U.S. Department of Energy
Portsmouth Gaseous Diffusion Plant

Annual Site Environmental Report – 2011

January 2013

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Piketon, Ohio

U.S. Department of Energy
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ACRONYMS AND ABBREVIATIONS

ACP	American Centrifuge Plant
ARARs	applicable or relevant and appropriate requirements
ARRA	American Recovery and Reinvestment Act
BWCS	B&W Conversion Services, LLC
CBOD	carbonaceous biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	curie
D&D	decontamination and decommissioning
DFF&O	*The April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action, including the July 16, 2012 Modification thereto*
DOE	U.S. Department of Energy
DUF_6	depleted uranium hexafluoride
EMS	Environmental Management System
FBP	Fluor-B&W Portsmouth LLC
IRM	interim remedial measure
LLW	low-level radioactive waste
LPP	LATA/Parallax Portsmouth, LLC
µg/kg	microgram per kilogram (equivalent to part per billion)
µg/L	microgram per liter (equivalent to part per billion)
$\mu g/m^3$	microgram per cubic meter
mL	milliliter
mrem	millirem
NCRP	National Council on Radiation Protection
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
Ohio EPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
pCi/L	picocurie per liter
pCi/mL	picocurie per milliliter
pCi/m^3	picocurie per cubic meter
PK	Peter Kiewit
PORTS	Portsmouth Gaseous Diffusion Plant
ppb	part per billion
ppm	part per million
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
SODI	Southern Ohio Diversification Initiative
SU	standard unit
TCE	trichloroethene
TSCA	Toxic Substances Control Act
TUa	acute toxicity unit
UDS	Uranium Disposition Services, LLC
U.S. EPA	U.S. Environmental Protection Agency
USEC	United States Enrichment Corporation
WEMS	Wastren-EnergX Mission Support, LLC

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DEFINITIONS

absorption – Taking up of energy from radiation by the medium through which the radiation is passing.

activity – See "radioactivity."

air stripper – Equipment that bubbles air through water to remove volatile organic compounds from the water.

alpha activity – The rate of emission of alpha particles from a given material.

alpha particle – A positively charged particle consisting of two protons and two neutrons, identical with the nucleus of a helium atom; emitted by several radioactive substances.

ambient air – The atmosphere around people, plants, and structures. Ambient air usually means outdoor air (as opposed to indoor air).

analyte – The specific component that is being measured in a chemical analysis.

aquifer – A permeable body of rock below the ground surface that is capable of yielding quantities of groundwater to wells and springs. A subsurface zone that yields economically important amounts of water to wells.

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

background radiation – The radiation in humans' natural environment, including cosmic rays and radiation from the naturally radioactive elements.

beta activity – The rate of emission of beta particles from a given material.

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

biota – Animal and plant life characterizing a given region.

categorical exclusion – A class of actions that either individually or cumulatively do not have a significant effect on the human environment and therefore do not require preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act.

chain-of-custody – A process that documents custody and control of a sample through sample collection, transportation and analysis.

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

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

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

contaminant – Any substance that enters a system (the environment, food, the human body, etc.) where it is not normally found. Contaminants include substances that spoil food, pollute the environment, or cause other adverse effects.

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

critical habitat – Specific geographic areas, whether occupied by a species listed under the Endangered Species Act or not, that are essential for conservation of the species and that have been formally designated by a rule published in the Federal Register.

curie (Ci) – A unit of radioactivity, defined as that quantity of any radioactive nuclide which has 3.7 x 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 x 10^{13} disintegrations per second.
millicurie (mCi) – 10^{-3} Ci, one-thousandth of a curie; 3.7 x 10^{7} disintegrations per second.
microcurie (µCi) – 10^{-6} Ci, one-millionth of a curie, 3.7 x 10^{4} disintegrations per second.
picocurie (pCi) – 10^{-12} Ci, one-trillionth of a curie; 0.037 disintegration per second.

decontamination and decommissioning – Removing equipment, demolishing buildings, disposing of wastes, and investigating potential contamination in areas of PORTS that are no longer part of current operations.

deferred unit – An area at PORTS that is in or adjacent to current production and operational areas such that remedial activities would interrupt operations, or an area that could become recontaminated from ongoing operations.

derived concentration guide – 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 a dose of 0.1 rem or a dose of 5 rem to any tissue, including skin and the lens of the eye. The guidelines for radionuclides in air and water are provided in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

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

- **absorbed dose** – The quantity of ionizing 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 gray).

- **dose** – The product of the absorbed dose (rad) in tissue and a quality factor. Dose is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

- **effective dose** – The sum of the doses received by all organs or tissues of the body after each one has been multiplied by the appropriate weighting factor. In this report, the term "effective dose" is often shortened to "dose."

- **collective dose/collective effective dose** – The sums of the doses of all individuals in an exposed population expressed in units of person-rem (or person-sievert). The collective effective dose is also frequently called the "population dose."

downgradient – The direction that groundwater flows; similar to downstream for surface water.

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

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

effluent monitoring – The collection and analysis of samples or measurement of liquid and gaseous effluents to characterize and quantify the release of contaminants, assess radiation exposures to the public, and demonstrate 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 exposure to ionizing radiation that takes place at a person's workplace. Population exposure is the exposure to the total number of persons who inhabit an area.

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

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.

glove box – An enclosure with built-in sleeves and gloves used by a person to manipulate hazardous materials such as highly enriched uranium without directly exposing the person to the material.

groundwater – Any water found below the land surface.

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; half-lives can range in duration from less than a second to many millions of years.

industrial solid waste landfill – A type of landfill that exclusively disposes of solid waste generated by manufacturing or industrial operations.

in situ – In its original place; field measurements taken without removing the sample from its original location; remediation performed while the contaminated media (e.g., groundwater or soil) remains below the surface or in place.

interim remedial measure (IRM) – Cleanup activities initiated after it has been determined that contamination or waste disposal practices pose an immediate threat to human health and/or the environment. These measures are implemented until a more permanent solution can be made.

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

irradiation – Exposure to radiation.

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

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.

maximum contaminant level (MCL) – The maximum permissible level of a contaminant in drinking water provided by a public water system.

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

millirem (mrem) – The dose that is one-thousandth of a rem.

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.

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

nuclide – An atom specified by atomic weight, atomic number, and energy state.

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

part per billion – A unit measure of concentration equivalent to the weight to volume ratio expressed as microgram per liter (µg/L) or the weight to weight ratio of microgram per kilogram (µg/kg).

part per million – A unit measure of concentration equivalent to the weight to volume ratio expressed as milligram per liter (mg/L), the weight to weight ratio expressed as milligram per kilogram (mg/kg), or the weight to weight ratio of microgram per gram (µg/g).

person-rem – A unit of measure for the 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 7, neutral solutions have a pH equal to 7, and basic solutions have a pH from 7 to 14.

polychlorinated biphenyls (PCBs) – Man-made chemicals that range from oily liquids to waxy solids. PCBs were used in hundreds of industrial and commercial applications due to their chemical properties until production in the United States ceased in 1977. PCBs have been demonstrated to cause a variety of adverse health effects in animals and possibly cause cancer and other adverse health effects in humans.

preliminary remediation goal – The maximum concentration of a constituent in environmental media (soil, groundwater, etc.) that is considered protective of human health and the environment.

quality assurance – Any action in environmental monitoring to demonstrate the reliability of monitoring and measurement data.

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

rad – The unit of absorbed dose deposited in a volume of material.

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

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

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

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

remediation – The correction or cleanup of a site contaminated with waste. See "Environmental Restoration."

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

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

riparian – related to the banks of a river or wetlands adjacent to rivers and streams.

settleable solids – Material settling out of suspension in a liquid within a defined period of time.

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

Superfund – The program operated under the legislative authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act that funds and conducts U.S. EPA emergency and long-term removal and remedial actions.

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 in the earth's soils such as potassium-40, thorium, and uranium. Terrestrial radiation contributes to natural background radiation.

transuranics – Elements such as americium, plutonium, and neptunium that have atomic numbers (the number of protons in the nucleus) greater than 92. All transuranics are radioactive.

trichloroethene (TCE) – A colorless liquid used in many industrial applications as a cleaner and/or solvent. One of many chemicals that is classified as a volatile organic compound. High levels of TCE

may cause health effects such as liver and lung damage and abnormal heartbeat; moderate levels may cause dizziness or headache. The International Agency for Research on Cancer considers TCE a probable human carcinogen.

trip blank – A quality control sample of water that accompanies sample containers from the analytical laboratory, to the field sampling location where environmental samples are collected, back to the analytical laboratory to determine whether environmental samples have been contaminated during transport, shipment, and/or site conditions.

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

upgradient – In the opposite direction of groundwater flow; similar to upstream for surface water.

upgradient well – A well installed hydraulically upgradient of a site to provide data to compare to a downgradient well to determine whether the site is affecting groundwater quality.

volatile organic compounds – Organic (carbon-containing) compounds that evaporate readily at room temperature. These compounds are present in solvents, degreasers, paints, thinners, and fuels. Due to a number of factors including widespread industrial use, they are commonly found as contaminants in soil and groundwater. Volatile organic compounds found at PORTS include TCE, vinyl chloride, benzene, and dichloroethenes.

weighting factor – A tissue specific number that represents the fraction of the total health risk resulting from uniform, whole body irradiation to the specific organ or tissue (bone marrow, lungs, thyroid, etc.).

wetland – An area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, floodplains, fens, and similar areas. A jurisdictional wetland is one that falls under state or federal regulatory authority; a non-jurisdictional wetland does not.

EXECUTIVE SUMMARY

PURPOSE

This Annual Site Environmental Report is prepared to summarize environmental activities, primarily environmental monitoring, at the U.S. Department of Energy (DOE) Portsmouth Gaseous Diffusion Plant (PORTS) for calendar year 2011. The report fulfills a requirement of DOE Order 231.1B, *Environment, Safety and Health Reporting*, for preparation of an annual summary of environmental data to characterize environmental management performance. The Annual Site Environmental Report also provides the means by which DOE demonstrates compliance with the radiation protection requirements of DOE Orders 458.1, *Radiation Protection of the Public and the Environment*, which replaced DOE Order 5400.5 during 2011.

SITE AND OPERATIONS OVERVIEW

PORTS, which produced enriched uranium via the gaseous diffusion process from 1954 to 2001, is one of three uranium enrichment facilities originally built in the United States; the other two were constructed in Oak Ridge, Tennessee and Paducah, Kentucky, respectively. PORTS is located on 5.9 square miles in Pike County, Ohio. The county has approximately 28,700 residents.

DOE is responsible for decontamination and decommissioning (D&D) of the gaseous diffusion process buildings and associated facilities, environmental restoration, waste management, depleted uranium hexafluoride (DUF_6) conversion, and management of other non-leased facilities at PORTS. DOE contractors LATA/Parallax Portsmouth, LLC (LPP), Fluor-B&W Portsmouth LLC (FBP), Wastren-EnergX Mission Support, LLC (WEMS), Uranium Disposition Services, LLC (UDS), and B&W Conversion Services, LLC (BWCS) managed DOE programs at PORTS in 2011.

LPP was responsible for the following activities from January 1, 2011 until March 29, 2011: 1) environmental restoration of contaminated areas; 2) monitoring and reporting on environmental compliance; 3) disposition of legacy radioactive waste; 4) D&D of inactive facilities; 5) disposition of highly enriched uranium; and 6) operation of the site's waste storage facilities. On March 29, 2011, FBP assumed responsibility for these activities, as well as D&D of PORTS.

WEMS provided facility support services including the following: 1) maintenance of facilities, grounds, and roadways; 2) janitorial services; 3) security access for DOE facilities; 4) training; 5) records and fleet management; and 6) information technology/network support for DOE operations.

UDS was responsible for operations associated with the DUF_6 Conversion Facility from January 1, 2011 until March 29, 2011. BWCS assumed responsibility for the DUF_6 Conversion Facility on March 29,2011, including surveillance and maintenance of DUF_6 cylinders, and environmental compliance and monitoring activities associated with operation of the DUF_6 Conversion Facility. DUF_6, which is a product of the uranium enrichment process, is stored in cylinders on site. The DUF_6 Conversion Facility converts DUF_6 into uranium oxide and hydrogen fluoride. The uranium oxide is made available for beneficial reuse, storage, or disposal, and the hydrogen fluoride is sold for reuse.

In 1993, DOE leased the uranium enrichment production and operations facilities at PORTS to the United States Enrichment Corporation (USEC), a company that was government-owned until it was privatized in 1998. USEC Government Services, a subsidiary of USEC that leased the gaseous diffusion production facilities from DOE, began the process of returning the gaseous diffusion process buildings to DOE in 2010. This process was completed on September 30, 2011. Environmental monitoring data collected by USEC Government Services prior to September 30, 2011, are reported by FBP (the DOE contractor that became responsible for this monitoring).

USEC, Inc. (the parent company of USEC) is developing a gaseous centrifuge uranium enrichment plant at PORTS. USEC, Inc. leases buildings from DOE, but the gaseous centrifuge uranium enrichment plant is a commercial enterprise of USEC, Inc. and is not pursuant to a DOE contract. The USEC, Inc. Lead Cascade, which is a small-scale demonstration centrifuge for uranium enrichment, has been operating since 2006. The commercial scale American Centrifuge Plant (ACP) is under development. Both of these facilities (the Lead Cascade and the ACP) are housed in existing buildings at PORTS.

With the exception of Chapter 2, Compliance Summary; Chapter 4, Environmental Radiological Program Information; and Chapter 5, Environmental Non-Radiological Program Information, this report does not cover USEC, Inc. operations at PORTS because their operations are not subject to DOE Orders. USEC, Inc. data are included in these chapters to provide a more complete picture of the operations in place at PORTS to detect and assess potential impacts to human health and the environment resulting from PORTS activities.

ENVIRONMENTAL COMPLIANCE

DOE and/or the responsible DOE contractor have been issued permits for discharge of water to surface streams, air emission permits, and a permit for the storage of hazardous waste. The National Pollutant Discharge Elimination System (NPDES) outfalls and numerous air emission permits that were associated with the gaseous diffusion plant were also transferred from USEC Government Services to FBP during 2011.

DOE contractors are responsible for preparing a number of reports for compliance with environmental regulations. These reports include: an annual groundwater monitoring report; an annual hazardous waste report; an annual polychlorinated biphenyl (PCB) document log; an annual summary of radionuclide air emissions and the associated dose to the public from these emissions; a biennial report of specified non-radiological air emissions; a monthly report of NPDES monitoring data; a quarterly radiological discharge monitoring report for NPDES outfalls; an annual hazardous chemical inventory; and an annual toxic chemical release inventory.

USEC, Inc. is responsible for compliance activities directly associated with the ACP and Lead Cascade including air emission permits associated with the gaseous centrifuge uranium enrichment operations (the proposed ACP and Lead Cascade), NPDES outfalls, and management of wastes generated by their current operations.

DOE and/or DOE contractors received three Notices of Violation in 2011. On April 6, 2011, Ohio EPA observed a release of used oil at the X-630 D&D project that was a violation of used oil storage regulations. In response to the release, FBP removed and disposed of absorbent materials saturated with oil and stained gravel in the area of the release. Absorbent material and straw was placed in or around the affected on-site drainage ditch and storm drain to catch any residual oil. Documentation of the cleanup was provided to Ohio EPA. In response, Ohio EPA stated that DOE and FBP had abated the violation in a letter dated April 15, 2011.

DOE received a Notice of Violation/Return to Compliance from the inspection conducted by U.S. Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (Ohio EPA) on June 27, 2011. The Notice of Violation was for failing to label containers of used oil and used fluorescent lamps with the words “used oil” or “used lamps”, respectively. The violation was immediately abated by labeling the containers. U.S. EPA stated in the Notice of Violation that DOE and FBP had resolved the violation. No further action was required.

LPP received a Notice of Violation dated August 2, 2011 from the Utah Radiation Control Board for a shipment of radioactive waste received on February 7, 2011 by the EnergySolutions facility in Clive,

Utah. The shipment, which consisted of three 85-gallon drums of radioactive waste, exceeded the facility's waste acceptance criteria for depleted uranium and uranium-235, based on samples of the waste that were collected and analyzed by EnergySolutions. A civil penalty of $10,000 was assessed by the Utah Radiation Control Board and paid by LPP. The waste was subsequently shipped to and disposed at a facility that was allowed to accept radioactive waste with the levels of depleted uranium and uranium-235 that were present in the waste.

ENVIRONMENTAL PROGRAMS

D&D, Environmental Restoration, Waste Management, and Public Awareness Programs are conducted at PORTS to protect and inform the local population, improve the quality of the environment, and comply with federal and state regulations.

D&D Program

In 2010, D&D of the PORTS gaseous diffusion process buildings and associated facilities began with the signing of the *April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action (which includes the July 16, 2012 Modification thereto)* (DFF&O). The DFF&O is a legal agreement between Ohio EPA and DOE that governs the process for D&D of the buildings/structures that are no longer in use at PORTS.

In 2011, the planning and investigations necessary for D&D of the gaseous diffusion process buildings and associated facilities included development of the process for characterization and removal of 46 of the less complex facilities at PORTS, development of the work plan to characterize the process buildings and other complex facilities, and sampling and evaluation necessary to determine alternatives for disposition of the waste generated by D&D.

D&D of eight facilities (X-103, X-334, X-344B, X-630, X-230J9, X-605H, X-605I, and X-605J) was completed during 2011. Three projects funded by the American Recovery and Reinvestment Act (ARRA) were also completed in 2011: environmental remediation (source removal) at the X-701B Holding Pond, D&D of the X-533 Switchyard Complex, and repackaging and disposition of excess uranium materials.

Environmental Restoration Program

The Environmental Restoration Program was established by DOE in 1989 to identify, control, and remediate environmental contamination at PORTS. The 1989 Ohio Consent Decree and the 1989 U.S. EPA Administrative Consent Order (as amended in 1994 and 1997) require investigation and cleanup of environmental media at PORTS in accordance with the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. The site was divided into quadrants to facilitate the investigation and cleanup. Corrective actions, also called remedial actions, are underway in each quadrant.

In 2011, the Environmental Restoration Program was responsible for investigations of soil and/or groundwater associated with several facilities removed as part of D&D, two projects to remediate soil and/or groundwater contamination in the Quadrant II Groundwater Investigative Area and X-740 Waste Oil Handling Facility, and the continued remediation of the western portion of the X-701B area, which was funded by ARRA and began in 2009.

The Environmental Restoration Program also monitors and maintains five closed landfills at PORTS in accordance with Ohio EPA regulations. Samples are collected periodically (most often semiannually) from groundwater monitoring wells around the landfills. The samples are analyzed for chemicals and radionuclides that could be released from the materials that were disposed in the landfills.

Four groundwater treatment facilities are operated by the Environmental Restoration Program to treat contaminated groundwater from the on-site groundwater plumes that are contaminated with industrial solvents, including trichloroethene (TCE). These facilities are part of the systems at PORTS that collect contaminated groundwater. The groundwater treatment facilities remove TCE from the water so it can be safely discharged to Little Beaver Creek or the Scioto River in accordance with NPDES permits issued by Ohio EPA.

Waste Management Program

The DOE Waste Management Program at PORTS directs the safe storage, treatment, and disposal of waste generated from D&D of facilities that are no longer in use, past plant operations, ongoing plant maintenance, and ongoing environmental restoration projects. In 2011, approximately 16,000 tons of waste from DOE activities at PORTS were recycled, treated, or disposed at off-site facilities.

Waste management activities are conducted in compliance with applicable DOE Orders, Ohio EPA regulations, and U.S. EPA regulations. Waste management requirements are varied and often complex because of the variety of wastes generated by DOE activities at PORTS. The types of waste managed by DOE at PORTS include:

- *Low-level radioactive waste* – radioactive waste not classified as high level or transuranic waste.
- *Hazardous (RCRA) waste* – waste listed under RCRA or waste that exhibits one or more of the four RCRA hazardous characteristics: ignitability, corrosivity, reactivity, and toxicity.
- *PCB wastes* – waste containing PCBs, a class of synthetic organic chemicals. Disposal of PCB-contaminated materials is regulated under the Toxic Substances Control Act.
- *Solid wastes* – Waste that includes construction and demolition debris, industrial waste, and sanitary waste, as defined by Ohio regulations.

Many of the wastes generated by DOE activities at PORTS are a combination of the first three waste types listed above; for example, some wastes are both RCRA hazardous waste and low-level radioactive waste (called mixed waste).

In addition to complying with DOE Orders and Ohio EPA/U.S. EPA regulations, DOE has also implemented supplemental policies for management of DOE waste at PORTS including: minimizing waste generation; characterizing and certifying wastes before they are stored, processed, treated, or disposed; pursuing volume reduction (such as blending and bulking); on-site storage in preparation for safe and compliant final treatment and/or disposal; and recycling.

With the beginning of D&D at PORTS, DOE is placing increased emphasis on the evaluation of materials generated by D&D for reuse or recycling. An agreement between DOE and the Southern Ohio Diversification Initiative (SODI) allows DOE to transfer excess equipment, clean scrap materials, and other assets to SODI. When SODI sells the materials, the proceeds are divided by SODI and DOE. In 2010-2011, SODI received approximately 13 million pounds of scrap metal and 270,000 gallons of transformer oil from D&D activities at PORTS, primarily D&D of the X-533 Switchyard Complex. Approximately 4.2 million dollars was generated from sales of these materials. SODI used the proceeds to support economic development in the southern Ohio region. Projects that received funding from SODI in 2011 included construction of a steel processing plant in New Boston, Ohio, and a sewer line extension project in Pike County.

Public Awareness Program

DOE provides a public Environmental Information Center to allow access to all documents used to make decisions on remedial actions being taken at PORTS. The information center is located just north of PORTS at the Ohio State University Endeavor Center (Room 207), 1862 Shyville Road, Piketon, Ohio 45661. The Information Center is open 9 a.m. to noon Monday and Tuesday, noon to 4 p.m. Wednesday and Thursday, or by appointment (call 740-289-8898). The email address is portseic@wems-llc.com. Additional information is provided by the DOE Site Office (740-897-5010) and the Office of Public Affairs (740-897-3486). This Annual Site Environmental Report and other information can also be obtained from the DOE web site for PORTS at www.pppo.energy.gov or the FBP web site at www.fbportsmouth.com.

The PORTS Site Specific Advisory Board, comprised of up to 20 citizens from the local area, provides public input and recommendations to DOE on environmental remediation, waste management, and related issues at PORTS. Additional information about the board can be obtained at www.ports-ssab.org or by calling 740-289-5249.

In 2011, DOE and FBP began the PORTS Envoy Program. The Envoy Program matches employee volunteers with community stakeholders such as families living next to DOE property, community groups, and local government organizations. The envoys communicate information about PORTS D&D and other site issues to the stakeholders and are available to answer stakeholder questions about PORTS.

Public update meetings and public workshops on specific topics are also held to keep the public informed and to receive their comments and questions. Periodically, fact sheets about major projects are written for the public. Additionally, notices of document availability and public comment periods, as well as other communications on the program, are regularly distributed to the local newspaper and those on the community relations mailing list, neighbors within 2 miles of the plant, and plant employees.

ENVIRONMENTAL MONITORING

Extensive environmental monitoring is completed at PORTS to comply with environmental regulations, permit requirements, and DOE Orders, and to address public concerns about plant operations. The *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* describes the DOE environmental monitoring programs at PORTS, with the exception of groundwater monitoring. Groundwater monitoring, which also includes related surface water monitoring and residential water supply monitoring, is described in the *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant.* This monitoring is discussed in Chapter 6, Groundwater Programs.

Environmental monitoring includes the collection of samples of air, water, soil, vegetation, and biota (animals and crops) on a regular basis that ranges from weekly (ambient air) to annually (sediment, soil, vegetation, and biota). In 2011, environmental monitoring information was collected for the following programs:

- ambient air
- direct radiation
- discharges to surface water
- local surface water
- sediment
- soil
- vegetation
- biota (crops, deer, fish, milk, and eggs).

Samples are analyzed for radionuclides, metals, and/or other chemicals that could be present in the environment due to PORTS activities, although many of these analytes also occur naturally or can be present due to human activities not related to PORTS. Over 1000 samples from these programs are collected on an annual basis.

Data collected for these programs in 2011 are consistent with data collected in previous years and indicate that radionuclides, metals, and other chemicals released by PORTS operations have a minimal effect on human health and the environment. The next section, Dose, provides more information about the potential impacts to human health from radionuclides released by PORTS.

DOSE

Potential impacts on human health from radionuclides released by PORTS operations are calculated based on environmental monitoring data. This impact, commonly called a dose, can be caused by radionuclides released into the air and/or water, or radiation emanating directly from buildings or other objects at PORTS. U.S. EPA sets a 10 millirem (mrem)/year limit for the dose from radionuclides released to the air, and DOE sets a 100 mrem/year limit for the dose from radionuclides from all potential pathways (air, water, and direct radiation). A person living in the United States receives an average dose of approximately 311 mrem/year from natural sources of radiation (National Council on Radiation Protection [NCRP] 2009). Figure 1 provides a comparison of the doses from various common radiation sources.

This Annual Site Environmental Report includes radiological dose calculations for the dose to the public from radionuclides released to the environment based on environmental monitoring data collected by DOE contractors and USEC, Inc. The maximum dose that a member of the public could receive from radiation released by PORTS in 2011 is 1.3 mrem, based on a maximum dose of 0.032 mrem from airborne radionuclides, 0.012 mrem from radionuclides released to the Scioto River, 0.81 mrem from direct radiation from the cylinder storage yards, and 0.42 mrem based on exposure to radionuclides detected at off-site monitoring locations in 2011. This dose calculation uses a worst-case approach; that is, the calculation assumes that the same individual is exposed to the most extreme conditions from each pathway. This dose (1.3 mrem) is significantly less than the 100 mrem/year limit set by DOE for the dose to a member of the public from radionuclides from all potential pathways. The dose to a member of the public from airborne radionuclides released by PORTS (0.032 mrem) is also significantly less than the 10 mrem/year standard set by U.S. EPA.

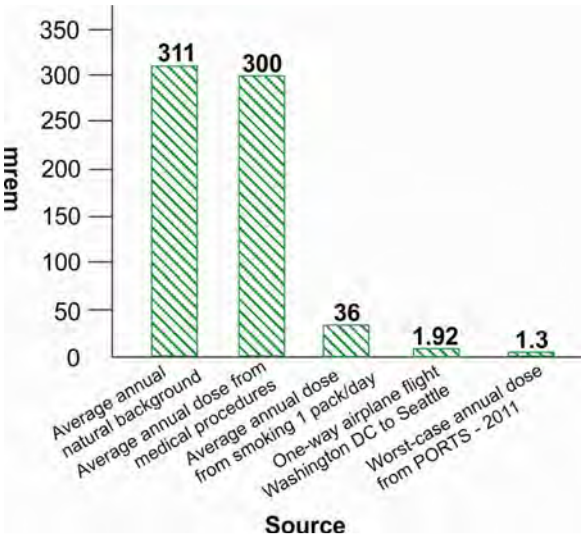

Figure 1. Comparison of dose from various common radiation sources

GROUNDWATER PROGRAMS

Groundwater monitoring at PORTS is performed at RCRA hazardous waste units, solid waste disposal units, and RCRA Corrective Action Program units. The *Integrated Groundwater Monitoring Plan* describes the groundwater monitoring program for PORTS, which has been reviewed and approved by Ohio EPA. In general, samples are collected from wells at 12 groundwater monitoring areas and

14 surface water locations that are part of the groundwater monitoring program. Samples are analyzed for metals, volatile organic compounds, and/or radiological constituents. Constituents detected in the groundwater are then evaluated to assess the potential for each constituent to affect human health and the environment.

Some groundwater monitoring is conducted in order to meet DOE Order requirements. Exit pathway monitoring assesses the effect of PORTS on regional groundwater quality and quantity.

Five groundwater contamination plumes have been identified on site at PORTS in the following areas: X-749/X-120/Peter Kiewit (PK) Landfill (Quadrant I), Quadrant I Groundwater Investigative Area, Quadrant II Groundwater Investigative Area, X-701B Holding Pond (Quadrant II), and X-740 Waste Oil Handling Facility (Quadrant III). The primary groundwater contaminant is TCE. Other monitoring areas may have groundwater contaminated with metals or may be monitored to comply with regulatory requirements for closed landfills. Remediation of groundwater is being conducted primarily under Ohio EPA's RCRA Corrective Action Program.

In 2011, concentrations of TCE continued to decrease in the X-749/X-120/PK Landfill area due to the groundwater extraction wells installed in this area in 2007-2008. TCE was detected at an estimated concentration of 0.25 microgram per liter (µg/L – or parts per billion) in the first quarter sample collected from off-site monitoring well WP-03G. No TCE or other volatile organic compounds were detected in any of the seven off-site monitoring wells sampled in the second, third, and/or fourth quarters of 2011. TCE has not been detected in groundwater beyond the DOE property boundary at concentrations that exceed the Ohio EPA drinking water standard of 5 µg/L. In general, the other contaminated groundwater plumes present at PORTS did not change significantly in 2011.

The *Integrated Groundwater Monitoring Plan* also addresses monitoring of residential water supplies near PORTS to verify that site contaminants have not migrated into off-site drinking water wells. Results of this program indicate that PORTS has not affected drinking water wells outside the site boundaries.

QUALITY ASSURANCE AND QUALITY CONTROL

Data reliability is of the utmost importance for monitoring releases and measuring radiation in the environment. To demonstrate that the monitoring and measurement results are accurate, DOE contractors have implemented a quality assurance and quality control program based on guidelines from U.S. EPA, the American Society for Testing and Materials, and other federal and state agencies. DOE and DOE contractors administer numerous quality control activities to verify reliability of the data on a day-to-day basis. DOE and DOE contractors also participate actively in quality control programs administered by agencies outside the site such as U.S. EPA.

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1. INTRODUCTION

1.1 SUMMARY

The Portsmouth Gaseous Diffusion Plant (PORTS) is located on a 5.9-square-mile site in a rural area of Pike County, Ohio. U.S. Department of Energy (DOE) activities at PORTS include environmental restoration, waste management, uranium operations, and decontamination and decommissioning (D&D) of the process buildings and associated facilities formerly used for the gaseous diffusion process of uranium enrichment. Fluor-B&W Portsmouth LLC (FBP) is the DOE contractor responsible for D&D of PORTS, which includes the three gaseous diffusion process buildings and other associated facilities.

The United States Enrichment Corporation (USEC) operated the gaseous diffusion uranium enrichment facilities at PORTS until 2001. USEC, Inc. (the parent company of USEC) leases facilities at PORTS for the development and planned operation of its gaseous centrifuge uranium enrichment facility – the American Centrifuge Plant (ACP). USEC Government Services, a subsidiary of USEC that leased the gaseous diffusion production facilities at PORTS from DOE, began the process of returning the facilities to DOE in 2010. This process was completed on September 30, 2011. USEC Government Services is no longer responsible for any activities at PORTS. Environmental monitoring data collected by USEC Government Services prior to September 30, 2011, are reported by FBP (the DOE contractor that became responsible for this monitoring).

In general, activities conducted by USEC, Inc. are not covered by this document because their operations are not subject to DOE Orders. However, some USEC, Inc. environmental compliance information is provided in Chapter 2 and radiological and non-radiological environmental monitoring program information is discussed in Chapters 4 and 5, respectively. USEC, Inc. data are included in these chapters to provide a more complete picture of the programs in place at PORTS to detect and assess potential impacts to human health and the environment resulting from PORTS activities.

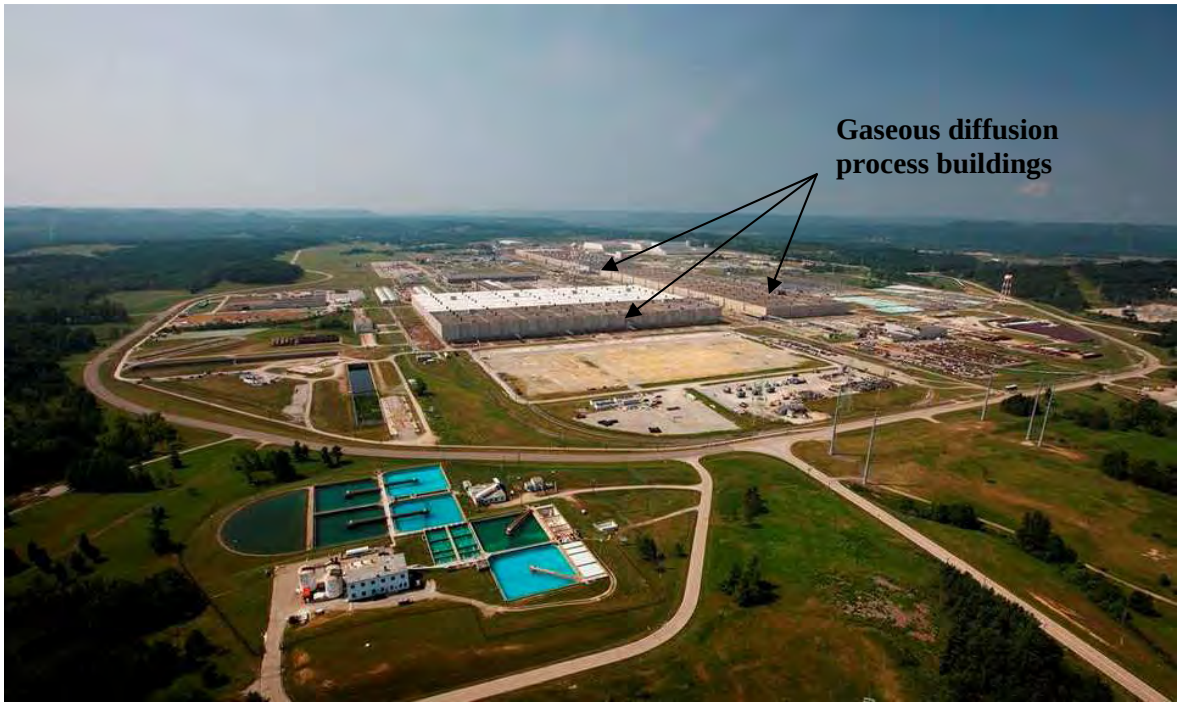

Figure 1.1 The Portsmouth Gaseous Diffusion Plant – 2011.

1.2 BACKGROUND INFORMATION

PORTS, which produced enriched uranium via the gaseous diffusion process from 1954 through 2001, is owned by DOE (see Figure 1.1). In 1993, DOE leased the uranium production facilities at the site to USEC, which was established by the Energy Policy Act of 1992.

DOE is responsible for D&D of the gaseous diffusion process buildings and associated facilities, environmental restoration, waste management, and uranium operations. DOE contractors LATA/Parallax Portsmouth, LLC (LPP), FBP, Wastren-EnergX Mission Support, LLC (WEMS), B&W Conversion Services, LLC (BWCS), and Uranium Disposition Services, LLC (UDS) managed DOE programs at PORTS in 2011.

LPP was responsible for the following activities from January 1, 2011 until March 29, 2011: 1) environmental restoration of contaminated areas; 2) monitoring and reporting on environmental compliance; 3) disposition of legacy radioactive waste; 4) D&D of inactive facilities; 5) disposition of highly enriched uranium; and 6) operation of the site's waste storage facilities. On March 29, 2011, FBP assumed responsibility for these activities, as well as D&D of PORTS.

WEMS provided facility support services including the following: 1) maintenance of facilities, grounds, and roadways; 2) janitorial services; 3) security access for DOE facilities; 4) training; 5) records and fleet management; and 6) information technology/network support for DOE operations.

UDS was responsible for operations associated with the Depleted Uranium Hexafluoride (DUF_6) Conversion Facility at PORTS until March 29, 2011. BWCS assumed responsibility for the DUF_6 Conversion Facility on March 29, 2011, including surveillance and maintenance of DUF_6 cylinders, and environmental compliance and monitoring activities associated with operation of the facility. DUF_6, which is a product of the uranium enrichment process, is stored in cylinders on site. The DUF_6 Conversion Facility converts DUF_6 into uranium oxide and hydrogen fluoride. The uranium oxide is made available for beneficial reuse, storage, or disposal, and the hydrogen fluoride is sold for reuse.

USEC, which became a publicly-held company in 1998, enriched uranium at PORTS via the gaseous diffusion process for use in commercial nuclear power reactors until 2001, at which time USEC ceased production at PORTS. USEC Government Services, a subsidiary of USEC that leased the gaseous diffusion production facilities at PORTS from DOE, began the process of returning the facilities to DOE in 2010. This process was completed on September 30, 2011.

USEC, Inc. (the parent company of USEC) is developing a gaseous centrifuge uranium enrichment plant at PORTS. The gaseous centrifuge uranium enrichment process requires much less electricity than the gaseous diffusion process. Gas centrifuge uranium enrichment uses a rotor that spins at a high speed within a casing to separate uranium-235 from uranium-238 (resulting in enriched uranium). Gaseous diffusion uranium enrichment uses a porous barrier to separate uranium-235 molecules from uranium-238 molecules.

The USEC, Inc. Lead Cascade, which is a small-scale demonstration centrifuge for uranium enrichment, has been operating since 2006. The commercial scale ACP is under development. Both of these facilities (the Lead Cascade and the ACP) are housed in existing buildings at PORTS that were constructed for DOE's Gaseous Centrifuge Enrichment Plant, which was cancelled in 1985.

This report is intended to fulfill the requirements of DOE Order 231.1B, *Environment, Safety and Health Reporting*. This DOE Order requires development of an annual site environmental report that includes information on regulatory compliance, environmental programs, radiological and non-radiological monitoring programs, groundwater programs, and quality assurance. The Annual Site Environmental

Report also provides the means by which DOE demonstrates compliance with the radiation protection requirements of DOE Order 458.1 *Radiation Protection of the Public and the Environment*, which replaced DOE Order 5400.5 during 2011.

This report is not intended to present all of the monitoring data at PORTS. Additional data collected for other site purposes, such as environmental restoration and waste management, are presented in other documents that have been prepared in accordance with applicable laws and regulations. These data are presented in other reports, such as the *2011 Groundwater Monitoring Report* and the *2011 Annual Hazardous Waste Report*, which are available at the PORTS Environmental Information Center.

1.3 DESCRIPTION OF SITE LOCALE

PORTS is located in a rural area of Pike County, Ohio, on a 5.9-square-mile site. The site is 2 miles east of the Scioto River in a small valley running parallel to and approximately 120 feet above the Scioto River floodplain. Figure 1.2 depicts the plant site within the State of Ohio and its immediate environs.

Pike County has approximately 28,700 residents (U.S. Census 2010). Scattered rural development is typical; however, the county contains a number of small villages such as Piketon and Beaver that lie within a few miles of the plant. The county's largest community, Waverly, is about 10 miles north of the plant and has a population of about 4,400 residents (U.S. Census 2010). The nearest residential center in this area is Piketon, which is about 5 miles north of the plant on U.S. Route 23 with a population of about 2,200 (U.S. Census 2010). Several residences are adjacent to the southern half of the eastern boundary and along Wakefield Mound Road (old U.S. 23), directly west of the plant.

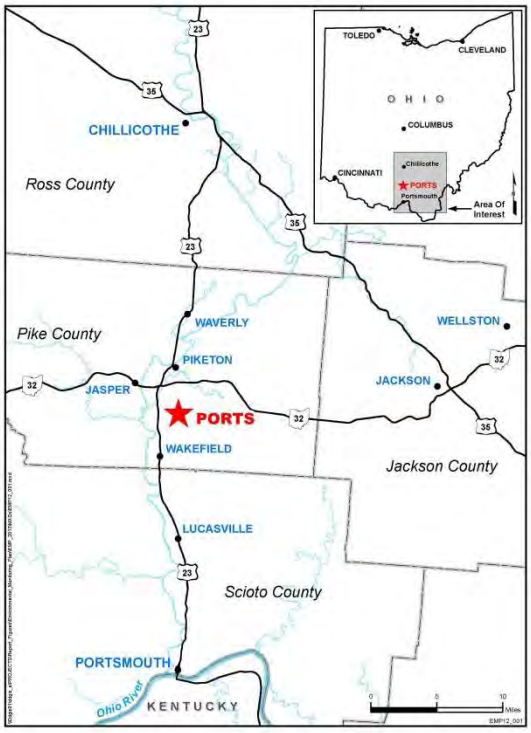

Figure 1.2. Location of PORTS.

Additional cities within 50 miles of the plant are Portsmouth (population 20,226), 22 miles south; Chillicothe (population 21,901), 27 miles north; and Jackson (population 6,397), 18 miles east (U.S. Census 2010). The total population within 50 miles of the plant is approximately 677,000 persons.

1.4 DESCRIPTION OF SITE OPERATIONS

DOE, through its managing contractors, is responsible for D&D of the gaseous diffusion uranium enrichment buildings and associated facilities, environmental restoration, and waste management associated with DOE activities. DOE is also responsible for uranium management, which includes the DUF_6 Conversion Facility.

D&D includes the gaseous diffusion process buildings and associated facilities subject to the DFF&O. D&D activities can consist of deactivation of equipment; removal and cleaning of process residues from equipment, structures, and piping; and dismantlement, demolition, and removal of equipment, structures, piping, and concrete foundations. The D&D Program is also responsible for conducting an evaluation of alternatives for disposition of waste generated by D&D.

Environmental restoration is the investigation and remediation of environmental contamination associated with the past operation of the gaseous diffusion uranium enrichment facilities. Remedial investigations and remedial actions define the nature and extent of environmental contamination, evaluate the risk to public health and the environment, remediate areas of environmental contamination, and monitor/evaluate ongoing remedial actions. The goal of the Environmental Restoration Program is to verify that releases from past operations at PORTS are thoroughly investigated and that remedial actions are taken to protect human health and the environment.

Waste management includes managing wastes generated by DOE activities at PORTS, including wastes generated by D&D, environmental restoration, the DUF_6 Conversion Facility, and other DOE site operations. Wastes must be identified and stored in accordance with all environmental regulations. The responsible DOE contractor also arranges the transportation and off-site disposal of wastes. The goal of the Waste Management Program is to manage waste from the time it is generated to its ultimate treatment, recycling, or disposal in accordance with all applicable regulations.

DOE is also responsible for uranium management, which includes management of uranium product, coordination of the DUF_6 program, and warehousing of other uranium materials such as normal uranium hexafluoride, uranium oxides, and uranium metal.

2. COMPLIANCE SUMMARY

2.1 SUMMARY

DOE and/or the responsible DOE contractor during 2011 (LPP, FBP, BWCS, or UDS) held permits for discharge of water to surface streams, air emission permits, and a permit for the storage of hazardous wastes. The National Pollutant Discharge Elimination System (NPDES) outfalls and numerous air emission permits that were associated with the gaseous diffusion plant were also transferred from USEC Government Services to FBP during 2011.

DOE contractors are responsible for preparing a number of reports for compliance with various applicable environmental regulations. These reports include an annual groundwater monitoring report, an annual hazardous waste report, an annual polychlorinated biphenyl (PCB) document log, an annual summary of radionuclide air emissions and the associated dose to the public from these emissions, a biennial fee report of specified non-radiological air emissions, a monthly report of NPDES monitoring data, a quarterly radiological discharge monitoring report for NPDES outfalls, an annual hazardous chemical inventory, and an annual toxic chemical release inventory. Additional information on each of these reports is provided within this chapter.

DOE activities at PORTS are inspected regularly by the federal, state, and local agencies responsible for enforcing environmental regulations at PORTS. DOE and/or DOE contractors received three Notices of Violation in 2011.

On April 6, 2011, Ohio EPA observed a release of used oil at the X-630 D&D project that was a violation of used oil storage regulations. In response to the release, FBP removed and disposed of absorbent materials saturated with oil and stained gravel in the area of the release. Absorbent material and straw was placed in or around the affected on-site drainage ditch and storm drain to catch any residual oil. Documentation of the cleanup was provided to Ohio EPA. In response, Ohio EPA stated that DOE and FBP had abated the violation in a letter dated April 15, 2011.

DOE received a Notice of Violation/Return to Compliance from the inspection conducted by U.S. EPA and Ohio EPA on June 27, 2011. The Notice of Violation was for failing to label containers of used oil and used fluorescent lamps with the words “used oil” or “used lamps”, respectively. The violation was immediately abated by labeling the containers. U.S. EPA stated in the Notice of Violation that DOE and FBP had resolved the violation. No further action was required.

LPP received a Notice of Violation dated August 2, 2011 from the Utah Radiation Control Board for a shipment of radioactive waste received on February 7, 2011 by the EnergySolutions facility in Clive, Utah. The shipment, which consisted of three 85-gallon drums of radioactive waste, exceeded the facility’s waste acceptance criteria for depleted uranium and uranium-235, based on samples of the waste that were collected and analyzed by EnergySolutions. A civil penalty of $10,000 was assessed by the Utah Radiation Control Board and paid by LPP. The waste was subsequently shipped to and disposed at a facility that was allowed to accept radioactive waste with the levels of depleted uranium and uranium-235 that were present in the waste.

2.2 INTRODUCTION

DOE is responsible for the D&D Program, Environmental Restoration Program, Waste Management Program, uranium operations, and maintenance of all facilities not leased to USEC, Inc. In 2011, air emission permits and NPDES outfalls associated with the former gaseous diffusion plant operations were transferred from USEC Government Services to DOE contractor FBP. USEC, Inc. remained responsible for compliance activities directly associated with the ACP and Lead Cascade including air emission

permits associated with the gaseous centrifuge uranium enrichment operations (the proposed ACP and the Lead Cascade), NPDES outfalls, and management of wastes generated by their current operations.

DOE and/or DOE contractors during 2011 (LPP, FBP, BWCS, or UDS) held two NPDES permits for discharge of water to surface streams, numerous air emission permits, and a Resource Conservation and Recovery Act (RCRA) Part B permit for the storage of hazardous wastes. Appendix B lists the active environmental permits and registrations held by DOE and/or DOE contractors (FBP and BWCS) at the end of 2011.

Several federal, state, and local agencies are responsible for enforcing environmental regulations at PORTS. Primary regulatory agencies include U.S. EPA and Ohio EPA. These agencies issue permits, review compliance reports, conduct joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

DOE and/or DOE contractors conduct self-assessments to identify environmental issues and consult the regulatory agencies to identify the appropriate actions necessary to achieve and maintain compliance.

2.3 COMPLIANCE STATUS

This section discusses the DOE compliance status at PORTS with respect to environmental laws and regulations, DOE Orders, and Executive Orders.

2.3.1 Environmental Restoration and Waste Management

This section discusses the DOE compliance status at PORTS with U.S. EPA and Ohio EPA regulations pertaining to environmental restoration and waste management.

2.3.1.1 Comprehensive Environmental Response, Compensation, and Liability Act

PORTS is not on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List of sites requiring priority cleanup. However, D&D of PORTS is proceeding in accordance with the *April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action, including the July 16, 2012 Modification thereto* (DFF&O) and CERCLA. The DFF&O describes the process for D&D of the gaseous diffusion process buildings and associated facilities that are no longer in use. Chapter 3, Section 3.2, provides additional information about the D&D Program.

Environmental remediation, or the cleanup of soil, groundwater and other environmental media contaminated by PORTS operations, is conducted in accordance with U.S. EPA Administrative Consent Order, issued on September 29, 1989 (amended in 1994 and 1997), and Consent Decree with the State of Ohio, issued on August 29, 1989. U.S. EPA and Ohio EPA oversee environmental remediation activities at PORTS under the RCRA Corrective Action Program and CERCLA Program. Chapter 3, Section 3.3, provides additional information on the Environmental Restoration Program.

Section 103 of CERCLA requires notification to the National Response Center if hazardous substances are released to the environment in amounts greater than or equal to the reportable quantity. Reportable quantities are listed in CERCLA and vary depending on the type of hazardous substance released. During 2011, DOE contractors had no reportable quantity releases of hazardous substances subject to Section 103 notification requirements.

2.3.1.2 Emergency Planning and Community Right-To-Know Act

The Emergency Planning and Community Right-To-Know Act of 1986, also referred to as the Superfund Amendments and Reauthorization Act Title III, requires reporting of emergency planning information,

hazardous chemical inventories, and releases to the environment. Emergency Planning and Community Right-To-Know Act reports are submitted to federal, state, and local authorities.

For emergency planning purposes, facilities must submit information on chemicals present on site above specified quantities (called the threshold planning quantity) to state and local authorities. When a new chemical is brought on site or increased to exceed the threshold planning quantity, information about the new chemical must be submitted to state and local authorities within three months.

Section 304 of the Emergency Planning and Community Right-To-Know Act requires reporting of off-site reportable quantity releases to state and local authorities**.** During 2011, DOE contractors had no reportable quantity releases.

The Hazardous Chemical Inventory Report includes the identity, location, storage information, and hazards of the chemicals present on site in amounts above the threshold planning quantities specified by U.S. EPA. This report is submitted annually to state and local authorities. The PORTS site, which included DOE contractors or lessees (LPP/FBP, WEMS, UDS/BWCS, and the Ohio Army National Guard) and USEC, Inc. reported the following chemicals for 2011: dichlorotetrafluoroethane (CFC-114), 1,3-dichloro-5,5-dimethylhydantoin, aluminum oxide, argon, asbestos, calcium chloride, calcium hydroxide, calcium oxide, carbon dioxide, chlorine, citric acid, coal, diesel fuel, ethylene glycol, fluorine, trichlorofluoromethane (CFC-11), fuel oil, gasoline, hydrofluoric acid, hydrogen fluoride, hydrogen peroxide, kerosene, lubricating oil, methanol, nitric acid, nitrogen, PCBs, perfluoro-1,3-dimethylcyclohexane, potassium hydroxide, potassium phosphate, propylene glycol, sodium chloride, sodium hydroxide, sodium fluoride, sodium persulfate, sodium polyacrylate, sulfuric acid, sulfur dioxide, transformer oil, triuranium octaoxide, uranium dioxide, uranium hexafluoride, uranium metal, uranium tetrafluoride, and uranium trioxide.

The Toxic Chemical Release Inventory is sent annually to U.S. EPA and Ohio EPA. This report details releases to the environment of specified chemicals when they are manufactured, processed, or otherwise used by the entire site (including USEC, Inc.) in amounts that exceed threshold quantities specified by U.S. EPA. For this report, U.S. EPA defines a release to include on-site treatment, off-site disposal, and recycling conducted in accordance with regulations.

For 2011, DOE contractors reported the release, off-site transfer, and/or on-site treatment of nine chemicals:

- chlorine: used for water treatment;
- dichlorotetrafluoroethane (CFC-114): approximately 6000 lbs released to the air from the gaseous diffusion cascade system formerly used to produce enriched uranium;
- hydrochloric acid: approximately 32,000 lbs released from the X-600 Steam Plant from coal combustion and 3000 lbs in waste disposed off site;
- hydrogen fluoride: approximately 3 lbs released to the air from the DUF_6 Conversion Facility and 35 lbs treated off site;
- lead compounds: approximately 8 lbs released from the X-600 Steam Plant from burning coal and 547 lbs in materials disposed or recycled off site;
- methanol: approximately 175 lbs released from fugitive and point source air emissions and 52 lbs released to the Scioto River through permitted NPDES outfalls (from water treatment);

- nitrate compounds: approximately 31,000 lbs released to the Scioto River through permitted NPDES outfalls (from water treatment);

- nitric acid: approximately 200 lbs released to the air from the X-600 Steam Plant from burning coal; and,

- sulfuric acid: approximately 34,000 lbs released to the air from the X-600 Steam Plant from burning coal.

2.3.1.3 Resource Conservation and Recovery Act

RCRA regulates the generation, accumulation, storage, transportation, and disposal of solid and hazardous wastes. "Solid wastes," as defined by Ohio EPA, can be solids, liquids, sludges, or other materials. Hazardous wastes are a subset of solid wastes, and are designated as hazardous by Ohio EPA because of various chemical properties, including ignitability, corrosivity, reactivity, and toxicity.

Hazardous waste. At the beginning of 2011, DOE and LPP held a permit to store hazardous waste within seven designated areas of the X-326 building (38,105 square feet or 0.9 acre). The permit was transferred to DOE and FBP on March 29, 2011, when FBP assumed responsibility for the D&D contract. The permit, often called a Part B Permit, was issued to DOE and the responsible DOE contractor in 1995 and renewed by Ohio EPA in 2001. Ohio EPA renewed the permit on March 25, 2011, with an expiration date of March 25, 2021. The permit governs the storage of hazardous waste and includes requirements for waste identification, inspections of storage areas and emergency equipment, emergency procedures, training requirements, and other information required by Ohio EPA.

In compliance with the provisions of the Part B Permit, DOE notified Ohio EPA on July 29, 2011, that incompatible waste was found being stored on the same spill prevention pallet during an inspection on June 30, 2011. A 5-gallon container of a basic solution was found being stored with four 5-gallon containers of waste acid solutions. The container of basic solution was moved the same day. No injuries or environmental impacts resulted from this non-compliance.

Facilities such as PORTS that generate or store hazardous waste are required to submit an annual report to Ohio EPA. This annual report contains the name and address of each facility that waste was shipped to during the previous calendar year, the name and address of the transporter for each waste shipment, the description and quantity of each waste stream shipped off site, and a description of waste minimization efforts. DOE submitted the report for calendar year 2011 to Ohio EPA on February 29, 2012. Chapter 3, Section 3.4, Waste Management Program, provides additional information on wastes from DOE activities at PORTS that were recycled, treated, or disposed in 2011.

RCRA also requires groundwater monitoring at certain hazardous waste management units. As discussed in Chapter 6, groundwater monitoring requirements at PORTS have been integrated into one document, the *Integrated Groundwater Monitoring Plan*. Hazardous waste management units monitored in accordance with the *Integrated Groundwater Monitoring Plan* include the X-749 Contaminated Materials Disposal Facility (northern portion), X-231B Southwest Oil Biodegradation Plot (Quadrant I Groundwater Investigative Area), X-701C Neutralization Pit (Quadrant II Groundwater Investigative Area), X-701B Holding Pond, X-701B retention basins, X-744Y Waste Storage Yard (X-701B Holding Pond area), X-230J7 Holding Pond (X-701B Holding Pond area), X-616 Chromium Sludge Surface Impoundments, and X-735 RCRA Landfill (northern portion). Chapter 6 discusses the groundwater monitoring requirements for these units.

A groundwater report that summarizes the results of monitoring completed in accordance with the *Integrated Groundwater Monitoring Plan* is submitted annually to Ohio EPA. Chapter 6 discusses these monitoring results for 2011.

Solid waste. Groundwater monitoring may be required at closed solid waste disposal facilities, such as landfills. Groundwater monitoring requirements for the closed X-734 Landfills, X-735 Industrial Solid Waste Landfill, and X-749A Classified Materials Disposal Facility are included in the *Integrated Groundwater Monitoring Plan*. Chapter 6 discusses the groundwater monitoring results for these units in 2011.

2.3.1.4 Federal Facility Compliance Act

Waste that is a mixture of RCRA hazardous waste and low-level radioactive waste is currently stored at PORTS. RCRA hazardous waste is subject to Land Disposal Restrictions, which with limited exceptions do not allow the storage of hazardous waste for longer than one year. The Federal Facility Compliance Act, enacted by Congress in 1992, allows for the storage of mixed hazardous/low-level radioactive waste for longer than one year because treatment for this type of waste is not readily available. The Act also requires federal facilities to develop and submit site treatment plans for treatment of mixed wastes. On October 4, 1995, Ohio EPA issued a Director's Final Findings and Orders allowing the storage of mixed waste beyond one year and approving the Proposed Site Treatment Plan. An annual update to the Site Treatment Plan is required by these Director's Final Findings and Orders. The annual update to the Site Treatment Plan for fiscal year 2011 was submitted to Ohio EPA in December 2011.

2.3.1.5 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) regulates the use, storage, and disposal of PCBs, which are most commonly found in older electrical power system components, such as transformers and capacitors. The PCB transformers and capacitors that were present in the gaseous diffusion process buildings have been removed. Only eight PCB transformers were in service at PORTS at the end of 2011. Waste contaminated with PCBs was also generated during 2011 through D&D of the X-334 Transformer Cleaning and Storage Building and other areas.

An annual document log is prepared to meet TSCA regulatory requirements. The document log provides an inventory of PCB items in use, in storage as waste, and shipping/disposal information for PCB items disposed in 2011. The *2011 PCB Document Log for the Portsmouth Gaseous Diffusion Plant* was prepared in June 2012. Over 800 tons of PCB waste (over 700,000 kilograms) was generated and shipped off site in 2011.

In February 1992, a TSCA Federal Facilities Compliance Agreement between DOE and U.S. EPA addressing PCB issues became effective and resolved several compliance issues. These issues included the use of PCBs in systems that are not totally enclosed, storage of wastes containing both PCBs and radionuclides in accordance with nuclear criticality safety requirements, and storage of wastes containing both PCBs and radionuclides for longer than one year. The agreement required installation of troughs under motor exhaust duct gaskets located in production facilities (the former gaseous diffusion facilities) to collect PCB oil leaks. When leaks or spills of PCBs occur, they are managed in accordance with the Federal Facilities Compliance Agreement.

Annual reports of progress made toward milestones specified in the Federal Facilities Compliance Agreement are submitted to U.S. EPA. DOE was in compliance with the requirements and milestones of this Federal Facilities Compliance Agreement during 2011.

The DUF_6 Conversion Facility stores and processes cylinders containing DUF_6 that may have paint containing greater than 50 parts per million (ppm) of PCBs present on the outside of the cylinders. The

cylinders are stored in the X-745C, X-745E and X-745G Cylinder Storage Yards. The cylinders are stored in accordance with an agreement with U.S. EPA that includes monitoring of PCBs in surface water and sediment in drainage basins downstream from the cylinder storage yards. Chapter 5, Sections 5.4.2 and 5.5.2 provide the results of this surface water and sediment sampling, respectively.

2.3.1.6 Federal Insecticide, Fungicide, and Rodenticide Act

No restricted-use pesticides were used by DOE contractors in 2011.

2.3.2 Radiation Protection

This section discusses the DOE compliance status with DOE Orders pertaining to radiation protection and management of radioactive waste.

2.3.2.1 DOE Orders 5400.5 and 458.1, *Radiation Protection of the Public and the Environment*

DOE Order 5400.5, which was replaced by DOE Order 458.1 during 2011, provides guidance and establishes radiation protection standards and control practices designed to protect the public and the environment from undue radiological risk from operations of DOE and DOE contractors. Both DOE Order 5400.5 and 458.1 require that off-site radiation doses do not exceed 100 millirem (mrem)/year above background for all exposure pathways. In addition, DOE Order 5400.5 and/or 458.1 set dose limits to protect biota (aquatic and/or terrestrial plants and animals) and limits for discharges of radioactive materials to natural waterways. Chapter 4 provides the dose calculations or monitoring results that demonstrate compliance with these DOE Orders.

2.3.2.2 DOE Order 435.1, *Radioactive Waste Management*

The objective of DOE Order 435.1 is to ensure that radioactive waste is managed in a manner that is protective of worker and public health and safety, and the environment.

Low-level radioactive waste is generated and stored in accordance with the *Authorization Agreement and Radioactive Waste Management Basis for Portsmouth Gaseous Diffusion Plant Facilities and Material Storage Areas* and its implementing procedures. Chapter 3, Section 3.4 provides additional information about the DOE Waste Management Program at PORTS.

2.3.3 Air Quality and Protection

This section discusses the DOE compliance status with U.S. EPA and Ohio EPA regulations pertaining to air emissions (both radionuclides and non-radiological pollutants) and stratospheric ozone protection.

2.3.3.1 Clean Air Act

In 2011, DOE contractor FBP became responsible for numerous air emission sources associated with the former gaseous diffusion production facilities and support facilities (the sources that were formerly the responsibility of USEC Government Services). These sources, which include the boilers at the X-600 Steam Plant, emit more than 100 tons per year of non-radiological air pollutants specified by Ohio EPA, which caused DOE to become a major source of air pollutants as defined in Title 40 of the *Code of Federal Regulations*, Part 70.

Facilities that are major sources of air pollutants are required to submit a Title V Air Permit Application to Ohio EPA. FBP submitted this permit application to Ohio EPA in 2012 (Ohio EPA did not require submittal of the application until 2012). Ohio EPA also requires an annual report called the Ohio EPA Fee Emissions Report to report emissions of selected non-radiological air pollutants. Chapter 5, Section 5.3.1 provides more information about this fee report and the reported emissions for 2011.

DOE and BWCS or UDS were responsible for four permitted sources associated with the DUF_6 Conversion Facility. Appendix B lists the DOE air emission sources at PORTS. Radiological air

emissions from the DOE air emission sources are discussed in Chapter 4 and non-radiological air emissions are discussed in Chapter 5.

2.3.3.2 Clean Air Act, Title VI, Stratospheric Ozone Protection

As part of the Stratospheric Ozone Protection Plan, DOE has instituted a record-keeping system consisting of forms and labels to comply with the Title VI record-keeping and labeling requirements. These requirements affect all areas that use ozone-depleting substances in units or devices. The appliance service record and retrofit or retirement plan forms apply to units with a capacity of more than 50 pounds. The refrigeration equipment disposal log and associated appliance disposal label are used by all units regardless of capacity. The contractor technicians who service air conditioning/refrigeration units under DOE control have been trained in accordance with U.S. EPA requirements.

An ozone-depleting substance, specifically dichlorotetrafluoroethane, was used as a coolant and remains present in the gaseous diffusion cascade system formerly used to produce enriched uranium**.** In 2011, approximately 6000 pounds of dichlorotetrafluoroethane were released to the air.

2.3.3.3 National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants require DOE to submit an annual report for radiological emissions from DOE air emission sources. DOE contractors FBP and BWCS are both responsible for radiological air emission sources. Chapter 4, Section 4.3.3, provides the radiological dose calculations from these emissions.

FBP sources

In 2011, air emission sources associated with the gaseous diffusion process were returned to DOE from USEC Government Services. FBP was responsible for these sources. These sources included 1) continuously monitored vents in the X-326 and X-330 Process Buildings, and the X-344A Uranium Hexafluoride Sampling Building and 2) room ventilation exhausts and/or pressure relief vents associated with the X-700 Chemical Cleaning Facility, X-710 Technical Services Building, X-705 Decontamination Facility, and the XT-847 Glove Box. In addition, DOE and LPP/FBP were responsible for five sources of radionuclide emissions that were transferred from LPP to FBP on March 29, 2011: the X-622, X-623, X-624, X-627 Groundwater Treatment Facilities and the X-326 L-cage Glove Box.

Radiological emissions from the vents in the X-326 and X-330 Process Buildings and the X-344A Uranium Hexafluoride Sampling Building were measured by continuous monitoring. Emissions from the room ventilation exhausts and/or pressure relief vents associated with the X-700 Chemical Cleaning Facility, X-710 Technical Services Building, X-705 Decontamination Facility, and the XT-847 Glove Box were estimated based on operating data and U.S. EPA emission factors. Emissions from the groundwater treatment facilities were conservatively estimated based on quarterly influent/effluent sampling and quarterly throughput. Emissions from the X-326 L-cage Glove Box were based on the mass of the materials transferred within the glove box, analytical data available for each material, and emission factors provided by U.S. EPA. Radiological air emissions from FBP sources in 2011 were 0.145 curie (Ci).

BWCS sources

DOE and BWCS/UDS were responsible for emissions from the DUF_6 Conversion Facility. Responsibility for the DUF_6 Conversion Facility was transferred from UDS to BWCS on March 29, 2011. Emissions from the DUF_6 Conversion Facility were based on the annual emissions provided in the permit application for the facility. Radiological air emissions from the DUF_6 Conversion Facility in 2011 were 0.0000042 Ci.

2.3.4 Water Quality and Protection

This section discusses the DOE compliance status with U.S. EPA and Ohio EPA regulations pertaining to water quality and protection.

2.3.4.1 Clean Water Act

DOE contractors LPP, FBP, UDS, and BWCS held NPDES permits during 2011 that allowed discharges of water to surface streams. Responsibility for the LPP and UDS NPDES permits was transferred to FBP and BWCS, respectively, on March 29, 2011. In addition, FBP became responsible for the majority of the NPDES outfalls that were formerly the responsibility of USEC Government Services on September 1, 2011.

At the end of 2011, FBP was responsible for 18 monitoring locations identified in the FBP NPDES permit. Nine outfalls discharge directly to surface water, six outfalls discharge to another outfall before leaving the site, and three other locations that are not outfalls are also monitored. Chapter 4, Section 4.3.5.1, and Chapter 5, Section 5.4.1.1, provide additional information on the FBP NPDES outfalls.

The BWCS NPDES permit allows the discharge of process wastewaters from the DUF_6 Conversion Facility. One outfall is monitored under the permit; the discharge from this outfall flows through the X-230J5 Northwest Holding Pond (FBP NPDES Outfall 010) before reaching waters of the state. During 2011, no process wastewater was discharged through the BWCS NPDES outfall; discharges from the BWCS NPDES outfall only consisted of precipitation runoff. Chapter 4, Section 4.3.5, and Chapter 5, Section 5.4.1.2, provide additional information on the BWCS NPDES outfall.

Data required to demonstrate compliance with the NPDES permits are submitted to Ohio EPA in monthly operating reports (see Chapter 5, Section 5.4.1.1). Two permit limitations associated with the FBP NPDES permit effluent limitations were exceeded during 2011, although one of the exceedences occurred in January 2011 when the outfall was the responsibility of USEC Government Services (see Chapter 5, Section 5.4.1.1). The overall FBP NPDES compliance rate for 2011 was 99%. BWCS had 14 exceedences of NPDES permit effluent limitations in 2011 (see Chapter 5, Section 5.4.1.2); therefore the overall BWCS NPDES compliance rate for 2011 was 96%.

A quarterly discharge monitoring report that provides radiological monitoring data for the FBP NPDES outfalls is also submitted to Ohio EPA (see Chapter 4, Section 4.3.5). The BWCS outfall is not monitored for radionuclides.

Stormwater runoff, water from precipitation that flows over land and is not absorbed into the ground, is regulated under the Clean Water Act because it can accumulate debris, chemicals, or other pollutants that affect water quality. A Stormwater Pollution Prevention Plan is prepared for construction activities covered by the NPDES Construction Stormwater General Permit. The Stormwater Pollution Prevention Plan includes a detailed description of the construction activity and the controls to be used to minimize impacts to stormwater runoff.

The final end state and future use of the PORTS site has not yet been determined. Storm water management and drainage design will be included in the plans for redevelopment of the site after D&D and remediation is completed.

2.3.4.2 Safe Drinking Water Act

In 2011, FBP became responsible for operation of the PORTS drinking water system, which was formerly operated by USEC Government Services. Drinking water systems are regulated by the Safe Drinking Water Act, which sets requirements for water testing, treatment, and disinfection, as well as distribution

system maintenance and operator training. The Safe Drinking Water Act also sets health-based standards for naturally-occurring and man-made contaminants that may be found in drinking water.

PORTS obtains its drinking water from two water supply well fields west of PORTS in the Scioto River Valley buried aquifer near the Scioto River. Ohio EPA provides the parameters and schedule for sampling the drinking water for various parameters, including nitrate, lead, disinfection byproducts, total coliform, and chlorine. Sampling results are submitted to Ohio EPA in a monthly report.

2.3.5 Other Environmental Statutes

This section discusses the DOE compliance status with other U.S. EPA and Ohio EPA regulations, including underground storage tank regulations, the Endangered Species Act, and others.

2.3.5.1 Underground storage tank regulations

The Underground Storage Tank Program is managed in accordance with the Ohio State Fire Marshal's Bureau of Underground Storage Tank Regulations. Seven underground storage tanks in the former gaseous diffusion plant buildings and associated facilities are owned by DOE. These tanks include six diesel fuel tanks ranging in size from 500 to 20,000 gallons and a 20,000 gallon gasoline tank. The registrations for these tanks are renewed annually.

2.3.5.2 National Environmental Policy Act

The National Environmental Policy Act requires evaluation of the environmental impacts of activities at federal facilities and of activities funded with federal dollars.

DOE has a formal program dedicated to compliance pursuant to DOE Order 451.1, *National Environmental Policy Act Compliance Program*. Restoration actions, waste management, enrichment facilities maintenance, and other activities are evaluated to determine the appropriate level of evaluation and documentation. No environmental impact statements or environmental assessments were planned, underway, or completed during 2011.

Routine operation and maintenance activities are also evaluated to assess potential environmental impacts. Most DOE activities at PORTS qualify for a categorical exclusion as defined in the regulations. These activities are considered routine and have no significant individual or cumulative environmental impacts. In 2009, DOE implemented a policy to post online specific classes of categorical exclusions as found in Title 10 of the *Code of Federal Regulations* Part 1021, Appendix B to Subpart D. The following categorical exclusions for PORTS were posted on the DOE Portsmouth/Paducah Project Office website (www.pppo.energy.gov) in 2011:

- transfer of a property easement to American Electric Power for installation and maintenance of an overhead power line from an existing power pole on DOE property,
- transfer of a property easement to the Pike County Board of Commissioners for a sanitary sewer line on DOE property,
- site characterization, investigation, and environmental monitoring activities,
- small-scale interim remedial actions, short-term cleanup and/or closure activities, and waste storage under RCRA,
- alteration of existing buildings, construction of small-scale structures, and relocation of machinery, equipment, and utilities, and

- routine maintenance activities.

2.3.5.3 Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of endangered and threatened wildlife and plants, and the habitat on which such species depend. When appropriate, formal consultations are made with the U.S. Fish and Wildlife Service and the Ohio Department of Natural Resources. A site-wide threatened and endangered species habitat survey and an Indiana bat (*Myotis sodalis*) survey were completed in August 1996. No Indiana bats were found at PORTS. Few potential critical habitats were identified, and a report of the survey activities and results was provided to the Ohio Department of Natural Resources as required by the Federal Fish and Wildlife permit obtained to conduct the survey. No additional activities were completed in 2011.

2.3.5.4 National Historic Preservation Act

The National Historic Preservation Act of 1966 is the primary law governing the protection of cultural resources (archaeological and historical properties). Cultural resource reviews are conducted on a case-by-case basis, and consultations with the Ohio Historic Preservation Office and other stakeholders are made as required by Section 106 of the Act. With the beginning of D&D at PORTS, DOE is working with the Ohio Historic Preservation Office and other stakeholders to determine how best to document the history associated with the buildings and other areas that are part of D&D. Requirements of the National Historic Preservation Act will be worked into the CERCLA process.

In 2011, Phase I and/or Phase II archaeological site surveys were completed at 51 historic farmsteads identified at locations throughout the undeveloped portions of the PORTS property. The former farmsteads were evaluated to determine whether the sites had potential to provide significant information regarding settlement in the late 1800s and early 1900s in Appalachian Ohio and therefore be eligible for the National Register of Historic Places. None of the sites were recommended as eligible for inclusion on the National Register of Historic Places, and no additional work was recommended at these sites.

Additionally, site surveys for prehistoric Native American activity were in progress during 2011 in the undeveloped portions of the PORTS property. Additional assessment and/or mitigation activities may be performed, as necessary, in the future.

2.3.5.5 Archaeological and Historic Preservation Act and Archaeological Resources Protection Act

The Archaeological and Historic Preservation Act and the Archaeological Resources Protection Act require the Secretary of the Department of Interior to report to Congress on various federal archaeological activities. The Archaeological Resources Protection Act requires federal land managers to provide archaeology program information to the Secretary of the Interior for this report; a questionnaire that provides information for PORTS is completed annually by DOE.

2.3.6 DOE Order 436.1 *Departmental Sustainability*

DOE Order 436.1, *Departmental Sustainability*, replaced DOE Order 450.1A, *Environmental Protection Program*, during 2011. Both DOE Orders require development and implementation of an Environmental Management System (EMS) in order to protect air, water, land, and other natural or cultural resources potentially impacted by DOE operations.

FBP and WEMS have developed the following EMS criteria, as applicable: site EMS policy statement, EMS implementation training, identification of significant environmental aspects of site operations, establishment of measurable environmental objectives and targets, EMS awareness training (initial and ongoing), and establishment of EMS procedures. BWCS is in the process of developing an EMS program.

The DOE contractor EMS programs were audited in May/June of 2009 to confirm that the DOE contractors at that time had fully implemented the requirements of DOE Order 450.1A. There were no findings as a result of the audit. An independent assessment of the EMS by qualified personnel outside the control or scope of the EMS is required at least every three years for the program to maintain its fully implemented status.

An annual EMS report is prepared to document DOE's progress, performance, and successes in implementing the EMS at PORTS. The highest priority aspects identified in the fiscal year 2011 EMS report were as follows:

- evaluate opportunities for energy efficiency, reduced water consumption, and reductions in greenhouse gas emissions related to DOE's increased footprint at PORTS (return of the gaseous diffusion buildings from USEC Government Services) and PORTS D&D activities;
- clean-up environmental contamination related to past activities at PORTS;
- remove inactive facilities; and
- reduce inventory of legacy waste and minimize waste generation.

The report stated that 80% or more of the established EMS objectives, targets, and programs were on schedule to be met. Chapter 3, Section 3.5, provides information about the DOE Environmental Sustainability Program at PORTS.

2.3.7 Executive Orders

An Executive Order is issued by a member of the executive branch of the government. Most Executive Orders are issued by the President to various federal agencies, including DOE. This section discusses the DOE compliance status at PORTS with Executive Orders pertaining to the environment.

2.3.7.1 Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*

In 2009, Executive Order 13514 introduced management requirements for greenhouse gas emissions and expanded previous energy reduction and other environmental sustainability goals. Chapter 3, Section 3.5, provides a summary of the DOE Environmental Sustainability Program at PORTS and associated activities for 2011, which includes goals related to this executive order.

2.3.7.2 Executive Order 11988, *Floodplain Management,* and Executive Order 11990, *Protection of Wetlands*

Part 1022 of Title 10 of the Code of Federal Regulations establishes policy and procedures for compliance with Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*.

The site-wide wetland survey report was completed and submitted to the Corps of Engineers in 1996. There are 41 jurisdictional wetlands and four non-jurisdictional wetlands totaling 34.361 acres at PORTS. During 2011, no DOE activities were conducted in jurisdictional wetlands.

2.4 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIONS

This section summarizes environmental inspections of DOE activities at PORTS during 2011 and the results of these inspections.

2.4.1 Environmental Program Inspections

During 2011, more than 15 inspections of DOE activities at PORTS were conducted by federal, state, or local agencies. Table 2.1 lists these inspections.

Table 2.1. Environmental inspections of DOE activities at PORTS for 2011

Date	DOE contractor	Agency	Type	Notices of Violation
April 12	FBP	Ohio EPA	NPDES compliance	None
April/May (multiple dates)	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-611A Prairie, Five-Unit area and X-749/X-120 groundwater extraction systems, X-624/X-627 Groundwater Treatment Facilities, X-230J7 East Holding Pond, and X-735 Landfill)	None
May 17	FBP	Ohio EPA	RCRA compliance	None
June 15	FBP	Pike County Health Department and Ohio EPA	Closed solid waste landfills: X-749A, X-749, and X-735 (solid waste portion)	None
June (multiple dates)	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-749A, X-734 Landfills, X-701C, X-705 area)	None
June 27	FBP	Ohio EPA and U.S. EPA	RCRA compliance	See Section 2.4.1
July 28	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-231A&B Oil Biodegradation Plots, X-749A Landfill)	None
August (multiple dates)	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-533 Former Switchyard, X-744 Warehouses, PK Landfill, X-616 Former Chromium Sludge Surface Impoundments)	None
September 27	FBP	Ohio EPA	RCRA compliance	None
October 5	BWCS	Ohio EPA	RCRA compliance	None
October 5	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-734 Landfills)	None
October 18	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-735 Landfills, X-705 area)	None
November 16	FBP	Ohio EPA	NPDES permit compliance	None
November 16	FBP	Ohio EPA	RCRA Corrective Action surveillance and maintenance (X-622, X-624, X-627 Groundwater Treatment Facilities and X-230J7 East Holding Pond)	None
December 1	FBP	Ohio EPA	RCRA compliance	None

DOE and/or DOE contractors received three Notices of Violation in 2011. On April 6, 2011, Ohio EPA observed a release of used oil at the X-630 D&D project that was a violation of used oil storage regulations. In response to the release, FBP removed and disposed of absorbent materials saturated with oil and stained gravel in the area of the release. Absorbent material and straw was placed in or around the affected on-site drainage ditch and storm drain to catch any residual oil. Documentation of the cleanup was provided to Ohio EPA. In response, Ohio EPA stated that DOE and FBP had abated the violation in a letter dated April 15, 2011.

DOE/FBP received a Notice of Violation/Return to Compliance from the inspection conducted by U.S. EPA and Ohio EPA on June 27, 2011. The Notice of Violation was for failing to label containers of used oil and used fluorescent lamps with the words “used oil” or “used lamps”, respectively. The violation was abated by appropriately labeling the containers. U.S. EPA stated in the Notice of Violation that DOE and FBP had resolved the violation. No further action was required.

LPP received a Notice of Violation dated August 2, 2011 from the Utah Radiation Control Board for a shipment of radioactive waste received on February 7, 2011 by the EnergySolutions facility in Clive, Utah. The shipment, which consisted of three 85-gallon drums of radioactive waste, exceeded the facility’s waste acceptance criteria for depleted uranium and uranium-235, based on samples of the waste that were collected and analyzed by EnergySolutions. A civil penalty of $10,000 was assessed by the Utah Radiation Control Board and paid by LPP. The waste was subsequently shipped to and disposed at a facility that was allowed to accept radioactive waste with the levels of depleted uranium and uranium-235 that were present in the waste.

2.5 UNPLANNED RELEASES

No unplanned releases from DOE activities at PORTS were reported in 2011.

2.6 SUMMARY OF PERMITS

Appendix B lists the permits held by DOE and/or DOE contractors in 2011.

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3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 SUMMARY

In 2011, the planning and investigations necessary for D&D of the gaseous diffusion process buildings and associated facilities included development of the process for characterization and removal of 46 of the less complex facilities at PORTS, development of the work plan to characterize the process buildings and other complex facilities, and sampling and evaluation necessary to determine alternatives for disposition of the waste generated by D&D.

D&D of eight facilities (X-103, X-334, X-344B, X-630, X-230J9, X-605H, X-605I, and X-605J) was completed during 2011. Three projects funded by the American Recovery and Reinvestment Act (ARRA) were also completed in 2011: environmental remediation (source removal) at the X-701B Holding Pond area, D&D of the X-533 Switchyard Complex, and repackaging and disposition of excess uranium materials.

In 2011, the Environmental Restoration Program was responsible for investigations of soil and/or groundwater associated with several facilities removed as part of D&D, two projects to remediate soil and/or groundwater contamination in the Quadrant II Groundwater Investigative Area and X-740 Waste Oil Handling Facility, and the continued remediation of the western portion of the X-701B area, which was funded by ARRA and began in 2009.

In 2011, approximately 16,000 tons of materials from D&D and other DOE activities at PORTS were recycled, treated, or disposed at off-site facilities. Activities undertaken by the Environmental Sustainability, Training, and Public Awareness programs are also discussed in this chapter.

Chapter 2, Section 2.3.6, provides information on implementation of the DOE EMS at PORTS.

3.2 D&D PROGRAM

On April 13, 2010, Ohio EPA issued the DFF&O, which is an enforceable agreement between Ohio EPA and DOE that governs the process for D&D of the gaseous diffusion process buildings and associated facilities that are no longer in use at PORTS. The DFF&O was revised in 2011 and 2012 to add structures that were inadvertently omitted from the original orders and to allow these structures to be addressed under one of two processes (see Sections 3.2.1 and 3.2.2 below) with the agreement of DOE and Ohio EPA. The DFF&O, which applies to the D&D of buildings down to and including the building slab and disposal of wastes generated by D&D, use the CERCLA framework for determining appropriate removal and remedial actions. Documents are submitted to Ohio EPA for either concurrence or approval. Chapter 2, Section 2.3.1.1, provides additional information about the DFF&O.

Community involvement is an important part of the CERCLA process and the DFF&O. Opportunities for public comment are built into the D&D process as described in Sections 3.2.1, 3.2.2, and 3.2.3. The PORTS Community Relations Plan identifies opportunities to provide information to the public and obtain public input. Additionally, the PORTS Site Specific Advisory Board provides recommendations to DOE based on the concerns of the communities surrounding PORTS. Section 3.7 provides additional information on the PORTS Public Awareness Program.

The primary components of the DFF&O are 1) engineering evaluations/cost analyses and action memoranda for less complex facilities (non-time critical removal actions), 2) a remedial investigation/feasibility study (RI/FS) and record of decision for process buildings and complex facilities, and 3) an RI/FS and record of decision for evaluation and selection of alternatives for site-wide waste

disposition. The following sections discuss each component of the DFF&O and the activities completed during 2011 for each component of the DFF&O.

3.2.1 Non-time critical removal actions

The smaller and less complex buildings at PORTS undergo D&D using the process for non-time critical removal actions. This process begins with a removal site evaluation. The removal site evaluation includes a preliminary assessment of the facility, including anticipated wastes and volumes, and an evaluation of the likelihood of releases of hazardous substances. Existing analytical data is compiled, potential hazards to human health, safety and the environment are evaluated, and data needs (if any) are identified. If necessary, a sampling and analysis plan is prepared to collect data to characterize wastes that will be generated during D&D and identify areas of contamination. If required, a preliminary assessment report, removal site investigation work plan, and removal site investigation report are prepared, or can be included in the engineering evaluation/cost analysis with Ohio EPA concurrence. If a preliminary assessment report, removal site investigation work plan, and/or removal site investigation report are prepared, Ohio EPA must review and concur with the documents.

An engineering evaluation/cost analysis is then prepared that includes the site characterization information obtained during the preliminary assessment, the technological options for removal of the facility/area, the recommended option for removal of the facility/area, and a schedule for completion of the work.

After Ohio EPA concurs with the engineering evaluation/cost analysis, a public comment period will commence. At the conclusion of the public comment period, DOE prepares an action memorandum to summarize and address public comments (if any). A removal action work plan is then prepared that details the activities necessary to remove the building. Upon completion of the building removal, a removal action completion report is submitted to Ohio EPA for review and concurrence.

3.2.1.1 Non-time critical removal action activities in 2011

In 2011, DOE continued the process begun in 2010 for evaluation and removal of two groups of buildings:

- X-103 Auxiliary Office Building, X-334 Transformer Cleaning and Storage Building, and X-344B Maintenance Storage Building, and

- X-626 and X-630 Recirculating Cooling Water Complexes.

Removal of the X-103 Auxiliary Office Building, X-334 Transformer Cleaning and Storage Building, and X-344B Maintenance Storage Building were completed in June (X-103 and X-334) and August 2011 (X-344B). Removal action completion reports for the X-103 and X-334 were submitted to Ohio EPA in November 2011, and Ohio EPA provided concurrence in December 2011. The removal action completion report for the X-344B was submitted to Ohio EPA in 2012, and Ohio EPA provided concurrence in 2012.

RCRA investigations to identify possible soil contamination associated with the former X-103 Auxiliary Office Building, X-334 Transformer Cleaning and Storage Building, and X-344B Maintenance Storage Building were also completed during 2011. Sections 3.3.1.4 (X-103), 3.3.4.3 (X-334), and 3.3.4.4 (X-344B) summarize the results of these investigations.

Removal of the X-630 Recirculating Cooling Water Complex was completed in August 2011. However, removal of the X-626 Recirculating Cooling Water Complex was placed on hold at the end of 2011 because it was determined that the facility was still needed to support site operations. The removal action

completion report for the X-630 was submitted to Ohio EPA in 2012 and Ohio EPA provided concurrence in 2012.

The RCRA investigation of soil and groundwater near the former X-630 Recirculating Cooling Water Complex was initiated in 2011. Section 3.3.4.6 provides more information about this investigation.

In 2011, DOE and Ohio EPA developed a single engineering evaluation/cost analysis for 46 of the buildings to be removed as non-time critical removal actions. The *Engineering Evaluation/Cost Analysis for the Plant Support Buildings and Structures* was initially submitted to Ohio EPA in April 2011. DOE and Ohio EPA worked together to finalize the document from April into October. Ohio EPA concurred with the *Engineering Evaluation/Cost Analysis for the Plant Support Buildings and Structures* in October 2011.

Several activities were undertaken to provide the public information about and the means to comment upon the proposed demolition of the buildings included in the *Engineering Evaluation/Cost Analysis for the Plant Support Buildings and Structures*. DOE provided information to the Site Specific Advisory Board in May and June of 2011 about the proposed demolition of the facilities. The Site Specific Advisory Board supported demolition of the buildings as they could not foresee any reuse of the facilities. The public comment period for the *Engineering Evaluation/Cost Analysis for the Plant Support Buildings and Structures* was held from October 24, 2011, through November 23, 2011. A public availability session was held on November 10, 2011. The Action Memorandum was completed in 2012.

Sampling plans for the following buildings included in the *Engineering Evaluation/Cost Analysis for the Plant Support Buildings and Structures* were submitted to Ohio EPA in the fourth quarter of 2011: X-100 Administration Building, X-100B Air Conditioner Equipment Building, X-101 Dispensary, X-109C Monitoring Station, X-744S Warehouse, and X-624-1 Decontamination Pad. The sampling plans were finalized in 2012.

3.2.2 Process buildings and complex facilities

D&D of seven buildings at PORTS will follow the RI/FS process. Under the revised DFF&O, other facilities may also be included in the RI/FS process or may be addressed as non-time critical removal actions with the agreement of DOE and Ohio EPA. The seven buildings that must be addressed by the RI/FS process are the most complex of the buildings to be removed under the DFF&O and include the three gaseous diffusion process buildings.

The D&D process begins with a pre-investigation evaluation report, which includes site history, a summary of existing data, and identification of problems to be addressed in the RI/FS work plan. The RI/FS work plan details the tasks to be completed to characterize site conditions, determine the nature of wastes to be generated, assess the risk to human health and the environment, and evaluate potential remedial alternatives. Specific activities can include identifying contaminants within the buildings (PCBs, radionuclides, and other chemicals), determining the quantity of wastes to be generated by D&D of the buildings, and identifying alternatives for handling and disposing of wastes (reusing various materials, landfill disposal, etc.). The RI/FS report provides the results of the RI/FS work plan. Ohio EPA reviews and provides concurrence for each report: the pre-investigation evaluation report, RI/FS work plan, and RI/FS report.

A proposed plan that identifies the proposed remedial action is then prepared and made available for public comment. The record of decision finalizes the remedial action selected by DOE with concurrence from Ohio EPA (with public input) and implementation of the remedial actions begins.

3.2.2.1 Process buildings and complex facilities RI/FS activities in 2011

DOE submitted the pre-investigation evaluation report and RI/FS work plan for D&D of the process buildings and complex facilities to Ohio EPA in April 2011. Ohio EPA provided comments on the report and work plan, with comments on the pre-investigation evaluation report addressed in the RI/FS work plan. DOE and Ohio EPA met throughout 2011 to discuss revisions to the RI/FS work plan. Several revisions were submitted to Ohio EPA, with the final *Remedial Investigation and Feasibility Study Work Plan for the Process Buildings and Complex Facilities Decontamination and Decommissioning Project* submitted in December 2011. Ohio EPA provided concurrence on the RI/FS work plan in December 2011.

3.2.3 Site-wide waste disposition

This portion of D&D evaluates off-site and on-site waste disposal alternatives for waste generated by D&D. The on-site disposal alternative to be evaluated involves construction of an on-site waste disposal facility. The waste disposition project follows a similar process as described for D&D of the process buildings and complex facilities, including the pre-investigation evaluation report, RI/FS work plan, RI/FS report, proposed plan, and record of decision. Development of waste acceptance criteria for an on-site waste disposal facility (if this alternative is selected) is also included as part of the RI/FS work plan.

3.2.3.1 Site-wide waste disposition activities in 2011

DOE submitted the pre-investigation evaluation report for site-wide waste disposition to Ohio EPA in 2010. Ohio EPA provided comments on the report, which were addressed in the site-wide waste disposition RI/FS work plan submitted to Ohio EPA in June 2011. Ohio EPA provided comments on the RI/FS work plan, and DOE and Ohio EPA met to discuss the comments, related technical issues, and the list of regulatory compliance requirements that are applicable or relevant and appropriate requirements (ARARs) under CERCLA. DOE and Ohio EPA agreed to maintain the list of ARARs in draft form until all items were agreed upon by both parties and both agreed that Ohio EPA could provide concurrence on the remainder of the RI/FS work plan. A revised RI/FS work plan was submitted to Ohio EPA in December 2011.

In 2011, DOE also developed the *Phase I Sampling and Analysis Plan for Process Equipment Characterization in Support of the Site-wide Waste Disposition Project*. This sampling and analysis plan summarized the approach to characterize the waste generated by removal of the process gas systems in the former gaseous diffusion process buildings. Ohio EPA provided conditional concurrence on the document in June 2011 so that sampling activities could begin in the process buildings (final concurrence was provided in July 2011). Sampling continued through the end of 2011.

The *Geotechnical Sampling and Analysis Plan for the Site-wide Waste Disposition Evaluation Project* was also developed in 2011. This plan was developed to gather data to evaluate potential on-site disposal locations for some of the waste generated by D&D, if the alternative is selected. Data collection began in May 2011, and Ohio EPA provided conditional concurrence with the plan in September 2011 (final concurrence was provided in December 2011). Data collected included water level measurements, soil/rock characterization, and measurement of naturally-occurring metals and other parameters in groundwater.

DOE submitted the *Test Plan for Batch Leaching of Contaminated Equipment and Debris from Building X-326* to Ohio EPA in October 2011. The Test Plan was developed to conduct laboratory measurements and theoretical evaluations of the leachability of radionuclides (uranium and technetium-99) from process building debris in case the debris is placed in an on-site disposal facility, if the alternative is selected. At the end of 2011, DOE and Ohio EPA were working together to finalize the plan.

In December 2011, Ohio EPA also concurred with the *Work Plan for Modeling Analysis in Support of Regulatory Decisions*, which identifies the models that are proposed for use as part of the waste disposition RI/FS.

3.2.4 Pre-D&D activities

In 2011, four small buildings, X-230J9 North Environmental Sampling Building, X-605H Booster Pump House, X-605I Chlorinator Building, and X-605J Diesel Generator Building, were removed as pre-D&D actions under the DFF&O due to the very small size and simplicity of the buildings. A RCRA investigation to identify possible soil contamination associated with the former buildings was also completed in during 2011. Section 3.3.4.5 summarizes the results of this investigation.

3.3 ENVIRONMENTAL RESTORATION PROGRAM

DOE established the Environmental Restoration Program in 1989 to identify, control, and remediate environmental contamination at PORTS. Environmental restoration is conducted in accordance with the RCRA corrective action process, under U.S. EPA Administrative Consent Order, issued on September 29, 1989 (amended in 1994 and 1997), and Consent Decree with the State of Ohio, issued on August 29, 1989. With implementation of D&D, removal of facilities and structures down to and including the building slab is controlled by the D&D process (see Section 3.2). Investigation and remediation of environmental contamination is completed under the RCRA corrective action process and in accordance with U.S. EPA Administrative Consent Order and Consent Decree with the State of Ohio.

In general, the RCRA corrective action process consists of the following:

1) an assessment to identify releases of contaminants and determine the need for further investigation (the RCRA facility assessment),

2) an investigation to determine the nature and extent of any contamination (the RCRA facility investigation), and

3) a study to identify and evaluate remedial alternatives to address contamination (the cleanup alternatives study/corrective measures study).

Following the approval of the final cleanup alternative study/corrective measure study, Ohio EPA selects the remedial alternatives that will undergo further review to determine the final remedial actions (the preferred plan). Upon concurrence from U.S. EPA and completion of the public review and comment period, U.S. EPA and Ohio EPA select the final remedial actions. Ohio EPA issues a decision document to select the final remedial actions and the remedial actions are implemented by DOE. Final remedial actions are reviewed by Ohio EPA on a schedule agreed upon by Ohio EPA and DOE (approximately every five years) to ensure that the remedial actions are performing as intended by the decision document and are protective of human health and the environment.

The initial assessment and investigation of PORTS under the RCRA corrective action process was completed in the 1990s. Because PORTS is a large facility, it was divided into quadrants (Quadrant I, II, III, and IV) to facilitate the cleanup process. Remedial actions have been implemented in each of the PORTS quadrants.

With the beginning of D&D, investigation of areas known as “deferred units” is beginning to occur. Deferred units are areas that were in or adjacent to the gaseous diffusion production and operational areas such that remedial activities would interrupt operations, or were areas that could become recontaminated from ongoing operations. Ohio EPA deferred investigation/remedial action of soil and groundwater

associated with these units until D&D of PORTS (or until the area no longer met the requirements for deferred unit status).

The following sections describe the remedial actions underway in each quadrant as well as investigations of any formerly deferred units that occurred during 2011. Table 3.1 lists remedial activities for the groundwater monitoring areas at PORTS, which include remedial actions required by decision documents and other actions.

3.3.1 Quadrant I

The *Quadrant I Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2000. Ohio EPA issued the Decision Document for Quadrant I in 2001, which provided the required remedial actions for the X-749/X-120 groundwater plume and the Quadrant I Groundwater Investigative Area (the Five-Unit Groundwater Investigative Area and X-231A/X-231B Oil Biodegradation Plots).

Remedial actions required for the X-749B Peter Kiewit Landfill (PK Landfill) were provided in separate Decision Documents issued by Ohio EPA in 1996 and U.S. EPA in 1997. The following sections discuss the remedial actions required for the X-749/X-120 groundwater plume, PK Landfill, and the Quadrant I Groundwater Investigative Area, as well as any RCRA investigations of environmental media associated with deferred units and other former buildings located in Quadrant I (see Section 3.3.1.2).

3.3.1.1 X-749/X-120 groundwater plume

The remedial actions identified for X-749/X-120 groundwater plume include phytoremediation of the groundwater plume, installation of a barrier wall around the eastern and southern portion of the X-749 Landfill, and continued operation of the groundwater collection trenches installed at the PK Landfill and X-749 Landfill. In addition, groundwater extraction wells were installed in 2007, 2008, and 2010 to control migration of the plume and remediate areas of higher trichloroethene (TCE) concentrations within the plume.

Phytoremediation is a process that uses plants to remove, degrade, or contain contaminants in soil and/or groundwater. Phytoremediation at the X-749/X-120 groundwater plume was installed in two phases during 2002 and 2003. The *Preliminary Evaluation Report for the X-749/X-120 Phytoremediation System,* completed in January 2008, provided a preliminary evaluation of the phytoremediation system. The trees selected for the phytoremediation system had just begun to develop sufficient leaf area (approximately equal to root volume) so that groundwater was transpired through the trees; therefore, a complete system evaluation could not be completed. Continued operation of the phytoremediation system was recommended in order for the trees to grow and develop a more extensive root system.

The *First Five-Year Review for the X-749/X-120 Groundwater Plume,* submitted to Ohio EPA in January 2011, found that the remedial actions implemented for the X-749/X-120 groundwater plume (both the remedial actions required by the Decision Document and the extraction wells installed in 2007 and 2008) were achieving remedial action objectives by preventing migration of contaminants from the X-749 Landfill and controlling migration of the X-749/X-120 groundwater plume. However, Ohio EPA and DOE agreed that the phytoremediation system was not as successful as anticipated in reducing concentrations of TCE in groundwater. The extraction wells that began operating in 2007-2008 in the groundwater collection trench on the southwest side of the X-749 Landfill and the X-749 South Barrier Wall Area, as well as the barrier wall on the south and east sides of the landfill (completed in 2002), appeared to be primarily responsible for the reductions in TCE concentrations within the X-749/X-120 groundwater plume.

Chapter 6, Section 6.4.1.4, provides additional information about the 2011 groundwater monitoring results for the X-749/X-120 groundwater plume.

Table 3.1. Remedial actions at PORTS in groundwater monitoring areas

Quadrant/monitoring area	Remedial action/year completed
Quadrant I X-749/X-120 groundwater plume	X-749 multimedia cap – 1992 X-749 barrier wall (north and northwest sides of landfill) – 1992 X-749 subsurface drains and sumps – 1992 South barrier wall – 1994 X-120 horizontal well – 1996 X-625 Groundwater Treatment Facility – 1996 X-749 barrier wall (east and south sides of landfill) – 2002 Phytoremediation (22 acres) – 2002 & 2003 Injection of hydrogen release compounds – 2004 X-749 South Barrier Wall Area extraction wells – 2007 Two additional extraction wells in the groundwater collection trench on the southwest side of the X-749 Landfill – 2008 X-749/X-120 groundwater plume extraction wells – 2010
Quadrant I PK Landfill (X-749B)	Relocation of Big Run Creek – 1994 Groundwater collection system – 1994 Groundwater collection system expansion – 1997 PK Landfill Subtitle D cap – 1998
Quadrant I Quadrant I Groundwater Investigative Area (Five-Unit Groundwater Investigative Area)	Groundwater extraction wells (3) – 1991 X-622 Groundwater Treatment Facility – 1991 (upgraded in 2001) Interim soil cover at X-231B – 1995 X-231A/X-231B multimedia caps – 2000 Groundwater extraction wells (11) – 2002 Groundwater extraction well (1) – 2009 Removal of contaminated soil at former X-770 Building – 2010
Quadrant I X-749A Classified Materials Disposal Facility	Cap – 1994
Quadrant II Quadrant II Groundwater Investigative Area (Seven-Unit Groundwater Investigative Area)	Operation of X-700 and X-705 building sumps – 1989 X-622T Groundwater Treatment Facility – 1992 Removal of X-720 Neutralization Pit – 1998 Removal of X-701C Neutralization Pit – 2001 Removal of contaminated soil near X-720 Neutralization Pit – 2001 X-627 Groundwater Treatment Facility – 2004 (replaced the X-622T facility) Enhanced anaerobic bioremediation – ongoing
Quadrant II X-701B Holding Pond	X-237 Groundwater Collection System – 1991 X-624 Groundwater Treatment Facility – 1991 (upgraded 2006) Extraction wells (3) – 1993 (removed 2009-2011) X-623 Groundwater Treatment Facility – 1993 X-701B sump – 1995 Groundwater remediation by oxidant injection – 2008 Groundwater and soil remediation by oxidant mixing – 2011

Table 3.1. Remedial actions at PORTS in groundwater monitoring areas (continued)

Quadrant/monitoring area	Remedial action/year completed
Quadrant III X-740 Waste Oil Handling Facility	Phytoremediation – 1999 Oxidant injections – 2008 Enhanced anaerobic bioremediation – 2011
Quadrant IV X-611A Former Lime Sludge Lagoons	Soil cover – 1996 Prairie vegetation planted – 1997
Quadrant IV X-735 Landfills	Cap on northern portion – 1994 Cap on southern portion – 1998
Quadrant IV X-734 Landfills	Cap on X-734B Landfill (Phase I) – 1999 Cap on X-734 and X-734A Landfills (Phase II) – 2000
Quadrant IV X-533 Switchyard	Contaminated soil removal – 2010

3.3.1.2 PK Landfill

The remedial actions required by the PK Landfill Decision Documents consisted of the continued operation of the eastern groundwater collection system installed in 1994 and construction of an engineered cap that meets the RCRA Subtitle D and related requirements. In addition, the southeastern groundwater collection system was constructed in 1997 to contain surface seeps, groundwater from the southern slope of the PK Landfill, and the groundwater plume migrating toward Big Run Creek from the X-749 Landfill.

The second five-year review for the PK Landfill was completed in 2008. This report, *the Second Five-Year Review for the X-749B Peter Kiewit Landfill*, found that the remedial actions implemented at the PK Landfill (the groundwater collection systems and landfill cap) were achieving remedial action objectives by eliminating exposure pathways and reducing the potential for contaminant transport. Concentrations of many of the contaminants detected in the PK Landfill wells, sumps, and manholes had decreased significantly from 1999 to 2007. Contaminants detected in the PK Landfill wells, sumps, and manholes were not detected in surface water samples collected from Big Run Creek adjacent to or downstream from PK Landfill. Based on these data, construction of a barrier wall on the upgradient sides of the PK Landfill did not appear to be necessary. The next review of the remedial actions implemented at the PK Landfill will be submitted to Ohio EPA in 2013.

Chapter 6, Section 6.4.1.4, provides 2011 groundwater monitoring results for the PK Landfill area.

3.3.1.3 Quadrant I Groundwater Investigative Area

Remedial actions identified for the Quadrant I Groundwater Investigative Area (also called the Five-Unit Groundwater Investigative Area) are: 1) installation of multimedia caps over the X-231A and X-231B Oil Biodegradation Plots; and 2) installation of 11 additional groundwater extraction wells to extract contaminated groundwater for treatment in the X-622 Groundwater Treatment Facility. The caps were constructed in 2000 and operation of the groundwater extraction wells began in 2002. In 2009, an additional extraction well was installed south of the X-326 Process Building to control and remediate a newly identified source of TCE beneath the building. Table 3.1 lists the remedial actions completed for the Quadrant I Groundwater Investigative Area.

A five-year review of both the groundwater extraction system for the Quadrant I Groundwater Investigative Area and the multi-layered caps for the X-231A and X-231B Oil Biodegradation Plots was completed in 2008. This report, the *First Five-Year Review for the Five-Unit Groundwater Investigative Area and X-231A/X-231B Oil Biodegradation Plots,* found that the remedial actions had eliminated potential exposure pathways to contaminants and reduced concentrations of TCE in the groundwater, although more slowly than expected. The next review of the remedial actions implemented at the Quadrant I Groundwater Investigative Area and X-231A/B Oil Biodegradation Plots will be submitted to Ohio EPA in 2013.

RCRA investigations of soil were completed in 2010 near two buildings in the northern portion of the monitoring area that have been removed: the X-760 Chemical Engineering Building and the X-770 Mechanical Testing Facility. These former buildings were removed in 2010 and 2007, respectively. Soil contaminated with TCE and other volatile organics was removed from the south and east sides of the former X-770 building. Contaminated soil was also identified on the north and west sides of the former X-760 building; however, the decision was made to leave this soil in place until cleanup determinations are made for all of Quadrant I.

Chapter 6, Section 6.4.2.3, provides information on the groundwater monitoring completed in the Quadrant I Groundwater Investigative Area during 2011.

3.3.1.4 X-103 Auxiliary Office Building investigation

The X-103 Auxiliary Office Building, which was located in Quadrant I immediately north of the Quadrant I Groundwater Investigative Area, was removed during 2011 as part of D&D (see Section 3.2.1.1). Soil samples were collected around the former building during March 2011 and analyzed for volatile organic compounds, semivolatile organic compounds, metals, PCBs, and radionuclides. If detected, none of these constituents were present at levels above PORTS preliminary remediation goals. DOE and Ohio EPA agreed that no additional sampling or remediation was necessary at this time.

3.3.2 Quadrant II

The *Quadrant II Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2001. After approval of the document, however, Ohio EPA requested an amendment to the approved study to address additional remedial alternatives for the X-701B area. Amendments were submitted in 2001 and 2002. In 2003, Ohio EPA informed DOE that a separate Decision Document would be prepared for the X-701B area, and the X-701B Decision Document was issued in 2003.

Chapter 6 provides 2011 groundwater monitoring results for the following areas in Quadrant II that require groundwater monitoring: Quadrant II Groundwater Investigative Area (Section 6.4.3.1), X-701B Holding Pond (Section 6.4.4.1), and X-633 Pumphouse/Cooling Towers Area (a deferred unit) (Section 6.4.5.1).

3.3.2.1 Quadrant II Groundwater Investigative Area

A number of deferred units are in the groundwater plume in the Quadrant II Groundwater Investigative Area (also known as the Seven-Unit Area). A special investigation conducted in 2009, which sampled soil and groundwater, identified areas of higher TCE concentrations that appeared to be associated with continuing sources of groundwater contamination in the southeastern portion of the plume. In 2010, Ohio EPA approved an interim remedial measure (IRM) for this area called enhanced anaerobic bioremediation. Enhanced anaerobic bioremediation utilizes injections of fermentable carbon compounds such as sodium lactate (a common ingredient in soaps and face creams) to provide additional food for naturally-occurring microorganisms in soil that degrade TCE to harmless substances. The project began in 2010 and continued throughout 2011.

Monitoring data collected in 2011 indicated that favorable conditions for enhanced anaerobic bioremediation were being established within the treatment areas, and TCE degradation was beginning to occur in some of the wells within the treatment areas. This project continued in 2012.

3.3.2.2 X-701B Holding Pond

Remedial actions required by the Decision Document for X-701B include groundwater remediation by injection of a chemical oxidant. The Decision Document also requires removal of contaminated soil in the western portion of the area and consolidation of the soil under two landfill caps to be constructed over the X-701B Holding Pond/East Retention Basin and the West Retention Basin.

The oxidant injections required by the Decision Document took place between 2006 and 2008. Following the end of the injections in 2008, an independent review of the X-701B project was completed by DOE Headquarters to evaluate remediation results to date and provide recommendations for a path forward.

The review of the X-701B oxidant injections determined that the method used to inject oxidant into the contaminated area was not able to address contaminants in the deepest portion of the contaminated soil. If contaminants remained in this portion of the soil, they would continue to be released into the groundwater plume. Therefore, DOE proposed an IRM to excavate soil in the western portion of the X-701B plume area and directly mix oxidant into the contaminated soil. With Ohio EPA approval, excavation and soil mixing began in December 2009 and was completed in January 2011. This remediation of contaminated soils in the X-701B area was one of the projects funded by ARRA. Sampling data collected as part of the X-701B IRM indicate that while TCE concentrations decreased in soil samples collected during the IRM, groundwater monitoring data collected during 2011 for wells that monitor the IRM area indicate a rebound in groundwater TCE concentrations.

A RCRA investigation of the X-747K Contaminated Scrap Metal Storage Yard (in the southeastern portion of the X-701B monitoring area directly south of the X-623 Groundwater Treatment Facility) took place during 2010. Areas of soil potentially contaminated with metals were identified, but the higher concentrations of metals may have been present in these areas (15 to 20 ft below ground surface) due to naturally-occurring variations in the geology of the area.

In 2011, DOE recommended and Ohio EPA agreed to additional investigation of the concentrations of naturally-occurring metals in soil and groundwater within the varying geologic formations at PORTS. DOE and Ohio EPA worked together throughout 2011 to develop the approach for this investigation, called a background study, and a work plan for a comprehensive background study was submitted to Ohio EPA in 2012.

3.3.2.3 X-633 Pumphouse/Cooling Towers Area investigation

The X-633 Recirculating Cooling Water Complex was demolished in 2010 using funding provided by ARRA. A work plan for the RCRA investigation of soil and groundwater in the area was approved by Ohio EPA in 2010 and implemented in 2011.

Areas of soil potentially contaminated with metals were identified, but the higher concentrations of metals may have been present in these areas (15 to 20 ft below ground surface) due to naturally-occurring variations in the geology of the area. A background study was under development at the end of 2011 to provide additional information about the concentrations of naturally-occurring metals in soil and groundwater within the varying geologic formations at PORTS (see Section 3.3.2.2).

Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals. DOE agreed to sample eight wells around the area semiannually through 2012 to continue evaluation of chromium and TCE in groundwater at this area.

3.3.3 Quadrant III

The *Quadrant III Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 1998. The Decision Document for Quadrant III required phytoremediation of the groundwater plume near the X-740 Waste Oil Handling Facility.

Over 700 hybrid poplar trees were planted on a 2.6-acre area above the X-740 groundwater plume in 1999. In 2003, a five-year review was completed for the X-740 groundwater plume to evaluate the effectiveness of the phytoremediation system. The report, entitled *Five-Year Evaluation Report for the X-740 Phytoremediation Project*, indicated that the trees in the phytoremediation system did not noticeably affect the overall groundwater flow in the Gallia at this area, although the trees did appear to influence water levels in individual wells. Concentrations of TCE in the X-740 groundwater plume had not decreased appreciably.

Upon review of the 2003 Five-Year Evaluation Report, Ohio EPA required another evaluation of this area in three years to determine if the phytoremediation system was effective in remediating the groundwater plume. Additional data collected for this evaluation included soil moisture at specified depths below ground surface, wind speed/direction, rainfall, air/soil temperature, tree growth rates, and sap flow measurements. The *Supplemental Evaluation to the Five-Year Evaluation Report for the X-740 Phytoremediation System*, submitted to Ohio EPA in 2007, found that the phytoremediation system had not performed as expected to remove TCE from groundwater in this area.

In response to Ohio EPA comments on the above mentioned report, DOE developed a work plan for additional remedial activities for the X-740 area. Three rounds of oxidant injections were completed in 2008 to remove TCE from the groundwater. Although the oxidant briefly reduced TCE concentrations detected in some of the wells, TCE concentrations in groundwater returned to typical levels in 2009. In 2010, Ohio EPA approved a pilot study of enhanced anaerobic bioremediation for the X-740 area. Section 3.3.2.1 provides additional information about enhanced anaerobic bioremediation. Emulsified oil, a slow-acting fermentable carbon compound, was injected into the selected portions of the X-740 groundwater plume during December 2010 and January 2011. Collection of groundwater samples to monitor the pilot study took place throughout 2011.

Chapter 6 provides 2011 groundwater monitoring results for the following areas in Quadrant III that require groundwater monitoring: X-616 Chromium Sludge Surface Impoundments (Section 6.4.6.1) and X-740 Waste Oil Handling Facility (Section 6.4.7.1).

3.3.4 Quadrant IV

The *Quadrant IV Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 1998. DOE received the Decision Document for Quadrant IV in 2000. No new remedial actions were required in Quadrant IV (remedial actions had already taken place at the X-344D Hydrogen Fluoride Neutralization Pit, X-735 Landfills, X-611A Former Lime Sludge Lagoons, and X-734 Landfills).

Chapter 6 provides 2011 groundwater monitoring results for the following areas in Quadrant IV that require groundwater monitoring: X-611A Former Lime Sludge Lagoons (Section 6.4.8.1), X-735 Landfills (Section 6.4.9.1), X-734 Landfills (Section 6.4.10.1), X-533 Switchyard Area (a deferred unit) (Section 6.4.11.1), and former X-344C Hydrogen Fluoride Storage Building (Section 6.4.12.1).

3.3.4.1 X-611A Former Lime Sludge Lagoons

Ohio EPA and U.S. EPA issued a Decision Document for the X-611A area in 1996, which required a soil cover over the former lagoons and establishment of a prairie habitat. The soil cover and planting of the prairie were completed in 1997. The *Second Five-Year Review for the X-611A Prairie* was submitted to Ohio EPA in 2008. The report found that the soil cover and prairie habitat were continuing to meet the

remedial action objectives for this unit by eliminating exposure pathways to the contaminants in the sludge at this area. The next review of the remedial actions implemented at the X-611A area will be submitted to Ohio EPA in 2013.

3.3.4.2 X-734 Landfills

Ohio EPA issued a Decision Document for the X-734 Landfills in 1999. Remedial actions required by the Decision Document included construction of a multimedia cap over the northern portion of the landfills and a soil cap over the southern portion of the area. These caps were installed in 1999 and 2000.

The *First Five-Year Review for the X-734 Landfill Area* was submitted to Ohio EPA in 2008. The report found that construction of the caps on the landfills had achieved remedial action objectives by isolating contaminants in soil and sediment from potential receptors. The caps were preventing contaminants in soil and sediment from migrating to groundwater and surface water. The next review of the remedial actions implemented at the X-734 Landfills will be submitted to Ohio EPA in 2013.

3.3.4.3 X-334 Transformer Cleaning and Storage Building investigation

The X-334 Transformer Cleaning and Storage Building, located in Quadrant IV west of the former X-533 Switchyard Complex, was removed during 2011 as part of D&D (see Section 3.2.1.1). Soil samples were collected around the former building during June 2011 and analyzed for volatile organic compounds, semivolatile organic compounds, metals, PCBs, and radionuclides. If detected, none of these constituents were present at levels above PORTS preliminary remediation goals. DOE and Ohio EPA agreed that no further actions were necessary at this time.

3.3.4.4 X-344B Maintenance Storage Building investigation

The X-344B Maintenance Storage Building, located in Quadrant IV west of the former X-533 Switchyard Complex, was removed during 2011 as part of D&D (see Section 3.2.1.1). Soil samples were collected around the former building during August 2011 and analyzed for volatile organic compounds, metals, and radionuclides. Uranium was detected in one sample at a concentration just above the PORTS preliminary remediation goal. None of the other constituents were detected at levels above preliminary remediation goals.

3.3.4.5 X-605H, I, and J; X-230J9 Building investigation

The X-605H Booster Pump House, X-605I Chlorinator Building, X-605J Diesel Generator Building, and X-230J9 North Environmental Sampling Building, located in Quadrant IV west or north of the X-734 Landfills, were removed during 2011 (see Section 3.2.4). Soil samples were collected around the former buildings during March 2011 and analyzed for volatile organic compounds, semivolatile organic compounds, metals, PCBs, and radionuclides. If detected, none of these constituents were present at levels above PORTS preliminary remediation goals.

3.3.4.6 X-630 Recirculating Cooling Water Complex investigation

The X-630 Recirculating Cooling Water Complex, located in Quadrant IV within Perimeter Road and west of the X-533 Switchyard Complex, was removed during 2011 as part of D&D (see Section 3.2.1.1). A work plan for the RCRA investigation of soil and groundwater at the X-630 Cooling Water Complex was implemented in 2011.

Areas of soil potentially contaminated with metals were identified, but the higher concentrations of metals may have been present in these areas (15 to 20 ft below ground surface) due to naturally-occurring variations in the geology of the area. A background study was under development at the end of 2011 to provide additional information about the concentrations of naturally-occurring metals in soil and groundwater within the varying geologic formations at PORTS (see Section 3.3.2.2).

Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals. DOE agreed to sample four wells around the area semiannually through 2012 to continue evaluation of chromium and TCE in groundwater at this area.

3.4 WASTE MANAGEMENT PROGRAM

The DOE Waste Management Program directs the safe storage, treatment, and disposal of waste generated by past and present operations and from current D&D and Environmental Restoration projects at PORTS. Waste managed under the program is divided into the following seven categories, which are defined below:

- *Low-level radioactive waste* – radioactive waste not classified as high level or transuranic waste.

- *Hazardous (RCRA) waste* – waste listed under RCRA or waste that exhibits one or more of the four RCRA hazardous characteristics: ignitability, corrosivity, reactivity, and toxicity. Universal waste, which includes common items such as batteries and light bulbs, is a subset of RCRA waste that is subject to reduced requirements for storage, transportation, and disposal or recycling.

- *PCB wastes* – waste containing PCBs, a class of synthetic organic chemicals. Disposal of PCB-contaminated materials is regulated under TSCA.

- *RCRA/low-level radioactive mixed waste* – waste containing both hazardous and radioactive components. The waste is subject to RCRA, which governs the hazardous components, and to the Atomic Energy Act that governs the radioactive components.

- *PCB/low-level radioactive mixed waste* – waste containing both PCB and radioactive components. The waste is subject to TSCA regulations that govern PCB components, and to the Atomic Energy Act that governs radioactive components.

- *PCB/RCRA/low-level radioactive mixed waste* – waste containing PCB and radioactive components that is also a RCRA hazardous waste. The waste is subject to RCRA regulations, TSCA regulations that govern PCBs, and to the Atomic Energy Act that governs radioactive components.

- *Solid waste* – Waste that includes construction and demolition debris, industrial waste, and sanitary waste, as defined by Ohio regulations. These wastes can include waste from construction or demolition activity and office waste. Waste contaminated with asbestos may also be included in this category if it is not included in any of the categories listed above (PCB, RCRA, and/or low-level radioactive waste).

In 2011, approximately 16,000 tons of waste from DOE activities at PORTS were recycled, treated, or disposed at off-site facilities (see Table 3.2).

Waste management requirements are varied and are sometimes complex because of the variety of waste streams generated by DOE activities at PORTS. DOE Orders, Ohio EPA regulations, and U.S. EPA regulations must be satisfied to demonstrate compliance with waste management activities. Additional

Table 3.2. Waste Management Program off-site treatment, disposal, and recycling accomplishments for 2011

Waste type	Waste stream	Quantity (pounds)	Treatment, disposal, or recycling facility
RCRA	Aerosol cans, spent solvents, and ignitable liquids	811	Environmental Quality Co.
LLW[a]	Scrap metal, demolition debris, soil, and other solids	3,266,229	EnergySolutions
LLW	Uranium materials, scrap metal, and other solids	827,977	Nevada National Security Site
LLW	Assorted excess solid materials (PVC, metals, and other debris)	292,820	Impact Services Inc.
PCB	Used transformer oil from X-533 Switchyard	1112	Veolia
PCB	Miscellaneous solids and soil from X-605 D&D	203,620	Environmental Quality Co./Wayne Disposal
PCB	Electrical equipment (bushings), and other equipment contaminated with PCBs	46,468	Environmental Protection Services
PCB/LLW	D&D waste, concrete, asphalt, and other solids contaminated with PCBs from X-334 D&D	808,381	EnergySolutions
PCB/LLW	Solid materials contaminated with PCBs from X-326	7609	Nevada National Security Site
RCRA/LLW	D&D waste, contaminated soil, electronic debris, and other solids contaminated with metals or solvents	1,100,489	EnergySolutions
RCRA/LLW	Spent solvents, waste potassium hydroxide solutions	2205	EnergySolutions
RCRA/LLW/ PCB	Gaskets contaminated with PCBs and chromium from X-533 D&D	622	EnergySolutions
Solid waste	D&D waste, concrete, asphalt, metal, and other materials	11,308,290	Pike County Landfill
PCB	Light ballasts contaminated with PCBs (recyclable)	896	USA Lamp & Ballast Recycling
Universal waste	Light bulbs (fluorescent, mercury vapor, incandescent, and compact fluorescent), batteries (ni-cad, lead acid, and gel cell), thermostats, and circuit boards	10,756	USA Lamp & Ballast Recycling
Used oils	Waste oil (recyclable)	37,035	Glockner Oil
Used oils	Waste oil (recyclable)	14,926	Environmental Quality Co.
-	Recyclable metals	10,025,330	JH Erectors
-	Recyclable metals	3,379,840	JVC Metals Co.
-	Recyclable lead materials	3666	Environmental Recycling

[a]Low-level radioactive waste.

policies have been implemented for management of radioactive, hazardous, and mixed wastes. These policies include the following:

- minimizing waste generation;
- characterizing and certifying wastes before they are stored, processed, treated, or disposed;
- pursuing volume reduction (such as blending and bulking) as well as on-site storage in preparation for safe and compliant final treatment and/or disposal; and
- recycling.

With the beginning of D&D at PORTS, DOE is placing increased emphasis on the evaluation of materials generated by D&D for reuse or recycling. An agreement between DOE and the Southern Ohio Diversification Initiative (SODI) allows DOE to transfer excess equipment, clean scrap materials and other assets to SODI. When SODI sells the materials, the proceeds are divided by SODI and DOE. In 2010-2011, SODI received approximately 13 million pounds of scrap metal and 270,000 gallons of transformer oil from D&D activities at PORTS, primarily D&D of the X-533 Switchyard Complex. Approximately 4.2 million dollars was generated from sales of these materials. SODI used the proceeds to support economic development in the southern Ohio region. Projects that received funding from SODI in 2011 included construction of a steel processing plant in New Boston, Ohio, and a sewer line extension project in Pike County.

3.5 ENVIRONMENTAL SUSTAINABILITY PROGRAM

DOE is committed to reducing environmental risks, costs, wastes, and future liability by effectively integrating environmental sustainability principles into DOE activities at PORTS in a cost effective and environmentally conscious manner. The DOE Environmental Sustainability Program is a balanced, holistic approach that links planning, budgeting, measuring, and improving PORTS overall environmental performance to specific goals and outcomes. The *Environmental Sustainability Plan* describes the Environmental Sustainability Program and integrates the tenets of an EMS. The Environmental Sustainability Program includes elements of pollution prevention, waste minimization, affirmative procurement, sustainable design, and energy and water efficiency.

DOE is committed to minimizing and/or eliminating the amounts and types of wastes generated and to achieving reduced life cycle costs for managing and dispositioning property and wastes during all of DOE projects and activities at PORTS.

Effective environmental sustainability management begins with an integrated strategy. In order to achieve the objectives and targets of the Environmental Sustainability Program, DOE has developed and implemented a well-defined strategy for setting, updating, and achieving objectives and targets in line with the EMS and in conjunction with DOE pollution prevention goals. The broad objectives are core elements of the Environmental Sustainability Program. These objectives, presented below, are both qualitative and quantitative and reduce the life cycle cost and liability of DOE programs and operations at PORTS:

- eliminating, minimizing, or recycling wastes that would otherwise require storage, treatment, disposal, and long-term monitoring and surveillance;
- eliminating or minimizing use of toxic chemicals and associated environmental releases that would otherwise require control, treatment, monitoring, and reporting;

- maximizing the use (procurement) of recycled-content materials and environmentally preferable products and services, thereby minimizing the economic and environmental impacts of managing by-products and wastes generated in the conduct of mission-related activities; and

- reducing the life-cycle cost of managing personal property at PORTS.

The Environmental Sustainability Program recycled approximately 55,500 pounds of office and mixed paper, 11,300 pounds of cardboard, 340 pounds of aluminum cans, and 820 pounds of plastic in 2011. Other materials including scrap metal and waste oil were also recycled (see Section 3.4 and Table 3.2).

DOE continued energy reduction programs at PORTS that focused on accomplishing the goals of Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, which replaced Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*. Executive Order 13514 introduced management requirements for greenhouse gas emissions and expanded previous energy reduction and other environmental sustainability goals. *The U.S. Department of Energy Fiscal Year 2012 Site Sustainability Plan for the Portsmouth Gaseous Diffusion Plant* provides goals and progress through fiscal year 2011 for reductions in greenhouse gas emissions, water consumption, recycling/waste diversion, electronic stewardship, and other areas. The following accomplishments were listed for fiscal year 2011:

- a decrease of 4.6% in greenhouse gas emissions (primarily associated for electricity consumption) versus the fiscal year 2008 baseline emissions.

- 8.4% of electricity consumption from renewable energy sources, which exceeds the goal of 7.5%

- an increase in the number of alternative fuel consumption vehicles to 69.6% of all vehicles. All newly acquired vehicles are either flex-fuel or hybrid vehicles.

- set duplex printing as the default for copiers and printers with duplex printing capability to decrease paper usage.

- implemented power management features on all eligible computers, printers, copiers, and monitors to decrease energy usage.

3.6 ENVIRONMENTAL TRAINING PROGRAM

DOE contractors at PORTS provide environmental training to increase employee awareness of environmental activities and to enhance the knowledge and qualifications of personnel performing tasks associated with environmental assessment, planning, and restoration. The program includes on- and off-site classroom instruction, on-the-job training, seminars, and specialized workshops and courses. Environmental training conducted or prepared by DOE contractors at PORTS includes hazardous waste training required by RCRA and numerous Occupational Safety and Health Administration training requirements.

3.7 PUBLIC AWARENESS PROGRAM

A comprehensive community relations and public participation program is in place at PORTS. The purpose of the program is to foster a spirit of openness and credibility between PORTS officials and local citizens, elected officials, business, media, and various segments of the public. The program also provides the public with opportunities to become involved in the decisions affecting environmental issues at PORTS.

The PORTS Site Specific Advisory Board, comprised of up to 20 citizens from the local area, provides public input and recommendations to DOE on D&D, environmental remediation, waste management, and related issues at PORTS. In 2011, the board provided recommendations to DOE on waste disposition alternatives for materials to be generated during D&D and construction of an off-site, multi-purpose facility to provide adequate meeting space and other areas for DOE and community needs. Additional information about the board can be obtained at www.ports-ssab.org or by calling 740-289-5249.

In 2011, DOE and FBP began the PORTS Envoy Program. The Envoy Program matches employee volunteers with community stakeholders such as families living next to DOE property, community groups, and local government organizations. The envoys communicate information about PORTS D&D and other site issues to the stakeholders and are available to answer stakeholder questions about PORTS.

DOE also maintains a public Environmental Information Center to provide public access to documents used to make decisions on remedial actions being taken at PORTS. The Information Center is located just north of PORTS at the Ohio State University Endeavor Center (Room 207), 1862 Shyville Road, Piketon, Ohio 45661. The email address is portseic@wems-llc.com. Hours for the Information Center are 9 a.m. to noon Monday and Tuesday, noon to 4 p.m. Wednesday and Thursday, or by appointment (call 740-289-8898). Other information, including this Annual Site Environmental Report, can also be obtained from the DOE Portsmouth/Paducah Project Office web site at www.pppo.energy.gov or the FBP web site at www.fbportsmouth.com.

Public update meetings and public workshops on specific topics are also held to keep the public informed and to receive their comments and questions. Periodically, fact sheets about major projects are written for the public. Additionally, notices of document availability and public comment periods, as well as other communications on the program, are regularly distributed to the local newspaper and those on the community relations mailing list, neighbors within 2 miles of the plant, and plant employees.

Points of contact have been established for the public to obtain information or direct questions regarding the Environmental Management Program. The DOE Site Office may be contacted at 740-897-5010. The Office of Public Affairs (740-897-3486) also provides information on the program.

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4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1 SUMMARY

Environmental monitoring at PORTS measures both radiological and chemical parameters in air, water, soil, sediment, and biota (animals, vegetation, and crops). This chapter discusses the radiological component of environmental monitoring programs at PORTS; Chapter 5 discusses the non-radiological parameters for the monitoring programs.

Environmental monitoring programs are required by state and federal regulations, permits, and DOE Orders. These programs may also be developed to address public concerns about plant operations. In 2011, environmental monitoring information was collected by DOE contractors (LPP, FBP, BWCS, and UDS), USEC Inc., and USEC Government Services. Because USEC Government Services responsibilities were returned to DOE in 2011, data collected by USEC Government Services is reported by FBP (the responsible DOE contractor). This chapter includes information on air emissions and water discharges from USEC, Inc. to provide a more complete summary of environmental monitoring at PORTS.

Environmental monitoring data collected at PORTS are used to assess potential impacts to human health and the environment from radionuclides released by current and historical PORTS operations. This impact, called a dose, can be caused by radionuclides released to air and/or water, or radiation emanating directly from buildings or other objects at PORTS. U.S. EPA sets a 10 mrem/year limit for the dose from radionuclides released to the air, and DOE sets a 100 mrem/year limit for the dose from radionuclides from all potential pathways. A person living in the United States receives an average dose of approximately 311 mrem/year from natural sources of radiation (National Council on Radiation Protection [NCRP] 2009).

This chapter includes radiological dose calculations for the dose to the public from radionuclides released to the air and surface water (the Scioto River), from direct radiation, and from radionuclides detected in 2011 by environmental monitoring programs for sediment, soil, vegetation, crops, deer, and drinking water. The maximum dose a member of the public could receive from radiation released by PORTS in 2011 or detected by environmental monitoring programs in 2011 is 1.3 mrem/year. This summary of the dose calculations uses a worst-case approach; that is, the summary of the dose calculations assumes that the same individual is exposed to the most extreme conditions from each pathway. Table 4.1 summarizes this dose information.

Table 4.1. Summary of potential doses to the public from PORTS in 2011

Source of dose	Dose (mrem/year)[a]
Airborne radionuclides	0.032
Radionuclides released to the Scioto River	0.012
Direct radiation from cylinder storage yards	0.81
Radionuclides detected by environmental monitoring programs (sediment, soil, vegetation, crops, deer, and drinking water)	0.42
Total	1.3

[a]100 mrem/year is the DOE limit.

4.2 INTRODUCTION

Environmental monitoring programs at PORTS are designed to detect the effects (if any) of PORTS operations on human health and the environment. Multiple samples are collected throughout the year and analyzed for radionuclides that could be present from PORTS activities. The results of these monitoring

programs are used to gauge the environmental impact of PORTS operations and to set priorities for environmental improvements.

Environmental regulations, permits, DOE Orders, and public concerns are all considered in developing environmental monitoring programs. State and federal regulations drive some of the monitoring conducted at PORTS such as limitations on discharges to air and water. DOE Orders 231.1B, *Environment Safety and Health Reporting*, and 458.1, *Radiation Protection of the Public and the Environment* (which replaced DOE Order 5400.5 during 2011), also address environmental monitoring requirements.

The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* describes the environmental monitoring programs for DOE activities at PORTS. Specific radionuclides monitored at PORTS are selected based on the materials handled at PORTS and on historic monitoring data. For example, samples are analyzed for uranium and isotopic uranium because of the uranium enrichment process. Samples are analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) and technetium-99 because these radionuclides are produced during the fission process in nuclear reactors and were introduced to PORTS via the use of recycled uranium beginning in the late 1950s.

In 2011, environmental monitoring data were collected by DOE contractors (FBP, LPP, BWCS, and UDS), USEC, Inc., and USEC Government Services. Because USEC Government Services responsibilities were returned to DOE in 2011, data collected by USEC Government Services is reported by FBP (the responsible DOE contractor). This chapter provides information on the USEC, Inc. NPDES monitoring program and air emissions of radionuclides from USEC, Inc. sources. USEC, Inc. data are provided for informational purposes only; DOE cannot ensure the quality of USEC, Inc. data.

Data from the following environmental monitoring programs are included in this chapter:

- airborne discharges
- ambient air
- direct radiation
- discharges to surface water
- surface water
- sediment
- soil
- vegetation
- biota.

DOE also conducts an extensive groundwater monitoring program at PORTS. Chapter 6 provides information on the groundwater monitoring program, associated surface water monitoring, and water supply monitoring.

As discussed in this chapter, dose is a measure of the potential biological damage that could be caused by exposure to and subsequent absorption of radiation to the body. Because there are many natural sources of radiation, a person living in the United States receives an average dose of approximately 311 mrem/year from sources of natural radiation (NCRP 2009). Appendix A provides additional information on radiation and dose.

Releases of radionuclides from PORTS activities can result in a dose to a member of the public in addition to the dose received from natural sources of radiation. PORTS activities that release radionuclides are regulated by U.S. EPA and DOE. Airborne releases of radionuclides from DOE

facilities are regulated by U.S. EPA under the Clean Air Act and the National Emission Standards for Hazardous Air Pollutants (NESHAP). These regulations set an annual dose limit of 10 mrem/year to any member of the public as a result of airborne radiological releases.

DOE regulates radionuclide emissions to all environmental media through DOE Orders 436.1, *Departmental Sustainability* (which replaced DOE Order 450.1A, *Environmental Protection Program* during 2011), and 458.1, *Radiation Protection of the Public and the Environment* (which replaced DOE Order 5400.5 during 2011). DOE Orders 458.1 and 5400.5 set an annual dose limit of 100 mrem/year to any member of the public from all radionuclide releases from a facility. The NESHAP apply only to airborne radiological releases.

Small quantities of radionuclides were released to the environment from PORTS operations during 2011. This chapter describes the methods used to estimate the potential doses that could result from radionuclides released from PORTS operations. In addition, this chapter assesses the potential doses that could result from radionuclides historically released by PORTS and detected in 2011 by environmental monitoring programs.

4.3 RADIOLOGICAL EMISSIONS AND DOSES

Exposure to radioactive materials can occur from releases to the atmosphere, surface water, or groundwater and from exposure to direct external radiation emanating from buildings or other objects. For 2011, doses are estimated for exposure to atmospheric releases, direct radiation, and releases to surface water (the Scioto River).

Doses are also estimated for exposure to radionuclides from PORTS operations that were detected in 2011 as part of the DOE environmental monitoring programs. Analytical data from the environmental monitoring programs are assessed to determine whether radionuclides were detected at locations accessible to the public. If radionuclides were detected at locations accessible to the public, a dose assessment is completed based on the monitoring data. In 2011, doses are estimated for exposure to radionuclides detected by the monitoring programs for sediment, soil, vegetation, crops, deer, and drinking water. Exposure to radionuclides detected in groundwater at PORTS is not included because contaminated groundwater at PORTS is not a source of drinking water.

In addition, DOE Order 458.1 sets absorbed dose rate limits for aquatic animals, riparian animals, terrestrial plants, and terrestrial animals. This chapter discusses the dose calculations completed to demonstrate compliance with these limits.

DOE staff, DOE contractors, and visitors to DOE areas who may be exposed to radiation are also monitored. These results are also provided in this chapter.

4.3.1 Dose Terminology

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, potentially resulting in tissue damage. Radiation may come from radionuclides outside the body (in or on environmental media or objects) 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, and 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.

The three natural uranium isotopes (uranium-234, uranium-235, and uranium-238) and technetium-99 are the most commonly detected radionuclides in environmental media samples collected around PORTS. Other radioactive isotopes (americium-241, neptunium-237, plutonium-238, plutonium-239/240, and uranium-236) are occasionally detected at PORTS but may be included as a conservative measure in the calculations used to determine the potential dose received from PORTS operations. Technetium-99 and transuranic radionuclides (americium-241, plutonium-238, and plutonium-239/240) are present in the environment in very small amounts due to radioactive fallout in the atmosphere from nuclear weapons testing by various countries around the world.

A number of specialized measurement units have been defined for characterizing exposures to ionizing radiation. Because the damage associated with exposure to radiation results primarily from the exposure of tissue to ionizing radiation, the units are defined in terms of the amount of ionizing radiation absorbed by human (or animal) tissue and in terms of the biological consequences of the absorbed energy. These units include the following:

- *Absorbed dose* – the quantity of ionizing radiation energy absorbed by an organ divided by the organ's mass. Absorbed dose is measured in units of rad or gray (1 rad = 0.01 gray).

- *Dose* – the product of the absorbed dose (rad) in tissue and a quality factor. Dose is expressed in units of rem or sievert (1 rem = 0.01 sievert).

- *Effective dose* – the sum of the doses received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. In this report, the term "effective dose" is often shortened to "dose."

- *Collective dose/collective effective dose* – the sum of the doses or effective dose of all individuals in an exposed population expressed in units of person-rem or person-sievert. The collective effective dose is also frequently called the "population dose."

4.3.2 Airborne Emissions

Airborne discharges of radionuclides from PORTS are regulated under the Clean Air Act NESHAP. Releases of radionuclides are used to calculate a dose to members of the public, which is reported annually to U.S. EPA and Ohio EPA. Section 4.3.3 discusses the results of this dose calculation.

In 2011, air emission sources associated with the gaseous diffusion process were returned to DOE from USEC Government Services. FBP was responsible for these sources. These sources included continuously monitored vents in the X-326 and X-330 Process Buildings, and the X-344A Uranium Hexafluoride Sampling Building. The vents in the X-326 and X-330 were in use to support *in-situ* deposit removal activities necessary before equipment was removed as part of D&D. The X-344A vents were in use for ongoing sampling activities of uranium product. Vents in the X-333 Process Building and X-343 Feed Vaporization and Sampling Building that were continuously monitored when the gaseous diffusion plant was operating were inactive during 2011.

Other radionuclide air emission sources returned to DOE from USEC Government Services included room ventilation exhausts and/or pressure relief vents associated with the X-700 Chemical Cleaning Facility, X-710 Technical Services Building, X-705 Decontamination Facility, and the XT-847 Glove Box. These emission sources were not continuously monitored; emissions from these sources were estimated based on operating data and U.S. EPA emission factors.

DOE and LPP/FBP were responsible for five additional radiological emission sources. One source, the X-326 L-cage Glove Box, was used to repackage wastes or other materials that contain radionuclides.

The remaining four sources, the X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities, treated groundwater contaminated with radionuclides. Emissions from the groundwater treatment facilities were calculated based on quarterly influent and effluent sampling at each facility and quarterly throughput. Emissions from the X-326 L-cage Glove Box were based on the mass of the materials transferred within the glove box, analytical data available for each material, and emission factors provided by U.S. EPA. Emissions from the DOE/FBP sources in 2011 were calculated to be 0.041 Ci.

DOE and UDS/BWCS were responsible for air emission sources associated with the DUF_6 Conversion Facility. Emissions from the DUF_6 Conversion Facility were based on the annual emissions provided in the permit application for the facility and the number of days the facility operated in 2011. Emissions from the DOE/BWCS sources in 2011 were calculated to be 0.0000042 Ci.

Emissions from all DOE sources in 2011 were calculated to be 0.041 Ci. USEC, Inc. reported emissions of 0.0000122 Ci from operation of the Lead Cascade.

4.3.3 Dose Calculation Based on Airborne Emissions

A dose calculation for atmospheric, or airborne, radionuclides is required by U.S. EPA under NESHAP and is provided to U.S. EPA in an annual report. The effect of radionuclides released to the atmosphere by PORTS during 2011 was characterized by calculating the effective dose to the maximally exposed person (the individual who resides at the most exposed point near the plant) and to the entire population (approximately 677,000 residents) within 50 miles of the plant. Dose calculations were made using a computer program called CAP88-PC Version 3.0, which was developed under sponsorship of U.S. EPA for use in demonstrating compliance with the radionuclide NESHAP. The program uses models to calculate levels of radionuclides in the air, on the ground, and in food (e.g., vegetables, meat, and milk) and subsequent intakes by individuals. The program also uses meteorological data collected at PORTS such as wind direction, wind speed, atmospheric stability, rainfall, and average air temperature.

Radionuclide emissions were modeled for each of the air emission sources discussed in Section 4.3.2. The dose calculations assumed that each person remained unprotected, resided at home (actually outside the house) during the entire year, and obtained food according to the rural pattern defined in the NESHAP background documents. This pattern specifies that 70% of the vegetables and produce, 44% of the meat, and 40% of the milk consumed by each person are produced in the local area (e.g., in a home garden). The remaining portion of each food is assumed to be produced within 50 miles of PORTS. These assumptions most likely result in an overestimate of the dose received by a member of the public, since it is unlikely that a person spends the entire year outside at home and consumes food from the local area as described above.

The maximum potential dose to an off-site individual from radiological releases from DOE air emission sources at PORTS in 2011 was 0.032 mrem/year. The combined dose from USEC, Inc. (the Lead Cascade) and DOE sources is also 0.032 mrem/year. The dose from the USEC, Inc. sources is negligible compared to DOE sources and much less than the dose from USEC, Inc. and USEC Government Services sources in 2010 because the numerous sources in the former gaseous diffusion plant were returned to DOE from USEC Government Services in 2011. This dose is well below the 10-mrem/year limit applicable to PORTS and the approximate 311-mrem/year dose that the average individual in the United States receives from natural sources of radiation (NCRP 2009).

The collective dose (or population dose) is the sum of the individual doses to the entire population within 50 miles of PORTS. In 2011, the population dose from PORTS emissions was 0.35 person-rem/year, (0.35 person-rem/year from DOE sources and 0.000038 person-rem/year from USEC, Inc.). The population dose based on PORTS emissions was insignificant; for example, the average population dose to all people within 50 miles of PORTS from the ingestion of naturally-occurring radionuclides in water

and food was approximately 19,630 person-rem/year based on an average dose of approximately 29 mrem/year to an individual (NCRP 2009).

4.3.4 Dose Calculation Based on Ambient Air Monitoring

DOE collects samples from 15 ambient air monitoring stations (see Figure 4.1) and analyzes them for the radionuclides that could be present in ambient air due to PORTS activities. These radionuclides are isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). The ambient air monitoring stations measure radionuclides released from DOE and USEC, Inc. point sources (the sources described in Section 4.3.2), fugitive air emissions (emissions that are not associated with a specific release point such as a stack), and background levels of radiation (radiation that occurs naturally in the environment and is not associated with PORTS operations).

The CAP88 model generates a dose conversion factor that was used to calculate a dose for a given level of each radionuclide in air. The following assumptions were made to calculate the dose at each station: 1) the highest level of each radionuclide detected in 2011 was assumed to be present for the entire year; or 2) if a radionuclide was not detected, the radionuclide was assumed to be present for the entire year at half the highest undetected result.

The dose associated with each radionuclide at each ambient air monitoring station was added to obtain the gross dose for each station. The net dose for each station was obtained by subtracting the dose measured at the background station (A37). The net dose for each station ranged from 0 at stations with a lower dose than the background station to 0.0012 mrem/year at station A9, which is near the southwestern corner of the PORTS property boundary.

The highest net dose measured at the ambient air monitoring stations (0.0012 mrem/year at station A9) is 4% of the dose calculated from the combined DOE and USEC, Inc. point source emissions (0.032 mrem/year). This dose is significantly less than the 10 mrem/year NESHAP limit for airborne radiological releases and 100 mrem/year DOE limit for all radiological releases from a facility.

4.3.5 Discharges of Radionuclides from NPDES Outfalls

DOE contractors (LPP/FBP and UDS/BWCS) and USEC Government Services were responsible for NPDES outfalls at PORTS during 2011. Outfalls that were the responsibility of LPP or UDS were transferred to FBP or BWCS on March 29, 2011, when FBP and BWCS took over responsibility for their respective contracts. The majority of the outfalls and monitoring locations that were the responsibility of USEC Government Services (associated with the former gaseous diffusion process buildings and areas) were transferred to the FBP NPDES permit on September 1, 2011. The outfalls and monitoring locations transferred from USEC Government Services to FBP are Outfalls 001, 002, 003, 004, 005, 009, 010, 011, 602, 604, and 605; and Monitoring Locations 801, 902, and 903. Three outfalls associated with the ACP remained the responsibility of USEC, Inc.

The BWCS NPDES outfall is not monitored for radionuclides; therefore, it is not discussed in this section. A description of the FBP and USEC, Inc. outfalls and the discharges of radionuclides from these outfalls during 2011 are included in this section. Quarterly reports that provide radiological monitoring data for the NPDES outfalls are submitted to Ohio EPA by FBP and USEC, Inc. for their respective outfalls.

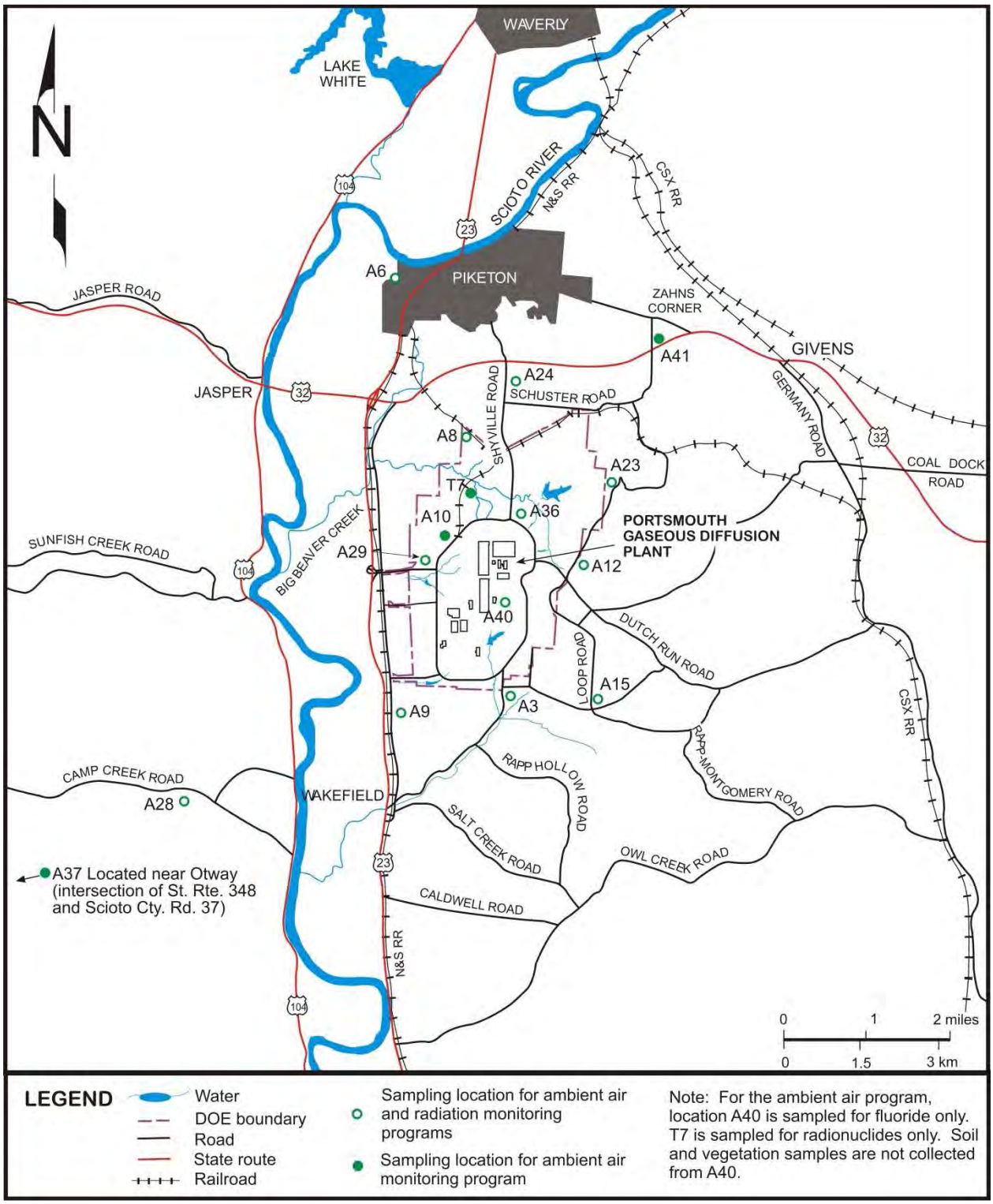

Figure 4.1. DOE ambient air and radiation monitoring locations.

4.3.5.1 FBP outfalls

At the end of 2011, FBP was responsible for 18 monitoring locations identified in the FBP NPDES permit. Nine outfalls discharge directly to surface water, six outfalls discharge to another outfall before leaving the site, and three other locations that are not outfalls are also monitored (see Figure 4.2). A brief description of each FBP outfall or monitoring location at PORTS follows.

FBP NPDES Outfall 001 (X-230J7 East Holding Pond) – The X-230J7 East Holding Pond receives non-contact cooling water, steam condensate, foundation drainage, storm runoff, hydro-testing water from cylinders, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to a ditch that flows to Little Beaver Creek.

FBP NPDES Outfall 002 (X-230K South Holding Pond) – The X-230K South Holding Pond receives non-contact cooling water, steam condensate, foundation drainage, treated coal pile runoff, storm runoff, fire-fighting training and fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, oil can be contained, and pH can be adjusted. Water from this holding pond is discharged to Big Run Creek.

FBP NPDES Outfall 003 (X-6619 Sewage Treatment Plant) – The X-6619 Sewage Treatment Plant treats PORTS sewage as well as water discharged from DOE groundwater treatment facilities, the X-700 Biodenitrification Facility, the X-705 Decontamination Microfiltration System, and miscellaneous waste streams. The X-6619 Sewage Treatment Plant uses screening, aeration, clarification, and filtering followed by chlorination to treat wastewater prior to release to the Scioto River.

FBP NPDES Outfall 004 (Cooling Tower Blowdown) – Outfall 004 is located at the junction of Pike Avenue and 15th Avenue at PORTS. It monitors blowdown water from various cooling towers on site prior to being discharged to the Scioto River.

FBP NPDES Outfall 005 (X-611B Lime Sludge Lagoon) – The X-611B Lime Sludge Lagoon is used to settle lime sludge used in a water-softening process. The X-611B also receives rainwater runoff. Currently the lagoon only discharges during periods of excess rainfall.

FBP NPDES Outfall 009 (X-230L North Holding Pond) – The X-230L North Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be contained. Water from this holding pond is discharged to an unnamed stream that flows to Little Beaver Creek.

FBP NPDES Outfall 010 (X-230J5 Northwest Holding Pond) – The X-230J5 Northwest Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire-fighting training and fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to the West Ditch, which flows to the Scioto River.

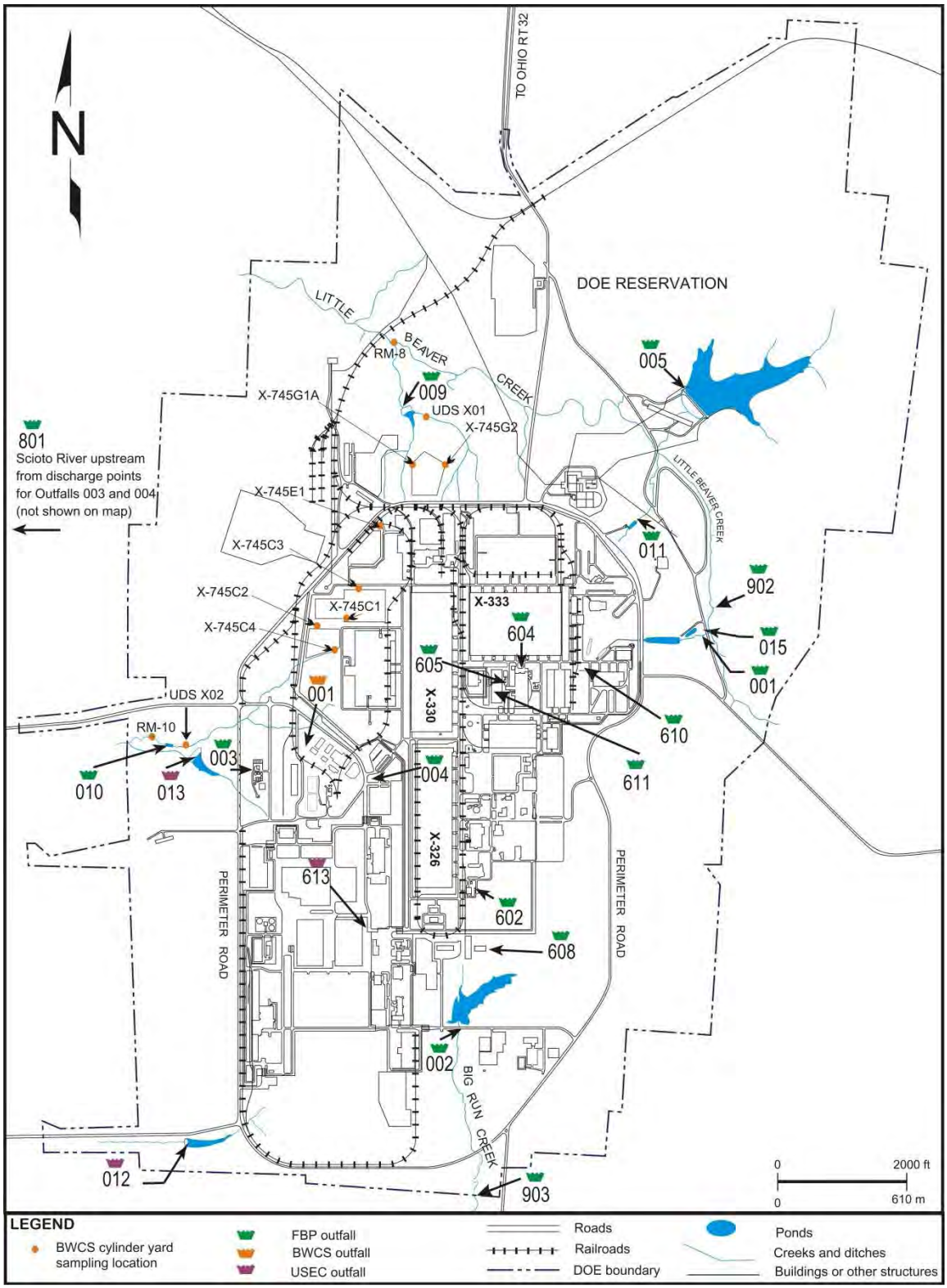

Figure 4.2. PORTS NPDES outfalls/monitoring points and cylinder storage yards sampling locations.

FBP NPDES Outfall 011 (X-230J6 Northeast Holding Pond) – The X-230J6 Northeast Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to an unnamed stream that flows to Little Beaver Creek.

FBP NPDES Outfall 015 (X-624 Groundwater Treatment Facility) – The X-624 Groundwater Treatment Facility removes volatile organic compounds from contaminated groundwater collected in the X-237 Groundwater Collection System in the X-701B Holding Pond area. This collection system was constructed to control the migration of groundwater contaminated with volatile organic compounds toward Little Beaver Creek. Treated water is released to a ditch that flows to Little Beaver Creek.

FBP NPDES Outfall 602 (X-621 Coal Pile Runoff Treatment Facility) – The X-621 Coal Pile Runoff Treatment Facility treats storm water runoff from the coal pile at the X-600 Steam Plant. The treated water is discharged to the X-230K South Holding Pond (FBP NPDES Outfall 002).

FBP NPDES Outfall 604 (X-700 Biodenitrification Facility) – The X-700 Biodenitrification Facility receives solutions from plant operations that are high in nitrate. At the X-700, these solutions are diluted and treated biologically using bacteria prior to being discharged to the X-6619 Sewage Treatment Plant (FBP NPDES Outfall 003).

FBP NPDES Outfall 605 (X-705 Decontamination Microfiltration System) – The X-705 Decontamination Microfiltration System treats process wastewater using microfiltration and pressure filtration technology. The treated water is discharged to the X-6619 Sewage Treatment Plant (FBP NPDES Outfall 003).

FBP NPDES Outfall 608 (X-622 Groundwater Treatment Facility) – The X-622 Groundwater Treatment Facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities in the southern portion of the site, which is Quadrant I in the RCRA Corrective Action Program (see Chapter 3, Section 3.2.1). Treated water is discharged to the sanitary sewer and then through FBP NPDES Outfall 003.

FBP NPDES Outfall 610 (X-623 Groundwater Treatment Facility) – The X-623 Groundwater Treatment Facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities in the X-701B Holding Pond area in Quadrant II and from miscellaneous well development and purge waters. Treated water is discharged to the sanitary sewer and then through FBP NPDES Outfall 003.

FBP NPDES Outfall 611 (X-627 Groundwater Treatment Facility) – The X-627 Groundwater Treatment Facility removes volatile organic compounds from groundwater collecting in sumps located in the basements of the X-700 and X-705 buildings, which are part of Quadrant II. Treated water is discharged to the sanitary sewer and then through FBP NPDES Outfall 003.

FBP is also responsible for three additional monitoring points that are not discharge points as described in the previous paragraphs. FBP NPDES Station Number 801 is a background monitoring location on the Scioto River upstream from FBP NPDES Outfalls 003 and 004. FBP NPDES Station Number 902 is a monitoring location on Little Beaver Creek downstream from FBP NPDES Outfall 001, and FBP NPDES Station Number 903 is a monitoring location on Big Run Creek downstream from FBP NPDES Outfall 002.

FBP NPDES Outfalls 015, 608, 610, and 611 were monitored for radiological discharges by collecting water samples and analyzing the samples for uranium, uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). The external outfalls transferred from USEC Government Services to FBP (Outfalls 001, 002, 003, 004, 005, 009, 010, and 011) were monitored for technetium-99, uranium, and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), due to different monitoring requirements under USEC Government Services.

Discharges of radionuclides in liquids through FBP NPDES outfalls have no significant impact on public health and the environment. In 2011, uranium discharges from the FBP external outfalls (Outfalls 001, 002, 003, 004, 005, 009, 010, 011, and 015) were estimated at 8.7 kilograms. Technetium-99 discharges from the same outfalls were estimated at 0.06 Ci.

Discharges of radionuclides were calculated using monthly or weekly monitoring data from the NPDES outfalls. Analytical results below the detection limit were assigned a value of zero in the calculations to determine the quantities of uranium and technetium-99 discharged through the outfalls. Discharges of radionuclides from the outfalls are used in the dose calculation for releases to surface water (Section 4.3.6). The dose calculated with these data is significantly less than the 100 mrem/year limit for all radiological releases from a facility.

No transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were detected in samples collected from the external FBP outfalls (Outfalls 001, 002, 003, 004, 005, 009, 010, 011, and 015) during 2011.

4.3.5.2 USEC, Inc. outfalls

At the end of 2011, USEC, Inc. was responsible for three NPDES outfalls through which water is discharged from the site (see Figure 4.2). Two outfalls discharge directly to surface water, and one discharges to the X-6619 Sewage Treatment Plant (FBP NPDES Outfall 003) before leaving the site. A brief description of each USEC, Inc. NPDES outfall follows.

USEC NPDES Outfall 012 (X-2230M Southwest Holding Pond) – The X-2230M Southwest Holding Pond accumulates precipitation runoff, non-contact cooling water, and steam condensate from the southern portion of PORTS. The pond provides an area where solids can settle, chlorine can dissipate, and oil can be separated from the water prior to its release to an unnamed stream that flows to the Scioto River.

USEC NPDES Outfall 013 (X-2230N West Holding Pond) – The X-2230N West Holding Pond accumulates precipitation runoff, non-contact cooling water, and steam condensate from the southwestern portion of PORTS. The pond provides an area where solids can settle, chlorine can dissipate, and oil can be separated from the water prior to its release to the West Ditch, which flows to the Scioto River.

USEC NPDES Outfall 613 (X-6002 Particulate Separator) – The X-6002 Particulate Separator removes suspended solids from water used in the X-6002 Recirculating Hot Water Plant, which provides heat to a number of buildings at PORTS. The treated water is discharged to the X-6619 Sewage Treatment Plant (FBP NPDES Outfall 003).

Uranium discharges in 2011 from external USEC, Inc. NPDES outfalls (Outfalls 012 and 013) were estimated at 0.55 kilogram. Technetium-99 discharges from Outfalls 012 and 013 were estimated at 0.001 Ci. These values were calculated using quarterly discharge monitoring reports for the USEC, Inc. NPDES outfalls. Analytical results below the detection limit were assigned a value of zero in the

calculations to determine the quantities of uranium and radiation (technetium-99) discharged through the USEC, Inc. NPDES outfalls.

Transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were not detected in any of the samples collected from USEC, Inc. NPDES outfalls in 2011.

Discharges of radionuclides from USEC, Inc. Outfalls 012 and 013 are used in the dose calculation for releases to surface water (Section 4.3.6). The dose calculated with these data and data from external FBP outfalls is significantly less than the 100 mrem/year limit for all radiological releases from a facility.

4.3.6 Dose Calculation for Releases to Surface Water

Radionuclides are measured at the FBP and USEC, Inc. NPDES external outfalls (nine FBP outfalls and two USEC, Inc. outfalls). Water from these external outfalls is either directly discharged to the Scioto River or eventually flows into the Scioto River from Little Beaver Creek, Big Run Creek, or unnamed tributaries to these water bodies. A hypothetical dose to a member of the public was calculated using the measured radiological discharges and the annual flow rate of the Scioto River.

Uranium mass (in micrograms per liter [µg/L]) and activity (in picocuries per liter [pCi/L]) for americium-241, neptunium-237, plutonium-238, plutonium-239/240, and technetium-99 were measured in the water discharged from the FBP or USEC, Inc. outfalls. As a conservative measure, radionuclides that were not detected were assumed to be present at the detection limit. Uranium was assumed to be 5.2% uranium-235, 94% uranium-238, and 0.8% uranium-234 based on the highest enrichment of uranium produced by PORTS in the years prior to shutdown of the gaseous diffusion uranium enrichment operations. The maximum individual dose was calculated using the above-mentioned measured radionuclide discharges from the plant outfalls and the annual flow rate of the Scioto River.

The dose calculations were derived from the procedures developed for a similar DOE facility: *LADTAP XL: An Improved Electronic Spreadsheet Version of LADTAP II* (Hamby 1991) and *LADTAP-PA: A Spreadsheet for Estimating Dose Resulting from E-Area Groundwater Contamination at the Savannah River Site* (Jannik and Dixon 2006), which updates the 1991 LADTAP XL. Specific exposure scenarios provided in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* were also used when available. Environmental pathways considered were ingestion of water, ingestion of fish, swimming, boating, and shoreline activities. This exposure scenario is very conservative because the Scioto River is not used for drinking water downstream of PORTS (97% of the hypothetical dose from liquid effluents is from drinking water). The dose from radionuclides released to the Scioto River in 2011 (0.012 mrem) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

4.3.7 Radiological Dose Calculation for Direct Radiation

Radiation is emitted from uranium hexafluoride cylinders stored on site at PORTS in the cylinder storage yards located in the northwest portion of the site near Perimeter Road. Data from direct radiation monitoring at the cylinder yards are used to assess potential exposure to the members of the public that drive on Perimeter Road.

Environmental radiation is measured at five locations along Perimeter Road near the boundaries of the cylinder storage yards in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (see Section 4.6.2). In 2011, the average dose recorded at the cylinder yards near Perimeter Road was 818 mrem/year, based on exposure to ionizing radiation for an entire year. The radiological exposure to members of the general public is estimated as the time that a person drives on Perimeter Road past the cylinder yards, which is conservatively estimated at 8.7 hours per year (1 minute per trip, 2 trips per day, 5 work-days per week, and 52 weeks per year).

Based on these assumptions, exposure to a member of the public from radiation from the cylinder yards is approximately 0.81 mrem/year. The average annual dose to a person in the United States from all radiation sources (natural and manmade) is approximately 620 mrem (NCRP 2009). The potential estimated dose from the cylinder yards to a member of the public is approximately 0.1 percent of the average yearly radiation exposure for a person in the United States and is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

4.3.8 Radiological Dose Results for DOE Workers and Visitors

The DOE Radiological Protection Organization at PORTS monitors direct radiation levels in active DOE facilities at PORTS on a continual basis. This radiation monitoring assists in determining the radiation levels that workers are exposed to and in identifying changes in radiation levels. These measurements provide 1) information for worker protection, 2) a means to trend radiological exposure data for specified facilities, and (3) a means to estimate potential public exposure to radiation from DOE activities at PORTS.

The Radiation Exposure Information Reporting System report is an electronic file created annually to comply with DOE Order 231.1B. This report contains exposure results for all monitored DOE employees, DOE contractors, and visitors to DOE areas at PORTS with a positive exposure during the previous calendar year. The 2011 Radiation Exposure Information Reporting System report indicated that no visitors received a measurable dose (defined as 10 mrem or more).

More than 1200 DOE employees and DOE contractors were monitored throughout 2011. Beginning in the fourth quarter of 2011, workers formerly associated with USEC Government Services transitioned to FBP or other DOE contractors and were added to the DOE monitoring program. The 2402 total workers monitored in 2011 received an average dose of 0.9 mrem (including former USEC Government Services workers). Only 38 DOE contractors, primarily cylinder yard workers, received a measurable dose (defined as 10 mrem total effective dose or more). These workers received a measurable dose that averaged 52 mrem. No administrative guidelines or regulatory dose limits were exceeded in 2011.

4.3.9 Radiological Dose Calculations for Off-site Environmental Monitoring Data

Environmental monitoring at PORTS includes collecting samples at off-site locations around PORTS and analyzing the samples for radionuclides that could be present due to PORTS operations. Samples are analyzed for uranium, uranium isotopes, technetium-99, and/or selected transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Uranium occurs naturally in the environment; therefore, detections of uranium cannot necessarily be attributed to PORTS operations. Technetium-99 and transuranics could come from PORTS operations because they were present in recycled uranium processed by PORTS during the Cold War. Technetium-99 and transuranic radionuclides could also come from sources other than PORTS because they are generally present in the environment in very small amounts due to radioactive fallout in the atmosphere from nuclear weapons testing by various countries around the world.

DOE sets a limit of 100 mrem/year for a potential dose to a member of the public via exposure to all radionuclide releases from a DOE facility. To ensure that PORTS meets this standard, dose calculations may be completed for environmental media (residential drinking water [well water], sediment, and soil) and biota (vegetation, deer, fish, crops, and dairy products) at off-site sampling locations with detections of radionuclides that could cause the highest dose to a member of the public. Detections of radionuclides in sediment and soil on the PORTS facility are not used to assess risk because the public does not have access to the sampled areas of the facility. The summary of these dose calculations uses a worst-case approach; that is, the summary of the dose calculations assumes that the same individual is exposed to the most extreme conditions from each pathway.

In 2011, dose calculations were completed for public exposure to radionuclides detected in sediment, soil, vegetation, crops, deer, and residential drinking water. Chapter 6, Section 6.4.13, provides additional information concerning detections of radionuclides in residential drinking water.

The following sections provide brief descriptions of the dose calculations for each monitoring program. Methodologies used to complete each risk calculation are based on information developed and approved by U.S. EPA including the *Exposure Factors Handbook* (U.S. EPA 1997) and *Federal Guidance Report No. 11 (FGR 11) Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Immersion, and Ingestion* (U.S. EPA 1988).

In addition, specific exposure scenarios provided in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* were used when available. This document integrates the results of technical meetings between U.S. EPA, Ohio EPA, and DOE and provides methods for completing risk analyses at PORTS to promote consistency in the risk approach.

Table 4.2 summarizes the results of each dose calculation. Potential doses to the public from radionuclides detected by the PORTS environmental monitoring program in 2011 are significantly less than the DOE limit of 100 mrem/year.

Table 4.2. Summary of potential doses to the public from radionuclides detected by DOE environmental monitoring programs in 2011

Source of dose	Dose (mrem/year)[a]
Sediment	0.012
Soil	0.036
Vegetation	0.002
Crops	0.009
Deer	0.19
Drinking water	0.169
Total	0.42

[a]100 mrem/year is the DOE limit.

4.3.9.1 Dose calculation for sediment

The dose calculation for sediment is based on the following detections of radionuclides in the duplicate sample collected in 2011 from monitoring location RM-13, an off-site sampling location on Big Beaver Creek downstream from PORTS:

- neptunium-237: 0.0151 (picocuries per gram [pCi/g]),
- technetium-99: 4.34 pCi/g,
- uranium-233/234: 1.41 pCi/g,
- uranium-235: 0.0612 pCi/g,
- uranium-236: 0.0118 pCi/g, and
- uranium-238: 0.815 pCi/g.

Based on an ingestion rate of 200 milligrams (mg)/day (0.0007 ounces/day) and an exposure frequency of 85 days/year, which are consistent with the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant*, and exposure factors in U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from

sediment contaminated at these levels is 0.012 mrem/year. Section 4.6.5 provides additional information on the sediment monitoring program as well as a map of sediment sampling locations.

4.3.9.2 Dose calculation for soil

The dose calculation for soil is based on the detections of 0.0105 pCi/g of plutonium 239/240, 0.822 pCi/g of uranium-233/234, 0.0394 pCi/g of uranium-235, and 0.891 pCi/g of uranium-238 in soil at the ambient air monitoring station at Zahns Corner 2.6 miles northeast of PORTS (A41).

Based on an ingestion rate of 200 mg/day (0.0007 ounces/day) and an exposure frequency of 350 days/year, which are consistent with the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant,* and exposure factors in U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from soil contaminated at these levels is 0.036 mrem/year. Section 4.6.7 provides additional information on the soil monitoring program.

4.3.9.3 Dose calculation for vegetation

The dose calculation for vegetation is based on the following detections of radionuclides in soil and vegetation at ambient air monitoring station A41 (Zahns Corner):

Vegetation
- uranium-233/234: 0.00785 pCi/g, and

Soil
- plutonium-239/240: 0.0105 pCi/g,
- uranium-233/234: 0.822 pCi/g,
- uranium-235: 0.0394 pCi/g, and
- uranium-238: 0.891 pCi/g.

The dose calculation of 0.002 mrem/year is based on human consumption of beef cattle that would eat grass (and soil) contaminated at this level. Based on an ingestion rate for beef of 2 ounces/day and an exposure frequency of 365 days/year, which are consistent with the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* and U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual eating beef from cattle that grazed on vegetation and soil contaminated at these levels is 0.002 mrem/year. Section 4.6.8 provides additional information on the vegetation monitoring program.

4.3.9.4 Dose calculation for crops

The dose calculation for crops is based on the detection of americium-241 at 0.0125 pCi/g in sample of crops consisting of grapes, tomatoes, corn, soy beans, and peppers collected from off-site location #5. Based on an ingestion rate for home-grown vegetables of 1.2 pounds/day and an exposure frequency of 365 days/year, which are consistent with the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* and U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by a person consuming crops contaminated at this level throughout the year is 0.009 mrem/year. Section 4.6.9.3 provides additional information on the monitoring program for crops.

4.3.9.5 Dose calculation for deer

The dose calculation for deer is based on the detection of uranium-233/234 at 0.01786 pCi/g in a deer muscle sample collected in January 2011 from a deer killed in a vehicle collision on site at PORTS. Based on a consumption rate for venison of 101 grams/day (0.2 pounds) for 365 days/year, as specified in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant,* the dose that could be received by a person consuming venison contaminated at

this level throughout the year is 0.19 mrem/year. Section 4.6.9.1 provides additional information on the deer monitoring program.

4.3.9.6 Dose calculation for residential drinking water

The dose calculation for residential drinking water is based on the detection of americium-241 at 0.0665 pCi/L in the first quarter sample collected from a residential drinking water supply north of PORTS on State Route 124. Based on a consumption rate of 700 liters of water/year (185 gallons), as specified in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant*, the dose that could be received by a person consuming water contaminated at this level throughout the year is 0.169 mrem/year. Chapter 6, Section 6.4.14 provides additional information on the water supply monitoring program.

4.4 PROTECTION OF BIOTA

DOE Order 458.1, which replaced DOE Order 5400.5 during 2011, sets absorbed dose rate limits for aquatic animals, riparian animals (animals that live on the banks of a river or in wetlands adjacent to a body of water), terrestrial plants, and terrestrial animals. DOE Technical Standard *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) was used to demonstrate compliance with these limits.

Analytical data for surface water and sediment collected from the northern side of the PORTS reservation (surface water sampling location NHP-SW01 and sediment sampling location RM-8) were used to assess the dose limits for aquatic and riparian animals. These locations were selected because levels of radionuclides detected in surface water and sediment from these locations were among the highest detected in samples collected in 2011. Section 4.6.5 and Chapter 6, Section 6.4.13 provide more information about these sediment and surface water sampling programs, respectively.

The maximum values of transuranic radionuclides, technetium-99, and uranium isotopes detected in sediment or surface water samples collected from these locations in 2011 were entered into the RESRAD-BIOTA program that is designed to implement the DOE Technical Standard (DOE 2002). The assessment indicates that the levels of radionuclides detected in water and sediment at these locations do not result in a dose of more than 1 rad/day to aquatic animals and 0.1 rad/day to riparian animals.

Analytical data for surface water and soil collected from the northern side of the PORTS reservation (surface water sampling location NHP-SW01 and soil sampling location A8) were used to assess the dose limits for terrestrial plants and animals. These locations were selected because levels of radionuclides detected in surface water and soil from these locations were among the highest detected in samples collected in 2011. Section 4.6.7 and Chapter 6, Section 6.4.13 provide additional information about these soil and surface water sampling programs, respectively.

Data for the highest levels of radionuclides detected at these locations in 2011 were entered into the RESRAD-BIOTA program that is designed to implement the DOE Technical Standard (DOE 2002). The assessment indicates that the levels of radionuclides detected in water and soil at these locations do not result in a dose of more than 1 rad/day to terrestrial plants and 0.1 rad/day to terrestrial animals.

4.5 UNPLANNED RADIOLOGICAL RELEASES

No unplanned releases of radionuclides took place at PORTS in 2011.

4.6 ENVIRONMENTAL RADIOLOGICAL MONITORING

This section discusses the radiological monitoring programs at PORTS: ambient air monitoring, environmental radiation, surface water, sediment, settleable solids, soil, vegetation, and biota (deer, fish, crops, milk, and eggs).

4.6.1 Ambient Air Monitoring

The ambient air monitoring stations measure radionuclides released from 1) DOE and USEC, Inc. point sources (the sources discussed in Section 4.3.2), 2) fugitive air emissions (emissions from PORTS that are not associated with a stack or pipe such as remediation sites or normal building ventilation), and 3) background levels of radionuclides (radionuclides that occur naturally, such as uranium). These radionuclides are isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240).

In 2011, samples were collected from 15 ambient air monitoring stations located within and around PORTS (see Section 4.3.4, Figure 4.1), including a background ambient air monitoring station (A37) located approximately 13 miles southwest of the plant. The analytical results from air sampling stations closer to the plant are compared to the background measurements.

Americium-241, plutonium-238, and plutonium-239/240 were detected in a few of the samples collected from the ambient air stations in 2011. The maximum activity of americium-241 detected in air was 0.000011 picocurie per cubic meter (pCi/m^3) at station T7. The maximum activities of plutonium-238 (station A15) and plutonium-239/240 (station T7) were 0.0000094 pCi/m^3 and 0.00013 pCi/m^3, respectively. These detections are well below the derived concentration standards for each radionuclide: 0.097 pCi/m^3 (americium-241), 0.088 pCi/m^3 (plutonium-238), and 0.081 pCi/m^3 (plutonium-239/240).

Technetium-99 was detected at each of the 15 ambient air stations. The maximum activity of technetium-99 in ambient air was 0.028 pCi/m^3 at station A9 (southwest of the plant on Old U.S. Route 23), which is well below the DOE derived concentration standard of 920 pCi/m^3.

Uranium-233/234 and uranium-238 were detected in all of the samples. The maximum activity of uranium-233/234 in ambient air (0.00071 pCi/m^3) was detected at station A10 (on the northeastern plant boundary). The maximum activity of uranium-238 in ambient air (0.00027 pCi/m^3) was detected at station A41 (northeast of the plant at Zahns Corner). These activities are well below the DOE derived concentration standards for uranium-233/234 (1.1 pCi/m^3) and uranium-238 (1.3 pCi/m^3).

To confirm that air emissions from PORTS are within regulatory requirements and are not harmful to human health, the ambient air monitoring data were used to calculate a dose to a hypothetical person living at the monitoring station. The highest net dose calculation for the off-site ambient air stations (0.0012 mrem/year) was at station A9, which is southwest of the plant on Old U.S. Route 23. This hypothetical dose is well below the 10 mrem/year limit applicable to PORTS. Section 4.3.4 provides additional information about this dose calculation.

4.6.2 Environmental Radiation

Radiation is measured continuously by DOE at 19 locations that include most of the ambient air monitoring locations (see Section 4.3.4, Figure 4.1) and other on-site locations (see Figure 4.3). Measuring devices are placed at the monitoring locations at the beginning of each quarter, remain at the monitoring location throughout the quarter, and are removed from the monitoring location at the end of the quarter and sent to the laboratory for processing. A new measuring device replaces the removed device. Radiation is measured in millirems as a whole body dose, which is the dose that a person would receive if they were continuously present at the monitored location.

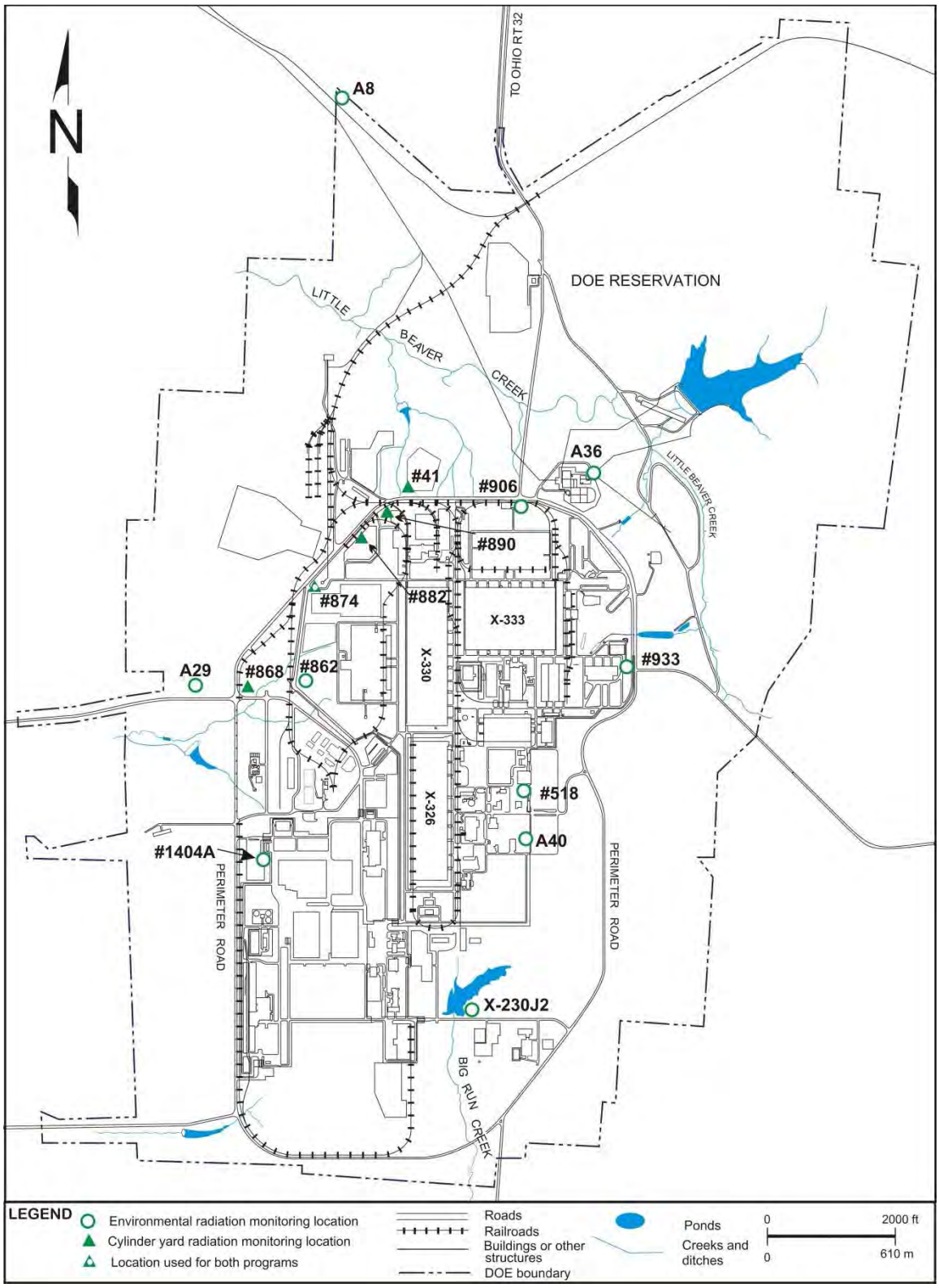

Figure 4.3. On-site radiation and cylinder yard dose monitoring locations.

Three locations detected elevated levels of radiation in 2011: location #874, which monitors the X-745C Cylinder Storage Yard; location #862, which is south of the cylinder yards and west of the X-530A Switchyards; and location #933, which is east of the X-744G building in the X-701B Holding Pond groundwater monitoring area. The cumulative whole body dose calculated for each of the other 16 locations (i.e., excluding locations #874, #862, and #933) ranged from 72 to 99 mrem and averaged 91 mrem. The cumulative whole body doses at locations #874, #862, and #933 were 765 mrem, 140 mrem, and 169 mrem, respectively. The control and trip blanks associated with all of the results for this monitoring program, which measure background radiation, averaged 73 mrem.

In addition, radiation is measured at five locations around the northwest corner of PORTS just inside Perimeter Road near the cylinder storage yards (see Figure 4.3). These locations are not accessible to the general public. The cumulative annual whole body doses at locations #41 and #890 were 280 mrem and 269 mrem, respectively. Locations #874 and #882 recorded cumulative annual whole body doses of 753 mrem and 1087 mrem, respectively, and location #868 recorded a cumulative annual whole body dose of 1702 mrem. Section 4.3.8 provides dose results for DOE workers, including workers in the cylinder yards. No administrative guidelines or regulatory dose limits were exceeded in 2011.

Section 4.3.7 provides a dose calculation for members of the public, such as delivery people, that are allowed on the portion of Perimeter Road near the cylinder storage yards. The potential estimated dose from the cylinder yards to a member of the public (0.81 mrem/year) is significantly less than DOE's 100 mrem/year dose limit to the public for radionuclides from all potential pathways.

4.6.3 Surface Water from Cylinder Storage Yards

Ohio EPA requires monthly collection of surface water samples from four locations: X-745C1 at the X-745C Cylinder Storage Yard, X-745E1 at the X-745E Cylinder Storage Yard, and X-745G1A and X-745G2 at the X-745G Cylinder Storage Yard. DOE voluntarily collects samples at three additional locations around the X-745C storage yard (X-745C2, X-745C3, and X-745C4). Figure 4.2 shows the sampling locations. Samples collected during 2011 were analyzed for alpha activity, beta activity, and uranium.

Uranium was detected at a maximum concentration of 17.2 µg/L in the sample collected during January 2011 at sampling location X-745C4. Maximum levels of alpha activity and beta activity (35.4 and 34.5 pCi/L, respectively) were detected in the sample collected from X-745C4 in July 2011. Other detections of alpha activity and beta activity during 2011 were less than 15 pCi/L. Surface water from the cylinder storage yards flows to FBP NPDES outfalls prior to discharge from the site; therefore, releases of radionuclides from the cylinder yards are monitored by sampling conducted at the FBP outfalls. Radionuclides detected at FBP outfalls (see Section 4.3.5.1) are used in the dose calculation for releases to surface water (see Section 4.3.6). The dose from radionuclides released to surface water (the Scioto River) in 2011 (0.012 mrem) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

4.6.4 Local Surface Water

In 2011, local surface water samples were collected from 14 locations upstream and downstream from PORTS. These samples were taken from the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek (see Figure 4.4). As background measurements, samples were also collected from local streams approximately 10 miles north, south, east, and west of PORTS.

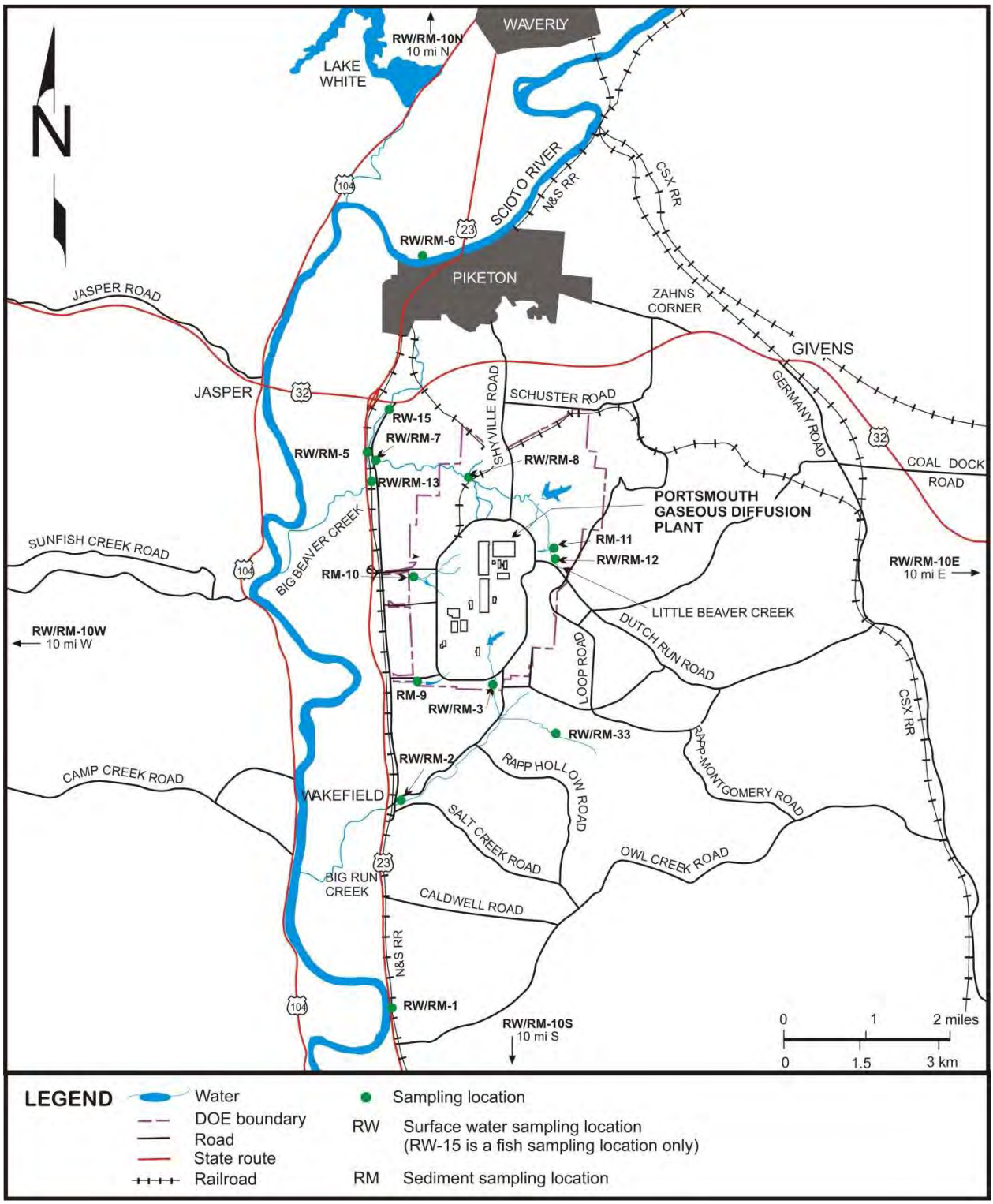

Figure 4.4. Local surface water and sediment monitoring locations.

Samples were collected semiannually and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

Americium-241 and/or plutonium-239/240 were detected at activities ranging from 0.0529 to 0.0756 pCi/L in samples collected from five locations: downstream locations on Big Run Creek (RW-2 and RW-3), a downstream location on Big Run Creek (RW-13), a downstream location on Little Beaver Creek (RW-7), and the upstream monitoring location on the Scioto River (RW-6). These detections are well below the DOE derived concentration standards for americium-241 and plutonium-239/240 in drinking water (170 pCi/L and 140 pCi/L, respectively).

Technetium-99 was detected at 9.05 pCi/L the second quarter sample collected from Little Beaver Creek at RW-7. Technetium-99 is occasionally detected at low levels in surface water samples collected downstream from PORTS. The detection is well below the DOE derived concentration standard for technetium-99 in drinking water (44,000 pCi/L).

Maximum detections of uranium and uranium isotopes in local surface water samples were detected at locations RW-7 or RW-8 on Little Beaver Creek. Uranium was detected at 1.84 µg/L, uranium-233/234 was detected at 2.42 pCi/L, uranium-235 was detected at 0.0937 pCi/L, and uranium-238 was detected at 0.608 pCi/L. Uranium-236 was not detected in any of the local surface water samples collected in 2011. Detections of uranium and uranium isotopes in local surface water samples in 2011 remain well below the DOE derived concentration standard for the respective uranium isotope in drinking water (680 pCi/L for uranium-233/234, 720 pCi/L for uranium-235, and 750 pCi/L for uranium-238).

4.6.5 Sediment

Sediment samples are collected from the same locations upstream and downstream from PORTS where local surface water samples are collected and at the NPDES outfalls on the east and west sides of PORTS (see Figure 4.4). Samples are collected annually and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

Uranium and uranium isotopes are naturally occurring, but may also be present due to PORTS activities. Maximum detections of uranium and uranium isotopes in sediment samples were detected at locations RM-10W (the background sampling location west of PORTS) and RM-8 (Little Beaver Creek). Uranium was detected at 6.08 µg/g (RM-10W), uranium-233/234 was detected at 5.41 pCi/g (RM-8), uranium-235 was detected at 0.206 pCi/g (RM-8), uranium-236 was detected at 0.0536 pCi/g (RM-8), and uranium-238 was detected at 2.03 pCi/g (RM-10W). Uranium and uranium isotopes detected in the 2011 samples have been detected at similar levels in previous sampling events from 2002 through 2010.

Plutonium-239/240 and neptunium-237 were detected at very low activities ranging from 0.00548 to 0.0217 pCi/g in sediment samples collected from three locations on Little Beaver Creek (RM-11, RM-7, and RM-8) and one location on Big Beaver Creek (RM-13). These detections are much less than the U.S. EPA preliminary remediation goal for each radionuclide in residential soil: neptunium-237 (1 pCi/g), and plutonium-239/240 (2.59 pCi/g).

Technetium-99 is often detected in sediment samples collected at locations downstream from PORTS. In 2011, technetium-99 was detected in the sample collected from the upstream location on Big Beaver Creek (RM-5), the downstream location on Big Beaver Creek (RM-13), the downstream location on Big Run Creek (RM-3), and downstream locations on Little Beaver Creek (RM-11, RM-7, and RM-8). The

highest detection (9.58 pCi/g) was at location RM-8, a downstream location on Little Beaver Creek. These detections of technetium-99 are consistent with data from previous sampling events (2002 through 2010).

Section 4.3.9.1 provides a dose assessment to a member of the public based on detections of radionuclides at the downstream sampling location on Big Beaver Creek (RM-13). This off-site sampling location had the following levels of radionuclides detected in 2011 in the duplicate sample that would cause the highest dose to a member of the public: 0.0151 pCi/g of neptunium-237, 4.34 pCi/g of technetium-99, 1.44 pCi/g of uranium-233/234, 0.0612 pCi/g of uranium-235, 0.0118 pCi/g of uranium-236, and 0.815 pCi/g of uranium-238. The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.012 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.6 Settleable Solids

DOE collects semiannual water samples from three NPDES effluent locations (see Figure 4.5) to determine the concentration of radioactive material that is present in the sediment suspended in the water sample. The data are used to determine compliance with DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Chapter II, paragraph 3a(4). This paragraph states:

> *To prevent the buildup of radionuclide concentrations in sediments, liquid process waste streams containing radioactive material in the form of settleable solids may be released to natural waterways if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (0.2 becquerel) per gram above background level, of settleable solids for alpha-emitting radionuclides or 50 pCi (2 becquerels) per gram above background level, of settleable solids for beta-gamma-emitting radionuclides.*

DOE Order 458.1, which replaced DOE Order 5400.5 during 2011, revised the requirements for this monitoring program. PORTS implemented the revised monitoring program in 2012.

Samples were collected from the three monitoring locations (X-616, X-6619, and Outfall 015) in June and December of 2011. Settleable solids were not detected in any of the samples collected in December 2011 or in the sample collected from X-616 in June 2011.

Settleable solids were detected in the samples collected in June 2011 from X-6619 (7.4 mg/L) and Outfall 015 (6.6 mg/L). When a low concentration of settleable solids is detected in a water sample, accurate measurement of the alpha and beta activity in the settleable solids portion of the sample is not practical due to the small sample size. A DOE memo (DOE 1995) states that settleable solids of less than 40 mg/L are in *de facto* compliance with the DOE Order 5400.5 limits (5 pCi/g above background for alpha activity and 50 pCi/g above background for beta activity). Therefore, monitoring results for the settleable solids monitoring program are in compliance with the DOE Order.

4.6.7 Soil

Soil samples are collected annually from ambient air monitoring locations (see Figure 4.1) and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

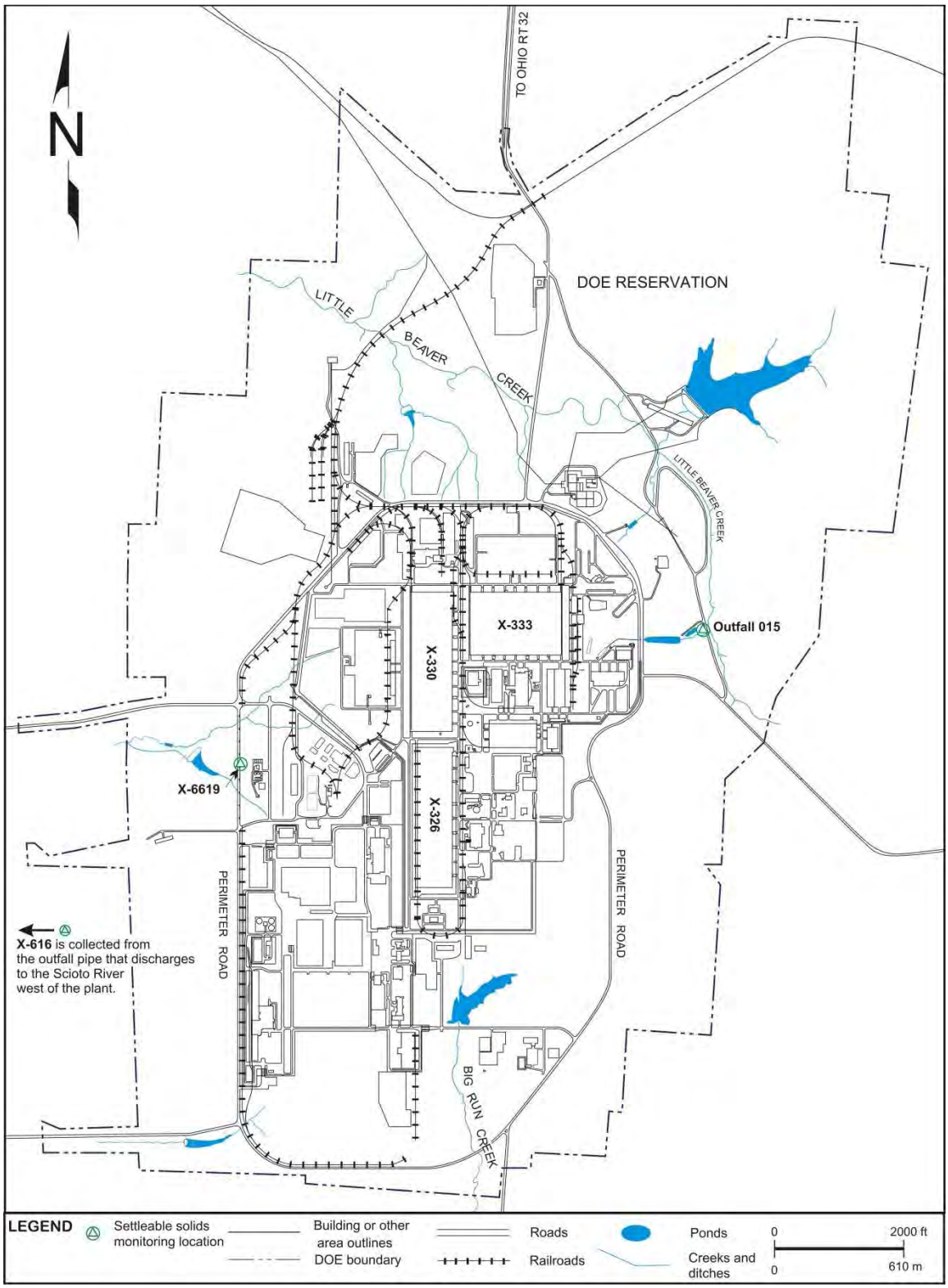

Figure 4.5. DOE settleable solids monitoring locations.

Plutonium-239/240 was detected at activities ranging from 0.0105 to 0.0144 pCi/g in the samples collected from 4 of the 15 monitoring stations. These detections are much less than the U.S. EPA preliminary remediation goal for plutonium-239/240 (2.59 pCi/g) in residential soil, and are most likely present due to atmospheric fallout from nuclear weapons testing. No other transuranics were detected in any of the soil samples collected during 2011.

Technetium-99 and uranium-236 were not detected in the soil samples collected during 2011. Uranium, uranium-233/234, uranium-235, and uranium-238 were detected at most of the sampling locations. Uranium and uranium isotopes are usually detected at similar levels at all the soil sampling locations, including the background location (A37), which suggests that the uranium detected in these samples is due to naturally-occurring uranium.

Section 4.3.9.2 provides a dose assessment based on the detections of plutonium-239/240 (0.0105 pCi/g), uranium-233/234 (0.822 pCi/g), uranium-235 (0.0394 pCi/g), and uranium-238 (0.891 pCi/g) in soil at the off-site ambient air station with the detections of radionuclides that could cause the highest dose to a member of the public (station A41 at Zahns Corner). The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.036 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.8 Vegetation

To assess the uptake of radionuclides into plant material, vegetation samples are collected in the same areas where soil samples are collected at the ambient air monitoring stations (see Figure 4.1). Samples are collected annually and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

With the exception of uranium-233/234, no radionuclides were detected in vegetation samples collected in 2011. Uranium-233/234 was detected at 0.00785 pCi/g in the sample collected from station A41 (Zahns Corner). Uranium isotopes are detected occasionally in vegetation samples, and have been detected at similar levels in previous sampling (2002 through 2010). Section 4.3.9.3 provides a dose assessment for a member of the public based on consumption of beef cattle that would eat grass contaminated with radionuclides. The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.002 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.9 Biological Monitoring

The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* requires biological monitoring to assess the uptake of radionuclides into local biota (deer, fish, crops, milk, and eggs).

4.6.9.1 Deer

Samples of liver, kidney, and muscle from deer killed on site in motor vehicle collisions were collected in January and December of 2011. The samples were analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238).

No transuranics or technetium-99 were detected in the deer samples collected during 2011. Uranium-233/234 was detected at levels ranging from 0.01521 to 0.0251 pCi/g in each of the samples collected from the deer killed in January 2011.

Section 4.3.9.5 provides a dose assessment to a member of the public based on consumption of venison containing uranium-233/234 at 0.01786 pCi/g (the level of uranium-233/234 detected in the muscle sample). The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.19 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.9.2 Fish

In 2011, samples from fish caught at downstream locations on the Scioto River (RW-1), Big Beaver Creek (RW-13), and Little Beaver Creek (RW-8) as well as the upstream locations on the Scioto River (RW-6) and Big Beaver Creek (RW-15) were analyzed for radionuclides. These radionuclides were transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238). No radionuclides were detected in the fish samples collected during 2011.

4.6.9.3 Crops

In 2011, crop samples, including peppers, corn, tomatoes, cucumbers, and squash, were collected from five off-site locations near PORTS. Individual vegetables from each location were combined to make one sample from each location, called a composite sample. The composite sample from each location was analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238).

Americium-241 was detected at 0.0125 pCi/g in the sample collected from one of the off-site locations. Uranium (0.0289 µg/g), uranium-233/234 (0.00697 pCi/g) and uranium-238 (0.00947 pCi/g) were detected in the crop sample from a different off-site location. Section 4.3.9.4 provides a dose assessment to a member of the public based on consumption of vegetables containing radionuclides that would cause the highest dose to a member of the public (americium-241 at 0.0125 pCi/g). The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.009 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.9.4 Milk and eggs

Samples were collected in 2011 of milk produced by a dairy near Waverly and eggs from a farm near Lucasville. Each sample was analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238). No radionuclides were detected in the milk and egg samples collected during 2011.

4.7 RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

In 2011, no DOE property (equipment, excess materials, etc.) was released to the public that contained radioactive material that exceeded DOE release limits. The release limits are established in accordance with DOE Order 5400.5, which was replaced by DOE Order 458.1 during 2011, and Title 10 of the *Code of Federal Regulations*, Part 835.

In 2011, BWCS began shipment of hydrogen fluoride produced by the DUF_6 Conversion Facility, which converts DUF_6 into uranium oxide and hydrogen fluoride. Each shipment must meet the release limit of less than 3 picocuries/milliliter (pCi/mL) of total uranium activity. Just over 39,000 gallons of hydrogen fluoride were shipped off site during 2011. The average total uranium activity of all the shipments was 0.01 pCi/mL.

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5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

5.1 SUMMARY

Non-radiological environmental monitoring at PORTS includes air, water, sediment, and fish. Monitoring of non-radiological parameters is required by state and federal regulations and/or permits, but is also performed to reduce public concerns about plant operations. Permits for NPDES outfalls and numerous air emission sources that were associated with the gaseous diffusion plant were transferred from USEC Government Services to FBP during 2011. Non-radiological data collected in 2011 are similar to data collected in previous years.

5.2 INTRODUCTION

Environmental monitoring programs at PORTS usually monitor both radiological and non-radiological constituents that could be released to the environment as a result of PORTS activities. The radiological components of each monitoring program were discussed in the previous chapter. The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* specifies non-radiological monitoring requirements for ambient air, surface water, sediment, and fish. Non-radiological data are not collected for all sampling locations or all monitoring programs.

Environmental permits issued by Ohio EPA to DOE contractors or USEC, Inc. specify discharge limitations, monitoring requirements, and/or reporting requirements for air emissions and water discharges. USEC, Inc. data for NPDES water discharges are included in this section to provide a more complete picture of environmental monitoring at PORTS. USEC, Inc. information for discharges to water is provided for informational purposes only; DOE cannot ensure the quality of USEC, Inc. data. Data from the following environmental monitoring programs are included in this chapter:

- air
- surface water
- sediment
- biota (fish).

DOE also conducts an extensive groundwater monitoring program at PORTS that includes both radiological and non-radiological constituents. Chapter 6 provides information on the groundwater monitoring program, associated surface water monitoring, and water supply monitoring.

5.3 AIR

Permitted air emission sources at PORTS emit non-radiological air pollutants. In addition, the DOE ambient air monitoring program measures fluoride at monitoring stations within PORTS boundaries and in the surrounding area.

5.3.1 Airborne Discharges

In 2011, DOE contractor FBP became responsible for numerous air emission sources associated with the former gaseous diffusion production facilities and support facilities (the sources that were formerly the responsibility of USEC Government Services). These sources, which include the boilers at the X-600 Steam Plant, emit more than 100 tons per year of non-radiological air pollutants specified by Ohio EPA, which caused DOE to become a major source of air pollutants as defined in Title 40 of the *Code of Federal Regulations*, Part 70.

Facilities that are major sources of air pollutants are required to submit an annual report called the Ohio EPA Fee Emissions Report to report emissions of selected non-radiological air pollutants. Because FBP

became a major source of air pollutants during 2011, FBP was required to submit this annual report instead of the biennial report that FBP completed in previous years when air emissions were less than 100 tons per year. FBP reported the following emissions of non-radiological air pollutants for 2011 in the Ohio EPA Fee Emissions Report: 0.155 ton of lead, 54.6 tons of particulate matter, 5.58 tons of organic compounds, 1495 tons of sulfur dioxide, and 176 tons of nitrogen oxides. These emissions are associated primarily with the boilers at the X-600 Steam Plant, which provide steam for PORTS, the X-670A Cooling Tower, and emergency generators.

The DUF_6 Conversion Facility emits only a small quantity of non-radiological air pollutants. Because of these small emissions, Ohio EPA requires a Fee Emissions Report only once every two years. BWCS reported less than 10 tons/year of specified non-radiological air pollutants for 2011 (the report requires reporting in increments of emissions: zero, less than 10 tons, 10-50 tons, more than 50 tons, and more than 100 tons). BWCS reported 3 lbs of hydrogen fluoride emitted to the air in the Toxic Chemical Release Inventory for 2011 (see Chapter 2, Section 2.3.1.2).

Another potential air pollutant present at PORTS is asbestos released by D&D of plant facilities. Asbestos emissions are controlled by a system of work practices. The amount of asbestos removed and disposed is reported to Ohio EPA. In 2011, 251.6 tons (503,164 lbs) of material contaminated with asbestos were shipped from PORTS.

5.3.2 Ambient Air Monitoring

In addition to the radionuclides discussed in Chapter 4, DOE ambient air monitoring stations also measure fluoride. Fluoride detected at the ambient air monitoring stations could be present due to background concentrations (fluoride occurs naturally in the environment), activities associated with the former gaseous diffusion process, and operation of the DUF_6 Conversion Facility.

In 2011, samples for fluoride were collected weekly from 14 or 15 ambient air monitoring stations in and around PORTS (see Chapter 4, Figure 4.1), including a background ambient air monitoring station (A37) located approximately 13 miles southwest of the plant. Beginning in May 2011, the monitoring station in Zahns Corner (A41) was removed due to road construction. The station was not replaced by the end of 2011.

In 2011, fluoride was not detected in more than half of the samples collected for the ambient air monitoring program. The average ambient concentration of fluoride measured in samples collected at background station A37 was 0.026 microgram per cubic meter ($\mu g/m^3$). Average ambient concentrations of fluoride measured at the stations around PORTS ranged from 0.021 $\mu g/m^3$ at station A6 in Piketon to 0.042 $\mu g/m^3$ at station A40 (on site near the X-100 Administration Building). There is no standard for fluoride in ambient air. The data indicate that ambient concentrations of fluoride at background locations are not appreciably different from concentrations near PORTS.

5.4 WATER

Surface water and groundwater are monitored at PORTS. Groundwater monitoring is discussed in Chapter 6, along with surface water monitoring conducted as part of the groundwater monitoring program. Non-radiological surface water monitoring primarily consists of sampling water discharges associated with the FBP, BWCS, and USEC, Inc. NPDES-permitted outfalls. PCBs are monitored in surface water downstream from the cylinder storage yards.

5.4.1 Water Discharges (NPDES Outfalls)

In 2011, DOE contractors (LPP, FBP, BWCS, and UDS) were responsible for NPDES outfalls at PORTS. FBP and BWCS became responsible for outfalls formerly operated by LPP and UDS on March 29, 2011. USEC Government Services NPDES outfalls were transferred to the FBP NPDES permit on September 1,

2011. USEC, Inc. retained responsibility for three outfalls. This section describes non-radiological discharges from these outfalls during 2011.

5.4.1.1 FBP NPDES outfalls

As of the end of 2011, FBP was responsible for 18 discharge points, or outfalls, through which water is discharged from the site. Nine outfalls discharge directly to surface water, and six outfalls discharge to another outfall before leaving the site. FBP also monitors three additional locations that are not discharge points. Chapter 4, Section 4.3.5.1, provides a brief description of each FBP outfall or monitoring point and provides a site diagram showing each FBP NPDES outfall (see Chapter 4, Figure 4.2).

Ohio EPA selects the chemical parameters that must be monitored at each outfall based on the chemical characteristics of the water that flows into the outfall and sets discharge limitations for some of these parameters. For example, some of the FBP outfalls discharge water from the groundwater treatment facilities; therefore, the outfalls are monitored for selected volatile organic compounds (*trans*-1,2-dichloroethene and/or TCE) because the groundwater treatment facilities treat water contaminated with volatile organics. Chemicals and water quality parameters monitored at each FBP outfall are as follows:

- FBP NPDES Outfall 001 (X-230J7 East Holding Pond) – cadmium, chlorine, dissolved solids, fluoride, oil and grease, pH, silver, suspended solids, and zinc.
- FBP NPDES Outfall 002 (X-230K South Holding Pond) – cadmium, fluoride, mercury, oil and grease, pH, silver, suspended solids, and thallium.
- FBP NPDES Outfall 003 (X-6619 Sewage Treatment Plant) – acute toxicity, ammonia-nitrogen, biochemical oxygen demand, chlorine (May-October only), copper, fecal coliform (May-October only), mercury, nitrite + nitrate, oil and grease, pH, silver, suspended solids, and zinc.
- FBP NPDES Outfall 004 (Cooling Tower Blowdown) – acute toxicity, chlorine, copper, dissolved solids, mercury, oil and grease, pH, suspended solids, and zinc.
- FBP NPDES Outfall 005 (X-611B Lime Sludge Lagoon) – pH and suspended solids.
- FBP NPDES Outfall 009 (X-230L North Holding Pond) – cadmium, fluoride, oil and grease, pH, suspended solids, and zinc.
- FBP NPDES Outfall 010 (X-230J5 Northwest Holding Pond) – cadmium, mercury, oil and grease, pH, suspended solids, and zinc.
- FBP NPDES Outfall 011 (X-230J6 Northeast Holding Pond) – cadmium, chlorine, copper, fluoride, oil and grease, pH, suspended solids, and zinc.
- FBP NPDES Outfall 015 (X-624 Groundwater Treatment Facility) – total PCBs, pH, and TCE.
- FBP NPDES Outfall 602 (X-621 Coal Pile Runoff Treatment Facility) – iron, manganese, pH, and suspended solids.
- FBP NPDES Outfall 604 (X-700 Biodenitrification Facility) – copper, iron, nickel, nitrate-nitrogen, pH, and zinc.

- FBP NPDES Outfall 605 (X-705 Decontamination Microfiltration System) – ammonia-nitrogen, chromium, hexavalent chromium, copper, iron, Kjeldahl nitrogen, nickel, nitrate-nitrogen, nitrite-nitrogen, oil and grease, pH, sulfate, suspended solids, TCE, and zinc.

- FBP NPDES Outfall 608 (X-622 Groundwater Treatment Facility) – TCE, pH, and *trans*-1,2-dichloroethene.

- FBP NPDES Outfall 610 (X-623 Groundwater Treatment Facility) – TCE, pH, and *trans*-1,2-dichloroethene.

- FBP NPDES Outfall 611 (X-627 Groundwater Treatment Facility) – pH and TCE.

The FBP NPDES Permit also identifies additional monitoring points that are not discharge points as described in the previous paragraphs. FBP NPDES Station Number 801 is a background monitoring location on the Scioto River upstream from FBP NPDES Outfalls 003 and 004. Samples are collected from this monitoring point to measure toxicity to minnows and another aquatic organism, *Ceriodaphnia*.

FBP NPDES Station Number 902 is a monitoring location on Little Beaver Creek downstream from FBP NPDES Outfall 001. FBP NPDES Station Number 903 is a monitoring location on Big Run Creek downstream from FBP NPDES Outfall 002. Water temperature is the only parameter measured at each of these monitoring points.

The monitoring data detailed in the previous paragraphs are submitted to Ohio EPA in a monthly operating report. In 2011, two of the discharge limitations at the FBP NPDES outfalls were exceeded. In January 2011, the maximum daily concentration limit for 5-day carbonaceous biochemical oxygen demand (15 mg/L) was exceeded at Outfall 003 (the X-6619 Sewage Treatment Plant) with a sample result of 22 mg/L. This exceedence was the responsibility of USEC Government Services because it occurred prior to the outfall's transfer to FBP. The exceedence was caused by a sudden increase in solids in the aeration basin that is a part of the sewage treatment plant due to a problem with the sewage lift station. The lift station was repaired, and no additional exceedences occurred during 2011.

In November 2011, the maximum limit for acute toxicity for fathead minnows (*Pimephales promelas*) (1 acute toxicity unit [TUa]) was exceeded at Outfall 004 (Cooling Tower Blowdown) with a sample result of 1.41 TUa. The toxicity resulted from the chemicals used to treat the cooling water to inhibit corrosion, scale, and algae. Adjustments to the treatment chemicals were implemented to correct the source of the toxicity. In 2011, the overall FBP NPDES compliance rate with the NPDES permit was 99%.

5.4.1.2 BWCS NPDES outfall

Beginning on March 29, 2011, BWCS assumed responsibility for the NPDES permit for the discharge of process wastewaters from the DUF_6 Conversion Facility to the West Ditch, which flows to the X-230J5 Northwest Holding Pond (FBP NPDES Outfall 010) and then to the Scioto River. Chapter 4, Figure 4.2 shows the location of the BWCS NPDES outfall. Water discharged from BWCS Outfall 001 is monitored for the following chemicals and water quality parameters: temperature, biochemical oxygen demand, pH, suspended solids, oil and grease, ammonia-nitrogen, phosphorus, chlorine, and dissolved solids.

The monitoring data are submitted to Ohio EPA in a monthly operating report. Although the outfall is permitted for the discharge of process wastewater, the only water released through BWCS NPDES Outfall 001 during 2011 was due to precipitation run-off. Beginning in November of 2008, any process wastewater from the DUF_6 Conversion Facility is taken to the X-6619 Sewage Treatment Plant for treatment prior to discharge through FBP NPDES Outfall 003.

Discharge limitations for total suspended solids (daily concentration, average monthly concentration, daily loading limit, and/or average monthly loading limit) were exceeded 14 times during 2011. The exceedences were generally due to precipitation and the accumulation of sediment within the storm sewers around the DUF_6 Conversion Facility. Rainwater runoff often causes an increase in concentrations of suspended solids in surface water. Many NPDES permits, including the FBP and USEC, Inc. NPDES permits, include a provision that the discharge limitations for suspended solids do not apply if flow increases due to precipitation; however, the BWCS NPDES permit does not include this provision.

Discharge limitations for dissolved solids (daily concentration and daily loading) were exceeded four times during 2011. Two of the exceedences appeared to be related to spillage of an ice melt product (calcium chloride). The spillage was cleaned up and the ice melt was moved into the warehouse. Rainfall appeared to cause the two additional exceedences of the discharge limitations for dissolved solids.

The minimum discharge limitation for pH was not met seven times during 2011. The pH of the discharge, which ranged from 6.11 to 6.44 standard units (SU), was slightly less than the permit limit of 6.5 SU. Upon investigation, it appeared that the low pH measurements were caused by malfunctioning pH meter probes. The probes were replaced and no additional exceedences were measured.

Only precipitation run-off was discharged through the BWCS outfall during 2011. The overall BWCS NPDES compliance rate in 2011 was 96%.

In 2011, Ohio EPA and BWCS began discussions to eliminate the BWCS NPDES permit because process effluents are not discharged through the outfall. Precipitation runoff from the BWCS outfall flows to the X-230J5 Northwest Holding Pond and is monitored by FBP NPDES Outfall 010. These discussions continued in 2012.

5.4.1.3 USEC, Inc. NPDES outfalls

At the end of 2011, USEC, Inc. was responsible for 3 NPDES outfalls through which water was discharged from the site (see Chapter 4, Figure 4.2). Two outfalls discharge directly to surface water, and one outfall discharges to FBP NPDES Outfall 003 before leaving the site. Chapter 4, Section 4.3.5.2, provides a brief description of each USEC, Inc. NPDES outfall. Chemicals and water quality parameters monitored at each USEC, Inc. outfall are as follows:

- USEC NPDES Outfall 012 (X-2230M Southwest Holding Pond) – chlorine, iron, oil and grease, pH, suspended solids, total PCBs, and TCE.

- USEC NPDES Outfall 013 (X-2230N West Holding Pond) – chlorine, oil and grease, pH, suspended solids, and total PCBs.

- USEC NPDES Outfall 613 (X-6002A Recirculating Hot Water Plant particle separator) – chlorine, pH, and suspended solids.

The monitoring data are submitted to Ohio EPA in a monthly operating report. No exceedences of permit limitations at USEC, Inc. Outfalls 012, 013 and 613 occurred during 2011; therefore, the overall USEC, Inc. compliance rate with the NPDES permit was 100%.

5.4.2 Surface Water Monitoring Associated with Cylinder Storage Yards

Surface water samples (filtered and unfiltered) are collected quarterly from four locations in the drainage basins downstream from the X-745C, X-745E, and X-745G Cylinder Storage Yards (UDS X01, RM-8, UDS X02, and RM-10 – see Chapter 4, Figure 4.2) and analyzed for PCBs. PCBs were not detected in

any of the surface water samples (filtered or unfiltered) collected during 2011. Section 5.5.2 presents the results for sediment samples collected as part of this program.

5.5 SEDIMENT

In 2011, sediment monitoring at PORTS included local streams and the Scioto River upstream and downstream from PORTS and drainage basins downstream from the DUF_6 cylinder storage yards.

5.5.1 Local Sediment Monitoring

Sediment samples are collected annually at the same locations upstream and downstream from PORTS where local surface water samples are collected and at the NPDES outfalls on the east and west sides of PORTS (see Chapter 4, Figure 4.4). In 2011, samples were analyzed for 20 metals and PCBs, in addition to the radiological parameters discussed in Chapter 4.

PCBs, primarily PCB-1260 and PCB-1254, were detected in sediment samples collected downstream from PORTS. PCBs were detected in samples collected from Little Beaver Creek at the confluence from the X-230L North Holding Pond (RM-8), Little Beaver Creek west of the PORTS boundary (RM-7), Little Beaver Creek at the discharge point from the X-230J7 Pond (RM-11), downstream Big Beaver Creek (RM-13), downstream Big Run Creek at the PORTS boundary (RM-3), downstream Big Run Creek at Wakefield (RM-2), and the West Drainage Ditch near Outfalls 010 and 013 (RM-10). PCBs were also detected in the upstream and downstream Scioto River sampling locations (RM-6 and RM-1, respectively).

Two of the detections of PCBs in sediment around PORTS were more than the risk-based concentration of PCBs for protection of human health developed by U.S. EPA Region 9 and utilized by Ohio EPA: 220 micrograms per kilogram (µg/kg) or parts per billion (ppb). These detections were in sediment samples collected on site in Little Beaver Creek at monitoring locations RM-11 (258 µg/kg) and RM-8 (303 µg/kg). Investigation and remediation of PCBs in soil and sediment at PORTS will be addressed as part of the environmental remediation of PORTS.

The results of metals sampling conducted in 2011 indicate that no appreciable differences are evident in the concentrations of metals present in sediment samples taken upstream from PORTS, at background sampling locations, and downstream from PORTS. Metals occur naturally in the environment. Accordingly, the metals detected in the samples most likely did not result from activities at PORTS.

5.5.2 Sediment Monitoring Associated with Cylinder Storage Yards

Sediment samples are collected quarterly from four locations in the drainage basins downstream from the X-745C, X-745E, and X-745G Cylinder Storage Yards (UDS X01, RM-8, UDS X02, and RM-10) and analyzed for PCBs. These locations are on site at PORTS and not accessible to the public.

In 2011, total PCBs (PCB-1254 and/or PCB-1260) were detected in at least one of the sediment samples collected from each location at concentrations up to 690 µg/kg (ppb). These concentrations are below the 1 ppm (1000 ppb) reference value set forth in the U.S. EPA Region 5 *TSCA Approval for Storage for Disposal of PCB Bulk Product (Mixed) Waste,* which applies to the storage of DUF_6 cylinders at PORTS that may have paint on the exterior of the cylinders that contains more than 50 ppm PCBs. Only one sample (the first quarter sample from location RM-8) contained total PCBs above the risk-based concentration of PCBs for protection of human health developed by U.S. EPA Region 9 and utilized by Ohio EPA: 220 µg/kg (ppb).

Section 5.4.2 presents the results for surface water samples collected as part of this program.

5.6 BIOLOGICAL MONITORING - FISH

In 2011, fish were collected from upstream locations on Big Beaver Creek (RW-15) and the Scioto River (RW-6) as well as downstream sampling locations on Little Beaver Creek (RW-8), Big Beaver Creek (RW-13), and the Scioto River (RW-1) as part of the routine fish monitoring program at PORTS. Chapter 4, Figure 4.4, shows the surface water monitoring locations where the fish were caught.

Fish samples were analyzed for PCBs, in addition to the radiological parameters discussed in Chapter 4. Fish samples collected for this program included only the fish fillet, that is, only the portion of the fish that would be eaten by a person. Fish samples collected from the Scioto River consisted of sheephead (RW-6) and bass (RW-1). The samples collected from Big Beaver Creek were a mixture of catfish and bass (RW-15) and sheephead (RW-13). The sample collected from Little Beaver Creek (RW-8) was small mouth bass.

PCBs (PCB-1254) were detected only in the duplicate sample of small mouth bass collected from on-site sampling location RW-8 at an estimated concentration of 347 µg/kg. This detection was compared to the Ohio Fish Consumption Advisory Chemical Limits provided in the *State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program* (Ohio EPA 2008). These limits are set for the following consumption rates: unrestricted, 1/week, 1/month, 6/year, and do not eat. The detection is above the 1/week maximum limit (220 µg/kg) and below the 1/month maximum limit (1000 µg/kg).

The Ohio Sport Fish Consumption Advisory, available from Ohio EPA, Division of Surface Water, advises the public on consumption limits for sport fish caught from all water bodies in Ohio and should be consulted before eating any fish caught in Ohio waters.

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6. GROUNDWATER PROGRAMS

6.1 SUMMARY

Groundwater monitoring at PORTS is required by a combination of state and federal regulations, legal agreements with Ohio EPA and U.S. EPA, and DOE Orders. More than 400 monitoring wells are used to track the flow of groundwater and to identify and measure groundwater contaminants. Groundwater programs also include on-site surface water monitoring and water supply monitoring.

Concentrations of TCE continued to decrease in the X-749/X-120/PK Landfill area during 2011. TCE was detected at an estimated concentration of 0.25 µg/L in the first quarter sample collected from off-site monitoring well WP-03G. No TCE or other volatile organic compounds were detected in any of the seven off-site monitoring wells sampled in the second, third, and/or fourth quarters of 2011. TCE has not been detected in groundwater beyond the DOE property boundary at concentrations that exceed the Ohio EPA drinking water standard of 5 µg/L.

In the third quarter of 2011, TCE was detected at concentrations above 5 µg/L (the preliminary remediation goal and definition of the groundwater plume perimeter) in wells that are typically not within the groundwater plumes at the X-749/X-120/PK Landfill, the Quadrant II Groundwater Investigative Area, and the X-701B Holding Pond. All of these wells were sampled in the fourth quarter of 2011, and concentrations of TCE in the wells (if detected) returned to less than 5 µg/L. These detections may be related to the higher than normal amounts of rain that occurred in 2011.

In 2011, the analytical laboratory that analyzed the environmental samples discussed in this chapter for radionuclides reported numerous small detections of americium-241 and plutonium-239/240, which are transuranic radionuclides. Although americium-241 and plutonium-239/240 are occasionally detected in PORTS environmental samples, there were more detections in 2011 than in previous years. Most of the detected results were above the minimum detectable activity but less than the laboratory reporting limit. Americium-241 and plutonium-239/240 are present in the environment at very small levels due to atmospheric fallout from nuclear weapons testing. The low levels of americium-241 and plutonium-239/240 detected in the samples may be present due to this fallout. Additionally, radionuclides detected at low levels near the minimum detectable activity may be false positives due to the statistical methodology used in analysis of radionuclides. These detections of americium-241 and plutonium-239/240 were less than the PORTS preliminary remediation goals for americium-241 and plutonium-239/240 in groundwater: 0.49 pCi/L and 0.51 pCi/L, respectively.

The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* provides further details on the groundwater plumes at PORTS, specific monitoring well identifications, and analytical results for monitoring wells. This document and other documents referenced in this chapter are available in the PORTS Environmental Information Center.

6.2 INTRODUCTION

This chapter provides an overview of groundwater monitoring at PORTS and the results of the groundwater monitoring program for 2011. The following sections provide an overview of the PORTS groundwater monitoring program followed by a review of the history and 2011 monitoring data for each area. Chapter 3, Section 3.2 provides additional information about the remedial actions implemented at a number of the areas discussed in this chapter to reduce or eliminate groundwater contamination.

This chapter also includes information on the groundwater treatment facilities at PORTS. These facilities receive contaminated groundwater from the groundwater monitoring areas and treat the water prior to discharge through the permitted FBP NPDES outfalls.

6.3 OVERVIEW OF GROUNDWATER MONITORING AT PORTS

This section provides an overview of the regulatory basis for groundwater monitoring at PORTS, groundwater use and geology, and monitoring activities and issues.

6.3.1 Regulatory Programs

Groundwater monitoring at PORTS was initiated in the 1980s. Groundwater monitoring has been conducted in response to state and/or federal regulations, regulatory documents prepared by DOE, agreements between DOE and Ohio EPA or U.S. EPA, and DOE Orders.

Because of the numerous regulatory programs applicable to groundwater monitoring at PORTS, an *Integrated Groundwater Monitoring Plan* was developed to address all groundwater monitoring requirements for PORTS. The initial plan was approved by Ohio EPA and implemented at PORTS starting in April 1999. The *Integrated Groundwater Monitoring Plan* is periodically revised by DOE and approved by Ohio EPA. An annual groundwater report is submitted to Ohio EPA in accordance with the *Integrated Groundwater Monitoring Plan*. Groundwater monitoring in 2011 was completed in accordance with the *Integrated Groundwater Monitoring Plan* dated September 2010.

Groundwater monitoring is also conducted to meet DOE Order requirements. Exit pathway monitoring assesses the effect of PORTS on off-site groundwater quality. DOE Orders are the basis for radiological monitoring of groundwater at PORTS.

6.3.2 Groundwater Use and Geology

Two water-bearing zones are present beneath PORTS: the Gallia and Berea formations. The Gallia is the uppermost water-bearing zone and contains most of the groundwater contamination at PORTS. The Berea is deeper than the Gallia and is usually separated from the Gallia by the Sunbury shale, which acts as a barrier to impede groundwater flow between the Gallia and Berea formations. Additional information about site hydrogeology is available in the PORTS Environmental Information Center.

Groundwater directly beneath PORTS is not used as a domestic, municipal, or industrial water supply, and contaminants in the groundwater beneath PORTS do not affect the quality of the water in the Scioto River Valley buried aquifer. PORTS is the largest industrial user of water in the vicinity and obtains water from two water supply well fields west of PORTS in the Scioto River Valley buried aquifer. DOE has filed a deed notification at the Pike County Auditor's Office that restricts the use of groundwater beneath the PORTS site.

6.3.3. Monitoring Activities

Groundwater monitoring at PORTS includes several activities. Samples of water are collected from groundwater monitoring wells and analyzed to obtain information about contaminants and naturally-occurring compounds in the groundwater. Monitoring wells are also used to obtain other information about groundwater. When the level of water, or groundwater elevation, is measured in a number of wells over a short period of time, the groundwater elevations, combined with information about the subsurface soil, can be used to estimate the rate and direction of groundwater flow. The rate and direction of groundwater flow can be used to predict the movement of contaminants in the groundwater and to develop ways to control or remediate groundwater contamination.

6.4 GROUNDWATER MONITORING AREAS

The *Integrated Groundwater Monitoring Plan* requires groundwater monitoring of 12 areas within the quadrants of the site designated by the RCRA Corrective Action Program. These areas (see Figure 6.1) are:

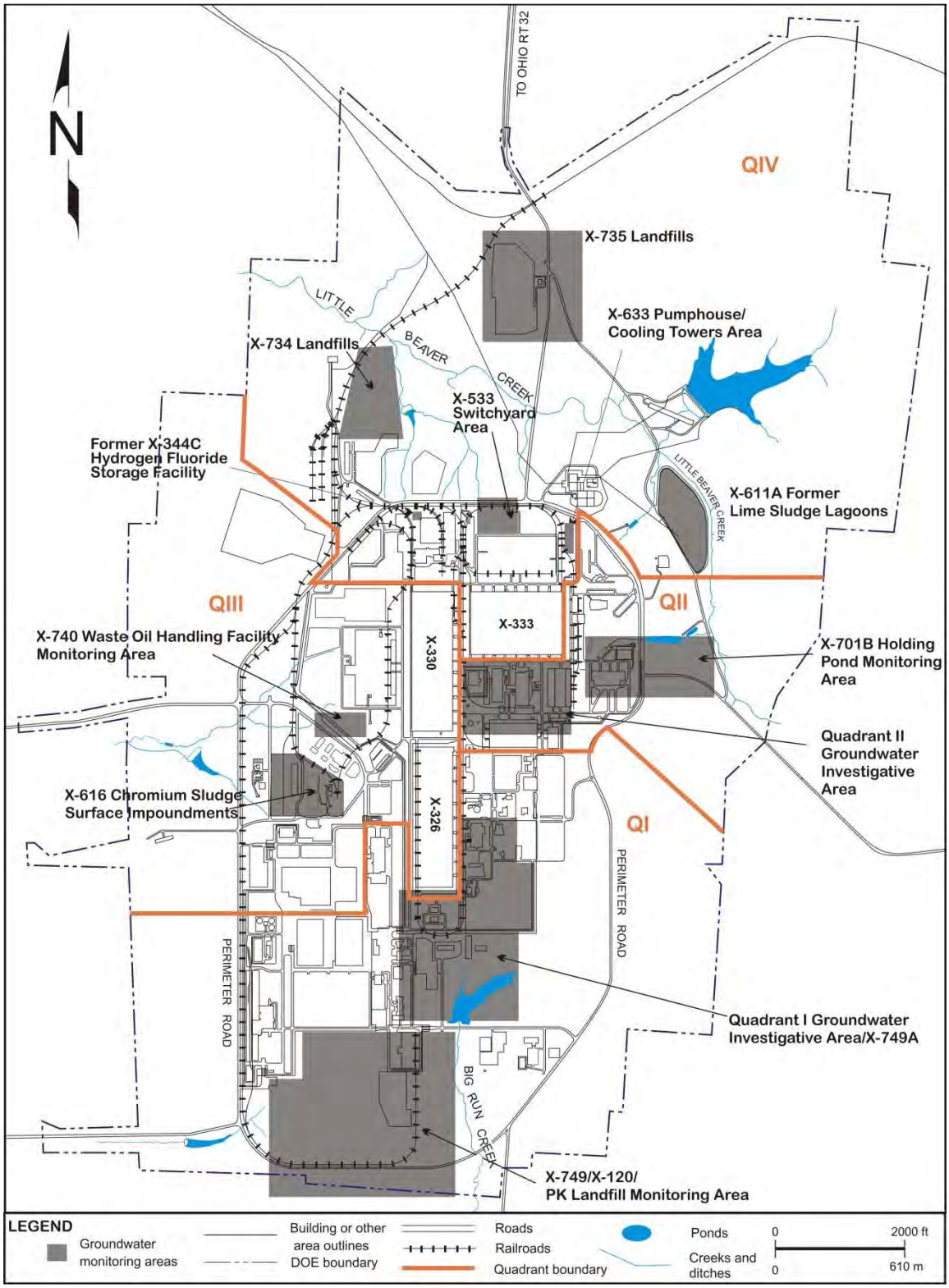

Figure 6.1. Groundwater monitoring areas at PORTS.

- Quadrant I
  - X-749/X-120/PK Landfill,
  - Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility,
- Quadrant II
  - Quadrant II Groundwater Investigative Area,
  - X-701B Holding Pond,
  - X-633 Pumphouse/Cooling Towers Area,
- Quadrant III
  - X-616 Chromium Sludge Surface Impoundments,
  - X-740 Waste Oil Handling Facility,
- Quadrant IV
  - X-611A Former Lime Sludge Lagoons,
  - X-735 Landfills,
  - X-734 Landfills,
  - X-533 Switchyard Area, and
  - Former X-344C Hydrogen Fluoride Storage Building.

The *Integrated Groundwater Monitoring Plan* also contains requirements for 1) surface water monitoring in creeks and drainage ditches at PORTS that receive groundwater discharge, and 2) water supply monitoring.

In general, samples are collected from wells (or surface water locations) at each area listed above and are analyzed for metals, volatile organic compounds, and/or radionuclides. Table 6.1 lists the analytical requirements for each groundwater monitoring area and other monitoring programs described in this chapter. Constituents detected in the groundwater are then compared to standards called preliminary remediation goals to assess the potential for each constituent to affect human health and the environment.

Five areas of groundwater contamination, commonly called groundwater plumes, have been identified at PORTS. Groundwater contamination consists of volatile organic compounds (primarily TCE) and radionuclides such as technetium-99. The areas that contain groundwater plumes are X-749/X-120/PK Landfill, Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility, Quadrant II Groundwater Investigative Area, X-701B Holding Pond, and X-740 Waste Oil Handling Facility. Other areas are monitored to evaluate groundwater contaminated with metals, to ensure past uses of the area (such as a landfill) have not caused groundwater contamination, or to monitor remediation that has taken place in the area.

The following sections describe the history of each groundwater monitoring area and groundwater monitoring results for each area in 2011.

6.4.1 X-749 Contaminated Materials Disposal Facility/X-120 Old Training Facility/PK Landfill

In the southernmost portion of PORTS in Quadrant I, groundwater concerns focus on three contaminant sources: X-749 Contaminated Materials Disposal Facility, X-120 Old Training Facility, and PK Landfill.

6.4.1.1 X-749 Contaminated Materials Disposal Facility

The X-749 Contaminated Materials Disposal Facility is a landfill located in the south-central section of the facility in Quadrant I. The landfill covers approximately 7.5 acres and was built in an area of highest elevation within the southern half of PORTS. The landfill operated from 1955 to 1990, during which time buried wastes were generally contained in metal drums or other containers compatible with the waste.

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS in 2011

Monitoring Area or Program	Analytes	
X-749/X-120/PK Landfill[a,b]		
X-749/X-120 plume	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
PK Landfill	volatile organic compounds[c]	total metals[d]: Be, Cd, Cr, Mn, Ni
Quadrant I Groundwater Investigative Area[a,b]		
X-231B plume	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
X-749A Classified Materials Disposal Facility	volatile organic compounds[e] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[c] alkalinity chloride sulfate chemical oxygen demand total dissolved solids	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn nitrite nitrate ammonia
Quadrant II Groundwater Investigative Area[a,b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
X-701B Holding Pond[a,b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]	alkalinity chloride sulfate total dissolved solids total metals[d]: Be, Cd, Cr, Mn, Ni
X-633 Pumphouse/Cooling Towers Area	total metals[d]: Cr	
X-616 Chromium Sludge Surface Impoundments	volatile organic compounds[c]	total metals[d]: Be, Cd, Cr, Mn, Ni
X-740 Waste Oil Handling Facility	volatile organic compounds[c]	

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS – 2011 (continued)

Monitoring Area or Program	Analytes	
X-611A Former Lime Sludge Lagoons	total metals[d]: Be, Cr	
X-735 Landfills	volatile organic compounds[e] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate chemical oxygen demand	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Hg, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn nitrite nitrate ammonia total dissolved solids
X-734 Landfills	volatile organic compounds[c] technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate chemical oxygen demand	total metals[d]: Be, Cd, Cr, Mn, Ni nitrite nitrate ammonia total dissolved solids
X-533 Switchyard Area	total metals[d]: Cd, Ni	
Former X-344C Hydrogen Fluoride Storage Building	volatile organic compounds[c]	
Surface Water	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]
Water Supply	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]
Exit Pathway[b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]

[a]Selected well(s) in this area are sampled once every two years for a comprehensive list of more than 200 potential contaminants (Title 40, Code of Federal Regulations, Part 264 Appendix IX – Appendix to Ohio Administrative Code Rule 3745-54-98).
[b]Not all wells in this area are analyzed for all listed analytes.
[c]Acetone, benzene, bromodichloromethane, bromoform, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, dibromochloromethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, bromomethane, chloromethane, methylene chloride, 2-butanone (methyl ethyl ketone), 4-methyl-2-pentanone (methyl isobutyl ketone), 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, TCE, trichlorofluoromethane (CFC-11), vinyl chloride, xylenes (M+P xylenes).
[d]Appendix C lists the symbols for metals and transuranic radionuclides.
[e]Volatile organic compounds listed in footnote c plus: acrylonitrile, bromochloromethane, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, trans-1,4-dichloro-2-butene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 2-hexanone (methyl butyl ketone), dibromomethane, iodomethane, styrene, 1,1,1,2-tetrachloroethane, 1,2,3-trichloropropane, and vinyl acetate.

The northern portion of the X-749 Landfill contains waste contaminated with industrial solvents, waste oils from plant compressors and pumps, sludges classified as hazardous, and low-level radioactive materials. The southern portion of the X-749 Landfill contains non-hazardous, low-level radioactive scrap materials.

The initial closure of the X-749 Landfill in 1992 included installation of 1) a multimedia cap, 2) a barrier wall along the north side and northwest corner of X-749 Landfill, and 3) subsurface groundwater drains on the northern half of the east side and the southwest corner of the landfill, including one sump within each of the groundwater drains. The barrier wall and subsurface drains extended down to bedrock. An additional barrier wall on the south and east sides of the X-749 Landfill was constructed in 2002. The groundwater drain and sump on the east side of the landfill were removed for construction of this barrier wall. Groundwater from the remaining subsurface drain is treated at the X-622 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 608, which flows to the X-6619 Sewage Treatment Plant.

In 2002 and 2003, hybrid poplar trees were planted in several areas of the X-749/X-120 groundwater plume. The trees are used in a process called phytoremediation to degrade or contain contaminants in soil and/or groundwater. Chapter 3, Section 3.3.1.1, provides additional information about the remedial actions implemented to address the X-749/X-120 groundwater plume.

The leading edge of the contaminated groundwater plume emanating from the X-749 Landfill is near the southern boundary of PORTS. In 1994, a subsurface barrier wall was completed across a portion of this southern boundary of PORTS. The X-749 South Barrier Wall was designed to inhibit migration of the plume off plant property prior to the implementation of a final remedial measure; however, volatile organics moved beyond the wall. In 2007, four groundwater extraction wells were installed in the X-749 South Barrier Wall Area, and in 2008, two extraction wells were installed in the groundwater collection system on the southwest side of the landfill. These extraction wells are controlling migration of the plume off plant property and reducing concentrations of TCE in groundwater. Two additional groundwater extraction wells were installed in 2010 to further control migration of the X-749/X-120 groundwater plume and remediate areas of higher TCE concentrations within the plume. A third extraction well was installed in the X-120 area of the plume (see Section 6.4.1.2).

Ninety-five wells and one sump/extraction well were sampled during 2011 to monitor the X-749/X-120 area. Table 6.1 lists the analytical parameters for the wells and sump in this area.

6.4.1.2 X-120 Old Training Facility

The former X-120 Old Training Facility, which is west and north of the X-749 Contaminated Materials Disposal Facility, covered an area of approximately 11.5 acres west of the present-day XT-847 building. The X-120 facility, which no longer exists, included a machine shop, metal shop, paint shop, and several warehouses used during the construction of PORTS in the 1950s. Groundwater in the vicinity of this facility is contaminated with volatile organic compounds, primarily TCE. In 1996, a horizontal well was installed along the approximate axis of the X-120 plume. Contaminated groundwater flowed from this well to the X-625 Groundwater Treatment Facility. In 2003, operation of the X-625 Groundwater Treatment Facility and horizontal well ceased with the approval of Ohio EPA due to the limited amount of groundwater collected by the well. A groundwater extraction well was installed in 2010 in the area west of the former X-120 Old Training Facility to remediate the higher concentrations of TCE in groundwater in this area. Chapter 3, Section 3.3.1.1, provides additional information about the remedial actions implemented to address the X-749/X-120 groundwater plume.

Ninety-five wells and one sump/extraction well were sampled during 2011 to monitor the X-749/X-120 area. Table 6.1 lists the analytical parameters for the wells and sump in this area.

6.4.1.3 PK Landfill

The PK Landfill is located west of Big Run Creek just south of the X-230K Holding Pond in Quadrant I. The landfill, which began operations in 1952, was used as a salvage yard, burn pit, and trash area during the construction of PORTS. After the initial construction, the disposal site was operated as a sanitary landfill until 1968, when soil was graded over the site and the area was seeded with native grasses.

During site investigations, intermittent seeps were observed emanating from the PK Landfill into Big Run Creek. In 1994, a portion of Big Run Creek was relocated approximately 50 feet to the east. A groundwater collection system was installed in the old creek channel to capture the seeps emanating from the landfill. A second collection system was constructed in 1997 on the southeastern landfill boundary to contain the groundwater plume migrating toward Big Run Creek from the southern portion of the PK Landfill. A cap was constructed over the landfill in 1998. Chapter 3, Section 3.3.1.2, provides additional information about the remedial actions implemented at PK Landfill.

In 2011, nine wells, two sumps, and two manholes were sampled to monitor the PK Landfill area. Table 6.1 lists the analytical parameters for the wells and sumps in this area.

6.4.1.4 Monitoring results for the X-749/X-120/PK Landfill in 2011

A contaminated groundwater plume is associated with the X-749/X-120/PK Landfill groundwater monitoring area (see Figure 6.2) in Quadrant I. The most extensive and most concentrated constituents associated with the X-749/X-120 plume are volatile organic compounds, particularly TCE.

In 2011, concentrations of TCE continued to decrease in a number of wells within the X-749/X-120 plume due to the extraction wells installed in the X-749 South Barrier Wall Area (X749-EW01G, X749-EW02G, X749-EW03G, and X749-EW04G) and the additional extraction wells installed in the collection trench on the southwest side of the X-749 Landfill (X749-EW05G and X749-EW06G). TCE was detected at an estimated concentration of 0.25 µg/L in the first quarter sample collected from off-site monitoring well WP-03G. No TCE or other volatile organic compounds were detected in any of the seven off-site monitoring wells sampled in the second, third, and/or fourth quarters of 2011.

The area within the central portion of the X-749/X-120 groundwater plume where TCE concentrations are less than 5 µg/L expanded from two wells in 2010 to four wells in 2011. The area of the plume with higher TCE concentrations (100 µg/L to 1000 µg/L) to the south and west of the X-749 Landfill remained detached from the higher TCE concentrations around the landfill and was continuing to diminish. Figure 6.2 provides data for selected X-749/X-120 monitoring wells that illustrate the decreasing TCE concentrations in the wells.

In the third quarter, TCE was detected in samples collected on July 7, 2011, from two wells that are typically outside of the X-749/X-120 groundwater plume (X749-14B and X749-112G). These wells are on the east side of the X-749/X-120 monitoring area, south of the landfill and 200-250 ft west of Big Run Creek (see Figure 6.2). TCE was detected at 6.7 µg/L in well X749-112G and 4.2 µg/L in well X749-14B.

To confirm these results, the wells were sampled again on September 7, 2011. TCE was detected at 1.8 µg/L in well X749-112G and 37 µg/L in well X749-14B. These two wells and eight additional wells on the east side of the monitoring area were sampled in October 2011. TCE was detected at typical concentrations in the eight additional wells (ranging from undetected to 4.8 µg/L). TCE was also detected again in wells X749-112G and X749-14B at estimated concentrations less than 1 µg/L. Samples were collected monthly in the fourth quarter of 2011 from wells X749-112G and X749-14B, as well as surface water sampling location BRC-SW02 in Big Run Creek, which is downgradient from the

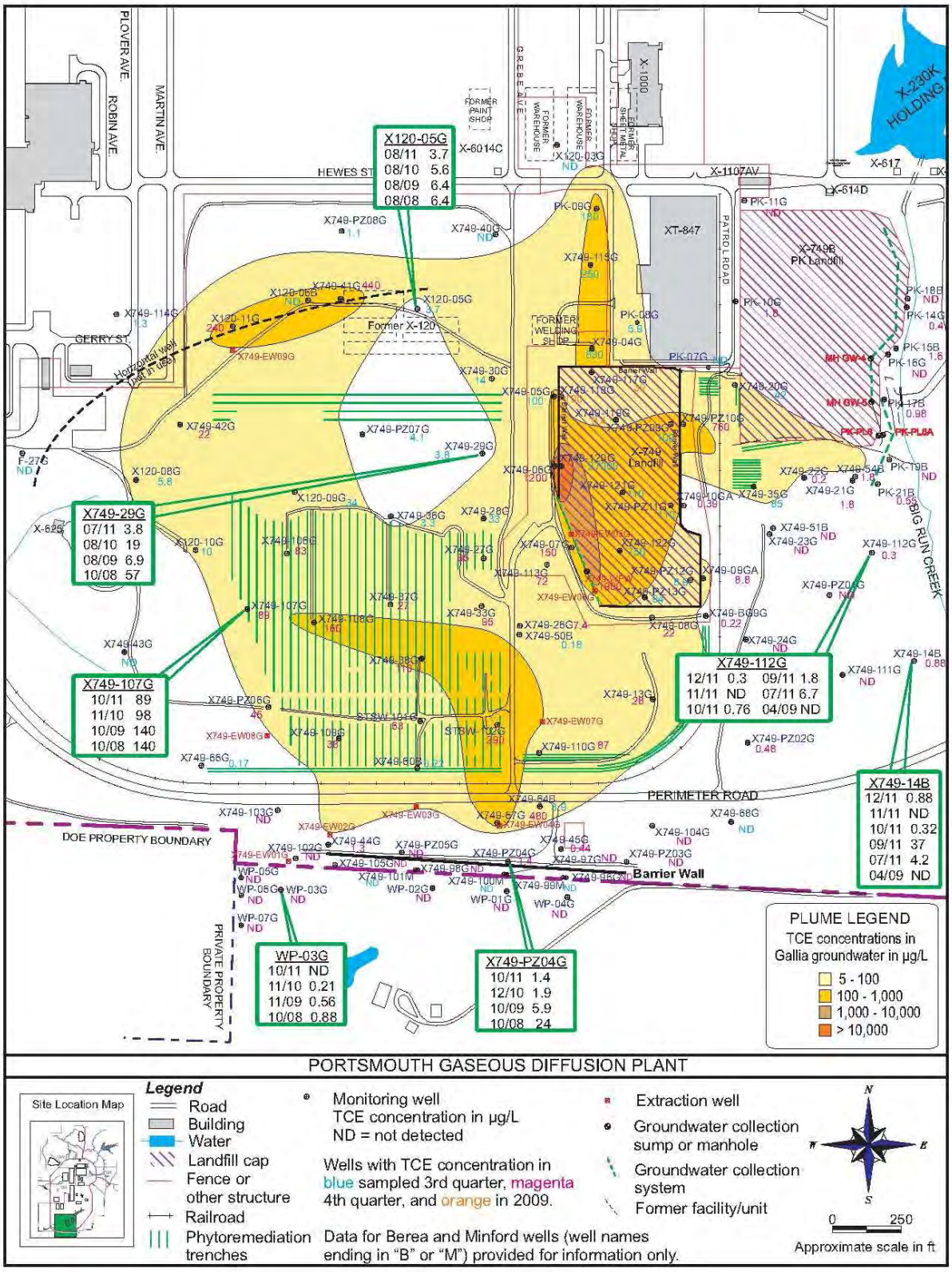

Figure 6.2. TCE-contaminated Gallia groundwater plume at the X-749/X-120/PK Landfill – 2011.

monitoring wells just before the creek flows under Perimeter Road. If detected, TCE was present in the samples collected in the fourth quarter of 2011 at estimated concentrations less than 1 µg/L. Figure 6.2 includes selected data for wells X749-14B and X749-112G. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes complete data collected in 2011 for this special sampling. More frequent monitoring of this area continued in 2012.

Samples from selected wells that monitor the X-749/X-120 groundwater plume were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Some of the wells associated with the PK Landfill are also contaminated with low levels of volatile organic compounds, but usually at concentrations below preliminary remediation goals. Vinyl chloride was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 14 to 22 µg/L, which exceed the preliminary remediation goal of 2 µg/L. Vinyl chloride is typically detected in these wells at concentrations above the preliminary remediation goal.

6.4.2 Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility

In the northern portion of Quadrant I, groundwater concerns are focused on two areas: the Quadrant I Groundwater Investigative Area and the X-749A Classified Materials Disposal Facility.

6.4.2.1 Quadrant I Groundwater Investigative Area

The Quadrant I Groundwater Investigative Area, also called the Five-Unit Groundwater Investigative Area, consists of a groundwater plume resulting from a number of potential sources of groundwater contamination: the X-231A and X-231B Oil Biodegradation Plots, X-600 Coal-Fired Steam Plant, X-600A Coal Pile Yard, X-621 Coal Pile Runoff Treatment Facility, X-710 Technical Services Building, X-749A Classified Materials Disposal Facility, the X-760 Pilot Investigation Building, and the X-770 Mechanical Testing Facility. The X-231B Southwest Oil Biodegradation Plot was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*.

Three groundwater extraction wells were installed in 1991 as part of an interim remedial measure for the X-231B Southwest Oil Biodegradation Plot. Eleven additional groundwater extraction wells were installed in 2001-2002 as part of the remedial actions required by the Quadrant I Decision Document. These wells began operation in 2002. An additional extraction well south of the X-326 Process Building began operating in 2009. The extracted groundwater is treated at the X-622 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 608, which flows into the X-6619 Sewage Treatment Plant. Multimedia landfill caps were installed over the X-231B area and a similar area, X-231A, in 2000 to minimize water infiltration and control the spread of contamination. Chapter 3, Section 3.3.1.3, provides additional information about the remedial actions implemented in the Quadrant I Groundwater Investigative Area.

Thirty-one wells were sampled in 2011 as part of the monitoring program for the Quadrant I Groundwater Investigative Area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.2 X-749A Classified Materials Disposal Facility

The 6-acre X-749A Classified Materials Disposal Facility (also called the X-749A Landfill) is a landfill that operated from 1953 through 1988 for the disposal of wastes classified under the Atomic Energy Act. Potential contaminants include PCBs, asbestos, radionuclides, and industrial waste. Closure of the landfill, completed in 1994, included the construction of a multilayer cap and the installation of a drainage system to collect surface water runoff. The drainage system discharges via an NPDES-permitted outfall.

Ten wells associated with the landfill were sampled in 2011. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.3 Monitoring results for the Quadrant I Groundwater Investigative Area/X-749A in 2011

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant I Groundwater Investigative Area (see Figure 6.3). Other volatile organic compounds are also present in the plume.

No significant changes in TCE concentrations were identified in wells that monitor the Quadrant I Groundwater Investigative Area in 2011. Figure 6.3 shows the groundwater plume for this area and provides data for selected Quadrant I Groundwater Investigative Area monitoring wells.

Samples from selected wells that monitor the Quadrant I Groundwater Investigative Area were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Under the detection monitoring program for the X-749A Landfill, concentrations of alkalinity, chloride, sodium, sulfate, and total dissolved solids in downgradient Gallia wells are evaluated to monitor potential impacts to groundwater and trends in concentrations of these parameters (alkalinity, chloride, sodium, sulfate, and total dissolved solids). None of the statistical control limits or background concentrations for alkalinity, chloride, sodium, sulfate, and total dissolved solids were exceeded in samples collected in 2011.

6.4.3 Quadrant II Groundwater Investigative Area

The Quadrant II Groundwater Investigative Area consists of an area of groundwater contamination with several potential sources. One of these sources, the X-701C Neutralization Pit, was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*. The X-701C Neutralization Pit was an open-topped neutralization pit that received process effluents and basement sump wastewater such as acid and alkali solutions and rinse water contaminated with TCE and other volatile organic compounds from metal-cleaning operations. The X-701C Neutralization Pit was located within a TCE plume centered around the X-700 and X-705 buildings. The pit was removed in 2001. In 2010, Ohio EPA approved an IRM to remediate contaminant source areas within the southeastern portion of the groundwater plume. Chapter 3, Section 3.3.2.1 provides additional information about the Quadrant II Groundwater Investigative Area.

The natural groundwater flow direction in this area is to the east toward Little Beaver Creek. The groundwater flow pattern has been changed in this area by use of sump pumps in the basements of the X-700 and X-705 buildings. Thus, the groundwater plume in this area does not spread but instead flows toward the sumps where it is collected and then treated at the X-627 Groundwater Treatment Facility. This facility discharges through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant. Eighteen wells are sampled annually or biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.3.1 Monitoring results for the Quadrant II Groundwater Investigative Area in 2011

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant II Groundwater Investigative Area (see Figure 6.4). The perimeter of the plume did not change in 2011, although concentrations of TCE and other volatile organic compounds within the southeastern portion of the plume changed due to the IRM.

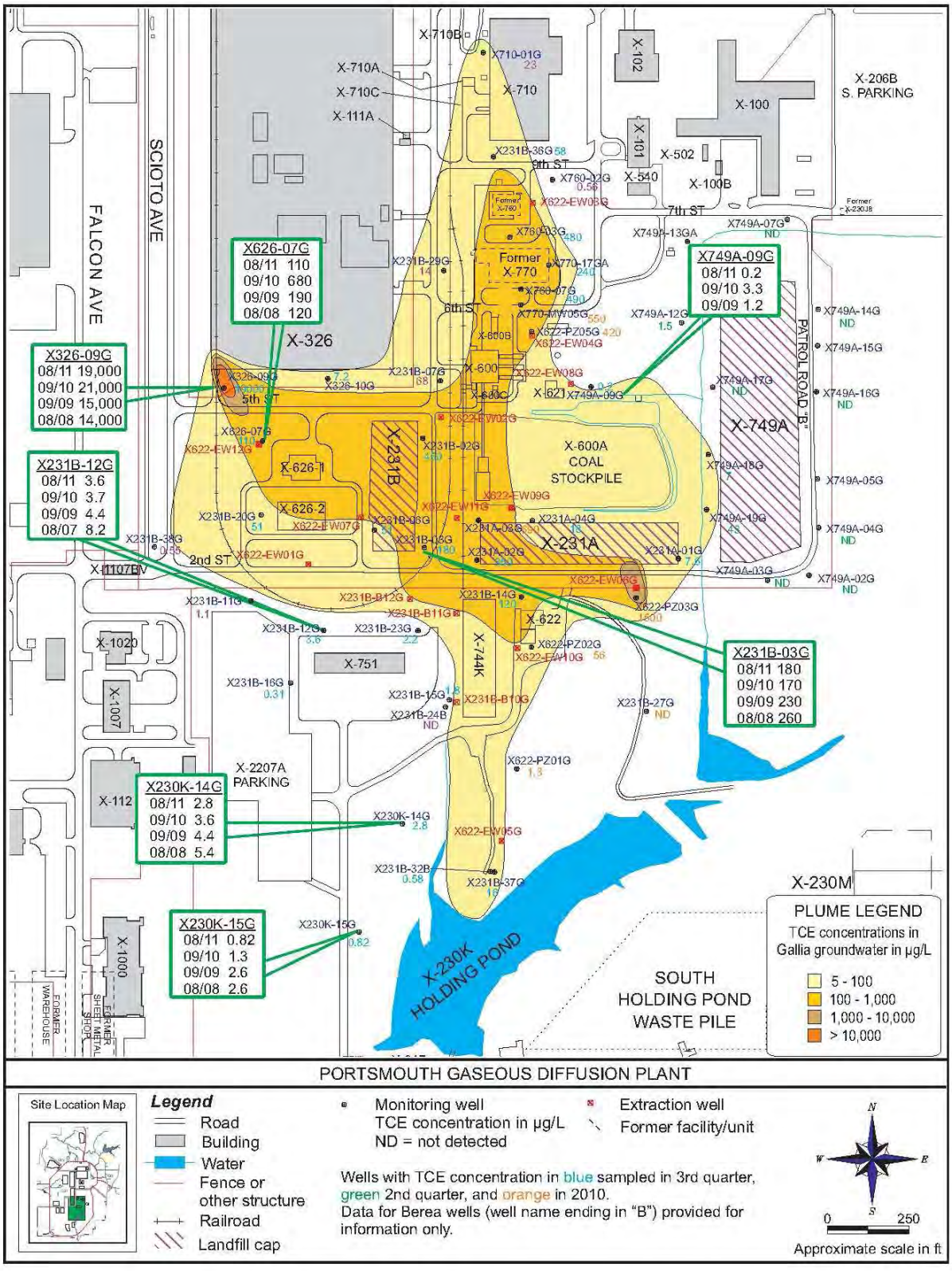

Figure 6.3. TCE-contaminated Gallia groundwater plume at the Quadrant I Groundwater Investigative Area – 2011.

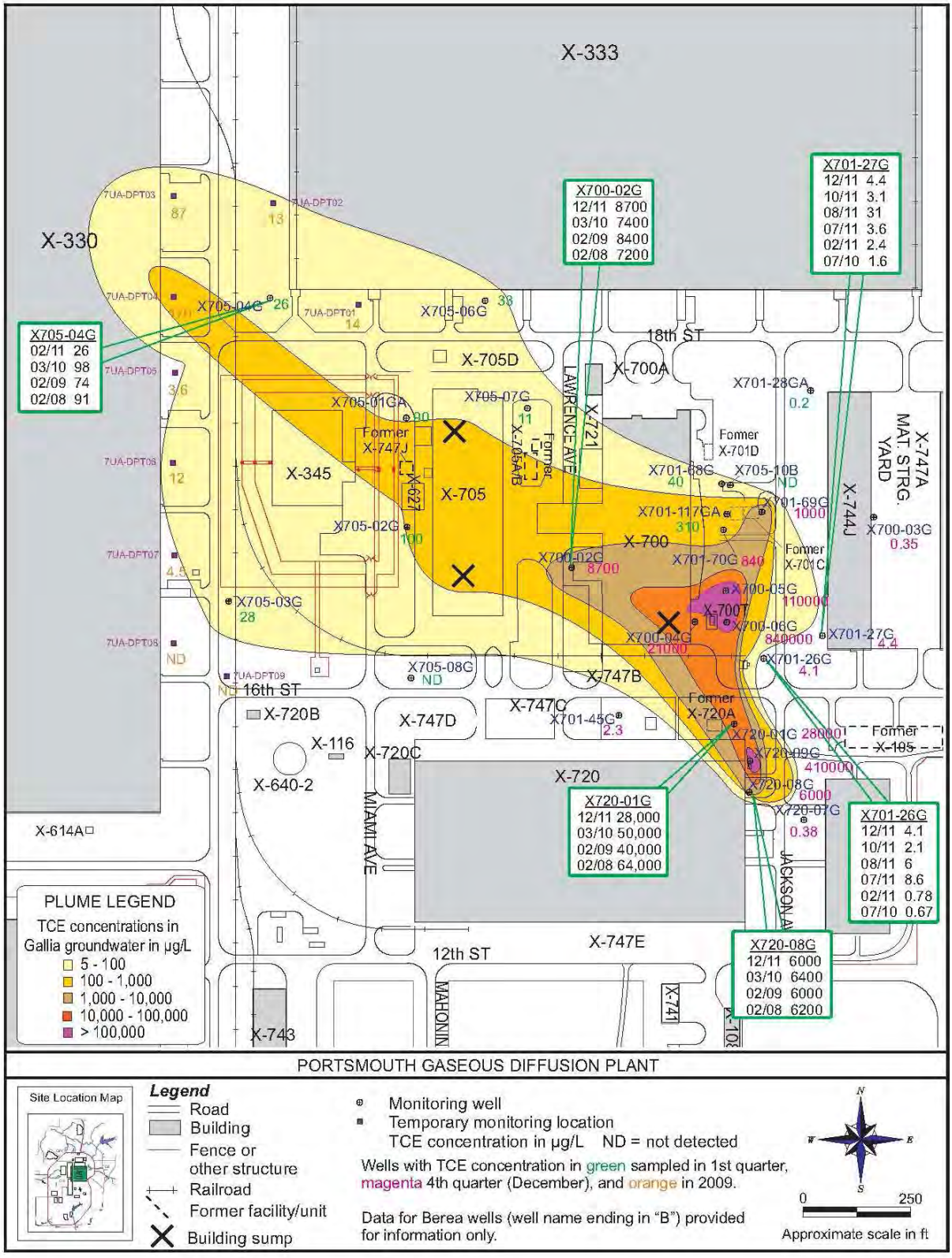

Figure 6.4. TCE-contaminated Gallia groundwater plume at the Quadrant II Groundwater Investigative Area – 2011.

In 2011, some of the wells that provide routine monitoring of the Quadrant II Groundwater Investigative Area were also monitored monthly as part of the IRM taking place in this area (see Chapter 3, Section 3.3.2.1). In the third quarter of 2011, TCE was detected at concentrations above 5 µg/L (the definition of the plume perimeter) in two wells (X701-26G and X701-27G) that monitor the east side of the Quadrant II Groundwater Investigative Area plume. TCE is not typically detected above 5 µg/L in these two wells. Concentrations of TCE decreased to less than the PRG in the fourth quarter samples collected from the wells. The increases in TCE may be due to the higher than average rainfall that occurred in 2011. Figure 6.3 includes selected data for wells X701-26G and X701-27G. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes the monthly monitoring data collected to support the IRM in this area.

Samples from selected wells that monitor the Quadrant II Groundwater Investigative Area were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.4 X-701B Holding Pond

In the eastern portion of Quadrant II, groundwater concerns focus on three areas: the X-701B Holding Pond, the X-230J7 Holding Pond, and the X-744Y Waste Storage Yard.

The X-701B Holding Pond was used from the beginning of plant operations in 1954 until 1988. The pond was designed for neutralization and settlement of acid waste from several sources. TCE and other volatile organic compounds were also discharged to the pond. Two surface impoundments (sludge retention basins) were located west of the holding pond. The X-230J7 Holding Pond received wastewater from the X-701B Holding Pond. The X-744Y Waste Storage Yard is south of the X-701B Holding Pond. The yard is approximately 15 acres and surrounds the X-744G Bulk Storage Building. RCRA hazardous waste was managed in this area.

A contaminated groundwater plume extends from the X-701B Holding Pond towards Little Beaver Creek. Three groundwater extraction wells were installed southeast of the X-701B Holding Pond and a sump was installed in the bottom of the pond as part of the ongoing RCRA closure of the unit. These wells and sump were designed to intercept contaminated groundwater emanating from the holding pond area before it could join the existing groundwater contaminant plume. The wells and sump were removed between 2009 and 2011 because of the X-701B IRM (see Chapter 3, Section 3.3.2.2). In 2011, extracted groundwater and other water generated by the X-701B IRM was processed at the X-623 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant.

Two groundwater interceptor trenches (French drains) are used to intercept TCE-contaminated groundwater in the eastern portion of the monitoring area. These interceptor trenches, called the X-237 Groundwater Collection System, control TCE migration into Little Beaver Creek. The 660-foot-long primary trench has two sumps in the backfill and a 440-foot-long secondary trench intersects the primary trench. The extracted groundwater is treated at the X-624 Groundwater Treatment Facility and discharges through FBP NPDES Outfall 015, which flows to Little Beaver Creek.

Groundwater remediation in the X-701B Holding Pond Area was initiated in 2006 (see Chapter 3, Section 3.2.2). Oxidant was injected into the subsurface in the western portion of the area from 2006 through 2008 to remediate volatile organic compounds in soil and groundwater. The X-701B IRM was initiated in December 2009 and completed in 2011 to further address contaminants remaining in soil and groundwater following the oxidant injections. Contaminated soil in the X-701B IRM area was removed

and mixed with oxidant, with additional oxidant mixed into soil remaining at the bottom of the excavation. Figure 6.5 shows the IRM area.

The groundwater monitoring wells in the area of the X-701B IRM (the western portion of the monitoring area) were removed from the monitoring program to be replaced following the completion of the X-701B IRM. Thirty wells were sampled in 2011 as part of the routine monitoring program for this area. Table 6.1 lists the analytical parameters for the wells that are routinely monitored in this area. Additional wells were sampled either quarterly or monthly throughout 2011 to monitor the IRM. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes the monitoring data collected to support the X-701B IRM.

6.4.4.1 Monitoring results for the X-701B Holding Pond in 2011

For the most part, concentrations of TCE detected in the eastern portion of the X-701B groundwater plume (the area that was not part of the IRM) and the X-744G area were similar to previous years. In the northeast corner of the monitoring area, however, TCE was detected at 84 µg/L in the third quarter sample collected from well LBC-PZ06G, which is located east of the X-237 Groundwater Collection System and just west of Little Beaver Creek. TCE is not typically detected in this well. TCE was not detected in third quarter samples collected from the two wells (X701-16G and X701-58B) closest to LBC-PZ06G. Well LBC-PZ06G, as well as four other wells in the vicinity of LBC-PZ06G were sampled in the fourth quarter and analyzed for volatile organic compounds to provide more information about this detection.

TCE was not detected in the fourth quarter sample collected from well LBC-PZ06G. TCE was detected in the sample collected from well X701-IRMPZ08G at 19 µg/L. Well X701-IRMPZ08G is located on the north side of the East Drainage Ditch in an area where the groundwater plume was not believed to be present. Additional sampling and remedial activities were completed in 2012 to evaluate the X-237 Groundwater Collection System. Figure 6.5 shows the TCE concentrations detected in well LBC-PZ06G in 2010-2011.

In the western portion of the monitoring area, TCE was detected in the new monitoring wells installed in the IRM area at concentrations similar to those detected in groundwater prior to the IRM. Figure 6.5 shows the groundwater plume in the western portion of the X-701B monitoring area and TCE concentrations in selected wells in 2011.

Samples from selected wells that monitor the X-701B Holding Pond were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Samples from five wells in or near the X-744G Bulk Storage Building and X-744Y Storage Yard were analyzed for cadmium and nickel, which were detected above preliminary remediation goals in three of the five wells (X701-01G, X744G-01G, and X744G-02G). These results are typical for the X-744 area wells.

6.4.5 X-633 Pumphouse/Cooling Towers Area

The X-633 Pumphouse/Cooling Towers Area in Quadrant II consisted of a recirculating water pumphouse and four cooling towers with associated basins. Chromium-based corrosion inhibitors were added to the cooling water until the early 1990s, when the system was converted to a phosphate-based inhibitor. In 2009, DOE received funding under ARRA for D&D of the X-633 Pumphouse and Cooling Towers. D&D of the facilities was completed in 2010. Chapter 3, Section 3.3.2.3 provides additional information about the RCRA investigation of soils and groundwater in this area.

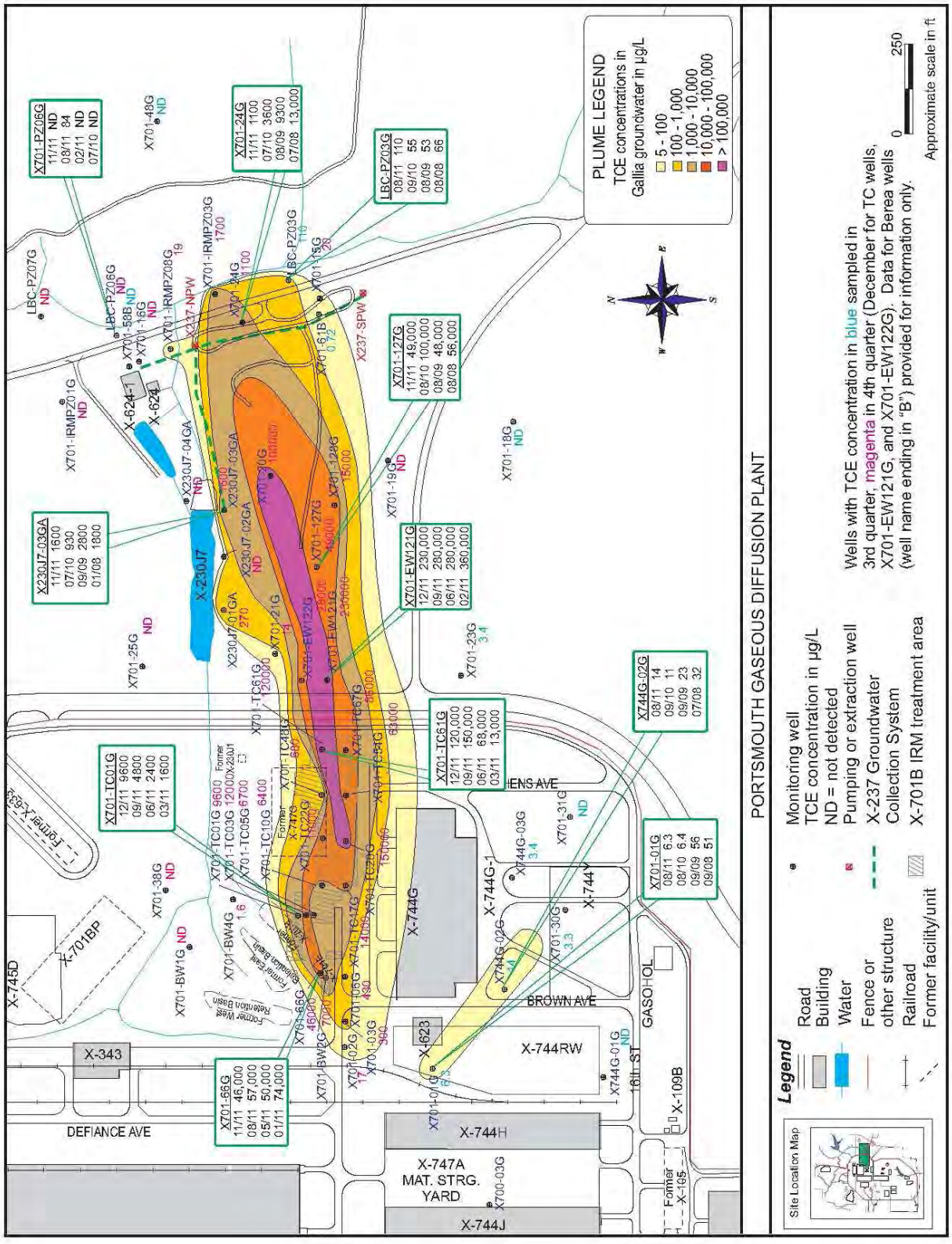

Figure 6.5. TCE-contaminated Gallia groundwater plume at the X-701B Holding Pond – 2011.

The X-633 Pumphouse/Cooling Towers Area was identified as an area of concern for potential metals contamination in 1996 based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. Based on detections of chromium above the preliminary remediation goal, this area was added to the PORTS groundwater monitoring program. Two wells are sampled semiannually for chromium as part of the monitoring program for this area.

6.4.5.1 Monitoring results for the X-633 Pumphouse/Cooling Towers Area in 2011

Chromium was detected in both of the X-633 monitoring wells in 2011. Samples collected from well X633-07G contained chromium at concentrations above the preliminary remediation goal of 100 µg/L: 560 µg/L (second quarter) and 980 µg/L (fourth quarter). Samples collected from well X633-PZ04G also contained chromium but at concentrations well below the preliminary remediation goal. These results are typical for these wells. Figure 6.6 shows the chromium concentrations detected in the X-633 Pumphouse/Cooling Tower area wells.

6.4.6 X-616 Chromium Sludge Surface Impoundments

The X-616 Chromium Sludge Surface Impoundments in Quadrant III were two unlined surface impoundments used from 1976 to 1985 for storage of sludge generated by the treatment of water from the PORTS process cooling system. A corrosion inhibitor containing chromium was used in the cooling water system. Sludge containing chromium was produced by the water treatment system and was pumped into and stored in the X-616 impoundments. The sludge was removed from the impoundments and remediated as an interim action in 1990 and 1991. The unit was certified closed in 1993. Seven wells are sampled annually and nine wells are sampled biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.6.1 Monitoring results for the X-616 Chromium Sludge Surface Impoundments in 2011

Chromium is of special concern at X-616 because of the previous use of the area. In 2011, chromium was detected above the preliminary remediation goal of 100 µg/L in one well that monitors the X-616 area: well X616-05G (on the northeastern boundary of the area). Chromium is typically detected above the preliminary remediation goal in this well. Nickel was detected above the preliminary remediation goal (100 µg/L for Gallia wells) in two wells (X616-05G and X616-25G). Nickel is typically detected above the preliminary remediation goal in these two wells. Figure 6.7 shows the concentrations of chromium and nickel in wells at the X-616 Chromium Sludge Surface Impoundments.

In 2011, volatile organic compounds were detected at low levels in samples collected from nine wells in this area. Volatile organic compounds are routinely detected in samples from wells in this area, primarily in wells located west or south of the former impoundments. The only volatile organic compounds detected above the preliminary remediation goals were 1,1-dichloroethene and TCE, which were detected in wells X616-09G, X616-13G, and/or X616-20B. Figure 6.7 shows the concentrations of TCE detected in the X-616 wells in 2011.

6.4.7 X-740 Waste Oil Handling Facility

The former X-740 Waste Oil Handling Facility, which was demolished in 2006, was located on the western half of PORTS south of the X-530A Switchyard in Quadrant III. The X-740 facility, which operated from 1983 until 1991, was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. A sump within the building was used between 1986 and 1990 to collect residual waste oil and waste solvents from containers crushed in a hydraulic drum crusher at the facility. The facility and sump were initially identified as hazardous waste management units in 1991. The X-740 Waste Oil Handling Facility (both the facility and sump identified as hazardous waste management units) underwent closure, and closure certification was approved by Ohio EPA in 1998.

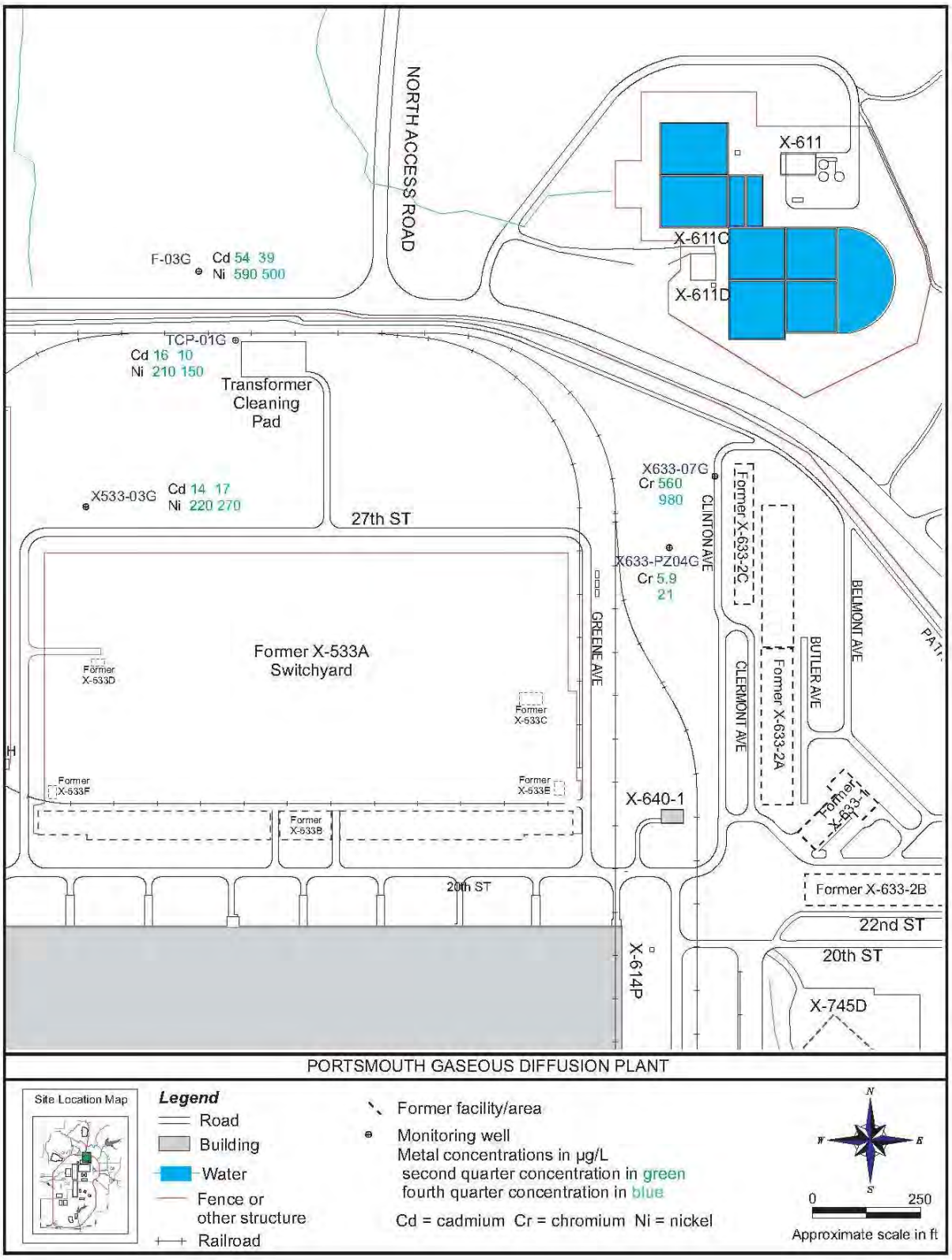

Figure 6.6. Metal concentrations in groundwater at the X-633 Pumphouse/Cooling Towers Area and X-533 Switchyard Area – 2011.

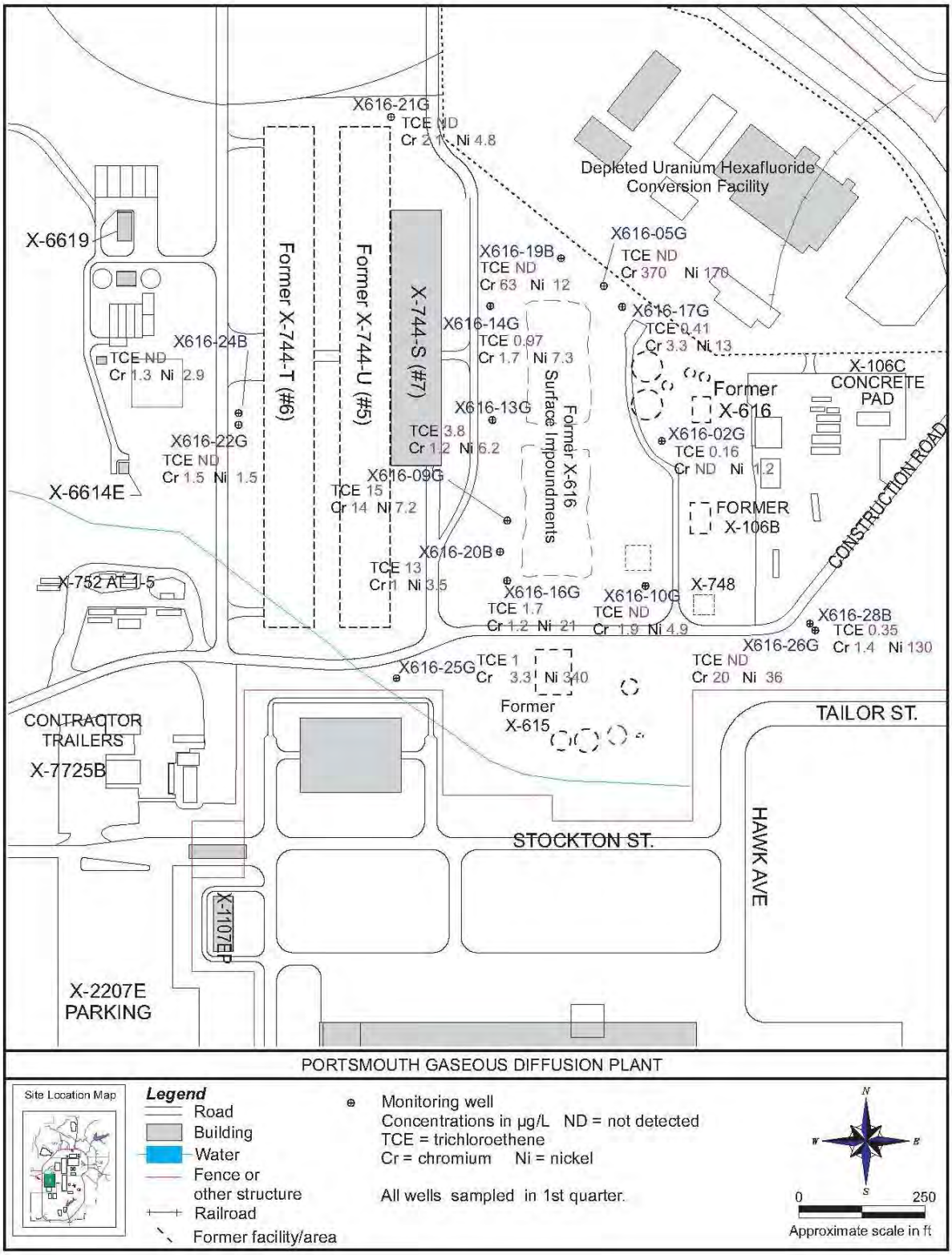

Figure 6.7. TCE and metal concentrations in groundwater at the X-616 Chromium Sludge Surface Impoundments – 2011.

In 1999, poplar trees were planted in a 2.6-acre phytoremediation area above the groundwater plume near the X-740 Waste Oil Handling Facility. Because phytoremediation did not work as anticipated to reduce the concentrations of volatile organics in groundwater in this area, three rounds of oxidant injections were completed during 2008. Additional alternatives for groundwater remediation in this area were evaluated in 2009, and a pilot study of enhanced anaerobic bioremediation began in 2010 and continued throughout 2011. Chapter 3, Section 3.3.3, provides additional information about the remedial activities for the X-740 area.

At the request of Ohio EPA, routine monitoring at the X-740 Waste Oil Handling Facility under the *Integrated Groundwater Monitoring Plan* was discontinued. However, monitoring of the area has continued in support of the pilot study underway in this area. Twelve monitoring wells were sampled in the second, third, and fourth quarters of 2011, including six new monitoring wells installed for the pilot study.

6.4.7.1 Monitoring results for the X-740 Waste Oil Handling Facility in 2011

A contaminated groundwater plume consisting of primarily TCE is located near the X-740 Waste Oil Handling Facility (see Figure 6.8) in Quadrant III. The perimeter of the X-740 groundwater plume did not change significantly in 2011, although concentrations of TCE and other volatile organic compounds within the plume changed due to the remedial activities. Figure 6.8 shows the TCE groundwater plume in 2011 for the X-740 area and concentrations of TCE detected in 2010 and 2011 in two new wells that monitor the current pilot study (X740-18G and X740-22G). TCE decreased in well X740-18G, which is within the treatment area, but TCE did not decrease in well X740-22G, which is downgradient from the treatment area. TCE also decreased in well X740-03G, within the treatment area. Well X740-03G typically has the highest concentrations of TCE detected in the X-740 monitoring area.

6.4.8 X-611A Former Lime Sludge Lagoons

The X-611A Former Lime Sludge Lagoons in Quadrant IV were comprised of three adjacent unlined sludge retention lagoons constructed in 1954 and used for disposal of lime sludge waste from the site water treatment plant from 1954 to 1960. The lagoons covered a surface area of approximately 18 acres and were constructed in a low-lying area that included Little Beaver Creek. As a result, approximately 1500 feet of Little Beaver Creek were relocated to a channel just east of the lagoons.

As part of the RCRA Corrective Action Program, a prairie habitat has been developed in this area by placing a soil cover over the north, middle, and south lagoons. A soil berm was also constructed outside the northern boundary of the north lagoon to facilitate shallow accumulation of water in this low-lying area. Chapter 3, Section 3.3.4.1, provides more information about this remediation. Six wells are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.8.1 Monitoring results for the X-611A Former Lime Sludge Lagoons in 2011

The six monitoring wells at X-611A are sampled and analyzed for beryllium and chromium. In 2011, chromium was detected in four of the six wells in this area at concentrations between 0.59 and 110 µg/L (X611-01B). The detection of chromium at 110 µg/L in the first quarter sample collected from well X611-01B was the first detection of chromium that exceeded the PRG (100 µg/L) since the current monitoring program began in 1999. Previous concentrations of chromium in well X611-01B did not exceed 15 µg/L. The concentration of chromium detected in well X611-01B in the third quarter decreased to 7.6 µg/L.

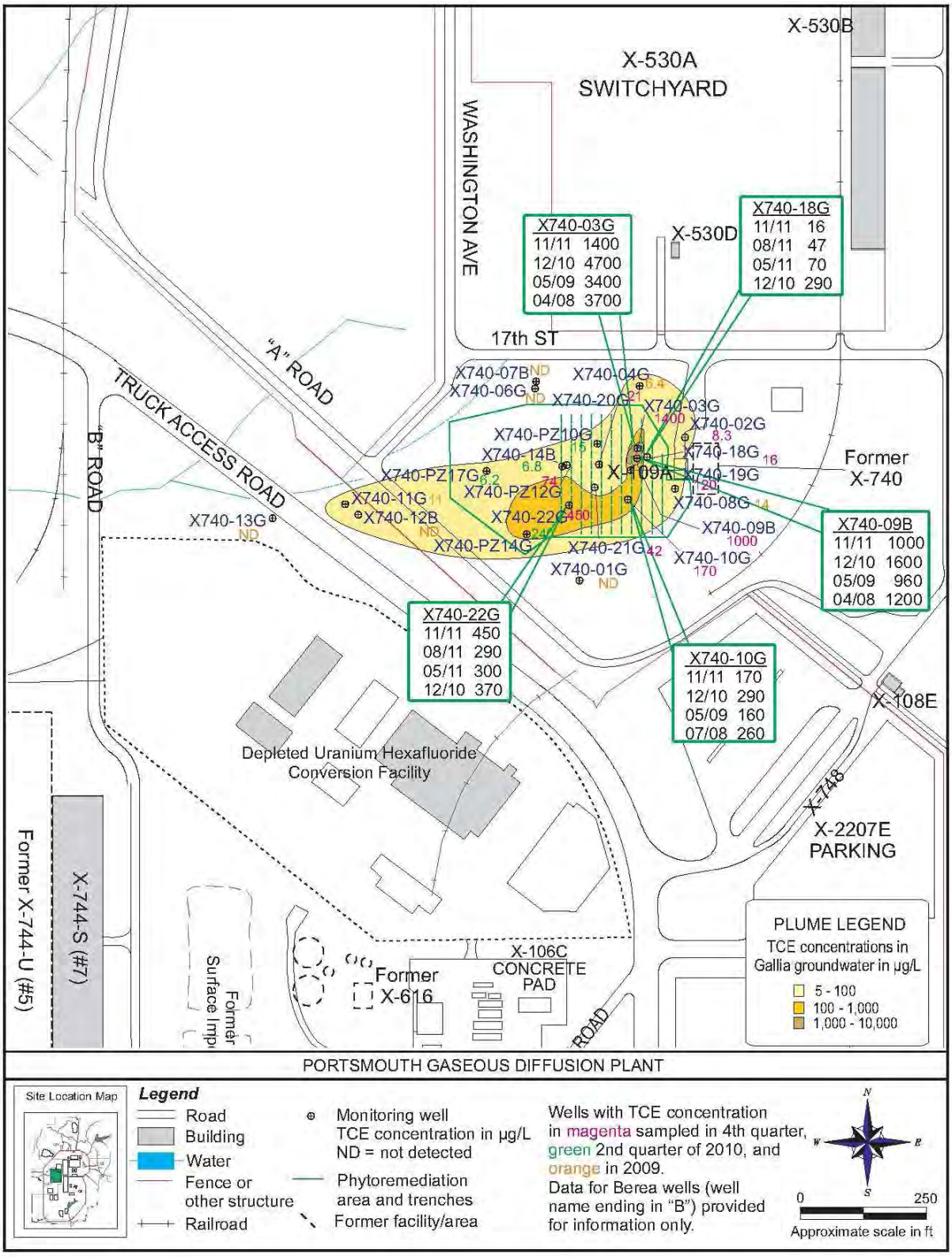

Figure 6.8. TCE-contaminated Gallia groundwater plume near the X-740 Waste Oil Handling Facility – 2011.

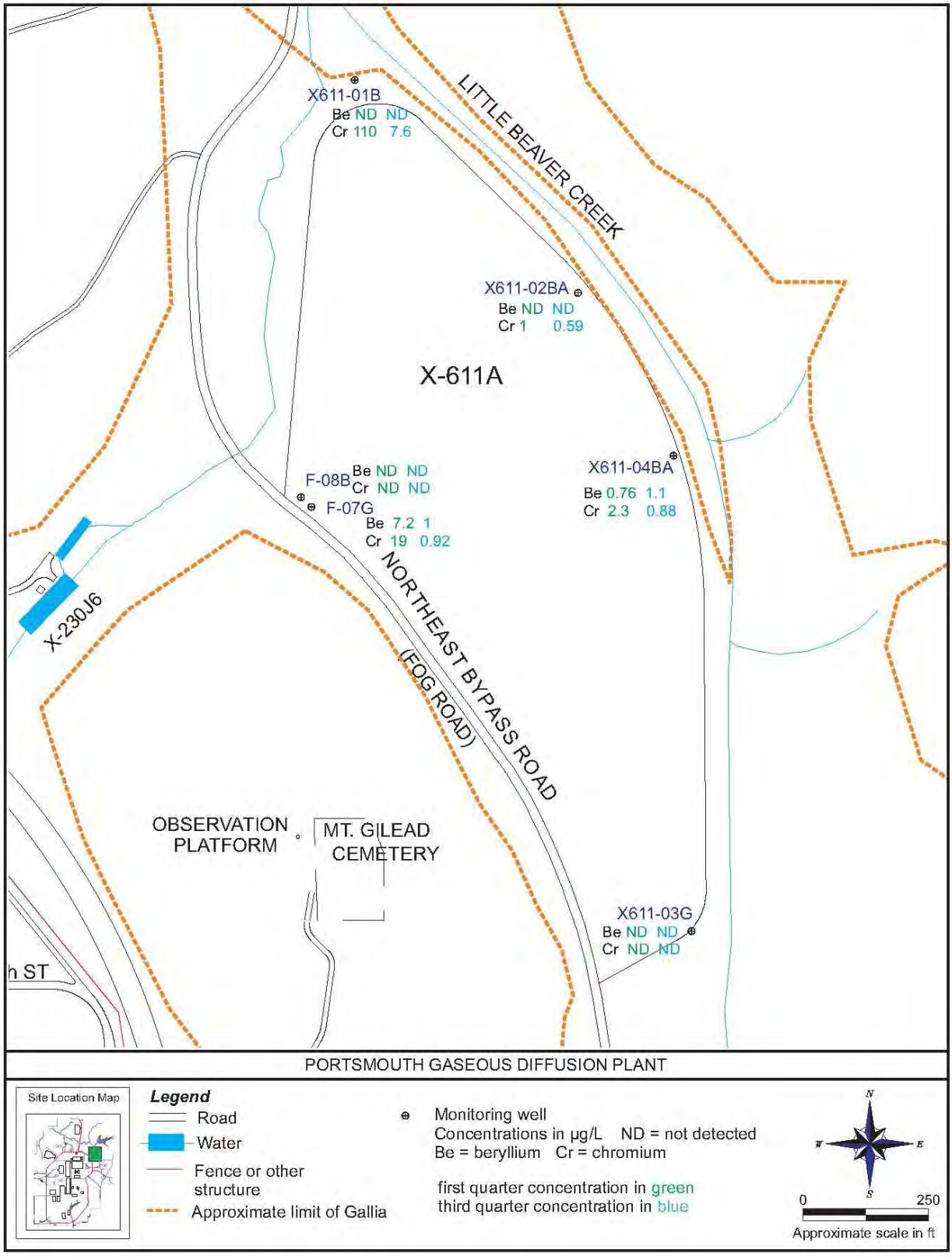

Figure 6.9. Metal concentrations in groundwater at the X-611A Former Lime Sludge Lagoons – 2011.

Beryllium was detected in both samples collected from well F-07G at 7.2 µg/L (first quarter) and 1 µg/L (third quarter). Beryllium is typically detected in samples collected from this well at concentrations just above or below the PRG (6.5 µg/L for Gallia wells). Beryllium was also detected in both samples collected from well X611-04BA at concentrations less than the PRG (7 µg/L for Berea wells). Figure 6.9 shows the concentrations of beryllium and chromium detected in the X-611A wells in 2011.

6.4.9 X-735 Landfills

Several distinct waste management units are contained within the X-735 Landfills area in Quadrant IV. The main units consist of the hazardous waste landfill, referred to as the X-735 RCRA Landfill, and the X-735 Industrial Solid Waste Landfill. The X-735 Industrial Solid Waste Landfill includes the industrial solid waste cells, asbestos disposal cells, and the chromium sludge monocells A and B. The chromium sludge monocells contain a portion of the chromium sludge generated during the closure of the X-616 Chromium Sludge Surface Impoundments.

Initially, a total of 17.9 acres was approved by Ohio EPA and Pike County Department of Health for landfill disposal of conventional solid wastes. The landfill began operation in 1981. During operation of the landfill, PORTS investigations indicated that wipe rags contaminated with solvents had inadvertently been disposed in the northern portion of the landfill. The contaminated rags were considered a hazardous waste. Waste disposal in the northern area ended in 1991, and Ohio EPA determined that the area required closure as a RCRA hazardous waste landfill. Consequently, this unit of the sanitary landfill was identified as the X-735 RCRA Landfill.

A buffer zone was left unexcavated to provide space for groundwater monitoring wells and a space between the RCRA landfill unit and the remaining southern portion, the X-735 Industrial Solid Waste Landfill. Routine groundwater monitoring has been conducted at the X-735 Landfills since 1991.

The industrial solid waste portion of the X-735 Landfills included a solid waste section and an asbestos waste section. The X-735 Industrial Solid Waste Landfill, not including the chromium sludge monocells, encompasses a total area of approximately 4.1 acres. Operation of the X-735 Industrial Solid Waste Landfill ceased in 1997; this portion of the landfill was capped in 1998.

The *Integrated Groundwater Monitoring Plan* incorporates monitoring requirements for the hazardous and solid waste portions of the X-735 Landfills. In addition, the *Corrective Measures Plan for the X-735 Landfill* was approved by Ohio EPA in 2008. This plan provides the monitoring requirements for Gallia wells that monitor the X-735 Landfill. Corrective measures monitoring was implemented because Ohio EPA determined that assessment monitoring of the landfill, completed between 2005 and 2007, identified that a small release of leachate constituents is occurring or has occurred from the X-735 Landfills. Twenty-two wells were sampled in 2011 as part of the monitoring programs for this area. Table 6.1 lists the analytical parameters and Figure 6.10 shows the monitoring wells in this area.

6.4.9.1 Monitoring results for the X-735 Landfills in 2011

The monitoring program at the X-735 Landfills includes corrective measures monitoring for Gallia wells and detection monitoring for Berea wells. As required by the corrective measures monitoring program, concentrations of three metals (cobalt, mercury, and nickel) and five indicator parameters (alkalinity, chloride, sodium, sulfate, and total dissolved solids) detected in downgradient Gallia wells are compared to concentration limits based on drinking water standards or site background concentrations. None of these concentration limits were exceeded in 2011.

The detection monitoring program for X-735 Berea wells continued in 2011. Concentrations of alkalinity, chloride, sodium, sulfate, and total dissolved solids in downgradient Berea wells are evaluated to monitor potential impacts to groundwater and trends in concentrations of these parameters (alkalinity,

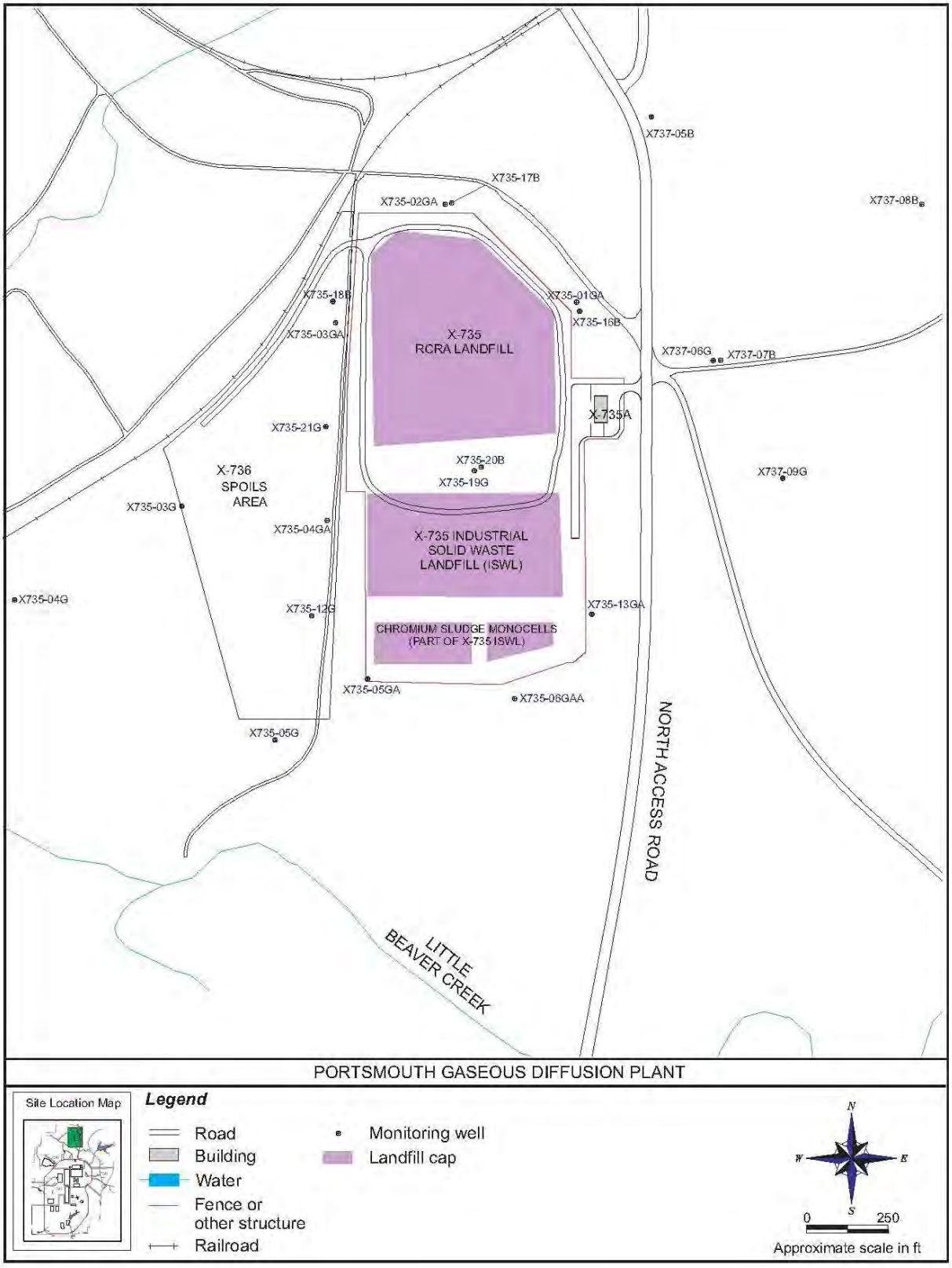

Figure 6.10. Monitoring wells at the X-735 Landfills.

chloride, sodium, sulfate, and total dissolved solids). None of the control limits used to determine a statistically significant change in the indicator parameters requiring Ohio EPA notification was exceeded in the X-735 Berea wells in 2011.

Samples from the X-735 monitoring wells were also analyzed for radionuclides (technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.10 X-734 Landfills

The X-734 Landfills in Quadrant IV consisted of three landfill units that were used until 1985. Detailed records of materials disposed in the landfills were not kept. However, wastes known to be disposed at the landfills included trash and garbage, construction spoils, wood and other waste from clearing and grubbing, and empty drums. Other materials reportedly disposed in the landfills may have included waste contaminated with metals, empty paint cans, and uranium-contaminated soil from the X-342 area.

The X-734 Landfills were closed in accordance with regulations in effect at that time, and no groundwater monitoring of the area was required. However, the RCRA Facility Investigation conducted in the early 1990s identified the presence of volatile organics, metals, and radionuclides in soil and/or groundwater in the area. The X-734 Landfills were capped in 1999-2000 as part of the remedial actions required for Quadrant IV. Chapter 3, Section 3.3.4.2, provides more information about the remedial actions for this area.

Fifteen wells (see Figure 6.11) are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the monitoring parameters for the wells in this area.

6.4.10.1 Monitoring results for the X-734 Landfills in 2011

Volatile organic compounds are routinely detected in a number of the wells that monitor the X-734 Landfills, but generally at concentrations below or just above preliminary remediation goals. In 2011, only vinyl chloride was detected above the preliminary remediation goal (2 µg/L). Vinyl chloride was detected at 2.4 µg/L in the second quarter sample collected from well X734-23G. Vinyl chloride is routinely detected in this well at concentrations just above or below 2 µg/L.

Samples from the X-734 monitoring wells were also analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.11 X-533 Switchyard Area

The X-533 Switchyard Area in Quadrant IV consisted of a switchyard containing electrical transformers and circuit breakers, associated support buildings, and a transformer cleaning pad. The groundwater area of concern is located north of the switchyard and associated support buildings near the transformer cleaning pad. In 2009, DOE received funding under ARRA for D&D of the X-533 Switchyard. D&D of the facilities began in 2010 and was completed in 2011. Chapter 3, Section 3.3.4.4, provides additional information about remedial activities in the area.

The X-533 Switchyard Area was identified as an area of concern for potential metals contamination in 1996 based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. The area was added to the PORTS groundwater monitoring program because the sampling identified metals that may have contaminated groundwater in this area. Three wells are sampled semiannually for cadmium and nickel.

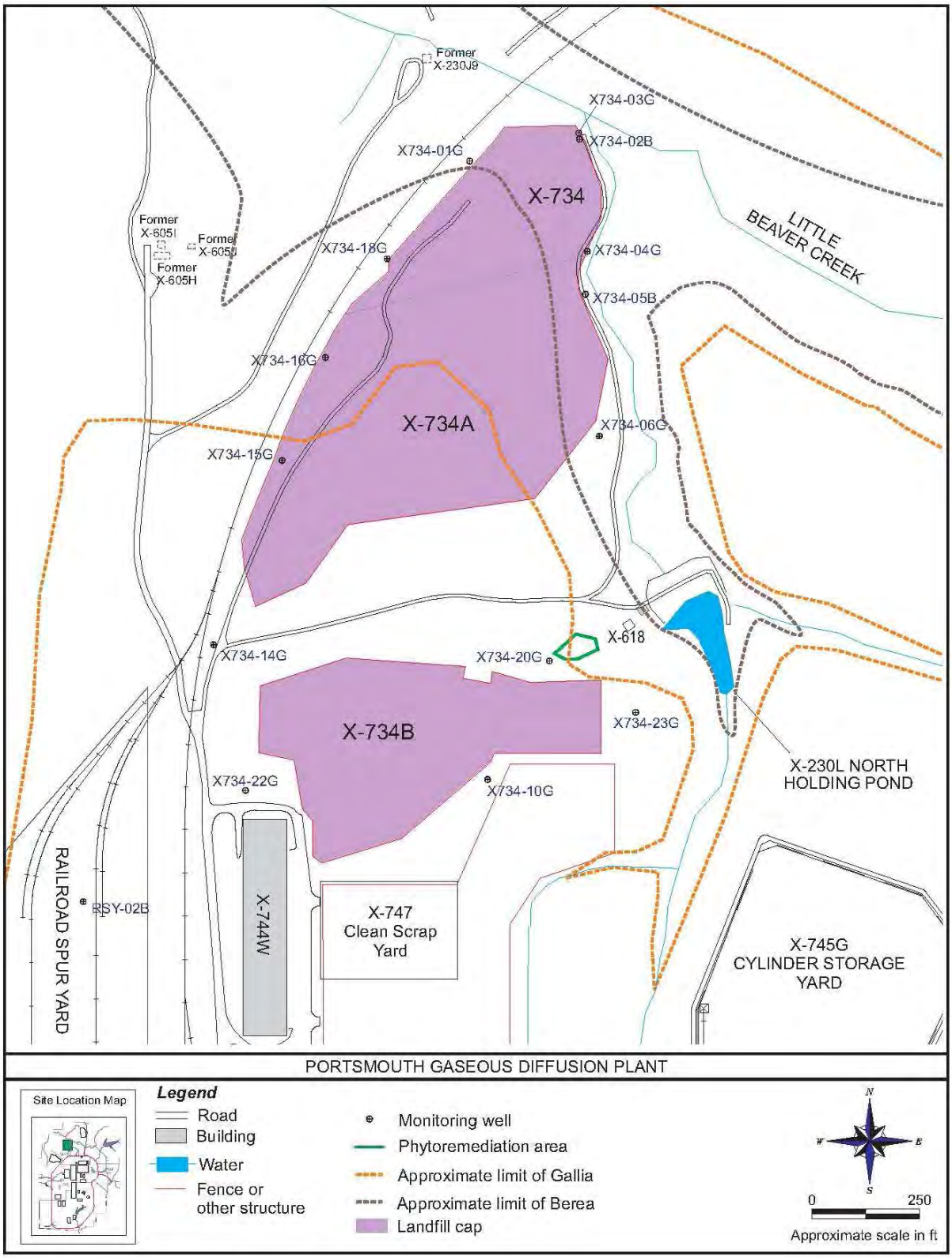

Figure 6.11. Monitoring wells at the X-734 Landfills.

6.4.11.1 Monitoring results for the X-533 Switchyard Area in 2011

Three wells that monitor the X-533 Switchyard Area were sampled in the second and fourth quarters of 2011 and analyzed for cadmium and nickel. Each of the well samples contained these metals at concentrations above the preliminary remediation goals (6.5 µg/L for cadmium and 100 µg/L for nickel). Concentrations of cadmium detected in the wells ranged from 10 to 54 µg/L, and concentrations of nickel detected in the wells ranged from 150 to 590 µg/L. Figure 6.6 shows the concentrations of metals detected in the X-533 wells in 2011.

6.4.12 Former X-344C Hydrogen Fluoride Storage Building

The former X-344C Hydrogen Fluoride Storage Building and associated hydrogen fluoride storage tanks were demolished and removed in 2006. In 2009, an investigation of soils and groundwater near the former building determined that groundwater in one monitoring well south of the former building contained two volatile organic compounds (*cis*-1,2-dichloroethene and *trans*-1,2-dichloroethene) at concentrations well below the applicable preliminary remediation goals.

This area was added to the PORTS groundwater monitoring program in 2010. One well is sampled annually for volatile organic compounds under the monitoring program for this area (see Figure 6.12).

6.4.12.1 Monitoring results for the Former X-344C Hydrogen Fluoride Storage Building in 2011

One volatile organic compound, *cis*-1,2-dichloroethene, was detected at 2 µg/L in the sample collected in the first quarter of 2011, which is less than the PRG of 70 µg/L. This detection is consistent with the data collected at this well in 2009 and 2010.

6.4.13 Surface Water Monitoring

Surface water monitoring is conducted in conjunction with groundwater assessment monitoring to determine if contaminants present in groundwater are detected in surface water samples. Surface water is collected quarterly from 14 locations (see Figure 6.13). Surface water samples are analyzed for the parameters listed in Table 6.1. The purpose for each surface water monitoring location is described as follows:

- Little Beaver Creek and East Drainage Ditch sample locations LBC-SW01, LBC-SW02, and EDD-SW01 assess possible X-701B area plume groundwater discharges.

- Little Beaver Creek sample locations LBC-SW02 and LBC-SW03 assesses potential contamination from the Former X-611A Lime Sludge Lagoons.

- Big Run Creek sample location BRC-SW01 assesses potential groundwater discharges from the Quadrant I Groundwater Investigative Area.

- Big Run Creek sample location BRC-SW05 monitors potential discharges from the X-749/PK Landfill groundwater collection system on the east side of the landfills, as well as the Quadrant I Groundwater Investigative Area.

- Big Run Creek sample location BRC-SW02 (downstream from BRC-SW01 and BRC-SW05) monitors potential discharges from the Quadrant I Groundwater Investigative Area and the X-749/ X-120/PK Landfill area.

- Southwestern Drainage Ditch sample locations UND-SW01 and UND-SW02 assess potential groundwater releases to this creek and the X-2230M Southwest Holding Pond from the western portion of the X-749/X-120 groundwater plume.

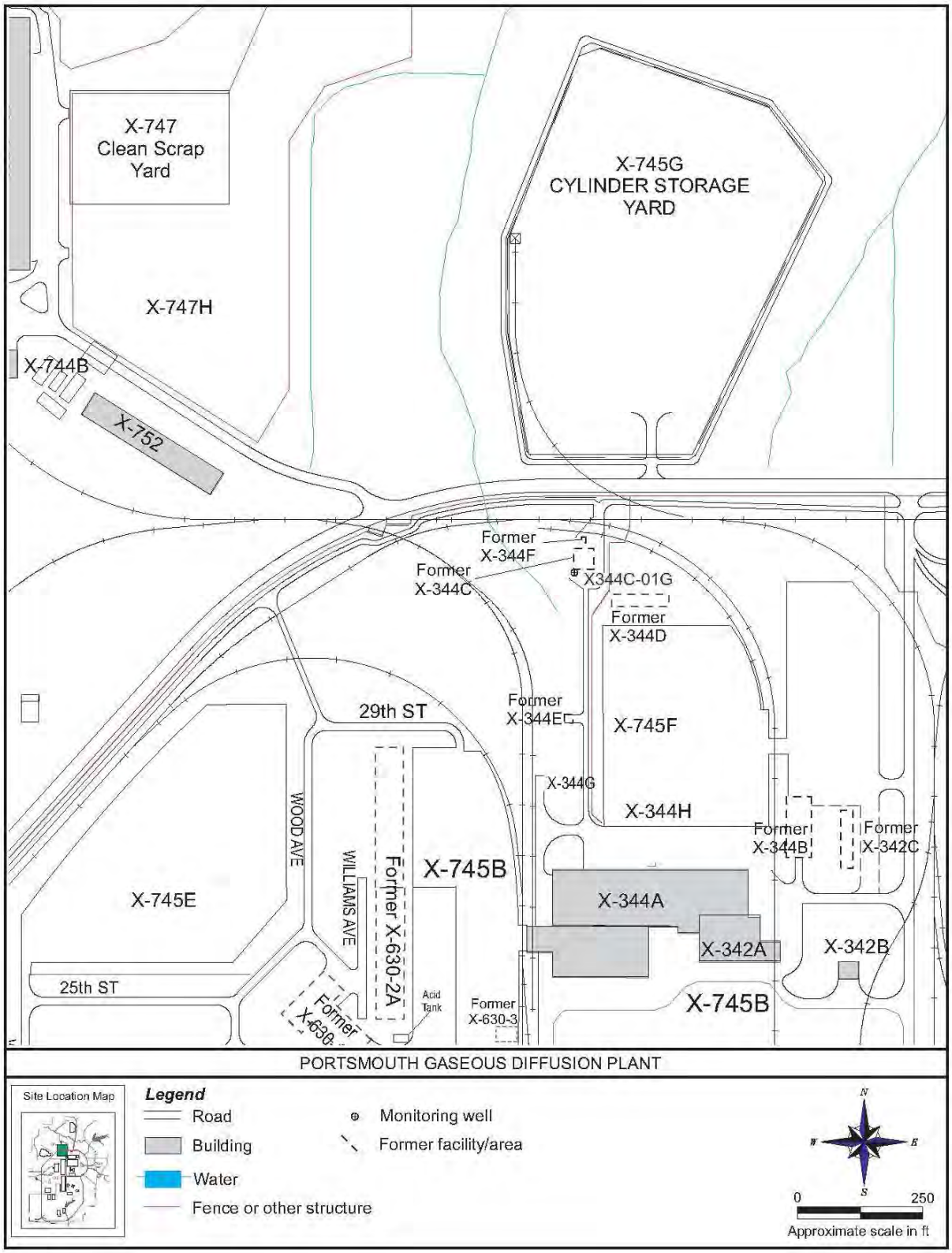

Figure 6.12. Monitoring well at the Former X-344C Hydrogen Fluoride Storage Building.

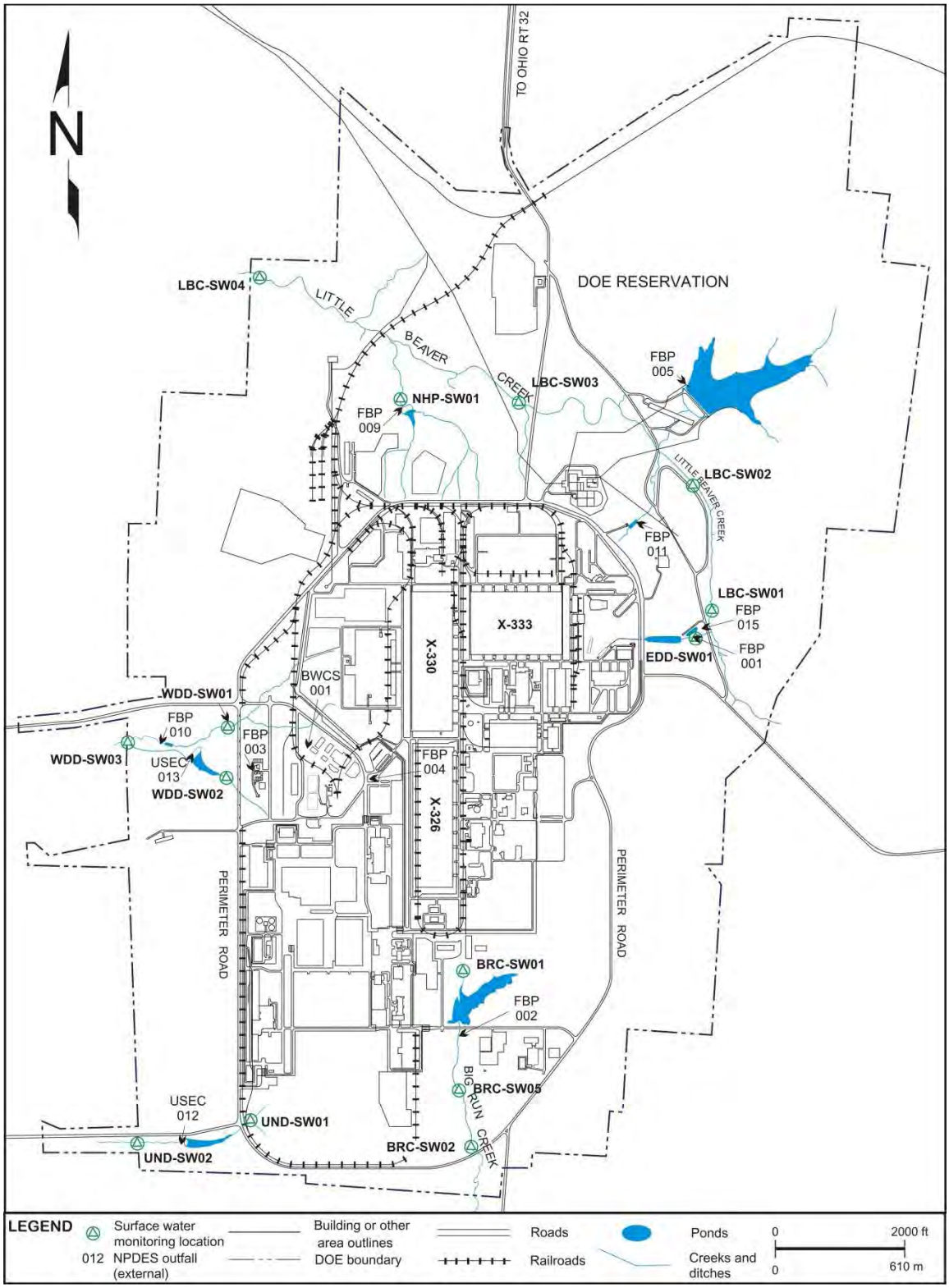

Figure 6.13. Surface water monitoring locations.

- North Holding Pond sample location NHP-SW01 and Little Beaver Creek sample location LBC-SW04 assess potential groundwater discharges from the X-734 Landfill and other Quadrant IV sources.

- Western Drainage Ditch sample locations WDD-SW01, WDD-SW02, and WDD-SW03 assess potential groundwater discharges from the X-616 and X-740 areas to the Western Drainage Ditch and the X-2230N West Holding Pond.

6.4.13.1 Monitoring results for surface water in 2011

Trihalomethanes are a category of volatile organic compounds that are byproducts of water chlorination and include bromodichloromethane, bromoform, chloroform, and dibromochloromethane. These compounds are detected at most of the surface water sampling locations because the streams receive discharges that contain chlorinated water from the PORTS NPDES outfalls. These detections were well below the applicable Ohio EPA water quality criteria for the protection of human health in the Ohio River drainage basin (bromodichloromethane – 460 µg/L; bromoform – 3600 µg/L; chloroform – 4700 µg/L; and dibromochloromethane – 340 µg/L).

Since the 1990s, TCE has been detected regularly at low levels in samples collected from the Southwestern Drainage Ditch (UND-SW01, located inside Perimeter Road). In 2011, TCE was detected at 1.8 to 3.8 µg/L in three of the four samples collected from the Southwestern Drainage Ditch at UND-SW01. TCE is routinely detected at low concentrations at this sampling point. 4-Methyl-2-pentanone (methyl isobutyl ketone) and *cis*-1,2-dichloroethene were also detected at estimated concentrations of 2.6 µg/L or less in one or more of the samples. TCE (1.6 µg/L) and 4-methyl-2-pentanone (2.8 µg/L) were detected in the second quarter sample collected from the Southwestern Drainage Ditch at UND-SW02. 4-Methyl-2-pentanone is a probable sample contaminant based on its detection in the trip and field blanks associated with the environmental samples. The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

TCE and/or *cis*-1,2-dichloroethene were detected at estimated concentrations of 2 µg/L or less at East Drainage Ditch sampling location EDD-SW01 and Little Beaver Creek sampling locations LBC-SW01, LBC-SW02, and LBC-SW03. Neither of these chemicals were detected at downstream Little Beaver Creek sampling location LBC-SW04. The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

Several volatile organic compounds were detected at estimated concentrations of 0.6 µg/L or less in samples collected from Big Run Creek in 2011. In special sampling conducted in the fourth quarter (December 2011) for the X-749/X-120 groundwater plume (see Section 6.4.1.4), TCE was detected at an estimated concentration of 0.28 µg/L in the sample collected from BRC-SW02. *Cis*-1,2-dichloroethene was detected at an estimated concentration of 0.15 µg/L in the second quarter sample collected from Big Run Creek at sampling location BRC-SW01. Toluene, a probable sample contaminant, was detected at estimated concentrations of 0.6 µg/L or less in the third quarter samples collected from BRC-SW02 and BRC-SW05.

Samples collected in the second and fourth quarters of 2011 were analyzed for selected transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Americium-241 was detected at activities ranging from 0.0549 to 0.082 pCi/L in the second quarter samples collected from Big Run Creek (BRC-SW01 and BRC-SW05), the Southwestern Drainage Ditch (UND-SW01 and UND-SW02), and the Western Drainage Ditch (WDD-SW01 and WDD-SW03). Americium-241 was also detected at 0.0737 pCi/L in the fourth quarter sample collected from WDD-SW03. Plutonium-239/240 was detected

at 0.0769 and 0.107 pCi/L in the fourth quarter samples collected at LBC-SW04 and BRC-SW05. Each of these results were above the minimum detectable activity but less than the laboratory reporting limit. No other transuranics were detected in the surface water samples collected during 2011.

Americium-241 and plutonium-239/240 are present in the environment at very small levels due to atmospheric fallout from nuclear weapons testing. The low levels of americium-241 and plutonium-239/240 detected in surface water may be present due to this fallout. Additionally, radionuclides detected at low levels near the minimum detectable activity, such as the detections of americium-241 and plutonium-239/240 in surface water, may be false positives due to the statistical methodology used in analysis of radionuclides. There are no PORTS preliminary remediation goals for americium-241 and plutonium-239/240 in surface water. However, these detections of americium-241 and plutonium-239/240 in surface water were less than the preliminary remediation goals for americium-241 and plutonium-239/240 in groundwater: 0.49 pCi/L and 0.51 pCi/L, respectively.

In the first and/or second quarters of 2011, technetium-99 was detected at activities ranging from 8.48 to 39.6 pCi/L in samples collected from the East Drainage Ditch (EDD-SW01) and the Little Beaver Creek sampling locations. Technetium-99 is occasionally detected at these locations. Technetium-99 was also detected at 11.5 pCi/L in the second quarter sample collected from Western Drainage Ditch at WDD-SW02. These detections are well below the Ohio EPA drinking water standard for technetium-99 (900 pCi/L, based on a 4 mrem/year dose from beta emitters). Technetium-99 was not detected in any of the other surface water samples collected during 2011.

Uranium was routinely detected in the 2011 surface water samples at levels similar to those detected in previous years. Detections of uranium isotopes were well below the DOE derived concentration standard for the respective uranium isotope in drinking water (680 pCi/L for uranium-233/234, 720 pCi/L for uranium-235, and 750 pCi/L for uranium-238). Because uranium occurs naturally in rocks and soil, some or all of the uranium detected in these samples may be due to naturally-occurring uranium.

6.4.14 Water Supply Monitoring

Routine monitoring of private residential drinking water sources is completed at PORTS in accordance with the requirements of Section VIII of the September 1989 Consent Decree between the State of Ohio and DOE and the *Integrated Groundwater Monitoring Plan.*

The purpose of the program is to determine whether PORTS has had any impact on the quality of the private residential drinking water sources. Although this program may provide an indication of contaminant transport off site, it should not be interpreted as an extension of the on-site groundwater monitoring program, which bears the responsibility for detection of contaminants and determining the rate and extent of contaminant movement. Data from this program will not be used in environmental investigations due to the lack of knowledge of how residential wells were constructed and due to the presence of various types of pumps (which may not be ideal equipment for sampling).

Six residential drinking water sources participated in the program in 2011 (see Figure 6.14). Wells are sampled semiannually with samples analyzed for the parameters listed in Table 6.1. The PORTS water supply (RES-012 on Figure 6.14) is also sampled as part of this program. Sampling locations may be added or deleted if requested by a resident and as program requirements dictate. Typically, sampling locations are deleted when a resident obtains a public water supply.

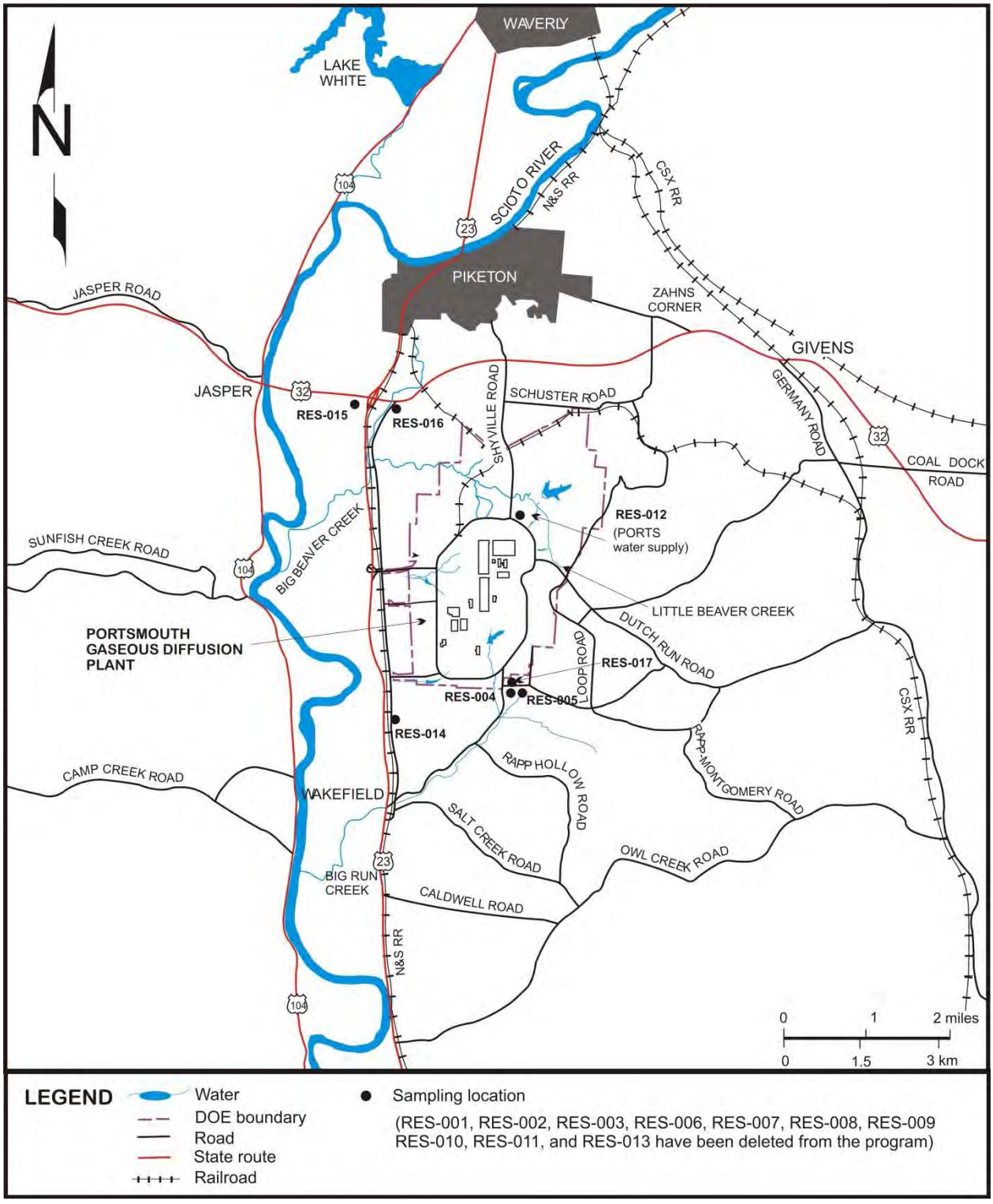

Figure 6.14. Water supply monitoring locations.

In the third quarter of 2011, TCE was detected at 1 µg/L in the sample collected from RES-017, which is south of PORTS on Big Run Road. TCE was not detected in the first quarter sample collected from this water supply. Since this residential water supply was added to the monitoring program in 2009, TCE has routinely been detected in the water supply samples at estimated concentrations ranging from 0.16 to 0.64 µg/L. These detections are less than the drinking water standard for TCE (5 µg/L). Big Run Creek is located between RES-017 and the affected water-bearing formation (i.e., Gallia groundwater) located in the southern portion of the plant site west of Big Run Creek. The Gallia groundwater drains into Big Run Creek.

Chloroform was detected at 0.35 and 1.7 µg/L in the first and third quarter samples collected from RES-015 (north of PORTS on State Route 124). Xylenes (M+P xylene and 1,2-dimethylbenzene) were detected at estimated concentrations of 1 µg/L or less in the third quarter samples collected from RES-004 and RES-005 (old and new wells at the same residence on Bailey Chapel Road south of PORTS).

No other volatile organic compounds (other than the sample contaminant acetone) were detected in the other residential water supply samples collected during 2011.

Each sample was analyzed for transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238). Americium-241 was detected at estimated activities between 0.0575 and 0.0665 pCi/L in the first quarter samples collected from RES-005 (south of PORTS on Bailey Chapel Road), RES-015 (north of PORTS on State Route 124), and RES-016 (north of PORTS on Wakefield Mound Road). A duplicate sample was collected from RES-005; americium-241 was undetected at 0.0281 pCi/L in the duplicate sample. These detections are approximately 0.4% of the drinking water standard of 15 pCi/L for alpha emitters. Chapter 4, Section 4.3.9.6, provides a dose assessment for a member of the public that would drink water throughout the year containing americium-241 at 0.0665 pCi/L. The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.169 mrem/year), is well below the DOE standard of 100 mrem/year.

Americium-241 was not detected in any of the third quarter samples collected from the water supply sampling locations. No other transuranics were detected in any of the water supply samples collected in 2011.

Technetium-99 was not detected in any of the water supply samples collected in 2011. Low levels of uranium and uranium isotopes detected in some of the wells are consistent with naturally-occurring concentrations found in groundwater in the area.

6.5 DOE ORDER MONITORING PROGRAMS

One of the DOE surveillance monitoring programs at PORTS is exit pathway monitoring. Exit pathway monitoring assesses the effect of the facility on off-site surface water and groundwater quality.

6.5.1 Exit Pathway Monitoring

Selected locations on local streams and drainage channels near the PORTS boundary are sampling points of the exit pathway monitoring program because surface water from PORTS NPDES outfalls and groundwater discharge to these surface waters. Monitoring wells near the PORTS boundary are also used in the exit pathway monitoring program. Figure 6.15 shows the sampling locations for exit pathway monitoring and Table 6.1 lists the analytical parameters.

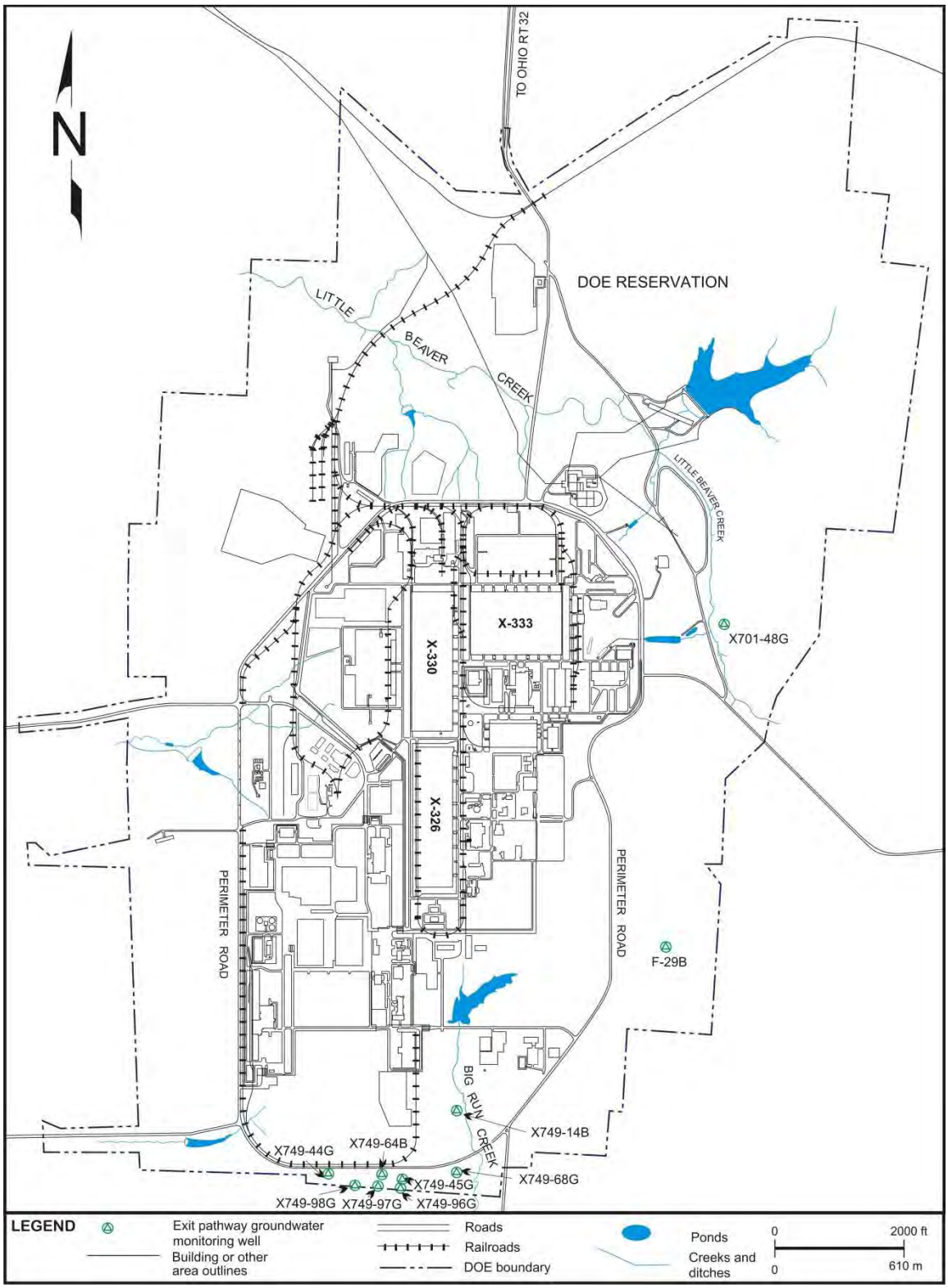

Figure 6.15. Exit pathway monitoring locations.

Surface water sampling points on Big Run Creek (BRC-SW02), Little Beaver Creek (LBC-SW04), Southwestern Drainage Ditch (UND-SW02), and Western Drainage Ditch (WDD-SW03) are part of the exit pathway monitoring program. TCE was detected at concentrations of 1.6 µg/L or less in samples collected from the Southwestern Drainage Ditch (UND-SW02) and Big Run Creek (BRC-SW02) (see Section 6.4.13.1). The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

Trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane), which are common residuals in chlorinated drinking water, were detected in samples collected from the Western Drainage Ditch at concentrations well below Ohio EPA non-drinking water quality criteria for trihalomethanes for the protection of human health in the Ohio River drainage basin (see Section 6.4.13.1). Probable sample contaminants were also detected in samples collected from Big Run Creek at BRC-SW02 and UND-SW02 (see Section 6.4.13.1).

Americium-241, plutonium-239/240, and/or technetium-99 were detected at surface water exit pathway monitoring locations on Little Beaver Creek (LBC-SW04), the Southwestern Drainage Ditch (UND-SW02), and the Western Drainage Ditch (WDD-SW03). Section 6.4.1.3 provides more information about these detections.

TCE and radionuclides were also detected in several on-site groundwater monitoring wells that are part of the exit pathway monitoring program. TCE was detected in several wells that monitor the X-749/ X-120/PK Landfill area (see Section 6.4.1.3). For all but one of these wells, concentrations of TCE were below the Ohio EPA drinking water standard for TCE (5 µg/L). TCE was detected at 37 µg/L in a sample collected from well X749-14B in September 2011. Section 6.4.1.3 provides additional information about these detections.

Americium-241, plutonium-239/240, and/or uranium were detected in one of the X-749 monitoring wells (X749-96G) and the exit pathway monitoring well located east of the Quadrant I Groundwater Investigative Area (F-29B). These radionuclides were present at levels below the preliminary remediation goals.

6.6 GROUNDWATER TREATMENT FACILITIES

In 2011, a combined total of almost 34 million gallons of water were treated at the X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities. Approximately 34 gallons of TCE were removed from the water. All processed water is discharged through NPDES outfalls before exiting PORTS. Facility information is summarized in Table 6.2.

Table 6.2. Summary of TCE removed by PORTS groundwater treatment facilities in 2011

Facility	Gallons of water treated	Gallons of TCE removed
X-622	20,912,800	2.3
X-623	1,403,900	2.5
X-624	3,018,800	10
X-627	8,640,500	19

6.6.1 X-622 Groundwater Treatment Facility

The X-622 Groundwater Treatment Facility consists of an air stripper with aqueous-phase activated carbon filtration. This facility processes groundwater from the following systems in Quadrant I (see Figures 6.2 and 6.3):

- groundwater collection system with associated sump (X749-WPW) and extraction wells X749-EW05G and X749-EW06G on the southwest boundary of the X-749 Landfill;
- groundwater extraction wells X749-EW01G, X749-EW02G, X749-EW03G, and X749-EW04G installed in 2007 in the X-749 South Barrier Wall area;
- groundwater extraction wells (X749-EW07G, X749-EW08G, and X749-EW09G) installed in 2010 in the X-749/X-120 groundwater plume;
- groundwater collection system and associated sumps (PK-PL6 and PK-PL6A) on the eastern boundary of the PK Landfill; and
- fifteen extraction wells located in the Quadrant I Groundwater Investigative Area.

The facility processed almost 21 million gallons of groundwater during 2011, thereby removing approximately 2.3 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 608, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 608 in 2011.

6.6.2 X-623 Groundwater Treatment Facility

The X-623 Groundwater Treatment Facility consists of an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. Prior to implementation of the X-701B IRM, the X-623 Groundwater Treatment Facility treated TCE-contaminated groundwater from a sump in the bottom of the X-701B Holding Pond and three groundwater extraction wells (X623-EW01G, X623-EW02G, and X623-EW03G) east of the holding pond. Extraction wells X623-EW02G and X623-EW03G were removed in November 2009 at the beginning of implementation of the IRM. The sump in the bottom of the X-701B Holding Pond was removed in 2010. Extraction well X623-EW01G was removed in January 2011.

During 2011, the X-623 Groundwater Treatment Facility treated water from extraction well X623-EW01G, water collected during activities associated with the X-701B IRM, and other miscellaneous water associated with site activities (in accordance with the NPDES permit). The X-623 Groundwater Treatment Facility did not operate in September and December of 2011 and operated intermittently in October and November of 2011.

The facility treated approximately 1.4 million gallons of water during 2011, thereby removing approximately 2.5 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 610, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 610 in 2011.

6.6.3 X-624 Groundwater Treatment Facility

At the X-624 Groundwater Treatment Facility, groundwater is treated via an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. This facility processes TCE-contaminated groundwater from the X-237 Groundwater Collection System on the east side of the X-701B groundwater plume. The X-237 Groundwater Collection System consists of north-south and east-west collection trenches and two sumps/pumping wells (see Figure 6.5).

The X-624 Groundwater Treatment Facility treated approximately 3 million gallons of water in 2011, thereby removing approximately 10 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 015, which discharges to Little Beaver Creek. No NPDES permit limitations were exceeded at Outfall 015 in 2011.

6.6.4 X-627 Groundwater Treatment Facility

The X-627 Groundwater Treatment Facility consists of an air stripper with offgas activated carbon filtration and aqueous phase activated carbon filtration. The X-700 and X-705 buildings are located above the Quadrant II Groundwater Investigative Area plume, and contaminated groundwater is extracted from sumps located in the basement of each building (see Figure 6.4).

Approximately 8.6 million gallons of groundwater were processed during 2011, thereby removing 19 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 611 in 2011.

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7. QUALITY ASSURANCE

7.1 SUMMARY

Quality assurance and quality control are essential components of DOE environmental monitoring programs at PORTS. Quality is integrated into sample preservation, field data and sample collection, sample transportation, and sample analysis. Numerous program assessment activities in the field and within the facilities are conducted at regular intervals to demonstrate that quality is built into and maintained in all DOE programs. Analytical laboratories used by DOE contractors during 2011 participated in the DOE Consolidated Audit Program and Mixed-Analyte Performance Evaluation Program.

7.2 INTRODUCTION

Quality assurance, an integral part of environmental monitoring, requires systematic control of the processes involved in sampling the environment and in analyzing the samples. To demonstrate accurate results, DOE uses the following planned and systematic controls:

- implementation of standard operating procedures for sample collection and analysis;
- training and qualification of surveyors and analysts;
- implementation of sample tracking and chain-of-custody procedures to demonstrate traceability and integrity of samples and data;
- participation in external quality control programs;
- frequent calibration and routine maintenance of measuring and test equipment;
- maintenance of internal quality control programs;
- implementation of good measurement techniques and good laboratory practices; and
- frequent assessments of field sampling, measurement activities, and laboratory processes.

Environmental sampling is conducted by DOE contractors at PORTS in accordance with state and federal regulations and DOE Orders. Sampling plans and procedures are prepared, and appropriate sampling instruments or devices are selected in accordance with practices recommended by U.S. EPA, the American Society for Testing and Materials, or other authorities. Chain-of-custody forms document sample custody from sample collection through receipt by the analytical laboratory. The samples remain in the custody of the sampling group until the samples are received at the laboratory. Samples shipped to an off-site laboratory are sealed within the shipping container to prevent tampering until they are received by the sample custodian at the off-site laboratory.

The analytical data are reviewed to determine compliance with applicable regulations and permits. The data are used to identify locations and concentrations of contaminants of concern, to evaluate the rate and extent of contamination at the site, and to help determine the need for remedial action. Adequate and complete documentation generated as a result of these efforts supports the quality standards established by DOE. Quality Assurance Project Plans were used by LPP and FBP during 2011 to ensure a consistent system for collecting, assessing, and documenting environmental data of known and documented quality.

7.3 FIELD SAMPLING AND MONITORING

Personnel involved in field sampling and monitoring are properly trained through a combination of classroom, on-line, and/or on-the-job training as required by environmental, health, and safety regulations and DOE contract requirements. Procedures are developed from guidelines and regulations created by DOE or other regulatory agencies that have authority over PORTS activities. These procedures specify sampling protocol, sampling devices, and containers and preservatives to be used. Chain-of-custody procedures (used with all samples) are documented, and samples are controlled and protected from the point of collection to the generation of analytical results.

Data generated from field sampling can be greatly influenced by the methods used to collect and transport the samples. A quality assurance program provides the procedures for proper sample collection so that the samples represent the conditions that exist in the environment at the time of sampling. The DOE quality assurance program at PORTS mandates compliance with written sampling procedures, use of clean sampling devices and containers, use of approved sample preservation techniques, and collection of field blanks, trip blanks, and duplicate samples. Chain-of-custody procedures are strictly followed to maintain sample integrity. In order to maintain sample integrity, samples are delivered to the laboratory as soon as practicable after collection.

7.4 ANALYTICAL QUALITY ASSURANCE

DOE contractors at PORTS only use analytical laboratories that demonstrate compliance in the following areas through participation in independent audits and surveillance programs:

- compliance with federal waste disposal regulations,
- data quality,
- materials management,
- sample control,
- data management,
- electronic data management,
- implementation of a laboratory quality assurance plan, and
- review of external and internal performance evaluation program.

After analytical laboratory data are received by DOE contractors, they are independently evaluated using a systematic process that compares the data to established quality assurance/quality control criteria. An independent data validator checks documentation produced by the analytical laboratory to verify that the laboratory has provided data that meet established criteria.

In 2011, samples collected for DOE environmental monitoring programs at PORTS such as NPDES monitoring, groundwater monitoring required by the *Integrated Groundwater Monitoring Plan*, and environmental monitoring required by the *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*, were sent to analytical laboratories that participated in DOE programs to ensure data quality. The DOE Consolidated Audit Program implements annual performance qualification audits of environmental laboratories. The DOE Mixed-Analyte Performance Evaluation Program provides semiannual performance testing and evaluation of analytical laboratories.

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APPENDIX A

RADIATION

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This appendix presents basic facts concerning radiation. The information is intended as a basis for understanding the dose associated with releases from PORTS, not as a comprehensive discussion of radiation and its effects on the environment and biological systems. *The McGraw-Hill Dictionary of Scientific and Technical Terms* defines radiation and radioactivity as follows.

> *radiation* — 1) The emission and propagation of waves transmitting energy through space or through some medium; for example, the emission and propagation of electromagnetic, sound, or elastic waves. 2) The energy transmitted through space or some medium; when unqualified, usually refers to electromagnetic radiation. Also known as radiant energy. (3) A stream of particles, such as electrons, neutrons, protons, alpha particles, or high-energy photons, or a mixture of these (McGraw-Hill 1989).
>
> *radioactivity*—A particular type of radiation emitted by a radioactive substance, such as alpha radioactivity (McGraw-Hill 1989).

Radiation occurs naturally; it was not invented but discovered. 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.

A.1 ATOMS AND ISOTOPES

All matter is made up of atoms. An atom is "a unit of measure consisting of a single nucleus surrounded by a number of electrons equal to the number of protons in the nucleus" (American Nuclear Society 1986). 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. Atoms of the same element with a different number of neutrons are called isotopes. In other words, isotopes have the same chemical properties but different atomic weights. Figure A.1 depicts isotopes of the element hydrogen.

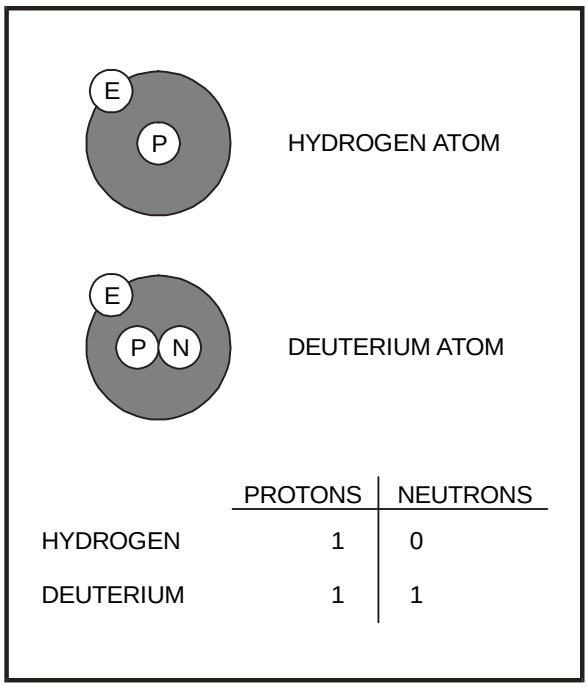

Figure A.1. Isotopes of the element hydrogen

Another example is the element uranium, which has 92 protons; all isotopes of uranium, therefore, have 92 protons. However, each uranium isotope has a different number of neutrons. Uranium-238 (also denoted ^{238}U) has 92 protons and 146 neutrons; uranium-235 has 92 protons and 143 neutrons; uranium-234 has 92 protons and 142 neutrons.

Some isotopes are stable, or nonradioactive; some are radioactive. Radioactive isotopes are called radioisotopes, or radionuclides. In an attempt to become stable, radionuclides "throw away," or emit, rays or particles. This emission of rays and particles is known as radioactive decay. Each radionuclide has a "radioactive half-life," which is the average time that it takes for half of a specified number of atoms to decay. Half-lives can be very short (less than a second) or very long (millions of years), depending on the radionuclide. Appendix C presents the half-lives of radionuclides of interest at PORTS.

A.2 RADIATION

Radiation, or radiant energy, is energy in the form of waves or particles moving through space. 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. Radiation also is characterized as ionizing or nonionizing radiation by the way in which it interacts with matter.

A.2.1 Ionizing Radiation

Normally, an atom has an equal number of protons and electrons; however, atoms can lose or gain electrons in a process known as ionization. Some forms of radiation can ionize atoms by "knocking" electrons off atoms. Examples of ionizing radiation include alpha, beta, and gamma radiation.

Ionizing radiation is capable of changing the chemical state of matter and subsequently causing biological damage and thus is potentially harmful to human health. Figure A.2 shows the penetrating potential of different types of ionizing radiation.

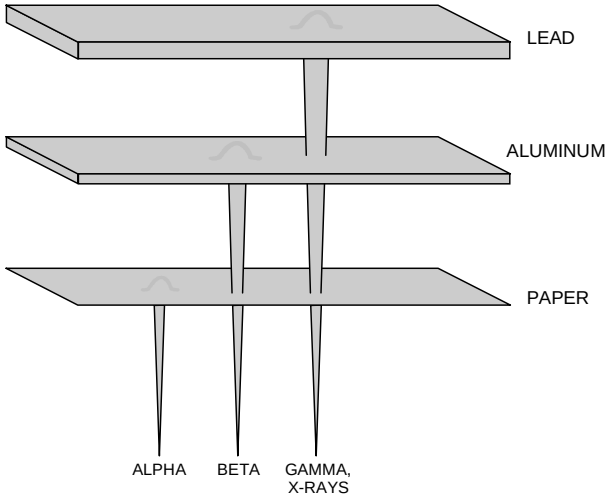

Figure A.2. Penetrating power of radiation.

A.2.2 Nonionizing Radiation

Nonionizing radiation bounces off or passes through matter without displacing electrons. Examples include visible light and radio waves. Currently, it is unclear whether nonionizing radiation is harmful to human health. In the discussion that follows, the term radiation is used to describe ionizing radiation.

A.3 SOURCES OF RADIATION

Radiation is everywhere. Most occurs naturally, but a small percentage is human-made. Naturally occurring radiation is known as background radiation.

A.3.1 Background Radiation

Many materials are naturally radioactive. In fact, this naturally occurring radiation is the major source of radiation in the environment. Although people have little control over the amount of background radiation to which they are exposed, this exposure must be put into perspective. Background radiation remains relatively constant over time; 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. Background radiation is categorized as space, terrestrial, or internal, depending on its origin.

A.3.1.1 Space radiation

Energetically charged particles from outer space continuously hit the earth's atmosphere. These particles and the secondary particles and photons they create are called space or cosmic radiation. Because the atmosphere provides some shielding against space radiation, the intensity of this radiation increases with altitude above sea level. For example, a person in Denver, Colorado, is exposed to more space radiation than a person in Death Valley, California.

A.3.1.2 Terrestrial radiation

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.

A.3.1.3 Internal radiation

Radioactive material in the environment can enter the body through the air people breathe and the food they eat; it also can enter through an open wound. Natural radionuclides that can be inhaled and ingested include isotopes of uranium, thorium, radium, radon, polonium, bismuth, and lead in the ^{238}U and ^{232}Th decay series. In addition, the body contains isotopes of potassium (^{40}K), rubidium (^{87}Rb), and carbon (^{14}C).

A.3.2 Human-made Radiation

Most people are exposed to human-made sources of radiation. Examples include consumer products, medical sources, and industrial or occupational sources. About one-half of 1% of the U.S. population performs work in which radiation in some form is present. Atmospheric testing of atomic weapons was a source of human-made radiation, but testing has been suspended in the United States and most parts of the world. Fallout from atmospheric weapons testing is not currently a significant contributor to background radiation (Health Physics Society 2010).

A.3.2.1 Consumer products and activities

Some consumer products are sources of radiation. In some consumer products, such as smoke detectors, watches, or clocks, radiation is essential to the performance of the device. In other products or activities, such as smoking tobacco products or building materials, the radiation occurs incidentally to the product function. Commercial air travel is another consumer activity that results in exposure to radiation (from space radiation).

A.3.2.2 Medical sources

Radiation is an important tool of diagnostic medicine and treatment, and, in this use, is the main source of exposure to human-made radiation. Exposure is deliberate and directly beneficial to the patients exposed. Generally, medical exposures result from 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 medicine 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.

A.3.2.3 Industrial and occupational sources

Other sources of radiation include emissions of radioactive materials from nuclear facilities such as uranium mines, fuel processing plants, and nuclear power plants; emissions from mineral extraction facilities; and the transportation of radioactive materials. Workers in certain occupations may also be

exposed to radiation due to their jobs. These occupations include positions in medicine, aviation, research, education, and government.

A.4 PATHWAYS OF RADIATION

Radiation and radioactive materials in the environment can reach people through many routes (see Figure A.3). Potential routes for radiation are referred to as pathways. For example, radioactive material in the air could fall on a pasture. The grass could then be eaten by cows, and the radioactive material on the grass would be present 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.

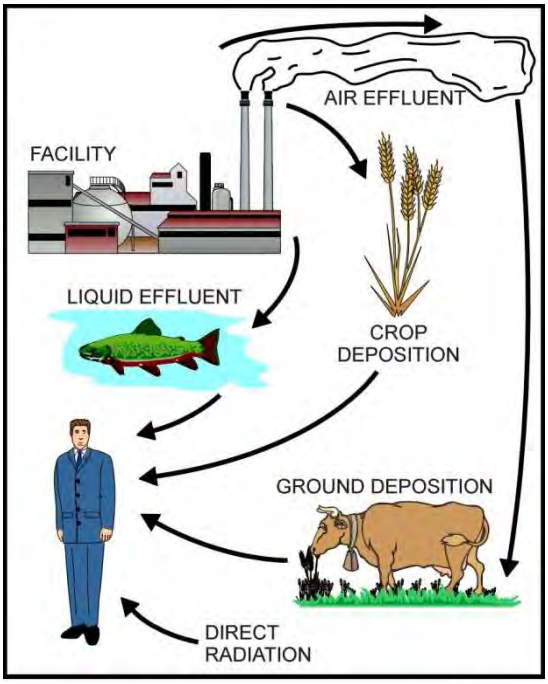

Figure A.3. Possible radiation pathways.

A.5 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.

A.5.1 Activity

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 radionuclides. For that reason, 1 gram of a radioactive substance may contain the same amount of activity as several tons of another material. This activity is expressed in a unit of measure known as a curie (Ci). More specifically, 1 Ci = 3.7E+10 (37,000,000,000) atom disintegrations per second (dps). In the international system of units, 1 dps = 1 becquerel (Bq). Table A.1 provides units of radiation measure and applicable conversions.

Table A.1. Units of radiation measures

Current System	International System	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

A.5.2 Absorbed Dose

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 rad. In the international system of units, 100 rad equals 1 gray (Gy). In terms of human health, however, it is the effect of the absorbed energy that is important, not the actual amount.

A.5.3 Dose

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 rem. One rem of any type of radiation has the same total damaging effect. Because a rem represents a fairly large dose, dose is expressed as a millirem (mrem) or 1/1000 of a rem. In the international system of units, 100 rem equals 1 sievert (Sv); 100 mrem equals 1 millisievert (mSv). Specific types of dose are defined as follows:

- **dose** – 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 sievert).

- **committed dose** – The calculated total dose 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 is expressed in units of rem (or sievert).

- **committed effective dose** – The sum of the committed doses to various tissues in the body, each multiplied by an appropriate weighting factor. Committed effective dose is expressed in units of rem (or sievert).

- **effective dose** – The sum of the doses received by all organs or tissues of the body after each one has been multiplied by the appropriate weighting factor. The effective dose includes the committed effective doses from internal deposition of radionuclides and the effective doses attributable to sources external to the body.

- **collective dose/collective effective dose** – The sums of the doses or effective doses of all individuals in an exposed population expressed in units of person-rem (or person-sievert). When the collective dose of interest is for a specific organ, the units would be organ-rem (or organ-sievert). This dose is also called the population dose.

A.6 DOSE

Many terms are used to report dose. 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 and effective dose 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, ionizing radiation 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.6.1 Comparison of Dose Levels

Table A.2 presents a scale of dose levels. 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 familiarize the reader with the type of doses individuals may receive.

A.6.1.1 Dose from space radiation

The average annual dose received by residents of the United States from space radiation is about 33 mrem (0.33 mSv) (NCRP 2009). The average dose to a person living in Honolulu, Hawaii (at sea level and near the equator) is about 20 mrem (0.2 mSv), while the average dose to a person living in Colorado Springs, Colorado (high altitude and latitude) is about 70 mrem (0.7 mSv) (Health Physics Society 2010a).

Table A.2. Comparison and description of various dose levels

Dose level	Description
0.85 mrem (0.0085 mSv)	Approximate daily dose from natural background radiation, including radon
1.92 mrem (0.0192 mSv)	Cosmic dose to a person on a one-way airplane flight from Washington D.C. to Seattle
10 mrem (0.10 mSv)	Annual exposure limit, set by U.S. EPA, for exposures from airborne emissions from operations of nuclear fuel cycle facilities, including power plants and uranium mines and mills
36 mrem (0.36 mSv)	Average annual dose to a person who smokes one pack of cigarettes per day
36 mrem (0.36 mSv)	Mammogram (two views)
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
60 mrem (0.60 mSv)	X-ray (single exposure) of abdomen or hip
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
244 mrem (2.44 mSv)	Average dose from an upper gastrointestinal diagnostic X-ray series
300 mrem (3.00 mSv)	Average annual dose to a person in the United States from all sources of medical radiation
311 mrem (3.11 mSv)	Average annual dose to a person in the United States from all sources of natural background radiation
700 mrem (7.0 mSv)	Computed tomography – chest
1-5 rem (0.01-0.05 Sv)	U.S. EPA protective action guideline calling for public officials to 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 the Nuclear Regulatory Commission and DOE
10 rem (0.10 Sv)	The Biological Effects of Ionizing Radiation V report estimated that an acute dose at this level would result in a lifetime excess risk of death from cancer of 0.8% (Biological Effects of Ionizing Radiation 1990)
25 rem (0.25 Sv)	U.S. EPA guideline for voluntary maximum dose to emergency workers for non-lifesaving work during an emergency
75 rem (0.75 Sv)	U.S. 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 and NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States* (NCRP 2009).

A.6.1.2 Dose from terrestrial radiation

The average annual dose received from terrestrial gamma radiation is about 21 mrem (0.21 mSv) in the United States (NCRP 2009). Similar to space radiation, this dose varies geographically across the country with the lowest doses on the Atlantic and Gulf coastal plains and highest doses in the mountains in the western United States.

A.6.1.3 Dose from internal radiation

Inhalation of the short-lived decay products of radon are the major contributors to the annual dose equivalent for internal radionuclides (mostly ^{222}Rn). They contribute an average dose of about 228 mrem (2.28 mSv) per year (NCRP 2009). The average dose from ingestion of radionuclides is about 29 mrem (0.29 mSv) per year, which can be attributed to the naturally occurring isotope of potassium, ^{40}K; and isotopes of thorium (Th), uranium (U), and their decay series (NCRP 2009).

A.6.1.4 Dose from consumer products

The U.S. average annual dose received by an individual from consumer products is about 13 mrem (0.13 mSv) (NCRP 2009). Almost 90 percent of this dose results from smoking cigarettes, commercial air travel, and building materials (radionuclides present in brick, masonry, cement, concrete, and other materials).

A.6.1.5 Dose from medical sources

Medical exams and procedures account for the largest portion of the average annual dose received from human-made sources. These procedures include x-rays, computed tomography (a more sophisticated type of x-ray), and fluoroscopy, and nuclear medicine. The increase in the use of medical imaging procedures, especially computed tomography, over the last 25 years has resulted in a marked increase in the average annual dose from medical sources received by a person in the United States: 53 mrem/year in the early 1980s to 300 mrem/year in 2006 (NCRP 2009). The actual doses received by individuals who complete such medical exams can be much higher than the average value because not everyone receives such exams each year.

A.6.1.6 Doses from industrial and occupational sources

Small doses received by individuals occur as a result of emissions of radioactive materials from nuclear facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials. The combination of these sources contributes less than 1 mrem (0.01 mSv) per year to the average dose to an individual (NCRP 2009).

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APPENDIX B

ENVIRONMENTAL PERMITS

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Table B.1. DOE environmental permits and registrations at PORTS

Permit/registered source	Source no.	Issue date	Expiration date	Status
FBP– Clean Air Act Permits				
Title V Permit (0666000000)	P0090473	7/31/2003	8/21/2008	Extended
Title V Permit Renewal Application	P0109662	OEPA Received 03/07/2012	-	-
Permit to Operate X-627 Groundwater Treatment Facility	P474, T104, T105	2/26/2008	2/26/2013	Active
Permit to Install and Operate X-326 L-cage Glove Box	P022	11/12/2008	11/12/2018	Active
Permit to Install and Operate X-735 Landfill Cap and Venting System (northern portion)	P023	11/12/2008	11/12/2018	Active
Permit to Install X-670A Cooling Tower	P539	07/29/2010	None	Active
Permit to Install X-333 Low Assay Withdrawal Seal Exhaust System	P117	01/10/2006	None	Inactive
Permit to Install Biodenitrification Vent #1	P040	11/03/2005	None	Active
Permit to Install Biodenitrification Vent #2	P041	11/03/2005	None	Active
Permit to Install Biodenitrification Vent #3	P042	11/03/2005	None	Active
Permit to Install X-700 Radiation Calibration Lab Fume Hood	P045	11/03/2005	None	Active
Permit to Install X-705 Calciners (B Area)	P053	11/03/2005	None	Active
Permit to Install X-720 Instrument Cleaning Room Hood 4	P065	11/03/2005	None	Active
Permit to Install X-720 Motor Shop Steam Cleaning Booth	P067	11/03/2005	None	Active
Permit to Install X-344 Pigtail Gulper	P430	05/17/2005	None	Active
Permit to Install X-701B In Situ Chemical Oxidation with Recirculation Treatment System	P475, T106	03/15/2005	None	Inactive
Permit to Install X-720 Instrument Cleaning Room Glove Box	P474	11/19/2002	None	Active
Permit to Install X-705 Dry Ice Blaster with HEPA Filter	P473	04/11/2002	None	Active
Permit to Install X-705 8 inch, 12 inch, and 2.5 Ton Uranium Cylinders, Cleaned for Reuse or Disposal	P470	04/11/2002	None	Active
Permit to Install X-344 Toll Transfer Facility	P469	12/12/2000	None	Active
Permit to Install X-343 Feed Vaporization and Sampling	P468	12/12/2000	None	Inactive
Permit to Install 85 Horsepower Trash Pump	P467	05/24/2000	None	Active
Permit to Install X-600 Ash Collection System	P024	02/24/2000	None	Active
Permit to Install X-847 Glove Box	P466	07/21/1999	None	Active

Table B.1. DOE environmental permits and registrations at PORTS (continued)

Permit/registered source	Source no.	Issue date	Expiration date	Status
FBP– Clean Air Act Permits (continued)				
Permit to Install 700 KW Mobile Emergency Generator	P463	09/02/1998	None	Active
Permit to Install X-600 0.52 MMBTU/Hr 50 KW Electric Generator	P464	09/02/1998	None	Active
X-624 Groundwater Treatment Facility (now considered a *de minimis* source)	P019	10/28/1992	None	Active
Registered Source X-623 Groundwater Treatment Facility	P018	01/08/1992	None	Active
Registered Source X-749 Contaminated Materials Disposal Facility	P027	04/17/1991	None	Active
Permit to Install Gasoline Dispensing Facility	G001	10/31/1990	None	Active
Permit to Install X-720 Burn Off Oven	N002	12/09/1987	None	Active
Permit by Rule X-152-J-3 Emergency Generator	P543	3/22/2012	None	Active
BWCS – Clean Air Act Permits				
Permit to Install and Operate Process Line 1 (DUF_6 Conversion Facility)	P001	3/23/2012	None	Active
Permit to Install and Operate Process Line 2 (DUF_6 Conversion Facility)	P002	3/23/2012	None	Active
Permit to Install and Operate Process Line 3 (DUF_6 Conversion Facility)	P003	3/23/2012	None	Active
Permit to Install and Operate HVAC System (DUF_6 Conversion Facility)	P004	3/23/2012	None	Active
FBP – Clean Water Act/Safe Drinking Water Act Permits				
NPDES Permit	0IO00000*KD	9/1/2011	4/30/2013	Active
NPDES Construction Stormwater General Permit	OHC000003	4/21/2008	4/20/2013	Active
Safe Drinking Water Act – License to Operate a Public Water System	OH6632414	1/1/2012	1/30/2013	Active
Permit to Install X-622 Groundwater Treatment Facility	06-2951	11/20/1990	None	Active
Permit to Install X-623 Groundwater Treatment Facility	06-3528	1/919/1996	None	Active
Permit to Install X-624 Groundwater Treatment Facility	06-3556	10/28/1992	None	Active
Permit to Install X-627 Groundwater Treatment Facility	06-07283	1/13/2004	None	Active
BWCS – Clean Water Act Permit				
NPDES Permit	0IS00034*AD	4/25/2007	5/31/2012	Active
FBP – Hazardous Waste Permit				
RCRA Part B Permit (DOE/FBP)	Ohio Permit No. 04-66-0680	3/25/2011	3/25/2021	Active
FBP – Registrations				
Underground Storage Tank Registration	66005107		Renewed annually	Active

APPENDIX C

RADIONUCLIDE AND CHEMICAL NOMENCLATURE

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Table C.1. Nomenclature for elements and chemical constituents

Constituent	Symbol
Aluminum	Al
Ammonia	NH_3
Antimony	Sb
Arsenic	As
Barium	Ba
Beryllium	Be
Cadmium	Cd
Calcium	Ca
Chromium	Cr
Cobalt	Co
Copper	Cu
Iron	Fe
Lead	Pb
Lithium	Li
Magnesium	Mg
Manganese	Mn
Mercury	Hg
Nickel	Ni
Nitrogen	N
Nitrate	NO_3
Nitrite	NO_2
Phosphorus	P
Phosphate	PO_4
Potassium	K
Selenium	Se
Silver	Ag
Sodium	Na
Sulfate	SO_4
Sulfur dioxide	SO_2
Thallium	Tl
Uranium	U
Vanadium	V
Zinc	Zn

Table C.2. Nomenclature and half-life for radionuclides

Radionuclide	Symbol	Half-life (years)
Americium-241	^{241}Am	432.2
Neptunium-237	^{237}Np	2,140,000
Plutonium-238	^{238}Pu	87.75
Plutonium-239	^{239}Pu	24,100
Plutonium-240	^{240}Pu	6,569
Technetium-99	^{99}Tc	213,000
Uranium-233	^{233}U	159,200
Uranium-234	^{234}U	244,500
Uranium-235	^{235}U	703,800,000
Uranium-236	^{236}U	23,415,000
Uranium-238	^{238}U	4,468,000,000

Source: *Radioactive Decay Tables: A Handbook of Decay Data for Application to Radioactive Dosimetry and Radiological Assessments (*DOE/TIC-11026), as reported in the *Oak Ridge Reservation Annual Site Environmental Report for 2005* (DOE/ORO-2218).

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