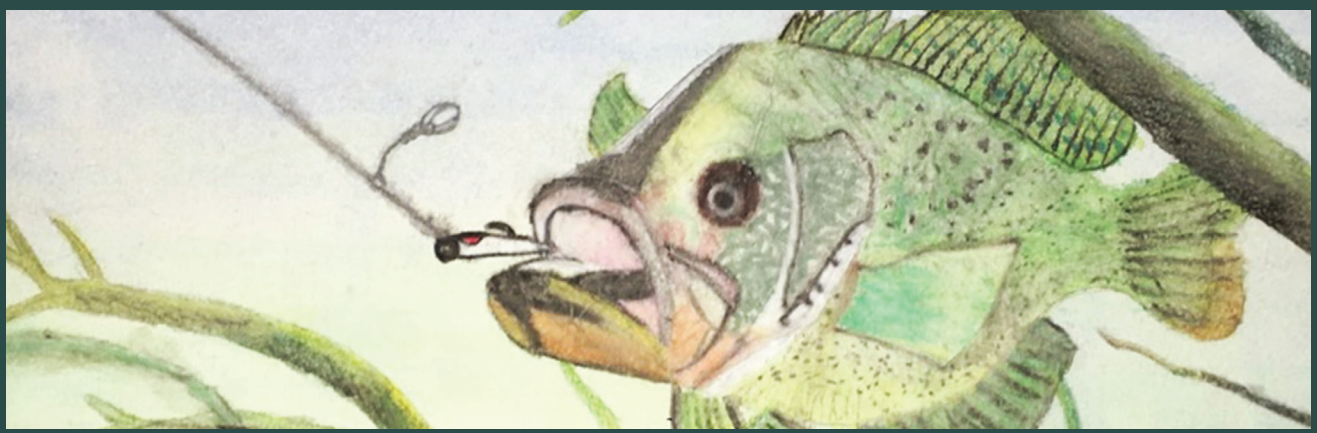
Student Summary of the U.S. Department of Energy Portsmouth Annual Site Environmental Report (ASER) for 2016



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, Waverly High School's (WHS) AP Biology class, 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 operated in an environmentally safe manner. 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 WHS 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 2016 Annual Site Environmental Report Summary.*

Production Team

Daniel Kloepfer, Research Associate, Ohio University (OU) Voinovich School of Leadership and Public Affairs
Lindsey Siegrist, Graphic Designer, OU Voinovich School of Leadership and Public Affairs

Special Thanks to

Robert Edwards, DOE EM PPPO Manager
Jeff Bettinger, DOE EM PPPO Deputy Manager
Tyler Hicks, DOE EM PPPO Contract Officer
Dr. Rich Bonczek, DOE EM PPPO Contract Officer Representative
Daniel Sand, Waverly High School Biology Teacher
Ashlee Stulley, Waverly High School Principal
Joe Moore, Restoration Services Inc.
Rick Greene, Public Affairs Manager, Restoration Services Inc.
Greg Simonton, DOE Federal Coordinator
Deneen Revel, Communications Specialist, Fluor-BWXT Portsmouth
Dr. Robert Hopkins, Assistant Professor of Biology, University of Rio Grande
Dr. Jacob White, Assistant Professor of Analytical Chemistry, University of Rio Grande
Robert Purtee, Fluor-BWXT Portsmouth
Julie Galloway, Project Manager, Portsmouth Site Specific Advisory Board
Trent Pernell, Environmental Science Tech 3, Fluor-BWXT Portsmouth
Marc Hill, NHPA Site Lead, Fluor-BWXT Portsmouth
Jeff Pinkerton, Communications Specialist, Fluor-BWXT Portsmouth
Stephanie Howe, PORTSfuture Program Director, OU Voinovich School of Leadership and Public Affairs
Mike Finney, CFAO, OU Voinovich School of Leadership and Public Affairs
Amy Mackey, Raccoon Creek Watershed Coordinator
Nora Sullivan, Research Associate, OU Voinovich School of Leadership and Public Affairs

Waverly High School Student Recognition 2019

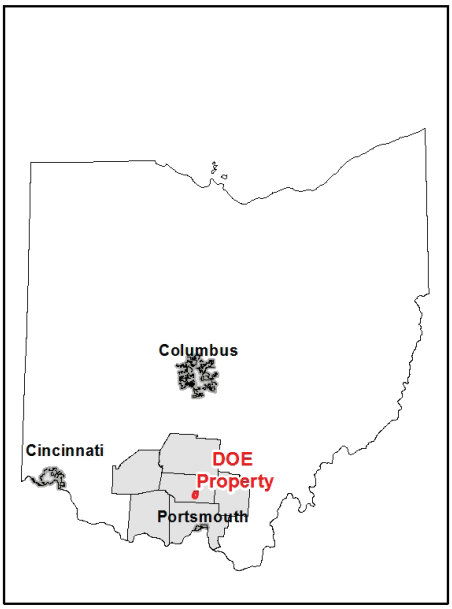
The students of Mr. Daniel Sand's AP Biology class at Waverly High School worked in collaboration with Ohio University's Voinovich School of Leadership and Public Affairs to produce this ASER Summary report. The Voinovich School thanks the students for their hard work. Their effort in this public service is much appreciated and worthy of special recognition. The 23 high school students who participated in the preparation of this ASER Summary report are listed below.

Hannah Adams
Macayne Bock
Ethan Brooker
McKenna Brooker
McKenzie Brookover
Hagen Childers
Landon Darst
Deagon Harris
Jacob Hicks
Landon Hoover
Logan Huber
Faith Kiser
Nate Manning
Cobe Marquez
Brystol Murphy
Bella Newsome
Brandon Nibert
Sydney Schuyler
Angel Seymor
Kayla Smith
Tyler Smith
Brayden Snodgrass
Brianna Tackett

Waverly High School AP Biology class, PORTS field trip

Background For The PORTS Facility

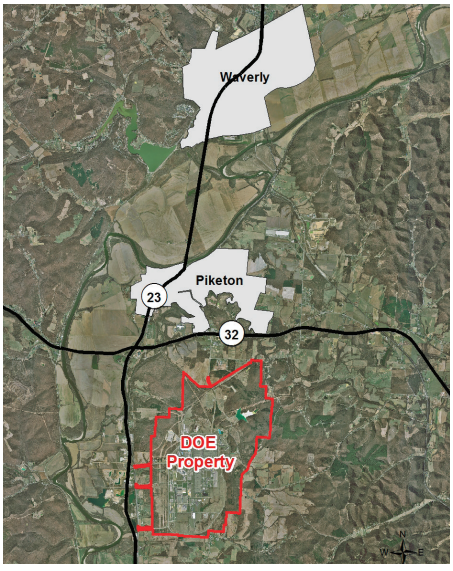
The Portsmouth Gaseous Diffusion Plant enriched Uranium from 1954 to 2001. The plant site covers roughly 5.9 square miles in the rural area of Pike County, Ohio. Pike County contains roughly about 28,160 community members living near the site (U.S. Census Bureau 2017).



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

DOE is responsible for the decontamination and decommissioning (D&D) of the site, where they deactivate and remove residue from equipment while demolishing facility structures. Fluor-BWXT Portsmouth LLC (FBP) is the DOE contractor responsible for D&D at PORTS which includes environmental restoration, monitoring plus reporting on environmental compliance, disposition of radioactive waste, uranium management, and the operation of site waste facilities.

BWCS Conversion Services, LLC (BWCS), another DOE contractor, is responsible for the Depleted Uranium hexafluoride (DUF6) conversion facility. Their responsibilities include surveillance and maintenance of the facilities, as well as environmental compliance and monitoring activities. These facilities housed uranium hexafluoride, uranium oxides, and Uranium metals.



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

The D&D at PORTS 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 agreement including July 16, 2012 Modification thereto* (D&D DFF&O) [Ohio Environmental Protection Agency (Ohio EPA) 2012]. The goal of DOE through the Environmental Restoration Program is to make sure that everything is clean and safe, such as the water and soil through past lab testings.

The purpose for the full Annual Site Environmental Report (ASER) is to give knowledge to the people about what is going on at the PORTS site and what they do. This summary and background report of the full ASER of 2016 is to inform the public about DOE environmental cleanup efforts that are in accordance with local, state, and federal regulations. This report is not intended to provide the public with the data of all the testing's done by the DOE of PORTS. More information can be found at the PORTS Environmental Information Center's website which is, https://www.energy.gov/pppo/portsmouth-enviromental-center

Compliance Summary

DOE is responsible for D&D program, Environmental Restoration Program, Waste Management Program, uranium operations, and maintenance of all facilities not leased to Centrus. FBP is responsible for air emission permits and NPDES outfalls associated with the former gaseous diffusion plant operations. BWCS is responsible for activities associated with the DUF6 Conversion Facility. Centrus is responsible for compliance activities directly associated with the ACP and Lead Cascade including air emission permits associated with the gaseous centrifuge uranium enrichment operations, NPDES outfalls, and management of wastes generated by their current operations.

Operations at PORTS are inspected regularly by the federal, state, and local agencies responsible for enforcing environmental regulations at PORTS. The primary agencies include U.S EPA and Ohio EPA. These agencies issue permits, review compliance reports, conduct joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

Artwork by LeAndrea Pompa

Environmental Laws and Regulations

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - PORTS is not on the CERCLA National Priorities List of sites requiring priority cleanup. However, D&D of PORTS is proceeding in accordance with the D&D DFF&O and CERCLA in order to bring down the buildings that are no longer in use.

Emergency Planning and Community Right-To-Know Act - The Emergency planning and community Right-To-Know act requires the reporting of emergency planning information, hazardous chemical inventories, and releases to the environment. They are also required to report which hazardous chemicals are being released.

Resource Conservation and Recovery Act (RCRA) - - RCRA regulates the generation, accumulation, storage, transportation, and disposal of solid and hazardous wastes. The designated areas that store hazardous wastes are inspected and monitored through permits put in place by Ohio EPA. The permits require PORTS to notify if there is any event that mishandles the storage of these hazardous wastes. RCRA also requires groundwater monitoring at certain hazardous waste management units. This will be discussed further in the Groundwater Section.

Federal Facility Compliance Act - RCRA hazardous waste and low-level radioactive waste (LLW) is currently stored at PORTS. The Federal Facility Compliance Act allows for the storage of mixed hazardous/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 the treatment of mixed chemicals.

DOE Order 458.1, Radiation Protection of the Public and the Environment - The purpose of DOE Order 458.1 is to protect the public and the environment against undue risk from radiation. This Order requires that off-site radiation doses do not exceed 100 millirem (mrem/year).

DOE Order 435.1, Radioactive Waste Management - The objective of DOE Order 435.1 is to ensure all DOE radioactive waste will be managed in a protective way for workers, public health and safety, and the environment.
Clean Air Act - FBP is responsible for many air emission sources involved with the former gaseous diffusion production and support facilities. The Clean Air Act requires FBP to submit quarterly Title V Deviation Reports that state any deviations from the requirements to Ohio EPA. FBP did not have any deviations from the permit requirements. BWCS is responsible for four permitted sources associated with the DUF_6 Conversion Facility. In 2016 the Annual Permit Evaluation Report for the BWCS air emission sources did not report any deviations.

Artwork by Paisley Alderman

National Emission Standards for Hazardous Air Pollutants (NESHAP) - NESHAP requires DOE to submit an annual report for radiological emissions from DOE air emission sources. FBP and BWCS are both responsible for multiple air emission sources at PORTS.

Clean Water Act and Safe Drinking Water Act - The Clean Water Act regulates the discharge of water from PORTS and requires reports to be submitted to the Ohio EPA to demonstrate compliance. The Safe Drinking Water Act sets the requirements for water testing, treatment and disinfection.

Other Regulations - DOE and DOE contractors must also comply with several other regulations. Some of these regulations are the National Environmental Policy Act, the Endangered Species Act, the National Historic Preservation Act, the Archaeological and Historic Preservation Act, the Archaeological Resources Protection Act as well as several Executive Orders.

Environmental Program Information

Decontamination & Decommissioning Program

On April 13, 2010 the Ohio EPA issued the D&D and DFF&O, which governs the D&D process over specific sites and buildings that are no longer in use at PORTS. Since being issued, it has been revised to include other buildings and structures as well. The D&D DFF&O process also include The PORTS Community Relations Plan which allows DOE opportunities to provide information to the public and obtain public input. The PORTS Site Specific Advisory Board (SSAB) provides DOE with recommendations based on the concerns of the surrounding communities.

Process Buildings and Other Facilities

D&D of process buildings is proceeding in accordance with the record of decision regarding process buildings agreed with by Ohio EPA (DOE 2015a). Actions determined by the record include the demolition of the structures, characterization and demolition of underground man-made features, treatment as needed to meet transportation and disposal requirements, preparation of waste for disposal, and procurement of transportation for waste.

The Process Buildings Deactivation Remedial Design/Remedial Action Work Plan (DOE 2016a) was developed by DOE and agreed with by the Ohio EPA. This plan details the disassembly and removal of equipment, the removal of waste (Asbestos, PCBs, RCRA hazardous waste), and the deactivation of utilities.

Artwork by Kaila Barr

Site Wide Waste Disposition

In 2015, a record of decision concerning waste disposal was concurred with by Ohio EPA (DOE 2015d). This selected a combination of on-site and off-site disposal which would include an on-site waste disposal facility (OSWDF).

In 2015, Ohio EPA concurred with Phase I and II of the remedial design/remedial action work plan for the OSWDF. This allowed them to begin with activities which continued into 2017. These activities included construction of retention ponds for surface water runoff and installation of office trailers and utilities.

Environmental Restoration Program

DOE established the Environmental Restoration Program in 1989 to identify, control, and remediate environmental contamination at PORTS. Environmental restoration is conducted in accordance with RCRA corrective action process, under U.S. EPA Administrative Order and the consent decree with the state of Ohio. Removal of facilities and structures including the building slab is controlled by the D&D process.

In general, the RCRA corrective action process consists of:

1. An assessment to identify releases of hazardous waste and constituents and determine the need for further investigation,
2. An investigation to determine the nature and extent of any contamination, and
3. A study to identify and evaluate alternatives to address contamination.

After the approval of the final cleanup study, Ohio EPA selects the remedial alternative that will undergo further review to determine the final remedial actions. With concurrence with the U.S. EPA and the completion of the public review and comment period, Ohio EPA will select the final actions. Final actions are reviewed by Ohio EPA on a schedule that was agreed on by themselves and DOE.

The initial assessment and investigation conducted at PORTS under the RCRA corrective action process was completed in the 1990's. Because it is a large facility, it was divided into four quadrants to facilitate the cleanup process. Remedial actions have been started in each of the four quadrants.

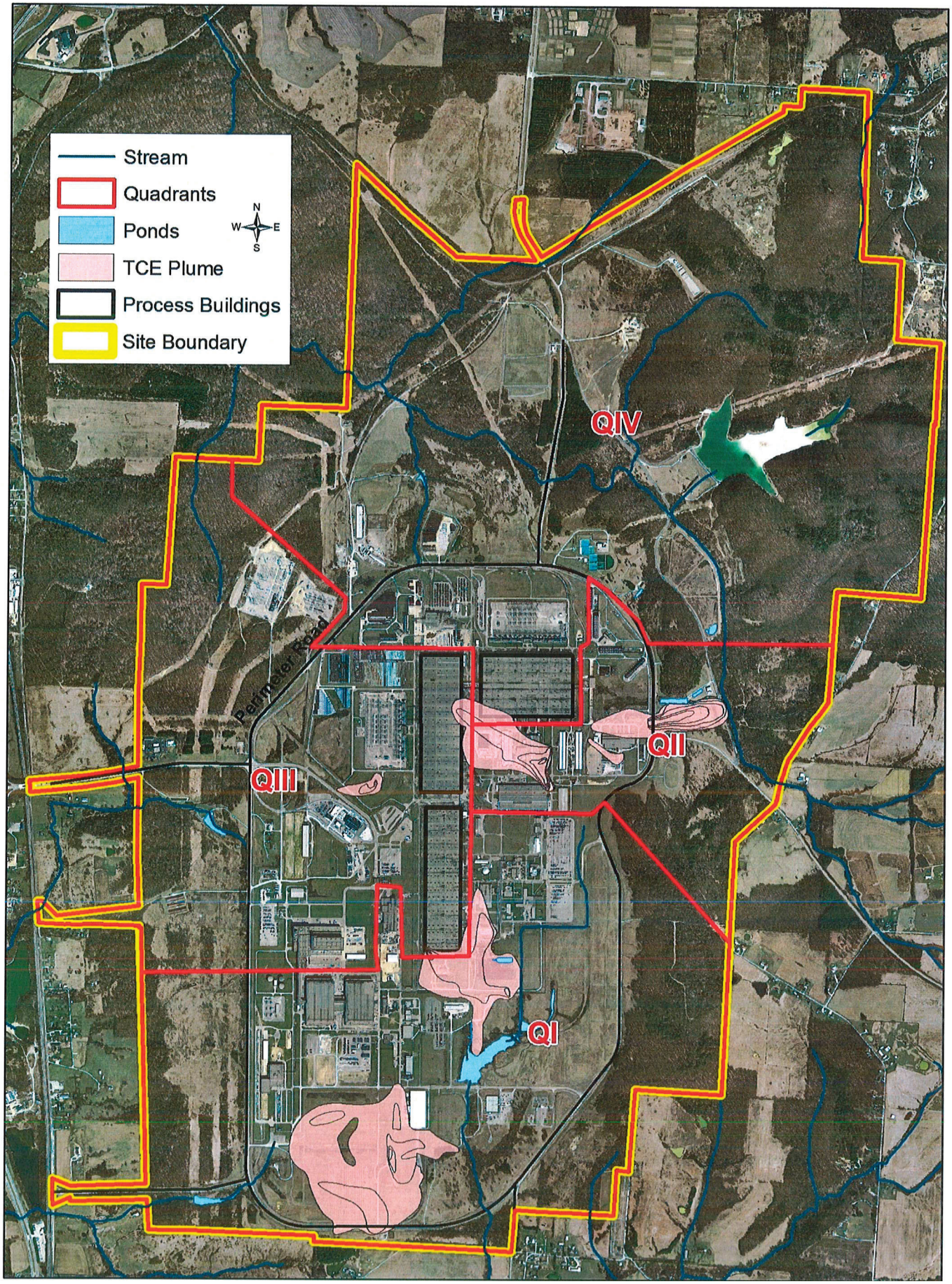
In 2016 the investigation of "deferred units" began, which includes areas that were around the gaseous diffusion production and operational areas. Any remedial action prior to D&D would have interrupted operations, or these were areas that could have been contaminated again from ongoing operations. Ohio EPA deferred investigation and remedial action of soil and groundwater until D&D of ports began. Environmental monitoring and on site worker health and safety programs monitor the contaminants in these areas prior to D&D.

The *Deferred Units Resource Conservation and Recovery Act Facility Investigation/ corrective Measures Study Work Plan* was approved by Ohio EPA in 2015 (DOE 2015c). In July of 2015 soil and groundwater sampling in the work plan started and was completed in 2016.

Quadrant I

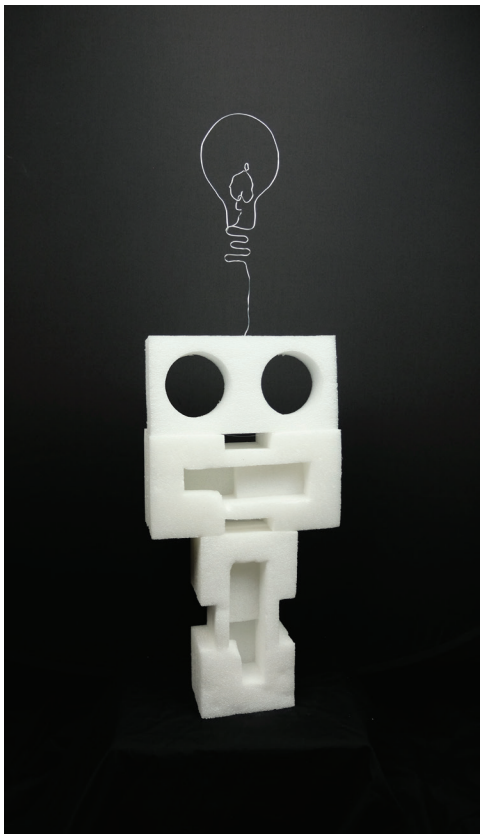
In 2000, the *Quadrant I Cleanup Alternative Study/ Corrective measures Study* was approved by Ohio EPA (DOE 2000). They issued the decision document for quadrant I in 2001 which gave them the required remedial actions for the X-749/X-120 groundwater plume and the Quadrant I Groundwater Investigation area (Ohio EPA 2001).

The remedial actions identified for the plume include phytoremediation of the plume, installation of a barrier wall around the eastern and southern portion of that landfill and continued operation of the collection of groundwater from trenches at the landfill. Additionally, groundwater extraction wells were installed in 2007, 2008 and 2010 to control the migration of the plume and remediate areas of higher trichloroethene concentrations.


Stream
Quadrants
Ponds
TCE Plume
Process Buildings
Site Boundary
N
W
E
S
QIV
QII
QIII
QI
Perimeter Road

The first five-year review for the groundwater plumes was submitted to Ohio EPA in January 2011. It found that remedial actions implemented for the plume were achieving the objectives by preventing migration. The walls put up on the eastern and southern side were responsible for the reduction in TCE in groundwater. The next review was implemented in 2016 and approved. Ohio EPA agreed with the second five-year review that remedial actions were working effectively to meet the remedial action objectives. Furthermore, a potential source to the plume was identified and has been investigated.

Remedial actions required for X-749B, which is a Peter Kiewit (PK) landfill were provided in separate documents issued by Ohio EPA in 1996 and to the U.S. EPA in 1997 (Ohio EPA 1996, U.S. EPA 1997). These actions consist of the continued operation of the eastern groundwater collection system, which was installed in 1994, and the construction of an engineered cap that meets the requirements of the Ohio EPA (Ohio EPA 1996, U.S. EPA 1997). The southeastern groundwater collection system was constructed in 1997 to contain surface seeps, groundwater from the slope of the PK landfill and the groundwater plume migrating towards Big Run Creek from the X-749 Landfill.



Artwork by Ethan Brooker

Five-year reviews (DOE 2008d, DOE 2013e) found that corrective actions were achieving corrective action objectives by eliminating exposure pathways. The next review for the PK landfill will be submitted to Ohio EPA in 2018.

The X-633 Recirculating Cooling Water Complex was demolished in 2010 and a RCRA investigation of soil and groundwater was implemented in 2011. Chromium and TCE were detected in groundwater at concentrations above remediation goals and DOE agreed to sample eight wells around the area annually to continue evaluation of chromium and TCE in this area.

Quadrant I Groundwater Investigative (5 unit) Area

The remedial actions for the Quadrant I Groundwater Investigative (5-unit) Area have been identified as

1. Installation of Multimedia caps over the X-231A and X-231B oil biodegradable plots, and
2. Installation of 11 additional groundwater extraction wells to extract contaminated groundwater for treatment at the X-622 facility (Ohio EPA 2001).

The caps were constructed in 2000 and the groundwater extraction wells began 2002. In 2009 another extraction well was installed south of the X-326 process building to control and remediate new sources of TCE beneath that building.

Five year reviews of the groundwater extraction systems for Quadrant I Groundwater Investigative (5-unit) Area and the multi-layered caps for the X-231A and X-231B oil biodegradation plots were completed in 2008 (DOE 2008a) and 2013 (DOE 2013b). The reports showed that these were continuing to eliminate potential exposure pathways to contaminants and reduced concentrations of TCE in the groundwater. The next review of this area will be submitted to Ohio EPA in 2018.

Quadrant II

The *Quadrant II Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2001 (DOE 2001). After approval, Ohio EPA requested an amendment to the study to address additional remedial alternatives for the X-701B area. A number of deferred units are in the groundwater plume in the Quadrant II Groundwater Investigative (7-Unit) Area and a special investigation was conducted in 2009. The investigation sampled soil and groundwater, which, identified areas of higher TCE concentrations that appeared to be associated with continuing sources of groundwater contamination in the southeastern portion of the plume. In 2010, the Ohio EPA approved an interim remedial measure (IRM) for this area.

The *Final Report for the 7-unit Interim Remedial Measure* was submitted to Ohio EPA in 2014 (DOE 2014). Enhanced anaerobic bioremediation successfully reduced TCE. The report concluded overall there was not a measurable reduction in the average concentration of TCE in groundwater most likely due to the potential presence of dense non-aqueous phase liquid TCE in the area, the decision was made to conclude the IRM. DOE and Ohio EPA have agreed that selection of a remedial action for the Quadrant II Groundwater Investigative (7-unit) Area will be incorporated into the deferred units preferred plan decision document.

Artwork by Zaria Hall

Remedial actions required by the decision document for X-701B, issued in 2003, include groundwater remediation by injection of a chemical oxidant (Ohio EPA 2003). The oxidant injections required by the decision document took place between 2006 and 2008. The review of the X-701B oxidant injections determined that the method used to inject oxidant into the contaminated area was not able to address contaminants in the deepest portion of the contaminated soil. Therefore, DOE proposed an IRM to remove soil in the western portion of the X-701B plume area and mix the oxidant into the contaminated soil. The IRM began in December 2009 and was completed in January 2011.

The X-633 Recirculating Cooling Water Complex was demolished in 2010. A RCRA investigation of soil and groundwater in the area was implemented in 2011. Areas of soil potentially contaminated with metals were identified, but the higher concentration of metals may have been present in these areas (15 to 20 feet below ground surface) due to naturally occurring variations in the geology of the area.

Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals during the 2011 RCRA investigation for the X-633 area. DOE agreed to sample eight wells around the area annually to continue evaluation of chromium and TCE and groundwater at the area. The *2016 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* provides the data for this monitoring (DOE 2017).

Quadrant III

The *Quadrant III Cleanup Alternative Study/Corrective Measure* Study was approved by Ohio EPA in 1998 (DOE 1998a). The Decision Document issued in 1999, required phytoremediation of the groundwater plume near X-740 Waste Oil Handling Facility (Ohio EPA 1999a). Over 700 hybrid poplar trees were planted on a 2.6 acre area above the groundwater plume in 1999. Reports for this remedial action were completed in 2003 and 2007, they concluded that the phytoremediation had not performed as expected to remove TCE from groundwater (DOE 2003, DOE 2007). In response to the concerns from the Ohio EPA about the performance of the phytoremediation system DOE implemented additional remedial activities for this area. Three rounds of oxidation injections were done in 2008 to remove TCE from the groundwater. Although it briefly reduced TCE concentrations detected in some of the wells, and in 2009 they returned to typical levels in the groundwater. In 2010 Ohio EPA approved a pilot study of enhanced anaerobic bioremediation for the X-740 area. Emulsified oil, a slow-acting fermentable carbon compound, was injected into selected portions of the groundwater during December of 2010 and January 2011. Collection of groundwater samples continued through 2015. TCE has decreased in wells within the area of the groundwater plume that was treated during the pilot study.

Artwork by Amelia Willis

Quadrant IV

The *Quadrant IV Cleanup Alternative Study/Corrective Measure Study* was approved by Ohio EPA in 1998 (DOE 1998b). No new remedial actions were required in Quadrant IV. Five-year reviews were completed in 2002, 2008, and 2013 (DOE 2002b, DOE 2008c, DOE 2013d) found that the soil cover and the prairie habitat were meeting the remedial action objectives for the X-611A Former Lime Sludge Lagoons by eliminating exposure ways to the contaminants in the sludge at this area.

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

Five year reviews completed in 2008 and 2013 found that the landfill caps have achieved remedial action objectives (DOE 2008b and DOE 2013c). The caps prevented contaminants from migrating from soil to groundwater and from groundwater to surface water.

Artwork by Sydney Laney

The X-630 Recirculating Cooling Water Complex was removed during 2011 as part of D&D. A RCRA investigation of soil and groundwater at the X-630 Recirculating Cooling Water Complex was implemented in 2011. Areas of soil potentially contaminated with metals were identified, but the higher concentrations of metals may have been present in these areas due to naturally-occurring variations in the geology of the area. Chromium and TCE were detected in groundwater at concentrations above the preliminary remediation goals during the 2011 RCRA investigation for the X-630 area. DOE agreed to sample four wells around the area annually to continue evaluation of chromium and TCE in groundwater at this area.

Waste Management Program

The DOE Waste Management Program directs the safe storage, treatment, and disposal of waste generated by past and present operations and from current D&D and Environmental Restoration projects at PORTS. Waste managed under the program includes radioactive waste, hazardous waste, waste containing PCBs and solid waste.

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

With the beginning of D&D at PORTS, DOE is placing increased emphasis on the evaluation of materials generated by D&D for reuse or recycling. An agreement between DOE and the Southern Ohio Diversification Initiative (SODI) allows DOE to transfer excess equipment, clean scrap materials and other assets to SODI. SODI first attempts to reuse the excess equipment and property within the local community. Pursuant to the agreement, if SODI is unable to place the property for reuse in the local community, SODI may sell the property. When SODI sells the property, the proceeds are used to support economic development in the southern Ohio region. In 2016, SODI received approximately 243 tons of materials from PORTS, primarily recyclable metals and reusable equipment. In 2016, FBP shipped almost 3650 tons of materials to off-site facilities for treatment, disposal, recycling, or reuse.

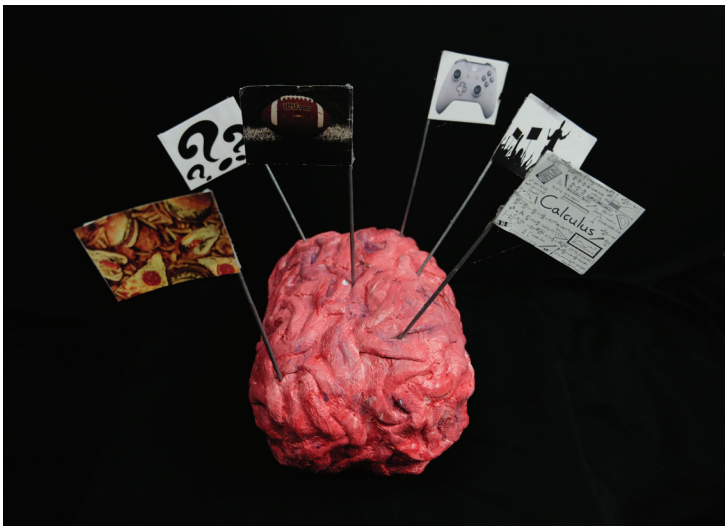
Environmental Sustainability Program

The DOE Environmental Sustainability Program is a balanced, holistic approach that links planning, budgeting, measuring, and improving PORTS overall environmental performance to specific goals and outcomes. The *Fiscal Year 2017 Site Sustainability Plan* describes the Environmental Sustainability Program and integrates the tenets of an EMS (DOE 2016b). The Environmental Sustainability Program includes elements of pollution prevention, waste minimization, affirmative procurement, sustainable design, and energy and water efficiency.

These objectives of the sustainability program, presented below, reduce the life cycle cost and liability of DOE programs and operations at PORTS:

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

DOE continued energy reduction programs at PORTS that focused on accomplishing the goals of Executive Order 13693, *Planning for Federal Sustainability in the Next Decade.* Executive Order 13693 provides goals for greenhouse gas emission reductions and environmental sustainability.



Artwork by Caleb Howard

In support of this Executive Order, the *Fiscal Year 2017 Site Sustainability Plan for the Portsmouth Gaseous Diffusion Plant* provides goals and progress through fiscal year 2016 for reductions in greenhouse gas emissions, water consumption, recycling/waste diversion, electronic stewardship, and other areas (DOE 2016b). The following accomplishments were listed for fiscal year 2016:

- a decrease of 56% in greenhouse gas emissions (primarily associated for electricity consumption) versus the fiscal year 2008 baseline emissions.
- a decrease in water consumption of 6% in fiscal year 2016 versus fiscal year 2015.
- 16.2% of electricity consumption from renewable energy sources, which exceeds the goal of 10%.
- an increase in alternative fuel vehicles (either flex-fuel or hybrid vehicles) to 81% of the total vehicle fleet. All new vehicles are alternative fuel vehicles.

Public Awareness Program

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

The PORTS SSAB, comprised of citizens from the local area, provides public input and recommendations to DOE on D&D, environmental remediation, waste management, and related issues at PORTS. Regularly scheduled meetings that are open to the public are held between DOE and the PORTS SSAB. Additional information about the PORTS SSAB can be obtained at www.energy.gov/pppo/ports-ssab or by calling 740-289-5249.

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

DOE also maintains a public Environmental Information Center to provide public access to documents used to make decisions. Public meetings and workshops on specific topics are also held to keep the public informed and receive their comments and questions.

Artwork by Brooklyn Adams

The following are information sources for the public:

- Site Specific Advisory Board: https://www.energy.gov/pppo/ports-ssab/portsmouth-site-specific-advisory-board or 740.289.5249
- Environmental Information Center: https://eic.ports.pppo.gov/or 740.289.8898
- DOE Portsmouth/Paducah Project Office: www.energy.gov/pppo
- DOE Site Office: 740.897.5010

An educational outreach program facilitated by a DOE grant administered by Ohio University includes a project in which local high school students produce a summary of the Annual Site Environmental Report for distribution to the public. The DOE Portsmouth/Paducah Project Office website at www.energy.gov/pppo provides additional information about this project.

[1] Subsequent to the completion of the 2016 ASER, the calculation of doses for airborne radionuclides was found to contain an error. The values in this summary are the corrected values and differ from the values in the 2016 ASER.

Environmental Radiological Information

Environmental monitoring at PORTS measures both radiological and chemical parameters in air, water, soil, sediment, and biota. Environmental monitoring programs are required by state and federal regulations, permits, and DOE Orders. These programs may also be developed to address public concerns about plant operations. DOE also conducts an extensive groundwater monitoring program at PORTS, which will be discussed throughout the following sections.

A US resident can expect to receive an average dose of 311 mrem/year of radiation from sources of natural occurrences (National Council on Radiation Protection [NCRP] 2009). A dose is a measure of potential biological damage that could be caused by exposure to and subsequent absorption of radiation to the body. DOE sets a dose limit as low as reasonably achievable, but no more than 100 mrem/year for the dose from radionuclides from all potential pathways in DOE Oder 458.1. U.S. EPA sets a dose limit of 10 mrem/year from radionuclides released to the air in the NESHAP. By way of comparison, the maximum dose of radiation a member of the pubic could receive from PORTS in 2016 was 0.85 mrem/year, which is below the DOE limit of 100 mrem/year.

Summary of potential doses to the public from PORTS in 2016[1]

Source of dose	**Dose (mrem/year)***
Airborne radionuclides (off-site individual)	0.033
Radionuclides released to the Scioto River	0.0015
External radiation near cylinder yards	0.76
Radionuclides detected by environmental monitoring programs	0.056
Total	**0.85**

**100 mrem/year is the DOE limit in DOE Order 458.1*

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

[1] Subsequent to the completion of the 2016 ASER, the calculation of doses for airborne radionuclides was found to contain an error. The values in this summary are the corrected values and differ from the values in the 2016 ASER.

Radiological Emission and Doses

Doses are estimated for exposure to radionuclides from PORTS operations that were detected in 2016 as part of the DOE environmental monitoring programs for sediment, soil, residential drinking water (well water – excluding naturally-occurring detections of uranium isotopes) and selected biota (vegetation, deer, fish, crops, and dairy products). Analytical data from the environmental monitoring programs are assessed to determine whether radionuclides were detected at locations accessible to the public. If radionuclides were detected at locations accessible to the public, a dose assessment is completed based on the monitoring data. Exposure to radionuclides detected in groundwater at PORTS is not included because contaminated groundwater at PORTS is not a source of drinking water. Radionuclides were not detected in 2016 in samples of residential drinking water, deer, fish, crops, and dairy products.

Artwork by Kailey Clark

Most consequences associated with radionuclides released to the environment are caused by interactions between human tissue and various types of radiation emitted by the radionuclides. Radiation may come from radionuclides outside the body (external) or from radionuclides inside the body (internal). External exposure happens only as long as a person is near the external radionuclide and internal exposure continues as long as the radionuclide remains inside the body. For uranium isotopes and other radioactive isotopes, a number of specialized measurement units have been defined to describe the amount of ionizing radiation in terms of biological consequences of the absorbed energy. These units are absorbed dose, equivalent dose, effective dose and collective dose.

Airborne Emissions

Airborne discharges of radionuclides from PORTS are regulated under the NESHAP. FBP was responsible for monitoring air emission from the former gaseous diffusion plant's operations such as the monitored vents. BWCS was responsible for air emission sources associated with the DUF6 Conversion Facility. Total emissions from all DOE airborne sources in 2016 were calculated to be 0.03068 Ci. BWCS reported total emissions of 0.0000416 Ci. Centrus reported total emissions of 0.00000615 Ci from airborne sources that are part of the Lead Cascade.

The effect of radionuclides released to the atmosphere by PORTS during 2016 was characterized by calculating the effective dose to the maximally exposed person (the individual who resides at the most exposed point near the plant) and to the entire population (approximately 662,000 residents) within 50 miles of the plant. The maximum potential dose to an off-site individual from radiological releases from DOE air emission sources at PORTS in 2016 was 0.033mrem/year, which is well below the 10 mrem/year limit.

DOE 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 net dose for each station ranged from 0 at stations with a lower dose than the background station to 0.14 mrem/year at station A6 in Piketon. These dose limits are significantly less the 10 mrem/year NESHAP limit and 100 mrem/year DOE limit.

Discharges of Radionuclides from NPDES Outfalls

In 2016, FBP was responsible for 18 monitoring locations in the FBP NPDES permit. Nine of which discharge directly to surface water, six discharge to another outfall before leaving the site, and three other locations that are not outfalls are also monitored. Centrus is also responsible for 3 NPDES Outfalls. All Outfalls are discharged to either Big Run Creek, Little Beaver Creek, and/or the Scioto River. Discharges of radionuclides from the outfalls are significantly less than the 100 mrem/year limit and have no significant impact on the public health and environment.

Dose Calculation for Releases to Surface Water

Radionuclides are measured at the FBP and Centrus NPDES external outfalls. Water from these outfalls is either directly or indirectly discharged into the Scioto River. 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 scenario is unlikely to underestimate the dose due to the fact that the Scioto River downstream from PORTS is not used for drinking water. The dose from radionuclides released to the Scioto River in 2016 (0.0015 mrem/year) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

Artwork by Marjorie Savely

Radiological Dose Calculation for External Radiation

Radiation is emitted from DUF_6 cylinders stored on site at PORTS in the cylinder storage yards located in the northwest portion of the site near Perimeter Road. External radiation is measured at five locations along Perimeter Road near the boundaries of the cylinder storage yards in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (Doe 2013a). The radiological exposure to an on-site member of the general public is estimated as the time that a person drives on Perimeter Road past the cylinder yards which is estimated at 8.7 hours per year (1 min. per trip, 2 trips per day, 5 work days per week, and 52 weeks per year).

In 2016, based on these assumptions, exposure to an on-site member of the public from radiation from the cylinder yards is approximately 0.76 mrem/year. There was also a dose calculation completed for a representative off-site member of the public based on the 5 mrem/year difference between the average off-site background dose (88 mrem/year) and the dose at station A29 (mrem/year). Assuming that the worker was exposed to this kind of radiation for 250 days/year, one hour being outdoors and 8 hours inside, the dose to this worker is 0.64 mrem/year. A person living in the United States receives an average dose of approximately 311 mrem/year from natural sources of radiation (NCRP 2009). The estimated dose from members of the public near the external radiation is approximately 0.2 percent of the average natural radiation a person in the United States receives yearly. This is significantly less than the 100 mrem/year limit. Furthermore, more than 2500 DOE employees and contractors were monitored throughout 2016 and received an average dose of 1 mrem/year.

Radiological Dose Calculations for Off-Site Environmental Monitoring Data

Environmental monitoring at PORTS consists of collecting samples at locations that are off-site and analyzing those samples for radionuclides that could be there due to PORTS. Radiological monitoring programs at PORTS include ambient air, surface water, sediment, soil, residential drinking water, and biota (vegetation, deer, fish, crops, milk, and eggs).

The following table summarizes the results of each dose calculation, which are significantly less than the 100 mrem/year DOE limit.

Summary of potential doses to public from radionuclides detected by DOE environmental monitoring programs 2016

Source of dose	Dose (mrem/year)[a]
Sediment	0.034
Soil	0.022
Vegetation	0.00033
Total	**0.056**

[a] *100 mrem/year is the limit for all potential pathways in DOE Order 458.1*

Protection of Biota

DOE Order 458.1 sets absorbed dose rate limits for aquatic animal, riparian animals, terrestrial plants, and terrestrial animals. Data for analyzation for surface water and sediment samples collected during 2016 form the east side of the PORTS reservation and the duplicate sample from sediment sampling location RM-11 were used to assess the dose limits for aquatic and riparian animals. Sampling locations were picked because levels of radionuclides were among the highest detected in samples collected in 2016. Those assessments indicate that the levels of radionuclides detected in both water and sediment at these locations had a dose of less than 1 rad per day

to aquatic animals and 0.1 rad per day to riparian animals. The doses to terrestrial plants and animals are also within the dose limits of 1 rad per day. There were no unplanned releases of radionuclides at PORTS in 2016.

Ambient Air Monitoring for Radionuclides

The ambient air monitoring stations measure radionuclides released from 1) DOE and Centrus point sources, 2) fugitive air emissions and 3) background levels of radionuclides. In 2016, samples were collected from 15 ambient air monitoring stations located within and around PORTS, including a background ambient air monitoring station (A37) located approximately 13 miles southwest of the plant. No transuranic radionuclides were detected at the monitoring stations in 2016. To confirm that air emissions from PORTS are within correct regulations and requirements and are not harmful to human health, the ambient air monitoring data were used to calculate a dose to a hypothetical person living at the monitoring station. The highest net dose for the off-site stations (0.14 mrem/year) was at station A6 in Piketon. This dose is much less than the 10 mrem/year limit applicable to PORTS in NESHAP.

Artwork by Makayla Palmer

External Radiation

External radiation is measured continuously with thermoluminescent dosimeters (TLDs) at five locations near the DUF_6 cylinder storage yards, 19 locations that include 12 of the ambient air monitoring stations, and seven additional on-site locations. TLDs are put at the monitoring locations at the start of each quarter, stay at the location throughout the quarter, and are then removed from the monitoring location at the conclusion of the quarter and sent to the lab for processing. A new TLD replaces the removed one. Radiation is measured in millirems as a whole-body dose, which is the dose that a person would receive if they were continuously present at the monitored location. The potential estimated dose from the cylinder yards to a delivery person is 0.76 mrem/year. This is significantly less than the 100 mrem/year dose limit. In 2016, the average annual dose measured at 8 off-site or background locations was 88 mrem/year. Two locations within PORTS measured levels of radiation approximately 50% higher or more than the average off-site radiation. The on-site locations with higher doses than the off-site average are not used by the general public, with the exception of location #874 near the cylinder yards and station A29, near OVEC. All doses fall under the DOE potential dose limits for on-site and off-site locations. No administrative guidelines or regulatory dose limits were exceeded in 2016.

Surface Water from Cylinder Storage Yards

In 2016, FPB collected surface water samples from locations at the Cylinder Storage Yards. BWCS collected surface water samples at the cylinder yards associated with the DUF_6 Conversion Facility. Samples were analyzed for alpha

activity, beta activity, and uranium. FBP collected samples from seven locations and found maximum levels of alpha activity at 308 picocurie per liter (pCi/L and beta activity at 414 pCi/L, both being collected in December of 2016. Uranium was detected in February of 2016 at 43.9 µg/L. BWCS reported alpha activity at 18.1 pCi/L and beta activity at 12.3 pCi/L, both being collected in November of 2016. Uranium was detected in January 2016 at 14 µg/L. The 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 radionuclides detected are used in the dose calculation for releases to surface water. The dose from radionuclides released to surface water (the Scioto River) in 2016 (0.0015 mrem/year) is significantly less than the 100 mrem/year limit for all radiological releases from a facility in DOE Order 458.1.

Local Surface Water Monitoring for Radionuclides

In 2016, local surface water samples were collected from 14 locations upstream and downstream from PORTS. Those samples were collected from the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek. 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* (DOE 2013a). No transuranic radionuclides, technetium-99, or uranium-235/236 were detected in the local surface water samples collected during 2016.

Artwork by Kara Crabtree

Settleable Solids

DOE collects semiannual water samples from nine effluent locations and three background locations to determine the concentration of radioactive material that is present in the sediment suspended in the water sample. The data are used to determine compliance with DOE Order 458.1, Radiation Protection of the Public and the Environment, which says that operators of DOE facilities releasing liquids containing radionuclides from DOE activities must make sure that the discharges do not exceed an annual average of either of the following:

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

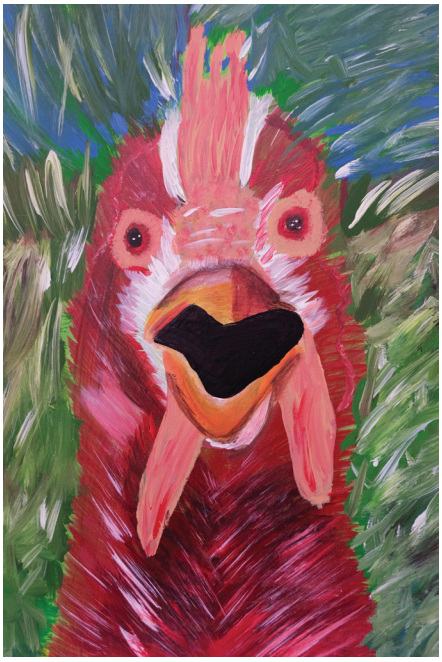
In 2016, settleable solids were not detected at concentrations above 40 mg/L at any of the monitoring locations; therefore, monitoring results are in compliance with DOE Order 458.1.

Soil

Soil samples are collected annually from ambient air monitoring locations 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* (DOE 2013a). Plutonium-239/240 was detected in soil at nine of 15 ambient air monitoring stations including the background monitoring station. The detection was much less than the soil screening level for residential soil. Americium-241 and Neptunium-237 were detected at 2 other monitoring stations. Those detections were also less than the soil screening for residential soil. Uranium, uranium-233/234, uranium-235/236, and/or uranium-238 were detected at each sampling locations. They are usually detected, so it suggests that the samples are naturally occurring. The total potential dose to a member of the public resulting from PORTS operations (0.85 mrem/year), which includes the soil dose calculation of 0.022 mrem/year, is well below the DOE standard of 100 mrem/year.

Biological Monitoring

The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2013a) requires biological monitoring to assess the uptake of radionuclides into selected local biota. For each selected biota, samples are collected and analyzed for transuranic radionuclides, technetium-99, uranium and uranium isotopes. Vegetation samples were collected in the same areas where soil samples are collected at the ambient air monitoring stations. Deer samples are collected from deer that are killed from vehicle collisions at PORTS, if available. Fish were caught from Big Beaver Creek, Little Beaver Creek, and the Scioto River. Crops were collected from five off-site locations near PORTS and no radionuclides were detected in the crop samples collected during 2016. Milk and eggs were produced near PORTS and no radionuclides were detected in the milk and egg samples collected during 2016. Finally, No other radionuclides were detected in any of the deer samples collected in 2016.



Artwork by Maci Cool

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 anything attached to property and the property itself. No real property was released from PORTS in 2016. FBP uses pre-approved authorized limits established by DOE Orders to evaluate and release materials defined as personal property. Personal property is any property that isn't real property. In 2016, FBP authorized 1893 release requests for material/items of personal property. In 2016, BWCS continued off-site shipment of aqueous hydrogen fluoride produced by the DUF6 Conversion facility, which converts DUF6 into uranium oxide and aqueous hydrogen fluoride. Each shipment must meet the release limit of less than 3 pCi/mL of total uranium activity. Approximately 12,220 gallons of aqueous hydrogen fluoride were shipped off site during 2016. The average total uranium activity of the shipment was 0.009 pCi/mL.

Environmental Non-Radiological Program Information

Non-radiological environmental monitoring on-site at PORTS includes air, surface, water, sediment and fish. This monitoring is required by state and federal regulations, but it is also to reduce public concern about the plant operations. Non-radiological data collected in 2016 are similar to data collected in previous years.
Both radiological and non-radiological constituents are monitored that could potentially be released by the activities done by PORTS. The DOE Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant (DOE 2013a) specifies non-radiological monitoring requirements for ambient air, surface water, sediment and fish. Non-radiological data are not collected for all sampling locations or all monitoring programs. Environmental permits issued by Ohio EPA to FBP, BWCS or Centrus specify discharge limitations, monitoring requirements, and reporting requirements for air emissions and water discharges.

DOE also conducts an extensive groundwater monitoring programs at PORTS that includes both radiological and non-radiological constituents.

Airborne Discharges

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

Artwork by Emily Jenkins

FBP is responsible for numerous air emission sources associated with the former gaseous diffusion production facilities and support facilities. FBP reported the following emissions of non-radiological air pollutants for 2016: 14.6 tons of particulate matter and 2.29 tons of organic compounds. Emissions for 2016 are associated with the X-627 Groundwater Treatment Facility, the X-670A Cooling Tower, X-333 Coolant System, and plant roads/parking areas.

The DUF6 Conversion Facility emits only a small quantity of non-radiological air pollutants and because of this, Ohio EPA requires a Fee Emissions Report only once every two years. BWCS reported less than 10 tons/year of non-radiological air pollutants in 2015.

U.S. EPA also requires annual reporting of greenhouse gas emissions. In 2016, FBP reported emissions of 13,817 metric tons of carbon dioxide, 0.26 metric ton of methane and 0.026 metric ton of nitrous oxide.

Another potential air pollutant present at PORTS is asbestos released by D&D of plant facilities. Asbestos emissions are controlled by a system of work practices. The amount of asbestos removed and disposed is reported to Ohio EPA. In 2016, 1.05 tons of asbestos-containing materials were shipped from PORTS.

Ambient Air Monitoring for Fluoride

Fluoride detected at the ambient air monitoring stations could be present due to background concentrations naturally in the environment, or activities associated with the former gaseous diffusion process and operation of the DUF_6 Conversion Facility. There are 15 different locations around and within PORTS that are monitored weekly for fluoride. In 2016 fluoride was not detected in 88% of samples collected for the ambient air monitoring program. Stations around PORTS measured from 0.015-0.021 $\mu g/m^3$. There is no standard for fluoride in ambient air. Data indicates that ambient concentration of fluoride are not significantly different off-site and background from concentrations at PORTS.

Non-Radiological Water Monitoring

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

FBP NPDES Outfalls

In 2016, FBP was responsible for 18 NPDES discharge points or sampling points. Nine out of the 18 outfalls discharged directly to surface water, and six other outfalls discharged to another outfall. There were three additional outfalls that were not discharge locations. In 2016, there were nine occasions in which discharge limitations were exceeded at FBP NPDES monitoring locations.

Artwork by Reese Nichols

These nine FBP NPDES outfalls were monitored and exceeded limits set by the Ohio EPA. The exceedances for mercury were below drinking water standards. Temperature exceedances were due to hot and dry weather. After the chlorine exceedance, adjustments were made to reduce additives and chlorine which decreased to less than limit in less than 4 hours. In 2016, the overall FBP NPDES compliance rate with the NPDES permit was 99%.

BWCS NPDES Outfall

BWCS is in charge of the NPDES permit for the discharge of process wastewaters from the DUF6 Conversion Facility. BWCS outfalls had no exceedances of permit limitations, as stated by the Ohio EPA, therefore the overall compliance rate was 100%.

Centrus NPDES Outfalls

Centrus is responsible for three outfalls through which water is discharged from the site. Centrus outfalls had no exceedances of permit limitations, as stated by the Ohio EPA, therefore the overall compliance rate was 100%.

Surface Water & Sediment Monitoring

Surface water samples are collected quarterly from four locations in drainage basins located downstream from the Cylinder Storage Yards and are then analyzed for PCBs. PCBs were not detected in any of the samples collected during 2016.

Sediment is monitored from up and down stream of the Scioto River from PORTS and drainage basins downstream from BWCS cylinder storage yards. Sediment samples are collected annually at the same locations where local surface water samples are collected. These locations are tested annually and analyzed for 20 different metals, PCBs, and radiological parameters. PCBs were detected in sediment samples collected downstream of PORTS. None of the detections of PCBs in sediment around PORTS were above the risk-based regional screening level for PCB-1254/1260 developed by U.S. EPA and utilized by Ohio EPA which is 240 micrograms per kilogram (µg/kg) or parts per billion (ppb) (U.S. EPA 2017).

Artwork by Ian Simonton

The result of the sampling of metals conducted in 2016 indicate that no noticeable differences are evident in the concentrations of metals present in samples that are taken upstream from PORTS, as well as at background sampling locations, and downstream from PORTS. The metals found in the samples were most likely not the result of activities at PORTS due to the fact that metals occur naturally in the environment.

In 2016, PCBs were detected in samples from each location associated with BWCS storage yards, but no PCBs were detected above the risk-based regional screening level. The highest level of PCBs was 150 µg/kg and the maximum boundary is 240 µg/kg as stated by the U.S. EPA and utilized by Ohio EPA (U.S. EPA 2017).

Biological Monitoring of Fish

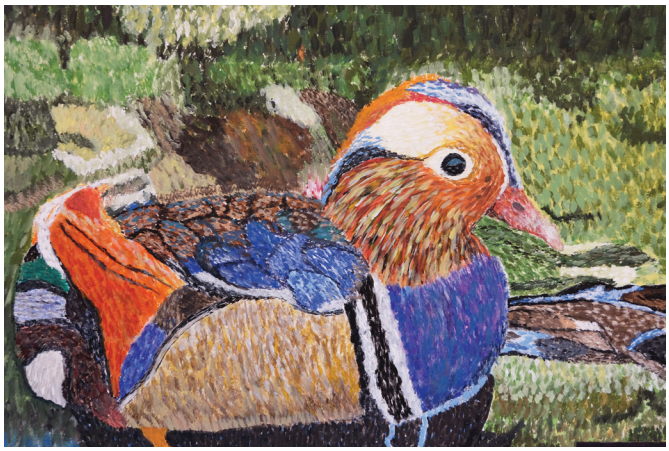
Fish samples are collected annually from Little Beaver Creek, Big Beaver Creek, and the Scioto River. Fillets are taken from the fish and tested for PCBs. PCBs were detected in bass at Little Beaver Creek of 307 µg/kg. PCBs were also detected in bass at Big Beaver Creek of 12.1 to 33.8 µg/kg. PCBs were detected in catfish at the Scioto River of 37.5 and 50.7 µg/kg. Detections were compared to the Ohio Fish Consumption Advisories Chemical Limits, which are provided in the *State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program* (Ohio EPA 2010). Limits for Consumption rates are categorized as: unrestricted, 1/week, 1/month, 6/year, and Do Not Eat. Little Beaver Creek bass was rated between 1/week of 220 µg/kg to 1/month of 1000 µg/kg consumption rate. Big Beaver Creek bass and Scioto River catfish were less than or just above the unrestricted limit of 50 µg/kg).

The Ohio Sport Fish Consumption Advisory advises the public on the consumption limits for sport fish that are caught from any body of water in Ohio and should be consulted before attempting to eat any fish caught in Ohio waters.

Groundwater Programs

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

This section provides an overview of groundwater monitoring at PORTS and the results of the groundwater monitoring program for 2016. In addition, the section provides information about the remedial actions implemented at a number of the areas to reduce or eliminate groundwater contamination. This section also includes information on groundwater treatment facilities at PORTS. These facilities receive contaminated groundwater from the groundwater monitoring areas and treat the water prior to discharge through the permitted FBP NPDES outfalls. Groundwater monitoring has been conducted in response to state and/or federal regulations, regulatory documents prepared by DOE, agreements between DOE and Ohio EPA or U.S. EPA and DOE Orders. The Integrated Groundwater Monitoring Plan was developed to address all groundwater monitoring requirements for PORTS and provides details on monitoring activities and issues. An annual groundwater report is submitted to Ohio EPA in accordance with the *Integrated Groundwater Monitoring Plan* (DOE 2015d). Groundwater monitoring is also conducted to meet DOE Order requirements.



Artwork by Katrina Entler

Groundwater Use and Geology

Two water-bearing zones are present beneath the industrialized portion of PORTS: Gallia and Berea formations. The Gallia is the uppermost water-bearing zone and contains most of the groundwater contamination at PORTS. The Berea is deeper than the Gallia and is usually separated from the Gallia by the Sunbury shale, which acts as a barrier to impede groundwater flow between the two formations.

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

Groundwater Monitoring Activities

Samples of water are collected from groundwater monitoring wells and analyzed to obtain information about contaminants and naturally occurring compounds in the groundwater. The groundwater elevation can be combined with information about subsurface soil to estimate the rate and direction of flow in the groundwater. This can be used to predict the movement of the contaminants in the water and to develop ways to remediate groundwater contamination.

Artwork by Chloe Kelley

Groundwater Monitoring Areas

The *Integrated Groundwater Monitoring Plan* requires groundwater monitoring of areas within the quadrants of the site designated by the RCRA Corrective Action Program (DOE 2015d). 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 (DOE 2015d).

In general, samples are collected from wells (or surface water locations) in each monitored area and are analyzed for metals, VOCs and/or radionuclides. Constituents detected in the groundwater are then compared to standards called preliminary remediation goals to assess the potential for each contaminant 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 facilities, Quadrant I Groundwater Investigative Area, Quadrant II Groundwater Investigative Area, X-701B Former Holding Pond and X-740 Former Waste Oil Handling Facility.

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

The X-749 Contaminated Materials Disposal Facility is a landfill located in the south section of Quadrant I. The Landfill covers approximately 11.5 acres and it was built in the highest elevated area. The landfill operated from 1955 to 1990. The northern portion was used for waste classified as hazardous or have low-level radiation. The southern portion was used for non-hazardous material waste. Upon closure in 1992, a variety of actions were taken to contain contamination. Some of these actions included the installation of barrier walls, groundwater drains and extraction wells. The last extraction well was completed in 2010. The extraction wells are used to control the migration of the plume off of plant property and to remediate areas with TCE concentration inside the plume. A total of 84 wells and one sump/extraction well were sampled in 2016 to monitor the X-749/X-120 area.

The X-120 Former Training Facility included a machine shop, metal shop, paint shop, and several warehouses used during the construction of PORTS. The groundwater in the vicinity is contaminated with VOCs, primarily TCE.

The PK Landfill began operation in 1952, and it was used as a salvage yard, burn pit, and trash area during the construction of PORTS. It was operated as a sanitary landfill until 1968, it was then soil was put over the site, and then seeded with native grasses. During investigations, seeps were observed emanating from the landfill, so in 1994, a portion of Big Run Creek was relocated to prevent contamination from the seeps. Two collection systems were installed in the old channel to capture the seeps. Although the PK Landfill is adjacent to the X-749 Landfill and X-749/X-120 groundwater plume, it is not a source of contaminants. There were nine wells and two sumps sampled in 2016 to monitor the PK Landfill.

Artwork by McKenna Brooker

The concentration of TCE were either stable or decreasing within the X-749/X-120 groundwater plume in 2016. The average concentration of TCE in well X120-11G in 2016 has decreased from average concentrations in 2012-2015.There were no VOCs detected in any of the off-site monitoring wells.

The PK Landfill is not part of the X-749/X-120 groundwater plume, although some of the wells associated with the PK Landfill are contaminated with low levels of VOCs, including TCE. In 2016, vinyl chloride was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 13 µg/L to 20 µg/L, which exceed the preliminary remediation goal of 2µg/L. Vinyl chloride is typically detected at concentrations above preliminary remediation goal. No other VOCs were detected in the PK Landfill monitoring wells at concentrations that exceed the preliminary remediation goals.

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 a number of different potential sources of groundwater contamination in the northern portion of Quadrant I. A total of fifteen extraction wells were installed from 1991 to 2009 in the X-231B Southwest Oil Biodegradation Plot area. The extracted groundwater is treated at the X-622 Groundwater Treatment Facility. Multimedia landfill caps were installed in 2000 to help control the spread of contamination. A total of 24 wells were sampled in this area in 2016.

The X-749A Classified Materials Disposal Facility (X-749A-Landfill) operated from 1953 through 1988 for

the disposal of wastes classified in the Atomic Energy Act. Potential contaminants include PCBs, asbestos, radionuclides and industrial waste. Closure of the landfill in 1994 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 2016.

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant I Groundwater Investigative (5-Unit) Area. The eastern and northwestern edges of the groundwater plume changed slightly in 2016. On the eastern edge of the plume, TCE was detected at 7.4 µg/L in X231A-01G and is routinely detected and just above remediation goals of 5 µg/L. No other significant changes in TCE concentrations were identified in wells that monitor the Quadrant I Groundwater Investigative (5-Unit) Area in 2016.

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. One of these sources, the X-701C Neutralization Pit, was monitored prior to implementation of the Integrated Groundwater Monitoring Plan. The X-701C Neutralization Pit was an open-topped neutralization pit that received process effluents and basement sump wastewater such as acid and alkali solutions and rinse water contaminated with TCE and other VOCs from metal-cleaning operations. In 2010, Ohio EPA approved an IRM to remediate contaminant source areas within the southeastern portion of the groundwater plume, which was completed in 2013. The natural groundwater flow direction in this area is to the east toward Little Beaver Creek. The groundwater flow pattern has been changed in this area by use of sump pumps in the basements of the X-700 and X-705 buildings. Thus, the groundwater plume in this area does not spread but instead flows toward the sumps where it is collected and then treated at the X-627 Groundwater Treatment Facility. Twenty-four wells are part of the routine monitoring program for this area.

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant II Groundwater Investigative (7-Unit) Area. Concentrations of TCE detected in the Quadrant II Groundwater Investigative (7-Unit) Area plume were generally stable or decreasing in 2016, with the exception of X705-03G on the southwest portion of the plume. TCE has increased to 88 µg/L in 2016 in well X705-03G. Wells at the eastern or southeastern boundary of the monitoring area were sampled semiannually to monitor movement of the east side of the Quadrant II Groundwater Investigative (7-Unit) Area plume towards the X-701B Former Holding Pond Area. TCE was not detected in any of the samples collected from well X700-03G. Concentrations of TCE detected in wells were similar to or less than TCE concentrations detected in 2015.

X-701B Former Holding Pond

In the eastern portion of Quadrant II, groundwater concerns focus on three areas: the X-701B Former Holding Pond, the X-230J7 Holding Pond, and the X-744Y Waste Storage Yard. The X-701B Former Holding Pond was used from the beginning of plant operations in 1954 until 1988. The pond was designed for neutralization and settlement of acid waste from several sources. TCE and other VOCs were also discharged to the pond. The X-230J7 Holding Pond received wastewater from the X-701B Former Holding Pond. A contaminated groundwater plume extends from the X-701B Former Holding Pond towards Little Beaver Creek. Three groundwater extraction wells were installed in 1993 southeast of the X-701B Former Holding Pond and a sump was installed in 1995 in the

bottom of the pond as part of the RCRA closure of the unit. These wells and sump were designed to intercept contaminated groundwater emanating from the holding pond area before it could join the existing groundwater contaminant plume. The extraction wells and sump were removed between 2009 and 2011 because of the X-701B IRM.

Two groundwater interceptor trenches are used to intercept TCE-contaminated groundwater in the eastern portion of the monitoring area. These interceptor trenches control TCE migration into Little Beaver Creek. The Groundwater remediation in the X-701B Former Holding Pond Area was initiated in 2006. Oxidant was injected into the subsurface in the western portion of the area from 2006 through 2008 to remediate VOCs in soil and groundwater. Sixty-two wells that monitor the X-701B Former Holding Pond area were sampled in 2016 as part of the Integrated Groundwater Monitoring Plan (DOE 2015d).

Concentrations of TCE were similar to previous years and remain elevated in wells X701-BW2G and X701-130G that monitor the western portion of the plume, west of the IRM treatment area. TCE is decreasing in well X701-EW121G, which is downgradient of the IRM treatment area. In the third quarter, TCE was detected at 210 µg/L in well X701-01G in the southwestern portion of the monitoring area. TCE increased to about 5 µg/L in wells X701-30G and X744G-03G in 2016.

Samples from 48 wells that monitor the X-701B Holding Pond were analyzed for radionuclides. Technetium-99 or uranium were detected above Ohio EPA drinking water standards in seven wells near the former X-701B Pond and east retention basin and in wells installed within the IRM area. Concentrations of radionuclides present in groundwater in the X-701B area can be affected by the oxidant used in the X-701B IRM and the oxidant injections conducted in 2006 through 2008 that were part of the X-701B groundwater remedy. Samples from five wells that monitor the area near the X-744G Bulk Storage Building and X-744Y Storage Yard were analyzed for cadmium and nickel, which were detected above preliminary remediation goals in three of the five wells. Nickel was also detected at concentrations equal to or above the preliminary remediation goal in samples collected from wells X701-20G and X701-127G, which monitor the center of the plume downgradient from the IRM treatment area and the area in which oxidant was injected from 2006 through 2008. This area is likely affected by the oxidant used in the X-701B IRM and the oxidant injections conducted in 2006 through 2008.

Additional Ground Monitoring

X-633 Former Recirculating Cooling Water Complex

The X-633 Former Recirculating Cooling Water Complex in Quadrant II consisted of a recirculating water pump house and four cooling towers with associated basins. Chromium-based corrosion inhibitors were added to the cooling water until the early 1990s, when the system was converted to a phosphate-based inhibitor. D&D of the facilities was completed in 2010. Two wells are sampled semiannually for chromium as part of the monitoring program for this area. Chromium was detected in both of the X-633 monitoring wells in 2016. Samples collected from well X633-07G contained chromium at concentrations above the preliminary remediation goal of 100 µg/L: 370 µg/L (second quarter) and 510 µg/L (fourth quarter). Samples collected from well X633-PZ04G also contained chromium but at concentrations well below the preliminary remediation goal.

X-616 Former Chromium Sludge Surface Impoundments

The X-616 Former Chromium Sludge Surface Impoundments in Quadrant III were two unlined surface impoundments used from 1976 to 1985 for storage of sludge generated by the treatment of water from the PORTS process cooling system. Sludge containing chromium was produced by the water treatment system and was pumped into and stored in the X-616 impoundments. The sludge was removed from the impoundments and remediated as an interim action in 1990 and 1991. Sixteen wells are sampled as part of the monitoring program for this area. In 2016, chromium was detected above the preliminary remediation goal of 100 µg/L in one well that monitors the X-616 area. Nickel was detected above the preliminary remediation goal in two wells. TCE was detected above the preliminary remediation goal of 5 µg/L in three wells west of the former surface impoundments. TCE has been detected above 5 µg/L in wells X616-09G and X616-20B since 2004 or earlier. Concentrations of TCE increased to above 5 µg/L in well X616-13G in 2013.

X-740 Former Waste Oil Handling Facility

The X-740 Former Waste Oil Handling Facility, located in Quadrant II, was demolished in 2006. The X-740 facility, which operated from 1983 until 1991, was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. A sump within the building was used between 1986 and 1990 to collect residual waste oil and waste solvents from containers crushed in a hydraulic drum crusher at the facility. The facility and sump were initially identified as hazardous waste management units in 1991. The X-740 Former Waste Oil Handling Facility underwent closure, and closure certification was approved by Ohio EPA in 1998. In 1999, poplar trees were planted above the groundwater plume near the X-740 Former Waste Oil Handling Facility. Because phytoremediation did not work as anticipated to reduce the concentrations of VOCs in groundwater in this area, three rounds of oxidant injections were completed during 2008. Additional alternatives for groundwater remediation in this area were evaluated in 2009, and a pilot study of enhanced anaerobic bioremediation began in 2010.

A contaminated groundwater plume consisting primarily of TCE is located near the X-740 Former Waste Oil Handling Facility in Quadrant III. However, concentrations of TCE are decreasing in Gallia wells that monitor the pilot study. TCE has also decreased in wells X740-03G and X740-09B, which had the highest concentrations of TCE in the X-740 groundwater plume prior to the pilot study.

X-611A Former Lime Sludge Lagoons

The X-611A Former Lime Sludge Lagoons in Quadrant IV were comprised of three adjacent unlined sludge retention lagoons constructed in 1954 and used for disposal of lime sludge waste from the site water treatment plant from 1954 to 1960. As part of the RCRA Corrective Action Program, a prairie habitat has been developed in this area by placing a soil cover over the north, middle, and south lagoons. A soil berm was also constructed outside the northern boundary of the north lagoon to facilitate shallow accumulation of water in this low-lying area. The six monitoring wells at X-611A are sampled and analyzed for beryllium and chromium. In 2016, chromium was detected in the samples collected from three of the six wells in this area at concentrations between 0.9 and 42 µg/L,

which are below the preliminary remediation goal of 100 µg/L. In 2016, beryllium was detected in five of the six wells in this area at concentrations of 1 µg/L or less, which are less than the preliminary remediation goals. The goals are 6.5 µg/L for Gallia wells and 7 µg/L for Berea wells.

X-735 & X-734 Landfills

Several distinct waste management units are contained within the X-735 Landfills area in Quadrant IV. The main units consist of the hazardous waste landfill, referred to as the X-735 RCRA Landfill, and the X-735 Industrial Solid Waste Landfill. The X-735 Industrial Solid Waste Landfill includes the industrial solid waste cells, asbestos disposal cells, and the chromium sludge monocells A and B. Initially, a total of 17.9 acres was approved by Ohio EPA and Pike County Department of Health for landfill disposal of conventional solid wastes. Seventeen wells were sampled in 2016 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 are compared to concentration limits based on drinking water standards or site background concentrations. None of these concentration limits were exceeded in 2016. Concentrations of alkalinity, ammonia, calcium, chloride, iron, nitrate/nitrite, potassium, sodium and sulfate in downgradient Berea wells were also evaluated to monitor potential impacts to groundwater. No control limits were exceeded for the Berea wells.

The X-734 Landfills in Quadrant IV consisted of three landfill units that were used until 1985. However, wastes known to be disposed at the landfills included trash and garbage, construction spoils, wood and other waste from clearing and grubbing, and empty drums. Other materials reportedly disposed in the landfills may have included waste contaminated with metals, empty paint cans, and uranium-contaminated soil from the X-342 area. However, the RCRA Facility Investigation conducted in the early 1990s identified the presence of VOCs, metals, and radionuclides in soil and/or groundwater in the area. Fifteen wells are sampled semiannually as part of the monitoring program for this area. In 2016, no VOCs were detected at concentrations above the preliminary remediation goals in the samples collected from the X-734 monitoring wells.

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. D&D of the facilities began in 2010 and was completed in 2011. Soil contaminated with PCBs or metals was removed from three areas within the complex in 2010; however, none of the soil removal areas were located near the groundwater area of concern. The X-533 Former Switchyard Complex was identified as an area of concern for potential metals contamination in 1996 based on historical analytical data for groundwater wells in this area. The area was added to the PORTS groundwater monitoring program because the sampling identified metals that may have contaminated groundwater in this area. There are three wells are sampled semiannually for cadmium and nickel.

Three wells that monitor the X-533 Former Switchyard Complex were sampled in the second and fourth quarters of 2016 and analyzed for cadmium and nickel. Each of the well samples contained these metals at concentrations above the preliminary remediation goals. Concentrations of cadmium detected in the wells ranged from 9.5 to 53 µg/L, and concentrations of nickel detected in the wells ranged from 130 to 590 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, an investigation of soils and groundwater near the former building determined that groundwater in one monitoring well south of the former building contained two VOCs at concentrations well below the preliminary remediation goals. One well is sampled annually for VOCs under the monitoring program for this area. Four VOCs, cis-1,2-dichloroethene, trans-1,2-dichloroethene, TCE, and vinyl chloride, were detected in the sample collected in the first quarter of 2016 at low concentrations less than 2 µg/L, which are less than the preliminary remediation goals.

Surface Water Monitoring

Surface water is collected from fourteen different locations along Little Beaver Creek, Big Run Creek, Southwestern Drainage Ditch, North Holding Pond, and Western Drainage Ditch. Trihalomethanes are a category of VOCs that are byproducts of water chlorination and include bromodichloromethane, bromoform, chloroform, and dibromochloromethane. Detections of these byproducts were well below the Ohio EPA non-drinking water quality criteria for the protection of human health in the Ohio River drainage basin. Since the 1990s, TCE has been detected regularly at low levels in samples collected from the Southwestern Drainage Ditch. In 2016, TCE was detected at 1.9 to 4.4 µg/L in each of the four samples collected from the Southwestern Drainage Ditch. TCE and cis-1,2-dichloroethene were detected in samples collected from the East Drainage Ditch and Little Beaver Creek at a maximum concentration of 4.7 µg/L. All detections of TCE were well below the Oho EPA non-drinking water quality criterion. No transuranics were detected in the surface water samples collected in 2016. Further, the detections of uranium and uranium isotopes in surface water during 2016 were within the historical range of uranium detected in surface water at PORTS.

Water Supply Monitoring

Routine monitoring of private residential drinking water sources is completed at PORTS in accordance with the requirements of Section VIII of the September 1989 Consent Decree between the State of Ohio and DOE and the Integrated Groundwater Monitoring Plan (DOE 2015d). The purpose of the program is to determine whether PORTS has had any impact on the quality of the private residential drinking water sources. In the first and third quarters of 2016, TCE was detected at estimated concentrations ranging from 0.19 µg/L and 0.38 µg/L, in the samples collected south of PORTS. No other VOCs were detected in the samples at this location. Chlorination byproducts were also detected in one of the other residential drinking water sources; however, they were less than the Ohio EPA drinking water standards. No transuranics or technetium-99 were detected in any of the water supply samples in 2016.

In first and third quarters of 2014, TCE was detected at estimated concentrations of 0.18 µg/L and 0.64 µg/L, respectively, in samples collected from RES-017, which is south PORTS. No other VOCs were detected in the samples at this location. 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 1µg/L. These detections are less than the drinking water standard for TCE (5 µg/L).

Chlorination byproducts called trihalomethanes, which are common residuals in treated drinking water, were detected in samples collected from residential sampling location RES-015 and RES-018. The total concentrations of these trihalomethanes was less than the Ohio EPA drinking water standard (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 2014. Low levels of uranium and uranium isotopes detected in some of the wells are consistent with naturally occurring concentrations found in groundwater in the area.

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. Selected locations on local streams and drainage channels near the PORTS boundary are sampling points of the exit pathway monitoring program because surface water from PORTS NPDES outfalls and groundwater discharge to these surface waters. Surface water sampling points on Big Run Creek, Little Beaver Creek, Southwestern Drainage Ditch, and Western Drainage Ditch are part of the exit pathway monitoring program. Levels of TCE, trihalomethanes, and VOCs detected were well below the Ohio EPA non-drinking water criterion.

Groundwater Treatment Facilities

In 2016, a combined total of approximately 32.7 million gallons were treated at the X-622, X-623, X-624 and X-627 Groundwater Treatment Facilities. Approximately 20 gallons of TCE were removed from the water. All processed water is discharged through permitted and monitored outfalls before exiting PORTS. No NPDES permit limitations were exceeded that were associated with these groundwater treatment facilities in 2016.

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 of this region are safe from any dangers 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 2016. The following are some of the major events of 2016:

- Disassembly and removal of equipment, removal of wastes including asbestos, PCBs, and hazardous waste, and deactivation of utilities and other systems.
- The *Deferred Units RCRA Facility Investigation/Corrective Measures Study Work Pla*n was approved in 2015 (DOE 2015c). Soil and groundwater sampling outlined in the work plan started in 2015 and was completed in 2016.
- SODI received approximately 243 tons of materials from PORTS, primarily recyclable metals and reusable equipment.
- In 2016, DOE and FBP received two Notices of Violation, which were 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 2016 is 0.85 mrem/year. 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 pathways. The dose to a member of the public from airborne radionuclides released by PORTS (0.033 mrem/year) is also significantly less than the 10 mrem/year standard set by the U.S. EPA. In addition, generally, concentrations of contaminants detected within the groundwater plumes at PORTS were stable or decreasing in 2016.

References

Decommissioning Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio, DOE/PPPO/03-0128&D2/A1, U.S. Department of Energy, Piketon, OH, September.

DOE 2013a. *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0009&D4, U.S. Department of Energy, Piketon, OH, February.

DOE 2013b. *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0032&D6, U.S. Department of Energy, Piketon, OH, May.

DOE 2013c. *Second Five-Year Review for the X-734 Landfill Area at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0559&D1, U.S. Department of Energy, Piketon, OH, December.

DOE 2013d. *Third Five-Year Review for the X-611A Prairie at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0482&D2, U.S. Department of Energy, Piketon, OH, July.

DOE 2013e. *Third Five-Year Review for the X-749B Peter Kiewit Landfill at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0489&D1, U.S. Department of Energy, Piketon, OH, September.

DOE 2014a. *Deferred Units Resource Conservation and Recovery Act Facility Investigation/Corrective Measures Study Work Plan for Solid Waste Management Units at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0252&D3, U.S. Department of Energy, Piketon, OH, March.

DOE 2014b. *Final Report for the 7-Unit Interim Remedial Measure at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0606&D1, U.S. Department of Energy, Piketon, OH, October.

DOE 2014c. *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0032&D7, U.S. Department of Energy, Piketon, OH, May.

DOE 2014d. *Proposed Plan for the Process Buildings and Complex Facilities D&D Evaluation Project* DOE/PPPO/03-0383&D4, U.S. Department of Energy, Piketon, OH, October.

DOE 2014e. *Proposed Plan for the Site-wide Waste Disposition Evaluation Project,* DOE/PPPO/03-0312&D5, U.S. Department of Energy, Piketon, OH, October. DOE 2015. *2014 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPO/03-0672&D1, U.S. Department of Energy, Piketon, OH, March.

DOE 2016. *U.S. Department of Energy Portsmouth Gaseous Diffusion Plant Annual Site Environmental Report—2013 Piketon, Ohio.* (Publication no. DOE/PPPO/03-0688&D1). Retrieved from: https://energy.gov/sites/prod/files/2016/04/f30/2014%20PORTSMOUTH%20ASER.pdf

National Council on Radiation Protection 2009. *Ionizing Radiation Exposure of the Population of the United States,* NCRP Report No. 160, National Council on Radiation Protection and Measurements, Bethesda, MD.

Ohio EPA 1996. *Decision Document Peter Kiewit Landfill, U.S. DOE Portsmouth, Pike County, Ohio,* Ohio Environmental Protection Agency, Columbus, OH, May.

Ohio EPA 1999. *Ohio Environmental Protection Agency's Decision Document for Quadrant III of the Portsmouth Gaseous Diffusion Plant,* Ohio Environmental Protection Agency, Columbus, OH, March.

Ohio EPA 2001. *U.S. DOE Portsmouth Quadrant I Decision Document Portsmouth Gaseous Diffusion Plant,* Ohio Environmental Protection Agency, Columbus, OH, March.

Ohio EPA 2008. *State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program,* February 2008, State of Ohio, Columbus, Ohio.

U.S. EPA 1997. *Exposure Factors Handbook,* EPA/600/P-95/002Fa, U.S. Environmental Protection Agency, Washington, D.C.

United States Nuclear Regulatory Commission 2015. *10 CFR § 20.1003 Definitions,* Retrieved from https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1003.html

United States Nuclear Regulatory Commission 2017. *Uranium Enrichment,* Retrieved from https://www.nrc.gov/materials/fuel-cycle-fac/ur-enrichment.html

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 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, 2017).

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 (United States Nuclear Regulatory Commission, 2015).

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, 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 dose 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 (soil, groundwater, etc.) that is considered protective of human health and the environment.

Quality assurance – any action in environmental monitoring to demonstrate the reliability of monitoring and measurement data.

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

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.

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.

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	BWXT Conversion Services, LLC
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
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
EHS	Eastern High School
FBP	Fluor-BWXT 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)
µg/m3	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
pCi/m3	picocurie per cubic meter
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
U.S. EPA	U.S. Environmental Protection Agency
VOCs	Volatile Organic Compounds

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