Student Summary of the U.S. Department of Energy Portsmouth Annual Site Environmental Report (ASER) for 2013

Message from the U.S. Department of Energy

The U.S. Department of Energy (DOE) conducts environmental monitoring at the Portsmouth Gaseous Diffusion Plant Site (PORTS) on an ongoing basis. Each year, the information collected is presented in a data volume and a comprehensive publication entitled the Annual Site Environmental Report (ASER). This year, a class at Waverly High School (WHS), located in Pike County, Ohio, developed this summary report. Both the ASER and this summary report are important as they allow DOE to clearly and concisely explain our environmental monitoring programs to our many stakeholders. The information presented in this summary shows that the PORTS site near Piketon, Ohio, is safe due in part to the Department's focus on safety. The work at DOE facilities is highly detailed and technically complex, but DOE is committed to performing each of these activities safely. DOE's first priority is to protect the well-being of our workers, the surrounding communities, and the environment. DOE would like to offer its sincerest appreciation to the students and faculty leader at Waverly High School who worked on this summary document. DOE congratulates each of you for your effort, enthusiasm, and willingness to support this project.

DOE hopes you enjoy reading the PORTS 2013 Annual Site Environmental Report Summary.

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Waverly High School Student Recognition 2016

The students of Mrs. Carla Evans' Environmental Science class at Waverly High School worked in collaboration with Ohio University's Voinovich School of Leadership and Public Affairs to produce this ASER Summary report. The Voinovich School thanks the students for their hard work. Their effort in this public service is much appreciated and worthy of special recognition. The 18 high school students who participated in the preparation of this ASER Summary report are listed below (photo does not include all students listed).

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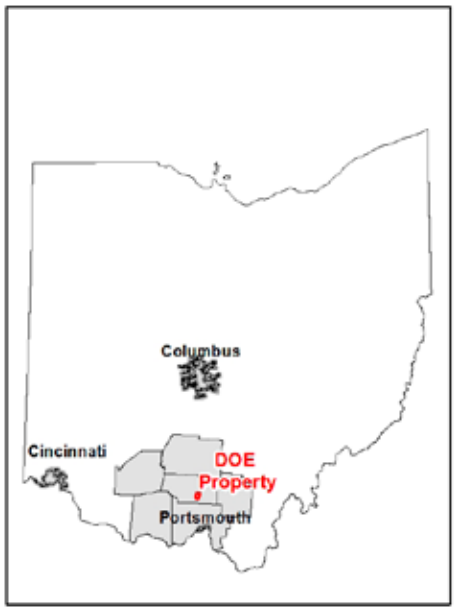
Voinovich staff and Waverly High School students in the field

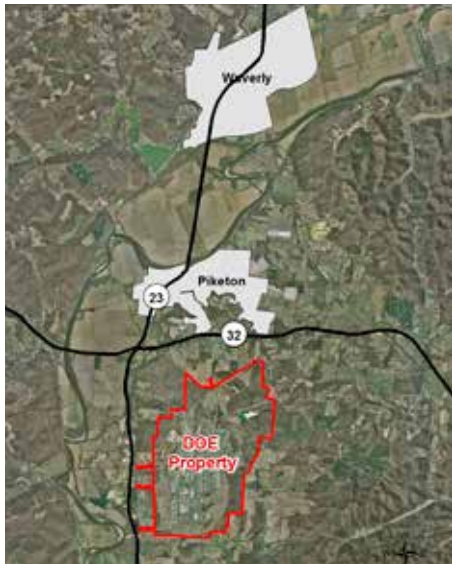
Background For The PORTS Facility

PORTS is located on a 5.9 square mile (3,776 acres) site in a rural area of Pike County, Ohio two miles east of the Scioto River in a small valley running parallel to and approximately 120 feet above the Scioto River flood plain. Pike County has approximately 28,370 residents with the largest community of 4,440 residents being Waverly about ten miles north of the site and Piketon being the nearest residential center about five miles north.



Map: Matt Trainer, Voinovich School of Leadership and Public Affairs

PORTS, which has produced enriched uranium via the gaseous diffusion process from 1954 through 2001, is owned by DOE. The United States Enrichment Corporation (USEC) operated the gaseous diffusion uranium enrichment facilities from 1993 through 2001. The current DOE activities at PORTS include environmental restoration, waste management, uranium management, which includes the DUF_6 Conversion Facility, and decontamination and decommissioning (D&D) of the process buildings and associated facilities formerly used for the gaseous diffusion process of uranium enrichment. D&D of the gaseous diffusion process buildings and associated facilities is subject to *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).



Map: Matt Trainer, Voinovich School of Leadership and Public Affairs

Currently, DOE contractor Fluor-B&W Portsmouth (FBP) is responsible for the D&D process and the environmental restoration, monitoring and compliance reporting. They also dispose of radioactive wastes and take care of uranium management and operate the site's waste storage facilities in accordance with all applicable regulations.

This report is a summary of the full 2013 ASER and is intended to demonstrate compliance with local, state, and federal regulations by providing information on regulatory compliance, environmental programs, radiological and non-radiological monitoring programs and groundwater programs (DOE, 2014). This report is not intended to present all of the monitoring data at PORTS. Further details are available at the PORTS Environmental Information Center (http://energy.gov/pppo/portsmouth-environmental-information-center).

Compliance Summary

DOE and the responsible contractor, FBP or B&W Conversion Services, LLC (BWCS), have permits for discharge of water to surface water streams, air emission permits, and a permit for the storage of hazardous wastes. Both FBP and BWCS are also responsible for preparing a number of reports for compliance with various applicable environmental regulations.

DOE is responsible for the D&D Program, Environmental Restoration Program, Waste Management Program, uranium operations at the DUF_6 Conversion Facility, and maintenance of all facilities not leased to USEC, Inc. FBP is responsible for air emissions permits and for the National Pollutant Discharge Elimination System (NPDES) outfalls associated with the former gaseous diffusion plant operations. USEC, Inc. is currently responsible for compliance activities directly associated with the American Centrifuge Plant (ACP) and Lead Cascade including air emission permits associated with the gaseous centrifuge uranium enrichment operations, NPDES outfalls, and management of wastes generated by their current operations.

Artwork by Wyatt Gilbert

DOE activities are inspected regularly by the federal, state, and local agencies responsible for enforcing environmental regulations at PORTS. Primary regulatory agencies responsible for enforcing environmental regulations at PORTS include the U.S. Environmental Protection Agency (U.S. EPA) and the Ohio Environmental Protection Agency (Ohio EPA).

DOE/FBP received one Notice of Violation during inspections conducted by U.S EPA and Ohio EPA in 2013 which was for failing to close containers of used fluorescent lamps and failing to label a container of used oil with the words "used oil." These violations were resolved by closing and/or labeling the containers.

Environmental Laws and Regulations

This next section discusses some of the environmental laws and regulations, DOE orders, and Executive Orders that DOE and DOE contractors must follow. PORTS is not on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List of sites requiring priority cleanup although D&D of PORTS is proceeding in accordance with the D&D DFF&O and CERCLA. 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. DOE contractors had no reportable quantity releases of hazardous substances in 2013.

The Emergency Planning and Community Right-to-Know Act of 1986 requires reporting of emergency planning information, hazardous chemical inventories, and releases to the environment.

For 2013, DOE contractors reported the release and/or off-site treatment of three chemicals:

- Chlorine: used for water treatment.
- Hydrogen fluoride: approximately 55 lbs. released to the air from the DUF_6 Conversion Facility and 508 lbs. treated off site.
- Nitrate compounds (from water treatment): approximately 27,600 lbs. released to the Scioto River through permitted NPDES outfalls.

The Resource Conservation and Recovery Act (RCRA) regulates the generation, accumulation, storage, transportation, and disposal of solid and hazardous wastes. In 2013, DOE and FBP held a permit to store hazardous waste within seven designated areas of the X-326 building, covering 0.9 acres. Facilities such as PORTS that generate or store hazardous waste are required to submit a biennial report to Ohio EPA in even-numbered years that covers waste shipped in the previous odd-numbered year.

Artwork by Abe Kelley

On January 28, 2013, DOE and FBP implemented the RCRA Contingency Plan in response to a release of what was thought to be groundwater contaminated with trichloroethene (TCE). Upon further investigation, the source of the water was determined to be a discharge point for a roof drainage system that had inadvertently been covered with soil during the force main replacement project. No hazardous waste or waste constituents were released to the environment.

RCRA also requires groundwater monitoring at certain hazardous waste management units. The groundwater report that summarizes the results of monitoring complete in accordance with the *Integrated Groundwater Monitoring Plan* is submitted annually to the Ohio EPA.

The Federal Facility Compliance Act enacted by Congress in 1992 allows for the storage of mixed hazardous/

low-level radioactive waste (LLW) 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. The Toxic Substances Control Act (TSCA) also regulates the use, storage, and disposal of polychlorinated biphenyl (PCBs) in order to protect workers, the public, and the environment. DOE was in compliance with the requirements and milestones of this act during 2013.

The Clean Air Act, the Clean Air Act Title VI Stratospheric Ozone Protection, and the National Emissions Standards for Hazardous Air Pollutants (NESHAP) require DOE to submit an annual report for radiological emissions from DOE air emissions sources. DOE contractors (FBP and BWCS) are both responsible for radiological air emissions sources. DOE and DOE contractors must also be in compliance with U.S. EPA and Ohio EPA regulations pertaining to water quality and protection. These regulations include the Clean Water Act and the Safe Drinking Water Act.

Finally, DOE must also comply with several other U.S. EPA and Ohio EPA regulations. The National Environmental Policy Act (NEPA) requires evaluation of the environmental impacts of activities at federal facilities and federally funded activities and the Endangered Species Act provides protection for federally endangered animals that may be present at PORTS.

Environmental Program Information

Decontamination & Decommissioning Program

On April 13, 2010, Ohio EPA issued the DFF&O, which is an agreement between the Ohio EPA and DOE governing the process for D&D of the gaseous diffusion process buildings and associated facilities that are no longer in use at PORTS. DFF&O applies to the D&D of buildings, including building slabs and wastes generated by D&D, uses the CERCLA framework for determining appropriate removal actions. Community involvement is also an important part of the CERCLA process and DFF&O. Opportunities for public comment are built into the D&D process and the PORTS Site Specific Advisory Board provides recommendations to DOE based on the concerns of the communities surrounding PORTS.

The main components of DFF&O include:

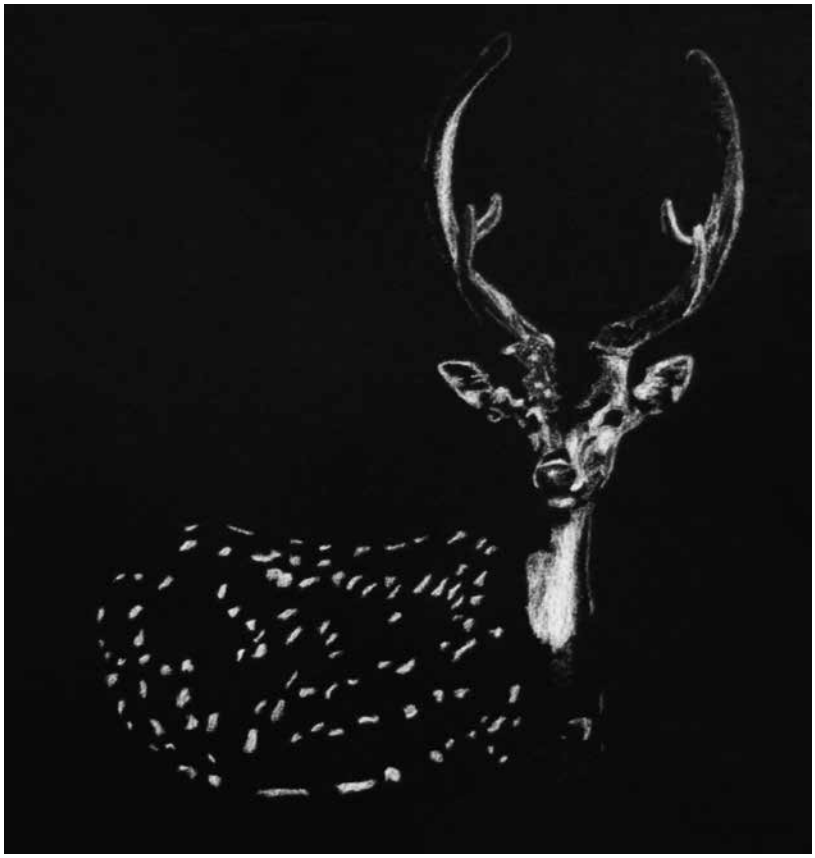
- Engineering evaluations/cost analyses and action memoranda for less complex facilities (non-time critical removal actions);
- A remedial investigation/feasibility study (RI/FS), proposed plan, and record of decision for process buildings and complex facilities; and,
- RI/FS, proposed plan, and record of decision for evaluation and selection of alternatives for site-wide waste disposal.

The smaller and less complex buildings at PORTS undergo D&D using the process for non-time critical removal actions. 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. Non-time critical buildings removed in 2013 were the X-100 Administration Building, the X-100B Air Conditioner Equipment Building, the X-101 Dispensary, and the X-109C Monitoring Station. Non-time critical buildings removal underway in 2013 include:

- X-744S Warehouse;
- X-624-1 Decontamination Pad;
- X-600 Steam Plant Complex (X-600 Steam Plant, X-600B Steam Plant Building, X-600C Ash Wash Treatment Building);
- X-102 Cafeteria; and,
- X-106 Tactical Response Building.

D&D of the most complex facilities at PORTS, including the three gaseous diffusion process buildings, is following the RI/FS process. Another 250 other facilities or structures (including but not limited to groundwater treatment

facilities, warehouses, concrete pads, trailers, storage yards, etc.) are also included in the RI/FS process. 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. The RI/FS report provides the results of the RI/FS work plan and Ohio EPA reviews each report and must provide concurrence on the RI/FS work plan and RI/FS report. Once the RI/FS work plan is concurred, a proposed plan is made available for public comment. Finally, the remedial action is selected by DOE with concurrence from Ohio EPA, and a record of decision is issued with a responsiveness summary to address public comments.



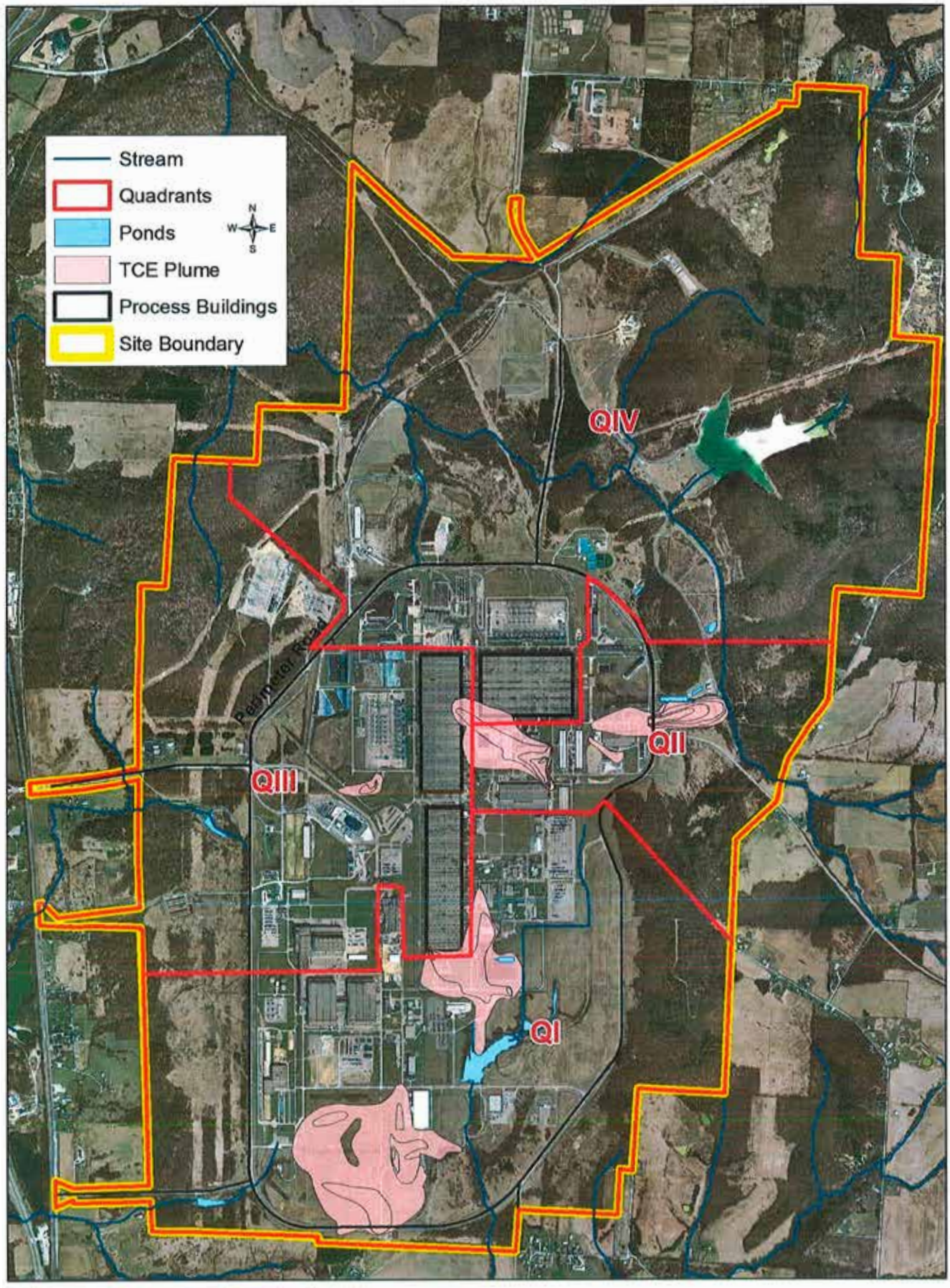
Artwork by Madison Fryling

Site-Wide Waste Disposition

The Site-Wide Waste Disposition portion of the D&D evaluates off-site and on-site waste disposal alternatives for waste generated by D&D at PORTS. The on-site disposal alternative involves construction of an on-site waste disposal facility. The waste disposition project follows a process similar to D&D of the Process Buildings and Complex Facilities. Development of waste acceptance criteria for an on-site waste disposal facility is included as part of the Waste Disposal Facility RI/FS work plan.

Environmental Restoration Program

DOE established the Environmental Restoration Program in 1989 to identify, control, and remediate environmental contamination at PORTS. 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 up into four quadrants. Remedial actions have been implemented in each quadrant.


Stream
Quadrants
Ponds
TCE Plume
Process Buildings
Site Boundary
N
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E
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QIII
QI
Peasmeter Road

Quadrant I

The *Quadrant I Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2000. In 2001, the Ohio EPA required remedial actions for the X-749/X-120 groundwater plume and the Quadrant I Groundwater Investigative Area. Remedial actions for the groundwater plume include phytoremediation, 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 Peter Kiewit Landfill (PK Landfill) and X-749 Landfill. Also, groundwater extraction wells were installed in 2007, 2008 and 2010 to control migration of the plume and remediate areas of higher TCE concentrations within the plume.

Phytoremediation, a process that uses plants to remove, degrade or contain contaminants in soil or groundwater was used as a remediation strategy for the X-749/X-120 groundwater plume. The *First Five-Year Review for the X-749/X-120 Groundwater Plume*, submitted to Ohio EPA in January 2011, found that remedial actions were achieving remedial action objectives by preventing migration of contaminants from the X-749 Landfill but was not as successful as anticipated in reducing concentrations of TCE in groundwater. The extraction wells and the barrier wall on the south and east sides of the landfill were primarily responsible for the reduction in TCE concentrations within the Quadrant I groundwater plume.

The remedial actions required of the PK Landfill consisted of the continued operation of the eastern groundwater collection system installed in 1994 and construction of an engineered cap that meets RCRA requirements. In 2008, the second Five-Year Review was completed and found that the remedial actions implemented were achieving their objectives by eliminating exposure pathways and reducing the potential for contaminant transport. In 2013, the third Five-Year Review also found that the corrective actions were continuing to achieve corrective action objectives.

The two remedial actions for the Quadrant I 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. The *First Five-Year Review for the Five-Unit Groundwater Investigative Area and X-231A/X-231B Oil Biodegradation Plots*, found that remedial actions had eliminated potential exposure pathways to contaminants and reduced concentrations of TCE in the groundwater. The second Five-Year Review of the groundwater extraction system, submitted in 2013, found that remedial actions were continuing to eliminate potential exposure pathways to contaminants, control migration of the groundwater plume, and remove volatile organic compounds (VOCs) from groundwater.

Quadrant II

The *Quadrant II Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2001. A number of deferred units are in the groundwater plume in the Quadrant II Groundwater Investigative (7-Unit) Area. In 2009, a special investigation was conducted in which soil and groundwater samples identified areas

of higher TCE concentrations. These higher concentrations appeared to be associated with continuing sources of groundwater contamination in the southeastern portion of the plume. In 2010, the Ohio EPA approved a remediation measure called anaerobic bioremediation. Fermentable carbon compounds, such as sodium lactate – found in soaps and face creams, were injected into the soil to provide additional food for naturally-occurring microorganisms that degrade TCE to a harmless substance. Data collected between 2010 and 2012 indicated that TCE degradation was occurring within the treatment area even though concentrations of TCE in groundwater remained elevated. DOE and the Ohio EPA agreed that further development of remedial alternatives will be incorporated into the *Deferred Units RCRA RFI/CMS Work Plan for Solid Waste Management Units*.
An interim remedial measure (IRM) was approved for the X-701B Holding Pond in 2009. The IRM was approved in order to excavate the soil in the western portion of the X-701B plume area and directly mix oxidant into the contaminated soil. The IRM was completed in 2011.

The X-633 Recirculating Cooling Water Complex was demolished in 2010 and a work plan for the RCRA investigation of soil and groundwater in the area was approved in 2010 and implemented in 2011. Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals and DOE agreed to sample eight wells around the area annually to continue evaluation of chromium and TCE in groundwater. A background study was also underway in 2013 to provide additional information about the concentrations of naturally-occurring metals in soil within the varying geologic formations at PORTS.

Quadrant III

The *Quadrant III Cleanup Alternative Study/Corrective Measure Study* was approved by Ohio EPA in 1998. In 1999, 700 hybrid poplar trees were planted on a 2.6-acre area above the X-740 groundwater plume in an attempt to reduce TCE concentrations through a process called phytoremediation. Multiple reviews were conducted to evaluate the effectiveness of the phytoremediation but results showed the system was not effective. In response, DOE developed a plan for additional remediation and in 2008, three rounds of oxidant injections were completed to remove TCE from groundwater. The oxidant briefly reduced TCE concentrations detected in the wells but then they returned to typical levels in 2009.

In 2010, the Ohio EPA approved a pilot study of enhanced anaerobic bioremediation. Emulsified oil, a slow-acting fermentable carbon compound, was injected into selected portions of the groundwater plume during December 2010 and January 2011. Samples collected from 2011 to 2013 showed that TCE decreased in two wells within the groundwater plume that was treated during the pilot study.

Quadrant IV

The *Quadrant IV Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 1998. No new remedial actions were required in Quadrant IV. In 1996, Ohio and U.S. EPA required a soil cover over the

former lagoons and the establishment of a prairie habitat. Second and third Five-Year Reviews in 2008 and 2013 found that the soil cover and prairie habitat were meeting the remedial action objectives for this unit by eliminating exposure pathways to the contaminants in the sludge in this area.

Areas of soil potentially contaminated with metals were identified at the X-630 Recirculating Cooling Water Complex, but the higher concentrations of metals may have been present due to naturally-occurring variations in the geology of the area. A background study was underway in 2013 to provide additional information about the concentrations of naturally-occurring metals in soil within the varying geological formations at PORTS.

Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals during the 2011 RCRA investigation and DOE agreed to sample four wells around the X-630 Recirculating Cooling Towers Water Complex area annually to continue evaluation of chromium and TCE in groundwater at this area.

Artwork by Paige Hall

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. In 2013, FBP shipped approximately 9,800 tons of materials to off-site facilities for treatment, disposal, recycling or reuse. The Southern Ohio Diversification Initiative (SODI) received approximately 1,380 tons of materials from PORTS including recyclable metals and excess office furniture, equipment, radios, refrigerators and passenger vehicles for auction.

DOE Orders, Ohio EPA and U.S. EPA regulations must be satisfied to demonstrate compliance with waste management activities with additional policies 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;
- pursing volume reduction – blending and bulking – as well as on-site storage in preparation for safe and compliant final treatment and/or disposal; and
- recycling.

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 Environmental Sustainability Program includes pollution prevention, waste minimization, affirmative procurement, sustainable design, and energy and water efficiency.

DOE is committed to minimizing/eliminating the amounts and types of wastes generated and to reducing life cycle costs for managing and disposing property and wastes during all DOE projects and activities at PORTS.
The objectives of the Environmental Sustainability Program are to reduce the life cycle cost and liability of DOE Programs and operations at PORTS. These goals include:

- eliminating, minimizing or recycling wastes that would require storage, treatments, disposal, and long-term monitoring and surveillance;
- eliminating or minimizing use of toxic chemicals and associated environmental releases that would require control, treatment, monitoring, and reporting;
- maximizing the use of recycled-content materials and environmentally preferable products and services, minimizing costs and environmental impacts managing byproducts and wastes generated in conducting mission-related activities; and
- reducing the life-cycle cost of managing personal property at PORTS.

The following are accomplishments of the *U.S. Department of Energy Fiscal Year 2014 Site Sustainability Plan for the Portsmouth Gaseous Diffusion Plant through the 2013 fiscal year*:

- a decrease of 33% in greenhouse gas emissions, primarily for electricity consumption, versus the 2008 baseline emissions;
- 8.4% of electricity consumptions from renewable energy sources, which exceeds the goal of 7.5%;
- an increase in alternative fuel consumption (E-85) of 43.2% versus fiscal year 2012; and
- a decrease of 10.9% in pounds of paper used per person versus fiscal year 2012.

Artwork by Addison Bonifield

Environmental Training Programs & Public Awareness Program

DOE contractors at PORTS provide environmental training to increase employee awareness for environmental activities and to enhance the knowledge and qualifications of personnel performing tasks associated with environmental assessment, planning and restoration. This program includes on and off-site classroom instruction, on-the-job training including required hazardous waste training and numerous Occupational Safety and Health Administration training requirements.

A comprehensive community relations and public participation program is in place at PORTS to foster a spirit of openness and credibility between PORTS officials and local citizens, elected officials, business, and media. The program provides the public with opportunities to become involved in the decisions affecting environmental issues at PORTS. The PORTS Site Specific Advisory Board is made up of local citizens that provide input and recommendations to DOE on D&D, environmental remediation, waste management and other similar issues at PORTS. The PORTS Envoy Program communicates information about PORTS D&D to community groups, local government, and families living next to DOE property by matching them with employee volunteers to answer questions about PORTS.

Some of the Programs and contact information for the public are listed below.

- Site Specific Advisory Board: www.ports-ssab.energy.gov or 740-289-5249
- The Environmental Information Center maintained by DOE provides public access to documents used to make decisions on remedial actions being taken at PORTS. This information center is located at the Ohio State University Endeavor Center (Room 207) and can be contacted by email at portseic@pma-iss.com or by phone at 740-289-8898.
- DOE Portsmouth/Paducah Project Office: http://energy.gov/pppo
- DOE Site Office (Environmental Management Program): 740-897-5010
- Office of Public Affairs (Environmental Management Program): 740-897-3933

Environmental Radiological Information

Environmental monitoring at PORTS measures both radiological and chemical parameters in air, water, soil, sediment and biota, which include animals, vegetation and crops. Environmental monitoring programs are required by state and federal regulations, permits and DOE Orders and they can also be used to address public concerns about plant operations.

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 the priorities for environmental improvements. The maximum dose of radiation a member of the public could receive from PORTS in 2013 is 1.4 mrem/year, which is below the DOE limit of 100 mrem/year. In order to be considered safe, 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. By way of comparison, a person living in the United States receives an average dose of approximately 311 mrem/year from natural sources of radiation.

Summary of potential dose to the public from PORTS in 2013

Source of dose	**Dose (mrem/year)***
Airborne radionuclides (fence line)	0.34
Radionuclides released to the Scioto River	0.0018
Direct radiation at station A29	0.96
Radionuclides detected by environmental monitoring programs (sediment and soil)	0.069
Total	**1.4**

**100 mrem/year is the DOE limit*

Environmental regulations, permits, DOE Orders, and public concerns are all considered in developing environmental monitoring programs. The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* describes the environmental monitoring programs for DOE activities at PORTS and specific radionuclides are monitored at PORTS and are selected based on materials handled at PORTS and on historic monitoring data.

Radiological Emission and Doses

Artwork by Kaylee Wells

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 2013, doses are estimated for exposure to atmospheric releases, direct radiation and releases to surface water in the Scioto River. Exposure in groundwater at PORTS is not included because contaminated groundwater at PORTS is not a source of drinking water.

Most consequences associated with radionuclides released to the environment are caused by interactions between human tissue and various types of radiation emitted by radionuclides. 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). Technetium-99 and three natural uranium isotopes, uranium-234, 235, and 238, are the most commonly detected radionuclides in the environmental media samples collected around PORTS.

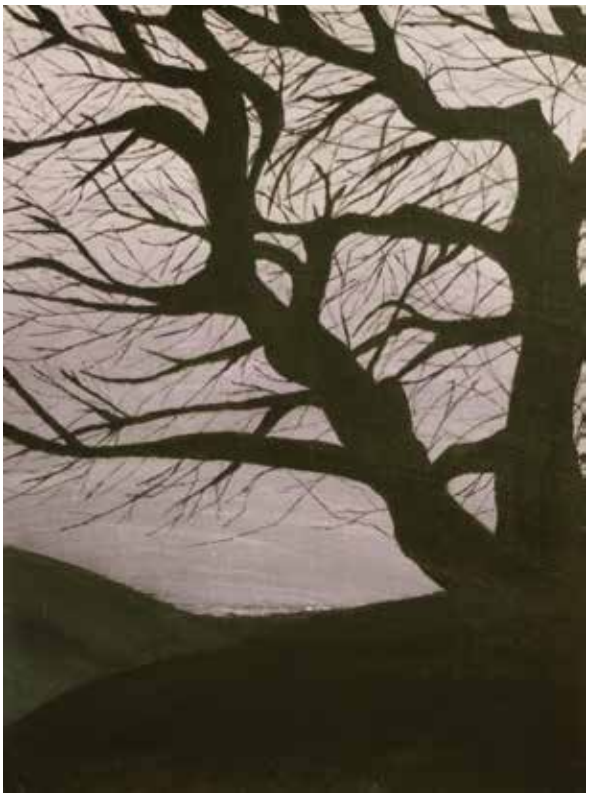
Several specialized measurement units have been defined in terms of the amount of ionizing radiation absorbed by human or animal tissue and in terms of the biological consequences of the absorbed energy. These units include:

- An *absorbed dose* is the amount of ionizing radiation energy absorbed by an organ divided by the organ's mass in grams and is measured in unit of rad or gray.
- A *dose* is the product of the absorbed dose (rad) in tissue and a quality factor. Dose is expressed in units of rem or sievert.
- An *effective dose* is 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".
- A *collective dose or collective effective* dose is the sum of the doses or effective dose of all individuals in an exposed population expressed units of person-rem or person-sievert. This is often called the "population dose".

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.

In 2013, FBP was responsible for air emission sources associated with the former gaseous diffusion plant operations including vents in X-326 and X-330 Process Buildings and the X-344A Uranium Hexafluoride Sampling Building. Emissions from the DOE/FBP sources in 2013 were calculated to be 0.02948 curie (Ci).



Artwork by Sydney Schuyler

BWCS was responsible for air emission sources associated with DUF_6 Conversion Facility. Emissions from the DOE/BWCS sources in 2013 were calculated to be 0.0000409 Ci.

USEC, Inc. reported emissions of 0.00000877 Ci from operation of the Lead Cascade and emissions from all DOE sources in 2013 were calculated to be 0.0295 Ci.

The maximum potential dose to an off-site individual from radiological releases from DOE air emission sources at PORTS in 2013 was 0.047 mrem/year which is well below the 10 mrem/year limit applicable to PORTS and the approximate 311 mrem/year from natural sources of radiation. In 2013, the maximum dose a hypothetical person living at the PORTS security fence line would receive from DOE radionuclide emissions was 0.34 mrem/year at the north sector. The collective dose or population dose is the sum of the individual doses to the entire population within 50 miles of PORTS. In 2013, the population dose was 0.256 person-rem/year from DOE sources and 0.000046 person-rem/year from USEC, Inc. This population dose based on PORTS emissions was insignificant.

DOE also collects samples from 15 ambient air monitoring stations and analyzes them for the radionuclides that could be present in ambient air due to PORTS activities. The highest dose measured at the ambient monitoring stations is 4% of the dose calculated from the combined DOE and USEC, Inc. point source emissions. 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.

Discharges of Radionuclides from NPDES Outfalls

In 2013, FBP was responsible for eighteen 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. In 2013, uranium discharges from the FBP external outfalls were estimated at 7.9 kg. Total radioactivity (technetium-99 and isotopic uranium) released from the same outfalls was estimated at 0.022 Ci.

The dose calculated with these data is significantly less than the 100 mrem/year limit for all radiological releases from a facility. No transuranics were detected in samples collected from the external FBP outfalls. Discharges of radionuclides in liquids through FBP NPDES outfalls have no significant impact on public health and the environment.

In 2013, USEC, Inc. was responsible for three NPDES outfalls through which water is discharged from the site. Transuranic radionuclides and technetium-99 were not detected in any of the samples collected from USEC, Inc. NPDES outfalls in 2013. 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.

Dose Calculation for Releases to Surface Water

Radionuclides are measured at the FBP and USEC, Inc. NPDES external outfalls and water from these 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. Environmental pathways considered were ingestion of water, ingestion of fish, swimming, boating, and shoreline activities. This exposure is conservative since the Scioto River is not used for drinking water downstream from PORTS. The dose from radionuclides released to the Scioto River in 2013 (0.0018 mrem) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

Radiological Dose Calculation for Environmental 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. In 2013, the average dose recorded at the cylinder yards near Perimeter Road was 743 mrem/year based on measurements by thermoluminescent dosimeters (TLDs) for an entire year. The radiological exposure to an on-site member of the 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. Based on these assumptions, exposure to an on-site member of the public from radiation from the cylinder yards is approximately 0.74 mrem/year.

Even given the persistent exposure of workers at the site, with more than 2600 DOE employees and DOE contractors being monitored, workers were estimated to have received an average dose of 3.2 mrem. Less than 4% of the monitored workers, mainly workers handling DUF_6 cylinders, received a measurable dose. No administrative guidelines or regulatory dose limits were exceeded in 2013. Potential doses to the public from radionuclides detected by the PORTS environmental monitoring program in 2013 are significantly less than the DOE limit of 100 mrem/year.

Dose calculation for sediment

The dose calculations for sediment is based on the detections of radionuclides in a sample collected in 2013 from an off-site sampling location on Little Beaver Creek downstream from PORTS:

- technetium-99: 5.81 pCi/g, (picocuries per gram [pCi/g])
- uranium-233/234: 2.67 pCi/g,
- uranium-235/236: 0.127 pCi/g, and
- uranium-238: 0.994 pCi/g.

Based on an incidental ingestion rate of 200 milligrams per day and an exposure frequency of 100 days per year, the dose that could be received by an individual from sediment contaminated at these levels is 0.021 mrem/year, which is below the 100 mrem/year limit set by DOE.

Dose calculation for soil

The dose calculations for soil is based on the detections of the following uranium isotopes in the regular sample collected at the ambient air monitoring station on the northeast PORTS property boundary:

- uranium-233/234: 1.23 pCi/g,
- uranium-235/236: 0.062 pCi/g, and
- uranium-238 1.25 pCi/g.

Based on an ingestion rate of 200 mg per day and an exposure frequency of 350 days per year, the dose that could be received by an individual from soil contaminated at these levels is 0.048 mrem/year, which is below the 100 mrem/year limit set by DOE.

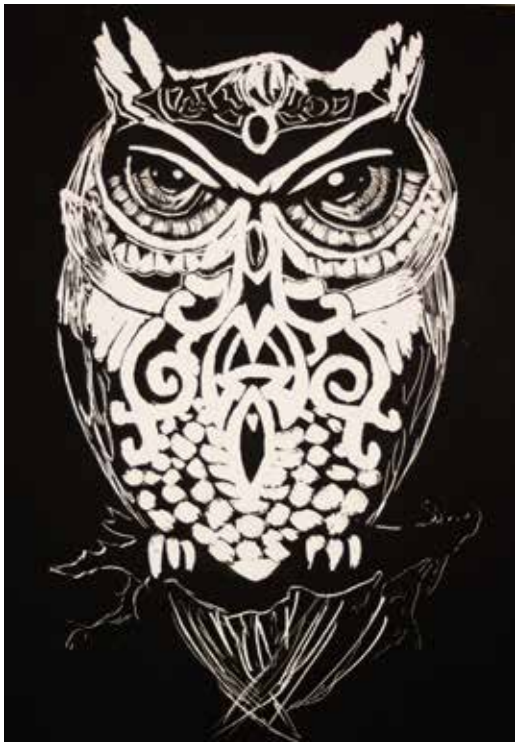
Protection of Biota

DOE Order 458.1 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. Analytical data for surface water and soil samples collected during 2013 from the northern side of the PORTS reservation

were used to assess the dose limits for aquatic and riparian animals as well as for terrestrial plants and animals. Dose limits for aquatic animals is 1 rad/day and 0.1 rad/day to riparian animals. Dose limits for terrestrial plants is 1 rad/day and 0.1 rad/day to terrestrial animals. No transuranic radionuclides or technetium-99 were detected from these samples and doses to aquatic and riparian animals and to terrestrial plants and animals were within the dose limits of 1 rad/day to riparian animals and terrestrial plants and 0.1 rad/day to aquatic and terrestrial animals.
No unplanned releases of radionuclides occurred at PORTS in 2013.

Ambient Air Monitoring

In 2013, samples were collected from 14 ambient air monitoring stations located within and around PORTS, including a background ambient air monitoring station located approximately 13 miles southwest of the plant. No transuranic radionuclides were detected at the stations but technetium-99 was detected at all of the ambient air stations. The maximum activity of technetium-99 in ambient air was 0.042 picocurie per cubic meter (pCi/m3), which was well below the DOE derived concentration standard of 920 pCi/m3. The maximum activity of uranium-233/234 was 0.00031 and uranium-238 was 0.00012 pCi/m3, which were both well below the DOE derived concentration standards of 1.1 and 1.3 pCi/m3, respectively. The highest net dose calculation for the off-site ambient air stations was 0.0018 mrem/year which was well below the 10 mrem/year limit applicable to PORTS.



Artwork by Faheem Gilbert

Environmental Radiation

Radiation is continuously measured at five locations near the uranium hexafluoride cylinder storage yards, 19 locations that that include 12 of the ambient air monitoring stations, and seven additional on-site locations. Radiation is measured as a whole body dose, which is the amount a person would receive if they were continuously present at the monitored location. The potential estimated dose from the cylinder yards to a representative on-site member of the public, such as a delivery person, is 0.74 mrem/year which is significantly less than DOE's 100 mrem/year dose limit to the public for radionuclides from all potential pathways.

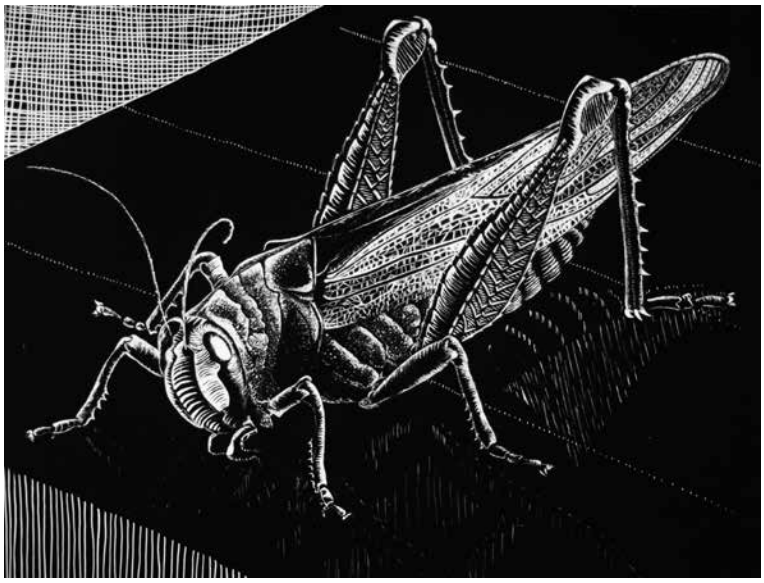
The on-site locations with higher doses than the off-site average are not used by the general public except for one location near the cylinder yards and station A29. The potential estimated dose to an off-site worker would be 0.96 mrem/year and is significantly less than DOE's 100 mrem/year dose limit to the public for radionuclides from all potential pathways. No administrative guidelines or regulatory limits were exceeded in 2013 for DOE workers, including workers in the cylinder yards.

Surface Water from Cylinder Storage Yards

In 2013, FBP collected surface water samples monthly from seven locations at the cylinder storage yards in order to analyze them for alpha activity, beta activity, and uranium. 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. The dose from radionuclides released to surface water of the Scioto River was 0.0018 mrem which is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

Local Surface Water

Local surface water samples were collected semiannually from 14 locations upstream and downstream from PORTS in 2013 from the Scioto River, Little Beaver Creek, Big Beaver Creek and Big Run Creek. As background measurements, samples were also collected from local streams approximately 10 miles north, south, east, and west of PORTS. Samples were collected semiannually and analyzed for transuranic radionuclides, technetium-99, uranium and uranium isotopes in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*. No transuranic radionuclides, technetium-99, or uranium-235/236 were detected in the local surface water samples collected in 2013. In samples collected in the second quarter, detections of uranium in local surface water samples were well below the Ohio EPA drinking water standard for uranium.



Artwork by Jordan Prall

Sediment

Sediment samples were collected annually 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. These samples were analyzed for transuranic radionuclides, technetium-99, uranium, and uranium isotopes 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. Uranium and uranium isotopes detected in 2013 samples have been detected at similar levels in previous sampling events from 2002 through 2012.

Neptunium-237 was detected at 0.0111 pCi/g in Big Beaver Creek and Little Beaver Creek which is much less than the U.S. EPA preliminary remediation goal for neptunium-237 in residential soil (1 pCi/g). Technitium-99 is often detected in sediment samples collected at locations downstream from PORTS. The highest detection of technetium-99 was consistent with data from previous sampling events from 2002 through 2012. The total potential dose to a member of the public resulting from PORTS operations was 1.4 mrem/year, which includes this sediment dose calculation of 0.021 mrem/year, is well below the DOE standard of 100 mrem/year.

Settleable Solids

DOE collects semiannual water samples from nine effluent and three background locations to determine the concentration of radioactive material that is present in the sediment suspended in the water sample to ensure that discharges do not exceed an annual average of either of the following:

- 5 pCi/g above background of settleable solids for alpha-emitting radionuclides, and
- 50 pCi/g above background for beta-emitting radionuclides.

Detections of settleable solids that monitor PORTS effluent ranged from 2.7 to 17.3 mg/L. These detections of settleable solids in PORTS effluent are less than 40 mg/L; therefore, monitoring results for the settleable solids monitoring program are in compliance with the DOE Order 458.1, *Radiation Protection of the Public and the Environment.*

Soil

Soil samples are collected annually from ambient air monitoring locations and analyzed for transuranic radionuclides, technetium-99, uranium, and uranium isotopes. Plutonium-239/240 was detected in 8 of 15 monitoring stations and are much less than the U.S. EPA preliminary remediation goal for plutonium-239/240 in residential soil and are mostly likely present due to atmospheric fallout from nuclear weapon testing. No other transuranics were detected in any of the soil samples collected during 2013.

Technetium-99 was not detected in the soil samples collected in 2013. Uranium and uranium isotopes were detected at each of the soil sampling locations at similar levels which suggests that the uranium detected in these samples is due to naturally-occurring uranium. The total potential dose to a member of the public resulting from PORTS operations (1.4 mrem/year), which includes this dose calculation (0.048 mrem/year), is well below the DOE standard of 100 mrem/year.

Vegetation & 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). In order to

assess the uptake of radionuclides into plant material, vegetation samples were collected in the same areas where soil samples are collected and the ambient air monitoring stations. For animal testing, samples are taken from deer killed on site in motor vehicle collisions and fish caught at downstream locations on the Scioto River and Little Beaver Creek. No radionuclides were detected in vegetation or local biota (deer, fish, crops, milk, and eggs) samples collected in 2013.

Release of Property Containing Residual Radioactive Material

DOE Order 458.1 establishes limits for unconditional release of personal and real property from DOE facilities. Real property is defined as land and anything permanently affixed to the land such as buildings, fences, and things attached to buildings such as light fixtures, plumbing, and heating fixtures. Personal property is defined as property of any kind, except for real property. In 2013, no real property was released from PORTS.

FBP uses pre-approved authorized limits established by DOE Orders to evaluate and release materials defined as personal property. In 2013, FBP authorized 1,577 release requests from materials/items of personal property.

In 2013, BWCS continued off-site shipment of aqueous hydrogen fluoride produced by the DUF_6 Conversion Facility, which converts DUF_6 into uranium oxide and aqueous hydrogen fluoride. Each shipment must meet the release limit of less than 3 picocuries/milliliter (pCi/mL) of total uranium activity. The average total uranium activity of all the shipments was 0.0074 pCi/mL.

Environmental Non-Radiological Program Information

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 DOE Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant specifies non-radiological monitoring requirements for ambient air, surface water, sediment, and fish. Environmental permits issued by Ohio EPA specify discharge limitations, monitoring requirements, and/or reporting requirements for air emissions and water discharges. Discharges of non-radiological air pollutants from PORTS permitted emission sources decreased substantially in 2013 due to the discontinuation of operations at the the X-600 Steam Plant Complex.

Airborne Discharges

FBP is responsible for numerous air emission sources associated with the former gaseous diffusion production facilities and support facilities. These sources emit more than 100 tons per year of non-radiological air pollutants specified by Ohio EPA, which caused DOE to be a major source of air pollutants. Because PORTS is a major source of air pollutants, FBP submitted an annual report called the Ohio EPA Fee Emissions Report. FBP reported emissions of 15.75 tons of particulate matter, 7.34 tons of organic compounds, 5 tons of sulfur dioxide and 1.59 tons of nitrogen oxides. These emissions decreased in 2013 versus previous years because of the discontinuation of operations at the X-600 Steam Plant Complex.

Artwork by Madison Elliot

The DUF_6 Conversion Facility emits only a small amount of non-radiological air pollutants, less than 10 tons per year of specified non-radiological air pollutants for 2013, so Ohio EPA only requires a Fee Emissions Report only once every two years. BWCS reported 55 lbs. of hydrogen fluoride emitted to the air in the Toxic Chemical Release Inventory for 2013.

U.S. EPA also requires annual reporting of greenhouse gas emissions (carbon dioxide, methane, and nitrous oxide). In 2013, FBP reported emissions of 23,101.4 metric tons of carbon dioxide, 0.44 metric ton of methane, and 0.044 metric ton of nitrous oxide which resulted from combustion fuels used at the natural gas and fuel oil X-690 Boilers. In 2013, 72 tons (143,870 lbs.) of material contaminated with asbestos, another potential air pollutant, were shipped from PORTS and controlled by a system of work practices.

DOE also measures fluoride at monitoring stations within PORTS boundaries and surrounding areas. Fluoride detected at the ambient air monitoring stations may be present due to activities associated with the former gaseous diffusion process, operation of the DUF_6 Conversion Facility or occurring naturally in the form of background concentrations. In 2013, samples of fluoride were collected weekly from 14 air monitoring stations including one approximately 13 miles southwest of the plant. Fluoride was not detected in more than 80 percent of the samples collected for the ambient air monitoring program. There is no standard for fluoride in ambient air and the data indicate that off-site and naturally occurring fluoride concentrations are not appreciably different from concentrations at PORTS.

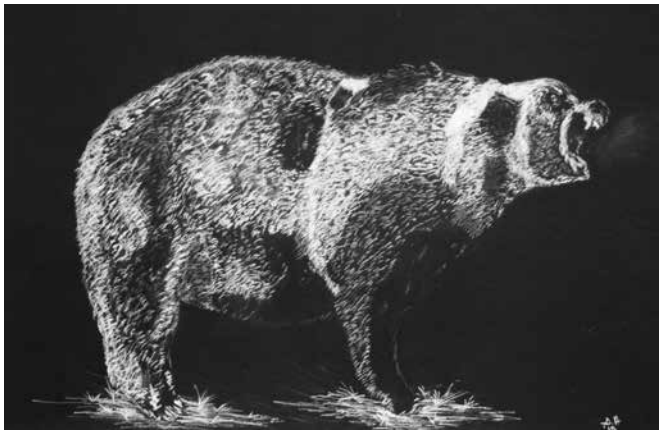
Water

Surface and groundwater are monitored at PORTS. 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.

In 2013, DOE contractors, FBP and BWCS, were responsible for 19 NPDES discharge points at PORTS and USEC, Inc. was responsible for three outfalls. 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.

FBP NPDES outfalls

In 2013, FBP was responsible for 18 outfalls or sampling points. Nine outfalls discharge directly to surface water, and six outfalls discharge to another outfall before leaving the site. FBP also monitors three additional sampling points that are not discharge locations. 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. Some of the chemicals that are monitored include trans-1,2-dichloroethene and/or TCE.



Artwork by Drew Harris

In 2013, discharge limitations at the FBP NPDES monitoring locations were exceeded on six occasions. The maximum daily concentration limit for carbonaceous biochemical oxygen demand was exceeded three times and the maximum loading limit for carbonaceous biochemical oxygen demand was exceeded once at Outfall 003 (X-6619 Sewage Treatment Plant.). The maximum daily exceedances ranged from 19 to 21 mg/L and the maximum

daily loading exceedance was 22.8 kg/day. Each of these exceedances was caused by releases of cooling water containing propylene glycol to the sanitary sewer which flowed to the X-6619 Sewage Treatment Plant.

In October 2013, the maximum concentration limit for chlorine (0.05 mg/L) was also exceeded at the X-6619 Sewage Treatment Plant with a sample result of 0.12 mg/L. Operators immediately adjusted the dechlorination treatment and compliance was restored within approximately five hours.

In May 2013, the maximum concentration limit for fecal coliform (2000/100 milliliters [mL]) was exceeded at the X-6619 Sewage Treatment Plant with a sample result of 2300/100mL and was likely attributable to a release of cooling water containing propylene glycol that caused an upset to the X-6619 Sewage Treatment Plant. In 2013, the overall FBP NPDES compliance rate with NPDES permit was 99%.

BWCS NPDES outfall

BWCS is responsible for the NPDES permit for the discharge of process wastewaters from the DUF_6 Conversion Facility to the West Ditch, which flows to the Northwest Holding Pond and then to the Scioto River. The monitoring data are submitted to Ohio EPA in a monthly discharge monitoring report. Process wastewater discharge is permitted but the only water released through BWCS NPDES Outfall 001 during 2013 was due to precipitation run-off.

Discharge limitations for total suspended solids were exceeded twice during 2013, and discharge limitations for dissolved solids were exceeded six times during 2013. The exceedances were due to precipitation. The permit loading limits are based on an estimated process flow of water through the outfall and when precipitation increases the flow above the assumed amount, exceedances of the loading limits can occur. Only precipitation run-off was discharged through the BWCS outfall during 2013. The overall BWCS NPDES compliance rate in 2013 was 99%.

USEC, Inc. NPDES outfalls

USEC, Inc. is responsible for three NPDES outfalls through which water is discharged from the site. Two outfalls discharge directly to surface water, and one outfall discharges to FBP NPDES Outfall 003 before leaving the site. The monitoring data are submitted to Ohio EPA in a monthly discharge monitoring report. No exceedances of permit limitations at USEC, Inc. occurred during 2013. The overall USEC, Inc. compliance rate with the NPDES permit was 100%.

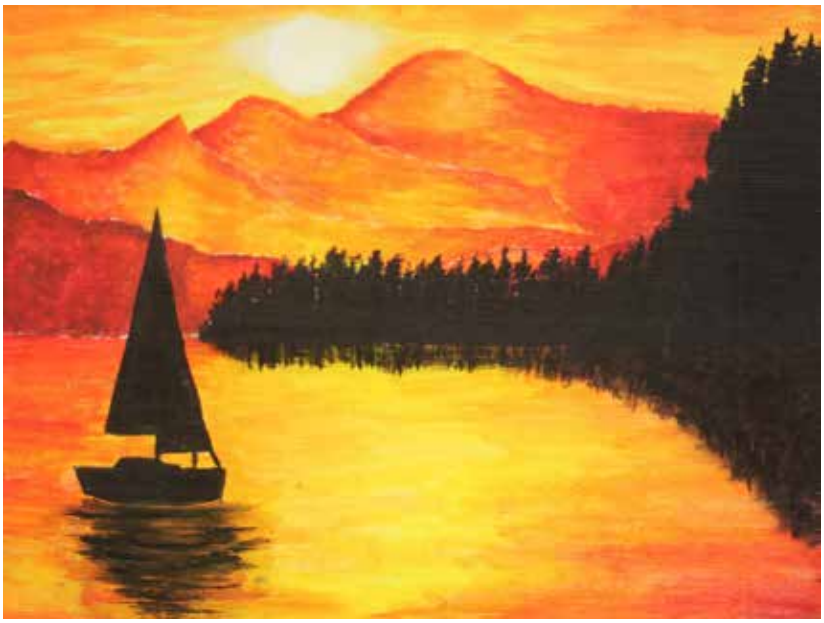
Surface Water Monitoring Associated with BWCS Cylinder Storage Yards

Surface water samples are collected quarterly from four locations in the drainage basins downstream from the Cylinder Storage Yards and were analyzed for PCBs. PCBs were not detected in any of the surface water samples collected during 2013.

Sediment

In 2013, sediment monitoring at PORTS included local streams and the Scioto River upstream and downstream from PORTS and drainage basins downstream from the BWCS cylinder storage yards. Sediment samples are collected annually at the same locations upstream and downstream from PORTS where local surface water samples are collected. In 2013, samples were analyzed for 20 metals and PCBs. Two detections of PCBs in sediment around PORTS were slightly above the risk-based concentration of PCBs for protection of human health developed by U.S. EPA and utilized by Ohio EPA (220 micrograms per kilogram [µg/kg] or parts per billion [ppb]). These detections were in the regular and duplicate samples collected at on-site sampling location RM-11 in Little Beaver Creek (224 and 254 µg/kg, respectively). Investigation and remediation of PCBs in soil and sediment will be addressed as part of the environmental remediation of PORTS.

The results of metals sampling conducted in 2013 indicate that no appreciable differences are evident in the concentrations of metals present in sediment samples taken upstream, downstream or at background sampling locations from PORTS. Metals occur naturally in the environment so these samples most likely did not result from activities at PORTS.



Artwork by Drew Harris

Sediment Monitoring Associated with BWCS Cylinder Storage Yards

Sediment samples are collected quarterly from four locations in the drainage basins downstream from the cylinder storage yards located on the PORTS site. In 2013, PCBs were detected in at least one of the sediment samples collected from each location at concentrations up to 180 µg/kg (ppb) and are below the 1ppm (1000 ppb) set by the U.S. EPA. None of the samples contained PCBs above the risk-based concentration of PCBs for protection of human health developed by U.S. EPA and used by Ohio EPA.

Biological Monitoring – Fish

In 2013, fish were collected from upstream and downstream locations on the Scioto River as well as the downstream sampling location on Little Beaver Creek as part of the routine fish monitoring program at PORTS.

Fish samples collected for this program included only the fish fillet which is analyzed for PCBs. Fish samples upstream from the Scioto River were carp and samples downstream from the Scioto River and Little Beaver Creek were bass. PCBs were detected in fish collected from each location at concentrations ranging from 59.6 to 301 µg/kg. The Ohio Fish Consumption Advisory Chemical Limits is provided in the *State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program* and the consumption rates are as follows: unrestricted, 1/week, 1/month, 6/year, and do not eat. The concentrations of PCBs detected in samples collected from the Scioto River (59.6 and 158 µg/kg) are above the unrestricted limit (50 µg/kg) and below the 1/week maximum limit (220 µg/kg). The concentrations of PCBs detected in regular and duplicate samples of bass caught on site in Little Beaver Creek were 207 and 301 µg/kg, respectively. The detection of PCBs in the duplicate sample (301 µg/kg) 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 the Ohio EPA, Division of Surface Water, provides information on chemical limits and consumption advisories for the amount of sport fish caught from all water bodies in Ohio and should be consulted before eating any fish caught in Ohio waters.

Groundwater Programs

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 wells are used to track the flow of groundwater and to identify and measure groundwater contaminants. Groundwater programs include on-site surface water and water supply monitoring.

Groundwater plumes that consist of VOCs, primarily TCE, are found at five of the PORTS monitoring areas including PK Landfill, Quadrant I Groundwater Investigative Area, Quadrant II Groundwater Investigative Area, Holding Pond and Former Waste Oil Handling Facility. In general, concentrations of contaminants detected within these plumes were stable, neither increasing nor decreasing, during 2013.

Artwork by Lindsey Richmond

In 2013, no VOCs were detected in any of the seven off-site monitoring wells and TCE has not been detected in groundwater beyond DOE property boundary at concentrations that exceed the Ohio EPA drinking water standard of 5 µg/L. Data collected in 2013 indicates that the groundwater extraction wells installed in the groundwater plume in 2010 are succeeding in reducing TCE concentrations within the plume.

This section provides an overview of groundwater monitoring at PORTS and the results of the groundwater monitoring program for 2013. *The 2013 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.

Regulatory Programs

Groundwater monitoring at PORTS was initiated in the 1980s and 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. The *Integrated Groundwater Monitoring Plan* was developed to address these requirements. The initial plan was approved by Ohio EPA and implemented beginning in April 1999. This plan is periodically revised by DOE and approved by Ohio EPA. An annual groundwater report is submitted to Ohio EPA in accordance with this plan. Groundwater monitoring is also conducted to meet DOE Order requirements.

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 and is usually separated from the Gallia by the Sunbury shale, which acts as a barrier to hinder groundwater flow between the two formations.

Groundwater directly beneath PORTS is not used as a domestic, municipal, or industrial water supply, and contaminants in the groundwater there 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 water supply well fields north or 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.

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, as well as other information about groundwater. 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.

Groundwater Monitoring Areas

The *Integrated Groundwater Monitoring Plan* requires groundwater monitoring of 12 areas within the site designated by the RCRA Corrective Action Program. This plan 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 and are analyzed for metals, VOCs, and/or radionuclides. Potential contaminants detected in the groundwater are then compared to standards called preliminary remediation goals in order to assess the potential for each substance 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 VOCs (primarily TCE) and radionuclides such as technetium-99. The areas that contain groundwater plumes are X-749/X-120, Quadrant I Groundwater Investigative Area, Quadrant II Groundwater Investigative Area, X-701B Holding Pond, and X-740 Former Waste Oil Handling Facility.

X-749/X-120/PK Landfill (X-749/X-120 groundwater plume)

The X-749 Contaminated Materials Disposal Facility covers an area of approximately 11.5 acres and was operated from 1955 to 1990, during which time buried wastes were generally contained in metal drums or other containers compatible with the waste. The northern part 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 while the southern part contains non-hazardous, low-level radioactive scrap materials. Remediation actions included: 1) the installation of a multimedia cap; 2) the installation of a barrier wall along the north side and northwest corner of the landfill; 3) the installation of subsurface groundwater drains with sumps installed; 4) the treatment of groundwater from the remaining subsurface drains at the X-622 Groundwater Treatment Facility; 5) the planting of hybrid poplar trees for phytoremediation; 6) the installation of nine extraction wells; and 7) the sampling of 98 wells and one sump/extraction well.

X-120 Old Training Facility

The X-120 Old Training Facility was built in the 1950s and included a machine shop, metal shop, paint shop, and several warehouses used during construction of PORTS. The facility no longer exists but groundwater in the vicinity is contaminated with VOC's, primarily TCE. Remediation involved installing a groundwater extraction well in 2010 to reduce TCE concentrations.

Artwork by Jamie Welch

PK Landfill

The groundwater plume at the PK Landfill is near the southern boundary of PORTS, west of Big Run Creek and south of the Holding Pond in Quadrant I. The landfill began operations in 1952 and was used as a salvage yard, burn pit, and trash area was during the construction of PORTS. After the initial construction, the site was operated as a landfill until 1968 when soil was graded over the site and the area was seeded with native grasses. In 1994, a part of Big Run Creek was relocated about fifty feet to the east to prevent occasional seeps from the landfill to the creek. A groundwater collection system was installed in the old creek channel to capture seeps. In 1998, a cap was constructed over the landfill and in 2013, nine wells, two sumps, and two manholes were sampled.

The most extensive and concentrated constituents associated with the X-749/X-120 groundwater plume are VOC's, particularly TCE. In general, concentrations of TCE are stable or decreasing within this plume. Monitoring results for this groundwater monitoring area show that TCE decreased in one well and remained less than 5 µg/L in

three wells. Groundwater extraction wells were installed in 2010 to remediate areas of higher TCE concentrations south of the X749 Landfill. Results indicate that the X-749 extraction well is functioning as intended to reduce concentrations of TCE in this area and the average concentration of TCE detected in 2013 in well X-120-11G (245 µg/L) has decreased from the average annual concentrations detected in 2012 (275 µg/L) . In 2013, TCE was not detected above the preliminary remediation goal of 5 µg/L nor were VOCs detected in any well downgradient of the X-749 South Barrier Wall.

TCE was detected at concentrations up to 37 µg/L in wells X-749-14B and X749-112G in 2011. Samples collected in 2013 show TCE levels less than 1.2 µg/L which is typical for these wells. In 2013, vinyl chloride was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 14 to 17 µg/L, which exceeded the preliminary remediation goal of 2 µg/L.

Quadrant I Groundwater Investigative (5-Unit) Area/X-749A Classified Materials Disposal Facility

The Quadrant I Groundwater Investigative (5-Unit) Area consists of a groundwater plume resulting from several sources of groundwater contamination: Oil Biodegradation Plots, Steam Plant Complex, Coal Pile Yard, Coal Pile Runoff Treatment Facility, Technical Services Building, Pilot Investigation Building and the Mechanical Testing Facility. Groundwater extraction wells were installed between 1991 and 2002 and the extracted groundwater is treated at the Groundwater Treatment Facility and discharged into the Sewage Treatment Plant. Multimedia landfill caps were installed to minimize water infiltration and control the spread of contamination. Thirty-one wells were sampled in 2013 as part of the monitoring program for the Quadrant I Groundwater Investigative (5-Unit) Area.

The six-acre X-749A Classified Materials Disposal Facility (X-749A Landfill) operated from 1953 through 1988 for the disposal of wastes classified under the Atomic Energy Act, including PCBs, asbestos, radionuclides and industrial waste. Closure of the landfill was completed in 1994 and included the construction of a multilayer cap and the installation of a drainage system to collect surface water runoff. Ten wells associated with the landfill were sampled in 2013.

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant I Groundwater Investigative area in 2013. No significant changes in TCE concentrations were identified in wells that monitor this area however, concentrations of TCE detected in two wells, X231B-07G (24 µg/L) and X231B-29G (5.2 µg/L) have decreased since the wells were sampled in 2011. Also, none of the statistical control limits for alkalinity, ammonia, calcium, chloride, iron, nitrate/nitrite, sodium, and sulfate were exceeded in samples from downgradient Gallia wells in 2013.

Quadrant II Groundwater Investigative (7-Unit) Area

The Quadrant II Groundwater Investigative (7-Unit) Area consists of an area of groundwater contamination with several potential sources including the X-701C Neutralization Pit, which was an open-topped pit that received process effluents and basement sump wastewater such as acid and alkali solutions and rinse water contaminated with TCE and other VOCs from metal-cleaning operations. The pit was removed in 2001.

The natural groundwater in this area flowed toward Little Beaver Creek but the flow pattern has been changed in this area by the use of sump pumps in the basements of the X-700 and X-705 buildings. Now, the groundwater plume does not spread but instead flows toward the sumps where it is collected and treated at the X-627 Groundwater Treatment Facility.

No concentrations of TCE were detected from well X700-03G, concentrations from well X-701-27G (ranged between 4 and 8.5 μg/L) were similar to 2012 sample results and TCE concentrations decreased in well X701-26G (ranged between 0.83 and 4.8 μg/L) compared to 2012. In all, 18 wells were sampled in 2013 as part of the routine monitoring program for this area.

X-701B Holding Pond

The X-701B Holding Pond was used from the beginning of plant operations in 1954 until 1988 and was designed for neutralization and settlement of acid waste. TCE and other VOCs were discharged to the pond. The area is about 15 acres and surrounds the X-744G Bulk Storage Building and 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 in 1993 and a sump was installed in 1995 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 and replaced with two groundwater interceptor trenches called French drains to intercept TCE-contaminated groundwater. The interceptor trenches, called the X-237 Groundwater Collections System, control TCE migration into Little Beaver Creek.

Groundwater remediation was initiated in 2006 and oxidant was injected through 2008 to remediate VOCs in soil and groundwater. Contaminated soil was also removed and mixed with oxidant with additional oxidant mixed in the soil remaining at the bottom of the excavation. In 2013, 53 wells were sampled as part of the *Integrated Groundwater Monitoring Plan* (IRM).

In general, concentrations of TCE detected in wells within the X-701B plume in 2013 were similar to previous years except TCE concentrations more than doubled in two wells that monitor the western part of the plume. In the third quarter, the concentration of TCE increased to 69 μg/L in well X701-01G. The TCE concentrations have

rebounded since the completion of the IRM in 2011 to concentrations similar to detected in 2009 prior to the IRM.

Samples from 48 wells that monitor the X-701B Holding Pond were analyzed for radionuclides. Technetium-99 and/or uranium were detected above Ohio EPA drinking water standards (900 pCi/L for technetium based on 4 mrem/year dose from beta emitters, and 30 µg/L for uranium) in ten wells near the pond. Concentrations of radionuclides in this area can be affected by the oxidant used in the X-701B IRM and the oxidant used in 2006 through 2008 that were part of the X-701B groundwater remedy. The oxidant temporarily causes metals in soil to be mobilized into the groundwater and it is expected that the metals will move down gradient with groundwater flow for a short distance then be reabsorbed into the soil matrix as they return to ambient condition.

Samples from three of the five groundwater wells in or near the X-744G Bulk Storage Building and X-744Y Storage Yard show levels of cadmium and nickel above preliminary remediation goals. Nickel was also detected above the preliminary remediation goal in samples from well X-701-127G. This area is likely affected by the oxidant used in the X-701B IRM and the oxidant injections conducted in 2006 through 2008.

Artwork by Jamie Welch

Additional Monitoring

X-633 Former Re-circulating Cooling Water Complex

The X-633 Former Re-circulating Cooling Water Complex in Quadrant II is an area of concern because chromium-based corrosion inhibitors were added to the cooling waters until 1990. D&D of the facilities was completed in 2010. Two wells are sampled semiannually and in 2013, chromium was found in both. Samples collected from X-633-07G contained chromium at concentrations above the preliminary remediation goal of 100 µg/L: 640 µg/L (second quarter) and 880 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.

X-616 Former Chromium Sludge Surface Impoundments

The X-616 Former Chromium Sludge Surface Impoundments, located 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. The sludge was removed from the impoundments and remediated as an interim action in

1990 and 1991. Nine wells are sampled annually and seven wells are sampled biennially. In 2013, chromium was detected above the preliminary remediation goal of 100 µg/L which is typical for this well. Nickel was also detected above the remediation goal (100 µg/L for Gallia wells) in two wells which is also typical.
In February 2013, TCE was detected near or above remediation goal of 5 µg/L in several wells including three wells that do not typically contain TCE above this amount. Sample contamination was suspected and in subsequent sampling, only well X616-13G had concentrations of TCE at 7.4 µg/L, which was similar to the February 2013 sample. TCE had not been detected above the preliminary remediation goal of 5 µg/L in previous samples collected from well X616-13G.

X-740 Former Waste Oil Handling Facility

The X-740 Former Waste Oil Handling Facility, operated from 1983 to 1991 and was demolished in 2006. It was located on the western half of PORTS in Quadrant III and was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. Because phytoremediation did not work to reduce the concentrations of VOCs in groundwater, three rounds of oxidant injections were completed during 2008. In 2010, a pilot study of enhanced anaerobic bioremediation began and was completed in 2013. Twelve monitoring wells were sampled quarterly in 2013, including six new monitoring wells installed for the pilot study.

Artwork by Kaila Barr

TCE decreased to less than 5 µg/L in well X740-18G. TCE was also decreasing in well X740-22G and TCE has decreased from over 1000 µg/L before the pilot study in well X740-03G to an average of 62 µg/L in 2013.

X-611A Former Lime Sludge Lagoons

The X-611A Former Lime Sludge Lagoons were comprised of three adjacent unlined sludge retention lagoons in Quadrant IV constructed in 1954 and used for disposal of lime sludge waste from the site water treatment plant until 1960. The lagoons covered about18 acres and were constructed in low-lying areas that included Little Beaver Creek and as a result, 1500 feet of this creek were relocated to a channel just east of the lagoons. A prairie habitat was developed by placing a soil cover over the north, middle and south lagoons and a soil berm was constructed outside the northern boundary to facilitate shallow accumulation of water in this low-lying area.

Six wells are monitored semiannually for beryllium and chromium. In 2013, chromium was detected in four out of six wells at concentrations between 1.3 and 57 µg/L, which are below the preliminary remediation goal of 100 µg/L.

In 2013, beryllium was detected in all six wells at concentrations of 1.5 µg/L or less, which is less than preliminary remediation goals of 6.5 µg/L for Gallia and 7 µg/L for Berea wells.

X-735 Landfills

Several distinct waste management units are contained within the X-735 Landfills are in Quadrant IV. The landfill began operation in 1981 and initially, 17.9 acres was approved by Ohio EPA and Pike County Department of Health for landfill disposal of solid wastes. Eighteen wells were sampled in 2013 and 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 were compared to concentration limits based on drinking water standards or site background concentrations. None of these concentration limits were exceeded in 2013.

X-734 Landfills

The X-734 Landfills in Quadrant IV consisted of three landfill units that were used until 1985. Detailed records of disposed materials were not kept but wastes known to be disposed included trash and garbage, construction spoils, wood and other clearing wastes, and empty drums. These landfills were closed in accordance with regulations in effect at that time and no groundwater monitoring of the area was required. The X-734 Landfills were capped in 1999-2000 as part of remedial action for Quadrant IV. Fifteen wells are sampled semiannually and no VOCs were detected at concentrations above preliminary remediation goals.

X-533 Former Switchyard Complex

The X-533 Former Switchyard Complex in Quadrant IV consisted of a switchyard containing electrical transformers and circuit breakers, associated support buildings, and a transformer-cleaning pad. Three wells are sampled semiannually for cadmium and nickel. In 2013, all three well samples contained these metals in concentrations above the preliminary remediation goals of 6.5 µg/L for cadmium and 100 µg/L for nickel. Concentrations of cadmium ranged from 14 to 49 µg/L, and concentrations of nickel ranged from 140 to 650 µg/L.

X-344C Former Hydrogen Fluoride Storage Building

The X-344C Former Hydrogen Fluoride Storage Building and associated hydrogen fluoride storage tanks were demolished and removed in 2006. In 2009, two VOCs were found in one well south of the former building at concentrations well below the applicable preliminary remediation goals. This area was added to the PORTS groundwater monitoring program in 2010 and one well is sampled annually. Four VOCs were detected in samples collected in the first quarter of 2013 at low concentrations of 2 µg/L or less, which are less than the preliminary remediation goals. These data are consistent with the data collected at this well in 2009 through 2012.

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 including Little Beaver Creek and East Drainage Ditch, Big Run Creek, Southwestern Drainage Ditch, North Holding Pond and Western Drainage Ditch. Although some VOCs were detected in some of these areas, all concentrations were well below water quality criterion or drinking water standard.

Monitoring results for surface water in 2013

Analytes Detected	Potential Contaminant Source	2013 Monitoring Results – Locations Detected	2013 Monitoring Results – Levels Detected	EPA water quality criteria and drinking water standards
Trihalomethanes	VOCs that are byproducts of water chlorination	Most of the surface water sampling locations	Below the 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 Dibromochloromethane —340 µg/L
TCE	Western portion of the X-749/X-120 groundwater plume	The Southwestern Drainage Ditch	Below the Ohio EPA water quality criterion for TCE for the protection of human health in the Ohio River drainage basin	810 µg/L
TCE	Groundwater from the plume associated with the X-701B Holding Pond	East Drainage Ditch and Little Beaver Creek	Below the Ohio EPA water quality criterion for TCE for the protection of human health in the Ohio River drainage basin	810 µg/L
Technetium-99	Groundwater from the plume associated with the X-701B Holding Pond	East Drainage Ditch and Little Beaver Creek	Below the Ohio EPA drinking water standard	900 pCi/L based on a 4 mrem/ year dose from beta emitters
Uranium	May be due to naturally-occurring uranium	Surface water samples	Below the Ohio EPA drinking water standard	30 µg/L

Water Supply Monitoring

Routine monitoring of private residential drinking water sources is completed at PORTS as required by the State of Ohio and DOE. The purpose of the program is to determine whether PORTS has had any impact on the quality of the private residential drinking water sources. One residential drinking water source was added in the fourth quarter of 2013 so seven residential drinking water sources participated in the program in 2013. Wells are sampled semiannually and the PORTS water supply is also sampled as part of this program.

In 2013, TCE was detected at a concentration of 0.18 and 0.51 µg/L respectively in the samples collected from RES-017, south of PORTS. Since this residential water supply was added to the monitoring program in 2009, TCE has routinely been detected in the water supply samples at concentrations up to 1 µg/L. These concentrations are less than the drinking water standard for TCE (5 µg/L). No other VOCs were detected in the samples at this location.

Chlorination byproducts called trihalomethanes, which are common residuals in treated drinking water, were detected in samples collected from sampling locations RES-004, RES-005 and RES-015. The total concentration of trihalomethanes was less than the Ohio EPA drinking water standard of 80 µg/L for total trihalomethanes.

Each sample was analyzed for transuranics, technetium-99, uranium, and uranium isotopes. No transuranics or technetium-99 were detected in any of the water supply samples collected in 2013. Low levels of uranium and uranium isotopes detected in some of the wells were consistent with naturally-occurring concentrations found in groundwater in the area.

Artwork by Kilee Perdue

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. Trihalomethanes were detected in samples from the Western Drainage Ditch at concentrations well below Ohio EPA non-drinking water quality criteria.

Technetium-99 was detected at 9.8 pCi/L at the surface water exit pathway monitoring location on Little Beaver Creek and were well below the Ohio EPA drinking water standard for technetium-99 (i.e., 900 pCi/L). TCE and VOCs were also detected in several on-site groundwater monitoring wells that monitor the X-749/X-120/PK Landfill area at concentrations below the Ohio EPA drinking water standard for TCE (i.e., 5 µg/L).

Groundwater Treatment Facilities

In 2013, a combined total of approximately 30.5 million gallons of water were treated at the X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities. Approximately 27 gallons of TCE were removed from the water. All processed water is discharged through permitted and monitored outfalls before leaving PORTS. No NPDES permit limitations were exceeded that were associated with these groundwater treatment facilities in 2013.

Conclusions

The PORTS facility is a large and complex industrial site that played a role in ensuring our nation's security. The people who worked, and continue to work there, have provided an invaluable service to our country and its people. It is now tasked to those involved in the D&D of the facility to make sure that the people and the environment of this region are safe from any potential hazards presented by the facility.

The processes of D&D, monitoring, and environmental remediation are huge tasks that require the hard work of many people and entities. From the individual worker to the U.S. DOE and from the local environmentalists to the U.S. EPA and Ohio EPA, we thank everyone for their hard work and dedication. This summary has covered environmental monitoring activities at PORTS for calendar year 2013. The following are some of the major events of 2013:

- The D&D process for removal of the X-600 Steam Plant Complex, X-744S Warehouse, X-624-1 Decontamination Pad, X-102 Cafeteria, the X-100 building, and X-106 Tactical Response Building was underway in 2013. The structures were removed in 2013.
- The Environmental Restoration Program implements remedial actions directed by the Ohio EPA for twelve PORTS areas where soil and/or groundwater contamination has been identified. In 2013, five year reviews were completed for the remedial actions implemented at the PK Landfill, Quadrant I Groundwater Investigative Area, X-611A Former Lime Sludge Lagoons, and X-734 Landfills. Each review found that the remedial actions were protective of human health and the environment. Two additional projects were underway in 2013 to remediate soil and/or groundwater contamination in the Quadrant II Groundwater Investigative Area and X-740 Former Waste Oil Handling Facility Area.

With large machinery making its way through the structure, a worker supplies a steady flow of water for dust suppression purposes.

The X-106 Tactical Response Building was taken down in September 2013. The 6,214-square-foot structure was built in 1955 to serve as a fire station for the site. Later, it was used by Protective Force personnel for office space and storage.

- SODI received approximately 1,380 tons of materials from PORTS, including recyclable metals, excess office furniture and equipment, over 350 radios, two refrigerators, and 115 passenger vehicles for auction.
- In 2013, DOE and FBP received one Notice of Violation which was resolved by DOE and FBP. The Notice of Violation from the U.S. EPA and Ohio EPA was for failing to close containers of used fluorescent lamps and failing to label a container of used oil with the words "used oil". The Notice of Violation was resolved by DOE and FBP.

Potential impacts to human health from PORTS operations are calculated based on environmental monitoring data. The maximum dose that a member of the public could receive from radiation released by PORTS in 2013 is 1.4 mrem. This dose 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 exposure pathways. The dose to a member of the public from airborne radionuclides released by PORTS (0.047 mrem) is also significantly less than the 10 mrem/year standard set by the U.S. EPA. Also, in general, concentrations of contaminants detected within the groundwater plumes at PORTS did not increase or decrease significantly during 2013.

Reference

U.S. Department of Energy. (2014, December). U.S. Department of Energy Portsmouth Gaseous Diffusion Plant Annual Site Environmental Report—2013 Piketon, Ohio (Publication No. DOE/PPPO/03-0598&D1). Retrieved from: http://energy.gov/sites/prod/files/2015/04/f21/2013%20Portsmouth%20ASER.

Definitions

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

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

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.

Beta activity – the rate of emission of beta particles from a given source.

Biota – animal and plant life characterizing a given region.

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.

Curie (Ci) – a unit of radioactivity, defined as that quantity of any radioactive nuclide which has 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are commonly used.

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.

Derived concentration standard – 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 458.1, *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).

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.

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.

Duplicate sample – a sample collected from the same location at the same time and using the same sampling device (if possible) as the regular sample.

Effluent – a liquid or gaseous waste discharge to the environment.

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 materials 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.

Gaseous diffusion – technology used to produce enriched uranium by forcing gases through a porous barrier (United States Nuclear Regulatory Commission, 2011).

Groundwater – any water found below the land surface.

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.

Ionizing radiation – radiation that has enough energy to remove electrons from substances that it passes through, forming ions (U.S. DOE, 2004).

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

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 measure periodically to regulate and control potential impacts.

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

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 does of 10 person-rem.

Polychlorinated biphenyls (PCBs) – man-made chemicals that range from oily liquids to waxy solids. PCBs were used in hundreds of industrials 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 effects in humans.

Preliminary Remediation Goal – The maximum concentration of a constituent in environmental media (e.g., soil and groundwater) 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.

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 – 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 – unit of radiation dose that reflects the ability of different types of radiation to damage human tissues and the susceptibility of different tissues to the damage (U.S. DOE, 2004).

Remediate – correction or cleanup of a contaminated site.

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 – materials settling out of suspension in a liquid within a defined period of time.

Stratospheric Ozone – the "good" ozone layer that extends upward from about 6 to 30 miles and protects life on Earth from the sun's harmful ultraviolet (UV) rays. This natural shield has been gradually depleted by manmade chemicals, allowing more UV radiation to reach the ground and leading to more health and environmental problems (U.S. EPA, 2010).

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

Suspended solids – particles suspended in water, such as silt or clay that can be trapped by a filter.

Switchyard complex – enclosed area used as the distribution center where power is supplied to the plant from the outside, and power is sent from the plant (Peak Power Engineering, 2012).

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.

Volatile Organic Compounds (VOCs) – 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. VOCs found at PORTs include TCE, vinyl chloride, benzene, and dichloroethenes.

Acronyms and Abbreviations

BWCS	B&W Conversion Services, LLC
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
FBP	Fluor-B&W Portsmouth LLC
IRM	interim remedial measure
LLC	Limited Liability Company
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
mrem	millirem
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
PK	Peter Kiewit
PORTS	Portsmouth Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
SODI	Southern Ohio Diversification Initiative
TCE	trichloroethene
TLD	thermoluminescent dosimeters
TSCA	Toxic Substances Control Act
USEC	United States Enrichment Corporation
EPA	U.S. Environmental Protection Agency
VOCs	Volatile Organic Compounds
WHS	Waverly High School

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