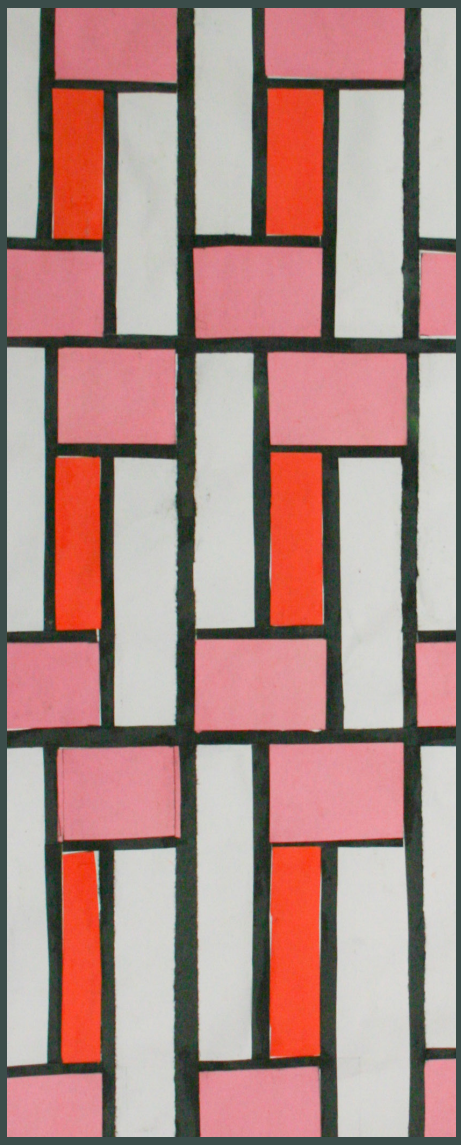
Student Summary of the U.S. Department of Energy Portsmouth Annual Site Environmental Report (ASER) for 2015



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, Eastern High School's (EHS) chemistry 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 DOE's 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 EHS 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 2015 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
Joel Bradburne, DOE EM PPPO Deputy Manager
Tyler Hicks,DOE EM PPPO Contract Officer
Dr. Rich Bonczek, DOE EM PPPO Contract Officer Representative
Janet Pennington, Eastern High School Chemistry Teacher
Lance Allen, Eastern 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
Bob Berry, Portsmouth Site Specific Advisory Board Member
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

Eastern High School Student Recognition 2018

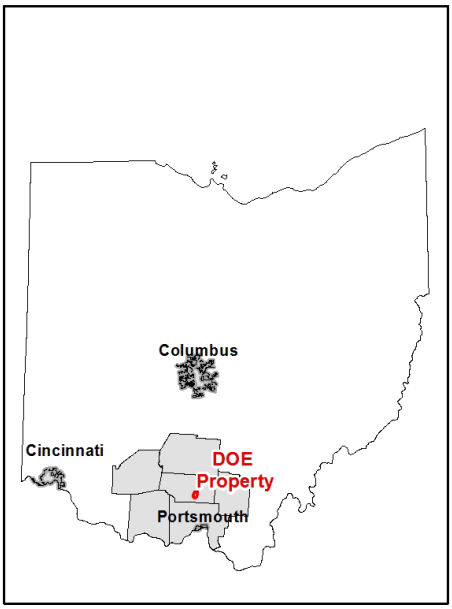
The students of Mrs. Janet Pennington's Chemistry class at Eastern High School worked in collaboration with Ohio University's Voinovich School of Leadership and Public Affairs to produce this ASER Summary report. The Voinovich School thanks the students for their hard work. Their effort in this public service is much appreciated and worthy of special recognition. The 9 high school students who participated in the preparation of this ASER Summary report are listed below.

Kayla Sigworth
Grace Pennington
Noah Gray
Clayton Hambrick
Jonathan Ratliff
Shelby Jenkins
Sydney Keller
Theo McDermott
Cassidie Farmer
Jarett Bernthold

Eastern High School Students, PORTS field trip

Background For The PORTS Facility

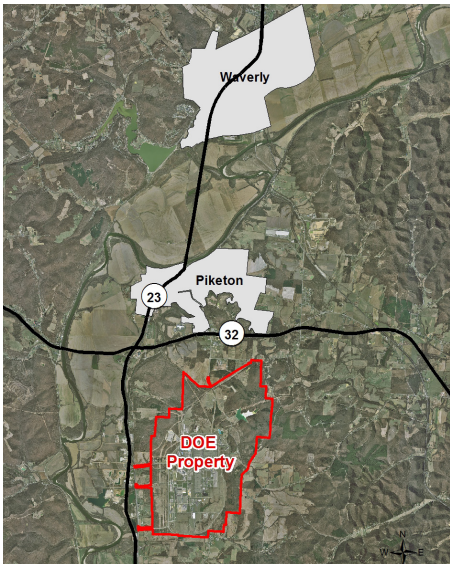
The Portsmouth Gaseous Diffusion Plant otherwise known as PORTS is located on a 5.9 square mile (3,777 acres) site, 2 miles east of the Scioto river, in Pike County Ohio. Approximately 28,256 Pike County residents live near PORTS. The villages of Beaver and Piketon lie within just a few miles from the plant. The cities of Jackson, Portsmouth, Waverly, and Chillicothe are within a 50-mile radius of PORTS.



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

In the United States three uranium enrichment plants were built by the federal government in the 1940s and 1950s for defense purposes and operated for over 50 years. PORTS was leased to the United States Enrichment Corporation (USEC) by the DOE. USEC operated gaseous diffusion plant facilities at PORTS from 1993 to 2001.

DOE is responsible for the decontamination & decommissioning (D&D) and environmental restoration at PORTS. DOE contracted Fluor-BWTX Portsmouth, LLC (FBP); and with Wastren-EnergX Mission Support LLC (WEMS) in 2015. Centrus is developing a gaseous centrifuge uranium enrichment plant in the old GCEP facilities PORTS.



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

DOE is responsible for the D&D of the uranium enrichment buildings, environmental restoration, waste management, and uranium operations, which are currently being conducted by FBP. D&D consist of activities such as process residue equipment cleaning, equipment deactivation, dismantlement and equipment removal, and demolition. 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)*, also referred to as the "D&D DFF&O." 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. Also, to make sure that everything is deeply investigated to protect biological life and the earth.

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 the site accomplished through its environmental programs.. This summary and background report of the full ASER of 2015 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 testings done by the DOE at PORTS. More information can be found at the PORTS Environmental Information Center website which is, http://energy.gov/pppo/portsmouth-enviromental-information-center.

Compliance Summary

DOE is responsible for the D&D Program, Environmental Restoration Program, Waste Management Program, uranium operations, and maintenance of facilities not leased to Centrus. FBP is responsible for air emissions permits and National Pollutant Discharge Elimination System (NPDES) outfalls associated with the former gaseous diffusion plant. BWXT Conversion Services, LLC (BWCS) is responsible for activities associated with the depleted uranium hexafluoride (DUF6) Conversion Facility. Centrus is responsible for compliance activities directly associated with the American Centrifuge Plant including air emission permits and management of wastes generated by their 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. Ohio EPA has day-to-day oversight of these activities.

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, the environmental remediation occurring at 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. (Environmental restoration is not being done under the D&D DFF&O. Environmental restoration is being done under the Resource Conservation and Recovery Act (RCRA) through a Consent Decree.)

Emergency Planning and 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.

For 2015, DOE contractors reported the permitted release and/or off-site treatment of three chemicals:

- Chlorine: used for water treatment;
- Hydrogen fluoride: approximately 9 lbs released to the air from the DUF_6 Conversion Facility; and
- Nitrate compounds: approximately 26,000 lbs released to the Scioto River through permitted NPDES outfalls.

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. In 2015, a modification request for the Part B Permit was submitted to Ohio EPA to allow storage of hazardous waste in designated areas of the X-330, X-345, and X-705 buildings. RCRA also requires groundwater monitoring at certain hazardous waste management units. This will be discussed further in the Groundwater Section. Environmental restoration is being done under RCRA through a Consent Decree.

Federal Facility Compliance Act - The Federal Facility Compliance Act allows the storage of mixed hazardous/low-level waste for longer than one year since treatment options for these chemicals are not readily available. The Act also requires federal facilities to develop and submit site treatment plans for the treatment of mixed chemicals.

Toxic Substances Control Act (TSCA) - At PORTS this act regulates the storage, use and disposal of polychlorinated biphenyls (PCBs). An annual log is prepared to meet the TSCA requirements which provides information on PCBs at PORTS.

DOE Order 458.1, Radiation Protection of the Public and the Environment – The purpose of this Order is to establish requirements to protect the public and the environment against undue risk from radiation associated with the radiological activities conducted at PORTS. This Order requires that off-site radiation doses do not exceed 100 millirem (mrem)/year above background for all exposed pathways.

DOE Order 435.1, Radioactive Waste Management - The objective of this Order is to ensure that all DOE radioactive waste is managed in a manner that is protective of 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 DUF6 Conversion Facility. In 2015 the Annual Permit Evaluation Report for the BWCS air emission sources did not report any deviations.

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 Inspections

During 2015, eight inspections of DOE activities at PORTS were conducted by federal, state, or local agencies. DOE and/or FBP received 5 notices of violations in 2015. All five violations were appropriately handled in timely fashion and no further actions were required.

Environmental Program Information

Decontamination & Decommissioning Program

April 13, 2010, Ohio EPA issued the D&D DFF&O, an enforceable agreement between Ohio EPA and sDOE that governs the process for D&D of the gaseous diffusion process buildings and associated facilities no longer in use at PORTS. The D&D DFF&O uses the CERCLA framework for determining the appropriate removal and remedial actions.

An important part of the CERCLA process and the D&D and DFF&O is the community involvement. The PORTS Community Relations Plan identifies opportunities to provide the public with information and receive their input. The PORTS Site Specific Advisory Board provides DOE with recommendations based on the concerns of the surrounding communities.

Process Buildings and Other Facilities

D&D at PORTS is proceeding in accordance with the record of decision for process buildings and other facilities agreed with by Ohio EPA (DOE 2015a). This decision includes:

- Demolition of buildings and structures;
- Characterization and demolition of underground man made features;
- Treatment if necessary to meet transportation and disposal requirements;
- Packaging of generated waste for disposal; and
- Transportation and disposal of the waste.

DOE and Ohio EPA met in 2015 to discuss a work plan for the general aspects of the work needed for the implementation of the record decision. Removal of the X-114A Outdoor Firing Range began in 2015 and continued to 2016.

Site Wide Waste Disposition

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

In September and October of 2015, Ohio EPA concurred with Phase I and II of the remedial design/remedial action work plan for the OSWDF. This allowed DOE to begin with activities which continued into 2016. These activities included tree clearing, fencing, utility installation, installation of erosion controls, and sediment controls.

Environmental Restoration Program

In 1989, DOE established the Environmental Restoration Program 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 slabs 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 will select 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, the 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 which takes place about every five years. This is to ensure the remedial actions are performing as they should by the Decision Document and are protecting human health and the environment.

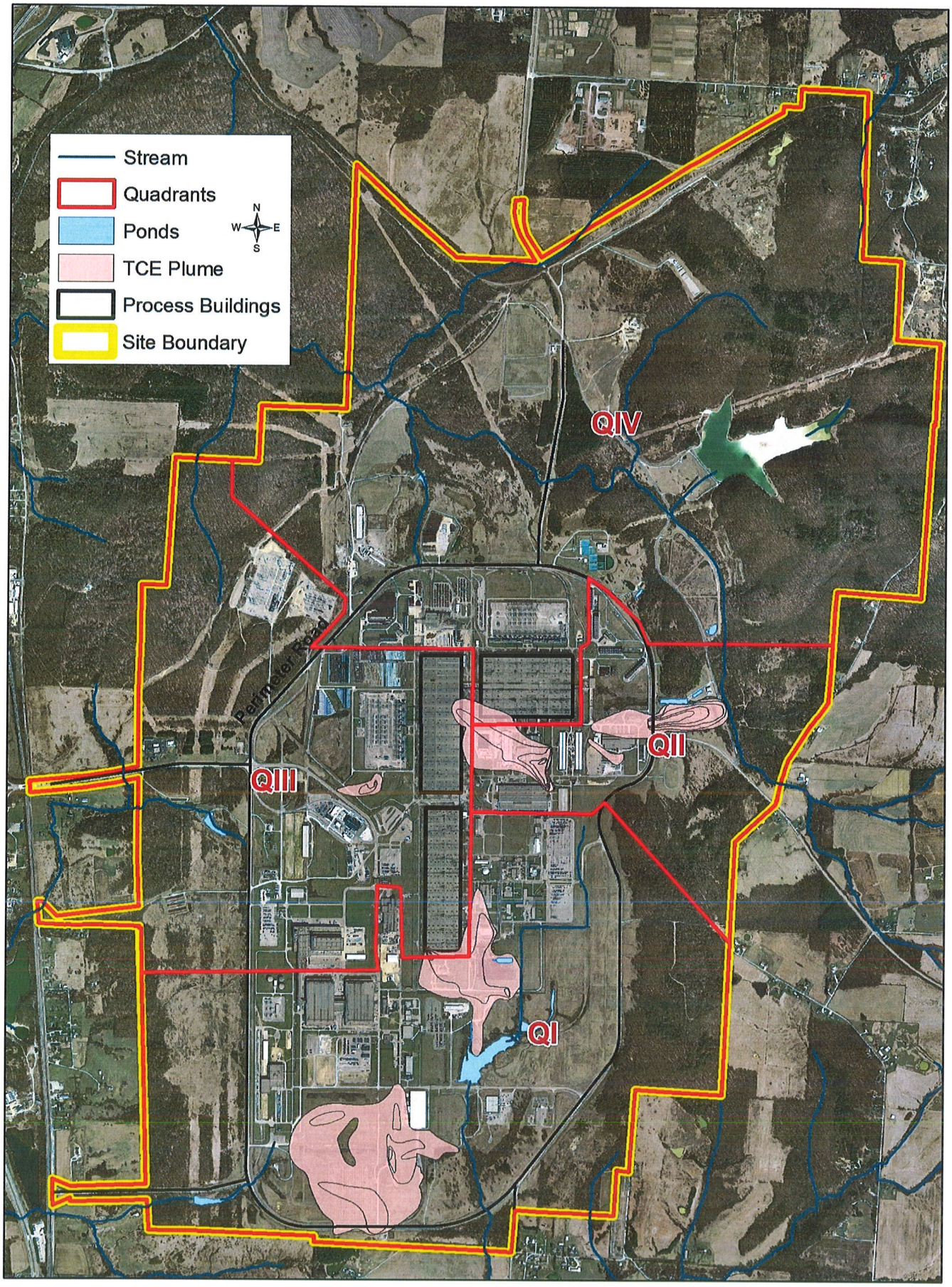
The initial assessment and investigation conducted at PORTS under the RCRA corrective action process was completed in the 1990's. Because it is a large facility, it was divided into four quadrants to facilitate the cleanup process. Remedial actions have been started in each of the four quadrants.

The D&D investigation of "deferred units" is beginning. These are 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 revised to respond to comments from the Ohio EPA received in 2013-2015 (DOE 2015c). Ohio EPA approved the work plan in June 2015 (DOE 2015d). In July of 2015 soil and groundwater sampling in the work plan started and continued into 2016.

To support the overall D&D and PORTS, and as part of the investigation of deferred units, DOE has prepared a soil background study to determine the concentration of metals, radionuclides and other things in the soil. This study will be used to:

1. Assess the possibility of soil contamination that can be from PORTS operations,
2. Support the development of risk based remediation goals, and
3. Support real property transfer under CERCLA.


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

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 provided the required remedial actions for the X-749/X-120 groundwater plume and the Quadrant I Groundwater Investigation area.

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. Phytoremediation is a process that uses plants to remove, degrade or contain contaminants in soil or groundwater. Groundwater extraction wells were installed in 2007, 2008 and 2010 to control the migration of the plume and remediate areas of higher trichloroethene (TCE) concentrations.

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, though they determined the phytoremediation was not as successful in reducing concentrations of TCE in groundwater. The walls installed on the eastern and southern side were responsible for the reduction in TCE in groundwater.

Marc Hill discusses historic site preservation with the students

Based on the first five year review, DOE initiated an 18 month evaluation period that went through September of 2012. The 18 month evaluation period showed the system was effective, so no changes have been made to the extraction well system in the X-749/X120 plume. The next review was implemented in 2016 and approved.

Remedial actions required for the X-749B which is a Peter Kiewit (PK) Landfill were provided in separate Decision Documents issued by Ohio EPA in 1996 and to the U.S. EPA in 1997 (Ohio EPA 1996). Remedial actions required by the PK Landfill documents 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). 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.

The second five year review, submitted in 2008, showed that the actions implemented at the landfill were succeeding in eliminating exposure pathways and reducing the opportunities for contamination transportation. This includes the groundwater collection system and the landfill cap. Many contaminants detected in the landfills wells, sumps, and manholes had decreased significantly from 1999 to 2007 and were not detected in surface water samples that were taken from Big Run Creek, just downstream from the landfill. Based on these findings, the barrier wall was not necessary.

The third five year review, submitted in 2013, for the landfill found that the corrective actions implanted were achieving the objectives set for them. These included groundwater collection systems, landfill caps, and institutional controls. They eliminate exposure pathways, and reduces potential for contamination transportation. The next review for the PK Landfill will be submitted to Ohio EPA in 2018.

Quadrant I Groundwater Investigative (5 unit) Area

The remedial actions for the Quadrant I Groundwater Investigative (5-unit) Area were 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).

Artwork by Tifany Frazier

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.

In 2008, a five year review 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 was completed (DOE 2008a). The report showed that these had eliminated potential exposure pathways to contaminants and reduced concentrations of TCE in the groundwater, though it was slower than expected.

The second five year review was submitted to Ohio EPA in 2013 (DOE 2013c). This covered the Quadrant I Groundwater Investigative (5-unit) Area and the multi-layered caps for the X-231A and X-231B oil biodegradation plots. The report showed that the remedial actions were continuing to eliminate potential exposure pathways to contaminants, control migration of the groundwater plume, and remove volatile organic compounds (VOCs) from the groundwater. The next review for Quadrant I Groundwater Investigative (5-unit) Area and the multi-layered caps for the X-231A and X-231B oil biodegradation plots 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 called enhanced anaerobic bioremediation, which utilizes injections of fermentable carbon compounds to provide additional food for naturally occurring microorganisms that degrade TCE.

The *Final Report for the 7-unit Interim Remedial Measure* was submitted to Ohio EPA in 2014 (DOE 2014a). The results show that appropriate conditions can be established at the site to degrade TCE despite the high concentrations in soil and groundwater. While enhanced anaerobic bioremediation was successful in reducing the TCE to cis-1, 2-DCE, the report concluded that there was not a measurable reduction in the average concentration of TCE in groundwater, most likely from the presence of dense non-aqueous phase liquid TCE.. 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.

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. If contaminants remain in this portion of the soil, they would continue to be released into the groundwater plume. 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.

Jeff Pinkerton discussing historic site preservation with the students

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 *2015 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* monitoring provides the data for this monitoring (DOE 2015e).

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. 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. TCE has decreased in wells within the area of the groundwater plume that was treated during the pilot study. DOE and Ohio EPA agreed on a new selection of remedy for the X-740 groundwater plume will be incorporated into the deferred plan and Decision Document.

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. Remedial actions had already taken place at the X-344D Hydrogen Fluoride Neutralization Pit, the X-611A, and at X-735 and X-734 Landfills. Five-year reviews were completed in 2002, 2008, and 2013 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 1999). Remedial actions required by the Decision Document included construction of a multimedia cap over the northern portion of the landfills and a soil cap over the southern portion of the area. 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 by isolating contaminants in soil and sediments from potential receptors (DOE 2008b and DOE 2013d). The caps prevented contaminants from migrating from soil to groundwater and from groundwater to surface water.

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, Ohio EPA regulations, 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 2015, SODI received approximately 236 tons of materials from PORTS, primarily recyclable metals and reusable vehicles. In 2015, FBP shipped almost 9200 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 2016 Site Sustainability Plan* describes the Environmental Sustainability Program and integrates the tenets of an Environmental Management System (EMS) (DOE 2015d). 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, are both qualitative and quantitative and reduce the life cycle cost and liability of DOE programs and operations at PORTS:

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

Artwork by Katie Shreck

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.

In support of this Executive Order, the *Fiscal Year 2016 Site Sustainability Plan for the Portsmouth Gaseous Diffusion Plant* provides goals and progress through fiscal year 2015 for reductions in greenhouse gas emissions, water consumption, recycling/waste diversion, electronic stewardship, and other areas (DOE 2015d). The following accomplishments were listed for fiscal year 2015:

- a decrease of 45% in greenhouse gas emissions (primarily associated for electricity consumption) versus the fiscal year 2008 baseline emissions.
- a decrease in water consumption of 7.9% in fiscal year 2015 versus fiscal year 2014.
- 13.4% of electricity consumption from renewable energy sources, which exceeds the goal of 7.5%.
- an increase in alternative fuel vehicles (either flex-fuel or hybrid vehicles) to 73% of the total vehicle fleet. All new vehicles are alternative fuel vehicles.

PORTS received a 3-Star Electronic Product Environmental Assessment Tool (EPEAT) Purchasing Award from the Green Electronics Council in fiscal year 2015 for its policies and procedures for the purchase of EPEAT-certified products. PORTS also received a GreenBuy Silver Award from DOE for fiscal year 2015 for buying products that save energy, conserve water, and reduce health and environmental impacts.

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.

Monitoring activities being conducted on site at PORTS

The PORTS Site Specific Advisory Board (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.ports-ssab.energy.gov 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.

The following are information sources for the public:

- Site Specific Advisory Board: www.energy.gov/pppo/ports-ssab or 740.289.5249
- Environmental Information Center: https://energy.gov/pppo/portsmouth-environmental-information-center or 740.289.8898
- DOE Portsmouth/Paducah Project Office: www.energy.gov/pppo or www.fbportsmouth.com
- DOE Site Office: 740.897.5010
- Office of Public Affairs: 740.897.2432

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.

Environmental Radiological Information

Environmental monitoring at PORTS measures both radiological and chemical parameters in air, water, soil, sediment, and biota (animals, vegetation, and crops). 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.

Vegetation at PORTS

Environmental monitoring takes place all through the year. Monitoring programs include airborne discharges, ambient air, external radiation, discharges to surface water, sediment, soil, vegetation and biota. DOE also conducts an extensive groundwater monitoring program at PORTS, which will be discussed in later sections. A US resident can expect to receive an average dose of 311 mrem/year of radiation from sources of natural radiation (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. Airborne releases from the facility are limited to a dose rate 10 mrem/year to any member of the public by U.S. EPA. DOE order 458.1, *Radiation Protection of the Public and the Environment*, sets the annual dose limit of 100 mrem/year or as low as reasonably achievable to any member of the public from all releases from a facility. The NESHAP regulations set dose limit of 10 mrem/year and applies only to airborne releases. By way of comparison, the maximum dose of radiation a member of the public could receive from PORTS in 2015 was 1.1 mrem/year, which is below the DOE limit of 100 mrem/year.

Summary of potential doses to the public from PORTS in 2015

Source of dose	Dose (mrem/year)*
Airborne radionuclides (off-site individual)	0.037
Radionuclides released to the Scioto River	0.0017
External radiation at station A29	0.96
Radionuclides detected by environmental monitoring programs	0.082
Total	**1.1**

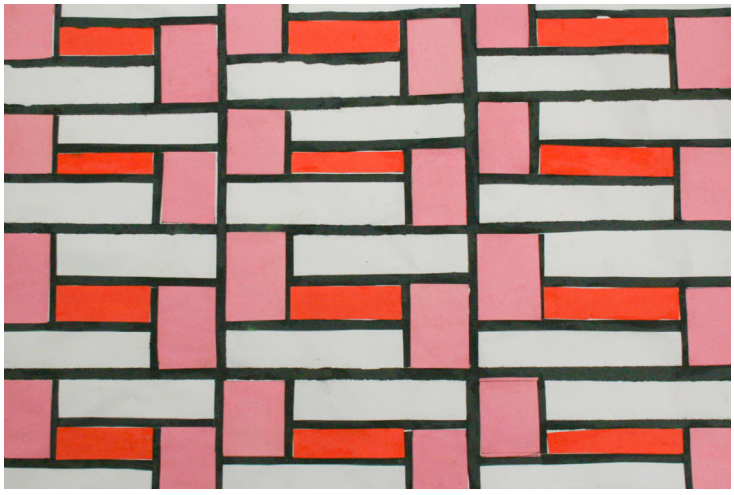
**100 millirem per year (mrem/year) is the DOE limit in DOE Order 458.1*

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.

Radiological Emission and Doses

Doses are also estimated for exposure to radionuclides from PORTS operations that were detected in 2015 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 2015 in samples of residential drinking water, deer, fish, crops, and dairy products.

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.



Artwork by Owen Strong

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, and room ventilation exhausts. BWCS was responsible for air emission sources associated with the DUF_6 Conversion Facility. Total emissions from all DOE/FBP airborne sources in 2015 were calculated to be 0.0366 Ci. BWCS reported total emissions of 0.0000414 Ci. Centrus reported total emissions of 0.0000153 Ci from airborne sources that are part of the Lead Cascade.

The effect of radionuclides released to the atmosphere by PORTS during 2015 was characterized by calculating the effective dose to the maximally exposed person (the individual who resides at the most exposed point near PORTS and to the entire population (approximately 677,000 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 2015 was 0.037 mrem/year. The combined dose from Centrus (the Lead Cascade) and DOE sources is also 1.1 mrem/year.

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 0.0012 mrem/year at stations A28 and A41A, which are off-site west of PORTS. 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 2015, FBP was responsible for 18 monitoring locations identified in the FBP NPDES permit. Nine outfalls discharge directly to surface water, six outfalls discharge to another outfall before leaving the PORTS site, and three other locations that are not outfalls are also monitored. Centrus is also responsible for three NPDES outfalls. All are discharged to one of the following; Little Beaver Creek, Big Run Creek or/and Scioto River. Discharges of radionuclides in liquids through FBP NPDES outfalls have no significant impact on public health and the environment. The dose calculated from FBP and Centrus outfalls is significantly less than the 100 mrem/year limit in DOE Order 458.1 for all radiological releases from a facility.

Dose Calculation for Releases to Surface Water

Radionuclides are measured at FBP and Centrus external outfalls. Water from these external outfalls is directly discharged or eventually flows into the Scioto River. A hypothetical dose to a member of the public was calculated using the 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 scenario is very conservative because the Scioto River is not used for drinking water downstream of PORTS. The dose of radionuclides released to the Scioto River in 2015 (0.0017 mrem) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

Radiological Dose Calculation for External Radiation

Radiation is emitted from DUF6 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 conservatively estimated at 8.7 hours per year (1 minute per trip, 2 trips per day, 5 work-days per week and 52 weeks per year). In 2015, based on these assumptions, exposure to an on-site member of the public from radiation

from the cylinder yards is approximately 0.77 mrem/year. A dose calculation was also completed for a representative off-site member of the public, such as a worker at the Ohio Valley Electric Corporation. Assuming that the worker was exposed to this radiation for 250 days/year, one hour outdoors and 8 hours indoors, the dose to this worker is 0.96 mrem. The average annual dose to a person in the United States from all radiation sources (natural and manmade) is approximately 311 mrem (NCRP 2009). The higher potential estimated dose from external radiation to a member of the public is approximately 0.3 percent of the average yearly radiation exposure for a person in the United States. This is significantly less than the DOE 100 mrem/year limit.

Radiological Dose Calculations for Off-Site Environmental Monitoring Data

Radiological monitoring programs at PORTS include ambient air, surface water, sediment, soil, residential drinking water (well water) and biota (vegetation, deer, fish, crops, milk and eggs). The summary of the dose calculations assumes that the same individual is exposed to the maximum dose calculated from each pathway. In 2015, dose calculations were completed for public exposure to radionuclides detected in sediment, soil and vegetation. Radionuclides were not detected in samples of drinking water, deer, fish, crops and dairy products.

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 2015

Source of dose	Dose (mrem/year)[a]
Sediment	0.035
Soil	0.044
Vegetation	0.0027
Total	**0.082**

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

Protection of Biota

DOE Order 458.1 determines absorbed dose rate limits for aquatic animals, riparian animals (animals that live on the banks of a river or in wetlands adjacent to a body of water), terrestrial plants and terrestrial animals. Analytical data for surface water and sediment samples collected during 2015 from the east side of the PORTS reservation were used to assess the dose limits for aquatic and riparian animals. These locations were selected because levels of radionuclides detected in surface water and sediment from these locations were among the highest detected in samples collected in 2015. The assessment indicates that the levels of radionuclides detected in water and sediment at these locations did not result in a dose of more than 1 rad/day to aquatic animals and 0.1 rad/day to riparian animals. Similar testing was completed for terrestrial plants and animals. The assessment for terrestrial plants and

animals indicates that the levels of radionuclides detected in water and soil at the sampled locations did not result in a dose of more than 1 rad/day to terrestrial plants and 0.1 rad/day to terrestrial animals. No unplanned releases of radionuclides took place at PORTS in 2015.

Environmental monitoring being conducted on site at PORTS

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. These radionuclides are isotopic uranium, technetium-99 and selected transuranic radionuclides.

In 2015, 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. The analytical results from air sampling stations closer to the plant are compared to the background measurements. With the exception of plutonium-238, no transuranic radionuclides were detected at the ambient air monitoring stations in 2015. To confirm that air emissions from PORTS are within regulatory requirements and are not harmful to human health, the ambient air monitoring data were used to calculate a dose to a hypothetical person living at the monitoring station. The highest net dose calculation for the off-site ambient air stations (0.0012 mrem/year) west and northeast of PORTS. This hypothetical dose is well below the 10 mrem/year limit applicable to PORTS in NESHAP.

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. 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 for the representative on-site member, such as a delivery person, is 0.77 mrem/year, which is significantly less than DOE's 100 mrem/year limit. The potential estimated dose for the representative off-site member of the public who works near station A29 is 0.96 mrem/year which is also well below DOE's limit of 100 mrem/year. Three locations on-site measured levels of radiation at least 50% higher than the average off-site locations. The on-site locations with higher doses than the off-site average are not used by the general public. 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 2015.

Surface Water from Cylinder Storage Yards

In 2015, FBP collected surface water samples from the Cylinder Storage Yards while BWCS collected surface water samples at the cylinder yards associated with the DUF6 Conversion Facility. The samples were analyzed for alpha activity, beta activity and uranium. FBP reported maximum levels of alpha activity (97.9 picocurie per liter (pCi/L)), beta activity (187 pCi/L), and total uranium (154 µg/L) were detected in samples collected in October 2015. BWCS reported maximum levels of alpha activity (12.6 pCi/L), beta activity (10.1 pCi/L), and total uranium (13 µg/L) in samples collected in October and April 2015. The surface water from the cylinder storage yard flows to FBP NPDES outfalls prior to discharge from the site. Releases of radionuclides from the cylinder yards are monitored by sampling conducted at the FBP outfalls. Radionuclides detected at FBP outfalls are used in the dose calculation for releases to surface water. The dose from radionuclides released to surface water (the Scioto River) in 2015 (0.0017 mrem) is significantly less than the DOE 100 mrem/year limit for all radiological releases from a facility.

Local Surface Water Monitoring for Radionuclides

In 2015, surface water was collected from 14 locations including the Scioto River, Little Beaver Creek, Big Beaver Creek and Big Run Creek. As background measurements, samples were also collected from local streams approximately 10 miles north, south, east and west of PORTS. Samples were collected semiannually and analyzed for transuranic radionuclides, technetium-99, uranium and uranium isotopes in accordance with the DOE Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant (DOE 2013a). No transuranic radionuclides were detected in the local surface water samples of these surface water sites. However, technetium-99 and uranium isotopes were detected. Detections of technetium-99 and uranium isotopes in local surface water samples were well below DOE derived concentration standards (DOE 2011a).

Artwork by Tyler Hale

Sediment

Sediment samples were collected from the same sites local surface water samples were taken 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). Uranium and uranium isotopes are naturally occurring, but may also be present due to PORTS activities. Technetium-99 was detected in the sample collected from Big Beaver Creek, Little Beaver Creek, and Big Run Creek. Transuranics were detected at sampling locations at Big Beaver Creek. Technetium-99, uranium and uranium isotopes detected in 2015 samples have been detected at similar levels in previous sampling from 2002 through 2014.Little Beaver Creek was the off-site sampling location that had the highest dose to a member of the public. The total potential dose to a member of the public resulting from PORTS operations is 1.1 mrem/year, which is well below the DOE standard of 100 mrem/year.

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* and ensure that the discharges do not exceed an annual average (at the point of discharge) of either of the following:

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

In 2015, settleable solids were not detected at concentrations above 40 mg/L at any of the monitoring locations; therefore, monitoring results for the settleable solids monitoring program 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. Plutonium-239/240 was detected at two ambient air monitoring stations, however these detections are much less than the soil screening level for plutonium-239/240. No technetium-99 or other transuranics were detected in any of the soil samples collected during 2015. Uranium, uranium-233/234, uranium-235/236 and/or uranium-238 were detected at each of the sampling locations. Uranium and uranium isotopes are usually detected at similar levels at all the soil sampling locations, including the background location, which suggests that the uranium detected in these samples is due to naturally occurring uranium.

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 such as vegetation, deer, fish, crops, milk and eggs. For each of the 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 motor vehicle collisions at PORTS, if available. Fish were caught on the Little Beaver Creek and Big Beaver Creek. Crops were collected from five off-site locations near PORTS and milk and eggs produced near PORTS were collected. Total uraniumranium, uranium-233/234 and uranium-238 were detected in the vegetation samples collected in 2015. The potential dose from to a member of the public from vegetation is 0.0027 mrem/year, which is well below the DOE limit of 100 mrem/year. No radionuclides were found in the other biota samples collected in 2015.

Release of Property Containing Residual Radioactive Material

DOE Order 458.1 establishes limits for unconditional release of personal and real property from DOE facilities. In 2015, no real property was released, which is land and anything permanently affixed to the land such as buildings, fences, light fixtures and other such items.

FBP uses pre-approved authorized limits established by DOE Orders to evaluate and release materials defined as personal property, which is property of any kind not considered real property. Real property is land and anything permanently affixed to the land. In 2015, FBP authorized 2263 release requests for materials/items of personal property.

In 2015, BWCS continued off-site shipping of aqueous hydrogen fluoride produced by the DUF6 Conversion Facility. Each shipment must reach the release limit of less than 3 pCi/mL of total uranium activity. Approximately 188,250 gallons of aqueous hydrogen fluoride was shipped off-site in 2015. The average total uranium activity of all the off-site shipments was 0.006 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.

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. DOE also has taken measures to prevent airborne contamination.

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 2015: 11.03 tons of particulate matter, 1.96 tons of organic compounds and 1.78 tons of nitrogen oxides. Emissions for 2015 are associated with the X-627 Groundwater Treatment Facility, X-330 Dry Air Plant Emergency Generator, 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.

Artwork by Rachelle Chenoweth

U.S. EPA also requires annual reporting of greenhouse gas emissions. In 2015, FBP reported emissions of 13,703 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 2015, 8.8 tons of asbestos-containing materials were shipped from PORTS.

Ambient Air Monitoring for Fluoride

In addition to radionuclides, the ambient air monitoring stations also measure fluoride. Any fluoride found could be the result of activities associated with the former gaseous diffusion process or they could be present due to naturally occurring background concentrations.

In 2015 samples for fluoride were collected from 15 ambient air monitoring stations around the plant. Fluoride was not found in 82 percent of the samples collected. The data indicate that ambient concentrations of fluoride at off-site and background locations are not appreciably different from concentrations at PORTS.

On site stream 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

FBP was responsible for the sampling of 18 outfalls in 2015. 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 2015, there were seven occasions in which discharge limitations were exceeded at FBP NPDES monitoring locations.

In March, the maximum limit of acute toxicity for fathead minnows and water fleas were exceeded at Outfall 004. Acute toxicity is a measurement that describes the characteristics of water that is discharged from an outfall that could possibly be harmful to aquatic organisms. The toxicity most likely resulted from a reduction in the water flow to the outfall. The toxicity would last no more than 24 hours.

The daily concentration limit for chlorine, which is 0.05 mg/L, was exceeded four times at Outfall 004, as well as once at Outfall 003 in 2015. Chlorine from Outfall 004 was detected in samples that ranged from 0.12 to 0.3 mg/L during the months of January, February, May, and September. On August 3, 2015, chlorine was detected at 0.06 mg/L in a sample that was collected from Outfall 003. These exceedances were caused by operational issues and were later corrected on the day of the exceedance.

The overall FBP NPDES compliance rate with the NPDES permit was 99% in 2015.

BWCS NPDES Outfall

BWCS is in charge of the NPDES permit for the discharge of process wastewaters from the DUF6 Conversion Facility. The BWCS NPDES permit provides monitoring requirements at two outfalls which are BWCS Outfall 001 and BWCS Outfall 602. The monitoring data collected in accordance with the BWCS permit was submitted to Ohio EPA in a monthly discharge report. There were no exceedances of permit limitations at BWCS Outfall 602 during 2015; therefore, the overall compliance rate was 100%. BWCS Outfall 001 did not operate in 2015.

Centrus NPDES Outfalls

Centrus is responsible for three outfalls through which water is discharged from the site. Two of the three outfalls discharge directly to surface water, and the third outfall discharges to FBP NPDES Outfall 003 before leaving the site. The monitoring data was submitted to Ohio EPA in a monthly discharge report. There were no exceedances of permit limitations at Centrus outfalls occurred during 2015; therefore, the overall compliance rate was 100%.

Surface Water

Surface water samples, both filtered and unfiltered, 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 2015. Centrus also is responsible for three NPDES outfalls. No exceedances of permit limitations at Centrus Outfalls occurred during 2015.

Sediment Monitoring

In 2015, sediment monitoring at PORTS included both local streams and the Scioto River upstream and downstream from PORTS, as well as drainage basins located downstream from the BWCS cylinder storage yards. Sediment samples are collected annually at the same locations where local surface water samples are collected. Samples were analyzed for 20 metals and PCBs in 2015. PCBs were detected in sediment samples that were collected from Little Beaver Creek, Big Beaver Creek, Big Run Creek, the West Drainage Ditch, Centrus NPDES Outfall 013, and near FBP Outfall 010.

None of the detections of PCBs were above the risk-based regional screening level for PCB-1254/1260 utilized by Ohio EPA: 240 micrograms per kilogram (µg/kg) or parts per billion (ppb) (U.S. EPA 2015). The highest detection

of PCBs was in Little Beaver Creek, where it was 159 µg/kg. Investigation and remediation of PCBs in sediment at PORTS will be addressed in the environmental remediation of PORTS.

The result of the sampling of metals conducted in 2015 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.

Samples are collected quarterly from four locations in drainage basins that are located downstream from several locations associated with the BWCS Cylinder Storage Yards that are not accessible to the public.

PCBs were detected in at least one of the samples that were collected from each location in 2015. At sampling location UDS X02, the concentration of PCBs was 100 µg/kg, which was the maximum concentration of PCBs. The concentrations of PCBs that were detected in 2015 were below the 1 ppm (1000 ppb) reference value set in the U.S. EPA Region 5 *TSCA Approval for Storage for Disposal of PCB Bulk Product (Mixed) Waste*, which applies to DUF6 cylinders at PORTS that may have excess paint on the exterior that contains more than 50 ppm PCBs. None of the samples contained PCBs that were above the risk-based regional screening level for PCB-1254/1260 developed by U.S. EPA and utilized by Ohio EPA: 240 µg/kg (ppb) (U.S. EPA 2015).

Biological Monitoring of Fish

Samples are collected annually, if available, from locations on Little Beaver Creek, Big Beaver Creek, and the Scioto River. Fish were caught in Little Beaver Creek and Big Beaver Creek during 2015 and were then analyzed for PCBs. The samples collected were sunfish and bass. In 2015, fish were not collected from the Scioto River.

Artwork by Tetiana Arturivna

PCBs were detected in each of the biological samples at concentrations that ranged from 20.8 to 278 µg/kg and were then compared to the Ohio Fish Consumption Advisory Chemical Limits, which are provided in the State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program (Ohio EPA 2008). The consumption rates include; unrestricted, 1/week, 1/month, 6/year, and do not eat. The concentration of PCBs that were detected in the biological samples caught in Little Beaver Creek were above the 1/week maximum limit (220 µg/kg) and below the 1/month maximum limit (1000 µg/kg). The concentrations of PCBs that were collected from Big Beaver Creek (20.8 and 21.8 µg/kg) were less than the unrestricted limit (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.

Wildlife at PORTS

This section provides an overview of groundwater monitoring at PORTS and the results of the groundwater monitoring program for 2015. 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. The plan from 2015 made minor changes to the monitoring program, such as adding wells to the program located in the Quadrant I Groundwater Investigative and the X-701B Former Holding Pond. The DOE Orders are the basis for radiological monitoring of the groundwater at PORTS.

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.

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 2014b, DOE 2015c). 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 2013b, DOE 2014b).

Artwork by Morgan Conley

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 Groundwater Investigative Area, 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 in the southern half of PORTS. 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 waste. During the span of 2007 to 2010 there were eight extraction wells installed near the X-749/X-120 groundwater plume. 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 ninety-eight wells were sampled in 2015 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. Contaminated water from this area flowed to the X-625 Groundwater Treatment Facility.

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, soil was then 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 sampled in 2015 to monitor the PK Landfill.

Eastern HS students learning about stream health at Lake Hope State Park

The concentration of TCE were either stable or decreasing within the X-749/X-120 groundwater plume in 2015. Although the concentrations of TCE went up from 2014, the areas with high concentrations are where it is expected. This indicates that the extraction wells are working as intended to prevent the migration of TCE from the X-749 Landfill. The average concentration of TCE in well X120-11G is consistently high, it was 230 and 240 µg/L in 2015, but it has continually decreased since 2011.The concentration of TCE in well X749-67G has decreased continually since 2011, and was 268 µg/L in 2015. The concentration of TCE detected in well X120-110G has decreased from the average annual concentrations detected from 2011-2014, and the level was 28µg/L. There were no VOCs detected in any of the off-site monitoring wells. If detected, radionuclides were present at levels below Ohio EPA drinking water standards.

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 2015, vinyl chloride was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 5.3 µg/L to 22 µg/L, which exceed the preliminary remediation goal of 2µg/L. Vinyl chloride is typically detected at concentrations above preliminary remediation goal in those two wells. 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

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. The X-231B Southwest Oil Biodegradation Plot was monitored prior to the implementation of the Integrated Groundwater Monitoring Plan. 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 thirty-four wells were sampled in this area in 2015.

X-749A Classified Materials Disposal Facility

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 2015.

Artwork by Heath Blackburn

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 moved inwards in 2015. On the eastern edge of the plume, TCE was detected at 3.8 µg/L in X231A-01G and 4.5 µg/l in well X749A-18G. On the northwestern edge of the plume, TCE decreased to 3.9 µg/L in well X231B-29G. TCE is increasing in well X231B-36G, which monitors the northern portion of the plume. No other significant changes in TCE concentrations were identified in wells that monitor the Quadrant I Groundwater Investigative (5-Unit) Area in 2015. Samples from selected wells that monitor the Quadrant I Groundwater Investigative (5-Unit) Area were analyzed for radionuclides. If detected, radionuclides were at levels below Ohio EPA drinking water standards.

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 2015, with the exception of X701-45G on the southern perimeter of the plume. TCE has increased to 6.2 µg/L in 2015 in well X701-45G. Wells at the eastern or southeastern boundary of the monitoring area, X700-03G, X701-26G, and X701-27G, 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 X701-26G and X701-27G were similar to or less than TCE concentrations detected in 2014.

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, called the X-237 Groundwater Collection System, 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 2015 as part of the Integrated Groundwater Monitoring Plan (DOE 2015e).

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 160 µg/L in well X701-01G in the southwestern portion of the monitoring area.

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 eight 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 2015. Samples collected from well X633-07G contained chromium at concentrations above the preliminary remediation goal of 100 µg/L: 450 µg/L (second quarter) and 630 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 2015, 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 2015.

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. DOE and Ohio EPA have agreed that selection of a new remedy for the X-740 groundwater plume will be incorporated into the deferred units preferred plan and Decision Document. Twenty-three wells that monitor the X-740 Former Waste Oil Handling Facility were sampled during 2015.

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 Sludge Lagoons

Artwork by Paige Sanders

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 2015, chromium was detected in the samples collected from two of the six wells in this area at concentrations between 2.7 and 12 µg/L, which are below the preliminary remediation goal of 100 µg/L. In 2015, beryllium was detected in three of the six wells in this area at concentrations of 1.9 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. Eighteen wells were sampled in 2015 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 2015. 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. Samples were also analyzed for radionuclides and if detected, they were below Ohio EPA drinking water standards.

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 2015, 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.

Artwork by Cheyanne Pickett

Three wells that monitor the X-533 Former Switchyard Complex were sampled in the second and fourth quarters of 2015 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 14 to 46 µg/L, and concentrations of nickel detected in the wells ranged from 170 to 450 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 2015 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. These detections 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 2015, TCE was detected at 0.7 to 5.3 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 3.8 µg/L. TCE was also detected at an estimated concentration of 0.33 µg/L in the second quarter sample collected from the West Drainage Ditch at WDD-SW02. Technetium-99 was detected at levels up to 33.1 pCi/L in samples collected from the East Drainage Ditch, Little Beaver Creek, and the West Drainage Ditch.

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 2014b, DOE 2015e). The purpose of the program is to determine whether PORTS has had any impact on the quality of the private residential drinking water sources. The wells are sampled semiannually. In the first and third quarters of 2015, TCE was detected at estimated concentrations of 0.4 µg/L and 0.65 µg/L, respectively, in the samples collected south of PORTS. No other VOCs were detected in the samples at this location. Chlorination byproducts were also detected, 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 2015.

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 2015, a combined total of approximately 33.7 million gallons were treated at the X-622, X-623, X-624 and X-627 Groundwater Treatment Facilities. Approximately 26 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 2015.

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.

Artwork by Ethan Leist

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 2015. The following are some of the major events of 2015:

- Proposed Plans were submitted in October 2014. In June 2015, the Waste Disposition Record of Decision was final and in July 2015, the Process Buildings Record of Decision was final.. The proposed plans recommended controlled removal of the process buildings and other facilities and a combination of on-site and off-site waste disposal (DOE 2015a, DOE 2015b). Ohio EPA concurred with the proposed plan in September and October 2015.
- DOE submitted the *Deferred Units RCRA Facility Investigation/Corrective Measures Study Work Plan for Solid Waste Management Units* to Ohio EPA in March 2015 (DOE 2015c). Ohio EPA approved the work plan in June 2015. Soil and groundwater sampling outlined in the work plan started in July 2015 and continued in 2016.
- SODI received approximately 236 tons of materials from PORTS, primarily recyclable metals.
- In 2015, DOE and FBP received five Notices of Violation, which were resolved by DOE and FBP.

Potential impacts to human health and the environment 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 2015 is 1.1 mrem. This dose is significantly less than the 100 mrem/year limit set by DOE for the dose to a member of the public from radionuclides from all potential exposure pathways and all media. The dose to a member of the public from airborne radionuclides released by PORTS (0.037 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 2015.

References

DOE 1998a. *Quadrant III Cleanup Alternatives Study/Corrective Measures Study Final Report for Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/OR/12-1360&D3, POEF-ER-4619&D3, U.S. Department of Energy, Piketon, OH, April.

DOE 1998b. *Quadrant IV Cleanup Alternatives Study/Corrective Measures Study Final Report for Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/OR/12-1332&D3, POEF-ER-4609&D3, U.S. Department of Energy, Piketon, OH, August.

DOE 2001. *Quadrant II Cleanup Alternatives Study/Corrective Measures Study Final Report for Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/OR/12-1223&D5, U.S. Department of Energy, Piketon, OH, February.

DOE 2008a. *First Five-Year Review for the X-734 Landfill Area at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0073&D2, U.S. Department of Energy, Piketon, OH, December.

DOE 2011a. *Derived Concentration Technical Standard,* DOE-STD-1196-2011, U.S. Department of Energy, Washington, D.C., April

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 2014a. *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 2014b. *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 2015a. *Record of Decision for Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0425&D2, U.S. Department of Energy, Piketon, OH, July.

DOE 2015b. *Record of Decision for the Site-wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0513&D2, U.S. Department of Energy, Piketon, OH, June.

DOE 2015c. *Deferred Units Resource Conservation and Recovery Act Facility Investigation/Corrective Measures Study Work Plan at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0252&D3, U.S. Department of Energy, Piketon, OH, March.

DOE 2015d. *Fiscal Year 2016 Site Sustainability Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0742&D1, U.S. Department of Energy, Piketon, OH, December.

DOE 2015e. *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0032&D8, U.S. Department of Energy, Piketon, OH, July.

DOE 2016a. *2015 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPO/03-0746&D1, U.S. Department of Energy, Piketon, OH, March.

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

Ohio EPA 1999. *The Decision Document for the X-734 Landfill Area in Quadrant IV of the Portsmouth Gaseous Diffusion Plant,* Ohio Environmental Protection Agency, Columbus, OH, September.

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

Ohio EPA 2003. *Ohio EPA's Decision Document for the X-701B SWMU in Quadrant II of the U.S. DOE Portsmouth Facility, Piketon, Ohio,* Ohio Environmental Protection Agency, Columbus, OH, December.

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 2015. Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1) November 2015, Screening level for PCB-1254/PCB-1260 in residential soil, www.epa.gov/risk/risk-based-screeningtable-generic-tables (accessed March 1, 2016).

United States Nuclear Regulatory Commission 2015. *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.

picoupi (mrem) – the dose that is one-thousandth of a rem.

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

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	B&W 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 hexafluorids
EMS	Environmental Management System
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)
$\mu g/m^3$	microgram per cubic meter
mrem	millirem
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
Ohio EPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram

pCi/L	picocurie per liter
pCi/mL	picocurie per milliliter
pCi/m^3	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

The ASER Summary Project is funded by a grant from the U.S. Department of Energy
Office of Environmental Management Portsmouth/Paducah Project Office