2024 U.S. Department of Energy

Paducah Annual Site Environmental Report (ASER): Student Summary

MURRAY STATE UNIVERSITY

TRANSFORMING THE LANDSCAPE

MURRAY STATE UNIVERSITY

Paducah Innovation hub

PORTSMOUTH PADUCAH PROJECT OFFICE

Message from the U.S. Department of Energy

PORTSMOUTH PADUCAH PROJECT OFFICE

The U.S. Department of Energy (DOE) conducts environmental monitoring at the Paducah Gaseous Diffusion Plant Site (PGDP) on an ongoing basis. Each calendar year, the information collected is presented in a comprehensive publication entitled the Annual Site Environmental Report (ASER).

Each academic year, high school students from the area are invited to participate in the student ASER summary project. Students review the most recent ASER, producing a group summary document that is reflective of their experience. Students are also invited to participate in educational outreach efforts to learn about the PGDP and help to develop this summary report.

During the 2024-25 academic year, students from Paducah Tilghman High School and Engineering Capstone students from the Paducah Innovation Hub participated in the program. These students not only participated in the program through the classroom, but through field activities as well. Additionally, students developed and presented summary academic posters at a student-led exposition open to the public, highlighting their work.

Environmental work at DOE's facilities is technically complex and challenging. Due to the size of the PGDP industrial complex, its infrastructure, and impacts on the surface and subsurface environment, management of cleanup efforts by DOE are complex.

The environmental monitoring program ensures DOE is protective of our workforce, the environment, and the general public. During calendar year 2023, PGDP environmental data collected from soil, surface water, sediment, air, and groundwater shows compliance with both state and U.S. Environmental Protection Agency regulatory and human health standards.

Both the ASER and Student ASER serve important functions as they allow DOE to clearly and concisely explain our environmental monitoring programs to our stakeholders.

The PGDP sincerely appreciates the work of the students and staff at Paducah Tilghman High School and the Paducah Innovation Hub in the production of this year's Student ASER. On behalf of the entire DOE complex, we congratulate each of you for your effort, enthusiasm, and willingness to support this project.

We hope you enjoy reading this informative report and appreciate your interest in the Student ASER.

Sincerely,
April Ladd, DOE Paducah Site Lead

Acknowledgment: This material is based upon work supported by the Department of Energy [National Nuclear Security Administration] under Award Number(s) DE-EM0005318.

Special Thanks to our Contributors

MESSAGE FROM MURRAY STATE UNIVERSITY

Dr. K. Renee Fister, Associate Provost

The Department of Energy and Murray State University collaboration results in an opportunity to involve secondary and postsecondary students in analyzing the history and the work that has and will occur in our western Kentucky region. The advances that are to come will create synergies among business partners, governmental agencies, and Murray State University. We are grateful to be a part of the partnership with the Department of Energy and all the people that make the work valuable for our communities.

SPECIAL THANKS

April Ladd: DOE Paducah Site Lead

Samuel Boss: FRNP Industrial Hygienist

Zachary Boyarski: ETAS Public Affairs Specialist

Tom Busclas: FRNP Project FLM

Steve Christmas: FRNP Community Outreach Coordinator

Valerie Crabtree: FRNP Engineering Program Services Manager

Barb DeNeve: FRNP Project Engineer

Clint Dietsch: FRNP Engineer

Mitchell Guthrie: DOE General Engineer

Adam Lyons: FRNP Emergency Management Specialist

Shay Mitchell: FRNP Pump and Treat Operations Manager

Dylan Nichols: FRNP Public Affairs Manager

Robby Purcell: FRNP Emergency Management Specialist

Karen Sizemore: FRNP Chief Engineer

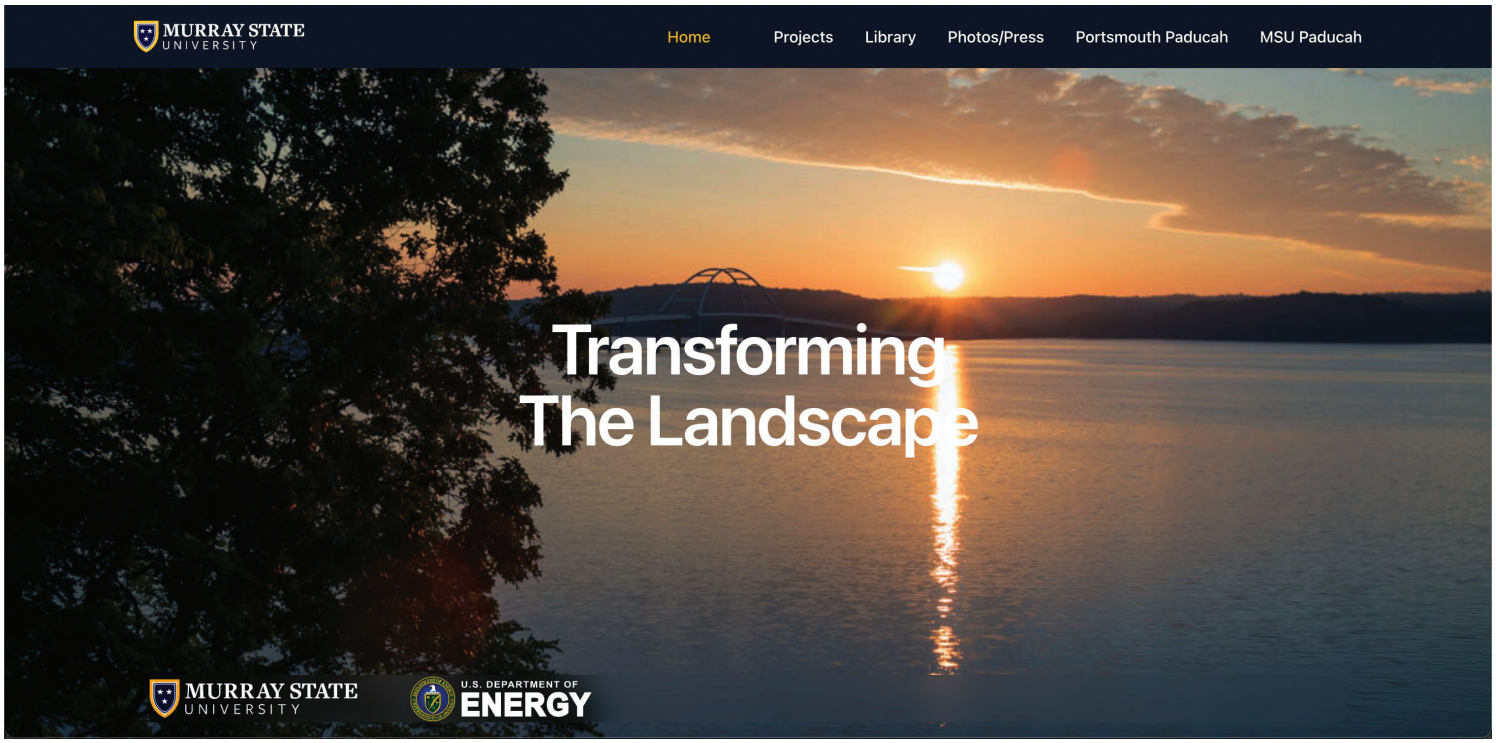
Colby Smith: FRNP IH/IS Technical Support Manager

Robert “Buz” Smith: DOE Program Analyst/Strategic Planner

Darren Tinsley: FRNP HSS&Q Safety and Health Manager

Chris Wagner: DOE Facility Representative

Special Thanks to our Contributors *(continued)*



MSU/DOE Grant Website, photo by Kristopher Fister

WEB DESIGN

Charley Allen is an award-winning web designer and poet with over 20 years of experience in front-end development and digital marketing. Born and raised in Western Kentucky, she has built a career that blends creativity with purpose. With a degree in creative writing and a master's in organizational communication from Murray State University, Charley's education brings a unique perspective to her work, helping her create websites that tell meaningful stories and incorporate empathy in design.

To view the website, scan the QR code or go to ***murraystate.edu/doegrant/index.html***

PHOTOGRAPHY

Kristopher Fister (*left*) is a Murray State News photographer who won College Journalist of the Year at the Kentucky Press Association convention on January 24, 2025, in Lexington, Kentucky.

PUBLICATIONS AND GRAPHIC DESIGN TEAM

Brittney McWaters: Design Specialist

Melissa Shown: Graphic Design Manager

Josey Smith: Administrative Assistant

Tobie Tubbs: Printing Manager

MSU's Office of the Provost Awarded $1.5 Million DoE Grant

Murray State University's Office of the Provost was recently awarded a $1.5 million grant by the Department of Energy (DOE) from May 1, 2024 to Sept. 30, 2028 to support the efficient and effective work consistent with the environmental cleanup and beneficial reuse of the Paducah Gaseous Diffusion Plant site.

The project goal is to develop information that the DOE's Portsmouth/Paducah Project Office (PPPO), its contractors and the public can use in decision-making for the environmental cleanup, beneficial reuse and public outreach at the Paducah site.

"The Murray State University/Department of Energy grant allows collaborative work with industry, community, K-12 and postsecondary education for connected study involving reuse of the land at the Paducah Gaseous Diffusion site," said Murray State Associate Provost Dr. Renee Fister. "We are grateful to learn more from the community, build partnerships for successful training and outreach, perform research and scholarship projects involving high school and college students and work to make a difference in workforce initiatives in this important area of our Commonwealth."

The project will focus on site repurposing, STEM activities in local high schools and public outreach as well as scholarship and creative activities for faculty and students.

"This grant will enable Murray State University to continue to serve the Jackson Purchase region, particularly Paducah-McCracken County, by providing public outreach, site repurposing assistance and educational programs regarding the Paducah Gaseous Diffusion Site," said Murray State Executive Director of Government and Institutional Relations Jordan Smith. "It's particularly appealing that we will be collaborating with our top-tier high schools in the region on the educational program piece of this grant. We are very grateful that the Department of Energy has afforded us this opportunity to continue collaboration efforts and work within our community."

Site repurposing feeds into the end-state configuration for the site, and is expected to expedite real property transfer for future repurposing of the site, resulting in reducing the PPPO-managed footprint at Paducah. The Paducah site has been an important economic driver in western Kentucky for many decades, impacting the region's socio-economic profile. As the Paducah site undergoes environmental remediation and decontamination and decommissioning, it is expected that the Paducah site will further impact the region's socio-economic profile, as well as growth opportunities. The extent to which decision-makers can minimize transitional stress and maximize the economic prospects for the area hinges greatly upon the cleanup and transfer of the Paducah site and site assets for other economic use.

The project will also utilize the Paducah site as a learning opportunity to promote careers in STEM disciplines to local high school students. After the hiring of the project director in Summer 2024, the work to connect with locals will ensue. Public outreach faculty/staff members at Murray State will assist with focus of STEM activities and interactions with local high school teachers and administrators.

The project's final focus will be on public outreach, including an update to "Community Visions for the Paducah Gaseous Diffusion Plant Site," a report finalized in September 2011 by the Kentucky Research Consortium for Energy and Environment. The process implemented in the study provided insights into a range of perspectives and community preferences related to the future use of the Paducah Gaseous Diffusion Plant site and surrounding DOE-owned properties. This step will involve several public meetings, workshops and training sessions. The updated report is expected to be available by March 31, 2026.

"We are very grateful to the Department of Energy for this grant, which will provide impactful opportunities on multiple levels such as student research and scholarship, as well as a deepening of our community and regional partnerships," Murray State President Dr. Bob Jackson said. "Murray State University's work in these areas is vitally important. We look forward to this collaboration in the months and years to come to assist Paducah and McCracken County, as well as the Jackson Purchase region."

Economic Impact on the Commonwealth

Located in western Kentucky, Murray State University is a nationally-recognized public regional comprehensive university. Murray State University offers in-person academic programs and 100 percent online programs at its Murray campus, as well as regional campuses in Fort Campbell, Henderson, Hopkinsville, Madisonville and Paducah. A total of 52 countries, 49 states and 115 counties in Kentucky comprise Murray State's student body.

Based on a 2017 comprehensive study led by Professor Emeritus Dr. Gil Mathis, updated for inflation, Murray State University generates more than $633 million in economic output activity through the Commonwealth.

COLLEGE GRADUATES

Murray State University alumni are working and contributing in their communities around the Commonwealth of Kentucky.

41,997 RACER ALUMNI

Total number of Murray State University graduates residing in Kentucky

$633 MILLION

Total economic impact Murray State University has on the Commonwealth of Kentucky annually

$265 MILLION

Total revenue generated by University employee, student and visitor spending ($726,000/day)

$23 MILLION

Annual state and local tax revenue generated by activity associated with Murray State University

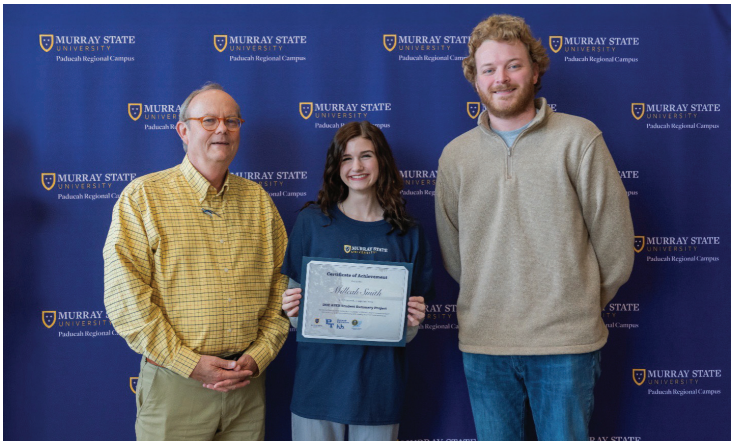
$1.18 BILLION

Estimated increase in earning capacity generated by Racer alumni

Murray State
Paducah Regional Campus

Left to Right: Melanie Watson, Academic Advisor; Karami Underwood, Director; and Elaine Fletcher, Administrative Assistant, of the Paducah Regional Campus

Murray State and OSH Faculty visit Paducah DOE Site Jan. 9, 2025



Left to Right: Buz Smith, DOE Paducah Site;
Milleah Smith, Student; and Mitchell Guthrie, DOE

Annual Site Environmental Report (ASER)

ANNUAL SITE ENVIRONMENTAL REPORT

Department of Energy (DOE) requires that environmental monitoring be conducted and documented for its facilities under DOE Order 231.1B, Environment, Safety, and Health Reporting. Several other laws, regulations, and DOE directives require compliance with environmental standards. The purpose of this Annual Site Environmental Report (ASER) is to summarize 2023 environmental management activities, including effluent monitoring and environmental surveillance, at the Paducah Site; report on environmental compliance status; and highlight significant Paducah Site program efforts. References in this report to the Paducah Site generally mean the property, programs, and facilities at or near the Paducah Gaseous Diffusion Plant (PGDP) for which DOE has ultimate responsibility.

Environmental monitoring includes two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the direct measurement or the collection and analysis of samples of liquid and gaseous discharges to the environment. At the Paducah Site, environmental surveillance includes the direct measurement or the collection and analysis of samples of ambient air, surface water, groundwater, and sediment. Effluent monitoring and environmental surveillance are performed to characterize and quantify contaminants; assess radiation exposure; demonstrate compliance

with applicable standards and permit requirements; and detect and assess the effects, if any, on the local population and environment. Samples are collected throughout the year and are analyzed for radioactivity, chemical constituents, and various physical properties.

DOE's overall goals for environmental management are to protect Paducah Site personnel, the environment, and the community and to maintain full compliance with all current applicable environmental regulations. DOE operates the Paducah Site in a manner that controls and reduces exposures of the public, workers, and the environment to harmful chemicals and radiation.

Student ASER Opportunity and Student ASER Team

STEM ENRICHMENT

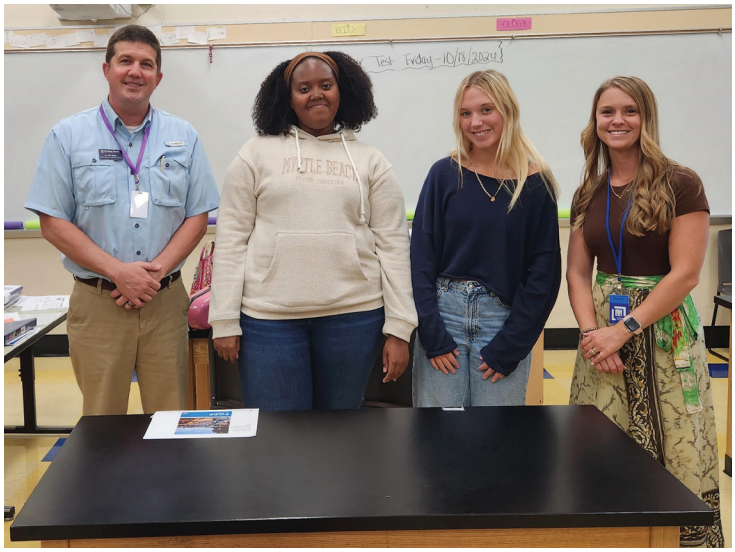
Thanks to a $1.5 million grant from the Department of Energy (DOE) awarded to Murray State University in 2024, the university collaborated with Paducah Tilghman High School and the Innovation Hub to incorporate environmental science into the school's Science, Technology, Engineering, and Mathematics (STEM) curriculum.

The partnership provides students with opportunities to apply their classroom knowledge to real-world environmental projects at the Paducah Gaseous Diffusion Site. Some of the experiences the grant offers students include connecting with STEM subject matter experts and area DOE leaders, learning about future career STEM opportunities, and completing a final project called the Student Annual Site Environmental Report. Students create the Student ASER by reviewing the annual DOE Paducah Site report and simplifying complex data to make the report more accessible to the community. Additionally, the Student ASER project teaches students how to convey scientific information to a broader audience, which is evident in developing the report and also a year-end community presentation.

Buz Smith, Strategic Planner, Department of Energy, PGDP

PADUCAH TILGHMAN AND PADUCAH INNOVATION HUB

The student ASER team consisted of students from Ms. Karlye Loy's environmental science class at Paducah Tilghman High School and Mr. Jimi Gwinn's engineering class at the Paducah Innovation Hub. The students worked in collaboration with Murray State University to produce this ASER summary report which serves as an important resource for the regional community. A special thanks to the students for their hard work and the guidance from their teachers. The high school students who participated in this year's project include Dawson Black, Jacob Hodge, Jasmine Elizabeth Jones, Landon Perkins, Ava Grace Russell, and Milleah Smith.



Karlye Loy's Environmental Science Class
Left to Right: Dr. Eric Batts (Murray State University), Jasmine Elizabeth Jones, Ava Grace Russell, Mrs. Karlye Loy

Jimi Gwinn's Engineering Class
Left to Right: Dr. Eric Batts (Murray State University), Landon Perkins, Jacob Hodge, Milleah Smith, Mr. Jimi Gwinn

Student Poster Expo

As part of this year's program, the students participated in the first PGDP Student Expo. An expo is a student-led celebration of deeper learning where students can highlight their abilities and share what they have learned with a wider audience through the development and presentation of a scientific poster.

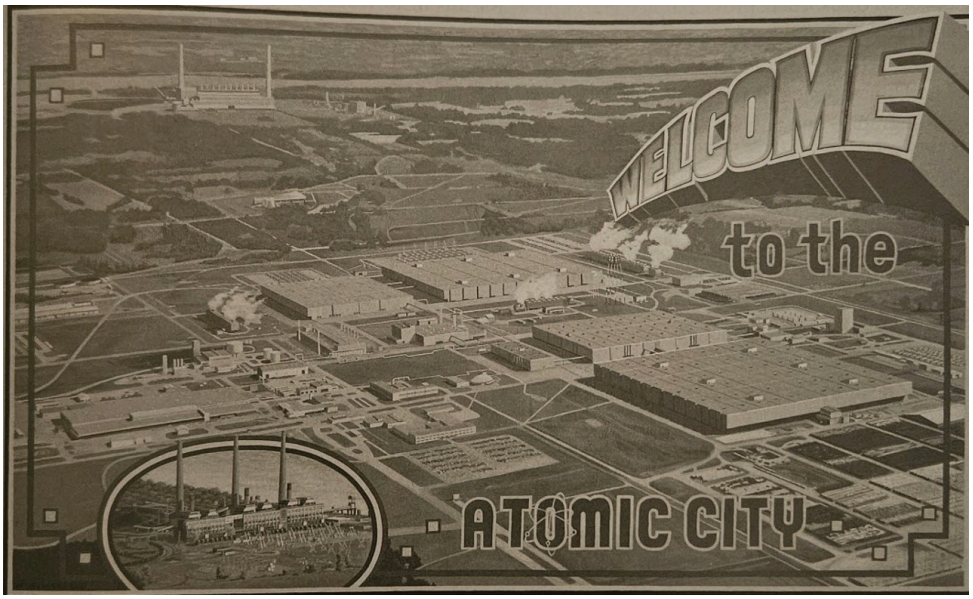
This culminating experience not only provides an outlet to summarize the annual report, but also promotes student engagement, deepens significant learning, encourages visual and scientific communication, and spreads knowledge throughout the community. Student expos are highly research-focused and lead to greater development and engagement. Through the PGDP Student Expo, students were able to articulate their research about the Paducah Gaseous Diffusion Plant (PGDP) site and directly to their local communities.

The PGDP Student Expo allowed students to produce high-quality research and develop confidence in their public speaking skills. The students were able to articulate what they learned and work through a structured process that aimed to build supportive relationships with the community. The students summarized several sections of the 2023 PGDP Annual Report to support community understanding of the past and present operations at the PGDP site. The sections below showcase the students' poster work and summary of the 2021 PGDP Annual Report. Posters were developed to provide an overview of the following topics from the Annual Report:

- Plant Site History
- Environmental Compliance
- Environmental Monitoring
- Environmental and Waste Management
- Environmental Statutes
- Groundwater Protection Programs
- Environmental Programs and Activities
- Quality Assurance
- Environmental Non-Radiological Programs

Plant Site History

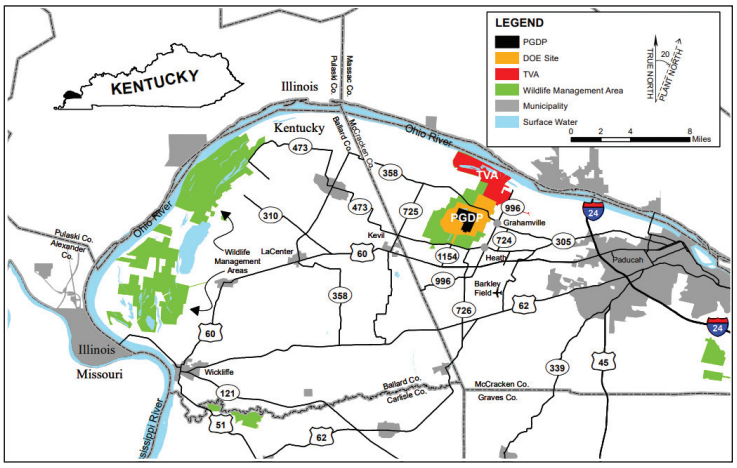
SITE HISTORY



The Paducah Gaseous Diffusion Plant (PGDP) was constructed in the early 1950s and began enriching uranium in 1952. In fact, the Paducah Site was an active uranium enrichment facility until 2013. The Energy Policy Act of 1992 provided for the lease of the enrichment facilities to a commercial entity that operated the enrichment facilities from 1998 to 2013. In 2014, the leased facilities were returned to DOE control, and then a DOE contractor began managing the uranium enrichment facilities for DOE. These facilities are now undergoing deactivation in preparation for decommissioning.

SITE LOCATION

The Paducah Site is in a rural area of McCracken County, Kentucky, 10 miles west of Paducah and 3.5 miles south of the Ohio River. The population of McCracken County is approximately 67,000. The major city in McCracken County (Paducah) has a population of approximately 27,000. Three small communities are located within 3 miles of the DOE property boundary at the Paducah Site: Heath and Grahamville to the east and Kevil to the southwest. The closest commercial airport is Barkley Regional Airport, which is approximately 5 miles to the southeast of the DOE property boundary at the Paducah Site.



The plant occupies a 3,556-acre DOE-owned Site, approximately 1,973 acres of which are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA). During World War II, Kentucky Ordnance Works operated its main process and some storage in an area southwest and west of the plant on what is now the WKWMA. WKWMA now consists of woodlands, meadows, and cultivated fields. Hunters and trappers of wildlife, such as rabbit, deer, quail, raccoon, squirrel, dove, turkey, waterfowl, and beaver, use the area, where fishing is also popular. The Kentucky Department of Fish and Wildlife Resources also sponsors field hunting trials for dogs in the WKWMA.

Field Experiences

SITE TOUR

During a site tour, students had the opportunity to visit several areas of the Paducah DOE site. The visit included a DOE guided tour of the site and multiple discussions with on-site workers.

Paducah Tilghman High School students and faculty visited the Department of Energy's Paducah site as part of the environmental science education grant program.

WKWMA

Students visited with a wildlife biologist at West Kentucky Wildlife Management Area adjacent to the Paducah DOE site. The visit allowed students to learn about additional environmental monitoring practices.

Environmental Monitoring Highlights

In 2023, measurements were taken on and around the Paducah Site; more than 2,000 samples of air, sediment, and water were collected and analyzed for radioactive and nonradioactive contaminants. Major sampling efforts of environmental monitoring for 2023 are summarized below:

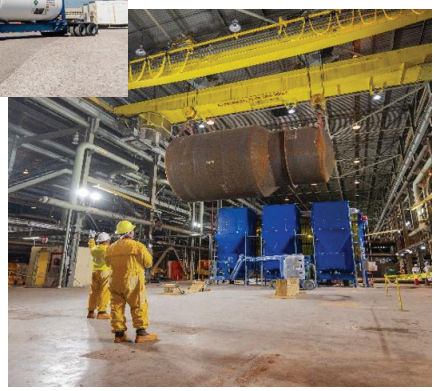
- DOE monitored for radionuclides, trichloroethene, metals, and other water quality parameters under the Kentucky Pollutant Discharge Elimination System (KPDES) Permit and the Environmental Radiation Protection Program at 15 locations where surface water flows into Bayou Creek and Little Bayou Creek.
- External radiation was measured continuously at 64 locations. The measurements were reported quarterly.
- Ambient air was sampled at nine locations, on-site and off-site, and was analyzed for radionuclides.
- Surface water samples were collected annually from two locations and quarterly from seven locations, both on-site and off-site, and analyzed for radionuclides.
- Surface water samples were collected quarterly from on-site landfill locations and one off-site location.
- Sediment was sampled at six locations and analyzed for radionuclides and at 14 locations for polychlorinated biphenyls.
- Surface water sampling included testing fathead minnows and water fleas for chronic toxicity at three locations and acute toxicity at one location.
- More than 200 wells were sampled at varying frequencies to monitor corrective actions, movement of groundwater contaminants, and groundwater quality.
- Potable water was sampled at five locations for per- and polyfluoroalkyl substances (PFAS) compounds.
- Additional PFAS sampling was conducted in 2023 from a variety of environmental media. The results will be presented in a forthcoming PFAS screening assessment summary report

Environmental and Waste Management

WASTE MINIMIZATION AND POLLUTION PREVENTION

All Paducah Site projects are evaluated for waste minimization and pollution prevention opportunities.

- In 2023, recycled materials included oils, paper, toner cartridges, nonradiological scrap metal, aluminum cans, light bulbs, batteries, tires, plastics, cardboard, and used electronics.
- In 2023, the Paducah Site recycled 16,777 pounds of various batteries, 169 pounds of various light bulbs, 500 pounds of excess unused chemicals, and 250 pounds of unpunctured aerosol cans as outlined in the Paducah Site treatment plan. In addition, 17,720 pounds of activated carbon that would have required disposal was sent off-site for regeneration.



FACILITY STABILIZATION, DEACTIVATION, AND INFRASTRUCTURE OPTIMIZATION

Stabilization and deactivation projects at the Paducah Site involve isolating utilities, removing, and compliantly disposing hazardous materials from facilities, and downgrading radiological facilities to make them ready for demolition.

- Significant Paducah Site accomplishments in 2023 included preparing waste for future disposition while continuing efforts to prepare the C-333 Process Building for future demolition; continued efforts to characterize and deactivate process gas systems within the C-333 Process Building.

DEPLETED URANIUM HEXAFLUORIDE CYLINDER PROGRAM

A coproduct of the uranium enrichment process, DUF6 is a solid at ambient temperatures and is stored in large metal cylinders.

- At the end of 2023, the Paducah Site managed an inventory of 50,652 DUF6 cylinders in its cylinder storage yards. The DUF6 Conversion Facility converts the inventory of DUF6 to uranium oxide, a more stable form of uranium, and hydrofluoric acid, which is sold for commercial use.
- During 2023, MCS converted approximately 4,112.38 metric tons of DUF6. Section 4.9 discusses the off- site shipment of these conversion products.

Environmental Statutes

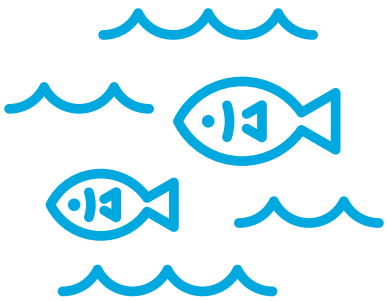
Ava Russell and Jasmine Jones

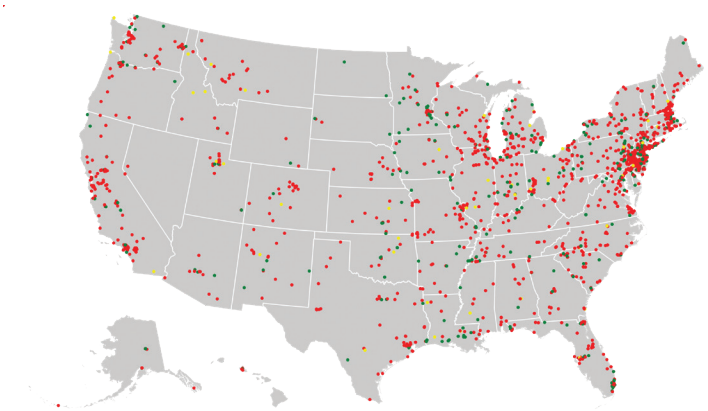
COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)

- Usually referred to as Superfund Act
- Passed in 1980 and amended in 1986
- Paducah site is a CERCLA site
- Under CERCLA, a site is investigated and remediated if it poses a significant risk to human health or environment
- The Paducah site complies with CERCLA

CLEAN WATER ACT

- Passed In 1972
- Goal was to control water pollution
- Regulates point-source and storm water discharges into waters of the US
- Regulates discharges of dredge and fill materials into waters of the US
- Controls and prevented spills of oil and hazardous substances
- Provides financial assistance to construct publicly owned sewage treatment works
- The Paducah site complies with the Clean Water Act





Distribution of Superfund sites in the United States. *Under the Superfund Act, the EPA maintains the National Priorities List of contaminated sites that are eligible for cleanup funds. (U.S. EPA, 2018)*

CLEAN AIR ACT

- The Paducah site complies with the Clean Air Act and its amendments, subsequent federal regulations, and Commonwealth of Kentucky rules by implementing programs, procedures, and permit requirements.

ENDANGERED SPECIES ACT

- Provides for the designation and protection of endangered and threatened animals and plants and protects the ecosystems
- If necessary, project-specific field surveys are performed to identify threatened and endangered species and their habitats, and mitigating measures are designed as needed.
- The Paducah site complies with the Endangered Species Act

Environmental Statutes *(continued)*

Ava Russell and Jasmine Jones

GREEN AND SUSTAINABLE REMEDIATION

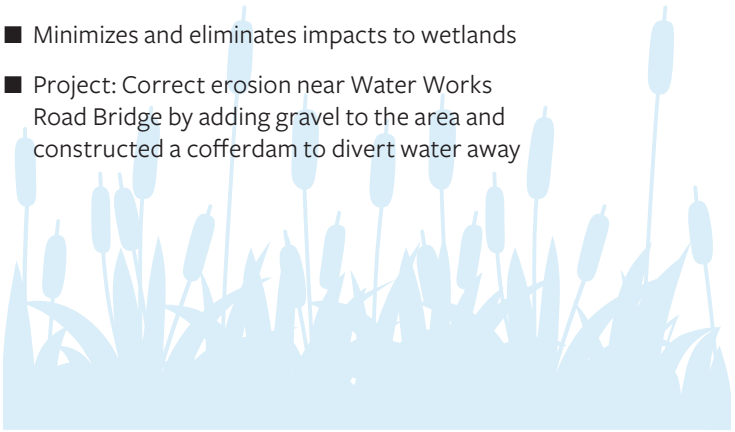
- The practice of using sustainable methods to reduce the environmental and social impacts of remedial cleanup and closure activities in a cost-effective way.
- Offers opportunities to meet compliance obligations at lower overall cost and reduced environmental impact.

RESOURCE CONSERVATION AND RECOVERY ACT

- Established standards concerning the treatment, storage, and disposal of hazardous waste
- Owners of hazardous waste treatment, storage, and disposal facilities must obtain operating and post closure permits
- DOE must report compliance issues in an annual report (The Hazardous Waste Report)

FLOODPLAIN MANAGEMENT AND PROTECTION OF WETLANDS

- Executive Orders, *Floodplain Management* and *Protection of Wetlands*
- Minimizes and eliminates impacts to wetlands
- Project: Correct erosion near Water Works Road Bridge by adding gravel to the area and constructed a cofferdam to divert water away



ATOMIC ENERGY ACT OF 1954

- Through the Atomic Energy Act, DOE regulates the control of radioactive materials, including the treatment, storage, and disposal of low-level radioactive waste from its operations.

IMPACTS OF INVASIVE SPECIES

- An invasive species is a species that spreads rapidly across large areas and causes harm
- Executive Order, *Safeguarding the Nation from the Impacts of Invasive Species*, calls on government agencies to prevent introduction and spread of invasive species
- Zebra mussels are an invasive species that are in supply lines used by Paducah Site water treatment plant
- Solution: Drain only one intake line at a time, allowing mussels to die, then backwashing the drained line and flushing out the mussels
- Solution: Routine Site maintenance such as mowing and spraying for weeds

Monitoring of Plants and Animals

Ava Russell and Jasmine Jones

WILDLIFE MONITORING

- Deer have been monitored in the past to aid in assessing Paducah Site conditions
- The DOE stopped monitoring deer in 2012 after a continuous decrease in contaminants

BIOTA MONITORING AND ESTIMATED DOSE

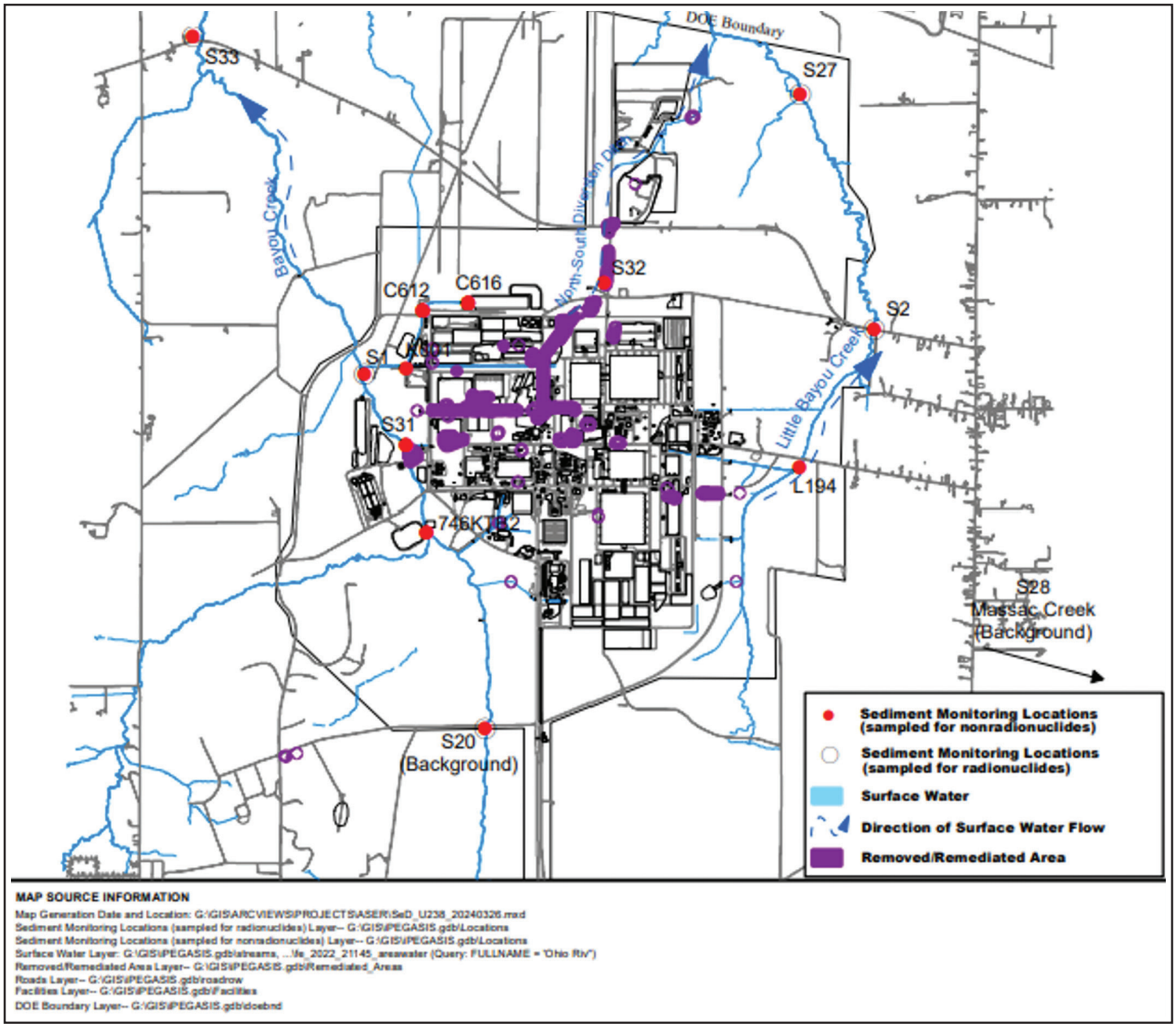
- Fish and animals can be exposed to radiologically contaminated water and soils. In order to protect animals affected by contaminated areas, DOE has measures to estimate potential dose and compare to acceptable levels.

WILDLIFE ESTIMATED DOSE

- This wildlife radiological exposure route and associated dose is captured in the food chain models associated with the CAP-88 PC program.

Sediment and Soil Monitoring and Estimated Dose

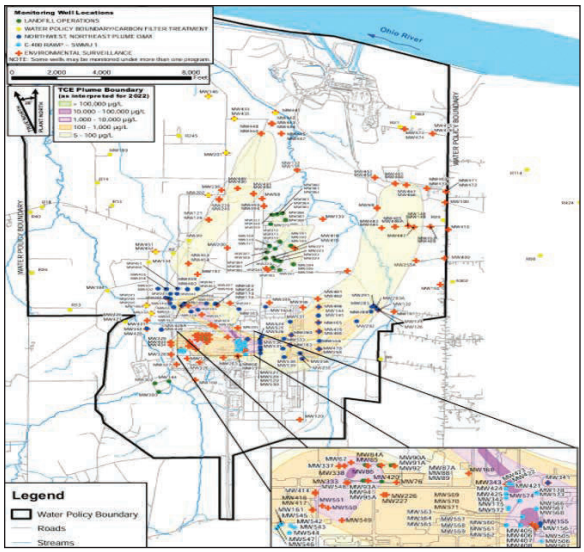
Ava Russell and Jasmine Jones



Sediment Monitoring Locations

Groundwater Protection Programs

Dawson Black



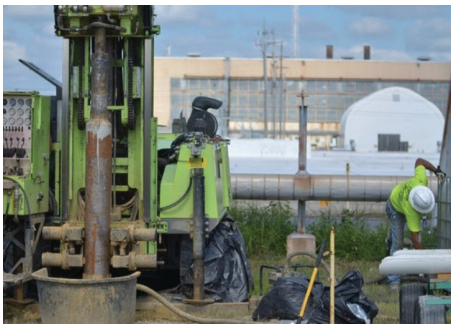
At the Paducah Site, groundwater has been contaminated. Many treatment methods are used to treat pollutants throughout the aquifer. The primary pollutants include trichloroethene, an industrial-grade degreaser, and technetium-99, a fission by-product contained in nuclear reactors. Trichloroethene, a dense nonaqueous-phase liquid, exhibits low solubility and greater density than water. Due to these properties, it tends to migrate downward through the subsurface, accumulating as pools within aquifers. These pools pose a challenge for remediation, as they are difficult to access and gradually release contaminants, leading to prolonged groundwater pollution.

At the Paducah Site, groundwater is monitored using more than 300 wells. The data collected from the wells are used to track the flow of pollutants throughout the aquifer. Volatile organic compounds (VOCs), primarily trichloroethene (TCE), and radionuclides are removed in treatment processes using activated carbon and ion exchange resins. Groundwater plume pump-and-treat operations have also made a significant impact on the purification of the aquifer.

Beginning in the 1990s, groundwater protection operations have made a significant positive impact on the surrounding environment. Thousands of gallons of contaminants, such as TCE, have been removed using groundwater pump and treatment system, Permeable Reactive Barriers (PRBs), and other cutting edge treatment technologies.

Analyte	Range
Volatile Organics (µg/L)	
1,1,1-Trichloroethane	0.81-0.81
1,1,2-Trichloroethane	0.37-7.96
1,1-Dichloroethane	0.39-19.1
1,1-Dichloroethene	0.35-172
1.2-Dichloroethane	0.41-0.79
Acetone	1.81-4.7
Acrolein	5.62-5.62
Benzene	0.38-2.65
Carbon tetrachloride	0.37-233
Chloroform	0.36-601
cis-1,2-Dichloroethene	0.34-2,130
Ethylbenzene	0.83-4.17
Methylene chloride	0.51-3.23
Tetrachloroethene	0.34-4.83
Toluene	0.51-6.43
Total Xylene	6.97-34.2
trans-1,2-Dichloroethene	0.36-21.5
Trichloroethene	0.34-35,800
Vinyl chloride	0.72-92.2
Polychlorinated biphenyls (µg/L)	
PCB-1242	0.0427-0.0427
PCB-1254	0.0614-0.0614
PCB-1260	0.0439-0.0439
Polychlorinated biphenyls	0.0427-0.105
Radionuclides	
Alpha activity (pCi/L)	6.67-6.67
Beta activity(pCi/L)	3.22-1,290
Radium-228 (pCi/L)	4.06-7.23
Technetium-99 (pCi/L)	10.6-44,600
Uranium-235 (µg/L)	0.00703-0.0117
Uranium-238 (µg/L)	0.238-1.84

Analyte	Range
Wet Chemistry (µg/L)	
Alkalinity	60,400-177,000
Chemical Oxygen Demand (COD)	9,210-43,300
Cyanide	1.76-16.8
Dissolved Solids	85,000-529,000
Iodide	245-681
Total Organic Carbon (TOC)	336-8,060
Total Organic Halides (TOX)	3.46-190
Anions (µg/L)	
Bromide	99.6-893
Chloride	774-234,000
Fluoride	95.6-1,120
Nitrate as Nitrogen	48.4-7,060
Sulfate	4,070-1,350,000



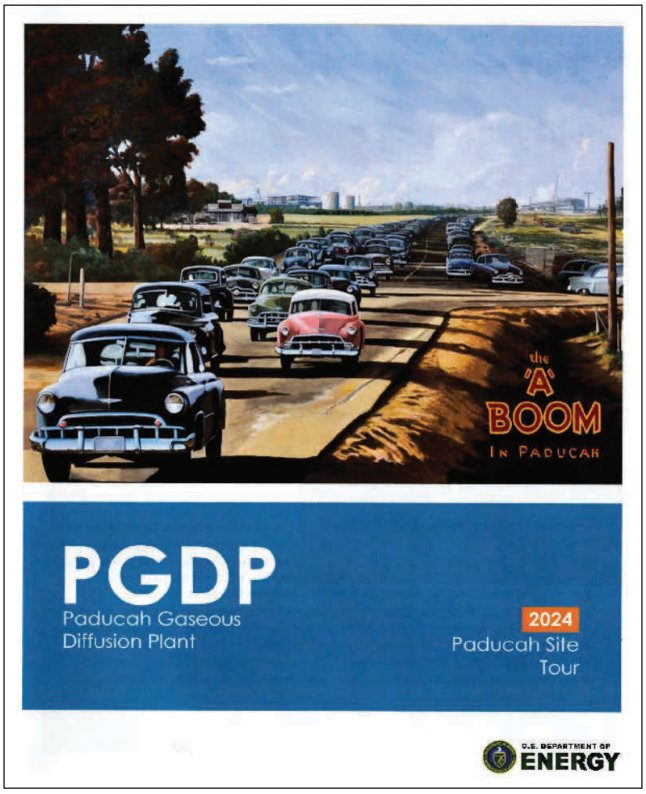
Analyte	Range
Metals (µg/L)	
Aluminum	19.8-4,300
Arsenic	2.05-35.1
Barium	22.3-406
Beryllium	0.301-0.301
Boron	5.27-2,060
Calcium	5,210-354,000
Chromium	3.1-596
Cobalt	0.302-44.2
Copper	0.333-5.06
Iron	33-137,000
Lead	0.514-4.29
Magnesium	2,950-80,900
Mercury	0.069-0.252
Molybdenum	0.202-7.79
Nickel	0.607-251
Potassium	92.1-25,800
Selenium	1.6-7.37
Silver	0.351-1.62
Sodium	15,200-127,000
Uranium	0.07-5.11
Vanadium	3.42-6.82
Zinc	3.34-21.5
Arsenic, Dissolved	2-28.4
Barium, Dissolved	21-418
Chromium, Dissolved	3.28-115
Lead, Dissolved	0.502-0.51
Selenium, Dissolved	1.7-1.7
Uranium, Dissolved	0.069-4.75

Environmental Programs and Activities

Landon Perkins

METHODS AND MATERIALS

- To achieve the objectives outlined in the environmental programs, DOE employs a variety of methods and materials. One primary method involves the collection and analysis of environmental samples, including groundwater, surface water, soil, and sediment. These samples are tested for contaminants such as TCE and technetium-99 (Tc-99), which have been identified as primary pollutants at the site.
- DOE utilizes both field measurements and laboratory analyses to assess contaminant levels and track their migration patterns. Additionally, DOE conducts independent environmental monitoring under the Agreement in Principle (AIP) Program, which allows for impartial assessments of DOE activities at the PGDP. This includes overseeing independent environmental research and enhancing communication with concerned citizens.
- The KDEP and U.S. EPA review and provide input on DOE's remediation plans and activities, ensuring that they comply with state and federal regulations. Furthermore, DOE engages in public outreach to inform and involve the community in environmental decision-making processes. By employing these methods and utilizing appropriate materials, DOE strives to ensure that environmental restoration activities at the PGDP are conducted effectively and transparently.



RESULTS AND CONCLUSIONS

- The environmental programs and activities at the Paducah Gaseous Diffusion Plant are the result of a concerted effort by the Commonwealth of Kentucky and U.S. Environmental Protection Agency (EPA) to address historical contamination and protect public health.
- Through comprehensive monitoring, independent assessments, and active community engagement, the EPA, DOE, and KDEP ensure that remediation efforts are both effective and transparent. The methods employed, including rigorous sampling and analysis, independent oversight, and public outreach, are integral to the success of these programs.
- These initiatives reflect a commitment to environmental stewardship and the safe future use of the PGDP site.
- Continued collaboration between state agencies, the DOE, and the public will be essential in achieving long-term environmental restoration goals.

Quality Assurance

Jacob Hodge

INTRODUCTION

The site has a Quality Assurance/Quality Control (QA/QC) program to verify the integrity of the data collected by the environmental monitoring program.

The QA/QC program specifies organization programs for

- Equipment
- Design
- Documents
- Data
- Records

LABORATORY ANALYTICAL QUALITY ASSURANCE

When available and appropriate, methods from EPA's SW-846 Compendium are used. When these are not available, other approved methods are used for laboratory samples. Using these methods laboratory QC samples are prepared and analyzed. If these samples do not meet the QC acceptance criteria, action is taken in specified by the analytical method. The Paducah site is required to participate in independent QC programs. The Paducah site also participates in voluntary independent programs.

FIELD SAMPLING

Efforts to ensure the quality of field samples begin with the planning for these samples. From the beginning, data quality objectives play a huge role in determining numbers of samples, location of samples, methods, and schedules. After planning, field measurements can be taken for ground and surface water, and the measurements include:

- Water Level
- pH
- Flow Rate
- Temperature
- Residual Chlorine
- Barometric Pressure

Samples that are collected use procedures specific to the media (surface and groundwater, sediment, or air filters). The QC program for groundwater and environmental monitoring activities have a target rate for field QC samples. This rate is 1 per 20 environmental samples. These include:

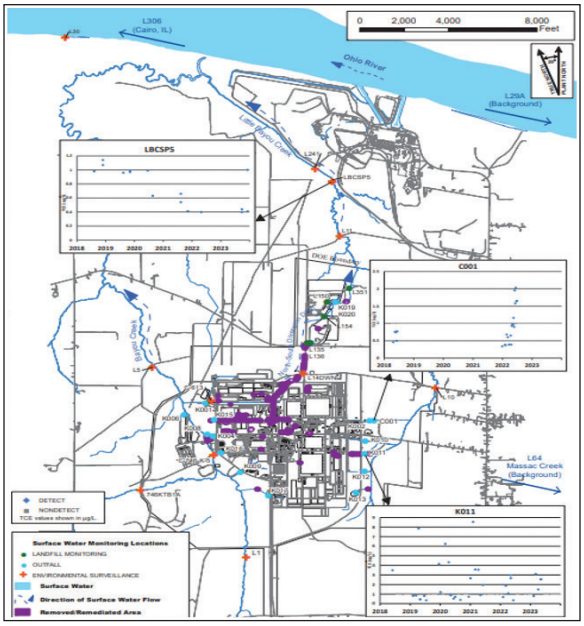
- Blanks
- Spikes
- Rinseates

Environmental Nonradiological Programs

Milleah Smith

NONRADIOLOGICAL MONITORING ON SITE

The Paducah Site conducts environmental monitoring to assess both radiological and nonradiological contaminants. There are no active nonradiological air emission points at the site requiring monitoring. However, surface water monitoring is extensive and complies with Clean Water Act regulations through a Kentucky Pollutant Discharge Elimination System (KPDES) permit. This monitoring covers multiple discharge outfalls, including those related to stormwater runoff and the Northeast Plume pump-and-treat operation. Surface water monitoring at multiple locations also tracks contaminants like trichloroethene (TCE), a colorless liquid industrial chemical used for metal cleaning, manufacturing, and as a solvent. Results are available to the public through the PPPO Environmental Geographic Analytical Spatial Information System (PEGASIS) website.



Surface water and seep monitoring locations with trichloroethene trends

SEDIMENT AND BIOLOGICAL MONITORING

Sediment monitoring at the Paducah Site focuses on detecting radionuclides and polychlorinated biphenyls (PCBs), with 2023 measurements showing PCB concentrations well within the acceptable risk range as defined by the EPA. These levels are below both the no-action and action levels set for recreational use, indicating that potential risks from PCB exposure are minimal. Biological monitoring in 2023, which includes fish and benthic macroinvertebrate sampling, was not required under the KPDES permit. The initial requirement for biological sampling was phased out after 2009 due to concerns that continued sampling could harm the local ecology. However, toxicity tests for effluent discharges remain a key component of the monitoring program, ensuring that potential pollutants in surface water do not pose a significant threat to aquatic life.

www.energy.gov/em/articles/virtual-museum-catalogs-history-paducah-gaseous-diffusion-plant

FIRE PROTECTION AND RECREATIONAL ACTIVITIES

The Paducah Site also emphasizes fire protection through its Wildland Fire Management Plan, which incorporates fire prevention measures like training, work restrictions, and vegetation control. In the event of a wildland fire, a multiagency response plan is in place to mitigate risks to public safety, personnel, and critical facilities. Fire protection responsibilities are shared with the West McCracken Fire Department for specific areas. Additionally, recreational activities are permitted within the West Kentucky Wildlife Management Area (WKWMA), where activities such as turkey hunting, horseback riding, mountain biking, and fishing are allowed. Hunting and fishing regulations are set by the Kentucky Department of Fish and Wildlife Resources, ensuring that these activities are safely managed and monitored.

Acronyms, Abbreviations, and Glossary

ASER - Annual Site Environmental Report
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
DOE - US Department of Energy
DOECAP - DOE Consolidated Audit Program
DUF6 - depleted uranium hexafluoride
EISA - Energy Independence and Security Act
EMS - Environmental Management System
FFA - Federal Facility Agreement
FRNP - Four Rivers Nuclear Partnership, LLC
FY - fiscal year
KAR - Kentucky Administrative Regulations
KDEP - Kentucky Department for Environmental Protection
KDOW - Kentucky Division of Water
KPDES - Kentucky Pollutant Discharge Elimination System
MCS - Mid-America Conversion Services, LLC
MEI - maximally exposed individual
NEPA - National Environmental Policy Act
NESHAP - National Emission Standards for Hazardous Air Pollutants
PACRO - Paducah Area Community Reuse Organization
PEGASIS - PPPO Environmental Geographic Analytical Spatial Information System
PEMS - Project Environmental Measurements System
PFAS - per- and polyfluoroalkyl substances
PGDP - Paducah Gaseous Diffusion Plant
PPPO - Portsmouth/Paducah Project Office
QA - quality assurance
QC - quality control
RCRA - Resource Conservation and Recovery Act
SST - Swift & Staley, Inc.
TSCA - Toxic Substances Control Act
EPA - US Environmental Protection Agency
WKWMA - West Kentucky Wildlife Management Area

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ambient air—The surrounding atmosphere as it exists around people, plants, and structures.

aquifer—A permeable layer of sand, gravel, or rock below the ground surface that is capable of yielding quantities of groundwater to wells and springs.

biota—Animal and plant life.

calibration—Determining the variance from a standard of accuracy of a measuring instrument to ascertain what correction factors are necessary.

compliance—Fulfillment of the applicable 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.

confluence—The point at which two or more streams meet; the point where a tributary joins the main stream.

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

contamination—Deposition of unwanted material on the surfaces of structures, areas, objects, or personnel.

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

dose—In this document, dose is used exclusively to refer to a radiological dose, defined as the energy imparted to matter by ionizing radiation.

effective dose—A measure of the potential biological risk of health effects due to exposure to radiation measured in millirem (1 millirem = 0.01 millisievert). In this document, the term effective dose is often shortened to dose.

absorbed dose—The total amount of energy absorbed per unit mass (the amount of energy deposited in body tissue) as a result of exposure to radiation. The unit of absorbed dose is the rad, equal to 0.01 joule per kilogram in any medium (1 rad = 0.01 gray).

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

exposure (radiation)—The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is exposure to ionizing radiation that takes place at a person's workplace. Population exposure is the exposure to the total number of persons who inhabit an area.

external radiation—Exposure to ionizing radiation when the radiation source is located outside the body.

groundwater—Any water found below the land surface.

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

maximum contaminant level—The maximum permissible level of a contaminant in drinking water provided by a public water system.

maximum contaminant level goal—A non-enforceable health goal set to allow for a margin of safety, which establishes the highest level of a contaminant found in drinking water that is not expected to cause adverse health effects.

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

monitoring—The process of periodically measuring the quantity and quality of factors that can affect the environment or human health to regulate and control potential impacts.

outfall—The point of conveyance, such as a drain or pipe, of wastewater or other effluents into a ditch, pond, or river.

perfluoroalkyl and polyfluoroalkyl substances—A group of man-made chemicals, collectively abbreviated as PFAS, used in nonstick products, such as Teflon, water- and stain-repellant fabrics, and firefighting foam, among others. PFAS are also used in the aerospace, automotive, construction, electronics, and military industries. Certain types of PFAS may have negative health effects for humans and the environment.

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

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

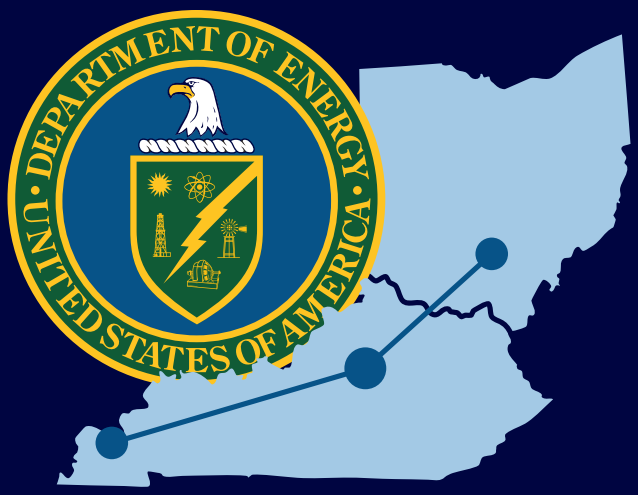
radioactivity—The spontaneous emission of radiation, generally alpha or beta particles or gamma rays, from the nucleus of an unstable isotope.

radionuclide—A radioactive nuclide capable of spontaneously transforming into other nuclides by changing its nuclear configuration or energy level. This transformation is accomplished by emitting photons or particles.

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, which can be trapped by a filter.

volatile organic compounds (VOCs)—Organic, or carbon-containing, compounds that evaporate readily at room temperature. These compounds are present in solvents, degreasers, paints, thinners, and fuels. Due to factors including widespread industrial use, they are commonly found as contaminants in soil and groundwater. Volatile organic compounds include trichloroethene, vinyl chloride, benzene, and dichloroethanes.



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