 2005a). 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.

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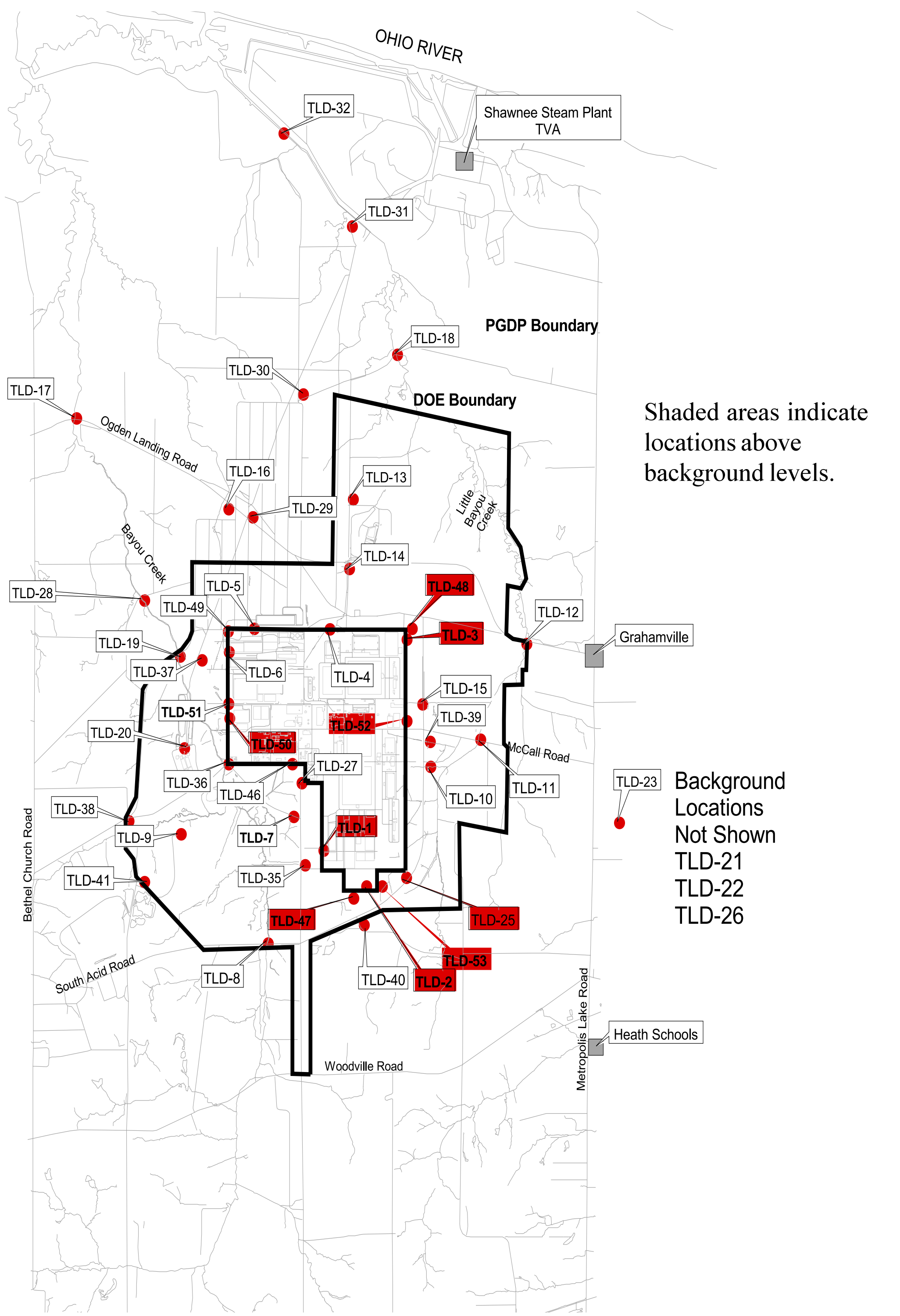

LEGEND:
● TLD Locations

2000 0 2000 Feet

TRUE NORTH 20° PLANT NORTH

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

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-03OR22980
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Figure 5.6 TLD locations in the vicinity of PGDP

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Annual dose rates for the background locations and 9 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 86 milliRoentgen (mR). See the *Annual Report on External Gamma Radiation Monitoring for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-698). 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 2004 attributed to the Paducah Site (Table 5.7). Exposure measured at these locations is assumed to result from DOE operations. Since the locations shown in Table 5.7 are in areas not accessible to members of the public, dose from direct radiation exposure to the maximally exposed individual member of the public from DOE operations is zero. Detailed information is discussed further in Section 6. Additional data are presented in Section 2, Table 2.47 of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II). Section 6 discusses dose calculations associated with direct radiation exposure.

Table 5.7 Net annual exposure from direct radiation attributed to the Paducah Site for 2004 (mR)

Location	TLD-1	TLD-2	TLD-3	TLD-25	TLD-47	TLD-48	TLD-50	TLD-52	TLD-53
Total annual exposure	633	858	169	99	291	113	117	111	327
Background[a]	86	86	86	86	86	86	86	86	86
Net annual exposure[b]	547	772	83	13	205	27	31	25	241

a Background is calculated based on the analysis of TLDs placed away from DOE property. See the *Annual Report on External Gamma Radiation Monitoring for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-698).

b Locations above with net annual exposure from direct radiation above background levels are in areas not accessible to the public.

-

6 Dose

Abstract

For 2004, exposure pathways potentially contributing to dose were determined to 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 0.359 mrem. This dose is less than 5 percent of the applicable federal standard of 100 mrem per year.

Introduction

This section presents the calculated doses to individuals and the surrounding population from atmospheric and liquid releases from the Paducah Site, as well as 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 a maximally exposed individual might have received from all combined DOE exposure pathways (worst-case scenario) was 0.359 mrem. This dose is less than five percent of the applicable federal standard of 100 mrem per year.

U.S. Department of Energy 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 and identification of on-site sources have indicated radionuclides and exposure pathways of concern.

For the Phase I Remedial Action SI, a preliminary assessment of risk to public health from contaminants at the Paducah Site was conducted. This study identified the following four primary pathways that each could contribute greater than 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 in the downgradient direction from PGDP have been replaced with public drinking water, resulting in the loss of that pathway. Surface water is not considered to be the primary pathway for water ingestion. In addition, the NWPGS began operation in 1995, resulting in an airborne pathway that is now included in the dose calculations. In 2004, the Scrap Metal Removal Projects and the C-410 D&D activities also were added to the airborne dose. Furthermore, in 1999, a drinking water pathway was added for consumption of surface water at the nearest public drinking water source [Ohio River at Cairo, Illinois (L306)].

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

Terminology and Internal Dose Factors

Most 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 possibly resulting 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 external radionuclide; simply leaving the area of the source will stop the exposure. Internal exposure continues as long as the radionuclide remains inside the body.

A number of specialized terms or quantities have been defined for characterizing exposures to radiation as defined in Appendix A. Because the damage associated with such exposures 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-effects 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.

Internal dose factors for several radionuclides of interest at the Paducah Site are included in Appendix A.

Direct Radiation

In 2004, DOE conducted continuous monitoring for direct external radiation exposure (Section 5). Access to PGDP is limited due to the increased security boundary implemented in September 2001. The monitoring results indicate that, due to limited access of the public to radioactive source areas, the dose to the maximally exposed individual member of the public (i.e., the neighbor living closest to the PGDP security fence) from DOE operations did not vary statistically from background (i.e., zero) (BJC 2005b).

For purposes of this ASER, 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. 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 assumed because any shielding from the receptor's vehicle is not considered. The closest location that would be accessible to the public in 2004 was TLD-14, which is near Harmony Cemetery located north of the plant security fence and south of Ogden Landing Road (Figure 5.6). This location resulted in external radiation exposures 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 zero.

Surface Water

The most common surface-water pathway for exposure 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. Typically, the average concentrations of radionuclides that were detected in Cairo are used to calculate the exposure resulting from consumption of surface water. In 2004, there were no radionuclides detected at the Cairo location. Therefore, the resulting net exposure to the maximally exposed receptor from the Paducah Site is 0.00 mrem.

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 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 is then 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 0.359 mrem in 2004. 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. Sediment sample locations were shown in Figure 5.4. 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 estimate of CEDE resulting from the intake.

Terrestrial wildlife, such as deer, can come into contact with contaminated soil, ingest plants that have taken up contaminants, 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.

In 2004, five deer from the Paducah Site were sampled. No reference deer was collected in 2004; therefore, 2002 data were used for comparison. In 2004, the results of the site deer did not vary significantly from the background deer values. Therefore, the site dose contribution is essentially 0 mrem (Hampshire 2005). This is less than the 1.5 mrem calculated in 2003.

Airborne Radionuclides

The DOE's radionuclide airborne point-sources that contributed to the public dose in 2004 included three sources. These sources were the NWPGS, the Scrap Metal Removal Projects, and the C-410 D&D Fluorine Cell Blasting Project. The three 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. Environmental Protection Agency-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 C.F.R. 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 1.8 x 10^{-5} mrem from the NWPGS; 2.2 x10^{-4} mrem from

Table 6.1 Annual dose estimates for 2004 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	---	9.0E-06	1.5E-03	3.5E-04	2.8E-04	2.7E-05	7.9E-04	2.1E-03	5.7E-04	3.1E-03	8.8E-03
S2	---	1.3E-05	---	---	4.3E-04	2.1E-06	5.9E-04	1.8E-03	3.3E-04	1.4E-02	1.8E-02
S20	---	5.6E-06	---	---	3.9E-04	---	5.1E-04	1.4E-04	---	1.2E-04	1.2E-03
S21	---	---	---	---	4.0E-04	1.3E-06	9.6E-04	2.0E-04	---	2.3E-04	1.8E-03
S27	4.6E-04	8.9E-06	---	9.4E-04	4.3E-04	4.0E-06	2.3E-03	6.7E-04	5.7E-04	2.4E-03	7.8E-03
S28 (Background)	---	---	---	---	3.8E-04	---	4.4E-04	1.1E-04	---	1.0E-04	1.0E-03
S30	---	---	---	---	4.4E-04	---	7.9E-04	---	0.0E+00	---	1.2E-03
S31	---	8.6E-06	---	6.3E-04	3.1E-04	2.0E-06	1.6E-03	1.1E-03	1.3E-03	6.4E-04	5.6E-03
S32 (Maximum)	2.8E-02	2.6E-04	2.5E-02	8.7E-02	7.2E-04	2.8E-04	2.0E-01	7.2E-03	7.8E-04	9.5E-03	3.6E-01
S33	---	8.8E-06	---	---	5.9E-04	2.0E-06	6.9E-04	6.7E-04	9.7E-04	6.7E-04	3.6E-03
S34	3.5E-03	1.2E-05	3.6E-04	2.8E-03	4.1E-04	1.1E-05	6.4E-03	7.1E-04	5.8E-04	2.0E-03	1.7E-02
C612	0.0E+00	1.8E-05	2.3E-03	8.4E-04	6.9E-04	8.0E-05	1.5E-03	2.7E-03	8.3E-04	3.7E-03	1.3E-02
C616	7.7E-04	3.7E-05	4.5E-03	2.6E-03	8.7E-04	1.6E-04	2.3E-03	7.0E-03	8.4E-04	8.1E-03	2.7E-02
C746KTB2	---	5.2E-06	---	---	3.4E-04	3.4E-06	6.7E-04	1.6E-04	---	1.1E-04	1.3E-03
C746KUP	---	9.8E-06	---	1.7E-04	5.1E-04	1.4E-06	5.4E-04	3.3E-04	9.1E-04	3.6E-04	2.8E-03
K001	---	8.7E-06	4.0E-04	5.1E-04	6.1E-04	1.8E-05	1.1E-03	1.3E-03	8.7E-04	1.8E-03	6.7E-03
	[a]Net exposure from Paducah Site to maximally exposed individual (S32—S28) =										**3.59e-1**

--- nondetect
^{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).

the Scrap Metal Removal Projects; and 1.1 x 10^{-7} mrem from the C-410 D&D Activities. If an individual was to receive the maximum dose from each of these sources, it would add up to approximately 0.00024 mrem, which is well below the 10 mrem limit of 40 C.F.R. Part 61, Subpart H.

Conclusions

Table 6.2 provides a summary of the dose for 2004 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 0.359 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 2004 (worst-case combined exposure pathways)

	Dose[a] (mrem/year)	Percent of total
Ingestion of surface water	0	0
Ingestion of sediments	0.359	99.94
Ingestion of deer meat	0	0
Direct radiation	0	0
Atmospheric releases[b]	2.4×10^{-4}	0.06
Total annual dose above background (all pathways)	**0.359**	**100**

[a] Maximum allowable exposure is 100 mrem/year (DOE Order 5400.5).

[b] DOE source emissions were from the NWPGS, the Scrap Metal Removal Projects, and the C-410 D&D Fluorine Cell Blasting Activities.

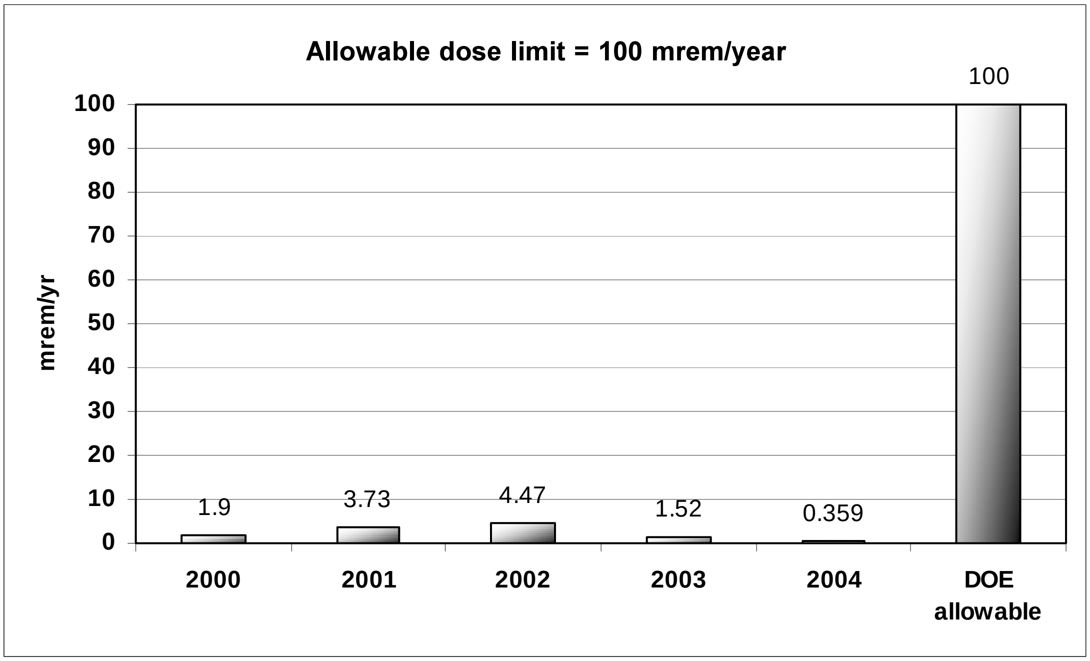

Figure 6.1 Potential radiological dose from DOE activities at the Paducah Site, 2000–2004

7 Nonradiological Effluent Monitoring

Abstract

In 2004, two KPDES outfalls at the Paducah Site experienced exceedences for toxicity. Outfall 001 exceeded reportable KPDES effluent discharge permit limits for chronic toxicity. Outfall 017 exceeded reportable KPDES effluent discharge permit limits for acute toxicity. The 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, spoil piles (resulting from construction excavation), metal scrap pile windage, and three point sources remained the responsibility of DOE in 2004. 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 Environmental Monitoring Plan* (BJC 2003a) 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.

Airborne Effluents

Airborne Effluent Applicable Regulations

The KDAQ administers much of the CAA at the Paducah Site. The 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 2004 were the NWPGS and the NEPCS. These systems, combined, removed approximately 1854 pounds (0.93 tons) of TCE, which is a VOC and HAP, from approximately 114,000,000 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 is then 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 2004.

Liquid Effluents

Liquid Effluent Applicable Regulations

The KDOW, through the KPDES Wastewater Discharge Permitting Program, administers the CWA for the Paducah Site. The site-wide KPDES permit (KY0004049) was effective April 1, 1998. A renewal permit application has been submitted to KDOW. A new permit has not been issued; therefore, the expired permit is still in effect. This site-wide KPDES permit contains discharge limits based on water quality criteria for a zero-flow receiving stream.

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

The 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 pollutants analyzed are listed in the permit and applicable regulations.

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. The samples taken included 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. One exceedance of permit limits was reported in 2004 for DOE Outfall 001. Three exceedances of permit limits were reported in 2004 for Outfall 017 (Table 7.1 and Section 2). Table 7.2 summarizes the maximum detected nonradiological analyses for samples collected as part of the required KPDES permit sampling. None of the detects reported in Table 7.2 resulted in KPDES permit violations.

Data for the KPDES samples and the surface runoff samples from the landfills are presented in Section 3, tables 3.1 through 3.4 of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

Table 7.1 KPDES permit exceedence summary for 2004

Location	Noncompliance Parameter	Species	Month Sampled	Result	KPDES Limit
Outfall 001	Chronic Toxicity	*Daphnids*[1]	April	1.76 TUc	1.0 TUc
Outfall 017	Acute Toxicity	*Daphnids*[1]	April	8.0 TUc	1.0 TUc
Outfall 017	Acute Toxicity	*Daphnids*[1]	April	4.3 TUc	1.0 TUc
Outfall 017	Acute Toxicity	*Daphnids*[1]	May	4.0 TUc	1.0 TUc

1 – *Ceriodaphnia dubia* (water fleas)
TUc – chronic toxicity unit

Table 7.2 KPDES permit sampling routine nonradiological maximum detected analyses

Parameter	K001	K015	K017	K019
Chlorine, Total Residual (mg/L)	.060	.030	.030	.040
Copper (mg/L)	.0079	.0067	.0096	.0071
Flow Rate (mgd)	7.6	1.0	3.4	.80
Hardness - Total as CaCO3 (mg/L)	318	220	121	100
Iron (mg/L)	.51	1.1	.42	1.7
Nickel (mg/L)	.011	.0093	ND	ND
PCB-1248 (µg/L)	.26	ND	ND	ND
Phosphorous (mg/L)	.55	NR	NR	NR
Suspended Solids (mg/L)	ND	ND	ND	28.
Uranium (mg/L)	.22	.21	.0025	ND
Zinc (mg/L)	ND	.048	.46	.021

ND – not detected
NR – not reported/collected

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 2004 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 non-radiological 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. Nonradiological sampling is conducted at upstream Bayou Creek (L1); downstream Bayou Creek (L5 and L6) and downstream Little Bayou Creek (L11, L12, and L241); the convergence of both creeks (L8), upstream Ohio River (L29), downstream Ohio River (L30); downstream Ohio River at the confluence with the Mississippi River (L306), which is the closest public drinking water supply source downstream of the plant; and background stream Massac Creek (L64). Samples were also collected near the plant from Bayou Creek (C612, C616, K006, and L291), Little Bayou Creek (K002, L10, L55, L56, and L194), and at the C-746-K Landfill (C746K-5, C746KTB1, and C746KUP). No sample point exists for upstream Little Bayou Creek because the watershed is insufficient to develop adequate flow to monitor. Nearly all the water in Little Bayou Creek is comprised of discharges from the plant outfalls. Therefore, background water quality for Little Bayou Creek is based on L1 (upstream Bayou Creek). L29 and L64 are background waterways also used for comparison with data from Little Bayou Creek. 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 (LBCSP1 through 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. Six 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. Similar to the groundwater sampling program, a different list of analytical parameters, presented in Table 8.2, was collected.

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 2002 and 2003, in 2004 the only results of significance were identified near the plant site and downstream of Little Bayou Creek.These results averaged a concentration of 1.6 and 37.75 µg/L, respectively, which is slightly higher than 2003. TCE was also detected at upstream Bayou Creek (L1) at 2.6 µg/L.

Table 8.4 also presents the maximum average concentrations of selected parameters for the seep sampling locations. One of the six Little Bayou Creek seep locations, LBCSP5, had the highest maximum average for TCE at 437.5 µg/L, which increased significantly from 232.5 µg/L in 2003.

Compared to background, TCE is only identified above background at the seep locations, which are related to groundwater contamination at the surface.

Similar to 2003, in 2004 there were no detections of surface-water PCBs. This is a decrease in PCB concentrations from 2002, which had PCB aroclors detected at low levels near the plant site on both Bayou Creek and Little Bayou Creek. Additionally, there were no detections of PCBs in surface water in 2001.

Additional data are presented in Section 4, Tables 4.1 through 4.29, of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

When compared with applicable KPDES permitted levels, 2004 surface water surveillance results indicate that there is not a threat to human health and the environment.

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 either adsorb 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 support the bottom-dwelling community of organisms. Sediments play a significant role in aquatic ecology by serving as a repository for radioactive or chemical substances that pass via bottom-feeding biota to the higher trophic levels.

Sediment Surveillance Program

Ditch sediments are sampled semiannually as part of a nonradiological environmental surveillance program. Sediment samples were taken from 16 locations in 2004 (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. Parameters were selected to include those that were detected. The results of detected parameters are compared to determine the difference between upstream (or background) and downstream concentrations. Aluminum, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, potassium, selenium, 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. Consistent with 2002 and 2003, chromium was identified in the NSDD at 59.5 mg/kg and near the plant site on Little Bayou Creek at 130.6 mg/kg

Table 8.1 Nonradiological parameters for surface-water samples

Parameter
Chloride
Nitrate/Nitrite as Nitrogen
Sulfate
Alkalinity
Conductivity
Dissolved Oxygen
Flow Rate
pH
Temperature
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Phosphorous
Potassium
Selenium
Silver
Sodium
Thallium
Uranium
Vanadium
Zinc
PCB Aroclors
Polychlorinated biphenyl, Total
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
Ammonia
Cyanide
Hardness - Total as CaCO3
Suspended Solids

Table 8.2 Nonradiological parameters for surface-water seep-sampling locations

Parameter
Chloride
Sulfate
Alkalinity
Conductivity
Dissolved Oxygen
Flow Rate
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)[a]

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	Creek Convergence[6]	C-746-K Landfill Area[7]	Upstream Ohio River[8]	Downstream Ohio River[9]	Massac Creek[10]	Cairo, IL[11]
Aluminum (mg/L)	0.886	1.320	0.443	**1.649**	1.216	0.545	0.451	0.627	0.606	0.240	0.398
Ammonia (mg/L)	ND	**0.425**	0.23	0.275	ND	ND	0.26	ND	ND	ND	ND
Barium (mg/L)	0.045	**0.126**	0.037	0.121	0.082	0.042	0.056	0.027	0.029	0.048	0.043
Calcium (mg/L)	14.9	**88.2**	39.3	31.6	38.2	27.0	18.6	20.5	25.1	12.9	37.2
Chloride (mg/L)	12.0	**141.3**	48.7	42.4	22.4	25.0	21.0	7.7	9.3	11.8	23.4
Cobalt (mg/L)	ND	0.0061	**0.0017**	ND	0.0015	0.0012	ND	ND	ND	ND	ND
Copper (mg/L)	0.0093	0.0123	0.0120	**0.0128**	0.0083	ND	0.0089	ND	ND	0.0116	ND
Hardness ($CaCO_3$) (mg/L)	53.25	**321.25**	145.50	112.25	120.33	105.33	68.80	75.33	89.00	49.00	124.33
Iron (mg/L)	0.572	**1.953**	0.553	1.341	1.031	0.826	0.565	0.512	0.433	0.758	0.496
Lead (mg/L)	ND	**0.0061**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium (mg/L)	2.59	**33.58**	13.01	8.43	6.36	8.55	4.08	4.72	6.10	3.08	11.97
Manganese (mg/L)	0.13	0.14	0.08	0.23	**0.37**	0.21	0.11	0.08	0.06	0.28	0.06
Nickel (mg/L)	ND	0.0152	0.0088	**0.0747**	ND	ND	ND	ND	ND	ND	ND
Nitrate as Nitrogen (mg/L)	0.63	**2.81**	1.39	1.03	1.27	1.11	0.68	0.42	0.94	0.70	1.20
PCB-1260 (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1268 (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphorous (mg/L)	0.12	**0.29**	0.15	0.22	0.13	0.11	0.08	0.11	0.11	0.06	0.12
Potassium (mg/L)	2.925	**23.6**	8.04	2.73	2.55	4.09	3.60	1.72	1.87	2.47	2.64
Suspended Solids (mg/L)	ND	25.5	ND	43	14	29	ND	**35**	26	ND	34.5
Trichloroethene (mg/L)	2.3	1.6	ND	ND	**37.75**	ND	ND	ND	ND	ND	ND
Uranium (mg/L)	ND	0.003	**0.054**	0.017	0.008	0.002	0.006	ND	ND	ND	ND
Zinc (mg/L)	ND	**0.0564**	0.0265	0.03435	ND	ND	ND	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.
Bold values indicate the highest concentrations for the parameter specified.
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.

1 = L1
2 = C612, C616, K006, L291
3 = L5, L6
4 = K002, L10, L55, L56, L194
5 = L11, L12, L241
6 = L8
7 = C746K-5, C746KTB1, C746KUP
8 = L29
9 = L30
10 = L64
11 = L306

Table 8.4 Selected routine nonradiological surface-water seep-sampling surveillance results (average concentrations)[a]

Parameter	LBCSP1	LBCSP2	LBCSP3	LBCSP4	LBCSP5	LBCSP6
Calcium (mg/L)	22.1	24.9	24.9	**26.6**	23.9	21.7
Magnesium (mg/L)	8.59	9.33	9.00	**9.45**	8.52	7.73
Manganese (mg/L)	0.0196	0.0162	0.0272	0.0055	0.0061	**0.0796**
Potassium (mg/L)	**2.12**	1.64	1.51	1.68	1.59	1.61
Sodium (mg/L)	30.38	30.35	31.80	**32.83**	32.15	30.23
Sulfate (mg/L)	12.2	12.2	11.5	13.0	**15.0**	14.7
Trichloroethene (mg/L)	4.2	9.1	24.8	22.5	**437.5**	192.5

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.

Bold values indicate the highest concentrations for the parameter specified.

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.

Table 8.5 Semiannual nonradiological parameters for sediment samples.

Parameter		
Grain Size Diameter	Lead	Zinc
Aluminum	Magnesium	PCB-1016
Antimony	Manganese	PCB-1221
Arsenic	Mercury	PCB-1232
Barium	Nickel	PCB-1242
Beryllium	Potassium	PCB-1248
Cadmium	Selenium	PCB-1254
Calcium	Silver	PCB-1260
Chromium	Sodium	PCB-1268
Cobalt	Thallium	Polychlorinated Biphenyl
Copper	Uranium	Moisture
Iron	Vanadium	Total Organic Carbon (TOC)

Table 8.6 Selected routine nonradiological sediment surveillance results (average concentrations)[a]

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Upstream Little Bayou[4]	Little Bayou Near Site[5]	Downstream Little Bayou[6]	C-746-K Area[7]	NSDD[8]	Massac Creek[9]
Aluminum (mg/kg)	2765	6580	4500	7025	6190	3285	2930	**7210**	3350
Arsenic (mg/kg)	ND	6.4	**8.1**	ND	ND	ND	ND	ND	ND
Barium (mg/kg)	31.5	**68.6**	42.0	57.5	63.0	28.9	34.2	52.0	35.1
Beryllium (mg/kg)	ND	0.60	ND	0.51	**0.65**	ND	0.31	0.51	ND
Cadmium (mg/kg)	ND	1.3	ND	ND	**2.1**	ND	ND	ND	ND
Calcium (mg/kg)	574	**6465**	633	1190	1145	574	914	2155	410
Chromium (mg/kg)	6.1	40.7	8.7	12.9	**130.6**	18.0	13.4	59.5	5.6
Cobalt (mg/kg)	3.0	5.2	2.7	4.5	**5.5**	2.4	3.1	2.7	3.3
Copper (mg/kg)	4.9	28.9	5.9	6.7	11.5	12.0	11.2	**51.4**	6.6
Iron (mg/kg)	5765	**11250**	5470	10665	10095	4615	6305	9240	4955
Lead (mg/kg)	ND	ND	ND	ND	**19**	ND	ND	ND	ND
Magnesium (mg/kg)	298	766	431	663	446	294	345	**831**	333
Manganese (mg/kg)	256	159	265	159	404	140	**297**	112	244
Mercury (mg/kg)	ND	**0.53**	ND	ND	ND	ND	ND	0.24	ND
Nickel (mg/kg)	3	12	ND	5	5	ND	4	**26**	ND
PCB-1248 (µg/kg)	ND	ND	ND	ND	ND	ND	ND	**2280**	ND
PCB-1254 (µg/kg)	ND	ND	ND	ND	ND	ND	ND	**805**	ND
PCB-1260 (µg/kg)	ND	ND	ND	ND	260	ND	ND	**395**	ND
PCB-1268 (µg/kg)	ND	ND	ND	ND	ND	**120**	ND	ND	ND
Potassium (mg/kg)	189	519	389	263	253	209	190	**596**	279
Selenium (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (mg/kg)	ND	ND	ND	ND	ND	ND	ND	**2**	ND
Sodium (mg/kg)	ND	**232**	100	122	ND	ND	100	ND	ND
Thallium (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (mg/kg)	10.9	20.0	11.3	**20.2**	20.0	8.6	14.3	18.1	9.5
Zinc (mg/kg)	12	**100**	24	16	77	25	25	59	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.
Bold values indicate the highest concentrations for the parameter specified.
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.
1 = S20 (background location to 2 and 3)
2 = C612, C616, K001, S1, S31
3 = S33
4 = S21 (background location to 5 and 6)
5 = S2, S30
6 = S27, S34
7 = C746KTB2, C746KUP (background location to 8 and 9)
8 = S32
9 = S28

(highest level). Arsenic was found downstream in Bayou Creek and near the plant site. Zinc was found at all locations, except the reference site. Generally, contaminants are more abundant near the plant site and decrease in areas downstream of the plant site.

Polychlorinated biphenyls were found in the NSDD, Little Bayou Creek near the plant site, and downstream Little Bayou Creek with the highest levels seen at the NSDD. The most abundant aroclor was PCB-1260. Additional sediment data are presented in Section 4, tables 4.30 through 4.45, of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

Results are consistent with levels seen in previous years' data. These areas are either within the DOE-controlled area or are posted for protection of the public.

Soil

The major source of soil contamination is from air pathways. Because DOE no longer controls any major air emission sources, routine soil surveillance is not performed. However, surface soil contamination 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 attributed to past plant practices. There were five deer harvested in 2004 from the WKWMA and one deer harvested in 2002 from the Stewart Island Habitat Restoration in Livingston County, Kentucky, to serve as a reference sample.

Polychlorinated biphenyls tend to accumulate in fat tissue. PCB-1268 was present in deer from the Paducah Site, while PCB-1260 was detected in the background deer. Table 8.7 shows the PCB results. All measurable PCBs were well below the Food and Drug Administration (FDA) standard of 3 parts per million (ppm) for red meat.

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 highest levels of PCBs found. The risk assessment concluded that the risk to the hunter who eats 100 pounds of the two worst-case deer (50 pounds/deer) would have an average increased cancer risk of 0.0000058, or approximately 5.8 chances of cancer development (over a lifetime) per one million people who eat the deer (Hampshire 2005).

A comparison of the metals detected in the 2004 deer with the average metals data from background deer collected over the past 10 years shows only a few chemicals that are significantly above background. Average chronium in liver,

Table 8.7 Summary of PCB detections in deer for 2004[a]

Parameter	Deer 1	Deer 2	Deer 3	Deer 4	Deer 5	Background Deer [b]
PCB-1260 (mg/kg)	ND	ND	ND	ND	ND	.337
PCB-1268 (mg/kg)	.147	.023	.025	.087	.116	ND

[Result] = Detected at the result indicated.
mg/kg = part per million
ND = Not detected
[a] Other PCB aroclors were analyzed but not detected in any deer.
[b] Background deer were collected during 2002 from Stewart Island Habitat Restoration in Livingston County, Kentucky.

muscle, and kidney are observed at greater than 2 times background levels. Average barium and silver in the kidney are also observed at greater than 2 times background levels. Similar levels for these metals have been observed in previous years. All other metals are not significantly above background levels. Overall evaluation of the results indicate that consumption of deer meat is not a threat to human health.

Additional deer data are presented in Section 4, tables 4.46 through 4.49, of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

Fish and Other Aquatic Life

Watershed (biological) 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. Watershed or biological monitoring of Bayou Creek and Little Bayou Creek has been conducted since 1987.

The objectives of the Watershed Monitoring Program 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 inadvertent spills or fish kills.

The 2004 sampling effort was conducted in accordance with the *Bayou Creek and Little Bayou Creek Watershed Monitoring Plan*. The plan is required by the KPDES permit. In January and February 2003, the U.S. Fish and Wildlife Service and the KDOW, respectively, requested additional changes to the watershed monitoring plan. The plan was revised in April 2003 to include the following changes:

- Fish bioaccumulation sampling will not be performed in 2003, but fish will be sampled for PCBs and metals, including mercury, in even years of sampling to avoid elimination of population by sampling (this began in CY 2004).
- The targeted species for the bioaccumulation samples at Bayou Creek will be changed from spotted bass to creek chubs and green sunfish.
- Sampling location UTM 6.9 will be deleted and a location on the West Fork of Massac Creek will be added. The West Fork of Massac Creek will be considered a reference site.
- Sampling location BM 7.6 was eliminated as a sampling site because a new reference site is being added at the West Fork of Massac Creek.
- Sampling location BM 5.55 will be moved downstream to BM 4.6.

Sampling for fish community and benthic macroinvertebrates at LUM 5.0 will be discontinued. These samples will be added to LUM 2.7 on Little Bayou Creek.

Study Area and Methods

As specified according to *Big Bayou Creek and Little Bayou Creek Revised Watershed Monitoring Program, April 2003,* the fish and benthic macroinvertebrate communities were sampled in June 2004 at eight locations, including locations in Massac Creek and in the West Fork of Massac Creek, both which serve as sources of background fish (MAM 8.6 and 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 offsite.

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. Organisms were identified to the lowest practical

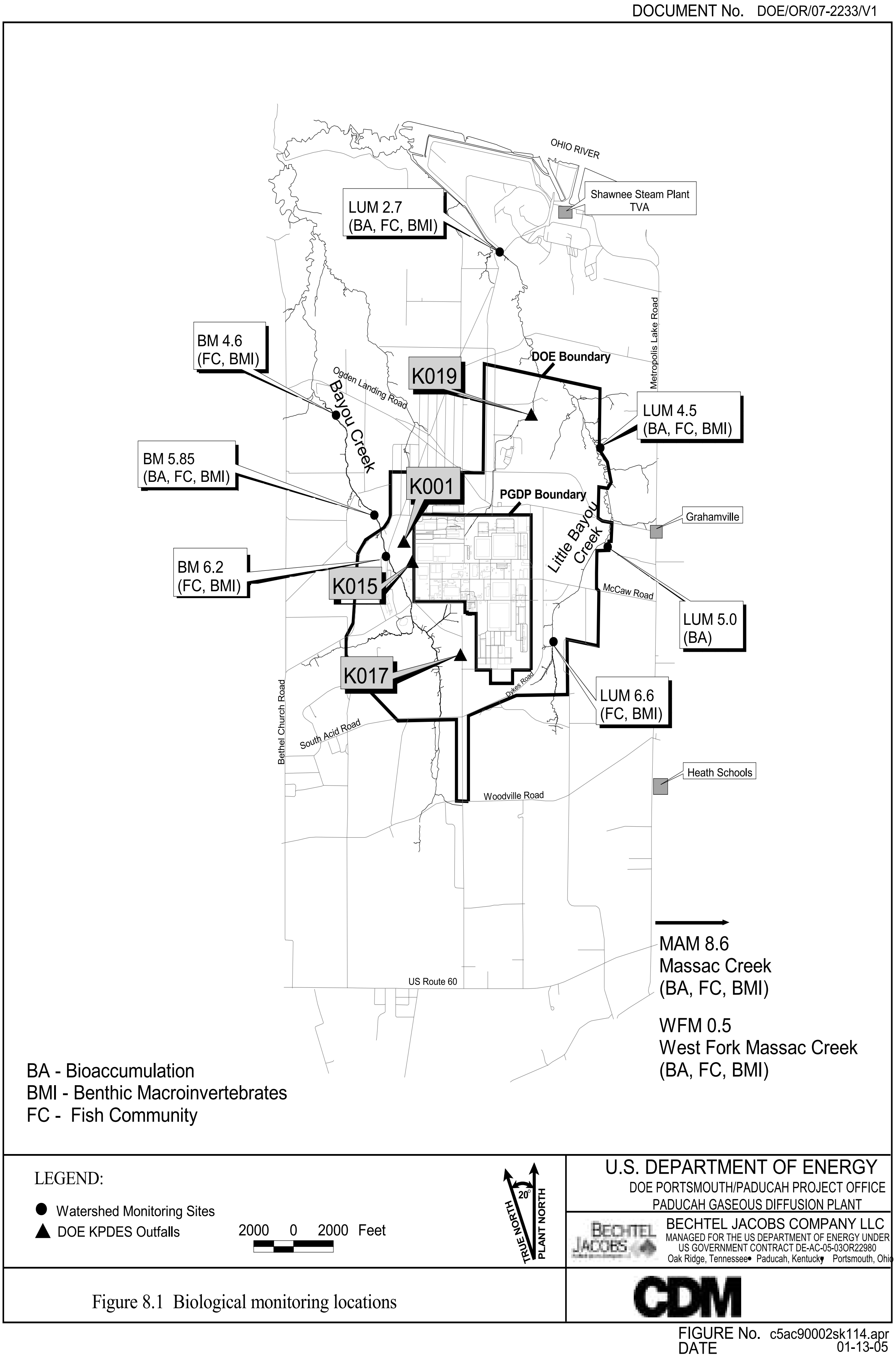

Figure 8.1 Biological monitoring locations

taxon and enumerated. 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 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, such as total density; total taxonomic richness; taxonomic richness of the pollution-sensitive Ephemeroptera, Plecoptera, and Trichoptera; percent community similarity index; and dominants in common are included in the analysis of the data.

Quantitative samplings of the fish communities in the PGDP area were conducted by electrofishing. Block nets defined the sample reaches [eight to 120 m (26 to 394 feet)] 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 for the bioaccumulation monitoring task has been changed in the Watershed Monitoring Program (WMP) to every two years and monitoring was not conducted in 2004.

Watershed Monitoring

Results of watershed monitoring are reported to KDOW annually. The 2004 monitoring is reported in the *Watershed Monitoring Report for Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2005b). Additional analysis of the data can be seen in this report. The report conclusions, which meet the objectives of the WMP, are presented as follows.

As in previous years, fish communities examined in 2004 showed some changes in density, biomass, total numbers, and species richness. The most dramatic change occurred in Bayou Creek mile 6.2, from 2003 to 2004, where density increased 4.7 times and biomass increased 2.2 times. This was attributed to the large numbers (4848 individuals) of central stonerollers collected.

An increased number of fish was seen in lower Little Bayou Creek and is probably the result of high water at the site, which would allow the fish to move into the area from the Ohio River. The changes noted for this year are not necessarily indicative of contaminant impacts. A possible factor affecting fluctuating levels of fish populations at several of the sites may be attributed to shifting stream bed substrates that affect changes in habitat within the streams sampled. The stream changes include 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" on the mHBI.

Figure 8.2 is a graphical representation of the mean PCB concentrations in longear sunfish tissue or spotted bass at locations in Bayou Creek and Little Bayou Creek during selected months from October 1996 to June 2004. A sample was not obtained in May 1997 for sample location LUM 4.5 due to the low volume of fish. Numbers reported as less than the detection level are graphically represented as 0.5 times the detection limit. Polychlorinated biphenyls have varied over the past seven years and have consistently been above the background level. The FDA action limit for fish is 2 ppm. All results in 2004 were below this value for fish collected near the plant site. The 2004 average concentration has slightly increased from the 2002 concentration (samples were not collected in 2003). Overall, there is a general down trend with a flattening profile for the locations monitored at Little Bayou Creek.

In accordance with the 2003 WMP, metals analyses were performed for the first time in 2004. Overall, most of the metals analyses results for the Bayou Creek and Little Bayou Creek sites do not vary significantly from the background levels. Cadmium and lead were present only at the Bayou Creek location, but in small concentrations.

Additional data are presented in Section 4, tables 4.50 through 4.54, of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2004, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2233 Volume II).

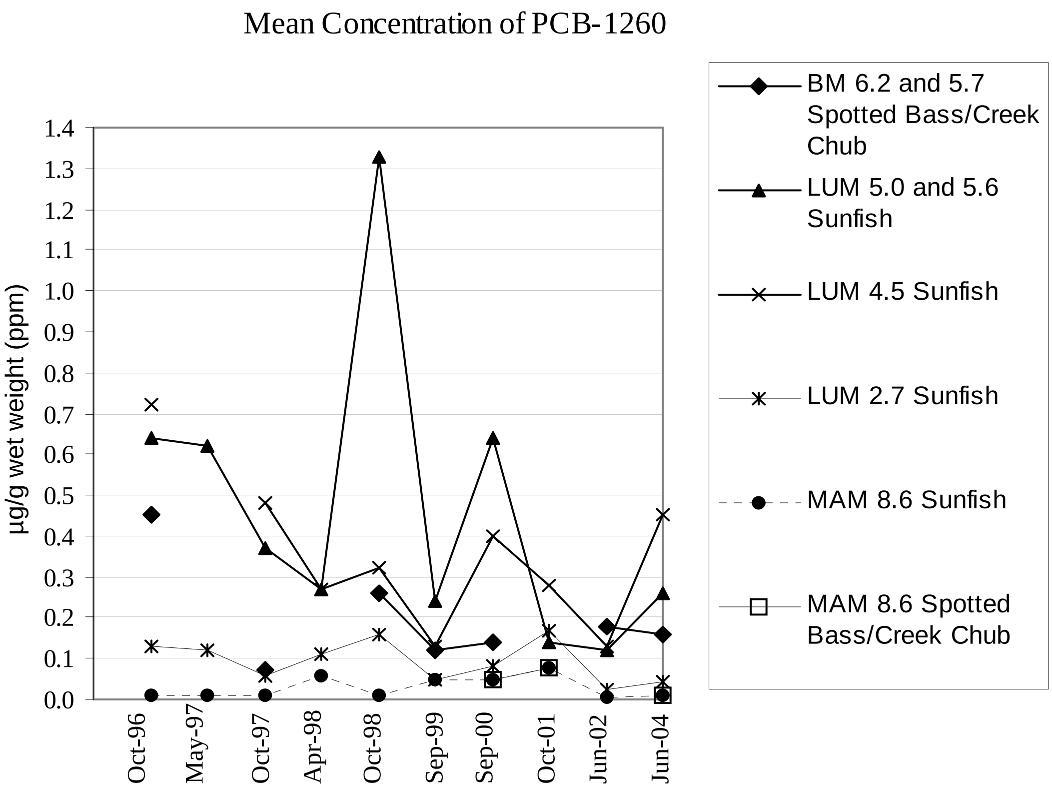

Figure 8.2 Average concentration of PCB-1260 in fish tissue from 1996–2004

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 persons off-site are protected by the water policy.

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 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 onsite several years ago for re-enrichment of ^{235}U. Such reactor returns are no longer used in the enrichment process; however, because the system is closed, ^{99}Tc is still 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. A common degreasing agent, TCE may act as a DNAPL due to its low solubility and higher density relative to water. DNAPLs either sink to the bottom of aquifers or come to rest on a less-permeable layer within an aquifer, forming pools. These DNAPL pools form a continuous source for the dissolved-phase contamination (plumes) that are migrating off-site toward the Ohio River (Figure 9.1). Pools of DNAPL are extremely difficult to clean due to low solubility in water and the inability to find them in groundwater. Currently, only the highest concentrations of dissolved TCE are controlled by pump-and-treat systems (in Northwest and Northeast plumes) at Paducah. The pump-and-treat system installed northwest of the plant also controls the highest concentrations of dissolved ^{99}Tc that would otherwise migrate offsite.

Continued groundwater monitoring serves to identify the extent of contamination, predict the possible fate of the contaminants, and determine the movement of groundwater near the plant. This year's (CY 2005) plume map (Figure 9.1) continues the basic interpretation presented in the plume maps for CY 2004. Revisions for CY 2004 update the following three items: (1) decreasing TCE trends in MWs along the core of the Northeast Plume and over a large area to the west of the Northeast Plume well field, (2) extension of >25 pCi/L ^{99}Tc east of PGDP toward the Northeast Plume well field, and (3) reinterpretation of the Southwest Plume and C-746-S&T areas using data from the recent site investigation (BJC 2005c).

Groundwater monitoring at the Paducah Site complies with applicable federal and state regulations and permits and includes perimeter exit pathway monitoring and off-site water well monitoring (see Groundwater Monitoring Program). Figures 9.2 and 9.3 show the locations of all wells sampled during 2004.

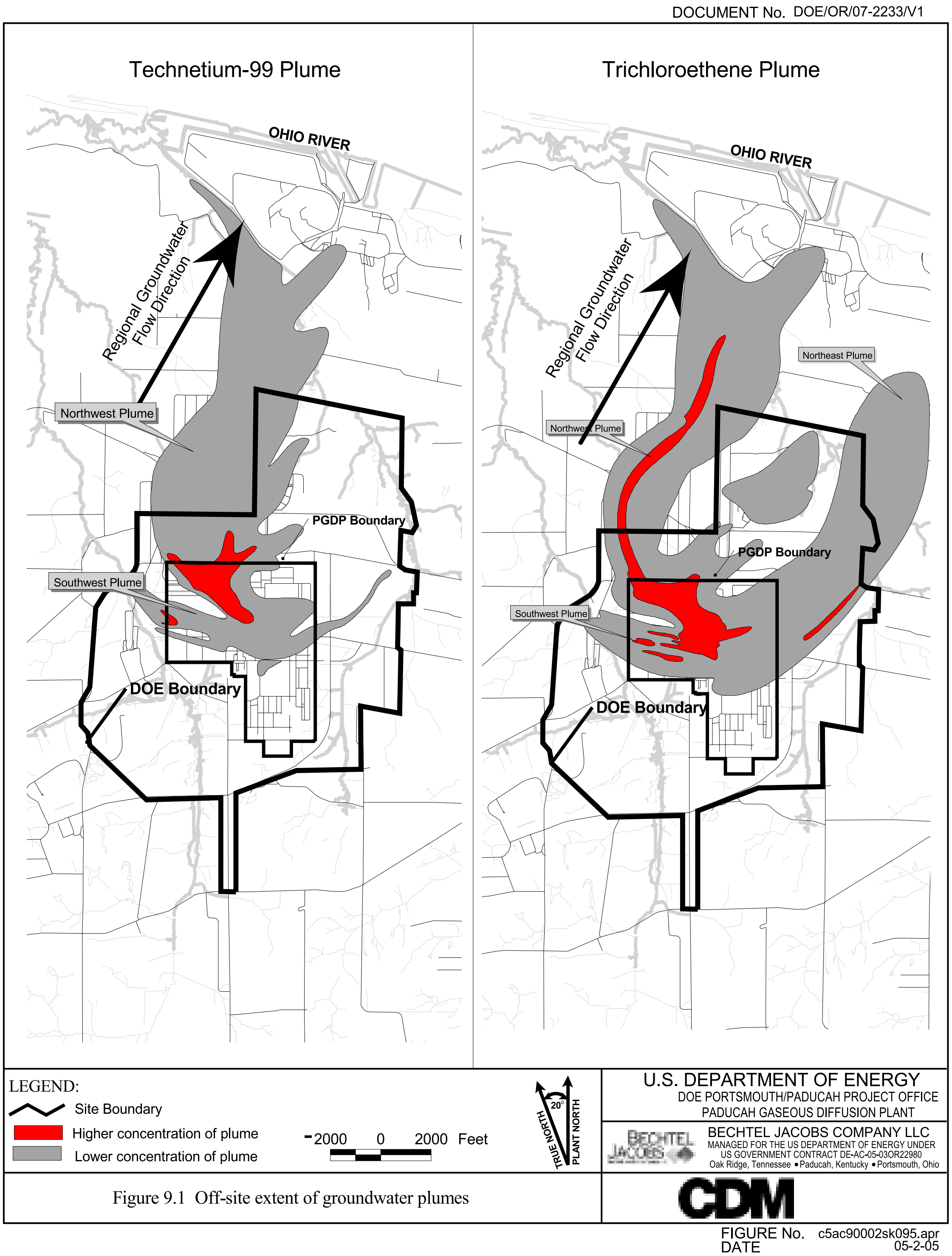

Figure 9.1 Off-site extent of groundwater plumes

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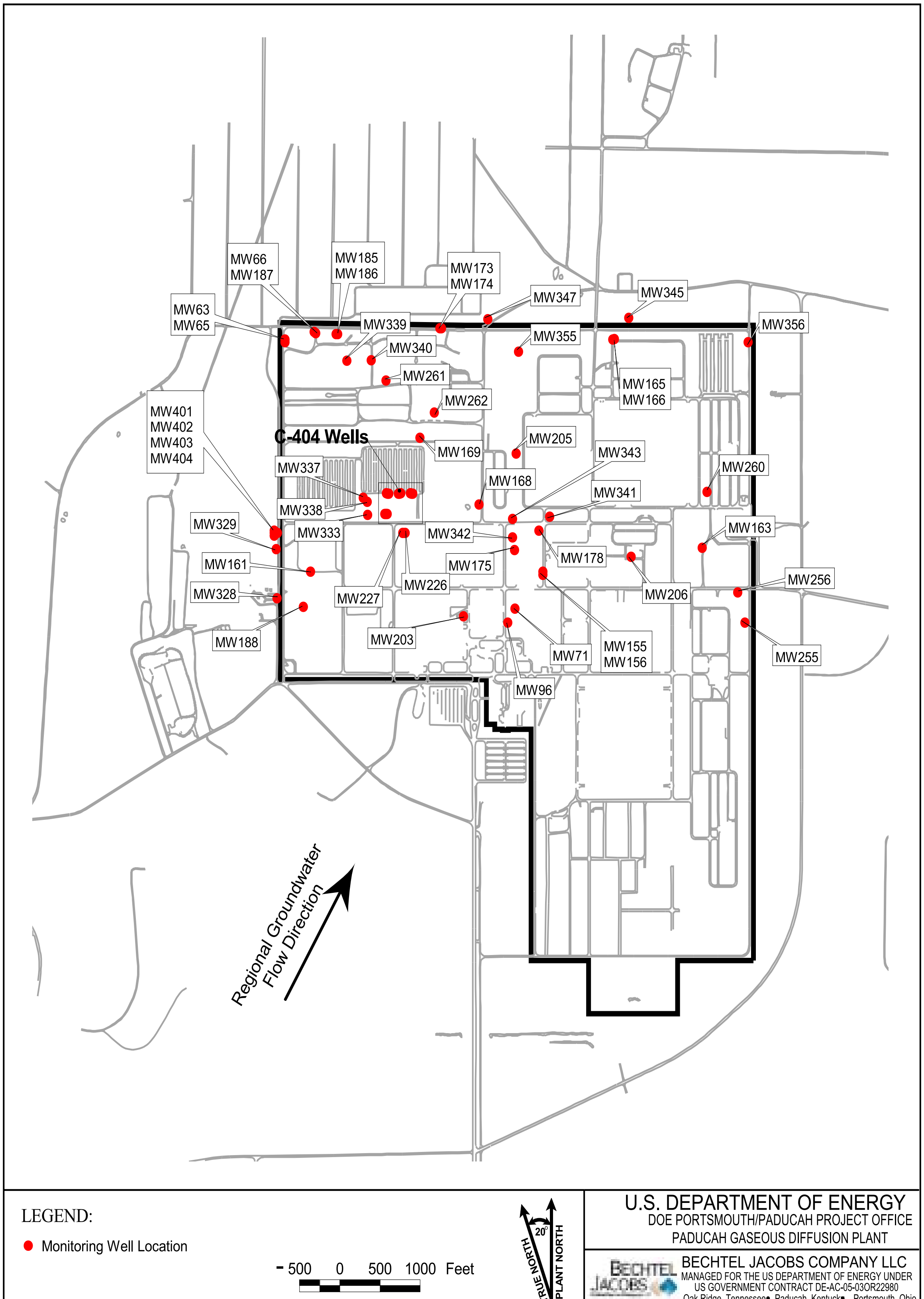

Figure 9.2 Wells sampled inside the perimeter fence

CDM

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DATE 01-13-05

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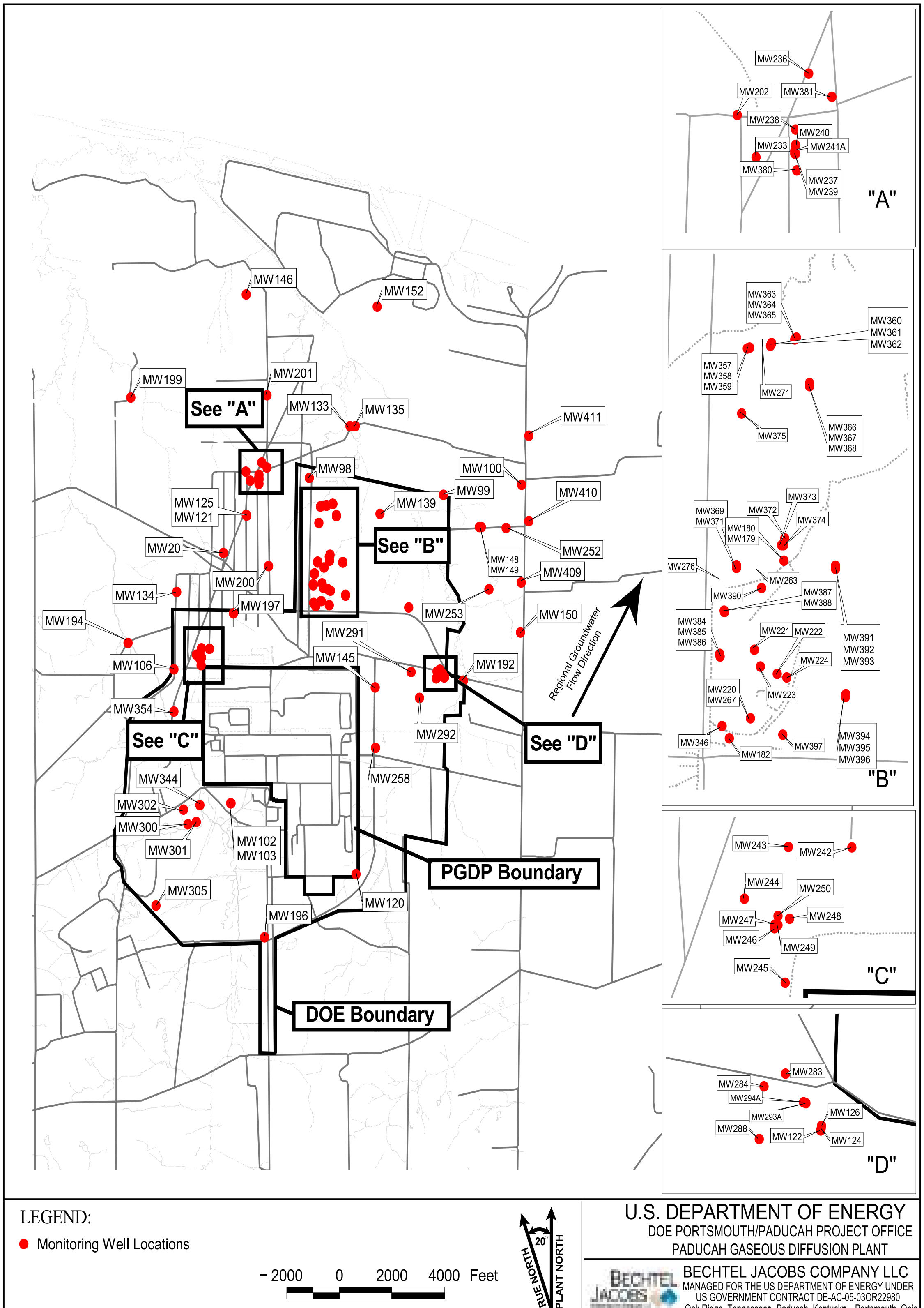

Figure 9.3 Wells sampled in the vicinity of the Paducah Site

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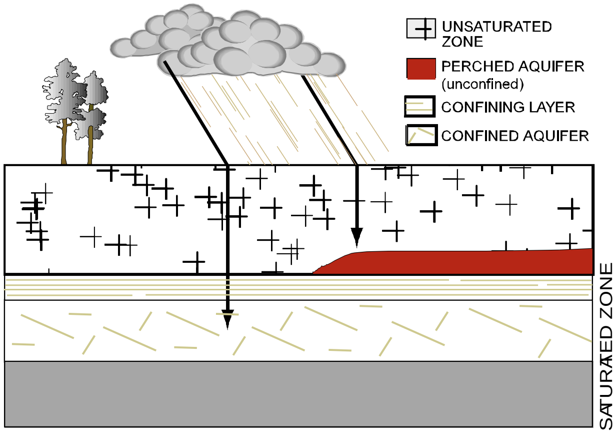

Figure 9.4 Typical path for rainwater accumulation as groundwater

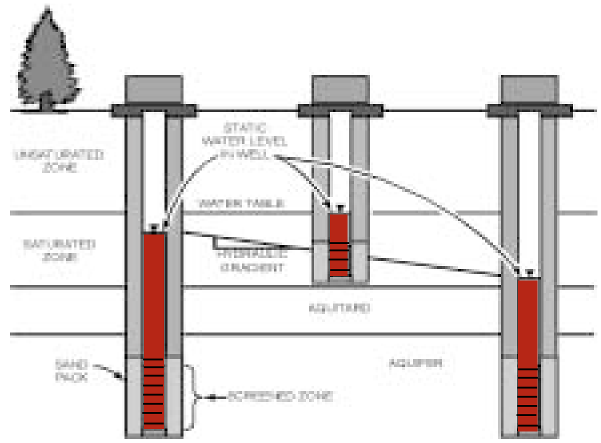

Figure 9.5 MW construction showing the relationship between the screened zone and the water level in wells where limited flow in the aquifer is to the right

Groundwater Hydrology

When rain falls to the ground, some of it flows along the surface as 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 moves into the spaces between the particles of soil and sand, infiltrating porous soil and rock. Groundwater is found underground in cracks and spaces in soil, sand, and rock. Groundwater is stored in, and moves slowly through, an aquifer, which is a source of useable water. Aquifers typically consist of layers of gravel, sand, sandstone, or fractured rock. The speed at which groundwater flows through the surface depends on the size of the spaces in 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 9.4). 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 than natural exits such as springs, swamps, and beds of 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 can then be brought to the surface using a pump.

Groundwater movement is determined by differences in the energy associated with the groundwater's elevation in a specific location to the elevation of other nearby groundwater. 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 9.5). The hydraulic gradient measures the difference in hydraulic head over a specified distance. By 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 also have different hydraulic heads, thus defining a vertical gradient. If the water levels in deeper wells are lower than those in shallower wells, vertical flow is primarily downward.

Groundwater aquifers are one of the primary pathways by which potentially hazardous substances can spread through the environment. Substances placed in the soil may migrate downward due to gravity or be dissolved in rainwater, which moves them downward through the unsaturated zone into the aquifer. The contaminated water then flows laterally downgradient toward the discharge point. 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 before it flows under a site are called upgradient wells. Any contamination of the downgradient wells that is not present in the upgradient wells at a site may be determined to be a result of that site.

Wells can be drilled to various depths in the saturated zone and be screened to monitor the recharge area above the aquifer, different horizons within the aquifer, or water-bearing zones below the aquifer. Vertical and horizontal groundwater flow directions are determined by the permeability and continuity of geologic strata, in addition to hydraulic head. To effectively monitor the movement of groundwater and any hazardous constituents it may contain, hydrogeologists at the Paducah Site have undertaken many detailed studies of the geology of strata beneath the site.

Geologic and Hydrogeologic Setting

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies within the northern tip 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, sediments were deposited in a coastal marine environment, creating the McNairy/Clayton Formation. For the most part, the McNairy/Clayton Formation is sandy at the bottom and silty at the top. However, variations in the geologic make-up of the McNairy/Clayton Formation do occur and lenses of clay, and at least one fairly continuous string of gravel, are present within the formation.

The Clayton Formation overlies the McNairy. The Clayton Formation was deposited during the early Paleocene geologic epoch in an environment so similar to that of the McNairy that the Clayton and upper portion of the McNairy are indistinguishable in lithologic samples. Later in the Paleocene, the Porters Creek Clay was deposited in marine and brackish water environments in a sea that occupied most of the Mississippi Embayment. The McNairy/Clayton and the Porters Creek Clay formations dip 30 to 35 ft (9 to 10.5 m) per mile to the south-southwest.

The next feature in the geologic history at the Paducah Site is a Pleistocene-age river valley, occupying approximately the same position as the present-day Ohio and Tennessee River valleys. In forming the valley, braided stream channels of the ancestral Tennessee River, and possibly several "feeder" streams, eroded any sediments deposited after the Paleocene Porters Creek Clay and before the Pleistocene. The river system also eroded portions of the Porters Creek Clay and the McNairy Formation and cut a prominent terrace in the Porters Creek Clay at the south end of the plant. The sediments deposited on this erosional surface are termed continental deposits. The lower portion of the continental deposits consists of approximately 30 ft (9 m) of stream gravel and sand.

Over time, sediments from the retreating glaciers dammed the river valley, causing the formation of a lake. Silts and clays with thin zones of sand and occasional gravel were deposited in the lake, forming the upper portion of the continental deposits. These deposits range from approximately 5 to 55 ft (1.5 to 17 m) thick.

Finally, loess, a wind-blown silt, overlies the continental deposits throughout the site. Thickness of loess deposits varies from approximately 5 to 25 ft (1.5 to 8 m), averaging 15 ft (4.6 m).

The local groundwater flow system at the Paducah Site contains the following four major components (from shallowest to deepest): (1) the terrace gravels, (2) Upper Continental Recharge System (UCRS), (3) RGA, and (4) the McNairy flow system. The Rubble Zone is the formation underlying the McNairy. The terrace gravels consist of shallow Pliocene gravel deposits in the southern portion of PGDP. 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 (9 m) and can be more than 70 ft (21 m) 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 consists of interbedded and interlensing sand, silt, and clay of the McNairy Formation. Sand facies account for 40 to 50 percent of the total formation thickness of approximately 225 ft (69 m).

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.

Both groundwater and surface water (Cairo, Illinois, only) sources have been used for water supply to residents and industries in the vicinity of the plant area. Wells in the area are screened at depths ranging from 15 to 245 ft (4.6 to 75 m). The majority of these wells are believed to be screened in the RGA. The Paducah Site continues to provide municipal water to all residents within the area of groundwater contamination from the site. These residents' out-of-service wells are utilized by DOE for sampling as a result of written agreements. Residential wells that are no longer sampled have been capped and locked. Water used on the plant site is provided from surface water sources.

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 orders 5400.1, *General Environmental Protection Program*, and 450.1, *Environmental Protection Program*, require that groundwater monitoring at all DOE facilities "...determine and document the effects of operations on groundwater quality and quantity." The DOE orders require groundwater monitoring to be conducted onsite and in the vicinity of DOE facilities to accomplish the following:

- Obtain data to determine baseline conditions of groundwater quality and quantity;
- Demonstrate compliance with, and implementation of, all applicable regulations and DOE orders;
- Provide data to permit early detection of groundwater pollution or contamination;
- Provide a reporting mechanism for detected groundwater pollution or contamination;
- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources; and
- Provide data for making decisions about land disposal practices and the management and protection of groundwater resources.

These objectives are outlined in the following three documents related to groundwater monitoring: (1) *Groundwater Protection Management Program for Calendar Year 2003, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2003b), (2) *Groundwater Protection Plan* (BJC 2001), (3) and the *Paducah Site Environmental Monitoring Plan* (BJC 2003a). Scheduled sampling continues for more than 170 MWs and residential wells 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 9.6). 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 precipitate was considered a hazardous waste under RCRA. The landfill was covered with a RCRA-compliant clay cap and was certified "closed" as a hazardous waste landfill in 1987. The landfill is now 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 (ten wells) during the required post-closure monitoring on a semiannual basis.

During 2004, 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. Trichloroethene exceeded the Maximum Contaminant Level (MCL) in four upgradient RGA wells and three downgradient RGA wells; however, this may be related to the underlying TCE plume and not C-404 itself. Total chromium also exceeded MCLs in two upgradient RGA wells. 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. The C-746-T Inert Landfill has fulfilled two years of post closure environmental monitoring and maintenance requirements.

The groundwater monitoring system for C-746-S and C-746-T consists of upgradient, sidegradient, and downgradient wells (Figure 9.6). 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 and C-746-T are sampled quarterly and in accordance with 401 K.A.R. 48:300. The analytes are dictated by a KDWM-approved solid waste landfill permit modification.

During 2004, beta activity exceeded contaminant levels in sidegradient and downgradient wells. Turbidity contaminant-level exceedences were seen in upgradient, sidegradient, and downgradient wells and TCE exceeded contaminant levels in some upgradient, sidegradient, and downgradient wells. The KDWM was notified of the exceedences. 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.

Table 9.1 Summary of maximum groundwater results from the RGA at C-404 Landfill

	Upgradient Wells				Downgradient Wells						
Parameter	MW 226	MW 227	MW 93	MW 95A	MW 84	MW 86	MW 87	MW 89	MW 90A	MW92	Criteria Reference
Arsenic (mg/L)	ND	0.034	ND	ND	ND	ND	ND	ND	ND	ND	0.05 MCL
Chromium (mg/L)	**.209**	**0.381**	ND	ND	ND	ND	ND	ND	ND	ND	0.1 MCL
Technetium-99 (pCi/L)	146	ND	ND	30.1	ND	ND	ND	ND	ND	ND	
Trichloroethene (µg/L)	**320**	**39**	**200**	**120**	**150**	**110**	**17**	ND	ND	ND	5 MCL

ND - Not detected
Bold - exceeds criteria
MCL - Maximum Contaminant Level (for reference only)

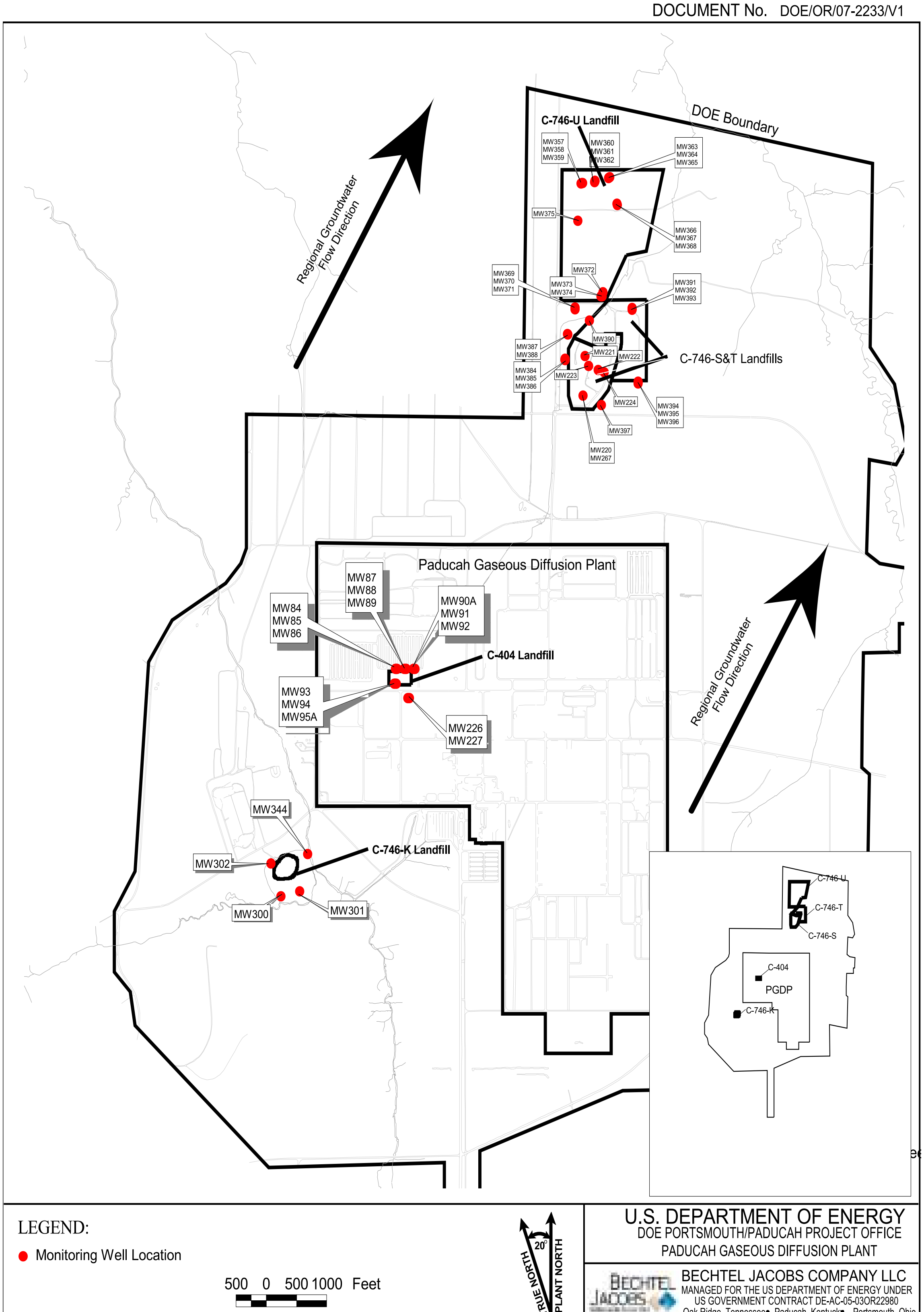

Figure 9.6 Monitoring well locations near the landfills

CDM

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Table 9.2 Summary of maximum groundwater results at C-746-S&T Landfills

		Lower RGA MWs			UCRS MWs			Upper RGA MWs			Criteria Reference	
	Parameter	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient		
Anion (mg/L)	Bromide	ND	ND	ND	1.7	2.7	ND	ND	ND	ND		
	Chloride	62	32	45	100	300	23	56	68	50		
	Fluoride	0.18	0.36	0.32	0.56	0.42	0.23	0.24	0.35	1.1	4	MCL
	Nitrate as Nitrogen	2	1.6	1.9	ND	ND	ND	1.5	ND	1.8	10	MCL
	Sulfate	12	19	17	20	19	5.3	14	28	28		
Metal (mg/L)	Aluminum	0.36	ND	ND	0.67	4.5	ND	0.32	ND	1.4		
	Arsenic	0.0016	0.0017	0.002	0.0036	0.0065	0.0027	0.0016	0.011	0.0025	0.05	MCL
	Barium	0.29	0.19	0.22	0.31	0.58	0.12	0.26	0.29	1.4	2	MCL
	Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	0.0011	0.005	MCL
	Calcium	40	41	29	52	85	15	34	39	43		
	Cobalt	ND	ND	ND	0.0034	0.0082	ND	0.0046	ND	0.15		
	Iron	0.3	0.16	5.2	4.9	12	7.7	0.79	9.8	5.8		
	Lead	0.012	0.0092	0.0052	ND	0.0098	ND	0.0071	0.0052	0.0072	0.05	MCL
	Magnesium	14	11	11	20	31	4.7	13	14	18		
	Manganese	0.013	0.019	0.75	0.8	0.56	0.068	0.16	0.99	14		
	Molybdenum	ND	0.0016	ND	0.0018	0.0046	ND	0.0057	ND	0.023		
	Nickel	ND	ND	ND	ND	0.043	ND	0.036	ND	0.14		
	Potassium	2	2.1	2.1	1.5	1.2	0.51	19	1.7	6.4		
	Selenium	0.0082	0.008	0.0094	0.011	0.028		0.0075	0.0062	0.011	0.05	MCL
	Sodium	37	42	59	160	140	110	43	100	180		
	Uranium	ND	0.0011	ND	ND	ND	ND	0.003	ND	0.0042	0.03	MCL
	Zinc	ND	ND	ND	ND	ND	ND	ND	ND	0.026		
Dissolved Metal (mg/L)	Barium, Dissolved	0.29	0.19	0.21	0.32	0.57	0.11	0.28	0.29	1.4	2	MCL
PHYSC (mg/L)	Dissolved Solids	240	270	250	800	750	340	240	400	310		
	Suspended Solids	ND	ND	ND	ND	40	ND	ND	ND	ND		
	Total Solids	240	220	230	580	770	320	230	380	310		
PCBs (µg/L)	PCB-1242	ND	ND	ND	ND	ND	ND	ND	ND	0.26	0.5	MCL
Rads (pCi/L)	Alpha activity	ND	7.1	ND	ND	10	ND	ND	ND	8.2	15	MCL
	Beta activity	11	**130**	**52**	ND	**84**	ND	34	47	**120**	50	MCL
	Radium-226	ND	ND	ND	ND	ND	ND	ND	ND	0.5	5	MCL
	Strontium-90	ND	ND	ND	ND	ND	ND	ND	9.2	ND	8	MCL
	Technetium-99	ND	130	53	ND	100	ND	19	63	120		
	Thorium-230	ND	ND	ND	ND	ND	0.86	ND	ND	ND		
	Thorium-232	ND	ND	ND	0.6	ND	1.7	ND	ND	0.47		
VOC (µg/L)	Trichloroethene	**11**	ND	**10**	ND	ND	ND	**21**	1.4	**14**	5	MCL
Wetchem	Chemical Oxygen Demand (mg/L)	ND	ND	ND	ND	45	42	ND	ND	ND		
	Iodide (mg/L)	ND	ND	ND	2.5	ND	3.2	ND	ND	ND		
	Total Organic Carbon (mg/L)	1.6	1.8	4	8.1	16	13	3.1	8.6	2.6		
	Total Organic Halides (ug/L)	12	18	79	160	390	200	25	180	19		
	Turbidity (NTU)	11	5	16	18	81	5.6	16	9.3	84		

MCL - Maximum Contaminant Level (for reference only)
ND - Not detected
Bold - exceeds criteria
VOC - volatile organic compound

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 9.6).

During 2004, uranium exceeded contaminant levels in one downgradient well. Beta activity exceeded contaminant levels in two upgradient wells and alpha activity exceeded contaminant levels in one upgradient well. Turbidity exceeded contaminant levels in upgradient, sidegradient, and downgradient wells. Levels of PCB exceeded contaminant levels in one downgradient well. Trichloroethene exceeded contaminant levels in two upgradient wells. The KDWM was notified of all exceedences 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 is provided in Table 9.3.

Table 9.3 Summary of maximum groundwater results at C-746-U Landfill

		Lower RGA MWs			UCRS MWs		Upper RGA MWs			
	Parameter	**Up-gradient**	**Side-gradient**	**Down-gradient**	**Up-gradient**	**Down-gradient**	**Up-gradient**	**Side-gradient**	**Down-gradient**	**Criteria Reference**
Anion	Bromide	ND	ND	ND	1.9	ND	ND	ND	1.2	
(mg/L)	Chloride	53	35	31	170	17	46	42	29	
	Fluoride	0.2	0.3	0.28	0.33	0.31	0.24	0.39	0.32	4 MCL
	Nitrate as Nitrogen	ND	ND	1	ND	1.6	ND	ND	ND	10 MCL
	Sulfate	210	26	110	11	100	95	23	100	
Metal	Aluminum	0.26	ND	0.97	0.85	0.95	0.93	0.37	1.6	
(mg/L)	Arsenic	0.012	0.0058	0.0022	0.0031	0.0029	0.0061	0.011	0.0037	0.05 MCL
	Barium	0.26	0.39	0.39	0.24	0.28	0.35	1.2	0.33	2 MCL
	Boron	1.6	ND	ND	ND	ND	0.68	ND	0.45	
	Cadmium	ND	ND	0.0018	ND	ND	ND	ND	ND	0.005 MCL
	Calcium	72	41	40	38	43	49	41	37	
	Cobalt	0.021	0.012	0.033	ND	0.062	0.079	0.017	0.043	
	Copper	ND	ND	0.021	ND	ND	ND	ND	0.021	
	Iron	5.1	41	20	7.9	18	11	62	18	
	Lead	ND	ND	0.0056	ND	ND	ND	ND	0.0055	0.05 MCL
	Magnesium	30	18	17	12	20	18	15	15	
	Manganese	0.5	5.8	3.7	0.34	3	0.81	11	5.3	
	Molybdenum	ND	ND	ND	ND	0.0024	ND	ND	ND	
	Nickel	0.0068	0.017	0.023	ND	0.018	0.012	0.048	0.015	
	Potassium	3.2	2.8	3.1	0.9	0.72	1.9	2	2	
	Selenium	0.0067	ND	0.007	0.011	ND	0.0077	ND	0.0079	0.05 MCL
	Silver	ND	ND	ND	ND	ND	ND	ND	0.0015	
	Sodium	59	41	50	210	200	57	77	74	
	Uranium	ND	ND	ND	0.0031	0.012	ND	ND	**0.029**	0.03 MCL
	Zinc	0.02	ND	0.031	ND	ND	ND	ND	ND	
Dissolved Metal	Barium, Dissolved	0.25	0.38	0.38	0.22	0.27	0.36	0.83	0.32	2 MCL
(mg/L)	Uranium, Dissolved	ND	ND	ND	0.0024	0.013	ND	ND	ND	0.03 MCL
PHYSC	Dissolved Solids	520	280	330	600	680	350	370	310	
	Total Solids	510	250	320	590	570	350	250	310	
PCBs (µg/L)	PCB-1016	ND	ND	0.35	ND	ND	0.42	ND	**2.5**	0.5 MCL
Rads	Alpha activity	**19**	8.8	9.2	ND	**18**	7.6	11	ND	15 MCL
(pCi/L)	Beta activity	**56**	11	38	8.8	8.1	**94**	18	45	50 MCL
	Radium-226	0.79	0.63	0.97	0.9	ND	ND	ND	ND	5 MCL
	Technetium-99	68	ND	46	ND	ND	100	32	52	
VOC	Acetone	ND	840	ND	ND	7100	ND	ND	13	
(µg/L)	Trichloroethene	**15**	ND	ND	ND	1	**6**	ND	1.4	5 MCL
Wetchem	Chemical Oxygen Demand (mg/L)	ND	ND	ND	68	110	ND	58	ND	
	Total Organic Carbon (mg/L)	1.7	3	4.5	12	60	3.7	7.8	60	
	Total Organic Halides (µg/L)	15	12	84	330	210	24	170	27	
	Turbidity (NTU)	55	7.1	100	6000	1200	53	38	100	

MCL - Maximum Contaminant Level (for reference only)
ND - Not detected

Bold - exceeds criteria
VOC - volatile organic compound

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. Post-closure 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 gravels (Figure 9.6). 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 was also found above regulatory criteria. No metals were found above the regulatory criteria.

Residential (Federal Facility Agreement) Monitoring

The DOE conducts sampling of residential wells potentially affected by the contaminant plume (DOE 1998). Currently, only three residential wells (R2, R294, and R302) are sampled monthly. Eighteen other residential wells are monitored semiannually. All residential wells sampled monthly 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 maximum detected results for the residential well monthly monitoring program. The 18 residential wells, sampled semiannually, showed no detections of TCE or ^{99}Tc. Three wells showed alpha activity and eight wells showed beta activity. These results are not listed in Table 9.5.

Table 9.4 Summary of maximum groundwater results at C-746-K Landfill

	Parameter	MW300	MW301	MW302	MW344	Reference/ Criteria	
Anion (mg/L)	Chloride	21	40	12	23		
	Sulfate	2100	180	160	200		
Metal (mg/L) **Total**	Aluminum	0.99	0.58	ND	4.2		
	Arsenic	0.005	ND	0.0012	0.0053	0.05	MCL
	Barium	0.017	0.029	0.085	0.12	2	MCL
	Beryllium	0.002	ND	ND	ND	0.004	MCL
	Cadmium	0.0011	ND	ND	ND	0.005	MCL
	Calcium	380	530	55	85		
	Iron	420	280	2.6	18		
	Iron 2+	360	2.8	3	15		
	Lead	0.015	ND	ND	ND	0.015	MCL
	Magnesium	100	81	28	23		
	Manganese	24	20	2	2.3		
	Nickel	0.14	0.01	0.012	0.0086		
	Potassium	16	34	0.46	2		
	Sodium	47	51	100	40		
	Uranium		ND	ND	0.0011	0.02	MCL
Metals (mg/L) **Dissolved**	Arsenic	0.0043	ND	ND	0.0052	0.05	MCL
	Barium	0.02	0.026	0.081	0.098	2	MCL
	Beryllium	0.0029	ND	ND	ND	0.004	MCL
	Cadmium	0.0011	ND	ND	ND	0.005	MCL
	Lead	0.013	ND	ND	ND	0.015	MCL
	Uranium	ND	0.0046	ND	ND	0.02	MCL
Rads (pCi/L)	Alpha activity	ND	ND	ND	10	15	MCL
	Beta activity	ND	**73**	9.5	10	50	MCL
	Thorium-230	0.62	ND	ND	ND		
	Uranium-238	ND	0.61	ND	ND		
VOC (µg/L)	1,1-Dichloroethane	ND	5	ND	ND		
	1,1-Dichloroethene	**160**	5	ND	ND	7	MCL
	cis-1,2-Dichloroethene	1300	59	ND	ND		
	Trichloroethene	**130**	ND	ND	ND	5	MCL
	Vinyl Chloride	**84**	**3.8**	ND	ND	2	MCL

MCL - Maximum Contaminant Level (for reference only)

ND - Not detected

Bold - Exceeds Criteria

Table 9.5 Summary of maximum groundwater results from residential monthly monitoring

Well Number	Alpha activity pCi/L	Beta activity pCi/L	^{99}Tc pCi/L	TCE µg/L
R2	3.26	42.7	58.6	**140**
R294	ND	5.3	ND	ND
R302	ND	12	ND	ND
	MCL=15	MCL=50		MCL=5

ND - Not detected
MCL - Maximum Contaminant Level (for reference only)
Bold - Exceeds Criteria

For one residential well, R424, DOE has provided the residents with a carbon filtering system to allow them to have safe drinking water. These filters are replaced semiannually and sampled before and after filter replacement. The groundwater in the well contains TCE above levels established by the EPA Safe Drinking Water Act (SDWA); however, its location 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 Environmental Monitoring Plan* (BJC 2003a). Specific wells monitored for environmental surveillance are as follows:

- Semiannual Monitoring Program—UCRS MWs 96, 149, 166, 174, 192, 180, 186, 182, and 187; RGA MWs 20, 63, 65, 71, 98, 99, 100, 106, 125, 134, 135, 139, 146, 148, 152, 155, 156, 161, 163, 165, 168, 169, 173, 175, 178, 185, 188, 191, 193, 197, 200, 201, 202, 203, 205, 206, 252, 253, 260, 261, 262, 328, 329, 333, 337, 338, 339, 340, 341, 342, 343, 354, 355, 409, 410, and 411; McNairy MW 133 and 356; Rubble Zone MWs 345, 346, 347;

- Annual Background Monitoring Program—Terrace Gravels MW196; Eocene Sand MW305; RGA MWs 103, 150, 194, and 199; McNairy MWs 102, 120, 121, and 122;

- Natural Attenuation Monitoring Program—RGA MWs 20, 99, 100, 125, 134, 152, 161, 163, 188, 193, 201, 206, 260, 328, 329, 409, 410, and 411; and

- Annual Radiological Monitoring Program—MWs 100, 102, 103, 106, 120, 121, 122, 125, 133, 134, 135, 139, 146, 148, 149, 150, 152, 155, 156, 161, 163, 165, 166, 168, 169, 173, 174, 175, 178, 180, 182, 185, 186, 187, 188, 191, 192, 193, 194, 196, 197, 199, 20, 200, 201, 202, 203, 205, 206, 252, 253, 260, 261, 262, 300, 301, 302, 305, 328, 329, 333, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 354, 355, 356, 401 Port 4, 402 Port 5, 403 Port 4, 404 Port 5, 409, 410, 411, 63, 65, 66, 71, 96, 98, and 99.

During 2004, surveillance wells 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 71,000 micrograms per liter (µg/L) from MW 343. The well is located at the northwest corner of C-400. Figure 9.7 shows the treatabilty study area located at the southeast corner of C-400. Trichloroethene was also detected in the McNairy at 7 µg/L in MW 356.

Figure 9.7 Six-Phase Treatability Study site

During 2004, ^{99}Tc activities in the RGA (8790 pCi/L-MW 343) exceeded maximum contaminant levels.

Three wells, MW 345, MW 346, and MW 347, have been installed, penetrating the Rubble Zone, which is the formation underlying the McNairy. Thorium-230 was detected in one well at 0.57 pCi/L. No TCE or ^{99}Tc detections were observed in 2004.

Monitoring Well Rehabilitation

In 2004, DOE continued an MW rehabilitation program to enhance the effectiveness of the MWs at the Paducah Site. Well rehabilitation activities were completed in 2004 for a total of 89 wells. The rehabilitation process utilized Blended Chemical Heat Treatment™ (BCHT) as either preventive maintenance or full rehabilitation depending on the severity of biofouling in the well. 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 bio film and blocking material redevelops the MW using surging and airlift pumping techniques.

Environmental Restoration Activities

Northwest Plume Monitoring

The site continued operations of the NWPGS. This action, which started operation in 1995, is to contain off-site migration of the high-concentration section of the Northwest Plume. This was the first phase of the high-concentration portion of remedial action for groundwater at the Paducah Site. Two extraction wells near a source of the Northwest Plume and two additional extraction wells farther north, near the centroid of the plume, were installed. Each set of extraction wells is surrounded by an MW network (Figure 9.8). The network is used for monitoring groundwater quality and water levels to determine the effectiveness of the interim action.

Trichloroethene trends for 2004 are similar to those of 2003. The 2004 maps continue to document a bifurcation in the distal end of the Northwest Plume. Both TCE and ^{99}Tc detection in the seeps of Little Bayou Creek suggest that a core of contaminant flow migrates downstream along the creek in the area of the TVA Shawnee Steam Plant settling ponds. The most notable change in the 2004 maps is the interpretation that the core of the Northwest Plume has migrated to the east of the north well field in both the middle and lower RGA.

The 2004, ^{99}Tc maps for the Northwest Plume depict two cores of contamination migrating from the north side of the PGDP. A significant change is the combination of the central and eastern cores compared to the CY 2003 maps (BJC 2005c).

Summaries of the program's monitoring results are listed in tables 9.7 and 9.8. 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 facility was completed in 1996 and operation began in 1997, which consisted of construction of two extraction wells, several MWs (Figure 9.9) with piezometers, and facilities required to transfer the TCE-contaminated water to the USEC C-637 Cooling Tower for treatment. Groundwater quality and water-level information obtained from the piezometers and MWs are used to evaluate the effectiveness of the remedial action. The upgradient MWs are used to detect possible ^{99}Tc contamination within the high-concentration area of the plume before it reaches the extraction wells.

Within the Northeast Plume, TCE trends showed that a large area of the Northeast Plume, located west of the Northeast Plume well field, had responded to the pump-and-treat system with significantly reduced contaminant levels. In the lower RGA, sharply declining TCE trends in MW 255 and MW 258 indicated that the area of higher concentration has migrated northeast. Meanwhile, the TCE values for MW 99 in 2004 continue to indicate that the tip of the Northeast Plume is migrating northwest in the middle RGA.

One significant change for ^{99}Tc in the CY 2004 map is that a discrete core of ^{99}Tc had migrated approximately 0.67 miles outside the plant boundary along the trend of the Northeast Plume. This is based on changes in levels in MW 256 and continued detections in MW 292 and MW 288 (BJC 2005c).

Table 9.6 Summary of maximum groundwater results from environmental surveillance monitoring

	Parameter	Eocene	McNairy	RGA	Rubble Zone	Terrace Gravel	UCRS	Reference/ Criteria	
Anion (mg/L)	Chloride	ND	NS	107	ND	ND	63		
	Nitrate as Nitrogen	ND	NS	6	ND	ND	2.1	10	MCL
	Sulfate	ND	NS	72	ND	ND	140		
Metal (mg/L)	Arsenic	ND	NS	0.0039	ND	ND	0.0078	0.05	MCL
	Barium	ND	NS	0.71	ND	ND	0.86	2	MCL
	Beryllium	ND	NS	0.001	ND	ND	**0.0053**	0.004	MCL
	Cadmium	ND	NS	0.0028	ND	ND	0.0026	0.005	MCL
	Calcium	ND	NS	38	ND	ND	49		
	Chromium	ND	NS	**1.3**	ND	ND	**0.66**	0.1	MCL
	Cobalt	ND	NS	0.21	ND	ND	0.27		
	Copper	ND	NS	0.025	ND	ND	0.027		
	Iron	ND	NS	12	ND	ND	48		
	Iron +2	ND	NS	9	ND	ND	26		
	Lead	ND	NS	ND	ND	ND	**0.02**	0.015	MCL
	Magnesium	ND	NS	14	ND	ND	19		
	Manganese	ND	NS	9.1	ND	ND	26		
	Molybdenum	ND	NS	0.026	ND	ND	0.0068		
	Nickel	ND	NS	1.4	ND	ND	0.59		
	Potassium	ND	NS	9.2	ND	ND	6.4		
	Selenium	ND	NS	0.012	ND	ND	0.0055	0.05	MCL
	Uranium	0.0017	ND	0.0036	ND	ND	**0.13**	0.02	MCL
	Zinc	ND	NS	0.061	ND	ND	0.049		
Rads (pCi/L)	Alpha activity	ND	ND	**75**	ND	6.6	**73**	15	MCL
	Beta activity	ND	ND	**6600**	11	20	**600**	50	MCL
	Dissolved Alpha	ND	ND	**42**	ND	ND	**68**	15	MCL
	Dissolved Beta	ND	ND	**3900**	14	23	**160**	50	MCL
	Potassium-40	ND	ND	32	ND	ND	59		
	Suspended Beta	ND	ND	33	ND	ND	**87**	50	MCL
	Technetium-99	ND	190	8800	ND	ND	790		
	Thorium-228	ND	ND	0.28	ND	ND	ND		
	Thorium-230	ND	ND	ND	0.57	ND	0.62		
	Thorium-234	ND	ND	47	ND	ND	ND		
	Uranium-235	ND	ND	ND	ND	ND	0.53		
	Uranium-238	0.49	ND	0.97	ND	ND	37		
VOC (µg/L)	1,1-Dichloroethane	ND	ND	19	ND	ND	ND		
	1,1-Dichloroethene	ND	ND	**31**	ND	ND	6.2	7	MCL
	Carbon tetrachloride	ND	ND	**130**	ND	ND	ND	5	MCL
	cis-1,2-Dichloroethene	ND	ND	310	ND	ND	290		
	Trichloroethene	ND	7	**71000**	ND	ND	**9600**	5	MCL
	Vinyl chloride	ND	ND	**550**	ND	ND	ND	2	MCL
Wetchem	Total Organic Compounds (mg/l)	ND	NS	48	ND	ND	190		
	Turbidity (NTU)	370	99	6000	30	6.3	920		

MCL - Maximum contaminant level (for reference only)
ND - Not detected
NS - Not sampled
Bold - Exceeds criteria

A summary of the program's monitoring results is listed in Table 9.9. The data for this program are reported in the FFA Semiannual Progress Report.

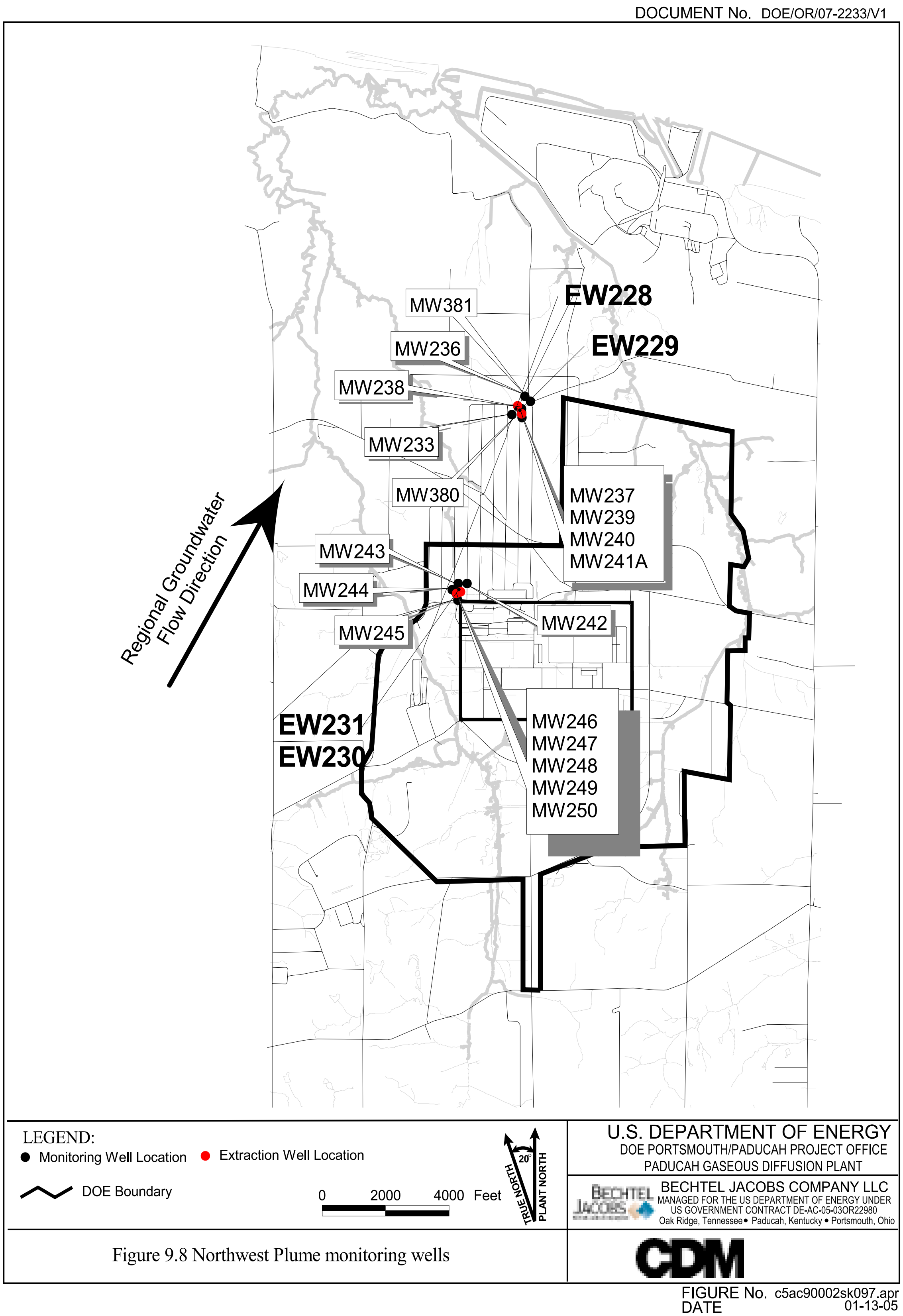

Figure 9.8 Northwest Plume monitoring wells

Table 9.7 Summary of maximum groundwater results from the Northwest Plume north field groundwater monitoring

	Analysis	MW 233	MW 236	MW 237	MW 238	MW 239	MW 240	MW 241A	MW 380	MW 381	Reference/ Criteria	
Anions (mg/L)	Chloride	30	26	ND	27	21	28	27	26	35		
	Fluoride	.20	.18	.59	.18	.38	.18	.18	.18	.18	4	MCL
	Nitrate as Nitrogen	2	1.8		1.7		1.6	1.5	1.8	1.9	10	MCL
	Sulfate	13	23	100	20	11	16	16	22	22		
Field (mg/L)	Turbidity (NTU)	10.0	7.1	58.0	38.0	8.7	9.0	6.0	9.8	8.2		
Metals Total (mg/L)	Aluminum	ND	ND	2.7	.62	ND	ND	ND	ND	ND		
	Arsenic	ND	ND	.0034	.0011	ND	ND	ND	ND	ND	0.05	MCL
	Barium	.16	.14	.19	.14	.030	.15	.12	.14	.15	2	MCL
	Calcium	21	23	26	21	3.8	20	20	23	25		
	Cobalt	ND	ND	.0053	ND	.0013	ND	ND	ND	ND		
	Iron	ND	.15	11.	1.5	22	.17	ND	ND	.14		
	Lead	ND	ND	ND	.0081	ND	.0095	ND	ND	ND	0.015	MCL
	Magnesium	8.4	9.4	10	8.6	2.7	8.2	8.3	9.2	10		
	Manganese	.22	.39	.16	.16	.59	.31		.088	.068		
	Molybdenum	.0014	ND	.0017	ND	ND	ND	ND	ND	ND		
	Nickel	.018	.039	.0071	ND	ND	ND	ND	ND	ND		
	Potassium	1.6	1.5	.46	1.4	7.6	1.3	1.3	1.3	1.5		
	Selenium	ND	ND	ND	.0055	ND	.0050	.0054	ND	ND	0.05	MCL
	Silver	ND	ND	.0014	ND	ND	ND	ND	ND	ND		
	Sodium	32	31	87	29	18	30	29	30	33		
Metals Dissolved (mg/L)	Arsenic	ND	ND	.0018	ND	ND	ND	ND	ND	ND	0.05	MCL
	Barium	.15	.14	.22	.14	.030	.16	.13	.14	.15	2	MCL
	Calcium	21	21	25	22	3.7	21	21	23	26		
	Cobalt	ND	.0010	.0071	ND	ND	ND	ND	ND	ND		
	Iron	ND	ND	4.8	ND	22.	ND	ND	ND	ND		
	Magnesium	8.4	8.9	10	8.9	2.6	8.6	8.6	9.4	11		
	Manganese	.24	.37	.12	.024	.70	.31	ND	.057	.062		
	Molybdenum	ND	ND	.0015	ND	ND	ND	ND	ND	ND		
	Nickel	.0086	.046	.0081	ND	ND	ND	ND	ND	ND		
	Potassium	1.5	1.3	.37	1.3	7.6	1.4	1.4	1.3	1.5		
	Sodium	32	29	93	31	19	31	31	31	36		
Physc (pCi/L)	Dissolved Solids	170	170	360	170	140	170	170	170	200		
Rads (pCi/L)	Alpha activity	ND	8.3	8.6	ND	ND	ND	ND	6.4	12.	15	MCL
	Beta activity	8	**130**	ND	**69**	12	17	12	**110**	**190**	50	MCL
	Technetium-99	ND	130	ND	75	ND	25	ND	130	240		
VOC (µg/L)	Trichloroethene	**8**	**300**	ND	**170**	**62**	**42**	**16**	**300**	**900**	5	MCL
Wetchem (mg/L)	Alkalinity	84	84	190	84	56	86	84	84	91		
	Silica	15	15	37	15	36	16	15	14	16		
	Total Organic Carbon (mg/L)	ND	ND	1.7	ND	ND	ND	ND	ND	ND		

Table 9.8 Summary of maximum groundwater results from the Northwest Plume south field groundwater monitoring

Parameter		MW 242	MW 243	MW 244	MW 245	MW 246	MW 247	MW 248	MW 249	MW 250	Reference/ Criteria	
Anion (mg/L)	Chloride	60	60	34	14	6.4	7.5	56	23	34		
	Fluoride	0.14	0.12	0.17	0.2	0.34	0.18	0.13	0.15	0.16	4	MCL
	Nitrate as Nitrogen	ND	1.6	1.5	ND	ND	ND	2.3	ND	1.5	10	MCL
	Sulfate	15	11	10	39	110	ND	10	9.1	12		
Metal Total (mg/L)	Aluminum	1.2	0.3	ND	1.4	0.38	0.3	ND	0.4			
	Arsenic	0.0041	0.0026	0.0014	0.012	ND	0.0016	0.0016	0.0015	0.0012	0.05	MCL
	Barium	0.37	0.16	0.11	0.5	0.059	0.12	0.14	0.17	0.1	2	MCL
	Calcium	24	28	20	40	30	12	27	22	21		
	Cobalt	0.013	ND	ND	0.056	ND	ND	ND	ND	ND		
	Copper	ND	ND	ND	ND	ND	ND	ND	0.02	ND		
	Iron	19	0.48	0.3	57	0.25	30	0.31	0.74	ND		
	Magnesium	11	12	8.5	16	13	6.7	11	8.9	8.9		
	Manganese	3.2	0.088	0.082	15	0.0074	0.7	0.15	0.82	0.0082		
	Molybdenum	0.0024	0.0024	0.0074	ND	ND	ND	ND	ND	ND		
	Nickel	0.026	ND	ND	0.079	ND	0.0091	ND	ND	ND		
	Potassium	1.1	1.1	1.2	1.3	0.25	4.4	1	1.2	1.2		
	Selenium	0.0062	0.0071	0.0069	ND	ND	ND	0.006	ND	0.0065	0.05	MCL
	Sodium	28	27	33	40	85	31	27	30	33		
	Zinc	ND	ND	0.04	ND	ND	ND	ND	ND	ND		
Metal Dissolved (mg/L)	Arsenic	0.0022	0.0018	ND	0.0081	ND	0.0016	ND	0.0011	ND	0.05	MCL
	Barium	0.37	0.17	0.12	0.43	0.061	0.12	0.15	0.17	0.1	2	MCL
	Calcium	24	28	20	36	29	12	26	22	21		
	Cobalt	0.013	ND	ND	0.047	ND	ND	ND	ND	ND		
	Iron, Dissolved	19	ND	ND	55	ND	28	ND	ND	ND		
	Magnesium	10	12	8.5	14	13	6.6	11	8.8	8.8		
	Manganese	3.1	0.074	0.049	29	ND	0.65	0.11	0.85	0.0061		
	Molybdenum	0.001	0.0027	0.0077	0.0012	ND	ND	ND	ND	ND		
	Nickel	0.027	ND	ND	0.066	ND	0.0091	ND	ND	ND		
	Potassium	1	1.1	1.2	1.1	0.24	4.5	1	1.2	1.2		
	Sodium	28	28	35	37	83	31	25	30	32		
	Zinc	ND	ND	0.041	ND	ND	ND	ND	ND	ND		
PHYSC (pCi/L)	Dissolved Solids	190	210	180	290	350	180	200	130	170		
RADS (pCi/L)	Alpha activity	ND	8.1	ND	ND	ND	7.2	11	ND	ND	15	MCL
	Beta activity	34	**300**	19		5.7	10	**390**	39	33	50	MCL
	Radon	ND	ND	ND	250	**1300**	ND	210	ND	ND	300	MCL
	Technetium-99	35	380	19	ND	ND	ND	550	50	41		
VOC (µg/L)	cis-1,2-Dichloroethene	14	ND	ND	ND	ND	ND	ND	ND	ND		
	Trichloroethene	**140**	**890**	2	**120**	ND	ND	**4100**	**54**	**30**	5	MCL
WETCHEM	Alkalinity (mg/L)	54	72	89	110	170	110	71	74	88		
	Silica (mg/L)	15	15	15	25	32	22	18	18	18		
	Total Organic Carbon	ND	ND	ND	2	ND	8.7	ND	ND	ND		
	Turbidity (NTU)	37	22	17	240	13	7.2	20	180	20		

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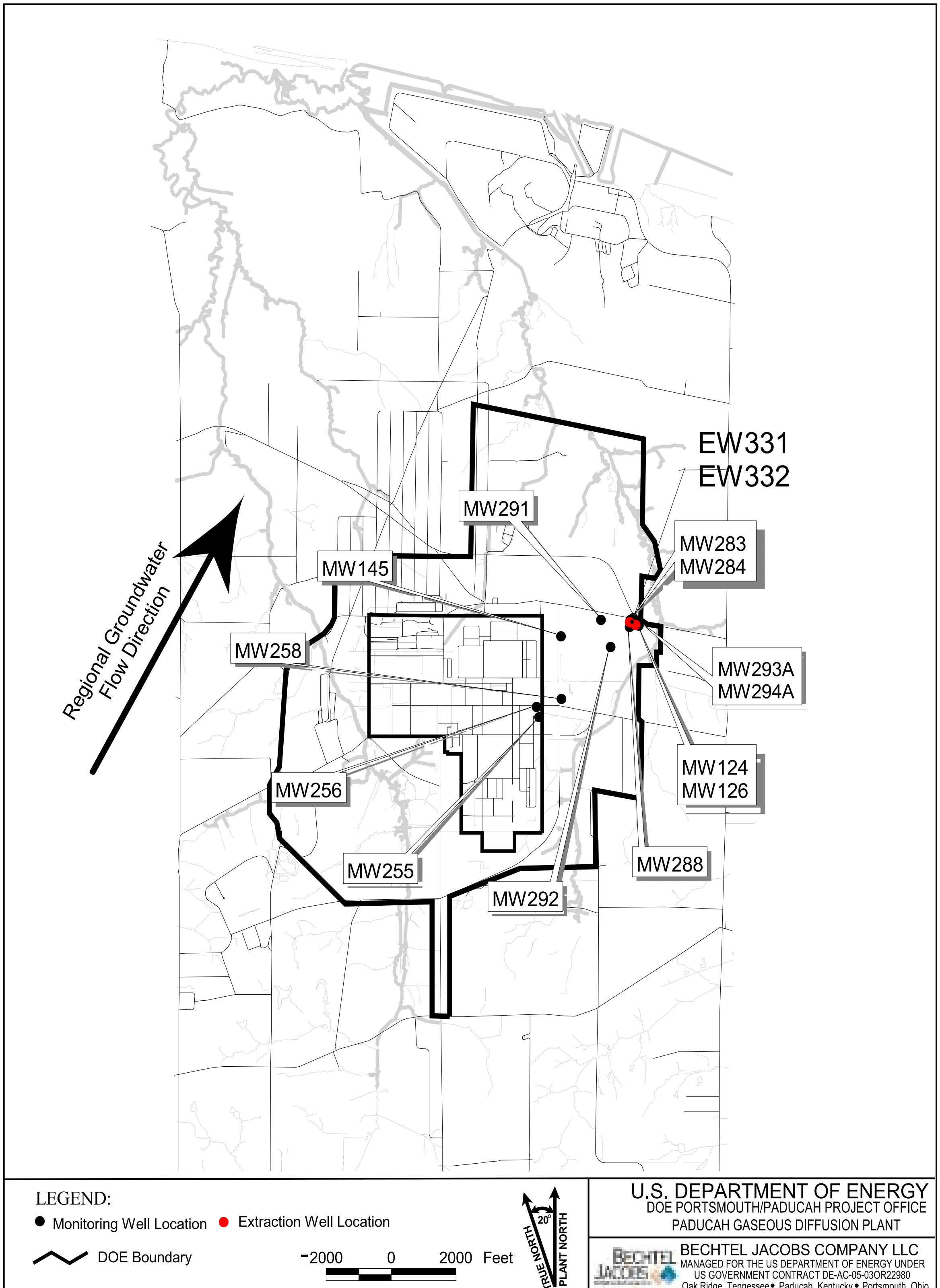

Figure 9.9 Northeast Plume monitoring wells

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Table 9.9 Summary of maximum groundwater results from the Northeast Plume groundwater monitoring

	Parameter	MW 124	MW 126	MW 145	MW 255	MW 256	MW 258	MW 283	MW 284	MW 288	MW 291	MW 292	MW 293A	MW 294A	Criteria	
Anion	Chloride	46	55	92	59	53	60	72	73	67	58	61	58	54		
(mg/L)	Fluoride	0.22	0.17	0.19	0.29	0.22	0.23	0.15	0.14	0.16	0.16	0.18	0.17	0.15	4	MCL
	Nitrate as Nitrogen	4.2	1.3	ND	ND	ND	1.2	1.2	1.2	1.2	1.2	1.3	3.2	4	10	MCL
	Sulfate	28	12	97	39	26	25	8.9	6.6	18	8.9	16	14	12		
Metal	Aluminum	0.73	ND	ND	3.1	ND	0.68	ND	ND	ND	0.67	ND	ND	ND		
Total	Arsenic	0.0023	0.0019	ND	0.0046	0.0018	0.0016	0.0022	0.0016	0.0025	0.0023	0.0023	0.002	0.0015	0.05	MCL
(mg/L)	Barium	0.2	0.19	0.068	0.3	0.18	0.16	0.29	0.28	0.25	0.23	0.22	0.21	0.22	2	MCL
	Cadmium	ND	ND	**0.0086**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005	MCL
	Calcium	23	22	48	27	28	24	28	27	29	21	27	22	20		
	Chromium	0.057	ND	0.037	0.028	**0.1**	ND	0.074	0.055	0.059	0.03	0.024	ND	ND	0.1	MCL
	Cobalt	0.0039	ND	ND	0.022	ND	0.0013	ND	ND	ND	ND	ND	ND	ND		
	Copper	ND	ND	0.025	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	Iron	0.87	0.27	0.52	3.9	0.51	0.4	0.39	0.75	0.58	0.62	0.3	ND	0.15		
	Lead	ND	ND	ND	ND	ND	ND	ND	0.0081	ND	ND	ND	ND	ND	0.015	MCL
	Magnesium	8.8	8.5	19	11	11	9.6	12	11	12	8.6	11	8.2	8.2		
	Manganese	0.57	0.012	0.0093	5.5	0.051	0.023	0.0069	ND	ND	0.0096	ND	0.076	0.0091		
	Molybdenum	ND	ND	ND	0.0035	0.0077	ND	0.0071	0.0053	0.003	0.0017	0.0023	ND	ND		
	Nickel	0.012	ND	0.023	0.0088	0.006	ND	0.0091	0.0064	ND	0.0074	0.015	0.0074	ND		
	Potassium	1.8	1.3	5.5	1.9	1.9	1.9	1.5	1.6	1.7	1.5	1.8	1.7	1.8		
	Selenium	0.015	0.013		0.0079	0.0094	0.0089	0.011	0.0088	0.014	0.01	0.015	0.014	0.014	0.05	MCL
	Sodium	42	41	65	85	63	62	34	32	45	37	51	37	36		
	Zinc	ND	ND	ND	0.029	ND	ND	ND	ND	ND	ND	0.03	ND	ND		
Metal Dissolved	Arsenic	0.001	ND	ND	0.0017	ND	0.0011	ND	ND	0.001	ND	0.0011	0.001	ND	0.05	MCL
(mg/L)	Barium	0.18	0.18	0.068	0.25	0.17	0.16	0.28	0.28	0.25	0.22	0.22	0.21	0.22	2	MCL
	Calcium	24	23	48	28	29	25	30	27	30	21	28	24	21		
	Cobalt	0.002	ND	ND	0.02	0.0011	ND	ND	ND	ND	ND	ND	ND	ND		
	Copper	ND	ND	ND	0.022	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	Iron	ND	ND	ND	0.87	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	Magnesium	8.9	8.6	19	11	11	9.8	12	11	12	8.6	11	8.6	8.3		
	Manganese	0.36	0.009	0.011	5.3	0.055	0.02	0.0059	ND	ND	0.0077	ND	0.082	0.0072		
	Molybdenum	ND	ND	ND	0.0021	ND	ND	0.0054	ND	ND	ND	0.0015	ND	ND		
	Nickel	0.0086	ND	0.024	0.0097	ND	ND	0.011	0.005	ND	0.009	0.018	0.0075	ND		
	Potassium	1.8	1.4	5.5	1.7	2	1.9	1.5	1.6	1.8	1.5	1.8	1.8	ND		
	Selenium	0.0099	0.0082	ND	ND	0.005	0.0075	0.0056	0.0054	0.0075	0.0056	0.0089	0.0098	0.011	0.05	MCL
	Sodium	42	41	68	84	64	65	35	33	45	37	51	38	38		
	Zinc	ND	ND	ND	0.13	ND	ND	ND	ND	0.025	ND	0.038	ND	ND		
PHYSC	Dissolved Solids	240	220	430	370	290	280	250	230	270	210	270	220	210		
Rads	Alpha activity	7.6	ND	ND	12	8.1	ND	ND	ND	ND	6.7	7.9	5.4	4.4	15	MCL
(pCi/L)	Beta activity	7.6	ND	22	6.9	**120**	25	6.7	10	30	8.3	31	7	7.5	50	MCL
	Technetium-99	ND	ND	23	ND	140	ND	ND	ND	33	ND	29	ND	ND		
VOC	1,1-Dichloroethene	ND	ND	ND	ND	**110**	ND	ND	ND	ND	ND	ND	ND	ND	7	MCL
(µg/L)	Trichloroethene	**23**	3	**56**	**540**	**500**	**550**	**130**	**150**	**330**	**120**	**480**	**610**	**550**	5	MCL
Wetchem	Alkalinity (mg/L)	87	94	130	180	150	140	83	81	110	76	120	77	72		
	Silica (mg/L)	15	17	17	15	16	16	17	17	16	17	16	18	18		
	Total Organic Carbon (mg/L)	ND	ND	1.2	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	Turbidity (NTU)	66	16	47	79	26	44	31	21	39	52	27	9.8	9.9		

Groundwater Monitoring Results

The primary objectives of groundwater monitoring at the Paducah Site are being met by the monitoring programs. Contamination has been detected in groundwater offsite. Through the monitoring program, in conjunction with RIs, a footprint of the groundwater contamination has been mapped and is annually updated. The program continues to expand each year to further delineate the boundaries of the footprint 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 BJC Public Affairs Department.

A more detailed interpretation of the TCE and ^{99}Tc groundwater contamination and plumes within the RGA is available from the DOE EIC in *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2004 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2005c). However, Figure 9.1 shows offsite groundwater plumes.

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. Monitoring and sampling organizations at Paducah select sampling methods, instruments, locations, schedules, and other sampling and monitoring criteria 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 address quality requirements and assessment standards. Requirements and guidelines for the QA/QC Program at the Paducah Site are established by DOE Order 414.1, *Quality Assurance*; state and federal regulations; and documentation 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.

The *Environmental Services Subcontract Quality Assurance and Data Management Plan* (EQADMP) defines the relationship of each element of the Environmental Monitoring Program to key quality and data management requirements. Training requirements, sample custody, procedures, instrument calibration and maintenance, and data review are a few of the subjects discussed in the EQADMP. In 2004, a variety of functions were performed for the Environmental Monitoring Program, such as conducting surveillances, reporting problems, reviewing data, reviewing procedures, and revising the EQADMP.

Field Sampling Quality Control

Data Quality Objectives and Sample Planning

From the point of conception 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 part of the DQO process and are documented in the *Paducah Site Environmental Monitoring Plan* (BJC 2003a).

Each sampling location and sample collected is assigned a unique identification number. Each segment of the sequence is used to designate information concerning the location from which a sample is collected. In order 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, are also recorded. Field measurements are collected and either 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 following: sample identification number, station (or location), date collected, time collected, person who performed the sampling, etc. This information is documented in a logbook and on a chain-of-custody form and sample container label, and then input directly into PEMS on a weekly or other appropriate basis. Chain-of-custody forms are maintained from the point of sampling, and the samples are properly protected 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.

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 an analytical SOW. Using guidance from EPA, laboratories document the steps in handling, analysis, and approval of results. Chain-of-custody procedures are followed until a sample is analyzed.

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 appropriately qualified.

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 are readily recognizable 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

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.

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. The laboratories currently utilized all received acceptable results during 2004.

Laboratory Audits/Sample Management Office

Laboratory audits are performed periodically by the BJC Oak Ridge Sample Management Office (SMO) to ensure that the laboratory is in compliance with regulations, procedures, and the contract between the laboratory and the SMO. Findings are documented and addressed by the audited laboratory through corrective actions.

Data Management

Project Environmental Management 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 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.

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 immediately reported to the laboratory so corrections can be made or new EDDs can be issued. Approximately 10 percent of the EDDs is 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 immediately reported to the laboratory and data validators. All data packages are forwarded to the PGDP Environmental Management and Enrichment Facilities 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 are required to participate. Two laboratories and one sampling organization participated in the study in 2004. Final results for the Dicharge Monitoring Report QA Study Number 24 were "acceptable." These 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 K.A.R. 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 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the Curie are commonly used:

- **kiloCurie (kCi)** – 10^{3} Ci, one thousand curies; 3.7×10^{13} disintegrations per second.
- **milliCurie (mCi)** – 10^{-3} Ci, one-thousandth of a curie; 3.7×10^{7} disintegrations per second.
- **microCurie (µCi)** – 10^{-6} Ci, one-millionth of a curie; 3.7×10^{4} disintegrations per second.
- **picoCurie (pCi)** – 10^{-12} Ci, one-trillionth of a curie; 3.7×10^{-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 C.F.R. 141 and 40 C.F.R. 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.

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 gives 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. ^{234}U has 92 protons and 142 neutrons; ^{235}U has 92 protons and 143 neutrons; and ^{238}U has 92 protons and 146 neutrons.

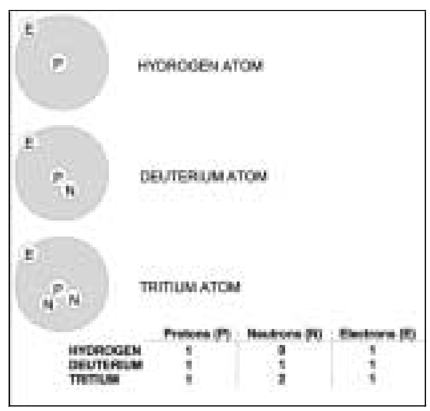

Figure A.1 Isotopes of the element hydrogen.

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 8000 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 ("Radioactivity" 2002, Appendix A references).

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. **Non-ionizing radiation** bounces off or passes through matter without displacing electrons. Non-ionizing radiation does not have enough energy to ionize an atom. It is unclear whether non-ionizing 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 (Bechtel Jacobs Company, LLC., Appendix A references).

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 are actually 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 ("Radiation" 2002, Appendix A references).

Radiation is everywhere. Most occurs naturally, but a small percentage is from human-made sources. Naturally occurring radiation is identical to the radiation resulting from human-made sources.

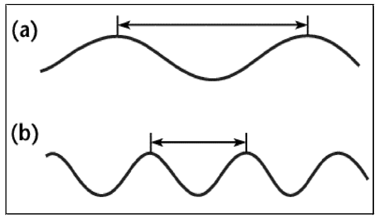

Figure A.2 Comparison between longer (a) and shorter (b) wavelengths[a].

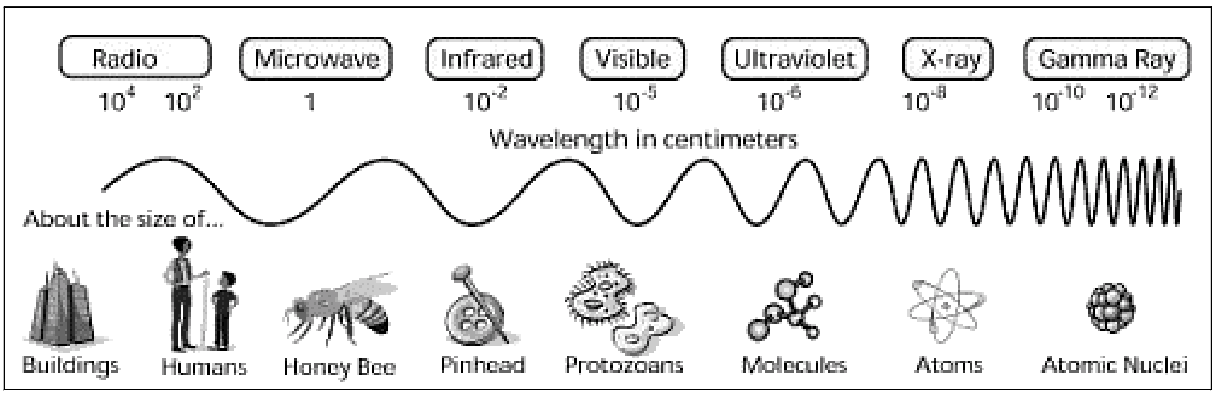

Figure A.3 The approximate wavelengths of the various regions of the electromagnetic spectrum and an example of something that is approximately the same size[b].

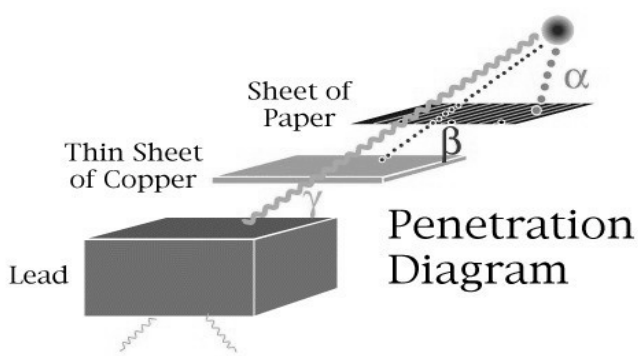

Figure A.4 The penetrating potential of the trhee types of ionizing radiation: alpha, beta, and gamma[c].

[a] ("Electromagnetic…" 2002, Appendix A references)
[b] ("Exploring …" 2002, Appendix A references)
[c] ("Experiment…" 2002, Appendix A references)

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% 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.

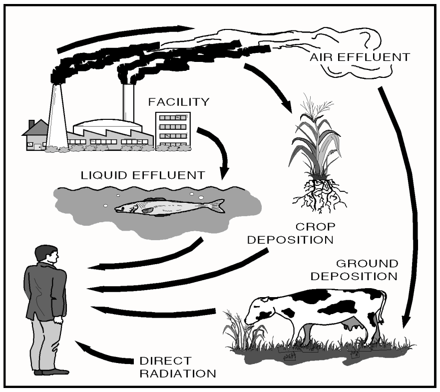

Figure A.5 Possible radiation pathways.

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 is actually 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 (3.7×10^{10} dps).
- 37,000,000,000 Becquerels (3.7×10^{10} Bq)
- 1,000,000 microcuries (1×10^{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)**, 100 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 effective dose equivalent 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 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 1997). 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, K-40. 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 include nuclear medicine examinations, which involve the internal administration of radiopharmaceuticals, and generally account for the largest portion of the dose received from human-made 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 14mrem (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

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 equivalents 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

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.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 United States 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 United States 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% (BEIR 1990).
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, Summary Pamphlet*, WSRC-TR-94-076, Westinghouse Savannah River Company, 1994.

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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U.S. Department of Energy. *Internal Dose Conversion Factors for Calculations of Dose to the Public*, DOE/EH-0071.

Appendix B: Radionuclide and Chemical Nomenclature

Table B.1 Half-life and DCG for selected radionuclides

Radionuclide	Symbol	Half-life	Ingested Water DCG (μCi/ml)
Americium-241	^{241}Am	432 years	3 E - 08
Bismuth-210	^{210}Bi	5.01 days	2 E - 05
Cesium-137	^{137}Cs	30.2 years	3 E - 06
Cobalt-60	^{60}Co	5.3 years	1 E - 05
Lead-206	^{206}Pb	Stable	None
Lead-210	^{210}Pb	21 years	3 E - 08
Lead-214	^{214}Pb	26.8 minutes	2 E - 04
Neptunium-237	^{237}Np	2,140,000 years	3 E - 08
Plutonium-239	^{239}Pu	24,110 years	3 E - 08
Polonium-210	^{210}Po	138.9 days	8 E - 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	7 E - 06
Protactinium-234m	^{234m}Pa	1. 17 minutes	None
Radium-226	^{226}Ra	1,602 years	1 E - 07
Radon-222	^{222}Rn	3.821 days	None
Technetium-99	^{99}Tc	212,000 years	1 E - 04
Thorium-230	^{230}Th	80,000 years	3 E - 07
Thorium-231	^{231}Th	25.5 hours	1 E - 04
Thorium-234	^{234}Th	24.1 days	1 E - 05
Uranium-234	^{234}U	247,000 years	5 E - 07
Uranium-235	^{235}U	710,000,000 years	6 E - 07
Uranium-236	^{236}U	23,900,000 years	5 E - 07
Uranium-238	^{238}U	4,510,000,000 years	6 E - 07

Derived Concentration Guide (DCG) is 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 an effective dose equivalent of 100 mrem. 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	NH_3	Mercury	Hg
Antimony	Sb	Nickel	Ni
Arsenic	As	Nitrate	NO_3^-
Barium	Ba	Nitrite	NO_2^-
Beryllium	Be	Nitrogen	N
Cadmium	Cd	Oxygen	O
Calcium	Ca	Ozone	O_3
Calcium carbonate	$CaCO_3$	Phosphate	PO_4^{3-}
Carbon	C	Phosphorus	P
Chlorine	Cl	Potassium	K
Chromium	Cr	Radium	Ra
Chromium, hexavalent	Cr^{6+}	Radon	Rn
Cobalt	Co	Selenium	Se
Copper	Cu	Silver	Ag
Fluorine	F	Sodium	Na
Hydrogen fluoride	HF	Sulfate	SO_4^{2-}
Iron	Fe	Sulfur dioxide	SO_2
Lead	Pb	Thorium	Th
Lithium	Li	Uranium	U
Magnesium	Mg	Zinc	Zn

DOE/OR/07-2233/V2
Volume II

Environmental Monitoring Results, Annual Site Environmental Report, Calendar Year 2004 Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—November 2005

Prepared by
CDM Federal Services Inc.,
under subcontract 23900-SC-RM056F

Prepared for the
U. S. Department of Energy
Office of Environmental Management

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
Paducah Gaseous Diffusion Plant   Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-03OR22980
for the
UNITED STATES DEPARTMENT OF ENERGY

List of Figures

List of Tables

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.

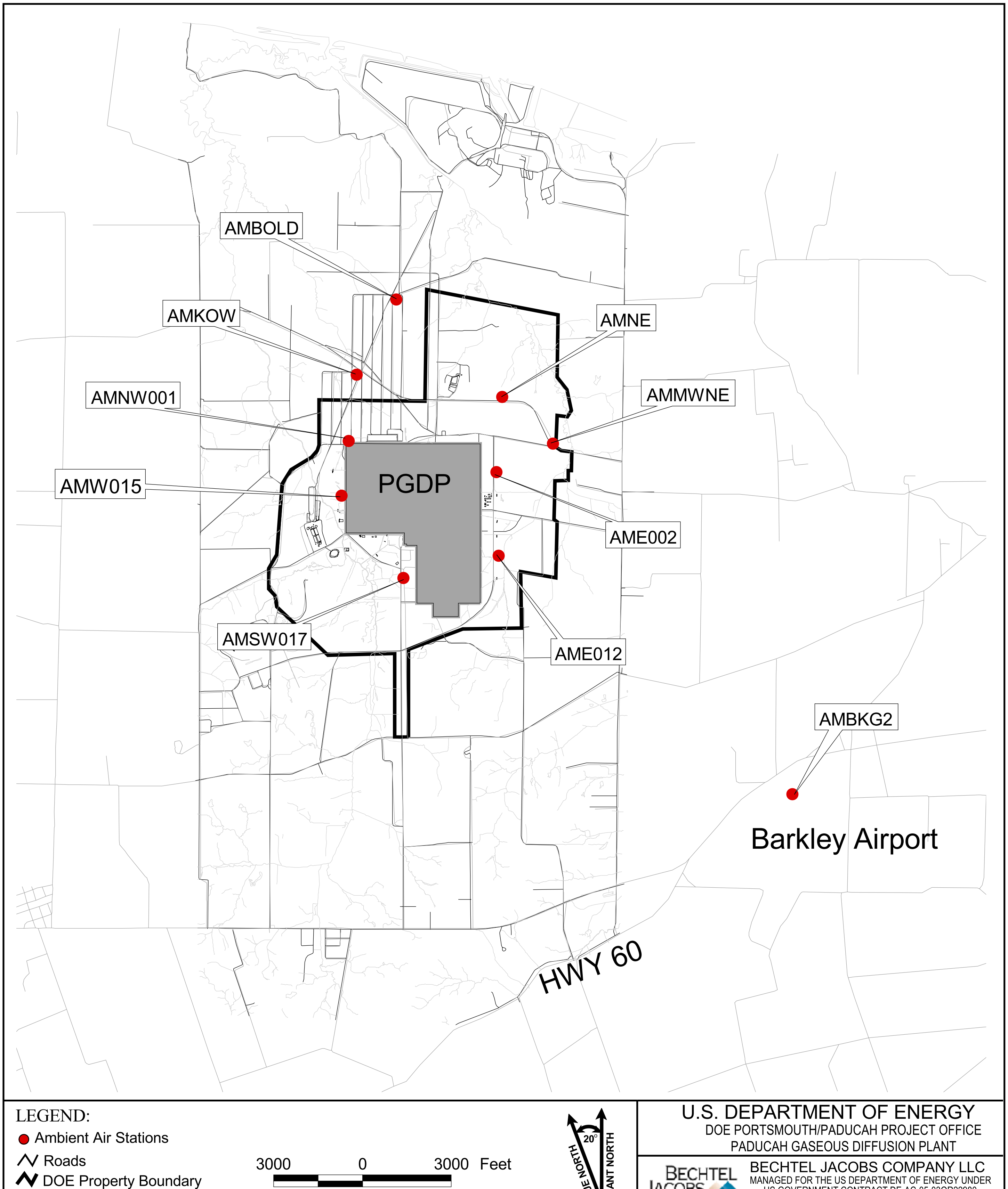
2. Monitoring programs often include measurement of extremely low concentrations of radionuclides, below the detection limit of the counting instruments. Less-than-detectable data will produce numerical measurements with values below the detection limit and sometimes negative values. All of the actual 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.

DOCUMENT No. DOE/OR/07-2233/VII



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

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Figure 1. Paducah Site ambient air monitoring stations

CDM

FIGURE No. c5ac90002sk124.apr
DATE 01-13-05

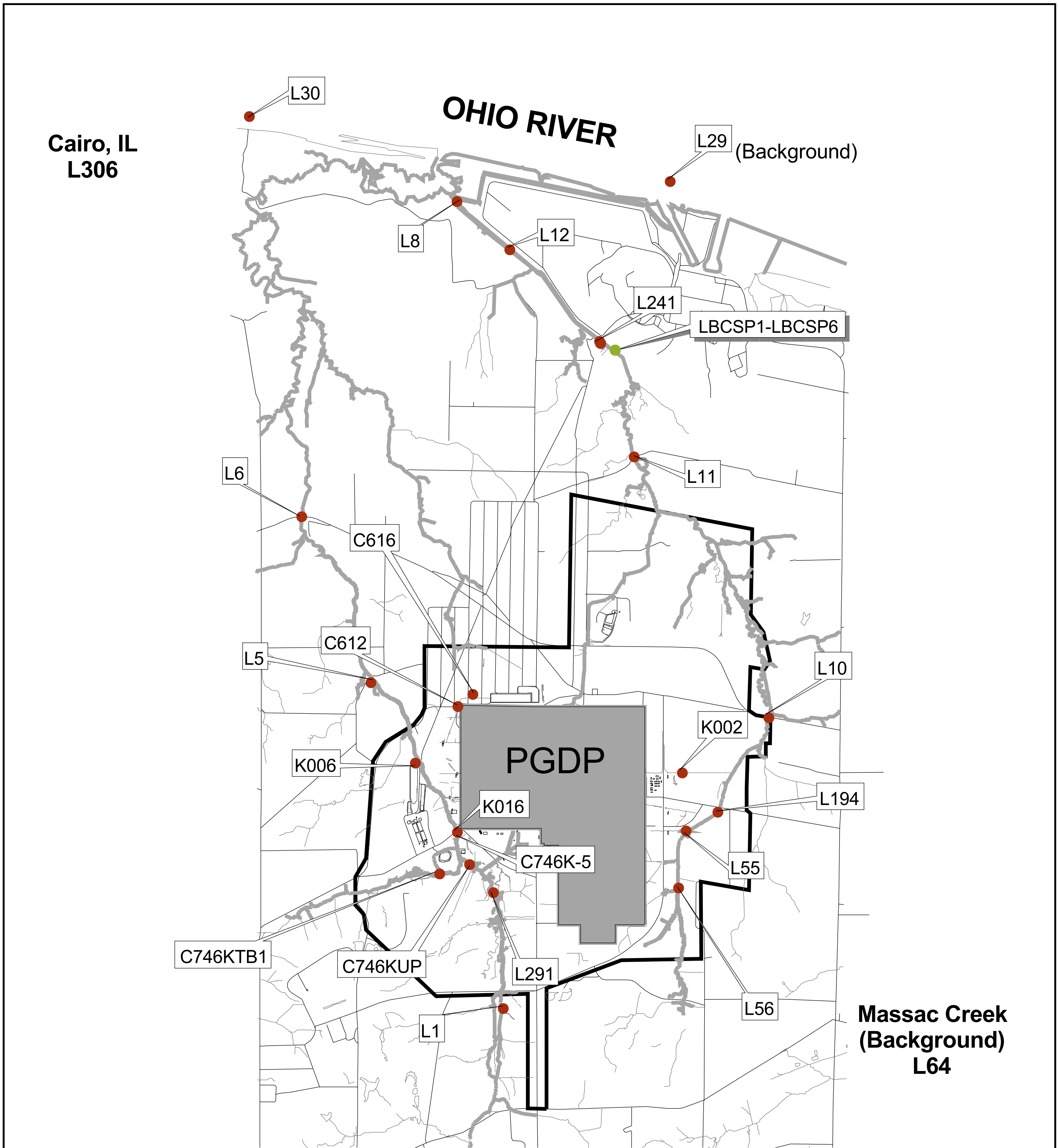


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Figure 2. Surface-water monitoring locations

CDM

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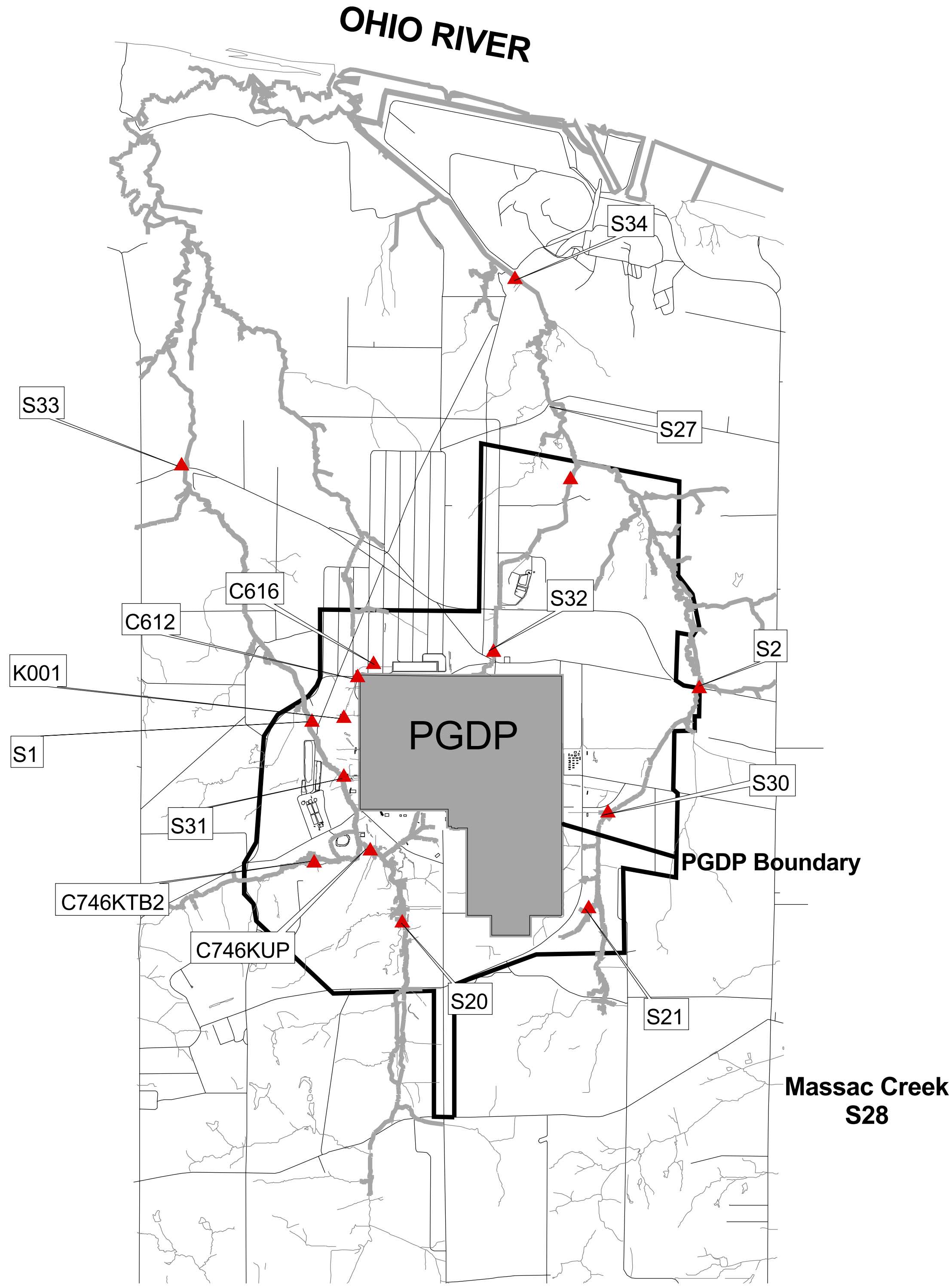

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Figure 3. Sediment monitoring locations

CDM

FIGURE No. c5ac90002sk112apr
DATE 0-13-05

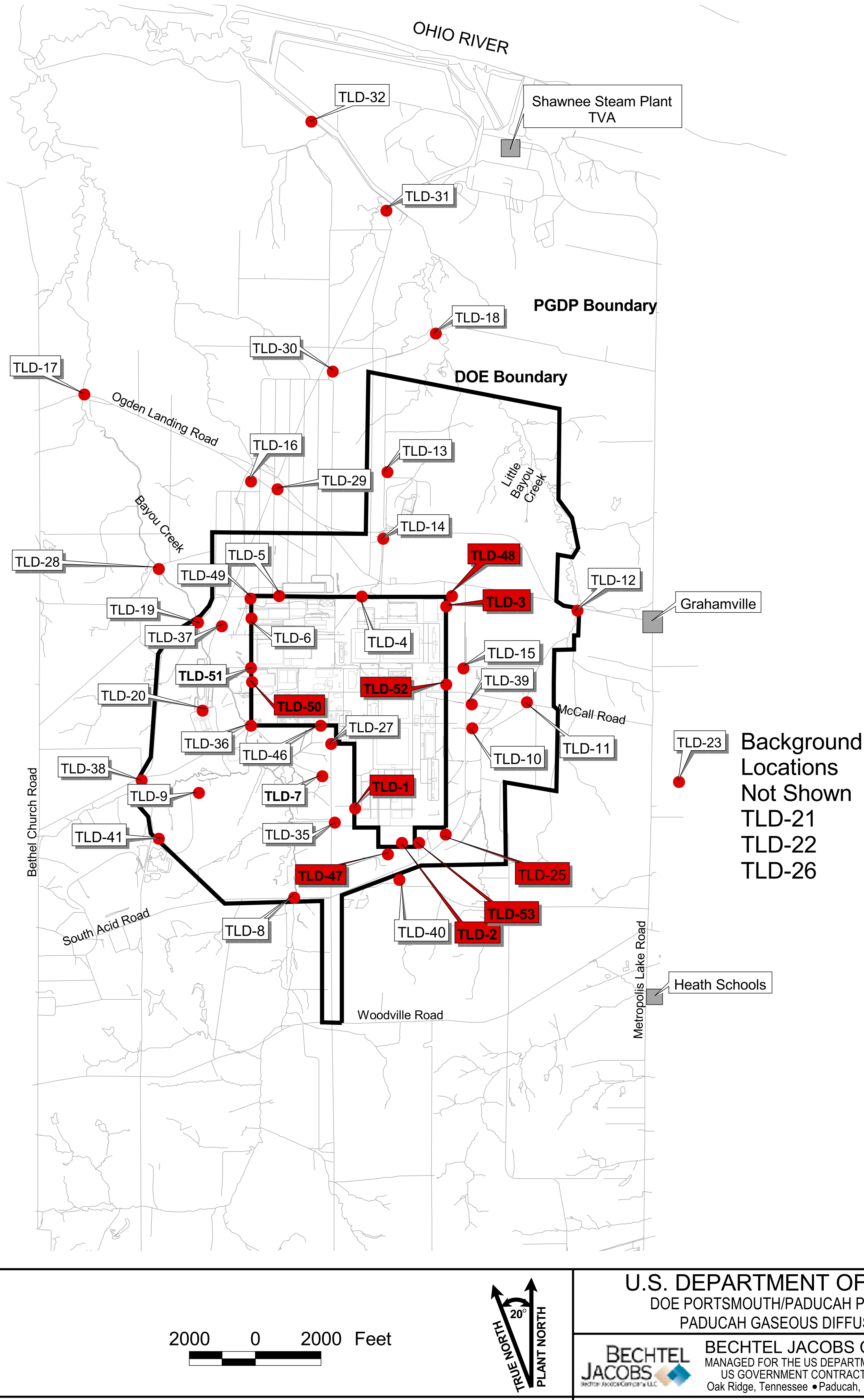

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Figure 4. TLD locations in the vicinity of PGDP

CDM

FIGURE No. c5ac90002sk113.apr
DATE 01-13-05

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
Dissolved Alpha	pCi/L	5.12	119	29.4	3	5		
Dissolved Beta	pCi/L	13.7	54.1	32.6	5	5		
Suspended Alpha	pCi/L	2.3	6.74	3.69	3	5		
Suspended Beta	pCi/L	-0.265	25.1	7.17	1	5		
Technetium-99	pCi/L	4.08	35.2	16.5	2	5	ActionLimit	900

Table 1.2 Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	10.7	78.7	51.9	3	3		
Dissolved Beta	pCi/L	38	51.6	45.3	3	3		
Suspended Alpha	pCi/L	3.18	5.61	4.38	2	3		
Suspended Beta	pCi/L	5.66	23.2	16	2	3		
Technetium-99	pCi/L	4	58	32.2	2	3	ActionLimit	900

Table 1.3 Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	-1.48	11	3.28	2	5		
Dissolved Beta	pCi/L	2.36	11.1	6.81	0	5		
Suspended Alpha	pCi/L	-0.626	2.34	0.962	1	5		
Suspended Beta	pCi/L	-4.38	3.83	0.928	0	5		
Technetium-99	pCi/L	3.77	18.4	10.4	1	5	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	-1.77	2.67	0.233	0	3		
Dissolved Beta	pCi/L	4.61	8.11	6.13	0	3		
Suspended Alpha	pCi/L	-2.36	0.392	-1.4	0	3		
Suspended Beta	pCi/L	0.51	7.75	3.6	0	3		
Technetium-99	pCi/L	-7.75	5.76	1.23	0	3	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	0.442	12.9	5.95	1	3		
Beta activity	pCi/L	19.7	74.2	43.7	3	3		

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	-3.7	19.1	4.05	1	4		
Beta activity	pCi/L	9.32	19.9	13.2	4	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	3.49	12	6.91	2	3		
Beta activity	pCi/L	18.5	74.3	39.1	3	3		

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	0.345	9.45	3.87	0	3		
Beta activity	pCi/L	7.34	16.2	12.5	3	3		

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	-2.31	6.81	1.03	1	4		
Beta activity	pCi/L	16.2	17.8	17.3	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	1.57	3.51	2.27	0	3		
Beta activity	pCi/L	7.6	18.6	12.5	3	3		

2. RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA

Ambient Air Data

Table 2.1 Kentucky Radiation Health and Toxics Branch Air Monitoring

	AMSW017	AMW015	AMNW001	AMNE	AME002	AME012	AMBKG2	AMBOLD	AMKOW	AMMWNE
Nuclide	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**
Quarter 1										
Americium-241	2.088E-17	7.723E-18	7.927E-18	1.275E-17	3.104E-17	1.521E-17	1.186E-17	1.663E-17	1.784E-17	1.095E-17
Neptunium-237	1.933E-17	4.094E-17	5.958E-17	1.145E-16	2.284E-16	-1.495E-16	-1.826E-16	-2.087E-16	1.761E-16	6.421E-16
Technetium-99	5.248E-16	4.258E-16	-1.217E-16	2.6205E-16	5.5104E-17	1.982E-16	3.586E-16	2.1831E-16	3.1062E-16	3.1506E-16
Uranium-238	2.09E-16	2.161E-16	2.074E-16	1.702E-16	2.222E-16	1.83E-16	1.931E-16	1.615E-16	2.216E-16	2.098E-16
Sum of ratios	0.06	0.07	0.08	0.12	0.23	-0.09	-0.12	-0.14	0.19	0.57
Quarter 2										
Americium-241	-9.845E-18	0	9.151E-18	1.06E-17	4.987E-18	1.437E-17	2.027E-17	6.661E-18	6.752E-18	7.315E-18
Neptunium-237	-5.641E-17	-2.134E-17	-7.087E-16	1.415E-16	1E-16	-3.808E-16	6.04E-17	-1.689E-16	4.975E-16	4.555E-17
Technetium-99	-1.2774E-16	-2.117E-16	-3.137E-16	-1.876E-16	1.8035E-16	-2.618E-16	-5.329E-17	-4.364E-16	-4.096E-16	-2.404E-16
U-238	1.76E-16	1.659E-16	1.809E-16	1.45E-16	1.8E-16	3.01E-16	-4.25E-15	2.037E-16	1.513E-16	1.529E-16
Sum of ratios	-0.03	0.00	-0.57	0.14	0.11	-0.28	-0.45	-0.12	0.43	0.06
Quarter 3										
Americium-241	-4.107E-18	9.702E-18	1.696E-17	4.818E-18	3.127E-18	0	7.967E-18	2.945E-17	0	1.497E-17
Neptunium-237	1.853E-16	-1.184E-16	-3.054E-16	5.096E-16	-2.048E-16	3.668E-16	2.964E-16	8.433E-16	1.571E-16	1.894E-16
Technetium-99	3.4272E-16	4.0101E-16	5.6235E-16	1.703E-16	4.2447E-16	1.1667E-16	-1.075E-16	1.2821E-15	2.9592E-16	1.4694E-16
Uranium-238	2.168E-16	2.866E-16	2.766E-16	2.414E-16	2.543E-16	2.126E-16	1.91E-16	5.571E-16	2.693E-16	2.461E-16
Sum of ratios	0.18	-0.06	-0.21	0.46	-0.14	0.33	0.27	0.79	0.17	0.20
Quarter 4										
Americium-241	-4.238E-18	-7.073E-18	8.502E-18	4.939E-18	-5.713E-18	1.823E-17	-4.797E-18	7.405E-18	-8.099E-17	-1.872E-17
Neptunium-237	-2.537E-16	8.748E-17	-4.843E-16	-4.74E-16	-2.366E-18	9.505E-18	2.861E-16	-2.627E-16	6.776E-16	-9.845E-17
Technetium-99	3.5596E-16	3.2114E-16	3.5716E-16	4.5585E-16	5.8117E-16	2.5258E-16	3.2692E-16	6.2239E-16	5.0536E-16	3.5282E-16
Uranium-238	2.372E-16	2.904E-16	3.244E-16	2.419E-16	2.834E-16	1.698E-16	1.429E-16	2.052E-16	5.745E-16	2.149E-16
Sum of ratios	-0.18	0.11	-0.36	-0.36	0.03	0.04	0.26	-0.19	0.59	-0.06

*Sum of Ratios: The ratio of the measured concentration to the allowable concentration is added for all radionuclides for each quarter for each location. A value of less than one indicates regulatory compliance.

40 CFR 61, Table 2, Limiting Values *Ci/m3): ^{241}Am 1.9E-15, ^{237}Np 1.2E-15, ^{99}Tc 1.4E-13, and ^{238}U 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	0.00541	2.2	1.65	0	4		
Americium-241	pCi/L	-0.0484	0.0104	-0.0191	0	4	10%DCG	3
Cesium-134	pCi/L	-0.384	0.169	-0.148	0	4		
Cesium-137	pCi/L	-0.32	0.821	-0.006	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.979	2.05	0.302	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-3.98	0.0885	-2.1	0	4		
Dissolved Beta	pCi/L	-1.67	5.51	2.29	0	4		
Neptunium-237	pCi/L	-0.595	0.0222	-0.153	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.029	0.153	0.0324	1	4		
Plutonium-239/240	pCi/L	-0.0106	0.0155	0.00284	0	4	10%DCG	3
Potassium-40	pCi/L	-107	70	-42.7	0	4		
Suspended Alpha	pCi/L	-2.24	0.586	-0.403	0	4		
Suspended Beta	pCi/L	-3.07	2.13	-0.247	0	4		
Technetium-99	pCi/L	-6.85	6.98	1.47	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.00151	0.0546	0.0265	0	4		
Thorium-230	pCi/L	-0.0406	0.264	0.103	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0216	0.0443	0.00704	0	4		
Thorium-234	pCi/L	-32.1	23.8	-1.3	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.121	30	22.5	0	4	10%DCG	60
Uranium-234	pCi/L	0.0509	30	20	0	4	10%DCG	50
Uranium-238	pCi/L	0.0644	0.35	0.279	0	4	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	0.825	22	6.81	1	4		
Americium-241	pCi/L	-0.195	0.0843	-0.0395	0	4	10%DCG	3
Cesium-134	pCi/L	-0.131	0.763	0.286	0	4		
Cesium-137	pCi/L	-1.76	0.358	-0.998	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.16	1.65	-0.0683	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-10.2	41.3	12.5	2	4		
Dissolved Beta	pCi/L	13.6	43.5	25.8	4	4		
Neptunium-237	pCi/L	-0.417	0.0404	-0.102	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0193	0.00907	-0.00812	0	4		
Plutonium-239/240	pCi/L	-0.0367	0.0195	-0.00671	0	4	10%DCG	3
Potassium-40	pCi/L	-83.2	67	2.98	0	4		
Suspended Alpha	pCi/L	-1.86	3.44	0.116	0	4		
Suspended Beta	pCi/L	-0.257	11.9	4.29	1	4		
Technetium-99	pCi/L	5.47	29.9	14.1	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.0079	0.0603	0.0269	0	4		
Thorium-230	pCi/L	-0.0934	0.123	0.0138	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0114	0.119	0.0456	0	4		
Thorium-234	pCi/L	-19.8	25.9	0.0158	0	4		
Uranium	pCi/L	30	300	98.2	1	4	10%DCG	60
Uranium	mg/L	0.05	0.05	0.05	1	1	10%DCG	0.0901
Uranium-234	pCi/L	12.3	300	90.6	1	4	10%DCG	50
Uranium-238	pCi/L	0.42	33.7	13.6	4	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	0.615	22	6.75	1	4		
Americium-241	pCi/L	-0.0469	-0.00958	-0.0341	0	4	10%DCG	3
Cesium-134	pCi/L	-1.1	0.0476	-0.537	0	4		
Cesium-137	pCi/L	-1.37	-0.277	-0.817	0	4	10%DCG	300
Cobalt-60	pCi/L	-2.6	0.599	-1.4	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	1.58	27	11.2	2	4		
Dissolved Beta	pCi/L	10.7	25.8	16.9	2	4		
Neptunium-237	pCi/L	-0.655	0.0262	-0.173	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.026	0.0238	0.00068	0	4		
Plutonium-239/240	pCi/L	-0.0113	0.0234	0.00913	0	4	10%DCG	3
Potassium-40	pCi/L	-82.7	29.2	-2.2	0	4		
Suspended Alpha	pCi/L	-2.54	0.626	-0.861	0	4		
Suspended Beta	pCi/L	0.532	17.3	7.42	1	4		
Technetium-99	pCi/L	-1.99	10.9	6.36	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0168	0.0871	0.0441	0	4		
Thorium-230	pCi/L	0.0454	0.532	0.272	0	4	10%DCG	30
Thorium-232	pCi/L	-0.00828	0.207	0.0785	0	4		
Thorium-234	pCi/L	-5.7	28.5	5.71	0	4		
Uranium	pCi/L	24.5	300	96.1	1	4	10%DCG	60
Uranium	mg/L	0.038	0.038	0.038	1	1	10%DCG	0.0901
Uranium-234	pCi/L	9.57	300	89.9	1	4	10%DCG	50
Uranium-238	pCi/L	0.356	21.1	9.18	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.5 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	-0.0138	2.2	1.65	0	4		
Americium-241	pCi/L	-0.0938	-0.000957	-0.0347	0	4	10%DCG	3
Cesium-134	pCi/L	-0.534	0.563	-0.0157	0	4		
Cesium-137	pCi/L	-1.03	0.796	0.177	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.92	0.859	-0.0975	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-3.6	0.0295	-2.33	0	4		
Dissolved Beta	pCi/L	-0.557	17.8	5.62	1	4		
Neptunium-237	pCi/L	-0.31	0.0138	-0.0884	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.103	0.00488	-0.033	0	4		
Plutonium-239/240	pCi/L	-0.0118	0.0103	-0.00264	0	4	10%DCG	3
Potassium-40	pCi/L	-104	60.7	-25	0	4		
Suspended Alpha	pCi/L	-1.01	0.11	-0.458	0	4		
Suspended Beta	pCi/L	-2.29	5.37	1.12	0	4		
Technetium-99	pCi/L	-2.61	28.2	9.34	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.0189	0.0109	-0.00251	0	4		
Thorium-230	pCi/L	0.28	0.505	0.438	1	4	10%DCG	30
Thorium-232	pCi/L	-0.00644	0.0876	0.0252	0	4		
Thorium-234	pCi/L	-59.6	-5.59	-25.7	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.0392	30	22.5	0	4	10%DCG	60
Uranium-234	pCi/L	0.0768	30	20	0	4	10%DCG	50
Uranium-238	pCi/L	-0.0237	0.35	0.257	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.6 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	0.0639	2.2	1.67	0	4		
Americium-241	pCi/L	-0.0536	0.034	-0.0155	0	4	10%DCG	3
Cesium-134	pCi/L	-1.16	0.141	-0.499	0	4		
Cesium-137	pCi/L	-2.19	0.656	-0.453	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.91	0.089	-0.701	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-4.08	6.89	0.535	0	4		
Dissolved Beta	pCi/L	23.8	44.6	36.7	4	4		
Neptunium-237	pCi/L	-0.536	0.0245	-0.136	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0569	0.0125	-0.0257	0	4		
Plutonium-239/240	pCi/L	-0.0225	0.00617	-0.00965	0	4	10%DCG	3
Potassium-40	pCi/L	-66.3	91	-7.56	0	4		
Suspended Alpha	pCi/L	-3.2	0.939	-1.7	0	4		
Suspended Beta	pCi/L	-1.6	2.98	0.025	0	4		
Technetium-99	pCi/L	0.161	15.6	8.24	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0391	0.0894	0.0168	0	4		
Thorium-230	pCi/L	0.167	0.493	0.302	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0172	0.0993	0.0467	0	4		
Thorium-234	pCi/L	-35	9.61	-9.18	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	2.03	30	23	0	4	10%DCG	60
Uranium-234	pCi/L	1.07	30	20.3	1	4	10%DCG	50
Uranium-238	pCi/L	0.35	0.896	0.605	3	4	10%DCG	60

Surface Water Radiological Data

Table 2.7 Radiological Monitoring Data for Surface Water Location K006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.027	2.2	1.77	0	5		
Americium-241	pCi/L	-0.0662	0.111	0.0117	0	5	10%DCG	3
Cesium-134	pCi/L	-1.79	0.173	-0.593	0	5		
Cesium-137	pCi/L	-0.494	0.797	0.018	0	5	10%DCG	300
Cobalt-60	pCi/L	-1.61	0.651	-0.62	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-3.49	2.17	-0.631	0	5		
Dissolved Beta	pCi/L	-3.01	7.94	2.53	0	5		
Neptunium-237	pCi/L	-0.456	0.0286	-0.106	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0352	0.289	0.0623	1	5		
Plutonium-239/240	pCi/L	-0.0118	0.0664	0.0174	0	5	10%DCG	3
Potassium-40	pCi/L	-101	59	-24.9	0	5		
Suspended Alpha	pCi/L	-2.1	1.36	-0.251	0	5		
Suspended Beta	pCi/L	-2.3	2.43	-0.0776	0	5		
Technetium-99	pCi/L	-14.7	6.52	-2.4	0	5	ActionLimit	900
Thorium-228	pCi/L	-0.00611	0.0901	0.0456	0	5		
Thorium-230	pCi/L	0.0311	0.711	0.343	0	5	10%DCG	30
Thorium-232	pCi/L	0.000986	0.136	0.0703	0	5		
Thorium-234	pCi/L	-40.1	9.64	-10.1	0	5		
Uranium	pCi/L	0.282	30	24.1	0	5	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.18	30	21	0	5	10%DCG	50
Uranium-238	pCi/L	0.0748	0.35	0.295	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.8 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	-0.0309	2.2	1.32	0	5		
Americium-241	pCi/L	-0.0615	0.0583	-0.00344	0	5	10%DCG	3
Cesium-134	pCi/L	-1.18	0.0134	-0.672	0	5		
Cesium-137	pCi/L	-4.7	0.813	-0.879	0	5	10%DCG	300
Cobalt-60	pCi/L	-4.18	0.459	-1.49	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-2.94	1.56	-1.55	0	5		
Dissolved Beta	pCi/L	-3.45	6.48	2.77	0	5		
Neptunium-237	pCi/L	-0.695	0.0175	-0.145	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0173	0.108	0.0247	0	5		
Plutonium-239/240	pCi/L	-0.00985	0.0226	0.00854	0	5	10%DCG	3
Potassium-40	pCi/L	-107	77.7	-40.9	0	5		
Suspended Alpha	pCi/L	-1.74	1.57	-0.656	0	5		
Suspended Beta	pCi/L	-6.37	1.65	-2.01	0	5		
Technetium-99	pCi/L	-5.47	11.7	2.86	0	5	ActionLimit	900
Thorium-228	pCi/L	0.00638	0.0666	0.0413	0	5		
Thorium-230	pCi/L	-0.0846	0.473	0.246	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0188	0.0239	0.00385	0	5		
Thorium-234	pCi/L	-36	14.1	-0.162	0	5		
Uranium	mg/L	0.005	0.005	0.005	0	2	10%DCG	0.0901
Uranium	pCi/L	0.251	40	20.1	0	5	10%DCG	60
Uranium-234	pCi/L	0.107	30	17.1	0	5	10%DCG	50
Uranium-238	pCi/L	0.175	0.35	0.288	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.9 Radiological Monitoring Data for Surface Water Location K002

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0607	2.2	1.67	0	4		
Americium-241	pCi/L	-0.0439	0.0478	0.0151	0	4	10%DCG	3
Cesium-134	pCi/L	-1.07	-0.403	-0.652	0	4		
Cesium-137	pCi/L	-2.24	-0.0672	-1.07	0	4	10%DCG	300
Cobalt-60	pCi/L	-3.05	0.301	-1.5	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.58	1.1	-0.126	0	4		
Dissolved Beta	pCi/L	1.6	14.3	8.32	1	4		
Neptunium-237	pCi/L	-0.046	0.0228	-0.0052	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0372	0.0294	-0.00282	0	4		
Plutonium-239/240	pCi/L	-0.0221	0.00176	-0.00711	0	4	10%DCG	3
Potassium-40	pCi/L	-80.4	18.3	-20.9	0	4		
Suspended Alpha	pCi/L	-1.57	3.9	0.269	0	4		
Suspended Beta	pCi/L	1.53	4.9	3.19	0	4		
Technetium-99	pCi/L	-0.348	11.2	7.23	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.524	0.0264	-0.204	0	4		
Thorium-230	pCi/L	-2.24	0.183	-0.69	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0155	0.0553	0.0205	0	4		
Thorium-234	pCi/L	-14.3	-2.82	-7.77	0	4		
Uranium	pCi/L	1.58	40	25.4	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.507	30	22.6	0	4	10%DCG	50
Uranium-238	pCi/L	0.377	1.05	0.852	4	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	0.145	2.2	1.69	1	4		
Americium-241	pCi/L	-0.0739	0.0046	-0.0266	0	4	10%DCG	3
Cesium-134	pCi/L	-1.53	0.0474	-0.506	0	4		
Cesium-137	pCi/L	-0.83	0.67	-0.078	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.522	0.934	0.361	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.85	4.64	1.59	0	4		
Dissolved Beta	pCi/L	1.1	15.8	8.06	1	4		
Neptunium-237	pCi/L	-0.956	0.0171	-0.239	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0291	0.0932	0.0105	0	4		
Plutonium-239/240	pCi/L	0.00203	0.0439	0.0172	0	4	10%DCG	3
Potassium-40	pCi/L	-97.3	42.9	-53.8	0	4		
Suspended Alpha	pCi/L	-2.23	0.902	-1.03	0	4		
Suspended Beta	pCi/L	-0.511	4.9	2.23	0	4		
Technetium-99	pCi/L	3.36	19.2	9.59	1	4	ActionLimit	900
Thorium-228	pCi/L	0.0168	0.0905	0.0389	0	4		
Thorium-230	pCi/L	-0.0335	0.383	0.187	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0259	0.00725	-0.00986	0	4		
Thorium-234	pCi/L	-28.9	32	-4.76	0	4		
Uranium	mg/L	0.013	0.013	0.013	1	1	10%DCG	0.0901
Uranium	pCi/L	5.7	30	23.9	1	4	10%DCG	60
Uranium-234	pCi/L	1.21	30	20.3	1	4	10%DCG	50
Uranium-238	pCi/L	1.67	4.35	2.82	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	0.147	2.2	1.69	1	4		
Americium-241	pCi/L	-0.0741	0.0711	-0.00443	0	4	10%DCG	3
Cesium-134	pCi/L	-1.01	0.598	-0.308	0	4		
Cesium-137	pCi/L	-0.961	0.329	-0.34	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.123	0.187	0.0329	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-2.11	7.16	1.59	0	4		
Dissolved Beta	pCi/L	1.17	14.6	7.12	1	4		
Neptunium-237	pCi/L	-0.496	0.0341	-0.135	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.126	0.0046	-0.0435	0	4		
Plutonium-239/240	pCi/L	0.00319	0.0894	0.0283	0	4	10%DCG	3
Potassium-40	pCi/L	-100	71	-45.3	0	4		
Suspended Alpha	pCi/L	-2.79	3.63	0.354	0	4		
Suspended Beta	pCi/L	-2.55	2.67	0.612	0	4		
Technetium-99	pCi/L	7.82	13.6	11.1	0	4	ActionLimit	900
Thorium-228	pCi/L	0.00999	0.0985	0.0743	0	4		
Thorium-230	pCi/L	-0.049	0.117	0.0201	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0148	0.00347	-0.00786	0	4		
Thorium-234	pCi/L	-53.5	-4.44	-18	0	4		
Uranium	mg/L	0.017	0.017	0.017	1	1	10%DCG	0.0901
Uranium	pCi/L	7.44	30	24.4	1	4	10%DCG	60
Uranium-234	pCi/L	1.47	30	20.4	1	4	10%DCG	50
Uranium-238	pCi/L	1.12	5.83	3.07	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.12 Radiological Monitoring Data for Surface Water Location L55

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	2.2	2.2	2.2	0	1		
Americium-241	pCi/L	-0.0568	-0.0568	-0.0568	0	1	10%DCG	3
Cesium-134	pCi/L	-0.484	-0.484	-0.484	0	1		
Cesium-137	pCi/L	-0.868	-0.868	-0.868	0	1	10%DCG	300
Cobalt-60	pCi/L	-0.739	-0.739	-0.739	0	1	10%DCG	1000
Dissolved Alpha	pCi/L	6.35	6.35	6.35	0	1		
Dissolved Beta	pCi/L	9.16	9.16	9.16	0	1		
Neptunium-237	pCi/L	-0.665	-0.665	-0.665	0	1	10%DCG	3
Plutonium-238	pCi/L	0.0793	0.0793	0.0793	0	1		
Plutonium-239/240	pCi/L	-0.0137	-0.0137	-0.0137	0	1	10%DCG	3
Potassium-40	pCi/L	83.9	83.9	83.9	0	1		
Suspended Alpha	pCi/L	2.08	2.08	2.08	0	1		
Suspended Beta	pCi/L	1.05	1.05	1.05	0	1		
Technetium-99	pCi/L	11	11	11	0	1	ActionLimit	900
Thorium-228	pCi/L	0.0146	0.0146	0.0146	0	1		
Thorium-230	pCi/L	0.0607	0.0607	0.0607	0	1	10%DCG	30
Thorium-232	pCi/L	0.00799	0.00799	0.00799	0	1		
Thorium-234	pCi/L	-31.2	-31.2	-31.2	0	1		
Uranium	pCi/L	30	30	30	0	1	10%DCG	60
Uranium-234	pCi/L	30	30	30	0	1	10%DCG	50
Uranium-238	pCi/L	3.51	3.51	3.51	1	1	10%DCG	60

Surface Water Radiological Data

Table 2.13 Radiological Monitoring Data for Surface Water Location L56

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0342	2.2	1.66	0	4		
Americium-241	pCi/L	-0.0549	0.00213	-0.0307	0	4	10%DCG	3
Cesium-134	pCi/L	-0.667	1.49	0.185	0	4		
Cesium-137	pCi/L	-1.69	0.797	-0.304	0	4	10%DCG	300
Cobalt-60	pCi/L	-4.17	0.858	-0.689	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.45	2.64	0.131	0	4		
Dissolved Beta	pCi/L	-0.865	7.18	2.02	0	4		
Neptunium-237	pCi/L	-0.298	0.201	-0.0446	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0744	0.00738	-0.0265	0	4		
Plutonium-239/240	pCi/L	-0.0165	0.0307	0.0098	0	4	10%DCG	3
Potassium-40	pCi/L	-105	33.7	-56.4	0	4		
Suspended Alpha	pCi/L	-3.63	0.523	-0.829	0	4		
Suspended Beta	pCi/L	-1.78	3.4	-0.0583	0	4		
Technetium-99	pCi/L	-4.19	9.01	2.35	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0205	0.0669	0.0393	0	4		
Thorium-230	pCi/L	0.243	0.924	0.429	1	4	10%DCG	30
Thorium-232	pCi/L	0.000736	0.0851	0.024	0	4		
Thorium-234	pCi/L	-22.3	21.7	2.38	0	4		
Uranium	pCi/L	0.695	30	22.7	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.224	30	20.1	0	4	10%DCG	50
Uranium-238	pCi/L	0.35	0.556	0.423	2	4	10%DCG	60

Surface Water Radiological Data

Table 2.14 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	0.059	2.2	1.77	0	5		
Americium-241	pCi/L	-0.0591	0.0613	-0.00898	0	5	10%DCG	3
Cesium-134	pCi/L	-1.44	0.49	-0.367	0	5		
Cesium-137	pCi/L	-0.125	1.08	0.582	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.998	2.08	0.803	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-1.55	5.43	2.15	0	5		
Dissolved Beta	pCi/L	3.04	15	9.04	2	5		
Neptunium-237	pCi/L	-0.0692	0.0381	-0.00467	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0632	0.0357	-0.00667	0	5		
Plutonium-239/240	pCi/L	-0.0154	0.0245	0.00239	0	5	10%DCG	3
Potassium-40	pCi/L	-97.9	61.5	-31.6	0	5		
Suspended Alpha	pCi/L	-3.35	1.82	-0.944	0	5		
Suspended Beta	pCi/L	-1.03	6.01	2.58	0	5		
Technetium-99	pCi/L	1.24	14.6	8.24	0	5	ActionLimit	900
Thorium-228	pCi/L	-0.515	0.0477	-0.179	0	5		
Thorium-230	pCi/L	-2.37	0.689	-0.688	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0845	0.131	0.0067	0	5		
Thorium-234	pCi/L	-50.6	18.8	-9.82	0	5		
Uranium	mg/L	0.007	0.007	0.007	1	1	10%DCG	0.0901
Uranium	pCi/L	2.99	30	24.6	0	5	10%DCG	60
Uranium-234	pCi/L	0.694	30	22.1	0	5	10%DCG	50
Uranium-238	pCi/L	1.45	3.35	2.38	5	5	10%DCG	60

Surface Water Radiological Data

Table 2.15 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	2.2	2.2	2.2	0	3		
Americium-241	pCi/L	-0.0555	-0.00786	-0.033	0	3	10%DCG	3
Cesium-134	pCi/L	-0.896	-0.525	-0.713	0	3		
Cesium-137	pCi/L	-1.1	0.44	-0.35	0	3	10%DCG	300
Cobalt-60	pCi/L	-0.235	1.06	0.306	0	3	10%DCG	1000
Dissolved Alpha	pCi/L	-0.222	2.81	1.44	0	3		
Dissolved Beta	pCi/L	9.46	23.8	15.8	2	3		
Neptunium-237	pCi/L	-0.0925	-0.00487	-0.0489	0	3	10%DCG	3
Plutonium-238	pCi/L	-0.0215	0.0191	-0.00347	0	3		
Plutonium-239/240	pCi/L	-0.0081	0.0125	-0.0001	0	3	10%DCG	3
Potassium-40	pCi/L	-102	69.6	-40.1	0	3		
Suspended Alpha	pCi/L	-2.29	-0.163	-1.55	0	3		
Suspended Beta	pCi/L	-5.93	4.12	-0.16	0	3		
Technetium-99	pCi/L	18	37.3	28.9	3	3	ActionLimit	900
Thorium-228	pCi/L	-0.61	0.127	-0.153	0	3		
Thorium-230	pCi/L	-2.6	0.55	-0.606	0	3	10%DCG	30
Thorium-232	pCi/L	-0.0248	0.127	0.0411	0	3		
Thorium-234	pCi/L	-33.6	36.1	-4.93	0	3		
Uranium	pCi/L	30	30	30	0	3	10%DCG	60
Uranium-234	pCi/L	25	30	26.7	0	3	10%DCG	50
Uranium-238	pCi/L	0.683	1.5	0.986	3	3	10%DCG	60

Surface Water Radiological Data

Table 2.16 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	0.0523	2.2	1.66	0	4		
Americium-241	pCi/L	-0.0871	0.0608	-0.00617	0	4	10%DCG	3
Cesium-134	pCi/L	-1.33	0.03	-0.708	0	4		
Cesium-137	pCi/L	-1.08	1.26	0.238	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.102	0.902	0.453	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	0.598	3.49	2.62	0	4		
Dissolved Beta	pCi/L	11.5	40.2	23.9	4	4		
Neptunium-237	pCi/L	-0.0573	0.0266	-0.00757	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0511	0.0576	-0.00486	0	4		
Plutonium-239/240	pCi/L	-0.0277	0.0352	0.00687	0	4	10%DCG	3
Potassium-40	pCi/L	-97.5	60.6	-44.5	0	4		
Suspended Alpha	pCi/L	-4.23	0.507	-1.24	0	4		
Suspended Beta	pCi/L	-2.05	7.7	1.93	0	4		
Technetium-99	pCi/L	23.1	58.5	39.3	4	4	ActionLimit	900
Thorium-228	pCi/L	-0.23	0.0481	-0.0319	0	4		
Thorium-230	pCi/L	-1.48	0.22	-0.26	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0537	0.126	0.00137	0	4		
Thorium-234	pCi/L	-29	27.4	2.78	0	4		
Uranium	pCi/L	1.93	30	23	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	1	1	10%DCG	0.0901
Uranium-234	pCi/L	0.452	30	20.1	0	4	10%DCG	50
Uranium-238	pCi/L	0.704	2.37	1.43	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.17 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	-0.000211	2.2	1.76	0	5		
Americium-241	pCi/L	-0.0342	0.0545	0.0019	0	5	10%DCG	3
Cesium-134	pCi/L	-1.37	0.525	-0.361	0	5		
Cesium-137	pCi/L	-3.47	0.964	-0.942	0	5	10%DCG	300
Cobalt-60	pCi/L	-5.28	1.4	-0.704	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-4.01	0.957	-1.33	0	5		
Dissolved Beta	pCi/L	-5.18	5.43	-1.09	0	5		
Neptunium-237	pCi/L	-0.0635	0.145	0.00898	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0388	0.0661	0.023	0	5		
Plutonium-239/240	pCi/L	-0.00461	0.0108	0.00194	0	5	10%DCG	3
Potassium-40	pCi/L	-97	83.3	-32.7	0	5		
Suspended Alpha	pCi/L	-4.2	3.01	-0.389	0	5		
Suspended Beta	pCi/L	-7.68	2.98	-3.64	0	5		
Technetium-99	pCi/L	0.519	7.76	4.62	0	5	ActionLimit	900
Thorium-228	pCi/L	-0.006	0.0728	0.0225	0	5		
Thorium-230	pCi/L	-0.0688	0.481	0.118	0	5	10%DCG	30
Thorium-232	pCi/L	-0.00593	0.0512	0.0238	0	5		
Thorium-234	pCi/L	-41	25.7	-3.75	0	5		
Uranium	pCi/L	0.29	30	24.1	0	5	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.0874	30	21	0	5	10%DCG	50
Uranium-238	pCi/L	0.202	0.35	0.32	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.18 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	0.0104	2.2	1.76	0	5		
Americium-241	pCi/L	-0.0595	0.0205	-0.0194	0	5	10%DCG	3
Cesium-134	pCi/L	-2.17	0.0743	-0.796	0	5		
Cesium-137	pCi/L	-3.73	1.42	-1.29	0	5	10%DCG	300
Cobalt-60	pCi/L	-4.81	-0.488	-2.79	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-3.22	0.12	-1.75	0	5		
Dissolved Beta	pCi/L	-7.03	8.67	1.83	0	5		
Neptunium-237	pCi/L	-0.516	0.0252	-0.112	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0862	0.0217	-0.0225	0	5		
Plutonium-239/240	pCi/L	-0.00795	0.024	0.00621	0	5	10%DCG	3
Potassium-40	pCi/L	-84.3	25.5	-23.1	0	5		
Suspended Alpha	pCi/L	-3.89	0.698	-2.23	0	5		
Suspended Beta	pCi/L	-4.58	6.27	0.575	0	5		
Technetium-99	pCi/L	-10.1	6.1	-0.998	0	5	ActionLimit	900
Thorium-228	pCi/L	0.0167	0.049	0.0277	0	5		
Thorium-230	pCi/L	0.121	0.416	0.268	0	5	10%DCG	30
Thorium-232	pCi/L	-0.026	0.136	0.0112	0	5		
Thorium-234	pCi/L	-15.1	18.7	-2.61	0	5		
Uranium	pCi/L	0.013	30	24	0	5	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.00651	30	21	0	5	10%DCG	50
Uranium-238	pCi/L	-0.00381	0.35	0.279	0	5	10%DCG	60

Surface Water Radiological Data

Table 2.19 Radiological Monitoring Data for Surface Water Location C746KUP

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.000184	2.2	1.65	0	4		
Americium-241	pCi/L	-0.0581	0.00737	-0.0238	0	4	10%DCG	3
Cesium-134	pCi/L	-1.5	0.557	-0.615	0	4		
Cesium-137	pCi/L	-4.49	0.398	-1.19	0	4	10%DCG	300
Cobalt-60	pCi/L	-4.57	1.21	-0.65	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-6.28	0.695	-2.59	0	4		
Dissolved Beta	pCi/L	4.31	8.54	6.37	0	4		
Neptunium-237	pCi/L	-0.794	-0.00121	-0.223	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0458	0.299	0.0814	1	4		
Plutonium-239/240	pCi/L	-0.0259	0.021	0.00376	0	4	10%DCG	3
Potassium-40	pCi/L	-102	67.7	-28.5	0	4		
Suspended Alpha	pCi/L	-2.29	0.729	-0.815	0	4		
Suspended Beta	pCi/L	-2.93	1.78	-0.517	0	4		
Technetium-99	pCi/L	-1.55	13.3	3.34	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0068	0.0971	0.053	0	4		
Thorium-230	pCi/L	0.0641	0.422	0.247	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0275	0.106	0.0328	0	4		
Thorium-234	pCi/L	-57.7	4.75	-11.2	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.0466	30	22.5	0	4	10%DCG	60
Uranium-234	pCi/L	0.0301	30	20	0	4	10%DCG	50
Uranium-238	pCi/L	0.0167	1.94	0.664	1	4	10%DCG	60

Surface Water Radiological Data

Table 2.20 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	2.2	2.2	2.2	0	3		
Americium-241	pCi/L	-0.0618	0.0378	-0.0261	0	3	10%DCG	3
Cesium-134	pCi/L	-0.0342	0.19	0.105	0	3		
Cesium-137	pCi/L	-1.38	0.0828	-0.645	0	3	10%DCG	300
Cobalt-60	pCi/L	-3.24	1.12	-0.832	0	3	10%DCG	1000
Dissolved Alpha	pCi/L	-2.35	1.36	0.0233	0	3		
Dissolved Beta	pCi/L	-1.07	10.9	6.68	0	3		
Neptunium-237	pCi/L	-0.0337	0.0457	-0.00623	0	3	10%DCG	3
Plutonium-238	pCi/L	-0.00285	0.0514	0.0245	0	3		
Plutonium-239/240	pCi/L	-0.0207	0.00627	-0.0069	0	3	10%DCG	3
Potassium-40	pCi/L	-88.6	20.1	-45.1	0	3		
Suspended Alpha	pCi/L	-1.75	3.63	0.542	0	3		
Suspended Beta	pCi/L	-7.42	6.18	-1.66	0	3		
Technetium-99	pCi/L	1.26	18.9	10.5	1	3	ActionLimit	900
Thorium-228	pCi/L	-0.316	0.0784	-0.0658	0	3		
Thorium-230	pCi/L	-0.748	-0.00986	-0.281	0	3	10%DCG	30
Thorium-232	pCi/L	-0.0975	0.0757	0.0178	0	3		
Thorium-234	pCi/L	-6.33	19.6	2.35	0	3		
Uranium	pCi/L	30	30	30	0	3	10%DCG	60
Uranium-234	pCi/L	25	30	26.7	0	3	10%DCG	50
Uranium-238	pCi/L	0.35	0.867	0.68	2	3	10%DCG	60

Surface Water Radiological Data

Table 2.21 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	2.2	2.2	2.2	0	3		
Americium-241	pCi/L	-0.0558	-0.00146	-0.0349	0	3	10%DCG	3
Cesium-134	pCi/L	-1.32	-0.253	-0.643	0	3		
Cesium-137	pCi/L	-1.93	0.57	-0.364	0	3	10%DCG	300
Cobalt-60	pCi/L	-3.41	0.55	-1.55	0	3	10%DCG	1000
Dissolved Alpha	pCi/L	-0.791	0.042	-0.351	0	3		
Dissolved Beta	pCi/L	-0.799	6.96	3.07	0	3		
Neptunium-237	pCi/L	-0.0449	0.00715	-0.0201	0	3	10%DCG	3
Plutonium-238	pCi/L	-0.0407	0.00689	-0.0214	0	3		
Plutonium-239/240	pCi/L	-0.0111	0.00694	-0.00437	0	3	10%DCG	3
Potassium-40	pCi/L	-78.7	5.19	-47.6	0	3		
Suspended Alpha	pCi/L	-0.907	1.21	-0.0233	0	3		
Suspended Beta	pCi/L	-9.48	5.82	0.483	0	3		
Technetium-99	pCi/L	3.47	9.23	5.95	0	3	ActionLimit	900
Thorium-228	pCi/L	-0.333	0.077	-0.0753	0	3		
Thorium-230	pCi/L	-2.26	0.0699	-0.731	0	3	10%DCG	30
Thorium-232	pCi/L	-0.0361	0.0267	0.0037	0	3		
Thorium-234	pCi/L	-5.45	9.24	1.22	0	3		
Uranium	pCi/L	30	30	30	0	3	10%DCG	60
Uranium-234	pCi/L	25	30	26.7	0	3	10%DCG	50
Uranium-238	pCi/L	0.35	0.35	0.35	0	3	10%DCG	60

Surface Water Radiological Data

Table 2.22 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	2.2	2.2	2.2	0	4		
Americium-241	pCi/L	-0.0505	-0.0193	-0.0397	0	4	10%DCG	3
Cesium-134	pCi/L	-2.22	-0.272	-1.07	0	4		
Cesium-137	pCi/L	-0.855	-0.0316	-0.423	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.44	1.17	0.0575	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-2.19	1.46	-0.594	0	4		
Dissolved Beta	pCi/L	0.533	8.92	4.19	0	4		
Neptunium-237	pCi/L	-0.0572	0.0485	-0.00992	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0371	-0.014	-0.0212	0	4		
Plutonium-239/240	pCi/L	-0.0214	0.000583	-0.00907	0	4	10%DCG	3
Potassium-40	pCi/L	-107	58.8	-54	0	4		
Suspended Alpha	pCi/L	-3.11	3.43	-0.252	0	4		
Suspended Beta	pCi/L	2.07	7.21	4.64	0	4		
Technetium-99	pCi/L	-8.99	7.31	2.12	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.405	0.22	-0.0309	0	4		
Thorium-230	pCi/L	-2.4	0.29	-0.488	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0143	0.23	0.0776	0	4		
Thorium-234	pCi/L	-35.6	17.8	-3.08	0	4		
Uranium	pCi/L	30	30	30	0	4	10%DCG	60
Uranium-234	pCi/L	25	30	26.2	0	4	10%DCG	50
Uranium-238	pCi/L	0.35	0.35	0.35	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.23 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	2.2	2.2	2.2	0	3		
Americium-241	pCi/L	-0.0298	0.00441	-0.0144	0	3	10%DCG	3
Cesium-134	pCi/L	-2.04	0.801	-0.665	0	3		
Cesium-137	pCi/L	-1.9	-1.43	-1.64	0	3	10%DCG	300
Cobalt-60	pCi/L	-3.8	-0.503	-2.41	0	3	10%DCG	1000
Dissolved Alpha	pCi/L	-3.04	1.3	-0.957	0	3		
Dissolved Beta	pCi/L	-3.32	8.94	4.18	0	3		
Neptunium-237	pCi/L	-0.0638	0.0415	-0.0205	0	3	10%DCG	3
Plutonium-238	pCi/L	-0.0132	0.0187	0.00723	0	3		
Plutonium-239/240	pCi/L	-0.0278	-0.00528	-0.0158	0	3	10%DCG	3
Potassium-40	pCi/L	-101	9.13	-52.9	0	3		
Suspended Alpha	pCi/L	-1.48	-0.119	-0.97	0	3		
Suspended Beta	pCi/L	-7.46	7.59	0.587	0	3		
Technetium-99	pCi/L	-5.36	11.5	5.48	0	3	ActionLimit	900
Thorium-228	pCi/L	-0.334	0.054	-0.0897	0	3		
Thorium-230	pCi/L	-2.14	0.0424	-0.725	0	3	10%DCG	30
Thorium-232	pCi/L	-0.0594	0.0289	-0.00363	0	3		
Thorium-234	pCi/L	-0.588	55.5	19.6	0	3		
Uranium	pCi/L	30	30	30	0	3	10%DCG	60
Uranium-234	pCi/L	25	30	26.7	0	3	10%DCG	50
Uranium-238	pCi/L	0.35	0.35	0.35	0	3	10%DCG	60

Surface Water Radiological Data

Table 2.24 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	-0.0151	2.2	1.65	0	4		
Americium-241	pCi/L	-0.0472	0.0312	0.00837	0	4	10%DCG	3
Cesium-134	pCi/L	-1.32	0.443	-0.33	0	4		
Cesium-137	pCi/L	-3.45	1.03	-0.557	0	4	10%DCG	300
Cobalt-60	pCi/L	-4.97	0.156	-1.56	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.268	3.51	1.06	0	4		
Dissolved Beta	pCi/L	-2.23	5.07	2.13	0	4		
Neptunium-237	pCi/L	-0.714	0.00358	-0.2	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0125	0.0787	0.0303	0	4		
Plutonium-239/240	pCi/L	-0.0386	0.0268	-0.000862	0	4	10%DCG	3
Potassium-40	pCi/L	-110	83.1	-31.1	0	4		
Suspended Alpha	pCi/L	-2.85	0.621	-1.32	0	4		
Suspended Beta	pCi/L	-7.18	2.29	-2.12	0	4		
Technetium-99	pCi/L	-0.886	12.5	4.4	0	4	ActionLimit	900
Thorium-228	pCi/L	0.0108	0.059	0.0267	0	4		
Thorium-230	pCi/L	-0.0448	0.247	0.0749	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0386	0.045	0.0117	0	4		
Thorium-234	pCi/L	-41.8	14	-3.08	0	4		
Uranium	pCi/L	0.0689	40	25	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium-234	pCi/L	0.0596	30	21.3	0	4	10%DCG	50
Uranium-238	pCi/L	0.0243	0.35	0.269	0	4	10%DCG	60

Table 2.25 Radiological Monitoring Data for Surface Water Seep Location LBCSP1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-2.43	8.86	2.37	1	4		
Beta activity	pCi/L	3.92	7.88	6.29	3	4		
Technetium-99	pCi/L	-0.21	13.8	5.82	0	4	ActionLimit	900
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	1.59	40	27.9	0	4	10%DCG	60

Table 2.26 Radiological Monitoring Data for Surface Water Seep Location LBCSP2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-0.454	2.84	1.28	0	4		
Beta activity	pCi/L	7.53	13.1	9.84	4	4		
Technetium-99	pCi/L	11.8	18.1	15.2	1	4	ActionLimit	900
Uranium	pCi/L	0.694	40	27.7	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901

Surface Water Radiological Data

Table 2.27 Radiological Monitoring Data for Surface Water Seep Location LBCSP3

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-1.64	4.41	1.25	0	4		
Beta activity	pCi/L	15.4	24.1	18.7	4	4		
Technetium-99	pCi/L	14.5	30.9	22.1	3	4	ActionLimit	900
Uranium	pCi/L	0.296	40	27.6	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901

Table 2.28 Radiological Monitoring Data for Surface Water Seep Location LBCSP4

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-1.16	5.35	2.09	1	4		
Beta activity	pCi/L	10.9	17.2	13.9	4	4		
Technetium-99	pCi/L	16.1	22.4	18.4	3	4	ActionLimit	900
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.187	40	27.5	0	4	10%DCG	60

Table 2.29 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	-1.01	8.18	4.38	2	4		
Beta activity	pCi/L	154	237	201	4	4		
Technetium-99	pCi/L	238	255	247	4	4	ActionLimit	900
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.164	40	27.5	0	4	10%DCG	60

Table 2.30 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	-2.4	4.45	1.88	1	4		
Beta activity	pCi/L	105	128	116	4	4		
Technetium-99	pCi/L	105	143	123	4	4	ActionLimit	900
Uranium	mg/L	0.005	0.005	0.005	0	1	10%DCG	0.0901
Uranium	pCi/L	0.228	40	27.6	0	4	10%DCG	60

Sediment Radiological Data

Table 2.31 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	0.00446	0.00446	0.00446	0	1		
Alpha activity	pCi/g	1.94	2.47	2.21	2	2		
Americium-241	pCi/g	0.00683	0.0544	0.0306	0	2		
Beta activity	pCi/g	1.98	2.31	2.14	2	2		
Cesium-137	pCi/g	0.021	0.0212	0.0211	2	2		
Cobalt-60	pCi/g	0.0039	0.00576	0.00483	0	2		
Neptunium-237	pCi/g	0.000632	0.00231	0.00147	0	2		
Plutonium-239/240	pCi/g	-0.00015	0.00271	0.00128	0	2		
Potassium-40	pCi/g	3.32	4.36	3.84	2	2		
Technetium-99	pCi/g	0.076	0.0891	0.0825	0	2		
Thorium-230	pCi/g	0.14	0.225	0.182	2	2		
Uranium	pCi/kg	198	198	198	0	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.102	0.102	0.102	1	1		
Uranium-238	pCi/g	0.0917	0.0917	0.0917	1	1		

Table 2.32 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	0.121	0.121	0.121	1	1		
Alpha activity	pCi/g	5.14	8.74	6.94	2	2		
Americium-241	pCi/g	0.011	0.0689	0.0399	0	2		
Beta activity	pCi/g	17.5	37.8	27.6	2	2		
Cesium-134	pCi/g	0.0228	0.0228	0.0228	1	1		
Cesium-137	pCi/g	0.0655	0.0714	0.0684	2	2		
Cobalt-60	pCi/g	0.00135	0.00209	0.00172	0	2		
Neptunium-237	pCi/g	0.11	0.214	0.162	1	2		
Plutonium-239/240	pCi/g	0.0348	0.0388	0.0368	2	2		
Potassium-40	pCi/g	6.08	7.56	6.82	2	2		
Technetium-99	pCi/g	5.27	17.9	11.6	2	2		
Thorium-230	pCi/g	0.344	0.727	0.535	2	2		
Uranium	pCi/kg	5040	5040	5040	1	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	1.93	1.93	1.93	1	1		
Uranium-238	pCi/g	3	3	3	1	1		

Sediment Radiological Data

Table 2.33 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	0.16	0.176	0.168	2	2		
Alpha activity	pCi/g	11.5	43.2	23.1	3	3		
Americium-241	pCi/g	0.016	0.269	0.106	1	3		
Beta activity	pCi/g	37	119	65.5	3	3		
Cesium-137	pCi/g	0.046	0.306	0.138	3	3		
Cobalt-60	pCi/g	0.00328	0.00502	0.00408	0	3		
Neptunium-237	pCi/g	0.125	0.282	0.216	5	5		
Plutonium-239/240	pCi/g	0.0614	0.19	0.114	3	3		
Potassium-40	pCi/g	8.06	9.08	8.62	3	3		
Technetium-99	pCi/g	8.01	44.8	22.6	3	3		
Thorium-230	pCi/g	0.663	1.04	0.808	3	3		
Uranium	ug/g	36.9	36.9	36.9	1	1		
Uranium	pCi/kg	6350	6950	6650	2	2		
Uranium-234	pCi/g	2.6	9.84	5.08	3	3		
Uranium-235	pCi/g	0.511	0.511	0.511	1	1		
Uranium-238	pCi/g	3.58	12.3	6.62	3	3		

Table 2.34 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	0.064	0.064	0.064	1	1		
Alpha activity	pCi/g	4.78	9.45	7.12	2	2		
Americium-241	pCi/g	0.0113	0.22	0.116	0	2		
Beta activity	pCi/g	11.5	16	13.7	2	2		
Cesium-137	pCi/g	0.032	0.0334	0.0327	2	2		
Cobalt-60	pCi/g	-0.0051	0.000034	-0.00253	0	2		
Neptunium-237	pCi/g	0.0193	0.0291	0.0242	1	2		
Plutonium-239/240	pCi/g	0.022	0.0231	0.0225	2	2		
Potassium-40	pCi/g	5.65	6.49	6.07	2	2		
Technetium-99	pCi/g	2.08	3.24	2.66	2	2		
Thorium-230	pCi/g	0.349	0.462	0.406	2	2		
Uranium	pCi/kg	2510	2510	2510	1	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.951	0.951	0.951	1	1		
Uranium-238	pCi/g	1.5	1.5	1.5	1	1		

Sediment Radiological Data

Table 2.35 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	0.112	0.112	0.112	1	1		
Alpha activity	pCi/g	5.17	6.96	6.07	2	2		
Americium-241	pCi/g	0.00809	0.128	0.068	0	2		
Beta activity	pCi/g	16	19.8	17.9	2	2		
Cesium-137	pCi/g	0.0219	0.0459	0.0339	2	2		
Cobalt-60	pCi/g	0.0107	0.0177	0.0142	0	2		
Neptunium-237	pCi/g	0.072	0.101	0.0865	1	2		
Plutonium-239/240	pCi/g	0.0131	0.0179	0.0155	2	2		
Potassium-40	pCi/g	2.67	2.83	2.75	2	2		
Technetium-99	pCi/g	2.12	5.76	3.94	2	2		
Thorium-230	pCi/g	0.234	0.329	0.281	2	2		
Uranium	pCi/kg	4210	4210	4210	1	1		
Uranium	ug/g	7.51	7.51	7.51	1	1		
Uranium-234	pCi/g	1.49	1.59	1.54	2	2		
Uranium-235	pCi/g	0.088	0.088	0.088	1	1		
Uranium-238	pCi/g	2.51	2.6	2.56	2	2		

Table 2.36 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	0.0418	0.0418	0.0418	1	1		
Alpha activity	pCi/g	5.02	5.64	5.33	2	2		
Americium-241	pCi/g	0.0137	0.0334	0.0236	0	2		
Beta activity	pCi/g	4.67	4.7	4.68	2	2		
Cesium-137	pCi/g	-0.0051	0.0324	0.0137	1	2		
Cobalt-60	pCi/g	0.000191	0.0234	0.0118	0	2		
Neptunium-237	pCi/g	0.00338	0.0286	0.016	0	2		
Plutonium-239/240	pCi/g	0.00719	0.0484	0.0278	2	2		
Potassium-40	pCi/g	2.69	3.39	3.04	2	2		
Technetium-99	pCi/g	0.121	0.285	0.203	1	2		
Thorium-230	pCi/g	0.505	0.642	0.573	2	2		
Uranium	pCi/kg	1370	1370	1370	1	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.801	0.801	0.801	1	1		
Uranium-238	pCi/g	0.522	0.522	0.522	1	1		

Sediment Radiological Data

Table 2.37 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	0.0294	0.0294	0.0294	1	1		
Alpha activity	pCi/g	3.22	3.48	3.35	2	2		
Americium-241	pCi/g	0.00256	0.169	0.0858	0	2		
Beta activity	pCi/g	3.58	3.75	3.66	2	2		
Cesium-137	pCi/g	0.0286	0.0377	0.0331	2	2		
Cobalt-60	pCi/g	-0.00264	0.00443	0.000895	0	2		
Neptunium-237	pCi/g	0.0064	0.0344	0.0204	0	2		
Plutonium-239/240	pCi/g	0.0085	0.0104	0.00945	0	2		
Potassium-40	pCi/g	4.32	7.36	5.84	2	2		
Technetium-99	pCi/g	0.271	0.322	0.296	2	2		
Thorium-230	pCi/g	0.211	0.28	0.245	2	2		
Uranium	ug/g	1	1	1	0	1		
Uranium	pCi/kg	1060	1060	1060	1	1		
Uranium-234	pCi/g	0.483	0.483	0.483	1	1		
Uranium-238	pCi/g	0.546	0.546	0.546	1	1		

Table 2.38 Radiological Data for Sediment Location S21

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.00693	0.00693	0.00693	0	1		
Alpha activity	pCi/g	3.35	3.72	3.54	2	2		
Americium-241	pCi/g	0.00514	0.0174	0.0113	0	2		
Beta activity	pCi/g	2.18	2.44	2.31	2	2		
Cesium-137	pCi/g	-0.00672	0.0108	0.00204	0	2		
Cobalt-60	pCi/g	0.0032	0.00561	0.0044	0	2		
Neptunium-237	pCi/g	-0.0328	0.00173	-0.0155	0	2		
Plutonium-239/240	pCi/g	-0.000811	0.00288	0.00103	0	2		
Potassium-40	pCi/g	3.95	4	3.98	2	2		
Technetium-99	pCi/g	0.0614	0.186	0.124	1	2		
Thorium-230	pCi/g	0.281	0.404	0.343	2	2		
Uranium	pCi/kg	324	324	324	0	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.143	0.143	0.143	1	1		
Uranium-238	pCi/g	0.174	0.174	0.174	1	1		

Sediment Radiological Data

Table 2.39 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	0.188	0.188	0.188	1	1		
Alpha activity	pCi/g	6.39	26.4	16.4	2	2		
Americium-241	pCi/g	0.00763	0.0448	0.0262	0	2		
Beta activity	pCi/g	8.04	42.1	25.1	2	2		
Cesium-137	pCi/g	0.0227	0.0718	0.0472	2	2		
Cobalt-60	pCi/g	0.00111	0.022	0.0116	0	2		
Neptunium-237	pCi/g	-0.00553	0.00333	-0.0011	0	2		
Plutonium-239/240	pCi/g	0.002	0.00381	0.0029	0	2		
Potassium-40	pCi/g	4.26	4.32	4.29	2	2		
Technetium-99	pCi/g	0.12	0.309	0.214	1	2		
Thorium-230	pCi/g	0.186	0.233	0.209	2	2		
Uranium	ug/g	1	1	1	0	1		
Uranium	pCi/kg	13200	13200	13200	1	1		
Uranium-234	pCi/g	1.3	1.3	1.3	1	1		
Uranium-238	pCi/g	11.8	11.8	11.8	1	1		

Table 2.40 Radiological Data for Sediment Location S30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/g	5.22	5.22	5.22	1	1		
Americium-241	pCi/g	0.00102	0.00102	0.00102	0	1		
Beta activity	pCi/g	5.11	5.11	5.11	1	1		
Cesium-137	pCi/g	-0.0141	-0.0141	-0.0141	0	1		
Cobalt-60	pCi/g	-0.000697	-0.000697	-0.000697	0	1		
Neptunium-237	pCi/g	-0.000798	-0.000798	-0.000798	0	1		
Plutonium-239/240	pCi/g	0.00678	0.00678	0.00678	0	1		
Potassium-40	pCi/g	4.35	4.35	4.35	1	1		
Technetium-99	pCi/g	0.0698	0.0698	0.0698	0	1		
Thorium-230	pCi/g	0.283	0.283	0.283	1	1		
Uranium	ug/g	1	1	1	0	1		

Sediment Radiological Data

Table 2.41 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	0.0539	0.0539	0.0539	1	1		
Alpha activity	pCi/g	6.62	7.02	6.82	2	2		
Americium-241	pCi/g	0.0194	0.128	0.0737	1	2		
Beta activity	pCi/g	6.64	6.65	6.64	2	2		
Cesium-137	pCi/g	0.0323	0.0349	0.0336	2	2		
Cobalt-60	pCi/g	0.00529	0.00555	0.00542	0	2		
Neptunium-237	pCi/g	0.00755	0.0326	0.0201	0	2		
Plutonium-239/240	pCi/g	0.0295	0.0529	0.0412	2	2		
Potassium-40	pCi/g	3.51	5.06	4.29	2	2		
Technetium-99	pCi/g	0.568	0.603	0.586	2	2		
Thorium-230	pCi/g	0.685	0.979	0.832	2	2		
Uranium	pCi/kg	2470	2470	2470	1	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.487	0.487	0.487	1	1		
Uranium-238	pCi/g	1.93	1.93	1.93	1	1		

Table 2.42 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	0.046	0.046	0.046	1	1		
Alpha activity	pCi/g	7.81	12.2	10.6	3	3		
Americium-241	pCi/g	0.0427	0.254	0.146	2	3		
Beta activity	pCi/g	7.85	12.4	10.4	3	3		
Cesium-137	pCi/g	0.0275	0.0574	0.0448	3	3		
Cobalt-60	pCi/g	0.000243	0.00699	0.00256	0	3		
Neptunium-237	pCi/g	0.00495	0.0174	0.00996	1	3		
Plutonium-239/240	pCi/g	0.0597	0.185	0.122	3	3		
Potassium-40	pCi/g	3.63	4.41	4.07	3	3		
Technetium-99	pCi/g	1.36	1.79	1.63	3	3		
Thorium-230	pCi/g	1.5	3.61	2.27	3	3		
Uranium	ug/g	1	1	1	0	2		
Uranium	pCi/kg	2180	2180	2180	1	1		
Uranium-234	pCi/g	0.515	0.515	0.515	1	1		
Uranium-238	pCi/g	1.62	1.62	1.62	1	1		

Sediment Radiological Data

Table 2.43 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	0.00755	0.00755	0.00755	0	1		
Alpha activity	pCi/g	2.28	2.3	2.29	2	2		
Americium-241	pCi/g	0.0152	0.0263	0.0208	0	2		
Beta activity	pCi/g	1.79	2.12	1.96	2	2		
Cesium-137	pCi/g	0.016	0.0198	0.0179	1	2		
Cobalt-60	pCi/g	-0.00581	0.00502	-0.000395	0	2		
Neptunium-237	pCi/g	0.004	0.0173	0.0106	0	2		
Plutonium-239/240	pCi/g	0.004	0.00404	0.00402	0	2		
Potassium-40	pCi/g	2.9	3.85	3.37	2	2		
Technetium-99	pCi/g	0.109	0.495	0.302	1	2		
Thorium-230	pCi/g	0.164	0.31	0.237	2	2		
Uranium	ug/g	1	1	1	0	1		
Uranium	pCi/kg	214	214	214	0	1		
Uranium-234	pCi/g	0.113	0.113	0.113	1	1		
Uranium-238	pCi/g	0.0938	0.0938	0.0938	1	1		

Table 2.44 Radiological Data for Sediment Location C746KUP

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0143	0.0143	0.0143	1	1		
Alpha activity	pCi/g	1.93	3.29	2.61	2	2		
Americium-241	pCi/g	0.00738	0.0511	0.0292	0	2		
Beta activity	pCi/g	1.49	3.3	2.39	2	2		
Cesium-137	pCi/g	0.0149	0.037	0.0259	1	2		
Cobalt-60	pCi/g	0.00191	0.00249	0.0022	0	2		
Neptunium-237	pCi/g	-0.00955	0.00467	-0.00244	0	2		
Plutonium-239/240	pCi/g	0.00204	0.00727	0.00465	1	2		
Potassium-40	pCi/g	4.15	6.01	5.08	2	2		
Technetium-99	pCi/g	0.194	0.209	0.202	2	2		
Thorium-230	pCi/g	0.136	0.245	0.19	2	2		
Uranium	ug/g	1	1	1	0	1		
Uranium	pCi/kg	552	552	552	1	1		
Uranium-234	pCi/g	0.243	0.243	0.243	1	1		
Uranium-238	pCi/g	0.296	0.296	0.296	1	1		

Sediment Radiological Data

Table 2.45 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	0.196	0.196	0.196	1	1		
Alpha activity	pCi/g	72.1	100	86	2	2		
Americium-241	pCi/g	0.86	1.46	1.16	2	2		
Beta activity	pCi/g	65.8	122	93.9	2	2		
Cesium-137	pCi/g	0.705	1.29	0.998	2	2		
Cobalt-60	pCi/g	0.00417	0.00725	0.00571	0	2		
Neptunium-237	pCi/g	0.906	1.53	1.22	2	2		
Plutonium-239/240	pCi/g	3.59	4.07	3.83	2	2		
Potassium-40	pCi/g	6.7	7.63	7.16	2	2		
Technetium-99	pCi/g	22.5	59	40.7	2	2		
Thorium-230	pCi/g	69.4	70.5	69.9	2	2		
Uranium	ug/g	36.2	36.2	36.2	1	1		
Uranium	pCi/kg	6680	6680	6680	1	1		
Uranium-234	pCi/g	3.01	7.49	5.25	2	2		
Uranium-235	pCi/g	0.416	0.416	0.416	1	1		
Uranium-238	pCi/g	3.48	12.1	7.79	2	2		

Table 2.46 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	0.00388	0.00388	0.00388	0	1		
Alpha activity	pCi/g	0.953	2.15	1.55	1	2		
Americium-241	pCi/g	0.00415	0.0296	0.0169	0	2		
Beta activity	pCi/g	1.39	2.23	1.81	2	2		
Cesium-137	pCi/g	0.00719	0.0156	0.0114	0	2		
Cobalt-60	pCi/g	0.0086	0.00922	0.00891	0	2		
Neptunium-237	pCi/g	0.00217	0.0105	0.00633	0	2		
Plutonium-239/240	pCi/g	0.00144	0.00218	0.00181	0	2		
Potassium-40	pCi/g	3.54	4.04	3.79	2	2		
Technetium-99	pCi/g	0.0841	0.0857	0.0849	0	2		
Thorium-230	pCi/g	0.152	0.162	0.157	2	2		
Uranium	pCi/kg	163	163	163	0	1		
Uranium	ug/g	1	1	1	0	1		
Uranium-234	pCi/g	0.0819	0.0819	0.0819	1	1		
Uranium-238	pCi/g	0.0772	0.0772	0.0772	1	1		

Direct Gamma Radiation (TLD) Data

Table 2.49 Radiological Exposure Due to Gamma Radiation (mrem)

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annualized[1]
TLD-1	123	177	181	162	633
TLD-2	121	212	273	266	858
TLD-3	32	46	50	44	169
TLD-4	19	21	23.5	22	84
TLD-5	18	21	23	23	84
TLD-6	18	18	21	19	75
TLD-7	21	24	26	22	91
TLD-8	16	16	19	15	65
TLD-9	17	17.5	NS	20	75
TLD-10	17	19	23	19	77
TLD-11	18	19	22	19	77
TLD-12	17	18	20	19	73
TLD-13	19	21	24	23	86
TLD-14	17	19	21	20	76
TLD-15	17	17	19	17	69
TLD-16	20	21	27	20	87
TLD-17	16	17	19	17	68
TLD-18	17	18	21	18	73
TLD-19	15	18	22	18	72
TLD-20	19	19	22	20	79
TLD-25	22	25	28	26	99
TLD-27	19	20	22	19	79
TLD-28	17	19	24	21	80
TLD-29	16	17	NS	18	70
TLD-30	18	19	24	19	79
TLD-31	19	22	27	NS	89
TLD-32	21	23	32	NS	99
TLD-35	18	20	21	19	77
TLD-36	14	17	21	17	68
TLD-37	17	18	21	17	72
TLD-38	16	18	23	28	84
TLD-39	16	16	20	15	66
TLD-40	20	24	25	22	90
TLD-41	16	17	18	16	66
TLD-46	16	18	21	18	72
TLD-47	43	77	97	79	291
TLD-48	23	31	32	29	113
TLD-49	17	20	22	18	76
TLD-50	27	33	30	29	117
TLD-51	19	25	22	20	85
TLD-52	28	31	29	25	111
TLD-53	44	74	111	103	327
TLD-21	20	22	27	22	90
TLD-22	20	22	25	22	88
TLD-23	20	21	26	23	89
TLD-26	18	19	22	19	77

[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.

NS – No Sample Obtained

Deer Radiological Data

Table 2.48 Radiological Analysis of Deer Bone Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.00638	0.00291	-0.00156	0	6		
Plutonium-239/240	pCi/g	0	0.00575	0.00197	0	6		
Technetium-99	pCi/g	-0.0225	0.256	0.0868	0	6		
Thorium-230	pCi/g	0.0105	0.0388	0.0291	1	6		
Uranium-233/234	pCi/g	-0.0163	0.00779	-0.00571	0	6		
Uranium-235	pCi/g	-0.00805	0.00454	-0.00203	0	6		
Uranium-238	pCi/g	0.00327	0.011	0.00547	0	6		

Table 2.49 Radiological Analysis of Deer Thyroid Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Technetium-99	pCi/g	0.344	3.43	1.4	0	6		

Table 2.50 Radiological Analysis of Deer Muscle Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.0362	0.00316	-0.0111	0	6		
Plutonium-239/240	pCi/g	-0.00627	0.0033	-0.00103	0	6		
Technetium-99	pCi/g	-0.128	0.0951	-0.0404	0	6		
Thorium-230	pCi/g	0.0138	0.0757	0.0393	2	6		
Uranium-233/234	pCi/g	-0.0264	0.0249	-0.000477	0	6		
Uranium-235	pCi/g	-0.00466	0.00439	0.000	0	6		
Uranium-238	pCi/g	-0.00979	0.0106	0.000229	0	6		

Table 2.51 Radiological Analysis of Deer Liver Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.0282	-0.00324	-0.0111	0	6		
Plutonium-239/240	pCi/g	-0.00323	0.00678	0.000095	0	6		
Technetium-99	pCi/g	-0.142	-0.021	-0.0996	0	6		
Thorium-230	pCi/g	-0.00869	0.0138	0.000025	0	6		
Uranium-233/234	pCi/g	-0.0074	0.0402	0.0126	1	6		
Uranium-235	pCi/g	0	0.00915	0.00229	0	6		
Uranium-238	pCi/g	-0.00647	0.0111	0.0025	0	6		

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
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Chlorine, Total Residual	mg/L	0.03	0.06	0.0315	93	93
Chromium	mg/L	ND	ND	ND	0	5
Chronic Toxicity	TUC	<1	1.01	1.77	12	12
Conductivity	umho/cm	614	1580	1160	93	93
Copper	mg/L	ND	0.00789	0.0053	3	5
Dissolved Oxygen	mg/L	4.41	12.7	8.46	93	93
Flow Rate	mgd	1	7.63	2.48	93	93
Hardness - Total as CaCO3	mg/L	66	318	235	14	14
Iron	mg/L	0.278	0.511	0.348	5	5
Lead	mg/L	ND	ND	ND	0	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	0.0108	0.0065	4	5
Oil and Grease	mg/L	ND	ND	ND	0	52
PCB-1016	ug/L	ND	ND	ND	0	14
PCB-1221	ug/L	ND	ND	ND	0	14
PCB-1232	ug/L	ND	ND	ND	0	14
PCB-1242	ug/L	ND	ND	ND	0	14
PCB-1248	ug/L	ND	0.26	0.0074	1	14
PCB-1254	ug/L	ND	ND	ND	0	14
PCB-1260	ug/L	ND	ND	ND	0	14
PCB-1268	ug/L	ND	ND	ND	0	14
pH	Std Unit	6.74	8.4	7.45	93	93
Phosphorous	mg/L	ND	0.55	0.21	51	52
Polychlorinated biphenyl	ug/L	ND	0.3	0.104	1	14
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Temperature	deg F	42.8	80.8	63.4	93	93
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	14
Uranium	mg/L	0.00333	0.22	0.0481	5	5
Zinc	mg/L	ND	ND	ND	0	5

KPDES Outfall Non-Radiological Data

Table 3.2 Non-Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Acute Toxicity	TUA	<1	<1	<1	4	4
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	10	10
Chromium	mg/L	ND	ND	ND	0	3
Conductivity	umho/cm	253	631	418	16	16
Copper	mg/L	ND	0.00672	0.0039	1	3
Dissolved Oxygen	mg/L	7.11	13.1	8.99	16	16
Flow Rate	mgd	0.0151	1.03	0.185	16	16
Hardness - Total as CaCO3	mg/L	104	220	169	9	9
Iron	mg/L	0.42	1.14	0.89	3	3
Lead	mg/L	ND	ND	ND	0	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	0.0066	0.00927	0.0077	3	3
Oil and Grease	mg/L	ND	ND	ND	0	9
PCB-1016	ug/L	ND	ND	ND	0	9
PCB-1221	ug/L	ND	ND	ND	0	9
PCB-1232	ug/L	ND	ND	ND	0	9
PCB-1242	ug/L	ND	ND	ND	0	9
PCB-1248	ug/L	ND	ND	ND	0	9
PCB-1254	ug/L	ND	ND	ND	0	9
PCB-1260	ug/L	ND	ND	ND	0	9
PCB-1268	ug/L	ND	ND	ND	0	9
pH	Std Unit	7.37	7.84	7.64	16	16
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	9
Redox	mg/L	0.05	0.05	0.05	1	1
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Temperature	deg F	32.7	74.5	56.6	16	16
Thallium	mg/L	ND	ND	ND	0	3
Uranium	mg/L	0.0463	0.209	0.149	3	3
Zinc	mg/L	ND	0.0484	0.0228	1	3

KPDES Outfall Non-Radiological Data

Table 3.3 Non-Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Acute Toxicity	TUA	<1	8	2.67	8	8
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	17	17
Chromium	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	83	306	153	23	23
Copper	mg/L	ND	0.00956	0.0058	3	5
Dissolved Oxygen	mg/L	6.53	12.3	9.16	23	23
Flow Rate	mgd	0.062	3.37	1.24	23	23
Hardness - Total as CaCO3	mg/L	30	121	65.2	11	11
Iron	mg/L	ND	0.42	0.251	3	5
Lead	mg/L	ND	ND	ND	0	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Oil and Grease	mg/L	ND	ND	ND	0	11
PCB-1016	ug/L	ND	ND	ND	0	11
PCB-1221	ug/L	ND	ND	ND	0	11
PCB-1232	ug/L	ND	ND	ND	0	11
PCB-1242	ug/L	ND	ND	ND	0	11
PCB-1248	ug/L	ND	ND	ND	0	11
PCB-1254	ug/L	ND	ND	ND	0	11
PCB-1260	ug/L	ND	ND	ND	0	11
PCB-1268	ug/L	ND	ND	ND	0	11
pH	Std Unit	7.38	8.24	7.67	23	23
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	11
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Temperature	deg F	37.2	80.2	57.4	23	23
Thallium	mg/L	ND	ND	ND	0	5
Uranium	mg/L	ND	0.00246	0.0016	4	5
Zinc	mg/L	ND	0.461	0.12	4	5

KPDES Outfall Non-Radiological Data

Table 3.4 Non-Radiological Effluent Data for Outfall 019

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Acute Toxicity	TUA	<1	<1	<1	2	2
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Chlorine, Total Residual	mg/L	0.03	0.04	0.03	6	6
Chromium	mg/L	ND	ND	ND	0	3
Conductivity	umho/cm	164	217	201	6	6
Copper	mg/L	ND	0.00705	0.004	1	3
Dissolved Oxygen	mg/L	9.2	16	13.8	6	6
Flow Rate	mgd	0.8	0.8	0.8	6	6
Hardness - Total as CaCO3	mg/L	73	100	86.5	2	2
Iron	mg/L	0.858	1.74	1.17	3	3
Lead	mg/L	ND	ND	ND	0	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	ND	ND	ND	0	3
Oil and Grease	mg/L	ND	ND	ND	0	2
PCB-1016	ug/L	ND	ND	ND	0	2
PCB-1221	ug/L	ND	ND	ND	0	2
PCB-1232	ug/L	ND	ND	ND	0	2
PCB-1242	ug/L	ND	ND	ND	0	2
PCB-1248	ug/L	ND	ND	ND	0	2
PCB-1254	ug/L	ND	ND	ND	0	2
PCB-1260	ug/L	ND	ND	ND	0	2
PCB-1268	ug/L	ND	ND	ND	0	2
pH	Std Unit	7.56	7.8	7.74	6	6
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	2
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Suspended Solids	mg/L	ND	28	19	1	2
Temperature	deg F	50.4	59.3	52.5	6	6
Thallium	mg/L	ND	ND	ND	0	3
Uranium	mg/L	ND	ND	ND	0	3
Zinc	mg/L	ND	0.0206	0.0014	1	3

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	ND	53	40.5	2	3
Chloride	mg/L	7	24.8	14.4	3	3
Conductivity	umho/cm	196	290	240	3	3
Dissolved Oxygen	mg/L	6.86	12.1	8.97	3	3
Dissolved Solids	mg/L	ND	179	133	2	3
Flow Rate	mgd	0.16	0.54	0.32	3	3
Iron	mg/L	0.735	1.74	1.16	3	3
pH	Std Unit	7.13	7.4	7.24	3	3
Sodium	mg/L	4.17	11.5	8.79	3	3
Sulfate	mg/L	13.9	43	23.8	3	3
Suspended Solids	mg/L	ND	180	75.3	1	3
Temperature	deg F	35.7	66.9	55.5	3	3
Total Organic Carbon (TOC)	mg/L	11	20.4	16.1	3	3
Total Solids	mg/L	204	395	272	3	3
Uranium	mg/L	0.00672	0.0156	0.0099	3	3

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	ND	43	34.1	3	4
Chloride	mg/L	3.1	7.1	4.53	4	4
Conductivity	umho/cm	268	667	378	4	4
Dissolved Oxygen	mg/L	5.22	10.1	6.99	4	4
Dissolved Solids	mg/L	181	460	252	4	4
Flow Rate	mgd	0.03	0.35	0.21	4	4
Iron	mg/L	ND	0.249	0.137	1	4
pH	Std Unit	7.29	7.8	7.47	4	4
Sodium	mg/L	2	15	6.1	4	4
Sulfate	mg/L	26	140	59.6	4	4
Suspended Solids	mg/L	ND	50	21.6	1	4
Temperature	deg F	46	67	61.1	4	4
Total Organic Carbon (TOC)	mg/L	7.1	17	14.2	4	4
Total Solids	mg/L	175	434	260	4	4
Uranium	mg/L	ND	0.0244	0.0064	1	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	48	35.5	2	3
Chloride	mg/L	6.2	17.6	10.2	3	3
Conductivity	umho/cm	172	358	252	3	3
Dissolved Oxygen	mg/L	5.65	12.4	8.59	3	3
Dissolved Solids	mg/L	141	242	205	3	3
Flow Rate	mgd	0.006	0.608	0.238	3	3
Iron	mg/L	0.456	1.27	0.879	3	3
pH	Std Unit	7.24	7.5	7.41	3	3
Sodium	mg/L	2.85	10.9	5.9	3	3
Sulfate	mg/L	15.4	34	24.2	3	3
Suspended Solids	mg/L	ND	50	25.7	1	3
Temperature	deg F	37	67.4	55.9	3	3
Total Organic Carbon (TOC)	mg/L	10	21.8	16.9	3	3
Total Solids	mg/L	132	294	200	3	3
Uranium	mg/L	0.00554	0.0268	0.0128	3	3

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	ND	ND	0	3
Chloride	mg/L	3.7	7.9	5.7	3	3
Conductivity	umho/cm	207	276	252	3	3
Dissolved Oxygen	mg/L	8.62	12.4	10	3	3
Dissolved Solids	mg/L	ND	226	167	2	3
Flow Rate	mgd	0.03	1.46	0.543	3	3
Iron	mg/L	0.674	1.02	0.826	3	3
pH	Std Unit	7.48	8	7.75	3	3
Sodium	mg/L	2.59	5.54	3.88	3	3
Sulfate	mg/L	27	50	35	3	3
Suspended Solids	mg/L	ND	836	413	2	3
Temperature	deg F	35.8	67.2	56	3	3
Total Organic Carbon (TOC)	mg/L	7.8	9.2	8.7	3	3
Total Solids	mg/L	168	883	518	3	3
Uranium	mg/L	0.00107	0.00239	0.0016	3	3

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	ND	62	46.9	3	4
Chloride	mg/L	4.3	18.8	8.15	4	4
Conductivity	umho/cm	129	185	168	4	4
Dissolved Oxygen	mg/L	4.74	13.4	7.06	4	4
Dissolved Solids	mg/L	126	151	138	4	4
Flow Rate	mgd	0.16	1.37	1	4	4
Iron	mg/L	0.93	1.63	1.33	4	4
pH	Std Unit	6.41	7.3	6.75	4	4
Sodium	mg/L	ND	10	2.89	3	4
Sulfate	mg/L	5.1	17.4	9.43	4	4
Suspended Solids	mg/L	ND	50	24.5	2	4
Temperature	deg F	37.4	65.6	57.2	4	4
Total Organic Carbon (TOC)	mg/L	12	30.8	22.8	4	4
Total Solids	mg/L	112	179	148	4	4
Uranium	mg/L	ND	0.00664	0.0021	2	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	ND	ND	0	3
Chloride	mg/L	11.5	26.6	18.7	3	3
Conductivity	umho/cm	124	348	268	3	3
Dissolved Oxygen	mg/L	6.62	12.6	8.64	3	3
Dissolved Solids	mg/L	85	200	132	3	3
Flow Rate	mgd	0.15	9.66	3.76	3	3
Iron	mg/L	0.363	1.51	0.894	3	3
pH	Std Unit	7	7.34	7.17	3	3
Sodium	mg/L	ND	37.8	23.5	2	3
Sulfate	mg/L	14.8	63	42.9	3	3
Suspended Solids	mg/L	ND	50	26.8	1	3
Temperature	deg F	37.2	66.3	56.1	3	3
Total Organic Carbon (TOC)	mg/L	3.6	8.4	5.6	3	3
Total Solids	mg/L	174	206	195	3	3
Uranium	mg/L	0.00447	0.00555	0.0049	3	3

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	16	70	39.2	4	4
Aluminum	mg/L	ND	1.36	0.493	2	4
Ammonia	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	0.0381	0.0515	0.0445	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	13.7	17.5	14.9	4	4
Chloride	mg/L	6.4	15.7	12	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	160	271	222	4	4
Copper	mg/L	ND	0.00925	0.00424	1	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.3	13.3	9.18	4	4
Flow Rate	mgd	0.25	1.42	0.625	4	4
Hardness - Total as CaCO3	mg/L	50	57	53.2	4	4
Iron	mg/L	ND	0.981	0.454	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	0.288	3.89	2.59	4	4
Manganese	mg/L	0.0652	0.266	0.132	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.51	0.71	0.627	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	7.45	7.54	7.49	4	4
Phosphorous	mg/L	ND	0.26	0.0987	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.69	4.66	2.91	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	7.49	34.9	21.2	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	38	75.8	57.5	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	2.6	1.4	2	4
Uranium	mg/L	ND	ND	ND	0	8

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
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	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
Alkalinity	mg/L	19	55	33.7	4	4
Aluminum	mg/L	ND	0.5	0.272	2	4
Ammonia	mg/L	ND	0.23	0.133	1	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.0286	0.0388	0.0331	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	35.7	45.3	39.3	4	4
Chloride	mg/L	32	61.4	48.7	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	0.00173	0.000807	1	4
Conductivity	umho/cm	464	740	591	4	4
Copper	mg/L	ND	0.015	0.00965	3	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.05	13.4	8.82	4	4
Flow Rate	mgd	2.73	8.73	5.7	4	4
Hardness - Total as CaCO3	mg/L	130	181	146	4	4
Iron	mg/L	ND	0.639	0.327	2	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	9.06	16.1	12.5	4	4
Manganese	mg/L	0.043	0.0632	0.0534	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.0102	0.00724	3	4
Nitrate/Nitrite as Nitrogen	mg/L	0.76	2.4	1.29	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	6.99	8.54	7.55	4	4
Phosphorous	mg/L	0.07	0.23	0.145	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	6.82	9.49	7.94	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	34.2	81.5	54.7	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	46.4	79.2	65	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.109	0.0407	5	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0265	0.0141	1	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	23	80	42.2	4	4
Aluminum	mg/L	ND	0.479	0.261	2	4
Ammonia	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	0.0297	0.0419	0.0371	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	35.7	46.1	39.3	4	4
Chloride	mg/L	33	60.1	48.4	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	465	712	594	4	4
Copper	mg/L	ND	0.0108	0.00551	2	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.66	15.3	9.54	4	4
Flow Rate	mgd	5.53	14.9	8.05	4	4
Hardness - Total as CaCO3	mg/L	132	150	141	4	4
Iron	mg/L	ND	0.554	0.287	2	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	9.33	16.1	13	4	4
Manganese	mg/L	0.0556	0.0963	0.0802	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.00775	0.00381	1	4
Nitrate/Nitrite as Nitrogen	mg/L	0.64	2.6	1.38	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	7.13	8.34	7.51	4	4
Phosphorous	mg/L	0.08	0.19	0.13	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	7.1	9.38	8.04	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	35.8	79.5	54.6	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	45.7	77	63.9	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.0731	0.0283	4	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0214	0.0128	1	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	15	35	24.5	4	4
Aluminum	mg/L	ND	1.32	0.405	1	4
Ammonia	mg/L	ND	0.6	0.263	2	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.0195	0.034	0.0257	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	72.3	108	88.2	4	4
Chloride	mg/L	119	168	141	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	0.00139	0.0187	0.0061	4	4
Conductivity	umho/cm	179	1540	1080	4	4
Copper	mg/L	0.00903	0.016	0.0123	4	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	7.69	9.88	8.56	4	4
Flow Rate	mgd	0.86	2.8	1.81	4	4
Hardness - Total as CaCO3	mg/L	278	369	321	4	4
Iron	mg/L	ND	3.66	1.03	2	4
Lead	mg/L	ND	0.0061	0.0034	1	4
Magnesium	mg/L	28.3	40.8	33.6	4	4
Manganese	mg/L	0.0703	0.25	0.125	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	0.00791	0.0347	0.0152	4	4
Nitrate/Nitrite as Nitrogen	mg/L	0.74	5.3	2.81	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	6.58	7.69	7.35	4	4
Phosphorous	mg/L	0.18	0.5	0.292	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	19.3	27.6	23.6	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	117	190	160	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	51.2	78.5	68.5	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.005	0.00206	2	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0564	0.0216	1	4

Surface Water Non-Radiological Data

Table 4.5 Non-Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	30	62	41.7	4	4
Aluminum	mg/L	ND	ND	ND	0	4
Ammonia	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	0.118	0.142	0.125	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	22.1	25.9	23.6	4	4
Chloride	mg/L	36.8	40.4	38.7	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	338	361	348	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	3.14	9.55	6.49	4	4
Hardness - Total as CaCO3	mg/L	96	114	102	4	4
Iron	mg/L	ND	ND	ND	0	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	9.21	10.5	9.68	4	4
Manganese	mg/L	ND	0.137	0.0361	1	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.00736	0.00371	1	4
Nitrate/Nitrite as Nitrogen	mg/L	1.71	3.1	2.3	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	7.49	8.15	7.92	4	4
Phosphorous	mg/L	ND	0.06	0.04	2	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.1	1.19	1.16	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	27.1	34.6	30.5	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	58.6	64.3	60.9	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	1	2	1.6	4	4
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 4.6 Non-Radiological Monitoring Data for Surface Water Location K006

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	24	40	31.2	5	5
Aluminum	mg/L	ND	1.13	0.43	4	5
Ammonia	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	0.0125	0.0275	0.0201	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	15	27.6	20.2	5	5
Chloride	mg/L	6.5	13.6	10.9	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	182	262	233	5	5
Copper	mg/L	ND	ND	ND	0	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	7.53	11.9	9.08	5	5
Flow Rate	mgd	1	2.4	1.78	5	5
Hardness - Total as CaCO3	mg/L	60	110	81.8	5	5
Iron	mg/L	0.425	1.08	0.804	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	4.33	8.02	5.93	5	5
Manganese	mg/L	0.0231	0.0561	0.0417	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	1.3	0.45	3	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	6.59	7.77	7.08	5	5
Phosphorous	mg/L	0.06	0.09	0.076	5	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	0.221	2.47	1.77	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	8.12	26.4	17.9	5	5
Suspended Solids	mg/L	ND	26	15.5	2	5
Temperature	deg F	39.5	76.9	66	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
Uranium	mg/L	ND	ND	ND	0	10
Vanadium	mg/L	ND	ND	ND	0	5
Zinc	mg/L	ND	0.0208	0.0122	1	5

Surface Water Non-Radiological Data

Table 4.7 Non-Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	50	32.8	5	5
Aluminum	mg/L	ND	1.7	0.812	3	5
Ammonia	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	0.0387	0.0501	0.0462	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	15.6	21.8	18.6	5	5
Chloride	mg/L	5.6	16.1	10.2	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	187	275	244	5	5
Copper	mg/L	ND	0.00889	0.00553	3	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	2.57	12	6.91	5	5
Flow Rate	mgd	0.13	3.75	1.66	5	5
Hardness - Total as CaCO3	mg/L	50	66	58.4	5	5
Iron	mg/L	ND	1.13	0.62	4	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.27	4.5	3.59	5	5
Manganese	mg/L	0.0427	0.163	0.0835	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.2	2.23	0.858	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	7.19	8.15	7.48	5	5
Phosphorous	mg/L	ND	0.24	0.125	4	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.53	4.47	3.45	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	6.64	31.2	17.2	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	33.5	74.1	55.9	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
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 4.8 Non-Radiological Monitoring Data for Surface Water Location K002

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	0.46	27	19.9	4	4
Aluminum	mg/L	0.334	2.51	1.38	4	4
Ammonia	mg/L	ND	0.31	0.187	2	4
Antimony	mg/L	ND	ND	ND	0	4
Arsenic	mg/L	ND	ND	ND	0	4
Barium	mg/L	0.019	0.36	0.111	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	20.2	25.6	23.1	4	4
Chloride	mg/L	7.1	30.6	18.9	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	140	261	206	4	4
Copper	mg/L	0.00899	0.0179	0.0128	4	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.84	13.9	10.6	4	4
Flow Rate	mgd	0.556	2.17	1.02	4	4
Hardness - Total as CaCO3	mg/L	56	82	70	4	4
Iron	mg/L	0.263	0.949	0.608	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.1	3.7	3.01	4	4
Manganese	mg/L	0.0107	0.0244	0.02	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.0747	0.0205	1	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.75	0.45	2	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	8.2	7.74	4	4
Phosphorous	mg/L	0.18	0.24	0.22	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.44	2.47	1.99	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	0.00143	0.000928	2	4
Sodium	mg/L	7.35	18.9	13.2	4	4
Suspended Solids	mg/L	ND	43	17	1	4
Temperature	deg F	56.2	81.8	65.7	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.005	0.00263	4	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0406	0.0222	2	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	17	38	25.7	4	4
Aluminum	mg/L	0.446	2.65	1.06	4	4
Ammonia	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	0.0449	0.0625	0.0511	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	19.7	25.5	21.9	4	4
Chloride	mg/L	13	29.6	21.4	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	258	365	317	4	4
Copper	mg/L	ND	0.0102	0.00555	2	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.47	10.9	7.56	4	4
Flow Rate	mgd	0.32	1.51	0.682	4	4
Hardness - Total as CaCO3	mg/L	69	89	78.5	4	4
Iron	mg/L	0.33	1.64	0.737	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.17	6.86	5.9	4	4
Manganese	mg/L	0.0333	0.112	0.0691	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.52	0.91	0.743	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	7.2	8.23	7.52	4	4
Phosphorous	mg/L	0.13	0.23	0.175	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.23	3.05	2.56	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	17.8	42.8	28.8	4	4
Suspended Solids	mg/L	ND	28	14.6	1	4
Temperature	deg F	41.5	74.9	60.6	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.013	0.0077	6	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0231	0.0133	1	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	30	37	33.5	4	4
Aluminum	mg/L	0.236	1.18	0.579	4	4
Ammonia	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	0.0273	0.0446	0.0352	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	19.9	22.5	21	4	4
Chloride	mg/L	15.7	25.4	20.2	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	280	352	323	4	4
Copper	mg/L	ND	0.00596	0.00341	1	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	4.4	9.37	7.09	4	4
Flow Rate	mgd	0.68	2.28	1.38	4	4
Hardness - Total as CaCO3	mg/L	75	85	80.2	4	4
Iron	mg/L	0.356	0.836	0.541	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.97	6.99	5.89	4	4
Manganese	mg/L	0.0241	0.0617	0.0454	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.53	0.94	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	7.02	7.62	7.33	4	4
Phosphorous	mg/L	0.18	0.24	0.212	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.21	3.22	2.73	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	23.6	41.5	28.9	4	4
Suspended Solids	mg/L	ND	20	10	1	4
Temperature	deg F	49.9	80.1	67.4	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.017	0.00891	6	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0224	0.0131	1	4

Surface Water Non-Radiological Data

Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L55

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	18	18	1	1
Aluminum	mg/L	0.85	0.85	0.85	1	1
Ammonia	mg/L	ND	ND	ND	0	1
Antimony	mg/L	ND	ND	ND	0	1
Arsenic	mg/L	ND	ND	ND	0	1
Barium	mg/L	0.121	0.121	0.121	1	1
Beryllium	mg/L	ND	ND	ND	0	1
Cadmium	mg/L	ND	ND	ND	0	1
Calcium	mg/L	26.9	26.9	26.9	1	1
Chloride	mg/L	42.4	42.4	42.4	1	1
Chromium	mg/L	ND	ND	ND	0	1
Cobalt	mg/L	ND	ND	ND	0	1
Conductivity	umho/cm	472	472	472	1	1
Copper	mg/L	0.00652	0.00652	0.00652	1	1
Cyanide	mg/L	ND	ND	ND	0	1
Dissolved Oxygen	mg/L	13.3	13.3	13.3	1	1
Flow Rate	mgd	0.08	0.08	0.08	1	1
Hardness - Total as CaCO3	mg/L	102	102	102	1	1
Iron	mg/L	0.807	0.807	0.807	1	1
Lead	mg/L	ND	ND	ND	0	1
Magnesium	mg/L	8.43	8.43	8.43	1	1
Manganese	mg/L	0.231	0.231	0.231	1	1
Mercury	mg/L	ND	ND	ND	0	1
Nickel	mg/L	ND	ND	ND	0	1
Nitrate/Nitrite as Nitrogen	mg/L	0.18	0.18	0.18	1	1
PCB-1016	ug/L	ND	ND	ND	0	1
PCB-1221	ug/L	ND	ND	ND	0	1
PCB-1232	ug/L	ND	ND	ND	0	1
PCB-1242	ug/L	ND	ND	ND	0	1
PCB-1248	ug/L	ND	ND	ND	0	1
PCB-1254	ug/L	ND	ND	ND	0	1
PCB-1260	ug/L	ND	ND	ND	0	1
PCB-1268	ug/L	ND	ND	ND	0	1
pH	Std Unit	8.35	8.35	8.35	1	1
Phosphorous	mg/L	0.05	0.05	0.05	1	1
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	1
Potassium	mg/L	1.35	1.35	1.35	1	1
Selenium	mg/L	ND	ND	ND	0	1
Silver	mg/L	ND	ND	ND	0	1
Sodium	mg/L	46	46	46	1	1
Suspended Solids	mg/L	ND	ND	ND	0	1
Temperature	deg F	36.9	36.9	36.9	1	1
Thallium	mg/L	ND	ND	ND	0	1
Trichloroethene	ug/L	ND	ND	ND	0	1
Uranium	mg/L	0.0105	0.0133	0.0119	2	2
Vanadium	mg/L	ND	ND	ND	0	1
Zinc	mg/L	ND	ND	ND	0	1

Surface Water Non-Radiological Data

Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L56

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	16	35	29	4	4
Aluminum	mg/L	0.558	4.03	1.65	4	4
Ammonia	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	0.0503	0.126	0.0961	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	18	61.3	31.6	4	4
Chloride	mg/L	ND	47.2	22.4	3	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	69	486	346	4	4
Copper	mg/L	ND	0.00748	0.00382	1	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.59	12.1	9.09	4	4
Flow Rate	mgd	0.02	10.3	2.7	4	4
Hardness - Total as CaCO3	mg/L	65	194	112	4	4
Iron	mg/L	0.474	2.48	1.34	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.56	11.4	6.96	4	4
Manganese	mg/L	0.0357	0.24	0.138	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	0.00559	0.00327	1	4
Nitrate/Nitrite as Nitrogen	mg/L	0.1	2.7	1.03	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	6.84	7.92	7.21	4	4
Phosphorous	mg/L	ND	0.23	0.0912	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.04	2.51	1.89	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	2.52	63.9	27.6	4	4
Suspended Solids	mg/L	ND	42	21	2	4
Temperature	deg F	41.5	71.6	57.7	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.005	0.0017	2	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	0.0224	0.0131	1	4

Surface Water Non-Radiological Data

Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	16	50	26.4	5	5
Aluminum	mg/L	0.496	3.27	1.22	5	5
Ammonia	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	0.0467	0.06	0.054	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	16.2	21.6	19.4	5	5
Chloride	mg/L	7.9	28.6	21	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	188	353	296	5	5
Copper	mg/L	ND	0.0105	0.00486	2	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	4.54	18.6	11.8	5	5
Flow Rate	mgd	0.74	14.8	4.04	5	5
Hardness - Total as CaCO3	mg/L	59	79	72.8	5	5
Iron	mg/L	0.56	2.14	1.03	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.23	6.81	5.72	5	5
Manganese	mg/L	0.0334	0.168	0.11	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.22	0.6	0.386	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	7.21	7.4	7.3	5	5
Phosphorous	mg/L	0.08	0.23	0.126	5	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.24	3.08	2.55	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	9.87	42	29.5	5	5
Suspended Solids	mg/L	ND	20	10.2	1	5
Temperature	deg F	41.6	74.5	55.3	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
Uranium	mg/L	ND	0.0104	0.00671	7	10
Vanadium	mg/L	ND	ND	ND	0	5
Zinc	mg/L	ND	ND	ND	0	5

Surface Water Non-Radiological Data

Table 4.14 Non-Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	24	43	33	3	3
Aluminum	mg/L	ND	0.249	0.15	1	3
Ammonia	mg/L	ND	ND	ND	0	3
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Barium	mg/L	0.0583	0.0848	0.0725	3	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Calcium	mg/L	34.4	43.3	38.2	3	3
Chloride	mg/L	19.4	24.7	22.1	3	3
Chromium	mg/L	ND	ND	ND	0	3
Cobalt	mg/L	ND	0.00162	0.00117	2	3
Conductivity	umho/cm	372	400	383	3	3
Copper	mg/L	ND	ND	ND	0	3
Cyanide	mg/L	ND	ND	ND	0	3
Dissolved Oxygen	mg/L	5.93	8.79	6.93	3	3
Flow Rate	mgd	0.28	3.35	1.81	2	2
Hardness - Total as CaCO3	mg/L	117	123	120	3	3
Iron	mg/L	0.412	0.425	0.42	3	3
Lead	mg/L	ND	ND	ND	0	3
Magnesium	mg/L	5.49	7.02	6.36	3	3
Manganese	mg/L	0.317	0.403	0.37	3	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	ND	ND	ND	0	3
Nitrate/Nitrite as Nitrogen	mg/L	1	1.7	1.27	3	3
PCB-1016	ug/L	ND	ND	ND	0	3
PCB-1221	ug/L	ND	ND	ND	0	3
PCB-1232	ug/L	ND	ND	ND	0	3
PCB-1242	ug/L	ND	ND	ND	0	3
PCB-1248	ug/L	ND	ND	ND	0	3
PCB-1254	ug/L	ND	ND	ND	0	3
PCB-1260	ug/L	ND	ND	ND	0	3
PCB-1268	ug/L	ND	ND	ND	0	3
pH	Std Unit	6.5	6.83	6.68	3	3
Phosphorous	mg/L	0.06	0.1	0.08	3	3
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	3
Potassium	mg/L	0.271	2.83	1.91	3	3
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Sodium	mg/L	20.5	28.8	25	3	3
Suspended Solids	mg/L	ND	ND	ND	0	3
Temperature	deg F	50.9	69.7	62.5	3	3
Thallium	mg/L	ND	ND	ND	0	3
Trichloroethene	ug/L	4.1	7	5.37	3	3
Uranium	mg/L	ND	0.005	2.68E-03	3	6
Vanadium	mg/L	ND	ND	ND	0	3
Zinc	mg/L	ND	ND	ND	0	3

Surface Water Non-Radiological Data

Table 4.15 Non-Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	45	31.5	4	4
Aluminum	mg/L	0.234	2.35	0.896	4	4
Ammonia	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	0.0552	0.108	0.0816	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	18.1	21.8	20.6	4	4
Chloride	mg/L	10	30.1	22.4	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	207	340	292	4	4
Copper	mg/L	ND	0.00628	0.00349	1	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.36	11.7	9.38	4	4
Flow Rate	mgd	0.2	6.3	2.85	4	4
Hardness - Total as CaCO3	mg/L	65	85	76.5	4	4
Iron	mg/L	0.427	1.98	0.866	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	3.82	8.27	6.23	4	4
Manganese	mg/L	0.0218	0.0885	0.0551	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.52	1.3	0.96	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	6.2	7.19	6.62	4	4
Phosphorous	mg/L	0.05	0.23	0.12	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.11	3.07	2.43	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	10.3	36.9	27.3	4	4
Suspended Solids	mg/L	ND	20	11	1	4
Temperature	deg F	48.4	486	168	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	15	59	37.7	4	4
Uranium	mg/L	ND	0.00707	0.00422	5	8
Vanadium	mg/L	ND	ND	ND	0	4
Zinc	mg/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	50	30.5	4	4
Aluminum	mg/L	ND	0.451	0.17	1	5
Ammonia	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	0.0266	0.0394	0.0337	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	16	21.5	18.4	5	5
Chloride	mg/L	13	27	16.9	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	246	285	257	5	5
Copper	mg/L	ND	0.00749	0.00358	1	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	5.25	15.2	7.97	5	5
Flow Rate	mgd	0.11	1.89	0.988	5	5
Hardness - Total as CaCO3	mg/L	60	78	68.8	5	5
Iron	mg/L	0.343	0.807	0.565	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.5	5.05	4.08	5	5
Manganese	mg/L	0.0742	0.139	0.107	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	0.91	0.427	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	7.21	8.3	7.49	5	5
Phosphorous	mg/L	ND	0.07	0.059	4	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	2.27	3.61	2.66	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	17.6	26.8	21.3	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	33.5	76.6	62.8	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
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 4.17 Non-Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	20	60	40	5	5
Aluminum	mg/L	ND	0.563	0.218	2	5
Ammonia	mg/L	ND	0.26	0.132	1	5
Antimony	mg/L	ND	ND	ND	0	5
Arsenic	mg/L	ND	ND	ND	0	5
Barium	mg/L	0.0502	0.0631	0.0556	5	5
Beryllium	mg/L	ND	ND	ND	0	5
Cadmium	mg/L	ND	ND	ND	0	5
Calcium	mg/L	12.2	17.3	15.5	5	5
Chloride	mg/L	11.8	25.7	21	5	5
Chromium	mg/L	ND	ND	ND	0	5
Cobalt	mg/L	ND	ND	ND	0	5
Conductivity	umho/cm	178	337	267	5	5
Copper	mg/L	ND	0.0089	0.00386	1	5
Cyanide	mg/L	ND	ND	ND	0	5
Dissolved Oxygen	mg/L	2.31	13.4	6.37	5	5
Flow Rate	mgd	0.03	1.26	0.322	5	5
Hardness - Total as CaCO3	mg/L	45	64	54.8	5	5
Iron	mg/L	0.248	0.442	0.322	5	5
Lead	mg/L	ND	ND	ND	0	5
Magnesium	mg/L	3.13	4.12	3.87	5	5
Manganese	mg/L	0.054	0.137	0.0904	5	5
Mercury	mg/L	ND	ND	ND	0	5
Nickel	mg/L	ND	ND	ND	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.19	0.97	0.678	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	7	7.5	7.14	5	5
Phosphorous	mg/L	ND	0.08	0.05	3	5
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	5
Potassium	mg/L	1.64	3.98	2.9	5	5
Selenium	mg/L	ND	ND	ND	0	5
Silver	mg/L	ND	ND	ND	0	5
Sodium	mg/L	13.2	40.5	30	5	5
Suspended Solids	mg/L	ND	ND	ND	0	5
Temperature	deg F	39.3	88.4	68.4	5	5
Thallium	mg/L	ND	ND	ND	0	5
Trichloroethene	ug/L	ND	ND	ND	0	5
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 4.19 Non-Radiological Monitoring Data for Surface Water Location C746KUP

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	50	33.5	4	4
Aluminum	mg/L	ND	0.407	0.243	2	4
Ammonia	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	0.0375	0.0508	0.0454	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	15.6	21.8	18.6	4	4
Chloride	mg/L	8.9	15.8	11.3	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	185	268	223	4	4
Copper	mg/L	ND	0.00765	0.00384	1	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	5.25	12.5	8.31	4	4
Flow Rate	mgd	0.13	1.43	0.608	4	4
Hardness - Total as CaCO3	mg/L	38	70	60.5	4	4
Iron	mg/L	ND	0.451	0.306	3	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.6	4.29	3.52	4	4
Manganese	mg/L	0.0503	0.175	0.0977	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.21	0.51	0.315	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	7.24	8.2	7.57	4	4
Phosphorous	mg/L	ND	0.11	0.0525	2	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	2.53	4.91	3.6	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	12.5	25.6	18.4	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	33.5	71.9	57.2	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
Uranium	mg/L	ND	0.00587	0.00192	1	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 L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	50	35	3	3
Aluminum	mg/L	0.241	1.1	0.545	3	3
Ammonia	mg/L	ND	ND	ND	0	3
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Barium	mg/L	0.0272	0.0511	4.21E-02	3	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Calcium	mg/L	18.1	36.5	27	3	3
Chloride	mg/L	12.9	42.2	25	3	3
Chromium	mg/L	ND	ND	ND	0	3
Cobalt	mg/L	ND	0.00117	7.23E-04	1	3
Conductivity	umho/cm	219	506	350	3	3
Copper	mg/L	ND	ND	ND	0	3
Cyanide	mg/L	ND	ND	ND	0	3
Dissolved Oxygen	mg/L	6.14	10.6	7.83	3	3
Hardness - Total as CaCO3	mg/L	76	137	105	3	3
Iron	mg/L	0.525	1.23	0.826	3	3
Lead	mg/L	ND	ND	ND	0	3
Magnesium	mg/L	5.75	12	8.55	3	3
Manganese	mg/L	0.0522	0.327	0.208	3	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	ND	ND	ND	0	3
Nitrate/Nitrite as Nitrogen	mg/L	0.42	2	1.11	3	3
PCB-1016	ug/L	ND	ND	ND	0	3
PCB-1221	ug/L	ND	ND	ND	0	3
PCB-1232	ug/L	ND	ND	ND	0	3
PCB-1242	ug/L	ND	ND	ND	0	3
PCB-1248	ug/L	ND	ND	ND	0	3
PCB-1254	ug/L	ND	ND	ND	0	3
PCB-1260	ug/L	ND	ND	ND	0	3
PCB-1268	ug/L	ND	ND	ND	0	3
pH	Std Unit	6.76	7.27	7.01	3	3
Phosphorous	mg/L	0.08	0.12	0.107	3	3
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	3
Potassium	mg/L	2.21	6.64	4.09	3	3
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Sodium	mg/L	11.7	43.9	26.1	3	3
Suspended Solids	mg/L	ND	29	16.3	1	3
Temperature	deg F	48	77.1	65.2	3	3
Thallium	mg/L	ND	ND	ND	0	3
Trichloroethene	ug/L	ND	ND	ND	0	3
Uranium	mg/L	ND	0.005	2.14E-03	2	6
Vanadium	mg/L	ND	ND	ND	0	3
Zinc	mg/L	ND	ND	ND	0	3

Surface Water Non-Radiological Data

Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	42	34	3	3
Aluminum	mg/L	ND	1	0.451	2	3
Ammonia	mg/L	ND	ND	ND	0	3
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Barium	mg/L	0.0244	0.0314	2.74E-02	3	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Calcium	mg/L	16.8	25.6	20.5	3	3
Chloride	mg/L	5.6	9.6	7.7	3	3
Chromium	mg/L	ND	ND	ND	0	3
Cobalt	mg/L	ND	ND	ND	0	3
Conductivity	umho/cm	160	202	179	3	3
Copper	mg/L	ND	ND	ND	0	3
Cyanide	mg/L	ND	ND	ND	0	3
Dissolved Oxygen	mg/L	6.46	13.9	9.64	3	3
Hardness - Total as CaCO3	mg/L	68	84	75.3	3	3
Iron	mg/L	0.372	0.664	0.512	3	3
Lead	mg/L	ND	ND	ND	0	3
Magnesium	mg/L	3.95	5.37	4.72	3	3
Manganese	mg/L	0.0531	0.135	8.12E-02	3	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	ND	ND	ND	0	3
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.75	0.402	2	3
PCB-1016	ug/L	ND	ND	ND	0	3
PCB-1221	ug/L	ND	ND	ND	0	3
PCB-1232	ug/L	ND	ND	ND	0	3
PCB-1242	ug/L	ND	ND	ND	0	3
PCB-1248	ug/L	ND	ND	ND	0	3
PCB-1254	ug/L	ND	ND	ND	0	3
PCB-1260	ug/L	ND	ND	ND	0	3
PCB-1268	ug/L	ND	ND	ND	0	3
pH	Std Unit	7.39	7.82	7.6	3	3
Phosphorous	mg/L	0.1	0.14	0.113	3	3
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	3
Potassium	mg/L	1.57	1.87	1.72	3	3
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Sodium	mg/L	5.45	8.59	6.71	3	3
Suspended Solids	mg/L	ND	45	26.7	2	3
Temperature	deg F	45.8	79	66	3	3
Thallium	mg/L	ND	ND	ND	0	3
Trichloroethene	ug/L	ND	ND	ND	0	3
Uranium	mg/L	ND	ND	ND	0	6
Vanadium	mg/L	ND	ND	ND	0	3
Zinc	mg/L	ND	ND	ND	0	3

Surface Water Non-Radiological Data

Table 4.22 Non-Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	27	50	42.2	4	4
Aluminum	mg/L	ND	0.93	0.353	2	4
Ammonia	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	0.0256	0.0323	0.0294	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	19.1	31.8	25	4	4
Chloride	mg/L	5.6	11.1	9.28	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	161	237	208	4	4
Copper	mg/L	ND	ND	ND	0	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.26	14.7	9.35	4	4
Hardness - Total as CaCO3	mg/L	67	105	89	4	4
Iron	mg/L	0.26	0.604	0.433	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	4.12	7.59	6.1	4	4
Manganese	mg/L	0.0365	0.0936	0.0638	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	1.7	0.796	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	7.36	7.86	7.62	4	4
Phosphorous	mg/L	0.09	0.14	0.11	4	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.64	2.08	1.87	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	5.68	9.2	7.63	4	4
Suspended Solids	mg/L	ND	30	22.2	3	4
Temperature	deg F	49	79.6	68.4	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
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 4.23 Non-Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	33	50	39.3	3	3
Aluminum	mg/L	0.2	0.759	0.398	3	3
Ammonia	mg/L	ND	ND	ND	0	3
Antimony	mg/L	ND	ND	ND	0	3
Arsenic	mg/L	ND	ND	ND	0	3
Barium	mg/L	0.0381	0.0498	4.33E-02	3	3
Beryllium	mg/L	ND	ND	ND	0	3
Cadmium	mg/L	ND	ND	ND	0	3
Calcium	mg/L	35.5	38.4	37.2	3	3
Chloride	mg/L	17.5	31.6	23.4	3	3
Chromium	mg/L	ND	ND	ND	0	3
Cobalt	mg/L	ND	ND	ND	0	3
Conductivity	umho/cm	360	412	380	3	3
Copper	mg/L	ND	ND	ND	0	3
Cyanide	mg/L	ND	ND	ND	0	3
Dissolved Oxygen	mg/L	6.46	12.9	9.19	3	3
Hardness - Total as CaCO3	mg/L	68	162	124	3	3
Iron	mg/L	0.291	0.852	0.496	3	3
Lead	mg/L	ND	ND	ND	0	3
Magnesium	mg/L	10.4	13.2	12	3	3
Manganese	mg/L	0.0349	0.0713	0.0571	3	3
Mercury	mg/L	ND	ND	ND	0	3
Nickel	mg/L	ND	ND	ND	0	3
Nitrate/Nitrite as Nitrogen	mg/L	0.77	1.42	1.2	3	3
PCB-1016	ug/L	ND	ND	ND	0	3
PCB-1221	ug/L	ND	ND	ND	0	3
PCB-1232	ug/L	ND	ND	ND	0	3
PCB-1242	ug/L	ND	ND	ND	0	3
PCB-1248	ug/L	ND	ND	ND	0	3
PCB-1254	ug/L	ND	ND	ND	0	3
PCB-1260	ug/L	ND	ND	ND	0	3
PCB-1268	ug/L	ND	ND	ND	0	3
pH	Std Unit	7.5	7.8	7.64	3	3
Phosphorous	mg/L	0.07	0.15	0.123	3	3
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	3
Potassium	mg/L	2.36	3.17	2.64	3	3
Selenium	mg/L	ND	ND	ND	0	3
Silver	mg/L	ND	ND	ND	0	3
Sodium	mg/L	12.6	22	16.6	3	3
Suspended Solids	mg/L	ND	37	26.3	2	3
Temperature	deg F	41.9	74.4	62.7	3	3
Thallium	mg/L	ND	ND	ND	0	3
Trichloroethene	ug/L	ND	ND	ND	0	3
Uranium	mg/L	ND	ND	ND	0	6
Vanadium	mg/L	ND	ND	ND	0	3
Zinc	mg/L	ND	ND	ND	0	3

Surface Water Non-Radiological Data

Table 4.24 Non-Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	15	28	21.5	4	4
Aluminum	mg/L	ND	0.274	0.17	2	4
Ammonia	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	0.0447	0.0519	0.0477	4	4
Beryllium	mg/L	ND	ND	ND	0	4
Cadmium	mg/L	ND	ND	ND	0	4
Calcium	mg/L	11.4	14.8	12.8	4	4
Chloride	mg/L	11	13	11.8	4	4
Chromium	mg/L	ND	ND	ND	0	4
Cobalt	mg/L	ND	ND	ND	0	4
Conductivity	umho/cm	141	172	155	4	4
Copper	mg/L	ND	0.0135	0.00709	2	4
Cyanide	mg/L	ND	ND	ND	0	4
Dissolved Oxygen	mg/L	6.02	12.6	9.05	4	4
Flow Rate	mgd	0.81	9.15	3.81	4	4
Hardness - Total as CaCO3	mg/L	39	54	49	4	4
Iron	mg/L	0.61	0.884	0.758	4	4
Lead	mg/L	ND	ND	ND	0	4
Magnesium	mg/L	2.91	3.24	3.08	4	4
Manganese	mg/L	0.235	0.329	0.277	4	4
Mercury	mg/L	ND	ND	ND	0	4
Nickel	mg/L	ND	ND	ND	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.56	0.9	0.697	3	3
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	7.45	7.15	4	4
Phosphorous	mg/L	ND	0.07	0.0537	3	4
Polychlorinated biphenyl	ug/L	ND	ND	ND	0	4
Potassium	mg/L	1.93	2.98	2.47	4	4
Selenium	mg/L	ND	ND	ND	0	4
Silver	mg/L	ND	ND	ND	0	4
Sodium	mg/L	9.48	13.2	10.6	4	4
Suspended Solids	mg/L	ND	ND	ND	0	4
Temperature	deg F	41.8	76.4	62	4	4
Thallium	mg/L	ND	ND	ND	0	4
Trichloroethene	ug/L	ND	ND	ND	0	4
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 4.25 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP1

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	41	70	57.7	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	21.2	24.3	22.1	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	31	32	31.7	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	212	353	306	4	4
Dissolved Oxygen	mg/L	4.71	4.97	4.84	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	7.88	9.87	8.59	4	4
Manganese	mg/L	ND	0.05	0.0124	1	4
pH	Std Unit	5.95	6.4	6.12	4	4
Potassium	mg/L	1.79	2.77	2.12	4	4
Sodium	mg/L	27.8	32.5	30.4	4	4
Sulfate	mg/L	11.7	13.1	12.2	4	4
Temperature	deg F	53.6	62.1	58.7	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	3.2	5.4	4.15	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.26 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP2

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	41	90	56.5	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	23.3	26.5	24.9	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	35.6	37.6	36.7	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	357	392	368	4	4
Dissolved Oxygen	mg/L	3.84	5.57	4.54	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	8.34	10.9	9.33	4	4
Manganese	mg/L	ND	0.0377	0.0128	3	4
pH	Std Unit	6	6.59	6.22	4	4
Potassium	mg/L	1.59	1.66	1.63	4	4
Sodium	mg/L	27	33	30.3	4	4
Sulfate	mg/L	11.1	13	12.2	4	4
Temperature	deg F	53.4	62.2	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	8	10	9.07	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.27 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP3

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	45	70	52.5	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	23.3	26	24.9	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	38	39.1	38.7	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	359	389	368	4	4
Dissolved Oxygen	mg/L	4.31	5.14	4.54	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	8.07	10.6	9	4	4
Manganese	mg/L	ND	0.0272	0.00867	1	4
pH	Std Unit	6	6.57	6.2	4	4
Potassium	mg/L	1.47	1.56	1.51	4	4
Sodium	mg/L	29.6	34.7	31.8	4	4
Sulfate	mg/L	11.2	12	11.5	4	4
Temperature	deg F	54.7	59.7	57.6	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	19	29	24.7	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.28 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP4

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	50	70	56.2	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	25.1	28	26.5	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	38	39.5	38.9	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	134	405	322	4	4
Dissolved Oxygen	mg/L	3.93	5.55	4.74	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	8.38	11.1	9.45	4	4
Manganese	mg/L	ND	0.00557	0.00399	2	4
pH	Std Unit	6.02	6.57	6.21	4	4
Potassium	mg/L	1.62	1.77	1.68	4	4
Sodium	mg/L	30.2	35.9	32.8	4	4
Sulfate	mg/L	12.7	13.2	13	4	4
Temperature	deg F	56	59.5	57.9	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	18	27	22.5	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.29 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	35	50	40.2	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	23	25.3	23.9	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	33.3	34.2	33.8	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	344	371	353	4	4
Dissolved Oxygen	mg/L	4.17	4.9	4.58	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	7.81	9.86	8.52	4	4
Manganese	mg/L	ND	0.00611	0.0034	1	4
pH	Std Unit	6.08	6.52	6.23	4	4
Potassium	mg/L	1.55	1.67	1.59	4	4
Sodium	mg/L	29	36.6	32.1	4	4
Sulfate	mg/L	14.8	15.3	15	4	4
Temperature	deg F	57.2	60.4	58.4	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	400	470	438	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Surface Water Non-Radiological Data

Table 4.30 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	35	50	43	4	4
Benzene	ug/L	ND	ND	ND	0	4
Bromodichloromethane	ug/L	ND	ND	ND	0	4
Calcium	mg/L	20.2	22.6	21.6	4	4
Carbon tetrachloride	ug/L	ND	ND	ND	0	4
Chloride	mg/L	34	36.3	35.1	4	4
Chloroform	ug/L	ND	ND	ND	0	4
cis-1,2-Dichloroethene	ug/L	ND	ND	ND	0	4
Conductivity	umho/cm	325	350	332	4	4
Dissolved Oxygen	mg/L	4.21	6	4.7	4	4
Ethylbenzene	ug/L	ND	ND	ND	0	4
m,p-Xylene	ug/L	ND	ND	ND	0	4
Magnesium	mg/L	6.78	8.84	7.73	4	4
Manganese	mg/L	ND	0.167	0.0603	3	4
pH	Std Unit	6	6.45	6.17	4	4
Potassium	mg/L	1.33	2	1.61	4	4
Sodium	mg/L	27.8	32.6	30.2	4	4
Sulfate	mg/L	13.4	17.8	14.7	4	4
Temperature	deg F	51.4	62.2	57.8	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	160	230	192	4	4
Uranium	mg/L	ND	ND	ND	0	1
Vinyl chloride	ug/L	ND	ND	ND	0	4

Sediment Non-Radiological Data

Table 4.30 Non-Radiological Data for Sediment Location S20

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2360	3170	2760	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	29.5	33.4	31.4	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	494	653	574	2	2
Chromium	mg/kg	5.61	6.65	6.13	2	2
Cobalt	mg/kg	2.7	3.3	3	2	2
Copper	mg/kg	4.08	5.81	4.95	2	2
Iron	mg/kg	5580	5950	5760	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	258	338	298	2	2
Manganese	mg/kg	165	346	256	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	44.4	52.2	48.3	2	2
Nickel	mg/kg	ND	5	2.67	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	153	224	188	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
Total Organic Carbon (TOC)	ug/g	4900	7300	6100	2	2
Uranium	mg/kg	ND	ND	ND	0	2
Uranium	ug/g	ND	ND	ND	0	1
Vanadium	mg/kg	10.6	11.1	10.8	2	2
Zinc	mg/kg	ND	20	11.2	1	2

Sediment Non-Radiological Data

Table 4.31 Non-Radiological Data for Sediment Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3680	3910	3800	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	44.5	50.8	47.6	2	2
Beryllium	mg/kg	ND	0.5	0.337	1	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	2430	10500	6460	2	2
Chromium	mg/kg	18.3	18.9	18.6	2	2
Cobalt	mg/kg	4.18	4.25	4.21	2	2
Copper	mg/kg	15.6	20.9	18.2	2	2
Iron	mg/kg	5720	6630	6180	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	726	806	766	2	2
Manganese	mg/kg	50	50.3	50.1	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	77.6	128	103	2	2
Nickel	mg/kg	8.09	8.36	8.22	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	375	418	396	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	220	243	232	2	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	2400	4500	3450	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	9.68	11.3	10.5	2	2
Zinc	mg/kg	40	159	99.5	2	2

Sediment Non-Radiological Data

Table 4.32 Non-Radiological Data for Sediment Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	5430	8720	6580	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	ND	13.1	6.16	1	3
Barium	mg/kg	58.4	85.7	68.6	3	3
Beryllium	mg/kg	0.502	0.752	0.603	3	3
Cadmium	mg/kg	ND	2	1.19	2	3
Calcium	mg/kg	1060	1210	1120	3	3
Chromium	mg/kg	35.3	51.1	40.7	3	3
Cobalt	mg/kg	3.72	6.27	5.16	3	3
Copper	mg/kg	24.1	37.8	28.9	3	3
Iron	mg/kg	8950	13800	11200	3	3
Lead	mg/kg	ND	ND	ND	0	3
Magnesium	mg/kg	693	878	765	3	3
Manganese	mg/kg	144	185	159	3	3
Mercury	mg/kg	ND	ND	ND	0	3
Moisture	%	46.8	83.2	61.7	3	3
Nickel	mg/kg	10.3	15.9	12.4	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	428	670	519	3	3
Selenium	mg/kg	ND	ND	ND	0	3
Silver	mg/kg	ND	ND	ND	0	3
Sodium	mg/kg	ND	222	174	2	3
Thallium	mg/kg	ND	ND	ND	0	3
Total Organic Carbon (TOC)	ug/g	2200	4000	2800	3	3
Uranium	ug/g	36.9	36.9	36.9	1	1
Uranium	mg/kg	ND	ND	ND	0	3
Vanadium	mg/kg	16.7	25	20	3	3
Zinc	mg/kg	30.1	32.2	31.1	3	3

Sediment Non-Radiological Data

Table 4.33 Non-Radiological Data for Sediment Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4210	4560	4380	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	29.9	39.2	34.5	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1130	1310	1220	2	2
Chromium	mg/kg	9.8	11.4	10.6	2	2
Cobalt	mg/kg	3	3.5	3.25	2	2
Copper	mg/kg	13.6	16.1	14.8	2	2
Iron	mg/kg	5290	6900	6100	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	697	738	718	2	2
Manganese	mg/kg	28	55.5	41.7	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	116	116	116	2	2
Nickel	mg/kg	5.3	6.35	5.83	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	406	443	424	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	213	156	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	2800	3400	3100	2	2
Uranium	mg/kg	ND	ND	ND	0	2
Uranium	ug/g	ND	ND	ND	0	1
Vanadium	mg/kg	8.58	10.6	9.59	2	2
Zinc	mg/kg	38.2	39.7	39	2	2

Sediment Non-Radiological Data

Table 4.34 Non-Radiological Data for Sediment Location S1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3070	6300	4680	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	23.2	24	23.6	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	719	4820	2770	2	2
Chromium	mg/kg	8.33	12.9	10.6	2	2
Cobalt	mg/kg	2.96	4.69	3.83	2	2
Copper	mg/kg	7.04	7.97	7.5	2	2
Iron	mg/kg	5840	6320	6080	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	370	446	408	2	2
Manganese	mg/kg	77	137	107	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	43.1	72.6	57.8	2	2
Nickel	mg/kg	ND	5	3.56	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	220	445	332	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	200	127	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	2600	3800	3200	2	2
Uranium	mg/kg	ND	ND	ND	0	2
Uranium	ug/g	7.51	7.51	7.51	1	1
Vanadium	mg/kg	10	13.9	11.9	2	2
Zinc	mg/kg	22.9	25.3	24.1	2	2

Sediment Non-Radiological Data

Table 4.35 Non-Radiological Data for Sediment Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	6390	6720	6560	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	25.9	38.3	32.1	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	985	1050	1020	2	2
Chromium	mg/kg	7.52	17.2	12.4	2	2
Cobalt	mg/kg	ND	3.62	2.44	1	2
Copper	mg/kg	5.82	10.9	8.36	2	2
Iron	mg/kg	7280	8790	8040	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	361	490	426	2	2
Manganese	mg/kg	126	191	158	2	2
Mercury	mg/kg	ND	0.53	0.31	1	2
Moisture	%	33	37.3	35.1	2	2
Nickel	mg/kg	ND	5.21	3.85	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	217	219	218	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
Total Organic Carbon (TOC)	ug/g	1800	2300	2050	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	12	21.6	16.8	2	2
Zinc	mg/kg	ND	24.9	17.4	1	2

Sediment Non-Radiological Data

Table 4.36 Non-Radiological Data for Sediment Location S33

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2580	6420	4500	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	16.1	7.85	1	2
Barium	mg/kg	29.5	54.4	42	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	318	948	633	2	2
Chromium	mg/kg	6.06	11.3	8.68	2	2
Cobalt	mg/kg	2.26	3.06	2.66	2	2
Copper	mg/kg	4.81	7.03	5.92	2	2
Iron	mg/kg	4580	6360	5470	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	276	585	430	2	2
Manganese	mg/kg	106	424	265	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	30.7	36.9	33.8	2	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	165	612	388	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	200	91	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	1900	3400	2650	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	8.38	14.3	11.3	2	2
Zinc	mg/kg	ND	23.5	15.8	1	2

Sediment Non-Radiological Data

Table 4.37 Non-Radiological Data for Sediment Location S21

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	6870	7180	7020	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	43.7	71.2	57.4	2	2
Beryllium	mg/kg	0.51	0.518	0.514	2	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1170	1210	1190	2	2
Chromium	mg/kg	11.9	13.8	12.8	2	2
Cobalt	mg/kg	3.77	5.2	4.49	2	2
Copper	mg/kg	5.61	7.71	6.66	2	2
Iron	mg/kg	9430	11900	10700	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	588	738	663	2	2
Manganese	mg/kg	155	163	159	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	25.3	42.7	34	2	2
Nickel	mg/kg	ND	5	3.72	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	257	269	263	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	200	111	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	1400	2200	1800	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	17.8	22.5	20.1	2	2
Zinc	mg/kg	ND	20	12.7	1	2

Sediment Non-Radiological Data

Table 4.38 Non-Radiological Data for Sediment Location S2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4100	4880	4490	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	32.6	72.4	52.5	2	2
Beryllium	mg/kg	ND	0.646	0.448	1	2
Cadmium	mg/kg	ND	2.07	1.53	1	2
Calcium	mg/kg	960	1330	1140	2	2
Chromium	mg/kg	12.2	249	131	2	2
Cobalt	mg/kg	2.71	8.23	5.47	2	2
Copper	mg/kg	5.33	17.6	11.5	2	2
Iron	mg/kg	5390	14800	10100	2	2
Lead	mg/kg	ND	20	14.4	1	2
Magnesium	mg/kg	381	511	446	2	2
Manganese	mg/kg	248	559	404	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	42.3	46.1	44.2	2	2
Nickel	mg/kg	ND	5.27	3.88	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	260	155	1	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	ND	260	162	1	2
Potassium	mg/kg	228	277	252	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
Total Organic Carbon (TOC)	ug/g	4200	6400	5300	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	10.5	29.4	19.9	2	2
Zinc	mg/kg	28.4	126	77.2	2	2

Sediment Non-Radiological Data

Table 4.39 Non-Radiological Data for Sediment Location S30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	6190	6190	6190	1	1
Antimony	mg/kg	ND	ND	ND	0	1
Arsenic	mg/kg	ND	ND	ND	0	1
Barium	mg/kg	63	63	63	1	1
Beryllium	mg/kg	ND	ND	ND	0	1
Cadmium	mg/kg	ND	ND	ND	0	1
Calcium	mg/kg	767	767	767	1	1
Chromium	mg/kg	12.5	12.5	12.5	1	1
Cobalt	mg/kg	3.88	3.88	3.88	1	1
Copper	mg/kg	4.08	4.08	4.08	1	1
Iron	mg/kg	8870	8870	8870	1	1
Lead	mg/kg	ND	ND	ND	0	1
Magnesium	mg/kg	438	438	438	1	1
Manganese	mg/kg	273	273	273	1	1
Mercury	mg/kg	ND	ND	ND	0	1
Moisture	%	38.9	38.9	38.9	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	ND	ND	ND	0	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
Polychlorinated biphenyl	ug/kg	ND	ND	ND	0	1
Potassium	mg/kg	243	243	243	1	1
Selenium	mg/kg	ND	ND	ND	0	1
Silver	mg/kg	ND	ND	ND	0	1
Sodium	mg/kg	ND	ND	ND	0	1
Thallium	mg/kg	ND	ND	ND	0	1
Total Organic Carbon (TOC)	ug/g	730	730	730	1	1
Uranium	mg/kg	ND	ND	ND	0	1
Uranium	ug/g	ND	ND	ND	0	1
Vanadium	mg/kg	10.9	10.9	10.9	1	1
Zinc	mg/kg	20.1	20.1	20.1	1	1

Sediment Non-Radiological Data

Table 4.40 Non-Radiological Data for Sediment Location S27

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2220	4350	3280	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	22.7	35	28.8	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	461	686	574	2	2
Chromium	mg/kg	14.5	17.4	15.9	2	2
Cobalt	mg/kg	ND	2.5	1.83	1	2
Copper	mg/kg	2.84	6.85	4.84	2	2
Iron	mg/kg	3960	5270	4620	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	213	374	294	2	2
Manganese	mg/kg	102	178	140	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	36.6	44.2	40.4	2	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	131	230	180	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
Total Organic Carbon (TOC)	ug/g	2700	4400	3550	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	6.95	10.2	8.57	2	2
Zinc	mg/kg	ND	24.5	17.2	1	2

Sediment Non-Radiological Data

Table 4.41 Non-Radiological Data for Sediment Location S34

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2490	3140	2820	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	ND	ND	ND	0	3
Barium	mg/kg	25.7	29.2	27	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Calcium	mg/kg	308	495	391	3	3
Chromium	mg/kg	17.2	19.1	18	3	3
Cobalt	mg/kg	ND	2.5	1.55	1	3
Copper	mg/kg	ND	14.4	8.31	2	3
Iron	mg/kg	3590	4150	3840	3	3
Lead	mg/kg	ND	ND	ND	0	3
Magnesium	mg/kg	229	328	275	3	3
Manganese	mg/kg	61.5	73	66.2	3	3
Mercury	mg/kg	ND	ND	ND	0	3
Moisture	%	25.1	41.7	36.1	3	3
Nickel	mg/kg	ND	ND	ND	0	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	120	66.7	1	3
Polychlorinated biphenyl	ug/kg	ND	130	83.3	1	3
Potassium	mg/kg	184	232	209	3	3
Selenium	mg/kg	ND	ND	ND	0	3
Silver	mg/kg	ND	ND	ND	0	3
Sodium	mg/kg	ND	ND	ND	0	3
Thallium	mg/kg	ND	ND	ND	0	3
Total Organic Carbon (TOC)	ug/g	1800	3900	2800	3	3
Uranium	ug/g	ND	ND	ND	0	2
Uranium	mg/kg	ND	ND	ND	0	3
Vanadium	mg/kg	7.95	8.21	8.05	3	3
Zinc	mg/kg	ND	ND	ND	0	3

Sediment Non-Radiological Data

Table 4.42 Non-Radiological Data for Sediment Location C746KTB2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2420	2850	2640	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	28.1	30	29	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	675	699	687	2	2
Chromium	mg/kg	5.46	6.97	6.21	2	2
Cobalt	mg/kg	ND	3.04	2.14	1	2
Copper	mg/kg	4.21	5.36	4.79	2	2
Iron	mg/kg	4510	5720	5120	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	290	296	293	2	2
Manganese	mg/kg	219	284	252	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	53.2	152	102	2	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	174	174	174	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	200	95.7	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	3200	9500	6350	2	2
Uranium	mg/kg	ND	ND	ND	0	2
Uranium	ug/g	ND	ND	ND	0	1
Vanadium	mg/kg	8.29	11.7	9.99	2	2
Zinc	mg/kg	ND	20	14.7	1	2

Sediment Non-Radiological Data

Table 4.43 Non-Radiological Data for Sediment Location C746KUP

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2060	3800	2930	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	32.2	36.1	34.1	2	2
Beryllium	mg/kg	ND	0.5	0.28	1	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	697	1130	914	2	2
Chromium	mg/kg	4.79	22.1	13.4	2	2
Cobalt	mg/kg	2.75	3.39	3.07	2	2
Copper	mg/kg	10	12.4	11.2	2	2
Iron	mg/kg	4810	7800	6300	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	279	411	345	2	2
Manganese	mg/kg	268	325	296	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	38.2	60.5	49.3	2	2
Nickel	mg/kg	ND	5	3.07	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	166	214	190	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	ND	ND	0	2
Sodium	mg/kg	ND	200	84.9	1	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	2400	4500	3450	2	2
Uranium	ug/g	ND	ND	ND	0	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	9.06	19.5	14.3	2	2
Zinc	mg/kg	ND	24.8	17.4	1	2

Sediment Non-Radiological Data

Table 4.44 Non-Radiological Data for Sediment Location S32

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	6040	8380	7210	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	50.6	53.3	51.9	2	2
Beryllium	mg/kg	ND	0.51	0.337	1	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	1930	2380	2160	2	2
Chromium	mg/kg	28.7	90.3	59.5	2	2
Cobalt	mg/kg	2.42	3.06	2.74	2	2
Copper	mg/kg	20.8	82	51.4	2	2
Iron	mg/kg	6680	11800	9240	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	778	884	831	2	2
Manganese	mg/kg	96.3	127	112	2	2
Mercury	mg/kg	ND	0.24	0.165	1	2
Moisture	%	51.8	67.5	59.6	2	2
Nickel	mg/kg	16.5	34.9	25.7	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	2280	1160	1	2
PCB-1254	ug/kg	320	1290	805	2	2
PCB-1260	ug/kg	210	580	395	2	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	530	4160	2340	2	2
Potassium	mg/kg	524	668	596	2	2
Selenium	mg/kg	ND	ND	ND	0	2
Silver	mg/kg	ND	2.5	1.47	1	2
Sodium	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Total Organic Carbon (TOC)	ug/g	3800	15000	9400	2	2
Uranium	ug/g	36.2	36.2	36.2	1	1
Uranium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	12.9	23.2	18	2	2
Zinc	mg/kg	46.3	72.4	59.3	2	2

Sediment Non-Radiological Data

Table 4.45 Non-Radiological Data for Sediment Location S28

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2760	3940	3350	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	ND	ND	ND	0	2
Barium	mg/kg	33.6	36.5	35	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	ND	ND	0	2
Calcium	mg/kg	291	529	410	2	2
Chromium	mg/kg	4.58	6.63	5.61	2	2
Cobalt	mg/kg	2.96	3.62	3.29	2	2
Copper	mg/kg	6	7.14	6.57	2	2
Iron	mg/kg	4820	5090	4960	2	2
Lead	mg/kg	ND	ND	ND	0	2
Magnesium	mg/kg	297	368	332	2	2
Manganese	mg/kg	228	259	244	2	2
Mercury	mg/kg	ND	ND	ND	0	2
Moisture	%	40.4	45.6	43	2	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	194	363	278	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
Total Organic Carbon (TOC)	ug/g	3400	5200	4300	2	2
Uranium	mg/kg	ND	ND	ND	0	2
Uranium	ug/g	ND	ND	ND	0	1
Vanadium	mg/kg	8.36	10.7	9.53	2	2
Zinc	mg/kg	ND	ND	ND	0	2

Deer Non-Radiological Data

Table 4.46 Non-Radiological Analysis of Deer Liver Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	1.8	0.782	2	6
Antimony	mg/kg	ND	1.33	0.765	1	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	0.0444	0.128	7.66E-02	6	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	ND	0.225	0.128	4	6
Chromium	mg/kg	2.17	2.73	2.37	6	6
Cobalt	mg/kg	ND	0.255	0.117	3	6
Copper	mg/kg	17.4	96.7	54.7	6	6
Iron	mg/kg	59.9	129	93.2	6	6
Lead	mg/kg	ND	1.34	0.877	4	6
Lipids	%	4.92	7.49	5.93	6	6
Manganese	mg/kg	2.67	4.72	3.6	6	6
Mercury	mg/kg	ND	ND	ND	0	6
Nickel	mg/kg	ND	0.661	0.245	2	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	21.5	7.57	1	6
PCB-1268	ug/kg	ND	ND	ND	0	6
Polychlorinated biphenyl	ug/kg	ND	21.5	7.57	1	6
Selenium	mg/kg	ND	ND	ND	0	6
Silver	mg/kg	ND	0.234	0.13	2	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	26.1	43.5	32	6	6

Deer Non-Radiological Data

Table 4.47 Non-Radiological Analysis of Deer Muscle Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	ND	ND	0	6
Antimony	mg/kg	ND	ND	ND	0	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	ND	0.0648	3.31E-02	5	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	ND	0.209	0.144	5	6
Chromium	mg/kg	1.59	1.8	1.71	6	6
Cobalt	mg/kg	ND	ND	ND	0	6
Copper	mg/kg	0.76	1.57	1.38	6	6
Iron	mg/kg	34	44.2	39.5	6	6
Lead	mg/kg	ND	1.05	0.575	2	6
Manganese	mg/kg	0.175	0.481	0.254	6	6
Mercury	mg/kg	ND	ND	ND	0	6
Nickel	mg/kg	ND	0.277	0.157	1	6
Selenium	mg/kg	ND	ND	ND	0	6
Silver	mg/kg	ND	1.37	0.303	1	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	12.8	18	15.3	6	6

Table 4.48 Non-Radiological Analysis of Deer Kidney Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	2.43	1.09	4	6
Antimony	mg/kg	ND	ND	ND	0	6
Arsenic	mg/kg	ND	ND	ND	0	6
Barium	mg/kg	0.383	0.698	0.527	6	6
Beryllium	mg/kg	ND	ND	ND	0	6
Cadmium	mg/kg	0.755	1.76	1.15	6	6
Chromium	mg/kg	1.21	1.88	1.6	6	6
Cobalt	mg/kg	ND	ND	ND	0	6
Copper	mg/kg	2.6	4.25	3.66	6	6
Iron	mg/kg	38.3	82.3	68.3	6	6
Lead	mg/kg	ND	1.48	0.659	2	6
Manganese	mg/kg	0.955	2.93	1.72	6	6
Mercury	mg/kg	0.025	0.042	0.0335	6	6
Nickel	mg/kg	0.288	0.861	0.498	6	6
Selenium	mg/kg	0.41	0.67	0.533	6	6
Silver	mg/kg	ND	0.398	0.138	1	6
Thallium	mg/kg	ND	ND	ND	0	6
Vanadium	mg/kg	ND	ND	ND	0	6
Zinc	mg/kg	16.2	29.7	20.9	6	6

Deer Non-Radiological Data

Table 4.49 Non-Radiological Analysis of Deer Fat Tissue for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Lipids	%	43.7	90.4	71.8	12	12
PCB-1016	ug/kg	ND	ND	ND	0	12
PCB-1221	ug/kg	ND	ND	ND	0	12
PCB-1232	ug/kg	ND	ND	ND	0	12
PCB-1242	ug/kg	ND	ND	ND	0	12
PCB-1248	ug/kg	ND	ND	ND	0	12
PCB-1254	ug/kg	ND	ND	ND	0	12
PCB-1260	ug/kg	18.8	147	60.6	12	12
PCB-1268	ug/kg	ND	ND	ND	0	12
Polychlorinated biphenyl	ug/kg	18.8	147	60.6	12	12

Fish Non-Radiological Data

Table 4.50 Non-Radiological Analysis of Fish Tissue at BM 5.85 for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3.82	19	11.4	2	2
Antimony	mg/kg	ND	ND	ND	0	2
Arsenic	mg/kg	0.0111	0.0514	0.0312	2	2
Barium	mg/kg	0.284	3.15	1.72	2	2
Beryllium	mg/kg	ND	ND	ND	0	2
Cadmium	mg/kg	ND	0.345	0.203	1	2
Chromium	mg/kg	0.211	0.494	0.352	2	2
Cobalt	mg/kg	ND	ND	ND	0	2
Copper	mg/kg	0.32	1.21	0.765	2	2
Iron	mg/kg	9.84	54.6	32.2	2	2
Lead	mg/kg	ND	0.129	0.0883	1	2
Lipids	%	5.48	5.48	5.48	1	1
Lipids	N	1.83	1.83	1.83	1	1
Manganese	mg/kg	0.515	7.12	3.82	2	2
Mercury	mg/kg	0.059	0.124	0.0915	2	2
Nickel	mg/kg	ND	0.366	0.232	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	39.5	22.2	1	2
PCB-1254	ug/kg	ND	ND	ND	0	2
PCB-1260	ug/kg	85.7	201	143	2	2
PCB-1268	ug/kg	ND	ND	ND	0	2
Polychlorinated biphenyl	ug/kg	125	201	163	2	2
Selenium	mg/kg	0.417	0.545	0.481	2	2
Silver	mg/kg	ND	ND	ND	0	2
Thallium	mg/kg	ND	ND	ND	0	2
Vanadium	mg/kg	ND	ND	ND	0	2
Zinc	mg/kg	5.43	25.5	15.5	2	2

Fish Non-Radiological Data

Table 4.51 Non-Radiological Analysis of Fish Tissue at LUM 2.7 for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2.14	3.86	3.21	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	0.0164	0.0225	1.85E-02	3	3
Barium	mg/kg	ND	ND	ND	0	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Chromium	mg/kg	ND	0.164	0.132	2	3
Cobalt	mg/kg	ND	ND	ND	0	3
Copper	mg/kg	0.172	0.455	0.307	3	3
Iron	mg/kg	6.47	10.6	8.46	3	3
Lead	mg/kg	ND	ND	ND	0	3
Lipids	%	1.24	1.5	1.35	3	3
Manganese	mg/kg	0.311	0.775	0.513	3	3
Mercury	mg/kg	0.0764	0.132	0.11	3	3
Nickel	mg/kg	ND	ND	ND	0	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	21.2	14.5	2	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	27.9	34.8	30.4	3	3
PCB-1268	ug/kg	ND	ND	ND	0	3
Polychlorinated biphenyl	ug/kg	27.9	56	43.3	3	3
Selenium	mg/kg	0.55	0.865	0.725	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	4.95	6.51	5.53	3	3

Fish Non-Radiological Data

Table 4.52 Non-Radiological Analysis of Fish Tissue at LUM 4.5 for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2.5	4.92	3.36	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	0.0144	0.017	0.0155	3	3
Barium	mg/kg	0.779	1.08	0.895	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Chromium	mg/kg	0.123	0.513	0.298	3	3
Cobalt	mg/kg	ND	ND	ND	0	3
Copper	mg/kg	0.306	0.541	0.402	3	3
Iron	mg/kg	5.98	19.5	11	3	3
Lead	mg/kg	ND	ND	ND	0	3
Lipids	%	1.32	1.97	1.75	3	3
Manganese	mg/kg	0.271	0.784	0.559	3	3
Mercury	mg/kg	0.0619	0.0789	0.0728	3	3
Nickel	mg/kg	ND	0.208	0.132	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	58.6	180	120	3	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	185	467	328	3	3
PCB-1268	ug/kg	ND	ND	ND	0	3
Polychlorinated biphenyl	ug/kg	244	647	448	3	3
Selenium	mg/kg	0.749	1.06	0.869	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	3.74	5.52	4.88	3	3

Fish Non-Radiological Data

Table 4.53 Non-Radiological Analysis of Fish Tissue at LUM 5.0 for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	8.98	37.4	21.4	3	3
Antimony	mg/kg	ND	ND	ND	0	3
Arsenic	mg/kg	0.0072	0.0206	0.0135	3	3
Barium	mg/kg	0.297	0.696	0.528	3	3
Beryllium	mg/kg	ND	ND	ND	0	3
Cadmium	mg/kg	ND	ND	ND	0	3
Chromium	mg/kg	ND	0.276	0.201	2	3
Cobalt	mg/kg	ND	ND	ND	0	3
Copper	mg/kg	0.297	0.402	0.339	3	3
Iron	mg/kg	6.54	9.74	8.14	3	3
Lead	mg/kg	ND	ND	ND	0	3
Lipids	%	1.14	1.23	1.19	3	3
Manganese	mg/kg	0.62	1.21	0.86	3	3
Mercury	mg/kg	0.057	0.0732	6.36E-02	3	3
Nickel	mg/kg	ND	ND	ND	0	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	59	64.1	61	3	3
PCB-1254	ug/kg	ND	ND	ND	0	3
PCB-1260	ug/kg	141	289	198	3	3
PCB-1268	ug/kg	ND	ND	ND	0	3
Polychlorinated biphenyl	ug/kg	201	348	259	3	3
Selenium	mg/kg	1.03	1.31	1.18	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	5.78	7.3	6.56	3	3

Fish Non-Radiological Data

Table 4.54 Non-Radiological Analysis of Fish Tissue at MAM 8.6 for 2004

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1.93	29.6	19.7	4	4
Antimony	mg/kg	ND	ND	ND	0	4
Arsenic	mg/kg	0.0142	0.0219	0.0179	4	4
Barium	mg/kg	0.28	4.95	1.5	4	4
Beryllium	mg/kg	ND	ND	ND	0	4
Cadmium	mg/kg	ND	ND	ND	0	4
Chromium	mg/kg	ND	0.222	0.163	3	4
Cobalt	mg/kg	ND	ND	ND	0	4
Copper	mg/kg	0.181	1.15	0.48	4	4
Iron	mg/kg	5.93	19.7	10.4	4	4
Lead	mg/kg	ND	ND	ND	0	4
Lipids	%	1.06	5.06	2.2	4	4
Manganese	mg/kg	0.446	8.52	2.62	4	4
Mercury	mg/kg	0.0546	0.173	0.117	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	ND	ND	ND	0	4
PCB-1254	ug/kg	ND	ND	ND	0	4
PCB-1260	ug/kg	ND	15.5	7.59	1	4
PCB-1268	ug/kg	ND	ND	ND	0	4
Polychlorinated biphenyl	ug/kg	ND	15.5	7.59	1	4
Selenium	mg/kg	0.424	0.517	0.488	4	4
Silver	mg/kg	ND	ND	ND	0	4
Thallium	mg/kg	ND	ND	ND	0	4
Vanadium	mg/kg	ND	ND	ND	0	4
Zinc	mg/kg	4.17	20.4	8.73	4	4

DOE/OR/07-2233/V3
Volume III

PADUCAH SITE

Annual Site Environmental Report Summary

2004

Preface

This report summarizes the information found in the Paducah Annual Site Environmental Report (ASER) for 2004, DOE/OR/07-2233/V1. The U.S. Department of Energy (DOE) requires an annual report to be prepared that presents the results from various environmental monitoring programs and activities carried out during the year. This report summary is written so that it can be easily understood and can educate the reader about the mission, goals, and activities of DOE at Paducah. This is a brief summary of calendar year 2004 activities. These activities include environmental monitoring, contamination cleanup, accomplishments, and general information. This report also includes and discusses data contained in the 2004 Paducah ASER. The data presented in this summary are a subset of the data included in the Paducah ASER volumes I and II.

You are encouraged to comment on the content of this summary, as well as make suggestions for future documents. Please send your comments and suggestions to:

U.S. Department of Energy

Portsmouth/Paducah Project Office

1017 Majestic Drive, Suite 200

Lexington, Kentucky 40513

Acronyms

ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	decontamination and decommissioning
DCG	derived concentration guide
DMSA	DOE Material Storage Area
DNAPL	dense, nonaqueous-phase liquid
DOE	U.S. Department of Energy
DUF_6	depleted uranium hexafluoride
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facility Compliance Agreement
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
NEPA	National Environmental Policy Act
NOV	notice of violation
PGDP	Paducah Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
SWMU	solid waste management unit
TCE	trichloroethene
TSCA	Toxic Substances Control Act
USEC	United States Enrichment Corporation

Contents

U.S. Department of Energy Planning and Management

The Paducah Gaseous Diffusion Plant (PGDP) reached its 50th anniversary of operation in October 2002 and is the only operating uranium enrichment plant in the United States. With a half century of production behind it, the plant faces significant environmental cleanup challenges. The PGDP is situated on a 3556-acre parcel of DOE-owned property in Western Kentucky, approximately ten miles west of the city of Paducah and three miles south of the Ohio River. The primary gaseous diffusion plant operations associated with the enrichment process are located on 748 acres within the plant security fence. Of the remaining acreage comprising the DOE-owned property (outside the main security fence), 1986 acres are leased to the Kentucky Department for Fish and Wildlife Resources, as part of the West Kentucky Wildlife Management Area, and the remaining land (822 acres) is maintained as a buffer zone around the secure area.

The area surrounding PGDP is predominantly rural. Immediately adjacent to PGDP is a wildlife area that is used by hunters and fishermen. The remaining area is lightly populated with randomly located residences and farms, with some private residences located immediately adjacent to the DOE property boundary and the wildlife area. The small communities of Grahamville and Heath are located approximately 1.5 and 2 miles east of the plant. Metropolis, Illinois, is located north of PGDP across the Ohio River. The PGDP is in an area of abundant surface water and groundwater resources. Bordering the east and west sides of the secure area are Little Bayou Creek and Bayou Creek, respectively. Little Bayou Creek originates in the adjacent wildlife area, and Bayou Creek originates about two and one-half miles south of PGDP. Both creeks flow north toward the Ohio River, which is about three miles north of PGDP. Water discharged from PGDP constitutes the majority of normal flow in Bayou Creek and Little Bayou Creek. The discharges are regulated by the Commonwealth of Kentucky.

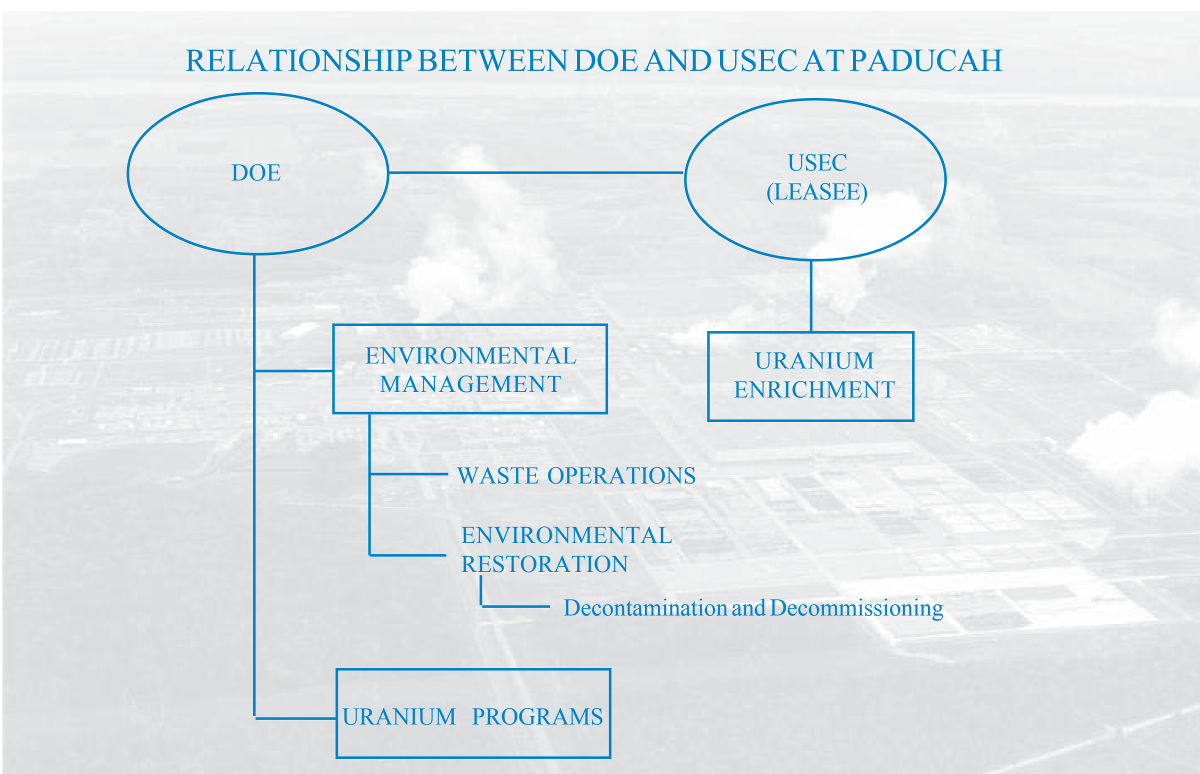
Currently, the United States Enrichment Corporation (USEC) operates the uranium enrichment facilities at PGDP. This corporation was established on October 24, 1992, by the enactment of the Energy Policy Act of 1992. The charter of USEC under this act is to provide profitable and competitive uranium enrichment services. The USEC has leased the uranium enrichment production facilities from DOE since July 1, 1993, but DOE has retained the nonleased facilities and is responsible for the decontamination and decommissioning (D&D) and cleanup for environmental conditions that existed before July 1, 1993.

In 2004, DOE began implementation of an agreement between DOE and the Commonwealth of Kentucky that was intended to promote accelerated cleanup at PGDP, develop integrated planning and funding requests, meet commitments under the Paducah Federal Facility Agreement, and settle all identified outstanding enforcement and compliance issues through an Agreed Order. The Letter of Intent documented the desire to move forward and share a vision to accomplish the agreed-upon scope by a mutually acceptable date, with a goal to achieve accelerated completion. DOE agreed to take all necessary steps to accelerate risk reduction and to apply as large a percentage as possible of the Paducah Site's budget to accelerated cleanup as a continuing and ongoing process. "Risk reduction" to human health and the environment would be considered an important factor in setting priorities and cleanup strategies. A preference would be for cleanup strategies that reduce site-wide long-term stewardship requirements and costs. DOE and the Commonwealth of Kentucky agreed to seek United States Environmental Protection Agency (EPA) agreement and cooperation as well with response to implementing these approaches.

Program Missions

The following two major programs are operated by DOE at the Paducah Site: (1) Environmental Management and (2) Uranium Programs. Environmental Restoration, Waste Operations, and D&D are projects under the Environmental Management Program. The program/project missions are described below.

Program/Project	Mission
Environmental Restoration	Ensure that releases from past activities at the Paducah Site are investigated, and that appropriate remedial action is taken for protection of human health and the environment.
Waste Operations	Characterize and dispose of the legacy waste stored onsite in compliance with various agreements between DOE and the regulatory agencies (including waste in DOE Material Storage Areas).
Decontamination and Decommissioning	A subset of the Environmental Restoration and Waste Management projects that will disposition surplus facilities and prepare materials or waste for disposal or future use.
Uranium Programs	Maintain safe, compliant storage of the DOE depleted uranium hexafluoride inventory, pending final disposal of the material, and manage facilities and grounds not leased to USEC. Design, contruct, and operate a facility to convert depleted uranium hexafluoride to uranium oxide and aqueous hydrogen fluoride.



Environmental Compliance

The DOE is required to comply with environmental laws and regulations that have been properly promulgated by the Commonwealth of Kentucky and EPA. These regulations have been established to limit exposure to levels of hazardous wastes and chemicals that may be detrimental to human health and the environment. The primary laws and regulations of concern applicable to the DOE-owned site are summarized as follows.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Resource Conservation and Recovery Act is a law that governs the management of hazardous waste. The PGDP received a RCRA permit to manage hazardous waste on August 19, 1991. The permit must be renewed every ten years. DOE submitted a hazardous waste permit renewal application to the Kentucky Division of Waste Management (KDWM) on February 21, 2001. On September 28, 2001, KDWM requested additional information. A revised permit application was submitted in February 2002. Additional revisions to the application were needed based on waste management operational changes, requests for additional treatment methods, and deficiencies in Part A in accordance with a request from KDWM dated March 15, 2004. The revised permit applications were submitted to KDWM on April 13, 2004. The new hazardous waste management facility permit was issued to DOE on September 30, 2004. The permit became effective on October 31, 2004, and is valid for ten years.

The DOE did not receive any notices of violation (NOVs) during 2004 from Kentucky or EPA regulators.

In 2004, DOE submitted closure plans to Kentucky regulators for 14 DOE Material Storage Areas (DMSAs).

Requirements associated with the October 2003 Agreed Orders were met in 2004. Seventeen solid waste management unit (SWMU) assessment reports were revised in accordance with the Agreed Order to identify newly discovered hazardous waste in DMSAs. Part A of the RCRA Permit was revised to include 15 of these areas. All Priority A DMSAs were characterized by September 30, 2004, in accordance with the Agreed Order. Material from 12 of the Priority A DMSAs was dispositioned from the DMSAs. Three Priority A DMSAs were turned over for reuse and six were characterized for waste material.

SOLID WASTE

The DOE disposes of a portion of its solid waste units in on-site landfill C-746-U. During 2003 and 2004, the amount of waste disposed of in the landfill was 9151 tons and 35,000 tons (8302 and 31,773 metric tons), respectively. In lieu of disposing of office waste at the C-746-U Landfill, office waste generated by DOE and its contractors at the plant site is taken offsite for disposal.

The DOE did not receive any NOVs during 2004 from Kentucky or EPA regulators.

UNDERGROUND STORAGE TANKS

The DOE is responsible for 16 of the 18 underground storage tanks that have been reported to Kentucky regulators, as required. USEC is responsible for the other two underground storage tanks. Of DOE's 16 underground storage tanks, none are currently in use. At the end of 2004, one DOE underground storage tank (C-746-A1) had not met all regulatory requirements necessary to achieve permanent "clean" closure. The DOE provided KDWM with closure information; however, KDWM has not yet provided DOE with a final closure determination.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

The DOE issued a Record of Decision (ROD) on July 27, 2004, for C*onstruction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, KY, Site* (DOE/EIS-0359). The facility will convert the stored inventory of depleted uranium hexafluoride (DUF_6) into a more stable uranium oxide for reuse or disposal. DOE also approved two categorical exclusions for refurbishing the C-745-F Cylinder Storage Yard and for repairing the access road to the C-745-C Cylinder Storage Yard.

In addition, numerous minor activities were within the scope of the previously approved categorical exclusions for routine maintenance, small-scale facility modifications, and site characterization. The Paducah DOE Site Office and the DOE Oak Ridge Operations Office NEPA compliance officer approve and monitor the internal applications of previously approved categorical exclusion determinations.

CLEAN AIR ACT COMPLIANCE STATUS

The Paducah Site had two air emission point sources in 2004. The Northwest Plume Groundwater System and the Northeast Plume Containment System are interim remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), addressing the containment of groundwater contamination. These separate facilities 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 an activated carbon system to remove the TCE prior to atmosphere discharge. The Northeast Plume Containment System extracts TCE-contaminated groundwater and pumps it to a cooling tower system that acts as an air stripper and removes TCE from the groundwater.

Kentucky and EPA Region 4 regulate airborne radionuclide emissions from DOE facilities under 40 Code of Federal Regulations 61 Subpart H, the National Emission Standards for Hazardous Air Pollutants regulations. The radiation dose calculations for the site were performed using the Clean Air Act Assessment Package-88 of computer codes. The dose calculations use dose conversion factors provided by EPA. Potential radionuclide sources at the Paducah Site in 2004 resulted from scrap metal removal/handling, the Northwest Plume Groundwater System, C-410 D&D activities, and fugitive dust sources. The fugitive source emissions include piles of contaminated scrap metal, roads, and building roofs. DOE utilized ambient air-monitoring data collected by 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. This was done to verify insignificant levels of radionuclides in off-site ambient air.

KENTUCKY POLLUTANT DISCHARGE ELIMINATION SYSTEM (KPDES) PERMITS

On July 9, 2004, DOE received an NOV dated July 6, 2004, from the Kentucky Division of Water (KDOW). The violation cited two KPDES permit noncompliances. The first noncompliance cited was a recurrence of failure for chronic toxicity at PGDP KDPES Outfall 001 for the April 18–23, 2004, sampling event. The violation required continuation of the monthly sampling and other measures in the Toxicity Reduction Evaluation Plan, and these efforts were ongoing at the end of 2004.

The second violation alleged failure to follow the EPA test method regarding requirements to chill and maintain samples at 4° Celsius (39° Fahrenheit) until the samples reach the testing laboratory. The temperatures cited in the violation correspond to the temperatures measured directly in the receiving stream flow at Outfall 001 and recorded by sampling personnel. The temperature values cited in the violation do not reflect the composite sampler temperature nor the temperature recorded by the laboratory at the time of sample receipt. Temperatures recorded at the receiving laboratory indicate that the samples were chilled and shipped at the proper temperature in accordance with the permit requirements.

On September 16, 2004, DOE received an NOV dated September 14, 2004, from the KDOW. The NOV cited three KPDES permit noncompliances. The first noncompliance cited an alleged violation of the acute toxicity limit at KPDES Outfall 017 (discussed below). In the second alleged violation, KDOW contends that samples collected at Outfall 001 during the June 2004 sampling event were improperly collected in accordance with KPDES permit sample temperature requirements (same issue as discussed above). The KDOW states in the third alleged violation that DOE did not conduct a monthly PGDP chronic toxicity test at Outfall 001, as required, based on the test being invalid due to the alleged sampling temperature violations.

Acute toxicity exceedances were reported to KDOW for Outfall 017 in April 2004, based on samples collected on April 12 and April 22. KDOW issued an NOV for this on May 21. The NOV required that acute toxicity testing frequency be increased from the routine quarterly testing to monthly testing, and that a Toxicity Reduction Evaluation Plan be submitted. Formal monthly testing was initiated in June and the plan was submitted to KDOW on June 22.

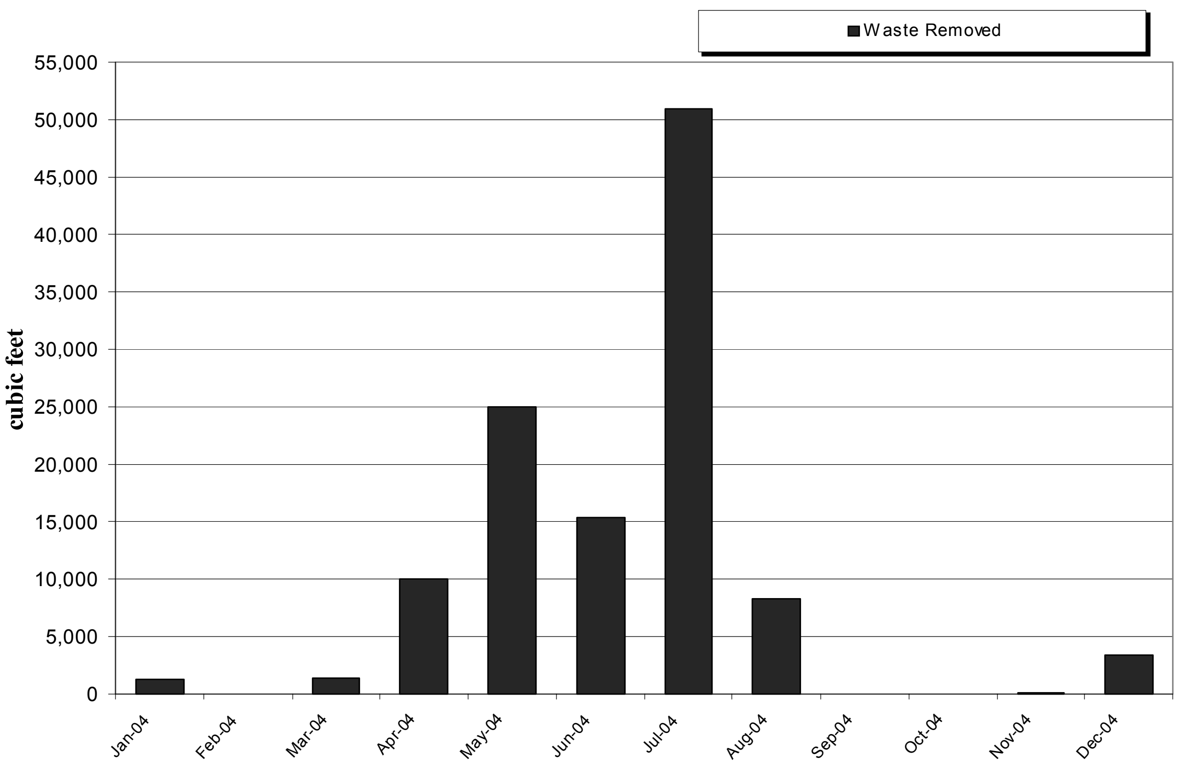
On May 10, prior to receipt of the May 21 NOV and initiation of required monthly sampling, an additional acute toxicity sample was collected from Outfall 017. This sample showed lower toxicity than in April, but still above the regulatory limit. This sample was reported to KDOW in the quarterly Discharge Monitoring Report in July 2004.

The September 14, 2004, NOV cites the acute toxicity exceedance identified on the voluntary May sample from Outfall 017. No direct impacts on the receiving stream (Bayou Creek) have been noted.

No exceedances of effluent permit limits occurred at Outfalls 015 or 019 in 2004.

Waste Removal

The primary objective of waste operations is to ensure that wastes do not migrate into the environment. Requirements for meeting waste management regulatory objectives are varied and complex because of the variety of waste streams generated by DOE activities. The goal, however, is to comply with current regulations while planning cleanup actions that will also comply with future regulations. The DOE off-site waste shipments in 2004 are summarized in the following graph. In September 2004, shipment of waste to off-site disposal facilities was placed on hold due to issues that were identified with some shipments leaving the Paducah Site. Corrective actions were developed and implemented in order to resume shipments to the off-site disposal facilities.



Legacy waste disposition during 2004

WASTE MINIMIZATION AND POLLUTION PREVENTION

Waste Minimization and Pollution Prevention are efforts employed at PGDP to reduce the amount of waste generated and eliminate pollution from DOE-funded activities. Waste Minimization and Pollution Prevention efforts are primarily implemented through recycling and reuse of materials and waste-reduction techniques. Recycling efforts in 2004 are summarized in following table.

Recycling efforts in 2004

10.1 metric tons (22,400 pounds) of office paper
0.25 metric tons (550 pounds) of aluminum cans
0.85 metric tons (1900 pounds) of telephone books
0.41 metric tons (816 pounds) of printer and fax toner cartridges
4.0 metric tons (8780 pounds) of carbon used in the Northwest Plume Groundwater Treatment Facility
Transfer of ownership of 54 out-of-service fluorine cells and 28 drums of oil for reuse
Spent motor oil , used electrical equipment, reuse of liners from a temporary sedimentation basin

Additional accomplishments of the Waste Minimization and Pollution Prevention Program included continued use of micropurging techniques in groundwater sampling to reduce wastewater volume and the transfer of unused chemicals and materials to other programs for reuse. The recycling of rechargeable batteries and fluorescent light bulbs continues to reduce the volume of hazardous waste generated at the site. The DOE has also converted to the use of fluorescent bulbs that are not hazardous.

Decontamination and Decommissioning

Decontamination and decommissioning is conducted on facilities and other structures contaminated with radiological and hazardous material when they are no longer required to fulfill a site mission. Legacy contamination on the floors, walls, and ceiling of a structure, and on equipment, constitutes a potential for release to the environment if not appropriately managed. Two major facilities comprising approximately 46,450 m^2 (500,000 ft^2) have been categorized for D&D at PGDP. These facilities are the C-340 Metal Reduction Plant Complex, where uranium hexafluoride was converted to uranium metal and hydrogen fluoride; and the C-410 Feed Plant Complex, where uranium trioxide was converted to uranium tetrafluoride. Contaminants at these facilities include depleted uranium, natural uranium and transuranic radionuclides, uranium tetrafluoride, polychlorinated biphenyls, asbestos, and lead paint. Fifteen less-significant inactive facilities are included in the D&D program at Paducah.

Comprehensive Environmental Response, Compensation, and Liability Act documentation for removal of the C-410 Complex Infrastructure has been completed, as a non-time-critical removal action. Additional documentation will be required for the C-410 Building demolition and for the C-340 Complex. Actual D&D of the C-410/C-420 Complex has been initiated.

Decontamination and decommissioning accomplishments in 2004 at the C-410/C-420 Complex included the following:

- Completed sorting and repackaging of over 100 B-25 boxes of compactible wastes from the C-410 complex for off-site disposal.
- Completed isolation of steam, air, nitrogen, and steam condensate lines that enter the C-410 Complex.
- Completed removal of support facilities around hydrofluoric acid tanks and shipped 11 hydrofluoric tanks to the Nevada Test Site for disposition.
- Shipped hydrofluoric acid tank residuals to Envirocare.

Disposition of Hydrogen Fluoride Tank at the Nevada Test Site

Additional Waste Removal

DOE MATERIAL STORAGE AREAS

The DMSAs are material and equipment storage areas at PGDP that are undergoing a characterization process to comply with potential nuclear criticality safety, regulatory, and solid waste requirements. Originally included with the PGDP facilities leased to USEC, the return of the areas was accepted by DOE from USEC on December 31, 1996, to facilitate Nuclear Regulatory Commission certification of PGDP. The 160 DMSAs are now nonleased areas located inside buildings leased to USEC or in designated outside areas.

The Kentucky Natural Resources and Environmental Protection Cabinet filed an administrative complaint in October 2001 regarding the enforcement of NOVs alleging violations of Kentucky's delegated hazardous waste management program regulations. Most of these NOVs alleged the failure to characterize materials in DMSAs at PGDP, or the unpermitted storage of hazardous waste in DMSAs. In October 2003, an Agreed Order between DOE and the Commonwealth of Kentucky was signed that resolved enforcement of the NOVs. The Agreed Order established regulatory deadlines for characterization and removal of DMSAs and also established RCRA closure requirements for DMSAs that are found to contain hazardous waste. As a result of the implementation of the order, 158,000 cubic feet of DMSA material have been disposed; 625,000 of 865,000 cubic feet have been characterized; and 14 outside DMSAs have been emptied. The three remaining active outside DMSAs have been fully characterized and plans are underway to complete material disposition of those areas.

The Agreed Order commitments for Priority A DMSAs have been met. Fieldwork gives priority to DMSAs located outside or those that may contain hazardous waste. Lower priority DMSAs are addressed, while sampling and analysis results from higher priority locations are prepared in order to achieve maximum efficiency in field operations. The DOE notifies the Commonwealth of Kentucky when hazardous waste is identified during the DMSA project.

TOXIC SUBSTANCES CONTROL ACT (TSCA)

The Uranium Enrichment TSCA Federal Facility Compliance Agreement (FFCA) between EPA and DOE was signed February 1992. To meet the compliance goals at the Paducah Site, the act is frequently revised and updated. Under this agreement, action plans have been developed and implemented for removal and disposal of polychlorinated biphenyl material at the Paducah Site. All Paducah Site Uranium Enrichment TSCA FFCA milestones for 2004 were completed.

Environmental Restoration

Environmental restoration includes the activities and tasks required by state and federal regulations that must be implemented to clean the Paducah site. The levels to which the site needs to be cleaned must be mutually agreed upon by DOE and the regulatory agencies.

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 for characterization and implementing response actions, as opposed to conducting a single site-wide comprehensive action. These discrete actions, referred to as operable units, may address a geographic portion of the site, 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 prioritized actions, ongoing site characterization activities, to support future response action decisions and D&D of the currently operating PGDP. Once the plant ceases operation, a Comprehensive Sitewide Operable Unit evaluation will be conducted. The operable units were established by developing a site-conceptual risk model for each source area (SWMU/Area of Concern). This process included a qualitative evaluation of contaminant types and concentration, release mechanisms, exposure pathways, points of exposure, and receptors based on current and reasonably foreseeable land use.

Sources and areas of contamination suspected as primary risk contributors to off-site residents from groundwater were grouped under the Groundwater Operable Unit. Similarly, the Surface Water Operable Unit contains sources and areas of contamination posing the greatest risks to recreational users. The Soils, D&D, and Burial Grounds operable units contain sources posing the greatest risks to on-site industrial workers. The objective of grouping the sources and areas of contamination into media-specific operable units is to provide a complete approach to assess site-wide risks, identify and prioritize response actions, and develop integrated cleanup solutions that will reduce risk.

The DOE uses a combination of factors to prioritize work being implemented under the Environmental Management Program at PGDP. These include risk-based criteria, compliance with other programs, technical considerations associated with PGDP operations, mortgage reduction, and demonstrated progress toward completing the environmental management mission. The risk-prioritization criteria (see table) incorporate the general program management principles of the National Contingency Plan, which emphasizes the use of accelerated actions to address imminent threats and reduce migration of off-site contamination.

Risk Prioritization Criteria

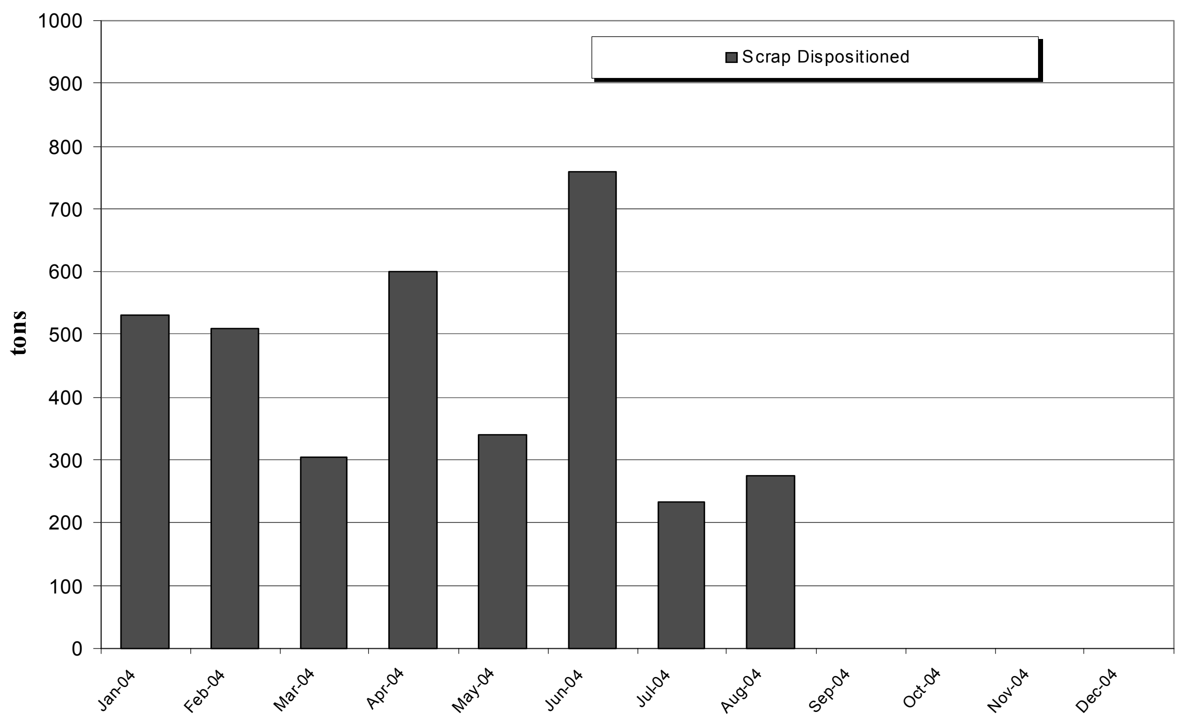
- **Mitigate immediate threats, both on- and off-site.**
- **Reduce further migration of off-site contamination.**
- **Address sources contributing to off-site contamination.**
- **Address remaining sources contributing to on-site contamination.**
- **Perform D&D of non-operating gaseous diffusion plant.**
- **Evaluate the final Comprehensive Sitewide Operable Unit.**

2004 REMEDIAL ACTIVITIES

Significant accomplishments for the environmental restoration program conducted in 2004 include the following:

Accomplishments
Submitted a Record of Decision for the C-400 groundwater action.
Completed the Southwest Plume and C-746-S&T Site Investigations.
Continued operation of the Northwest and Northeast Plume Groundwater Treatment Systems.
Completed the North-South Diversion Ditch Section 2 remediation.
Issued for regulatory review of the *Surface Water Operable Unit Sampling and Analysis Plan*.
Continued characterization, removal, and disposal of scrap metal. At the end of 2004, approximately 7000 tons of scrap had been removed from the Paducah Site. (The following graph shows scrap disposition for calendar year 2004.)

The Paducah Site had an estimated 54,000 tons of scrap metal in ten scrap yards, most of which are adjacent to each other, located in the northwestern portion of the plant's fenced area. During 2002, DOE completed construction of a stormwater control basin to support the removal action. In 2003, removal of scrap metal was initiated. At the end of 2004, approximately 7000 tons of scrap had been removed from the Paducah Site. The following graph shows the disposition of scrap by month during 2004.



Scrap Metal Removal Project disposition during 2004

Uranium Programs

The mission of the Uranium Programs is to maintain safe, compliant storage of the DOE DUF_6 inventory, pending final disposal of the material, and manage facilities and grounds not leased to USEC. The programs must also design, construct, and operate a facility to convert DUF_6 to uranium oxide and aqueous hydrogen fluoride. The management activities associated with DUF_6 cylinders are described as follows.

DEPLETED URANIUM HEXAFLUORIDE CYLINDER MANAGEMENT

Depleted uranium hexafluoride is a product of the uranium enrichment process. A solid, at ambient temperatures, DUF_6 is stored in large metal cylinders. At the end of 2004, the Paducah Site managed an inventory of approximately 38,000 cylinders containing approximately 454,000 metric tons of uranium hexafluoride (most containing DUF_6) stored in outdoor facilities, commonly referred to as cylinder storage yards. Additional cylinders are added to the DOE inventory annually as a result of formal agreements with USEC.

Depleted uranium hexafluoride is stored as a crystalline solid at less than atmospheric pressure. When DUF_6 is exposed to the atmosphere, hydrogen fluoride and uranium-reaction products form. The hazard potential of DUF_6 is primarily chemical toxicity from any released hydrogen fluoride, rather than a radiological hazard. The DOE has an active Cylinder Management Program that includes cylinder and cylinder yard maintenance, routine inspections, cylinder yard construction and improvement, and other programmatic activities, such as cylinder corrosion studies. A cylinder inventory database is maintained, which 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*, in response to the Defense Nuclear Facility Safety Board's request to analyze alternative chemical forms for the storage of DUF_6. In 2002, as a result of this study, DOE selected Uranium Disposition Services, LLC, to design, build, and operate facilities at Paducah, Kentucky, and Portsmouth, Ohio, that would convert the inventory of DUF_6 to triuranium octoxide, a more stable form of uranium that is suitable for disposal or reuse. Construction began in July 2004, consistent with Public Law 107-206. Initial construction activities focused on building a site sediment pond and installing truck entrance pads and roadways.

DUF_6 facility construction activities

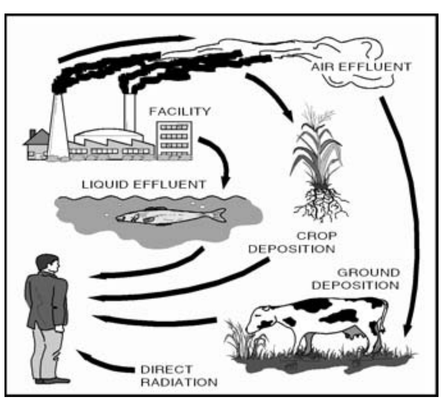
The DOE also entered into an Agreed Order with the Commonwealth of Kentucky in October 2003 that included a Cylinder Management Plan for continued activities associated with cylinder management at Paducah. The DOE continued to comply with activities outlined in this Agreed Order.

Radiation--What Is It?

It comes from outer space, the ground, the food we eat, and even from within our own bodies. Radiation is all around us and has been present since the birth of this planet. Naturally occurring radioactive materials were discovered in 1896. Less than 50 years later, physicist Enrico Fermi split the atom, producing the first sustainable nuclear chain reaction. Today, both man-made and natural radiation are part of our lives. We use radioactive materials for beneficial purposes, such as generating electricity and diagnosing and treating medical problems. For example, more than 200 million X-rays are performed in America every year. Over 80 percent of our exposure to radiation comes from natural sources. Our own bodies, which contain the radioactive element potassium, account for 11 percent of our total exposure. Consumer products make up another three percent of our exposure. The average annual radiation exposure for a person living in the United States is 360 millirem (mrem).

Though radiation offers many benefits, exposure to it can also threatens our health and the quality of our environment. We cannot eliminate radiation from our environment. We can, however, reduce our risks by controlling our exposure to it. Radiation can cause cancer if the exposure is great enough. In this respect, it is similar to many hazardous chemicals found in the environment that can cause cancer. It may cause other adverse health effects, including genetic defects in the children of exposed parents or mental retardation in the children of mothers exposed during pregnancy. However, the risk of developing cancer due to radiation exposure is much higher than the risk of these other effects. Much of our knowledge about the risks from radiation is based on studies of over 100,000 survivors of the atomic bombs at Hiroshima and Nagasaki, Japan. In these studies that have continued over the last 50 years, scientists have been able to observe the effects of a wide range of radiation doses, including doses comparable to an average person's lifetime dose from naturally occurring background radiation (about 20,000 mrem). We have learned many things from these studies. The most important are as follows:

- The higher the radiation dose a person receives, the greater the chance of developing cancer.
- It is the chance of cancer occurring, not the kind or severity of cancer, that increases as the radiation dose increases.
- Most cancers do not appear until many years after the radiation dose is received (typically 10 to 40 years).

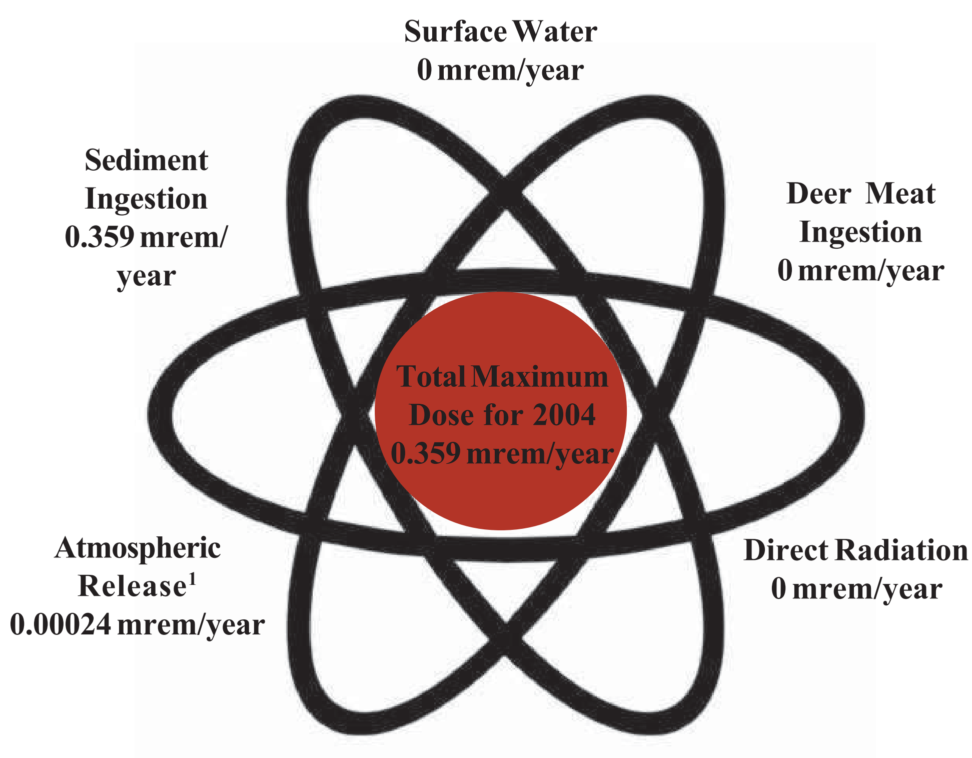


Possible radiation pathways

2004 Paducah Site Radiation Dose

Radiation and radioactive material in the environment can reach people through many routes. Potential routes for radiation are referred to as pathways, as shown in the figure below. 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.

The graph to the right shows DOE's maximum potential contribution to the radiation dose that a person could receive from being exposed to various media in the environment around the Paducah Site (potential USEC dose contributions are not included) for 2004. The dose is calculated based on 2004 monitoring of media, such as air, surface water, sediment, and deer meat. Groundwater is not included because residents living near the site are not drinking the groundwater. The worst-case combined (internal and external) dose to an individual member of the public was calculated at 0.359 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 a 10-mrem airborne dose to the public. The dose chart shows all media used for the calculation.



[1]DOE source emissions were from the Northwest Plume, Scrap Metal Removal, and C-410 D&D Fluorine Cell blasting activities.

Environmental Monitoring

The DOE performs environmental monitoring at the Paducah Site to comply with applicable laws and regulations, to identify trends, and to raise environmental awareness. Effluent monitoring and environmental surveillance monitoring are two ways environmental monitoring are performed. Effluent monitoring (required by environmental regulations) is performed by collecting and analyzing samples of discharges from PGDP into the air and water. Surveillance monitoring (performed by DOE to evaluate its impacts on the environment) is performed by collecting and analyzing samples of environmental media to measure the concentration of contaminants. The information obtained from effluent discharge monitoring is used to determine the effects on the environment of the DOE facilities operations.

Bayou Creek

WHAT ENVIRONMENTAL MEDIA ARE SAMPLED?

Routine sampling is performed on several different media, including air, groundwater, sediment, surface water, fish, and deer. When a need for non-routine sampling is identified, other types of samples may be collected under special one-time studies. In 2004, approximately 900 samples were collected. The different media are discussed in the text on the following pages, providing some detail of what is sampled, the results of sampling during 2004, and the relative effect on the radiation dose calculation. In most cases, contaminants that are specific to the plant site are discussed in detail, such as uranium, technetium-99, TCE, and polychlorinated biphenyls.

Air and Direct Radiation Monitoring

AIR AND RADIOLOGICAL MONITORING RESULTS

The DOE monitors specific sources of contamination, such as systems emitting radionuclides. Through a grant funded by DOE, the Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the Kentucky Cabinet for Health Services Department for Public Health monitors ambient air for radionuclides. Thermoluminescent dosimeters (radiation measuring devices) are used to monitor the dose that may be received from radioactivity at, or near, the plant site.

The DOE had three sources of airborne radionuclides in 2004. These sources were the Northwest Plume Groundwater System, the Scrap Metal Removal Projects, and the C-410 D&D Fluorine Cell Blasting Project. The amount of radionuclides emitted were calculated or determined based on sampling data and emission factors. Based on the radionuclide results, the radiation dose from these projects to the maximally exposed individual through emissions to the air was calculated to be ***approximately 0.00024 mrem/year in 2004***. The DOE sources of air discharge for contaminants other than radionuclides were the Northwest Plume Groundwater System and the Northeast Plume Groundwater System. Combined, these systems removed 1854 pounds (0.93 tons) of TCE from the groundwater through the use of air-stripping processes.

The DOE utilized ambient-air-monitoring data to verify insignificant levels of radionuclides in off-site ambient air. Ambient-air data were collected at ten sites surrounding the plant in order to measure radionuclides emitted from Paducah Site sources, including fugitive emissions. Results indicated that radionuclides emitted in the air emissions were at, or below, background at the sampling locations. The radiation dose to the maximally exposed individual member of the public (the neighbor living closest to the PGDP security fence) from DOE operations did not vary statistically from background and was essentially zero.

On a quarterly basis, environmental thermoluminescent dosimeters were placed at 46 locations in and around PGDP or at background locations. Monitoring results indicate that nine locations were consistently above background levels. These nine locations were all, at or near, the PGDP security fence in the vicinity of uranium hexaflouride cylinder storage yards. For purposes of this ASER Summary, an additional potential receptor was considered. In a very conservative exposure scenario, this receptor is assumed to be exposed to the closest location that would be accessible to the public in 2004. This location is near Harmony Cemetery, located north of the plant security fence and south of Ogden Landing Road. This location resulted in external radiation exposures below background. This means that the dose was effectively zero.

Surface Water and Sediment Monitoring

NONRADIOLOGICAL PARAMETERS IN SURFACE WATER

None of the detected nonradiological analytes in samples collected as part of the required permit sampling at the four DOE outfalls were in excess of permit limits. There was one exceedance of permit limits for toxicity reported in 2004 for DOE Outfall 001 and three toxicity exceedances reported for DOE Outfall 017.

Similar to 2002 and 2003, the only results of significance compared to background data were TCE results identified near the plant site and downstream of Little Bayou Creek at an average concentration of 1.6 and 37.75 micrograms per liter (µg/L), respectively, which is slightly higher than 2003. Trichloroethene was also detected upstream of Bayou Creek at 2.3 µg/L.

There was one detection of polychlorinated biphenyls in surface water in 2004 at Outfall 001. In 2002, polychlorinated biphenyl concentrations were detected at low levels near the plant site on both Bayou Creek and Little Bayou Creek. Additionally, there were no detections of polychlorinated biphenyls in surface water in 2001 or 2003.

NONRADIOLOGICAL PARAMETERS IN SEDIMENT

Aluminum, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, potassium, selenium, and vanadium were detected at all sites. The highest levels of metals were seen at the North-South Diversion Ditch and Bayou Creek and Little Bayou Creek near the plant site. Consistent with 2002 and 2003, chromium was identified in the North-South Diversion Ditch at 59.5 milligrams per kilogram (mg/kg) and near the plant site on Little Bayou Creek at 130.6 mg/kg (highest level). Arsenic was found downstream in Bayou Creek and near the plant site. Zinc was found at all locations, except the reference site. Generally, contaminants are more abundant near the plant site and decrease in areas downstream of the plant site.

In 2004 polychlorinated biphenyls were found in the North-South Diversion Ditch, Little Bayou Creek near the plant site, and downstream of Little Bayou Creek, with the highest levels seen at the North-South Diversion Ditch.

RADIONUCLIDES IN SURFACE WATER

The PGDP effluents are monitored at DOE outfalls under the Kentucky permit for radionuclides known to be emitted or to have been present at the Paducah Site. Uranium and technetium-99 are compared with the corresponding derived concentration guide (DCG) and are presented as a percentage. The DCG is 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 an effective dose equivalent of 100 mrem. The combined average concentrations at all outfalls were small percentages when compared to the DCG values.

The average concentration of uranium being discharged to Outfall 015 was 15 percent of the DCG, Outfall 001 was 3.8 percent, and Outfalls 017 and 019 was less than 1 percent. Outfall 015 received runoff from the uranium burial ground, with small quantities of surface contamination from uranium compounds. Runoff from the burial ground is suspected as being responsible for the elevated uranium concentrations associated with Outfall 015.

Technetium-99 averages for 2004 for all four outfalls were well below 0.1 percent of the DCG. Data for 2004 do not indicate a significant change in relation to DCG levels for any radionuclide compared to data for the past five years.

Radiological parameters were not found in significant concentrations at any sampled location in 2004 when compared to the DCGs. Concentrations of technetium-99 were elevated near the plant site and in downstream creek locations, including the creek convergence, with the highest concentrations found downstream of plant effluents in Little Bayou Creek. These concentrations are well below the plant release criteria of 900 picoCuries per liter (pCi/L). More radionuclides at higher concentrations were detected downstream of Bayou Creek, with locations in both creeks near the plant site at similar levels. The level of radiological parameters seen at the C-746-K Landfill was similar to those found upstream of Bayou Creek. Radionuclides were not detected at Massac Creek or upstream or downstream on the Ohio River in Cairo, Illinois (the nearest public drinking water source). Concentrations of radionuclides in effluents at the Paducah Site were far below DCGs and do not pose a health risk.

The average concentrations of radiological parameters at the Little Bayou Creek seep locations are shown in the following table. Results indicate that higher levels of technetium-99 were measured at LBCSP5 than at other surface water locations on Little Bayou Creek; however, these concentrations are well below the plant release criteria of 900 pCi/L and below the DCG.

Average radiological concentrations for seep locations in Little Bayou Creek (LBC)

Parameter	LBCSP1	LBCSP2	LBCSP3	LBCSP4	LBCSP5	LBCSP6
Alpha activity (pCi/L)	2.4	1.3	1.3	2.1	**4.4**	1.9
Beta activity (pCi/L)	6.3	9.8	19	14	**201**	117
Technetium-99 (pCi/L)	5.8	15	22	18	**247**	123

[**Bold**] values indicate the highest radionuclide concentrations for the parameter specified.

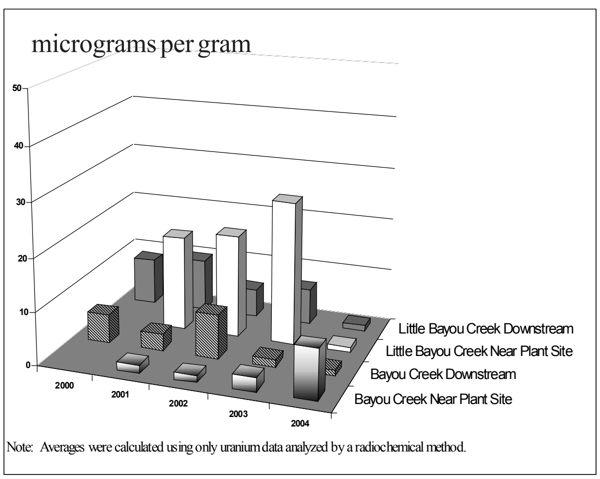
Surface water-pathway dose was calculated for individuals assumed to consume water from the public drinking water supply at Cairo, Illinois. Cairo is the closest drinking water system that uses water downstream where PGDP discharges water into the Ohio River. In 2004, there were no radionuclides detected at the Cairo, Illinois, location. ***The net exposure to the maximally exposed receptor from the Paducah Site based on theoretical assumptions was 0.0 mrem.***

RADIONUCLIDES IN SEDIMENT

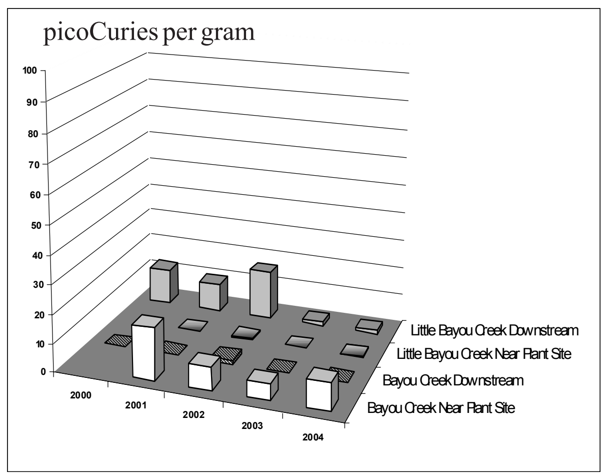
The highest concentrations of radiological parameters at sediment locations sampled in the North-South Diversion Ditch, Bayou Creek, Little Bayou Creek, and at the Massac Creek background stream were found in the North-South Diversion Ditch. Remediation activities are completed for the North-South Diversion Ditch sections 1 and 2 (inside the security fence) due to the potential risk, and access to this area is limited. ***The estimated worst-case dose above background from sediment ingestion at this location was 0.359 mrem.***

Uranium activity is elevated in Bayou Creek and Little Bayou Creek near the plant site and downstream. The levels are similar to those seen in 2001 and 2002. Technetium-99 levels are elevated on Bayou Creek near the plant site, and also downstream on Little Bayou Creek.

The figures below show uranium concentrations in sediment over the past five years. A small increase was seen in the uranium concentrations in sediment in Bayou Creek at the plant site and a large decrease in Little Bayou Creek near the plant site. Locations sampled near the plant site on both Bayou and Little Bayou creeks indicate higher amounts of uranium. There was a decrease in technetium-99 concentrations in sediment in 2004 as compared to previous years. Other radionuclides, although present, are not significantly above background values.

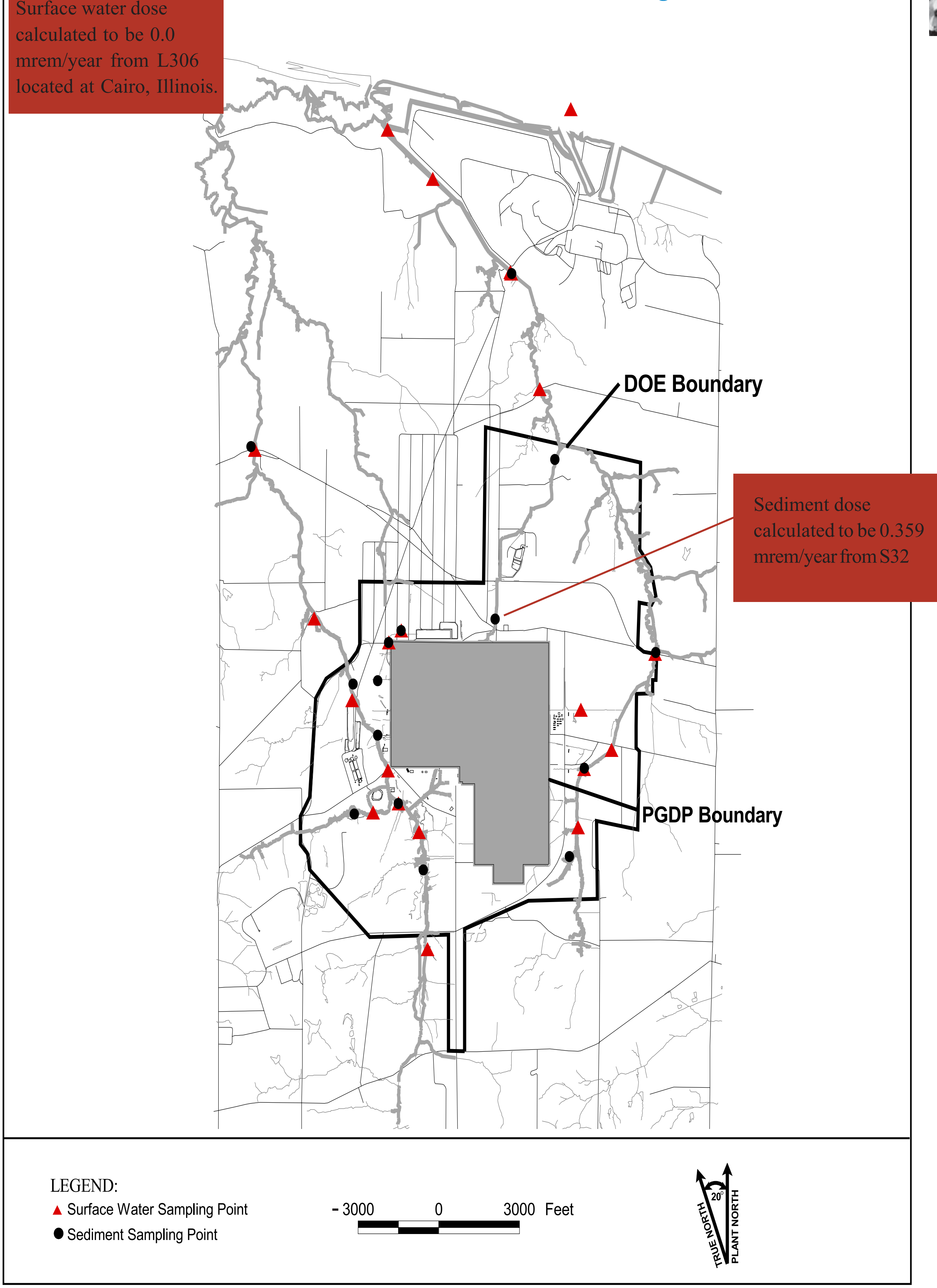


Five-year uranium concentration in sediment



Five-year technetium-99 activity in sediment

Surface Water and Sediment Monitoring



Biological Monitoring

DEER SAMPLING

In 2004, a total of five deer were harvested around the plant 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 2004 due to sufficient background data available from previous year's sampling; therefore, 2002 data were used for comparison. Liver, muscle, and bone samples were analyzed for several radionuclides [cesium-137, neptunium-237, plutonium-239, technetium-99, thorium-230, uranium-234, uranium-235, uranium-238, and strontium-90 (bone samples only)]. In addition, thyroid samples were analyzed for technetium-99. Because the liver and muscle tissue are considered consumable by humans, these tissues can be evaluated for radiological risks (dose). Bone and thyroid samples are used only as indicators of contamination.

The following table lists the radionuclides detected in deer tissue for 2004. In deer muscle, which is normally considered consumable by humans, concentrations of thorium-230 were detected at low levels in deer. In deer bone, thorium-230 was found at, or above, detectable levels in deer from this area. In deer liver, uranium-233/234 was detected. No thorium-230 and uranium-233/234 were detected in background deer. Dose assessments indicate that deer are acceptable for consumption, and levels are consistent with previous years' data.

Radiological parameters detected in deer tissue

RADS (pCi/g)	Parameter[a]	Deer 1	Deer 2	Deer 3	Deer 4	Deer 5	Deer (Background)[b]
	Thorium-230 (Bone)	0.037	ND	ND	ND	ND	ND
	Thorium-230 (Muscle)	ND	0.076	0.054	ND	ND	ND
	Uranium-233/234 (Liver)	ND	ND	ND	0.04	ND	ND

ND - Nondetect

[a] Other radionuclides were analyzed, but not detected in any deer.

[b] Background deer were collected during 2002 from Stewart Island Habitat Restoration in Livingston County, Kentucky.

The thyroid and bone are not considered edible portions of deer, but are analyzed for the presence of target radionuclides. Specifically, strontium-90 accumulates in the bone and technetium-99 accumulates to some lesser degree in the thyroid. In 2004, all results were nondetect for strontium-90 in the bone and technetium-99 in the thyroid for the deer harvested, and for background deer from Stewart Island taken in 2002. Stewart Island in Livingston County is well away from PGDP and provides a good background reference sample.

As a worst-case scenario for site dose contribution, it is assumed that a person harvests and eats the two deer with the two highest dose estimates. The worst-case dose was calculated to be 0 mrem above background due to the background deer results not being significantly different than the site deer results. This is lower than the 1.5 mrem calculated in 2003.

Polychlorinated biphenyls tend to accumulate in fat tissue. Polychlorinated biphenyl-1260 was present in deer from the Paducah Site and the background location. The following table shows the polychlorinated biphenyl results. All measurable polychlorinated biphenyls were well below the Food and Drug Administration standard of 3 parts per million (mg/kg) for red meat.

A comparison of the metals detected in the 2004 deer with average metals data from background deer collected over the past ten years shows only a few chemicals that are significantly above background. Average chromium in liver, muscle, and kidney are observed at greater than two times background levels. Average barium and silver in the kidney are also observed at greater than two times background levels. Similar levels for these metals have been observed in previous years. All other metals are not significantly above background levels.

Summary of polychlorinated biphenyl detections in deer for 2004

Parameter	Deer 1	Deer 2	Deer 3	Deer 4	Deer 5	Background Deer [b]
Polychlorinated biphenyl-1260 (mg/kg)	0.147	0.045	0.025	0.088	0.116	0.034

[Result] — Detected at the result indicated.
mg/kg — part per million
[a] Other polychlorinated biphenyl aroclors were analyzed, but not detected in any deer.
[b] Background deer were collected during 2002 from Stewart Island Habitat Restoration in Livingston County, Kentucky.

WATERSHED MONITORING

Watershed (biological) monitoring was conducted in accordance with federal and KDOW requirements. Sampling was conducted in June 2004 at eight locations, including locations in Massac Creek and in the West Fork of Massac Creek, both of which serve as background fish sources. The frequency for the bioaccumulation monitoring task has been changed to every two years, and monitoring was not conducted in 2004.

Quantitative samplings of the fish communities in the PGDP area were conducted. Data from these samples were used to estimate species richness, population size (numbers and biomass per unit area), and annual production. All fish community locations overlap locations used in the benthic macroinvertebrate community task. The macroinvertebrate task studies small organisms located in the creek bed. All fish observed in 2004 were found to be in good health. As in previous years, fish communities examined in 2004 showed some changes in density, biomass, total numbers, and species richness. The most dramatic change occurred in Bayou Creek mile 6.2 where density increased 4.7 times and biomass increased 2.2 times from 2003 tgo 2004. This result is possibly indicative of a higher nutrient load and sparse canopy cover at Bayou Creek mile 6.2, which would promote increased growth of periphyton as a suitable food source.

Metals analyses were performed for the first time in 2004. Overall, most of the metals analyses results for the Bayou Creek and Little Bayou Creek sites do not vary significantly from the background location concentrations. Cadmium and lead were present only at the Bayou Creek location, but in small concentrations.

Groundwater Monitoring

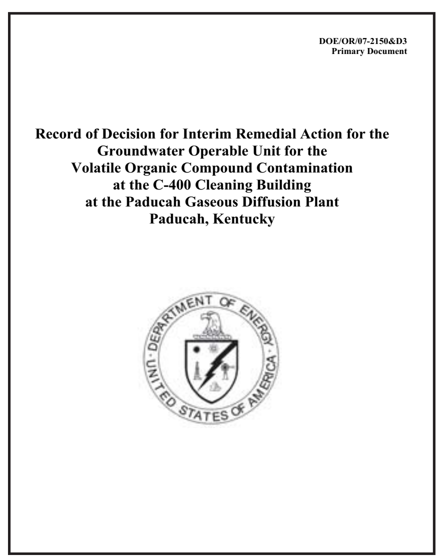
Monitoring and protection of groundwater resources at the Paducah Site are required by federal and state regulations and by DOE orders. Federal groundwater regulations generally are enacted and enforced by EPA. When off-site groundwater contamination from the Paducah Site was discovered in 1988, EPA Region 4 and DOE entered into an Administrative Consent Order. The DOE provided an alternate water supply to affected residents. Under CERCLA, DOE is also required to determine the nature and extent of off-site contamination through sampling of potentially affected wells and a comprehensive site investigation.

Investigations of the on-site source areas of TCE at the Paducah Site are ongoing. A common degreasing agent, TCE is a dense, nonaqueous- phase liquid (DNAPL), with typically low solubility in water. These types of liquids either sink to the bottom of aquifers or come to rest on a less-permeable layer within an aquifer, forming pools. DNAPL pools form a continuous source for dissolved-phase contamination (plumes) that is migrating offsite toward the Ohio River. Pools of DNAPL are extremely difficult to clean.

In 2004, a ROD was developed that presents the selected interim remedial action for the Groundwater Operable Unit volatile organic compound source zone, comprised primarily of TCE, at the C-400 Cleaning Building at PGDP. The ROD includes discussion of the contribution that this interim remedial action will make toward the final decision for the Groundwater Operable Unit at PGDP. For the Groundwater Operable Unit, a phased approach is used to meet the primary objectives. This approach is used because the complex groundwater contamination problems at the site (i.e., complex hydrogeology, multiple sources of contamination, and suspected presence of DNAPL) prevent PGDP from implementing one comprehensive, cost-effective remedy at this time. Additionally, the phased approach allows the site to use information gained in earlier phases of the cleanup to refine and implement subsequent cleanup objectives and actions.

The DOE continued two pump-and-treat systems at Paducah to treat TCE contamination. The pump-and-treat system installed northwest of the plant also treats the highest concentrations of dissolved technetium-99 in the groundwater. DOE also continues to perform required groundwater sampling at the C-746-S&T, the C-746-U, and the C-404 landfills.

In addition to the groundwater activities described in the previous paragraph, groundwater monitoring continued to identify the extent of contamination, predict the possible fate of the contaminants, and determine the movement of groundwater near the plant. Currently, there are three plumes identified. The 2004 plume map (next page) continues the basic interpretation presented in the plume maps for 2004. Revisions for calendar year 2004 reflect the following: (1) decreasing TCE trends in monitoring wells along the core of the Northeast Plume and over a large area to the west of the Northeast Plume well field, (2) extension of >25 pCi/L technetium-99 east of PGDP toward the Northeast Plume well field, and (3) reinterpretation of the Southwest Plume and C-746-S&T areas using data from the recent site investigations.

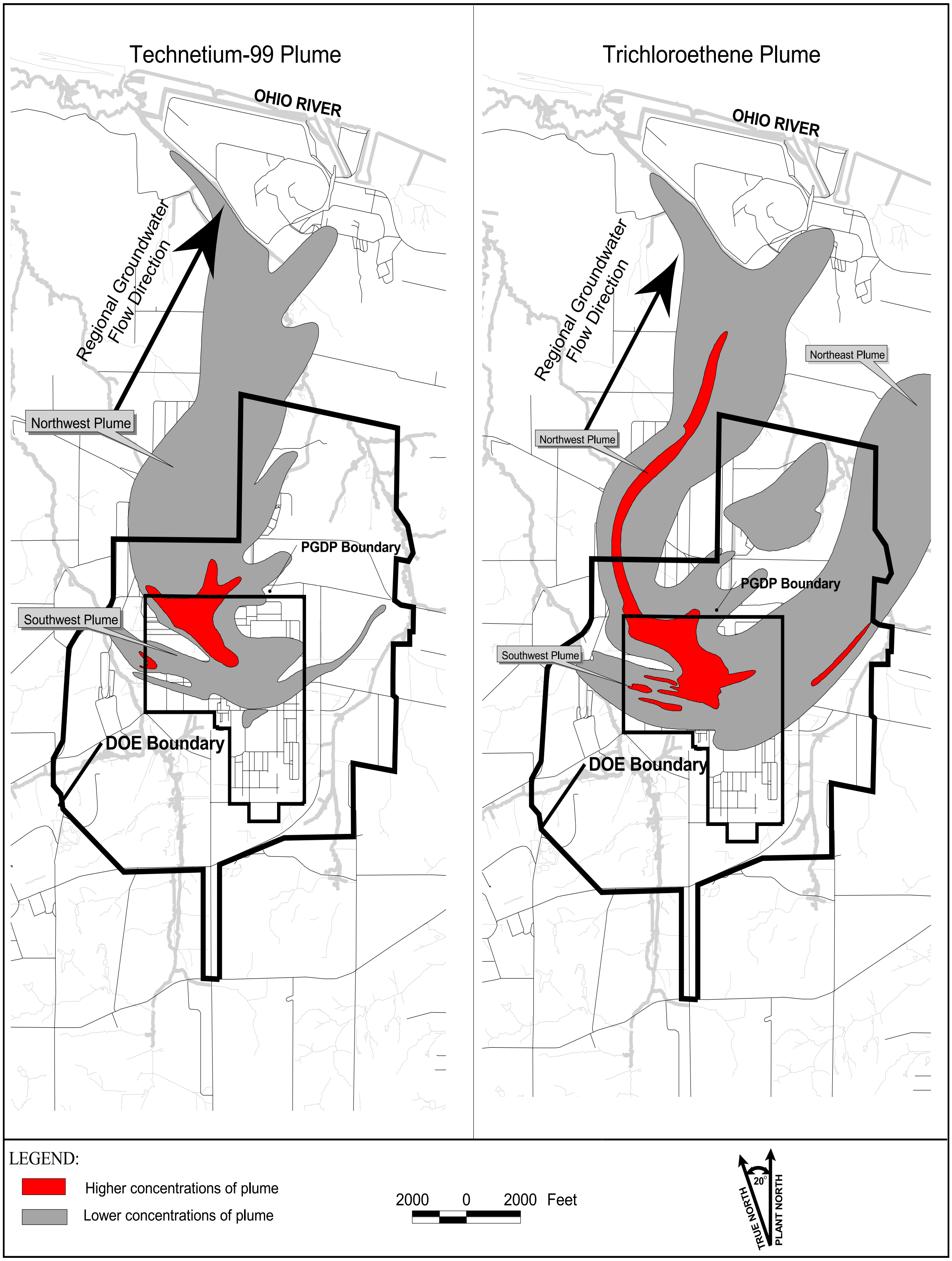


DOE/OR/07-2150&D3
Primary Document

Record of Decision for Interim Remedial Action for the
Groundwater Operable Unit for the
Volatile Organic Compound Contamination
at the C-400 Cleaning Building
at the Paducah Gaseous Diffusion Plant
Paducah, Kentucky

C-400 Record of Decision

Paducah Site Groundwater Plumes



Public Involvement and Information

DOE Environmental Information Center. The public has access to Administrative Records and programmatic documents at the DOE Environmental Information Center located at the Barkley Centre, 115 Memorial Drive, Paducah, Kentucky. It is open Monday through Friday from 9 a.m. to 5 p.m. The telephone number is (270) 554-6979. Information on the Environmental Information Center can be found at http://www.bechteljacobs.com/p_eic.shtml.

Citizens Advisory Board. In 2004, the Paducah Citizens Advisory Board had 13 voting members, four *ex-officio* members, a deputy-designated federal official, and a federal coordinator. The Paducah Citizens Advisory Board consists of individuals with diverse backgrounds and interests. It meets monthly to focus on early citizen participation in environmental cleanup priorities and related issues at the DOE facility. The Paducah board participates only in activities that are governed by DOE. Information on the board can be found at http://www.oro.doe.gov/pgdpssab. The office phone number is (270) 554-3004.

ADDITIO NAL INFORMATION

Additional information concerning DOE activities at PGDP can be found on the Internet at:

Web Site	Link To
http://www.oro.doe.gov/Paducah	DOE Paducah
http://www.energy.gov	DOE
http://www.bechteljacobs.com	Bechtel Jacobs Company LLC
http://www.epa.gov/region4/	EPA Region 4
http://publichealth.state.ky.us	Kentucky Radiation Health and Toxic Agents Control Branch
http://www.waste.ky.gov/	Kentucky Division of Waste Management
http://www.kdfwr.state.ky.us	Kentucky Department of Fish Wildlife Resources

ADDITIONAL READING

These documents are available at the DOE Environmental Information Center:

Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 93, National Council on Radiation Protection and Measurements, Washington, DC.

Paducah Site Annual Site Environmental Report for Calendar Year 2004, DOE/OR/07-2233/V1 and VII, Department of Energy, Lexington, KY.

Paducah Site Environmental Monitoring Plan, BJC/PAD-285/R2, Bechtel Jacobs Company LLC, Paducah, KY.

Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2004 at the Paducah Gaseous Diffusion Plant, Paducah Kentucky, BJC/PAD-169/R5, Bechtel Jacobs Company LLC, Paducah, KY.

Paducah Annual Site Environmental Report 2004 Summary