Commonwealth of Kentucky
2022
Environmental Oversight Report
Paducah Gaseous Diffusion Plant

Kentucky Division of Waste Management
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This 2022 Environmental Oversight Report, finalized in August 2023, was prepared by the Kentucky Division of Waste Management to report activities under the U.S. Department of Energy Federal Facility Agreement (FFA) and Agreement in Principle (AIP) grants, covering the period from January 1, 2022, to December 31, 2022. This report summarizes activities undertaken by the Commonwealth of Kentucky (Kentucky) to oversee environmental restoration activities at the Paducah Gaseous Diffusion Plant (PGDP). Copies of the report are available from the Hazardous Waste Branch, Division of Waste Management, 300 Sower Blvd., Frankfort, Kentucky 40601, phone 502-782-6478.

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Kentucky Pollutant Discharge Elimination System	KPDES
Little Bayou Creek	LBC
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Memorandum of Agreement	MOA
Minimum Detectable Activity	MDA
Monitoring Well	MW
Not Applicable	NA

Operable Unit	OU
Paducah Gaseous Diffusion Plant	PGDP
Parts Per Billion	ppb
Portsmouth/Paducah Project Office	PPPO
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Introduction

In July 2013, the Paducah Gaseous Diffusion Plant (PGDP) ended over 60 years of continuous uranium enrichment production. Today, the United States Department of Energy (DOE) oversees environmental cleanup activities at the site, including environmental management, waste management, depleted uranium hexafluoride conversion, deactivation, decontamination, and decommissioning. The PGDP is located on a 3,556-acre federal reservation in northwestern McCracken County, Kentucky. Most of the historical and ongoing operations at the PGDP occur within a footprint the size of approximately 750 acres. This area is surrounded and bounded by the West Kentucky Wildlife Management Area (WKWMA) to the north, east and west. Since construction, the PGDP has been owned by the DOE or its predecessor U.S. government agencies. The United States Enrichment Corporation (USEC) was responsible for the operation and maintenance of the PGDP production facilities from July 1993 to October 2014. Although DOE retains ultimate responsibility for environmental restoration and waste management, DOE has employed a series of support contractor teams to assist with the implementation of various activities at the site. Four Rivers Nuclear Partnership was the deactivation and environmental remediation contractor during calendar year (CY) 2022.

A variety of environmental concerns have been identified at the site since 1988. Historical PGDP activities have adversely affected soil, sediment, surface water and groundwater. Groundwater sampling and analyses have detected concentrations of primarily trichloroethene (TCE) and technetium-99 (Tc-99), a radioactive by-product of historic PGDP process operations. Soil and sediment sampling analyses have detected the presence of polychlorinated biphenyls (PCBs) and uranium. In addition, historic surface water studies have documented polychlorinated biphenyl (PCB) concentrations in fish collected from both, Bayou Creek to the west of the site, and Little Bayou Creek to the east of the site.

Site cleanup activities are prioritized and sequenced in the fiscal year (FY) 2022/2023 Site Management Plan (SMP). Activities focus on environmental investigations to determine if any impacts or releases have occurred to the environment within the 750-acre Paducah Site that have yet to be investigated or were previously inaccessible. Field

activities associated with the C-400 Complex Operable Unit (OU) pertaining to the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (WP), was the primary environmental focus during 2022.

At the Paducah Site, media-specific operable units (OU) were established by developing a site conceptual risk model for each solid waste management unit (SWMU) and Area of Concern (AOC). This process included a qualitative evaluation of contaminant types and concentrations, release mechanisms, likely exposure pathways, estimated points of exposure, and potential receptors. Potential receptors included current and reasonably foreseeable future land-use assumptions in the evaluation.

The OUs (based on the 2022/2023 SMP) identified for the Paducah Site are:

- C-400 Complex OU
- Groundwater OU
- Surface Water OU
- Soils OU
- Soils and Slabs OU (note: contains 17 Geographical Areas (GA))
- Burial Grounds OU
- Decontamination and Decommissioning OU (Remaining Balance of Facilities)
- Lagoons OU
- Depleted Uranium Hexafluoride (DUF_6) Footprint Underlying Soils OU (DUFUS)
- CERCLA Waste Disposal Alternatives Operable Unit
- Comprehensive Site Operable Unit (CSOU)

A final CSOU evaluation will occur at PGDP following completion of the remaining OUs.

Public Engagement

Citizens Advisory Board

The Paducah Citizens Advisory Board (CAB) is a stakeholders' board that provides advice and recommendations to DOE regarding environmental management programs at the Paducah Site. It is their responsibility to represent and communicate the views of their community as well as keep the public informed on key issues, upcoming decisions and

board recommendations. Kentucky's Division of Waste Management (DWM) and Cabinet for Health and Family Services (CHFS) are non-voting (ex-officio) members that serve as advisors and inform the CAB on their respective agencies' policies and views. The CAB is a local board organized under the umbrella charter of the Office of Environmental Management Site-Specific Advisory Board, whose activities are governed by the Federal Advisory Committee Act (FACA). The website for the Paducah CAB can be found at: https://www.energy.gov/pppo/pgdp-cab/paducah-citizens-advisory-board.

Full board CAB meetings and CAB educational meetings are held on alternating months, the third Thursday of every month. Multiple representatives from Kentucky (AIP and FFA) routinely attend these meetings. The full board and educational meetings allow for meaningful interaction between the CAB board members and any members of the general public choosing to attend. Meeting minutes from three of the meetings held during 2022 were placed on the Paducah CAB website. Significant presentations and discussions were memorialized in those minutes. During a meeting held on March 22, 2022, a presentation about PACRO (Paducah Area Community Reuse Organization) was given that included the opportunity for questions and discussion. During the meeting held August 25, 2022, an update on work at SWMU 211-A and the C-400 Complex OU was provided and a status report on plans for investigating PFAS at the site were presented. Additionally, several videos were played, one was for Black History Month and provided insight into the experiences and site history of former and current black employees. During the final CAB meeting of 2022, Tracey Duncan (DOE Paducah FFA Manager) gave a presentation that outlined the design and purpose of the Federal Facility Agreement (FFA) for the site. This included requirements for the remedial action process.

Oversight Newsletter

The Kentucky Department for Environmental Protection (KDEP) Paducah Site Section releases periodic newsletters titled *Oversight News*. The newsletters are an effort to better inform the public and stakeholders about available resources and significant updates at the Paducah Site. Major features in the newsletters cover topics such as communication efforts by DOE and Kentucky's Energy and Environment Cabinet (EEC), Radiation Health Branch (RHB) monitoring, updates on the northwest and northeast

plumes, historical actions, and future planning for the C-400 Complex, and activities held at the WKWMA surrounding the PGDP. The newsletter also features Paducah Site Section staff changes whenever applicable.

During 2022, no editions of Oversight News were issued. This was primarily due to a lull in major developments at the site and a shortage in KDEP staff working on the project.

Kentucky's Oversight Program

The Commonwealth of Kentucky (Kentucky) is responsible for overseeing the environmental cleanup of the PGDP and protecting human health and the environment. The EEC has designated the Hazardous Waste Branch (HWB) within the Division of Waste Management (DWM) to serve as the lead agency to coordinate this oversight and to implement both the Agreement in Principle (AIP) and the Federal Facility Agreement (FFA) federal grant programs for Kentucky. The CHFS RHB has radiation authority for Kentucky and serves a critical role in implementing these two oversight programs. State agencies and other organizations assisting the HWB and RHB with various types of activities and oversight responsibilities include:

- Division of Waste Management (DWM)
- Division of Water (DOW)
- Division for Air Quality (DAQ)
- Office of Legal Services (OLS)
- Kentucky Department of Fish and Wildlife Resources (KDFWR)
- University of Kentucky Research Consortium Energy and Environment (KRCEE)
- Division of Environmental Program Support Lab
- Radiation Health Branch Radiation/Environmental Monitoring Section
- Program Planning and Administration Branch

For the purposes of this report, all references to activities conducted by the Paducah Gaseous Diffusion Plant (Paducah Site) Section, within the DWM, will be referred to as Kentucky. References to activities by other state government agencies that are not part of the EEC (and in some cases, not part of DWM) will be specified as appropriate.

Coordination with Kentucky's government agencies, federal agencies, and citizen's groups is another important function of the Paducah Site Section. Kentucky regularly cooperates and interacts with the U.S. DOE, the U.S. Environmental Protection Agency (EPA), and the Paducah CAB. Kentucky is an active participant in federal facility DOE inter-governmental groups associated with the National Governor's Association Federal Facilities Task Force, the National Conference of State Legislatures' State and Tribal Government Working Group, the Environmental Council of the States, and the EPA's Federal Facilities Forum.

Federal Facility Agreement (FFA) / Site Management Plan (SMP)

The FFA is a three-party agreement between DOE Portsmouth/Paducah Project Office (PPPO), EPA Region 4, and the KDEP. The FFA was developed to ensure compliance with, and to avoid duplication between, the cleanup provisions of the Resource Conservation and Recovery Act (RCRA) and those of CERCLA. Moreover, the FFA outlines regulatory structure and guides interactions between the three parties. The FFA allows Kentucky and EPA to address contaminated areas at the PGDP that are not subject to permitting but nonetheless require investigation and remediation. The FFA also provides a framework for project management, investigation, dispute resolution, and remediation.

The SMP establishes the clean-up priorities, planning dates, and enforceable milestones for the current fiscal year (FY) and the next two FYs. The SMP is evaluated and scoped annually. Once approved it becomes part of the FFA as an appendix. If the three parties to the FFA cannot agree on the current year's SMP, then the last approvable SMP remains in effect. The SMP also documents the three-party prioritization strategy for the complete remediation of the PGDP in a life-cycle baseline and life-cycle plan. The FFA parties meet to convey priorities and scope revisions for the document in the months leading up to DOE's annual transmittal deadline on November 15.

In early August 2017, the senior managers of DOE PPPO, EPA Region 4, and KDEP signed a Memorandum of Agreement (MOA) to reconfigure the sequence of all environmental remediation work at the Paducah Site. DOE identified and initiated resequencing efforts in April/May 2016. While several factors influenced DOE's

conclusion, the main factor was that DOE regained control of the PGDP facilities in 2014, making the C-400 building accessible to investigate and remediate.

The C-400 building has long been understood as the main source of the two ~four-mile long TCE groundwater (dissolved phase) contamination plumes, commonly identified as the Northeast and Northwest Plumes. These groundwater plumes are the longest known contamination plumes leaving any DOE property within the United States and therefore constitute the main risk to human health and the environment associated with the Paducah Site. In 1989 DOE established an administrative geographical boundary called the Water Policy Box. Within this geographic area, DOE offered free hookups to the municipal water supply for residents living within the Water Policy boundary. To clean up contamination associated with the C-400 Complex Operable Unit (OU), a comprehensive investigation of the area beneath and around the C-400 building was performed. This investigation set out in 2020 to define all sources of contamination and how each are distributed spatially (vertically and laterally) within the C-400 Complex OU.

In order to accomplish a comprehensive investigation of the C-400 Complex OU, the senior managers of the FFA agreed in the 2017 MOA that the C-400 building would be demolished to slab by the first quarter of 2019. The plan is that once the building was down, then the area beneath the building would be more accessible to heavy drilling equipment. Multiple documents for demolishing the C-400 building were submitted by DOE, which were not approved by the EPA. Multiple meetings occurred regarding the state of characterization of contamination within the walls, floors, pipes, and multiple basement areas that are associated with the C-400 building.

Since the C-400 MOA was not signed until August 2017, the senior managers agreed not to finalize a 2017 SMP, but instead to concentrate efforts toward a 2018 SMP. The draft 2018 SMP was scoped over several meetings with an independent technical facilitator to guide discussions. The draft 2018 SMP was rewritten to incorporate the pre-GDP OUs with several (new) post-GDP OUs. The C-400 Complex OU was one of the new OUs created. The draft 2018 SMP was scoped by all three parties without the benefit of a DOE-Headquarters approved Life Cycle Baseline (LCB). This resulted in an initial draft 2018 SMP that consisted of >90% of all out-year planning dates labelled as TBD (To Be

Determined). Once DOE received permission from their own headquarters to reveal dates in their LCB, the PGDP project completion date slid from 2032 to a range of 2065 - 2070. All remaining environmental projects, except the C-400 Complex OU and the area directly north of the C-720 “Machine Shop” Building, referred to as SWMU 211-A, were moved out decades into the future.

The C-400 building is the main source of the two four-mile long TCE groundwater contamination plumes, commonly identified as the Northeast and Northwest Plumes. In order to clean up contamination at the C-400 complex, an exhaustive investigation of the nature and extent of contamination was needed to set the parameters for, and delineate the cleanup project area, beneath and surrounding the C-400 building. Scoping meetings for the investigation work plan, to be completed in a Remedial Investigation / Feasibility Study (RI/FS) Work Plan, began in 2018 and concluded in 2019. During the scoping process, sample locations were identified; concepts and data needs were determined; technical exchanges of investigation methods were discussed; and concerns relating to RI/FS Work Plan development were resolved.

Although the 2022 SMP was submitted on November 15, 2021, it is important to mention as it establishes the clean-up priorities, planning dates, and enforceable milestones for fiscal year (FY) 2022. Discussion between the three parties concerning site priorities, determination of document submittal dates and enforceable milestones was performed throughout the year. The SMP is an ever-evolving document, and scoping meetings for development of the next years’ SMP have traditionally begun in August of each year. Historically, approval of the SMP has taken several months and involved multiple meetings. The 2022 Site Management Plan was approved in one month as a collaborative updating process was used throughout the year to produce a document that could be quickly approved.

Site Management Plan Documents Reviewed In 2022

FY 2022 Site Management Plan (2473&D1), dated November 15, 2021. Kentucky and the EPA submitted comments to the D1 on December 10, 2021.

FY 2022 Site Management Plan (2473&D2), dated December 16, 2021. Kentucky and the EPA approved the D2 on December 17, 2021.

Agreement in Principle (AIP)

Under the AIP program, Kentucky conducts independent environmental monitoring activities and oversees DOE monitoring activities and procedures. Additionally, the program serves to disseminate information relevant to ongoing site cleanup activities to concerned citizens and the public in general. During 2022, AIP personnel wrote and distributed the 2023 Annual Strategic Environmental Sampling Plan and submitted the 2021 Environmental Oversight Annual Report. Electronic copies documents listed above are available at https://eec.ky.gov/Environmental-Protection/Waste/hazardous-waste/Pages/paducah-gaseous-diffusion-plant.aspx. A fundamental task of the AIP program allows Kentucky to conduct independent and impartial assessments of the potential environmental impacts of past, present, and future DOE activities at the Paducah Site.

Kentucky AIP Program Sampling for 2022

One of the primary goals of the AIP is to monitor and evaluate current site activities through sampling and observation, as well as identify possible threats to human health and the environment. The secondary goal is to independently verify data collected by DOE contractors to ensure data quality. To achieve these goals, AIP staff routinely observe DOE facilities and operations to identify environmental issues or concerns. Any resulting observations, findings of concern, or significant conditions are brought to DOE's attention for review.

AIP staff collect independent environmental samples (soil, surface water, air, and groundwater) and can also split samples with DOE contractors. Over the years, AIP staff has also worked with organizations, such as the University of Kentucky, in conducting scientific research, apart from DOE cleanup and monitoring efforts. Some of the research involved collecting environmental samples. Samples collected by AIP, and by independent researchers working with AIP, are routinely sent to laboratories under contract to the AIP program (all laboratories are independent of US DOE) or, in the case of independent researchers, selected by the researcher.

AIP sampling includes the collection of groundwater samples (at the request of nearby property owners) from private residential wells to inform the public and DOE of current groundwater conditions. AIP personnel also split environmental media samples (primarily groundwater) to independently corroborate/validate DOE's sampling results. Historically, AIP has split biological samples collected from animals living near the PGDP to monitor any potential impact to wildlife.

During 2022, AIP independently contracted with TestAmerica Laboratories located in Earth City, Missouri, McCoy & McCoy Pace Analytical Laboratories located in Madisonville, KY, and used two State Laboratories - the Kentucky Department for Environmental Protection Laboratory and the Cabinet for Health and Family Services' Radiation Health Branch Laboratory (CHFS RHB), both of Frankfort, Kentucky. All four laboratories are independent (of DOE) laboratories. The CHFS RHB laboratory analyzes groundwater samples, as well as air and surface water samples for gross alpha and gross beta concentrations, and gamma spectroscopy. If trigger levels for gross alpha and/or gross beta are exceeded, then CHFS will further analyze the sample for isotopic radionuclides. AIP staff directly receives all analytical data from TestAmerica, McCoy & McCoy Pace Analytical, the KDEP and CHFS Laboratories. The results are verified and shared formally by Kentucky AIP staff electronically in the formats specified by the DOE and their contractors. DOE developed a public website to share environmental data with the public. Analytical results collected by Kentucky AIP and DOE contractors can be searched, viewed spatially, and downloaded on the PPPO Environmental Geographic Analytical Spatial Information System, referred to as PEGASIS: https://pegasis.pad.pppo.gov/.

AIP Groundwater Investigations

Groundwater Sampling

During 2022, AIP staff collected 139 samples from 74 monitoring wells and 15 samples from 15 residential wells. The 2022 AIP monitoring wells and seep sampling locations map (Figure 1) and residential well sampling map (Figure 2) shows all groundwater related locations sampled during the 2022 reporting period. Most of the wells sampled were located within two miles from PGDP groundwater plumes and/or less than two miles from the PGDP property boundary. Kentucky AIP environmental sampling results provide a line of evidence that supports validation of DOE data collection procedures and confirms that DOE analytical laboratory results are accurate, reproducible, and independently verifiable. AIP independent oversight of DOE's groundwater sampling program also helps to ensure that analytical results used to construct contaminant plume maps are accurate.

In 2022, AIP staff split water samples with DOE Contractors from 24 monitoring wells. Also, an additional two field replicates were split with DOE Contractors. In most cases, AIP staff arranged to split groundwater samples with DOE during their scheduled sampling activities. These sampling events were conducted to evaluate and substantiate that DOE contractors are following their own sampling procedures and to verify the quality and accuracy of their laboratory analyses. AIP also reviews DOE Contractor procedures to insure they are scientifically sound and in compliance with EPA guidance. AIP samples were shipped to independent analytical laboratories (not affiliated with DOE). Split-sampling results demonstrated a general similarity between those samples collected and analyzed by independent laboratories and those collected and analyzed by DOE Contractors. Of the 24 monitoring well samples split between AIP and DOE Contractors in 2022, most had similar trichloroethene (TCE) and Technetium 99 (Tc-99) concentrations (Table 1).

Seeps Sampled by Kentucky AIP

At the beginning of 2022, six seeps in Little Bayou Creek (LBC) were a part of Kentucky's sampling program. These seeps are located where groundwater is observable (upwelling) in a channelized portion of LBC. The locations of the seeps can move by several feet over time and have been known to cease discharging for long periods of time.

The base flow in LBC is comprised primarily of discharges from plant outfalls. These seeps are located downstream of the Paducah Site, approximately two miles south from the plant and approximately two miles from northeast of the confluence of LBC and the Ohio River. AIP staff monitor the LBC seep area monthly for any migrating and/or new seeps. Seep sampling locations are dependent on localized groundwater conditions and the elevation of the Ohio River, which seasonally backs up into portions of LBC.

AIP staff conducted a seep sampling event on June 22, 2022. Of the six seeps accessible for sampling, the TCE concentrations ranged from non-detect to 1.05 µg/L. Tc-99 concentrations in the seeps ranged from < 1.1 pCi/L to 14.4 pCi/L. Figure 3 presents a graph of TCE concentrations in seep-proximate monitoring wells MW445 and MW447 as well as the most-frequently sampled seep, LBCSP5. The graph reports that TCE concentrations from 2011 to 2022 steadily declined until 2019, when analytical results for all three sampling points were below the minimum detection limit of 0.5 µg/L. Analytical data collected from 2020-2022 did not report concentrations of TCE exceeding 1.05 µg/L.

During an AIP monitoring walk down of the LBC in August 2022, AIP staff reported a beaver dam obstructing the channel, rendering the known seeps inaccessible due to elevated water levels for the remainder of 2022. The beaver dam was located downstream of the raw water lines crossing LBC. AIP staff monitored the dam's impact on water levels in LBC through field observations and in stream measurements throughout the rest of 2022. Another impact on LBC water levels at this time was a significant ongoing leak from one of the raw water lines supplying the PGDP water treatment plant. AIP monitored this leak, its impact on the surrounding drainage areas, and efforts to repair the leak for the remainder of 2022. The raw water line was removed from service in November 2022, and the discharge to LBC ceased. Repair of the eroded area around the pipe at the site of the leak is scheduled to occur in 2023. A scheduled LBC stream gauging event scheduled for August was not impacted by the beaver dam or the raw water line leak. The stream gauging effort was conducted by the University of Kentucky's Earth and Environmental Sciences Department over a two-day period in mid-August with field support provided by AIP Staff.

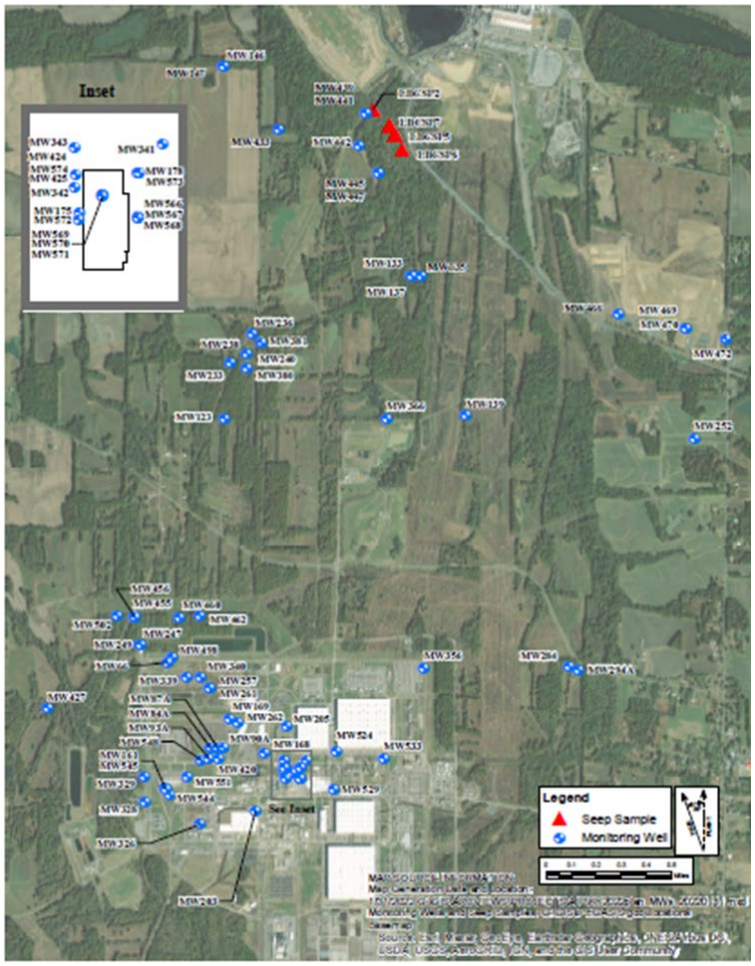

Figure 1. AIP 2022 MW and Seep Sampling Locations

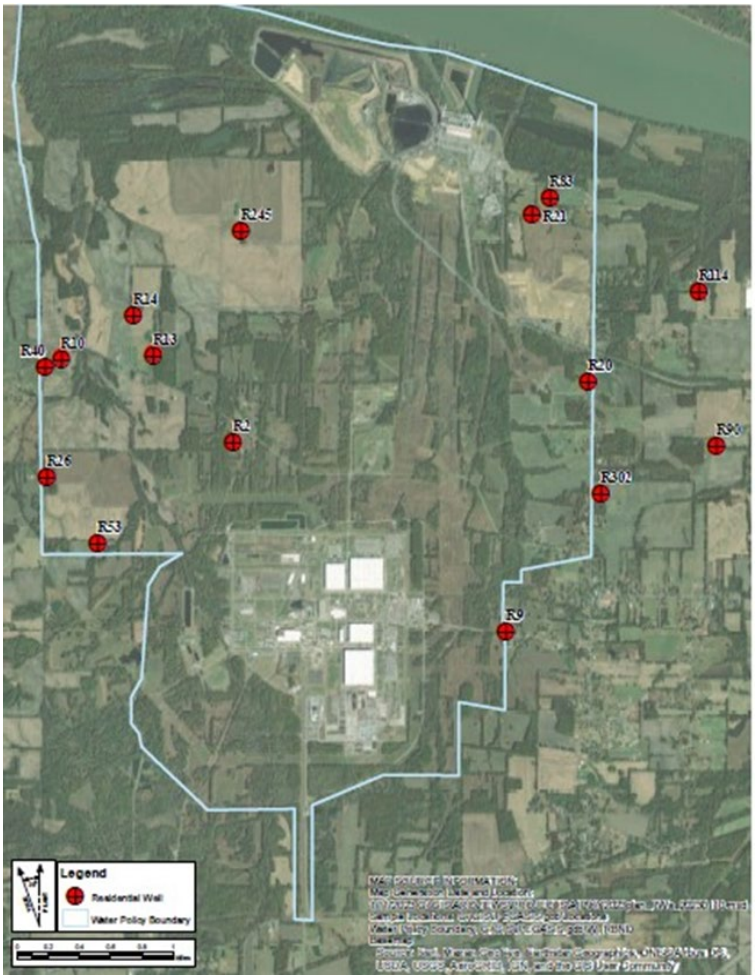

Figure 2. AIP 2022 Residential Well Sampling Locations

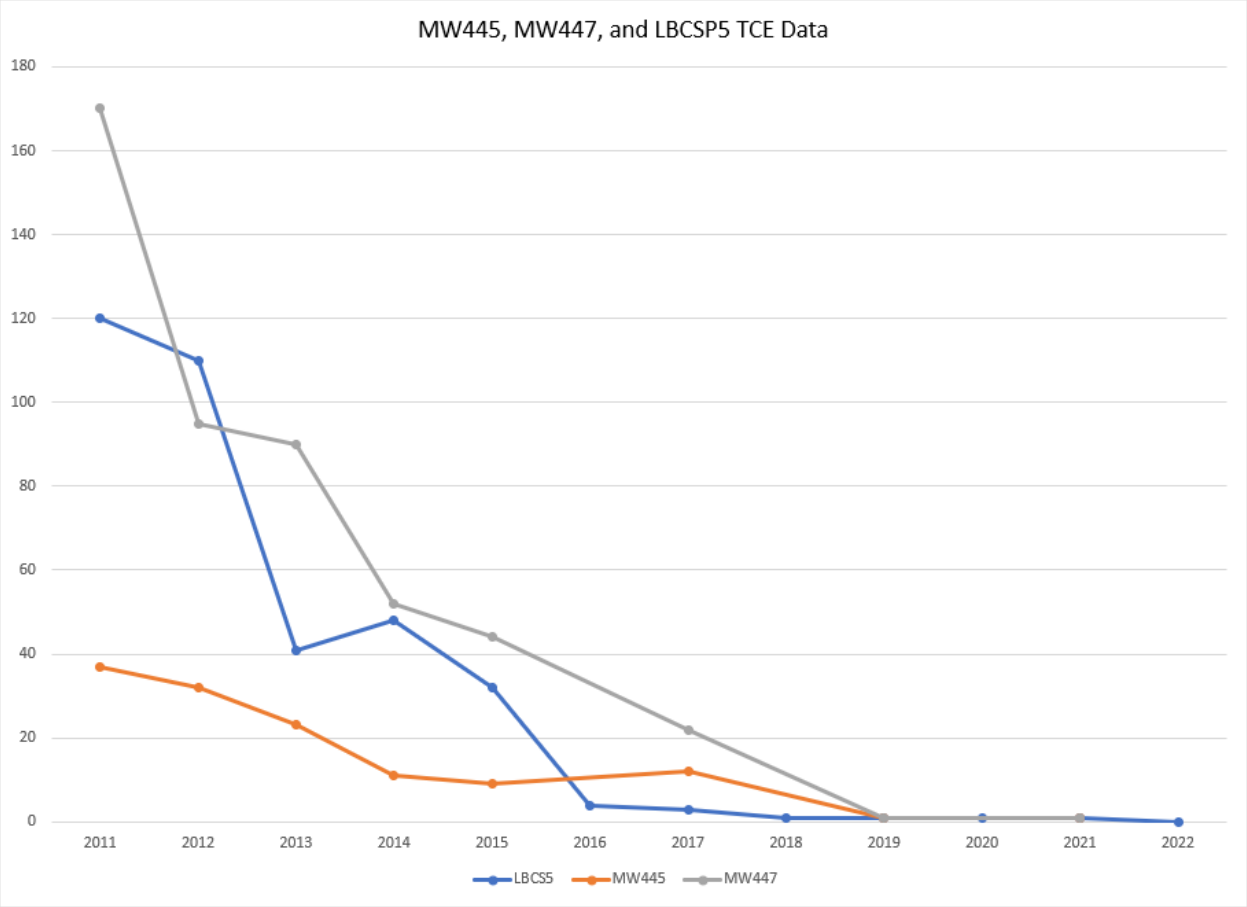

Figure 3: TCE Concentrations in MW445, MW447 and LBCSP5 (2011-2022)

		AIP: TCE µg/L		DOE: TCE µg/L		AIP: Tc-99 pCi/L		DOE: Tc-99 pCi/L	
Well #	Sample Date	Value and/or Qualifier	DL	Value and/or Qualifier	DL	Value and Uncertainty	MDA	Value and Uncertainty	MDA
MW84A	1/6/2022	6,640 (DL)	50.0	6,560	100	240 +/- 1.43	1.73	193 +/- 15.7	19.2
MW87A	1/6/2022	2,150 (DL)	50	1,890	50	ND	N/A	0.113 +/- 11.6 (U)	20.0
MW90A	1/6/2022	188 (DL)	0.500	146	4	16.2 +/- 0.628	1.73	7.36 +/- 11.3 (U)	19.1
MW420	1/6/2022	2,380 (DL)	5.00	2,100	40	ND	N/A	-5.91 +/- 11 (U)	19.3
MW93A	1/6/2022	3,070 (DL)	50.0	2,550	50	ND	N/A	1.33 +/- 12.2 (U)	20.9
MW548	1/6/2022	4,330 (DL)	50.0	4,030	100	41.2 +/- 0.760	1.73	37 +/- 12.3	19.3
MW548X	1/6/2022	4,660 (DL)	50.0	4,030	100	39.8 +/- 0.938	1.73	37 +/- 12.3	19.3
R53	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	-1.69 +/- 11.3 (U)	19.4
R2	2/8/2022	5.09 (L)	0.500	5.05	1	ND	N/A	-7.24 +/- 9.74 (U)	17.1
R26	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	-5.62 +/- 11.1 (U)	19.4
R40	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	N/A	N/A
R10	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	N/A	N/A
R14	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	-6.15 +/- 9.67 (U)	16.9
R13	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	0.754 +/- 9.77 (U)	16.8
R245	2/8/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	0.491 +/- 10.2 (U)	17.5
MW455	3/14/2022	5.40 (L)	0.500	5.36	1	ND	N/A	-0.474 +/- 8.61 (U)	15.0
MW456	3/14/2022	3.98	0.500	4.96	1	ND	N/A	8.08 +/- 9.32 (U)	15.7
R40	3/16/2022	0.957	0.500	1.1	1	ND	N/A	N/A	N/A
R40X	3/16/2022	0.794	0.500	1.1	1	ND	N/A	N/A	N/A
R40	4/27/2022	0.500 (U)	0.500	1 (U)	1	ND	N/A	N/A	N/A
MW566	6/6/2022	1,740 (DL)	5.00	1,640	25	48.9 +/- 1.36	3.48	36.7 +/- 12.1	19.2
MW567	6/6/2022	3,620 (DL)	50.0	4,220	100	35.3 +/- 1.28	3.48	41.7 +/- 12.3	19.2
MW568	6/6/2022	4,950 (DL)	50.0	5,250	100	51.1 +/- 1.37	3.48	48.9 +/- 12.8	19.7
MW161	6/6/2022	243 (DL)	5.00	407	5	ND	N/A	ND	N/A
MW545	6/6/2022	16.5 (L)	0.500	18	1	ND	N/A	ND	N/A
R40	7/7/2022	0.573	0.500	0.52 (J)	1	ND	N/A	N/A	N/A
R40	7/7/2022	0.305 (J)	0.500	1 (U)	1	ND	N/A	N/A	N/A
MW339	9/6/2022	632 (DL)	5.00	NS	N/A	25.6 +/- 1.25	3.58	30.5 + / -7.88	11
MW66	9/6/2022	391 (DL)	1.00	NS	N/A	205 +/- 2.05	3.58	233 + / -14.7	10.9
MW340	9/6/2022	2,390 (DL)	12.5	NS	N/A	1,060 +/- 4.11	3.58	1,130 + / -29.2	10.3
MW569	9/12/2022	275 (DL)	5.00	251	5	482 +/- 2.88	3.58	502 +/- 21	17.2

MW570	9/12/2022	2,930 (DL)	50.0	2,680	50	5,220 +/- 12.6	7.17	5,720 +/- 115	34.1
MW571	9/12/2022	2,980 (DL)	50.0	2,960	50	2,710 +/- 6.43	3.58	2,730 +/- 55.9	22
MW339	9/19/2022	756 (DL)	0.500	354	10	47.8 +/- 1.38	3.61	NS	N/A
MW66	9/19/2022	224 (DL)	0.500	314	20	183 +/- 1.98	3.61	NS	N/A
MW340	9/19/2022	2,120 (DL)	5.00	2,550	100	1,040 +/- 4.08	3.61	NS	N/A
MW524	10/3/2022	6.71 (OL)	0.500	8.12	1	ND	N/A	6.05 +/- 6.71 (U)	11.3
MW529	10/3/2022	976 (DOL)	5.00	791	10	203 +/- 2.05	3.61	196 +/- 15.1	11.9
MW529X	10/3/2022	974 (DOL)	5.00	791	10	204 +/- 2.06	3.61	196 +/- 15.1	11.9
R302	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R20	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R21	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R83	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R114	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R90	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R9	11/2/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
R40	11/3/2022	0.500 (U)	0.500	N/A	N/A	ND	N/A	N/A	N/A
MW574	12/7/2022	1,570 (DL)	5.00	1,590	25	894 +/- 3.80	3.51	974 +/- 28.3	20.8
MW572	12/7/2022	1,060 (DL)	5.00	943	20	116 +/- 1.69	3.51	124 +/- 13.8	18.6
MW573	12/7/2022	5,740 (DL)	5.00	7,000	100	66.7 +/- 1.46	3.51	84.1 +/- 14.5	21.3

In Tc-99 samples, +/- represents the uncertainty in the measurement.

Kentucky samples were analyzed by TestAmerica of St. Louis and the Kentucky Radiation Health Branch.

[1]A field replicate was also analyzed. The higher of the two results is shown.

DL – Detection Limit

J – Estimated Quantitation

MDA – Minimum Detectable Activity

NA – Not applicable. Technetium-99 was not analyzed because the following criteria were not met:

Gross Alpha ≥ 5 pCi/L and Gross Beta ≥ 9 pCi/L

NS – Not sampled

U – TCE: Not detected; Tc-99: Value reported is <MDA and/or TPU.

Table 1: 2022 Split-Sampling Results between EEC AIP & DOE

NW and NE Plume Extraction Wells Area of Influence / Cone of Depression Assessments

Northwest Plume Extraction Wells

AIP personnel did not collect independent water levels surrounding the Northwest Plume Extraction Wells during 2022. The most recent AIP cone of depression interpretation, based off AIP groundwater levels surrounding the Northwest Plume, is presented in Figure 4. EW232 and EW233 went online in August 2010, after being relocated further east from their dormant predecessors EW230 and EW231. The optimized EW232 and EW233 were moved to account for an observed eastward shift of the high concentration portion of the NW plume. The optimized extraction wells each have 20-foot screens with the intake pumps located roughly 8 feet below the top of each well screen. The depth below ground surface for the pump intake at EW232 is 74.5 feet and for EW233 it is 81.5 feet. The lowest portion of the Regional Groundwater Aquifer (RGA) at EW232 is 88.8 feet and at EW233 it is 95.7 feet. AIP has conducted the water level monitoring for the last several years to evaluate the potential for high concentration TCE bypass under and around EW232 and/or EW233. TCE concentrations in the RGA (upper, middle, lower), surrounding and upgradient of the extraction wells, were also evaluated. Three of these monitoring wells are compared in Figure 5. These three monitoring wells illustrate that overall concentrations are decreasing over the period from 2009 - 2022. Concentrations of TCE in MW261 and MW339 in samples collected in late 2021 were both approximately double what they had been in 2020. However, in the last samples collected in 2022, concentrations of TCE in both wells had reduced to levels below those found in 2020. Concentrations of TCE in MW340 spiked in the sampling periods from September of 2020 to March of 2021, before spiking again in March of 2022. MW261, MW340 and MW339 are all upgradient from the extraction wells and listed in order from east to west. The fluctuation in concentrations in MW340 not seen in MW261 and MW339 could possibly be related to depth, as MW340 is only screened in the bottom 5 feet of the RGA, while MW261 and MW339 are screened in the bottom 10 feet of the RGA. However, the specific reason for the fluctuation can only be speculated.

Generally, TCE concentrations in the middle RGA NW Plume monitoring wells near the extraction wells have stabilized in the last three years. In 2022, the NW plume extraction wells pumped a total of 92,250,274 gallons of water. On the west side of the NW plume, MW456 was split-sampled with DOE on March 11, 2022. The DOE sample reported a concentration of TCE at 4.96 µg/L and the KDWM sample was 3.98 µg/L. Samples from this well have contained TCE in the single-digit ppb concentration range from 2020-2022. During the same period, TCE concentrations in proximal deep downgradient wells also appear to be trending down, with fluctuations in some wells, notably MW460. AIP has speculated that the higher concentrations of TCE (dissolved phase) are by-passing the extraction wells. DOE conducted their own evaluation of the two NW Plume extraction wells in a white paper entitled *Evaluation of TCE Trends in MW460* where they independently concluded "that the likely condition is that the Northwest Plume is bypassing the EW232/EW233 well field within the lower RGA." The same white paper provided an alternative explanation for elevated TCE concentrations in MW460 as being residual downgradient TCE concentrations being pulled upgradient. The white paper also noted that higher concentrations (centroid) of TCE have shifted towards the east since 2010.

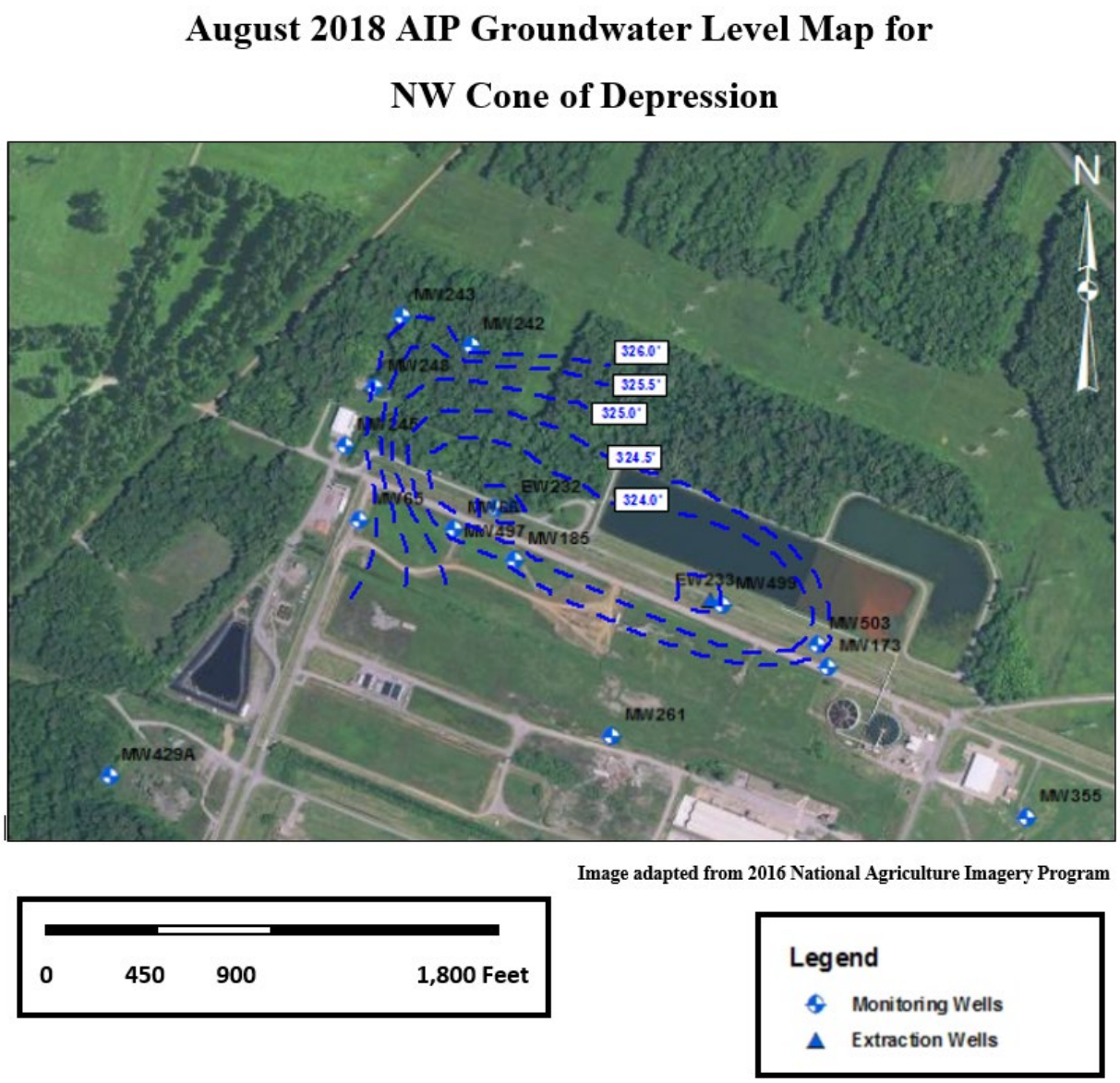

Figure 4. Northwest Groundwater Cone of Depression

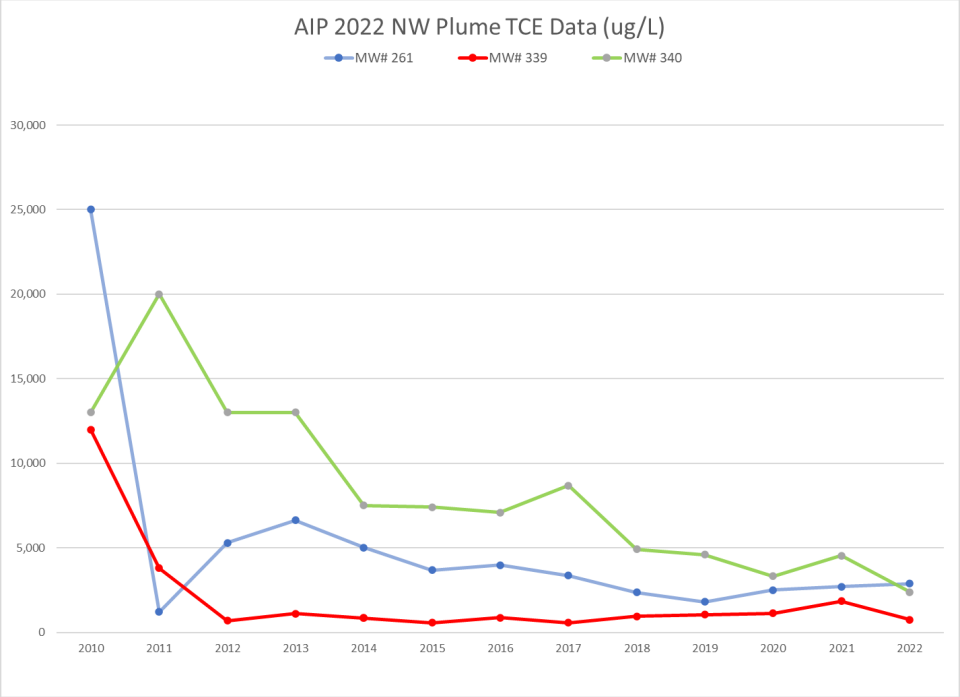

Figure 5. Northwest Plume TCE Data

Northeast Plume Extraction Wells

During the 2022 reporting period, the Northeast extraction wells (EW234 and EW235) removed 79,158,639 gallons of water, and since becoming operational, a total of 2,175,384,677 gallons of water has been removed via the NE Plume Extraction System. AIP personnel did not complete a comprehensive water level synoptic event surrounding the Northeast extraction well field during 2022, but the most recent synoptic water level measurements, collected by AIP personnel, is presented as Table 2. Water elevation measurements (August 2018) were plotted to visualize the cone of depression present around EW234 and EW235 extraction wells.

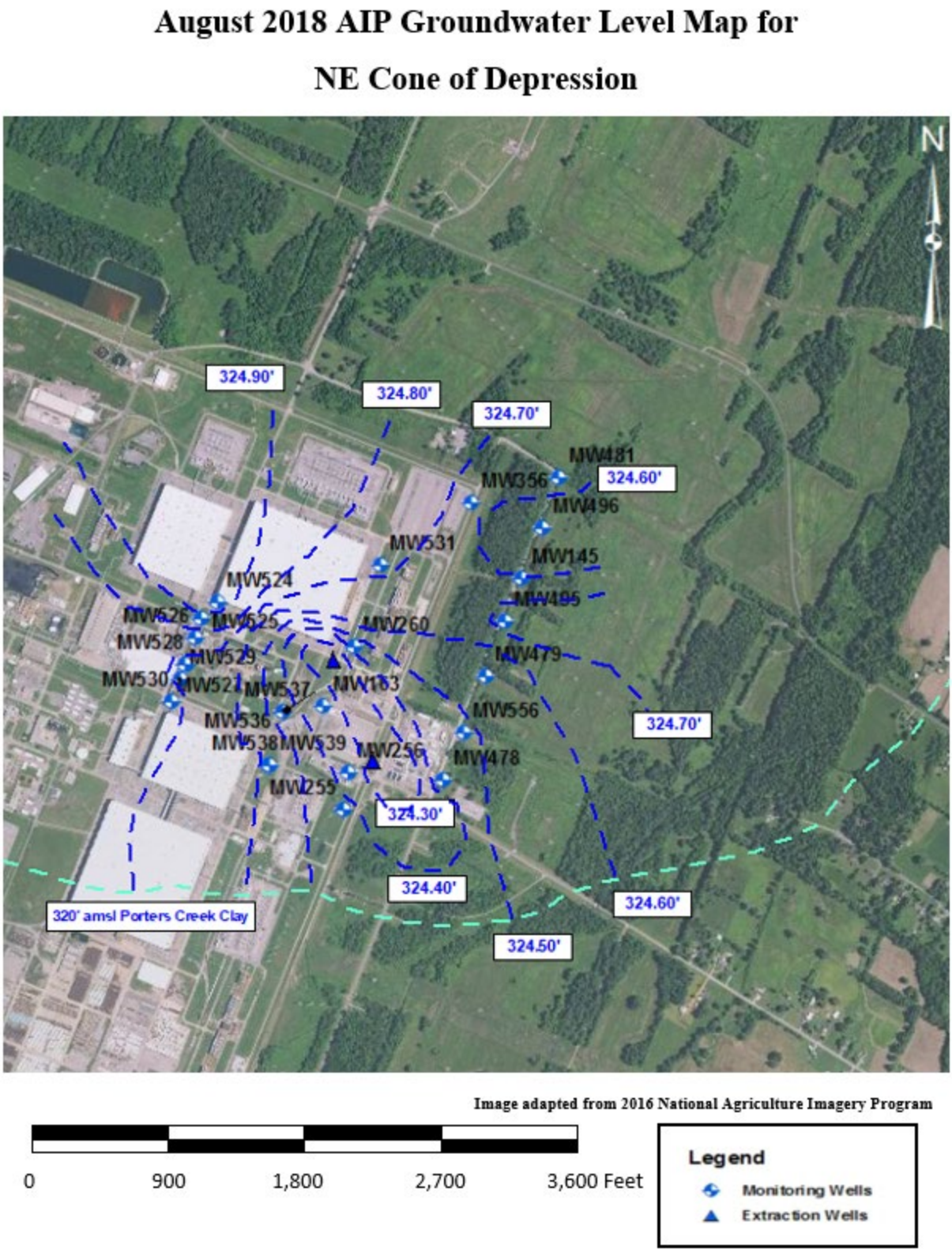

Figure 6. Northeast Groundwater Cone of Depression

EW234 and EW235 were installed as an optimization effort to the northeast system and officially started pumping October 10, 2017. The original wells EW331 and EW332 were placed in stand-by mode. The new extraction wells were installed to increase TCE mass removal, enhance control of the northeast plume migration at the eastern edge of the facility, and reduce further offsite migration.

Sampling results for several of the northeast plume transect monitoring wells, located ~800 ft east of the C-400 Building, revealed increasing TCE concentration trends in 2018. Once increasing TCE trends were observed, DOE consulted with KDEP and EPA which resulted in a reduction to pumping rates on June 14, 2018.

TCE increased in MW526 from the established baseline concentration of 267 µg/L to 2,790 µg/L in January 2019, then drastically decreased in the remaining 2019 sampling events, where it fluctuated between 1,250 µg/L and 1,460 µg/L. Results from four sampling events from MW526 during 2020 yielded results of 3,180 µg/L, 2,520 µg/L, 2,800 µg/L and 2,680 µg/L, in chronological order. Quarterly sampling results collected in 2021 yielded results of 2,890 µg/L, 2,950 µg/L (duplicate of 2,820 µg/L), 2,750 µg/L, and finally 1,940 µg/L. Results of samples obtained during 2022 were, in chronological order, 3,160 µg/L, 2,020 µg/L (duplicate of 1,840 µg/L), 1,820 µg/L, and 1,720 µg/L. This represents a reducing trend as compared to concentrations from 2020 and 2021.

Similarly, TCE levels in MW529 (baseline concentration of 130 µg/L) increased to 3,070 µg/L in January 2019, continued to increase to 6,380 µg/L, and then peaked at 8,320 µg/L in July 2019. On the last quarterly sampling event in 2019, MW529 experienced a 50% reduction in TCE concentrations with a result of 4,150 µg/L. The four samples collected in 2020, chronologically, yielded results of 4,020 µg/L, 5,880 µg/L, 3,240 µg/L and 3,180 µg/L, an overall trend of reduction from 2019 results. The reduction in concentration trends continued in 2021, with concentrations of 3,230 µg/L, 4,730 µg/L, 3,650 µg/L, 2,560 µg/L (KY AIP) and 2,400 µg/L being detected. Concentrations of TCE detected in MW529 during 2022 were, in chronological order, 4,850 µg/L, 3,570 µg/L (duplicate of 3,490 µg/L), 2,090 µg/L, 1,810 µg/L and 791 µg/L. While the first two events were elevated compared to the end of 2021, the last three samples are indicative of a continued overall long-term trend of lower concentrations.

MW530 concentrations rose from 88.5 µg/L in early 2018 to 808 µg/L in July 2018. Results steadily dropped during the remainder of 2018 and throughout 2019 to a low of 269 µg/L. Results continued to steadily decline during each sampling event in 2020, with an early year concentration of 171 µg/L and a last sampling event yielding a result of 80.1 µg/L. The trend of reducing concentrations continued in 2021, with concentrations of 60.1 µg/L, 66.4 µg/L, 59.5 µg/L, and 39.2 µg/L being detected. In 2022, concentrations detected were, chronologically, 56 µg/L, 41.7 µg/L, 55.5 µg/L, and 42.9 µg/L. This represents a continued trend of a reduction in concentration of TCE.

The reduced extraction system pumping rates initiated in mid-2018 appear to be mostly favorable in reducing the eastern migration of TCE from the C-400 Building Complex. Concentrations of TCE in MW526 were higher during all sampling events in 2020 than they were in 2019, and concentrations detected during 2021 were generally stable compared to those detected in 2020. Results from the last two sampling events in 2022 were both the lowest concentrations detected since the end of 2019.

Concentrations of TCE in MW529 peaked in July 2019 and exhibited a declining trend in concentration that continued in 2020. The last two samples collected in 2022 contained the lowest concentrations of TCE detected in the well since before 2019.

Concentrations of TCE in MW530 showed a steady decline beginning in June 2018, and the decline continued through 2022. Of the four samples collected during 2022, all four were below the concentrations found in three of the four samples collected in 2021.

Sampling results from transect wells support the effectiveness of the lowered pumping rates in inhibiting mobilization of TCE from the C-400 Building Complex area. While concentrations of TCE have fluctuated in MW526 and MW529, they have shown an overall downward trend since 2019. TCE concentrations in MW530 have steadily decreased since a peak in concentration only one month after pumping rates were reduced. Quarterly sampling of the transect wells by DOE contractors will continue to be monitored and pumping rates in one or both EWs can be further modified should future trends indicate continued mobilization.

TCE concentrations in the wells downgradient of EW234 and EW235 varied, but overall have been showing a reduction in TCE concentrations. Wells in a transect line, listed in order from north to south, include MW145, MW495, MW479, MW556, and MW478.

TCE concentrations in MW145 fluctuated but remained within a range of 30 µg/L during the 2018-2022 period. Concentrations of TCE from four sampling events in 2022 ranged from a high of 36.8 µg/L to a low of 29.3 µg/L. Only two samples collected during the nine sampling events in 2020 and 2021 were lower than any of the samples collected in 2022. The results from 2022 may represent the beginning of a downward trend in TCE in this portion of the plume.

Results of five samples collected from MW495 during 2021 ranged from 222 µg/L to 257 µg/L, which was the first year since 2013 that TCE had not been detected above 300 µg/L. This trend continued in 2022, with all four sampling event results lower than the lowest concentration detected in 2021. The sample collected during the first sampling event of 2022 reported a concentration of 159 µg/L. It is noteworthy that the three samples collected during the remainder of the year were all below 100 µg/L.

An overall reduction of concentrations trend in MW479 that began in late 2019 continued through 2022. All samples collected from MW479 from April 2021 through 2022 contained less than 2 µg/L of TCE.

Samples were collected at four separate dates during 2021 from MW556, and concentrations of TCE in all four samples were lower than the lowest concentration detected during 2020. Concentrations detected during 2021 fell to a low of 55.1 µg/L. Concentrations found during 2022 somewhat stabilized around the 2021 low, ranging from 59.2 µg/L to 46.5 µg/L

Since April 2019, concentrations of TCE in MW478 have hovered around the 300 µg/L mark, and this trend continued through most of 2021 until concentrations rose to 380 µg/L in a sample collected in December. The lowest concentration detected during 2020 and 2021 was 282 µg/L, while samples collected during 2022 ranged between 241 µg/L and 86.3 µg/L.

Based on an analysis of sample results such as those presented above, the extraction of TCE contaminated water from the NE Plume extraction wells is successfully reducing TCE concentrations in this portion of the aquifer. Monitoring of downgradient wells will continue to be performed by DOE field contractors on a routine basis. KY AIP staff will continue to observe, split, and independently sample MWs associated with the northeast plume monitoring well network.

C-400 Monitoring Wells Sampled by Kentucky AIP

Since July 2009, the AIP has monitored the effectiveness of various groundwater actions taken at C-400 by sampling all functional depths of the following downgradient multi-port monitoring wells: MW421, MW422, MW423, MW424 and MW425. These monitoring wells are in the vicinity of the northwest corner of the C-400 building and are used to compare TCE concentrations over time. Each of the monitoring wells contain three screened intervals corresponding to the upper (shallow), middle, and lower (deep) RGA zones. The AIP has collected samples from these downgradient wells since 2009 and tracked the associated chemical data to chart downgradient impact of the remediation efforts.

Concentrations in the majority of downgradient C-400 monitoring wells continue to decline over time or remain relatively constant. An increase in concentration was noted in MW421 P3 in 2016, then decreased in 2017, steadily increased throughout 2020, and began to decrease throughout 2022. MW421 P3 is screened at a depth of 83 to 85 feet below ground surface (bgs). DOE data is used to supplement AIP data in this analysis. The results can be seen in Figure 7 below.

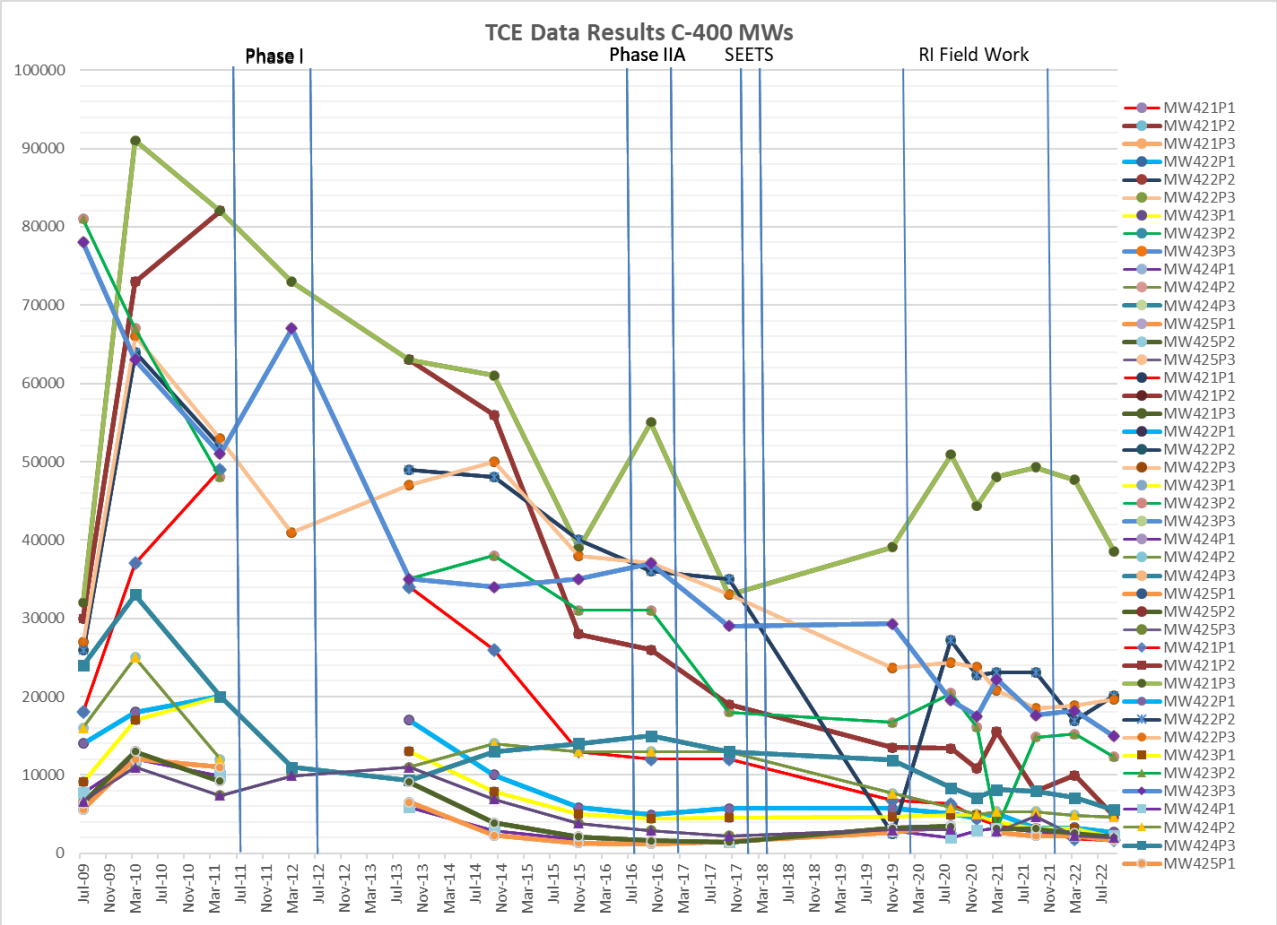

Figure 7. C-400 Monitoring Well TCE Data

Historically, AIP has split samples with DOE contractors from monitoring well clusters MW506 and MW507, which are located south and hydraulically upgradient of the C-400 building. Each of the monitoring wells has a unique screened interval corresponding to the shallow, middle, and deep RGA zones. The monitoring well clusters provide a good comparison to several downgradient multi-port monitoring wells. AIP last collected split samples with DOE contractors from monitoring well clusters MW506 and MW507 in 2020. DOE contractors continue to sample these monitoring well clusters on a quarterly basis with AIP evaluating the results.

Several remedial actions have historically occurred around the C-400 Building to extract TCE from the subsurface. In 2003 a treatability study was conducted utilizing six-phase heating, a form of electrical resistance heating (ERH) which removed ~1,900 gallons (22,000 lbs.) of TCE. Phase I ERH became operational on March 29, 2010, and ran for seven months, removing ~535 gallons (6,525 lbs.) of TCE along the southern portions of the C-400 building. TCE concentrations in all downgradient wells showed a decline after the Phase I operational period. During Phase 2a, TCE totaling ~1,137 gallons (13,871 lbs.) was removed during ERH operation (Jan. 1 through Oct. 9, 2014). TCE concentrations also generally declined downgradient during the months and years following Phase 2a.

In 2016 a treatability study utilizing steam enhanced extraction was conducted upgradient from the Phase IIb area and no extraction component was utilized. Increasing concentrations of TCE were observed in upgradient monitoring well cluster MW506 and MW507. The increase in TCE concentrations in the middle and lower RGA wells is suspected to be inadvertent mobilization, from southern portions of the Phase IIb area, during the Steam Enhanced Extraction Treatability Study in 2016. TCE concentrations leveled off in 2017 and continued to trend downward through 2022 as can be seen in Figure 8.

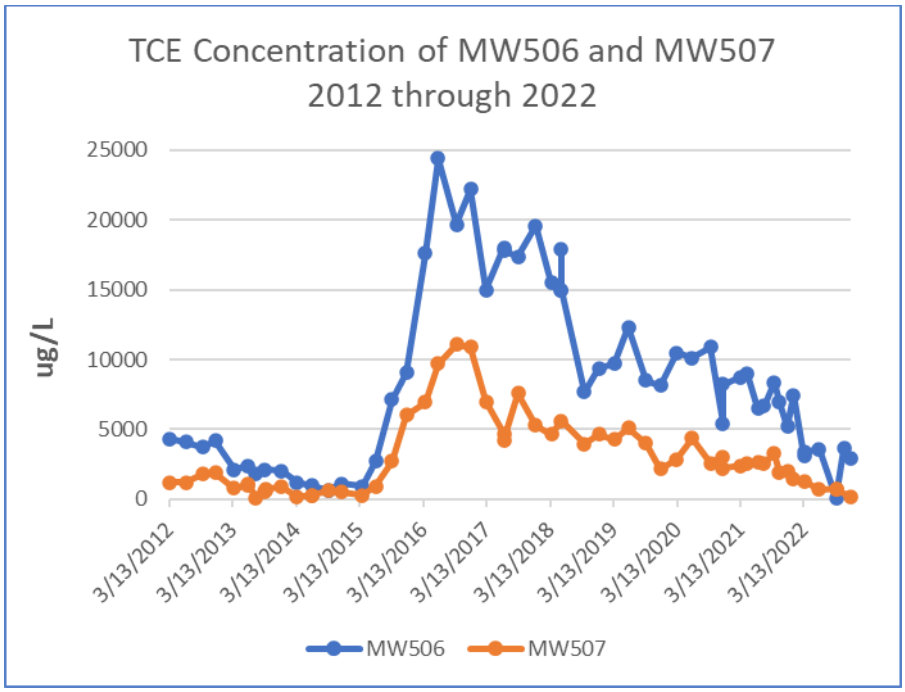

Figure 8. MW506 and MW507 are Located Hydraulically Upgradient of the C-400 Remedial Groundwater Actions

PGDP Sitewide Groundwater Flow Model

Groundwater models are used to help evaluate hydrogeologic systems to simulate and predict aquifer conditions and travel times. A groundwater model is a simplified mathematical representation of the subsurface hydrogeologic flow conditions at a site. The Paducah Gaseous Diffusion Plant (PGDP) Sitewide Groundwater Flow Model was created to develop a tool that can assist in evaluating potential remedies. The Groundwater Model Working Group is comprised of technical experts that work collaboratively to develop, discuss, evaluate, refine, modify, and make recommendations in support of potential groundwater related projects.

In a series of meetings, DOE, EPA, Kentucky, and their associated contractors worked together to revise the PGDP groundwater model to determine if additional data needs are necessary to support the evaluation of potential groundwater remedies. The first groundwater flow model at the PGDP was designed in 1990 and revised several times through 1997. A transport model was developed in 1997 and 1998. The next major

revision to the model did not occur until 2008. That revision was developed to assist in determining additional data needs, evaluating potential remedies, calculating cleanup criteria, and developing inputs to design selected remedies. The model was further refined in 2012 to evaluate how potential variability in anthropogenic recharge rates (e.g., leaking water from plant utility lines) can influence groundwater flow and extraction well capture zone performance. Revisions to the 2016 model included revisions to the southern model boundary, refinement of anthropogenic recharge rates within the industrial area, upgradient Terrace Gravel recharge refinement, optimization of calibration periods by utilizing more complete synoptic water level datasets, refinement of lithologic/stratigraphic/hydrostratigraphic thickness intervals, and changing drain cells to river boundary cells in the lower reaches of Bayou and Little Bayou Creeks.

The PGDP groundwater model simulates flow within the Regional Gravel Aquifer (RGA) and essentially ignores flow in both the Upper Continental Recharge System (UCRS) and the McNairy Formations - which are the units above and below the RGA, respectively. The UCRS conveys natural and anthropogenic recharge vertically to the RGA and an evaluation was conducted to identify UCRS lithologic areas with less than 2-ft of clay above the RGA, which also was near suspected areas of elevated anthropogenic recharge. The underlying McNairy Formation is represented in the model as a no-flow boundary. The model includes an upgradient zone which accounts for recharge (upgradient input) to the model along Terrace Gravel deposits.

Prior to 2010 water elevations collected at PGDP were collected during routine sampling events which typically occurred over several months. Water level elevations fluctuated over time which introduced uncertainty into all water level potentiometric surface interpretations/maps prior to 2010. In August 2010, DOE initiated synoptic water level events on an annual basis. A synoptic water level event occurs over a relatively short time period (1-3 days) when atmospheric conditions are expected to remain consistent. Subsequent revisions to the groundwater model include multiple sets of synoptic water level elevation events to test model predictions against actual recorded conditions.

DOE submitted the 2016 update of the PGDP Sitewide Groundwater Flow Model document to the regulators in April 2017, even though it is not subject to regulatory review

and approval under the Federal Facilities Agreement (FFA). The 2016 update was the result of a collaborative approach and process undertaken by all three parties to the FFA, with an objective to represent and reflect groundwater flow conditions of the past, present, and future. The intent of the model update is to provide FFA decision makers with a tool that can predict how contamination will migrate in the RGA over time. Both Kentucky and EPA reviewed and provided comments and recommendations to be considered in the next groundwater model revision effort. The model will continue to be evaluated and updated periodically, as warranted. The Groundwater Modeling Group met virtually on a quarterly basis during 2022.

Efforts to collect additional water level data (based on recommendations) to refine the groundwater model proceeded in 2018. For the first time, fifteen monitoring wells belonging to and located on Tennessee Valley Authority (TVA) property were collected by Kentucky AIP field staff as part of the sitewide synoptic water elevation monitoring event. The water level elevations (Table 2) were collected in 2022 by Kentucky AIP to enhance the DOE synoptic water level event that occurred during the same week. In 2019, Kentucky AIP discovered two more TVA wells, bringing the total of TVA wells to seventeen. TVA abandoned monitoring wells TVA-D8A during the installation of the sheet-pile wall in August 2021 and SHF-D10 during scoping working conducted in February 2022. Synoptic water level events occurred in February, May, August, and November of 2022. The data collected during the 2022 events were officially transmitted to DOE where it will be combined with the Paducah Site wells. The water level data will likely be used to refine future iterations of the groundwater model.

AIP staff assisted DOE and Contractors on reconnaissance efforts along Metropolis Lake to search for suitable locations for placement of a semi-permanent measuring stick to gauge fluctuations in lake levels more precisely. AIP personnel also worked with the Kentucky Nature Preserves Permitting Program Department to understand their expectations and concerns, which were passed along to DOE and their contractors.

Well	OREIS Name	Measuring Point	Measured GW Elevation	Water Level	Date	Barometric Pressure (inHg)
TVAGW-6D	TVAGW-6D	372.77	321.12	51.65	2/23/2022	30.43
			322.27	50.50	5/25/2022	29.43
			319.22	53.55	8/22/2022	29.57
			317.67	55.10	11/15/2022	29.70
TVAGW-5D	TVAGW-5D	372.55	320.85	51.70	2/23/2022	30.43
			321.55	51.00	5/25/2022	29.43
			318.75	53.80	8/22/2022	29.57
			316.22	56.33	11/15/2022	29.70
TVAGW-4D	TVAGW-4D	369.26	320.78	48.48	2/23/2022	30.43
			321.66	47.60	5/25/2022	29.43
			318.76	50.50	8/22/2022	29.57
			317.32	51.94	11/15/2022	29.70
TVAGW-3D	TVAGW-3D	366.9	320.68	46.22	2/23/2022	30.43
			321.54	45.36	5/25/2022	29.43
			318.72	48.18	8/22/2022	29.57
			315.36	51.54	11/15/2022	29.70
TVAGW-2D	TVAGW-2D	372.82	324.31	48.51	2/23/2022	30.43
			327.2	45.62	5/25/2022	29.43
			323.85	48.97	8/22/2022	29.57
			321.55	51.27	11/15/2022	29.70
TVAGW-1D	TVAGW-1D	374.94	321.12	53.82	2/23/2022	30.44
			322.2	52.74	5/25/2022	29.43
			319.48	55.46	8/22/2022	29.57
			317.85	57.09	11/15/2022	29.70
SHF-D74B	TVA-D74B	332.16	319.58	12.58	2/23/2022	30.42
			307.49	24.67	5/25/2022	29.43
			305.27	26.89	8/22/2022	29.60
			304.87	27.29	11/15/2022	29.70
SHF-D30B	TVA-D30B	324.61	319.76	4.85	2/23/2022	30.42
			300.63	23.73	5/25/2022	29.43
			298.26	26.10	8/22/2022	29.60
			297.97	26.39	11/15/2022	29.70
SHF-D17	TVA-D17	365.43	318.02	47.41	2/23/2022	30.42
			318.71	46.72	5/25/2022	29.43
			315.87	49.56	8/22/2022	29.60
			314.43	51.00	11/15/2022	29.70

SHF-D11B	TVA-D11B	321.79	N/A	N/A	2/23/2022	N/A
			308.49	13.3	5/25/2022	29.43
			301.29	20.50	8/22/2022	29.60
			301.34	20.45	11/15/2022	29.70
SHF-201C	SHF-201C	323.75	N/A	N/A	2/23/2022	N/A
			309.57	14.18	5/25/2022	29.44
			305.38	18.37	8/22/2022	29.60
			303.86	19.89	11/15/2022	29.71
SHF-201B	SHF-201B	323.75	N/A	N/A	2/23/2022	N/A
			309.6	14.15	5/25/2022	29.44
			305.47	18.28	8/22/2022	29.60
			303.98	19.77	11/15/2022	29.71
SHF-201A	SHF-201A	323.75	N/A	N/A	2/23/2022	N/A
			309.5	14.25	5/25/2022	29.44
			305.36	18.39	8/22/2022	29.60
			303.91	19.84	11/15/2022	29.71
SHF-102G	SHF-102G	362.85	321.85	41	2/23/2022	30.40
			322.99	39.86	5/25/2022	29.44
			319.85	43.00	8/22/2022	29.60
			318.26	44.59	11/15/2022	29.71
SHF-101G	SHF-101G	322.43	N/A	N/A	2/23/2022	N/A
			309.28	13.15	5/25/2022	29.43
			304.39	18.04	8/22/2022	29.60
			304.16	18.27	11/15/2022	29.70
Ohio River Elevation				320.21	2/23/2022	30.42
				303.40	5/25/2022	29.43
				301.50	8/22/2022	29.60
				300.55	11/15/2022	29.70

Table 2. 2022 AIP Synoptic Water Level Events

Sediment Basin Sampling

The C-613 Northwest Storm Water Control Facility (a.k.a. the C-613 Sediment Basin) was constructed as part of the first phase of the scrap metal removal project. The sediment basin began operation in March 2003, has a capacity of 4.5 million gallons and was specifically designed to collect surface water runoff from the facilities' 61-acre northwest watershed, which includes the 27-acre former scrap yard area. The sediment basin collects storm water runoff and allows suspended sediments time to settle, after which the storm water is discharged through the Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 001 into Bayou Creek. The Outfall 001 regulatory discharge limits are defined in the Division of Water (DOW) Permit as: Total Suspended Solids (TSS) will not exceed 30 mg/L averaged over a 30-day period and shall not exhibit a pH outside the range of six to nine standard units.

The AIP C-613 Sediment Basin sampling regimen began in October of 2002. The C-613 Sediment Basin sampling regimen has been significantly modified twice. Frequent, non-periodic samples were collected from 2003 to 2007. These sample results identified specific contaminants of concern, provided baseline analyte concentrations, and allowed trends to be determined. After sufficient information was collected, sampling was reduced to a quarterly sampling regimen that was established during the first quarter of 2008. This quarterly regimen was performed from 2008 to 2011. Due to budgetary constraints and the fact that analyte concentrations had stabilized, the sampling regimen was again modified in the first half of 2012, when the frequency of sample collection was again reduced from quarterly to semi-annually. The semi-annual sampling regimen, continued through 2022, includes one non-discharge sampling event per year to continue assessment of changes in contaminant concentrations that sediment basin releases may have on West Kentucky Wildlife Management Area (WKWMA) receptors (Figure 9).

The semi-annual sampling regimen for 2022 is as follows:

First Semi-Annual Sampling Event:

Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge Sampling Points

Purpose: The first semi-annual event collects samples from the basin inlet (Sediment Basin), outlet (Outfall 001) and at a point (Iron Bridge) where WKWMA recreators can be exposed to Bayou creek water. Samples are always collected during a Sediment Basin discharge event.

Figure 9. AIP 2022 C-613 Sediment Basin Surface Water Sampling Locations

Second Semi-Annual Sampling Event:

Part 1) Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge Sampling Points

Purpose: The second semi-annual event collects samples from the basin inlet (Sediment Basin), outlet (Outfall 001) and at a point (Iron Bridge) where WKWMA recreators can be exposed to Bayou creek water. Samples are collected during a Sediment Basin discharge event.

Part 2) KPDES Outfall 001 and Iron Bridge Sample Points (Annual)

Purpose: This annual sample is collected to determine analyte concentrations when there is no active discharge from the Sediment Basin. This sample is referred to as a non-discharge event. This sample is collected during the second semi-annual event as it has historically been a period of both steady rainfall and stream flow. This sampling event was designed to be representative of an average WKWMA recreator's possible contaminant exposure during normal stream flow.

Each sample is analyzed for the following analytes:

Total Suspended Solids (TSS)

Metals, including Uranium and Mercury

Gross Alpha and Beta activity

Isotopic Uranium (U-234, U-235 and U-238)

Results: TSS and pH

During the 2022 reporting period, neither the TSS concentrations nor the pH limits exceeded DOW KPDES Outfall 001 permit requirements. Flocculent, a material used to enhance particulate precipitation, was not used during 2022; and the last flocculent treatment was in December of 2007. After the Scrap Metal Removal project was completed in March of 2007, DOE's service contractor planted and continues to maintain a well-developed grass cover over the (former) Scrap Yards area. Observations indicate the vegetative cover stabilizes the soil, reduces sediment flow into the basin and allows for greater absorption of rainfall. This results in low sediment basin turbidity

measurements and low TSS sample results. Based on a comparison of these sample results and the Outfall 001 discharge requirements, AIP concludes that the sediment basin continues to perform its primary design function, which is to comply with DOW KPDES requirements.

Results: Uranium Metal, Uranium radionuclides and alpha and beta

The following is a presentation of the 2022 analytical results for the C-613 Sediment Basin for the Discharge Event Samples Collected on April 7, 2022:

Analyte	Basin Inlet	MDL / MDA	Total Uncertainty (2σ +/-)	Basin Outlet (Outfall 001)	MDL / MDA	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDA	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	**230.0**	0.40	N/A	**61.0**	0.40	N/A	**2.9**	N/A	N/A
Gross Alpha (pCi/L)	**44.94**	1.30	2.55	**31.41**	1.30	2.26	**9.05**	1.42	1.24
Gross Beta (pCi/L)	**162.15**	3.69	3.97	**97.11**	3.69	3.17	**31.91**	4.03	2.15
U-234 (pCi/L)	**43.70**	0.16	3.99	**30.5**	0.29	3.05	**5.07**	3.79	2.40
U-235 (pCi/L)	**3.09**	0.20	0.64	**2.48**	0.18	0.58	**0.23**	0.81	0.47
U-238 (pCi/L)	**83.6**	0.29	7.18	**51.6**	0.26	4.82	**12.7**	3.74	2.66

Table 3. 2022 First Semi-Annual Discharge Sampling Event

2022 Second Semi-Annual Sampling Event:

The non-discharge sample was collected at a time the Sediment Basin was not being actively discharged. Samples were collected at KPDES Outfall 001 (Outlet) and at the "Iron Bridge" sample point, which is representative of potential contaminant exposure to an average recreator, as this sample point borders the WKWMA. Several of the Basin Outlet and Iron Bridge radionuclide results indicate they were not analyzed. This means they were not analyzed for the analyte specified in the row. All samples are analyzed for gross alpha/gross beta utilizing gas flow proportional counters and for gamma emitting isotopes utilizing gamma spectrometry. Uranium and plutonium isotopes are not specifically analyzed for unless the gross alpha results from the screening are greater than or equal to 5.0 pCi/L. Technetium-99 will be analyzed if the gross beta results are equal to or exceed 9.0 pCi/L.

Part 1: Results from the Non-Discharge Event Samples collected on September 28, 2022:

Analyte	Basin Outlet (Outfall 001)	MDL / MDC	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	**0.68**	0.4	N/A	**< 0.4**	0.4	N/A
Gross Alpha (pCi/L)	**1.21**	1.51	0.86	**0.62**	1.51	0.74
Gross Beta (pCi/L)	**14.40**	3.41	1.44	**3.36**	3.41	1.17
U-234 (pCi/L)	N/A	N/A	N/A	N/A	N/A	N/A
U-235 (pCi/L)	N/A	N/A	N/A	N/A	N/A	N/A
U-238 (pCi/L)	N/A	N/A	N/A	N/A	N/A	N/A
Tc-99 (pCi/L)	**2.0**	3.61	1.11	N/A	N/A	N/A

Table 4. 2022 Second Semi-Annual Non-Discharge Sampling Event

Part 2: Results from the Discharge Event Samples collected on November 9, 2022:

Analyte	Basin Inlet	MDL / MDC	Total Uncertainty (2σ +/-)	Basin Outlet (Outfall 001)	MDL / MDC	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	**120.0**	0.4	N/A	**76.0**	0.4	N/A	**22.0**	0.4	N/A
Gross Alpha (pCi/L)	**30.70**	1.51	1.87	**24.09**	1.51	1.82	**10.64**	1.51	1.31
Gross Beta (pCi/L)	**60.06**	3.07	2.15	**49.26**	3.07	2.01	**22.26**	3.07	1.53
U-234 (pCi/L)	**24.7**	0.35	2.85	**16.3**	0.265	2.01	**5.33**	0.27	0.93
U-235 (pCi/L)	**1.4**	0.22	0.47	**1.16**	0.211	0.42	**0.14**	0.26	0.17
U-238 (pCi/L)	**43.0**	0.22	4.56	**28.7**	0.264	3.17	**8.45**	0.34	1.26
Tc-99	**28.2**	3.65	1.28	**18.3**	3.65	1.22	**9.26**	3.65	1.17

Table 5. 2022 Second Semi-Annual Discharge Sampling Event:

Sediment Basin sampling has been performed regularly since the Sediment Basin became operational in March of 2003. Discharge times, volumes and water quality parameters have been collected and compiled since November of 2004. The following data was compiled from 2003 to 2022 concerning average uranium concentrations (averaged from all results available for a given year) and the annual discharge through the Sediment Basin (in gallons). According to the National Oceanic and Atmospheric Administration (NOAA), the average yearly rainfall in the Paducah, Kentucky area is 49.1 inches. Average inlet and outlet Uranium metal (total) concentrations, Sediment Basin discharge volume, annual rainfall, and percentage of annual rainfall for each year from 2003 through 2022 are as follows:

2003: Inlet: 346.0 µg/L Outlet: 156.0 µg/L

Annual Discharge: Not Collected Rainfall: 47.84 inches (97% of Average)

2004: Inlet: 371.0 µg/L Outlet: 206.0 µg/L

Annual Discharge: Nov & Dec Only Rainfall: 40.66 inches (82% of Average)

2005: Inlet: 458.0 µg/L Outlet: 193.0 µg/L

Annual Discharge: 57,800,000 Gallons Rainfall: 37.45 inches (76% of Average)

2006: Inlet: 454.0 µg/L Outlet: 244.0 µg/L

Annual Discharge: 101,100,000 Gallons Rainfall: 67.11 inches (136% of Average)

2007: Inlet: 276.0 µg/L Outlet: 36.0 µg/L

Annual Discharge: 34,000,000 Gallons Rainfall: 43.33 inches (88% of Average)

2008: Inlet: 338.0 µg/L Outlet: 110.0 µg/L

Annual Discharge: 51,000,000 Gallons Rainfall: 53.69 inches (109% of Average)

2009: Inlet: 439.0 µg/L Outlet: 46.0 µg/L

Annual Discharge: 45,000,000 Gallons Rainfall: 55.60 inches (113% of Average)

2010: Inlet: 176.7 µg/L Outlet: 93.3 µg/L

Annual Discharge: 32,550,000 Gallons Rainfall: 36.67 inches (74% of Average)

2011: Inlet: 188.0 µg/L Outlet: 75.7 µg/L

Annual Discharge: 51,012,000 Gallons Rainfall: 74.85 inches (152% of Average)

2012: Inlet: 196.0 µg/L Outlet: 31.3 µg/L

Annual Discharge: 2,820,000 Gallons Rainfall: 30.06 inches (61% of Average)

2013: Inlet: 78.5 µg/L Outlet: 57.5 µg/L

Annual Discharge: 24,439,000 gallons Rainfall: 60.3 inches (122% of Average)

2014: Inlet: 93.0 µg/L Outlet: 100.0 µg/L

Annual Discharge: 30,663,000 gallons Rainfall: 46.84 inches (95% of Average)

2015: Inlet: 167.0 µg/L Outlet: 71.3 µg/L

Annual Discharge: 42,399,000 gallons Rainfall: 51.77 inches (105% of Average)

2016: Inlet: 218.0 µg/L Outlet: 111.0 µg/L

Annual Discharge: 37,760,800 gallons Rainfall: 49.24 inches (100% of Average)

2017: Inlet: 165.0 µg/L Outlet: 114.0 µg/L

Annual Discharge: 31,345,800 gallons Rainfall: 46.33 inches (94% of Average)

2018: Inlet: 155.0 µg/L Outlet: 50.5 µg/L

Annual Discharge: 45,670,800 gallons Rainfall: 59.46 inches (121% of Average)

2019: Inlet: 230.0 µg/L Outlet: 12.0 µg/L

Annual Discharge: 63,012,000 gallons Rainfall: 49.08 inches (100% of Average)

2020: Inlet: 167.5 µg/L Outlet: 89.0 µg/L

Annual Discharge: 38,828,500 gallons Rainfall: 58.28 inches (109% of Average)

2021: Inlet: 230.0 µg/L Outlet: 150.0 µg/L

Annual Discharge: 34,818,000 gallons Rainfall: 49.38 inches (100% of Average)

2022: Inlet: 175.0 µg/L Outlet: 68.5 µg/L

Annual Discharge: 28,066,500 gallons Rainfall: 45.10 inches (92% of Average)

Observations:

The data reports that the concentration of uranium metal has historically decreased by roughly one-half to three-fourths between the C-613 Sediment Basin inlet and the KPDES Outfall 001 discharge point. The average reduction in uranium concentrations and radionuclide readings for 2022 was roughly 61%, a historically average percentage. From 2003 to 2008, when active scrap metal removal was being performed, the average inlet concentration was 374.0 µg/L. The scrap metal removal project was completed in late 2008 and the area was seeded with native grasses. From 2009 to 2022, concentrations of uranium metal at Outfall 001 have varied from a low of 12.0 µg/L (2019) to a high of 150.0 µg/L (2021).

- **C-613 Sediment Basin Inlet:**

The average inlet concentration in 2022 for uranium was 175.0 µg/L, which is historically average since removal of the scrap metal. The fourteen-year average inlet concentration from 2009 to 2022 was 191.3 µg/L. In 2005, the highest historically reported average inlet concentration was 458.0 µg/L and the lowest to date, in 2013, was 78.5 µg/L.

- **C-613 Sediment Basin Outlet (KPDES Outfall 001):**

The average outlet concentration of uranium metal in 2022 was 68.5 µg/L, which was slightly higher than the fourteen-year (2009 to 2022) average of 59.1 µg/L. The highest reported average outlet concentration was 244.0 µg/L (2006), which was during the scrap metal removal project and before the growth of a vegetative cover. The lowest concentration, 12.0 µg/L, occurred in 2019.

- **Iron Bridge**

The average concentration of uranium metal at the Iron Bridge sampling point in 2022 during the two discharge sampling events was 12.5 µg/L. The concentration of uranium reported at the Iron Bridge non-discharge sampling event performed on September 28, 2022, was 0.7 µg/L. The Iron Bridge sampling point was first integrated into the sample regimen in 2007, and the average concentration of uranium metal in non-discharge events from 2007 to 2022 is 1.4 µg/L.

Conclusions:

The average 2022 discharge event inlet measurement for alpha particles in water was 37.8 pCi/L and the average outlet measurement was 27.8 pCi/L. The average 2022 inlet measurement for beta particles in water was 111.1 pCi/L and the outlet measurement was 73.2 pCi/L. Alpha and beta activity measurements showed an approximate 20-40% decrease between the C-613 Sediment Basin inlet and the KPDES Outfall 001 discharge point. As a percentage decrease in concentrations, these are the lowest recorded decreases since the Sed Basin became operational. The concentration of uranium metal decreased from an inlet average of 175.0 µg/L to an outlet average of 68.5 µg/L, an approximate 61% reduction. Analytical results for uranium metal from the Iron Bridge sampling point reported concentrations approximately 18 times higher for uranium metal as compared to the outlet results during discharge events (12.5 µg/L) as compared to the non-discharge event results (0.7 µg/L). Average concentrations of alpha particles as compared from the outlet (27.8 µg/L) during discharge events to the Iron Bridge (9.8 µg/L) during non-discharge events were roughly 3 times higher. Average concentrations of beta particles as compared from the outlet (73.2 µg/L) during discharge events to the Iron Bridge (3.36 µg/L) during non-discharge events were roughly 22 times higher.

Analysis of the data reported that uranium metal continues to be released during discharge events, which warrants continued oversight and management of on-site storm water. Based on data analysis and field observations, AIP concludes that former Scrap Yard storm water runoff, building demolition and remedial investigation activities contribute to the off-site migration of metals and radionuclides. Interpretation of this data has determined that the Sediment Basin continues to serve its function by reducing the off-site migration of concentrations of metals, suspended solids and radionuclides. Analytical data collected during 2022 reported percentage reductions from inlet to outlet concentrations of 55% for uranium metal, 25% for alpha particles, and 30% for beta particles. These percentage reductions in radionuclide concentrations in the past few years have been trending lower, as past reductions have been approximately one-half to two-thirds. Based on the observed lower percentage reduction in concentrations, AIP has concerns as to the amount of sediment that has precipitated into the Sed Basin during its over eighteen years of operation. High concentrations of radionuclides in the precipitated sediment may be impeding additional sediments from precipitating. AIP recommends that DOE collects a rough measurement of the accumulated sediment thickness that could be used to calculate the approximate volume of sediment in the C-613 Sediment Basin. Even with reduced precipitation, the AIP continues to believe that the C-613 Sediment Basin is performing as designed and should continue operation.

Radiation Health Branch AIP Sampling

The RHB has a robust environmental monitoring program, funded by the AIP, designed to ensure that there is no danger to public health from PGDP's radionuclide releases to groundwater, surface water, or air. In 2022, RHB collected 1,430 samples and performed 1,000 analyses on samples collected by RHB, plus 421 analyses on samples collected by EEC.

Groundwater

RHB monitors groundwater by routinely collecting quarterly samples at 10 residential wells surrounding the site (Figure 10). Each sample is analyzed for gross alpha/beta counting and gamma spectroscopy. If gross alpha equals or exceeds 5 pCi/L and/or gross beta equals or exceeds 9 pCi/L, then technetium-99 is also analyzed.

The majority of the locations are private drinking water wells that are potentially impacted by the TCE and Tc-99 plumes travelling off the site. These wells are no longer used for drinking water. RHB continually evaluates the results from this activity, along with results from third party activities and activities at the site, to determine the need for additional monitoring locations or modification of current locations.

In 2022, there were no abnormal measurements from RHB groundwater monitoring efforts.

Surface Water

RHB AIP monitors surface water by taking quarterly samples at 28 locations surrounding the site and through continuous sampling at an additional 4 locations (Figure 11). Note: Sampling locations are labeled “ISCO” due to the brand name of the samplers that are used. Gross alpha/beta analysis and isotope specific analyses are performed on the samples, with the ISCO samples being collected and composited over 21-day periods.

The locations for surface water monitoring were selected based on outfalls from the site, locations of known runoff from contaminated areas, and historical sampling locations. The background locations are located upstream in Bayou Creek (ISCO B and BBCUG), upstream in Little Bayou Creek (LBCUG), upstream of the C-746-K Landfill (UPC746K), and approximately 5 miles to the southeast on Massac Creek (a known unimpacted local waterway, not shown on map).

In 2013, elevated levels of uranium were found leaving the C-746-U solid waste landfill in surface water. This contamination was determined to be sourced from recently removed C-340 paneling that had high levels of surface contamination by a mobile uranium compound (likely UO_2F_2, uranyl fluoride). In response, RHB AIP began monitoring points in the discharge path from C-746-U, beginning in August 2013, to ensure that effluent

release limits were not exceeded. These levels have naturally decreased with time and have been well below the effluent release limits. During the fourth quarter of 2015, DOE implemented treatment on C-746-U discharges, significantly lowering the levels of contamination. Future results are expected to be comparable to background at current landfill inventory, but monitoring will continue.

In 2022, there were no abnormal measurements from samples collected at RHB AIP surface water monitoring locations.

Air

RHB AIP monitors air by taking continuous samples at 10 locations surrounding the site (Figure 12), collected at 21-day periods. A gross alpha/beta analysis is performed on each filter, and the filters are composited quarterly for isotope specific analyses.

The locations for air monitoring were selected based on prevailing winds at the plant and expected release points/types from the plant (Figure 13). The background location is approximately three miles southeast of the plant at the Barkley Regional Airport (not shown on map) and is > 90 degrees offset from prevailing winds. RHB continually evaluates the results from this activity, along with results from third party activities and other activities at the site, to determine the need for additional monitoring locations or modification of current locations.

In 2022, there were no observed abnormal measurements from RHB AIP air monitoring efforts.

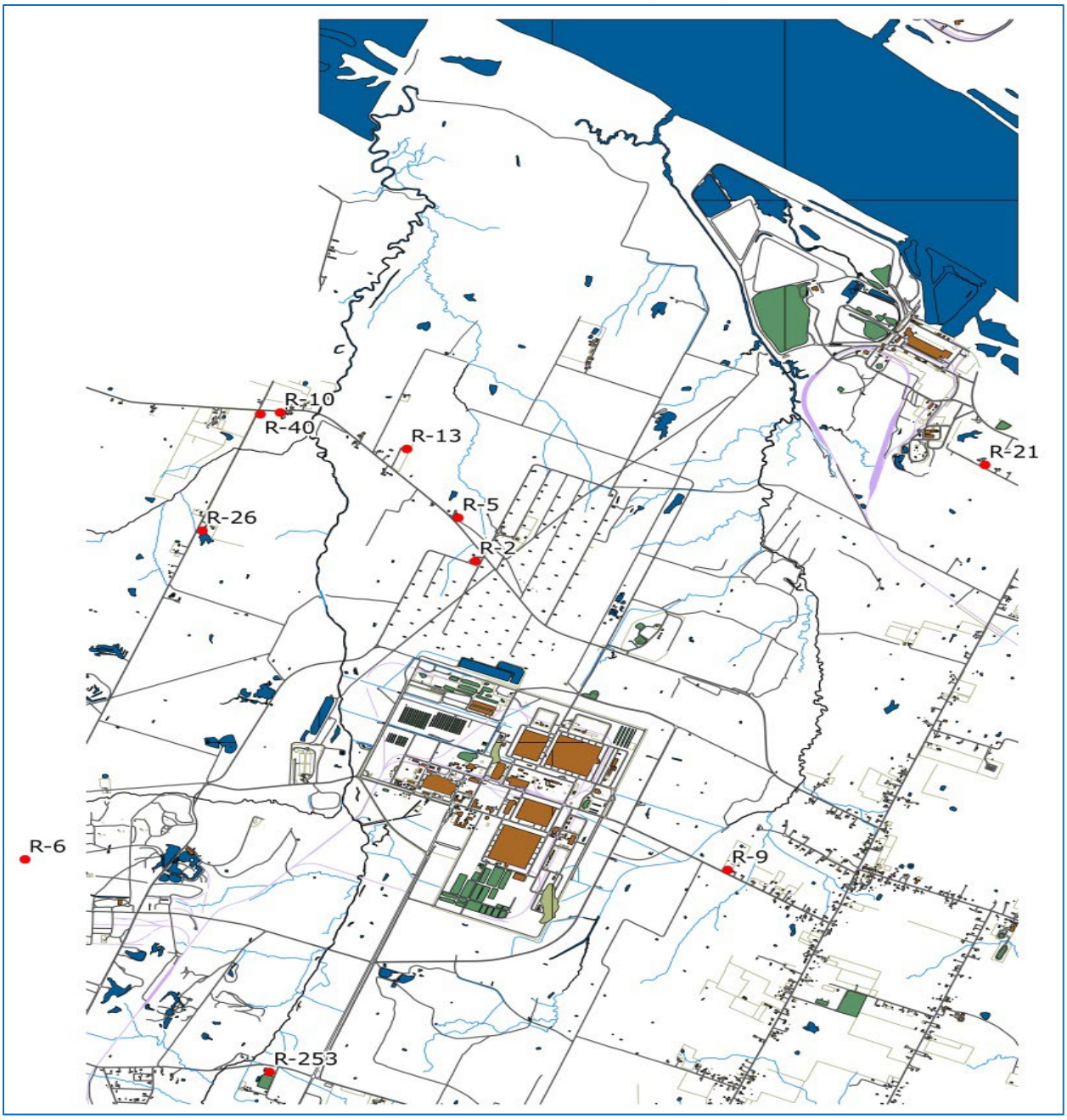

Figure 10. RHB AIP 2022 Groundwater Monitoring Locations

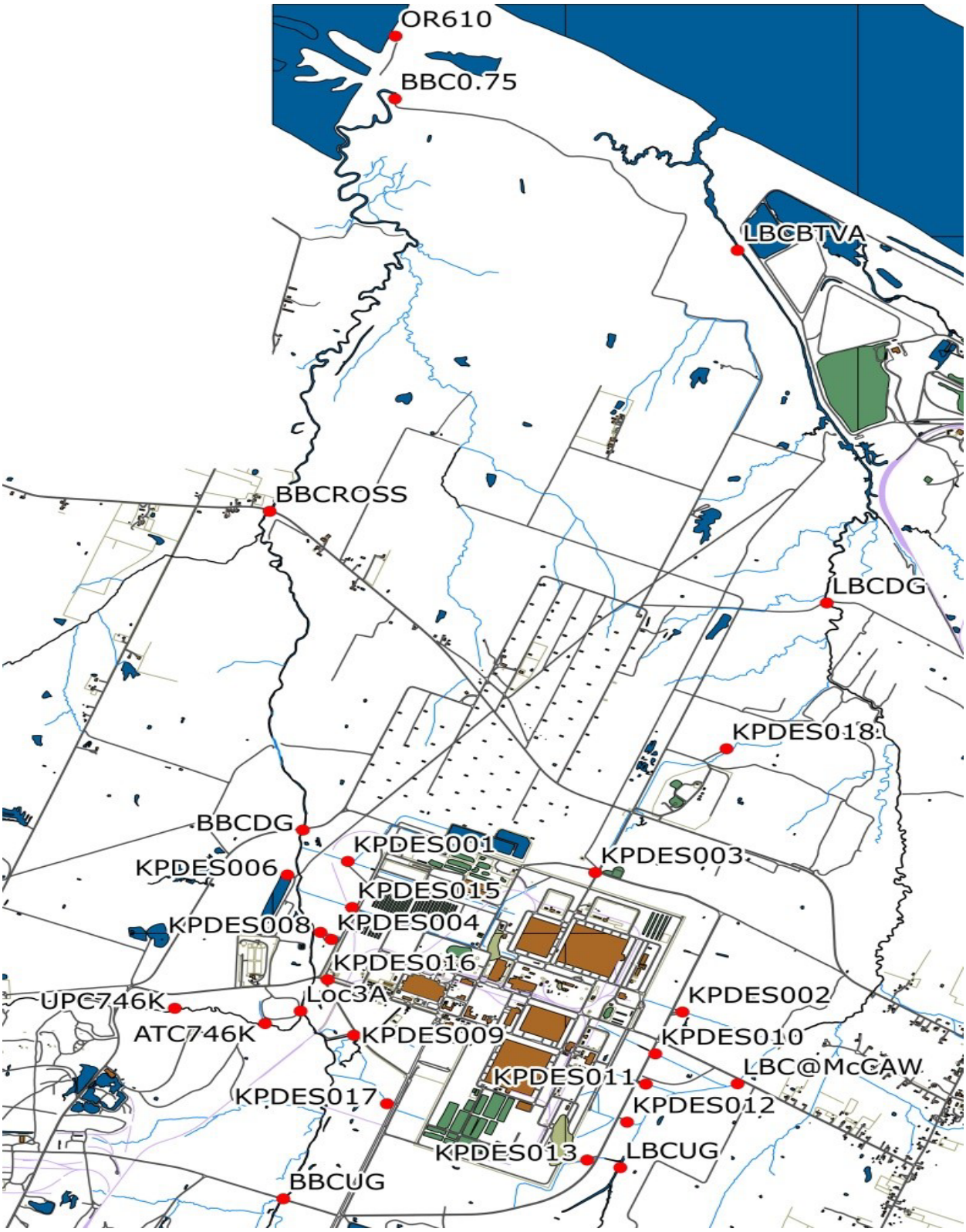

Figure 11. RHB AIP 2022 Quarterly Surface Water Sampling Locations

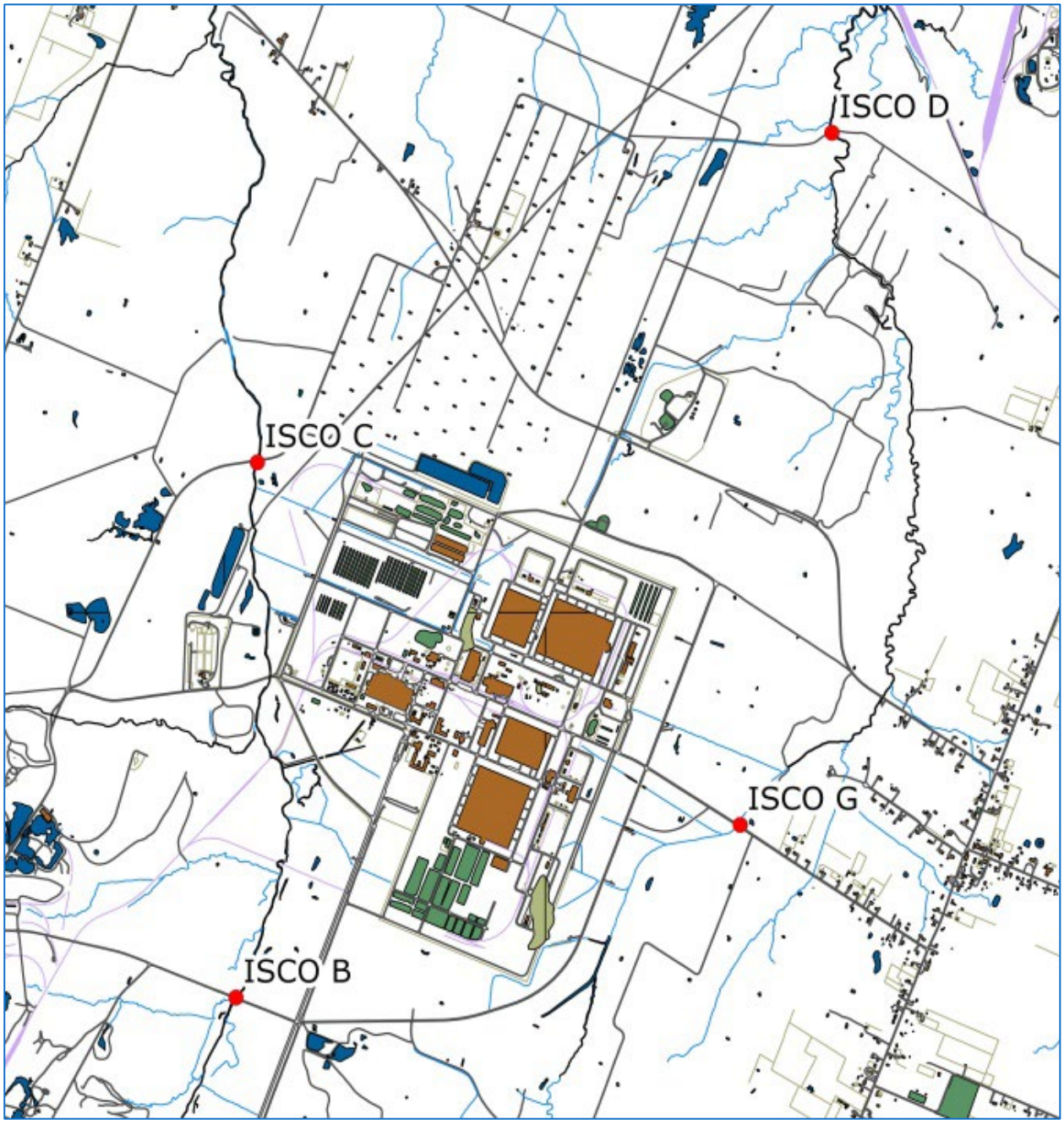

Figure 12. RHB AIP 2022 ISCO Sampling Locations

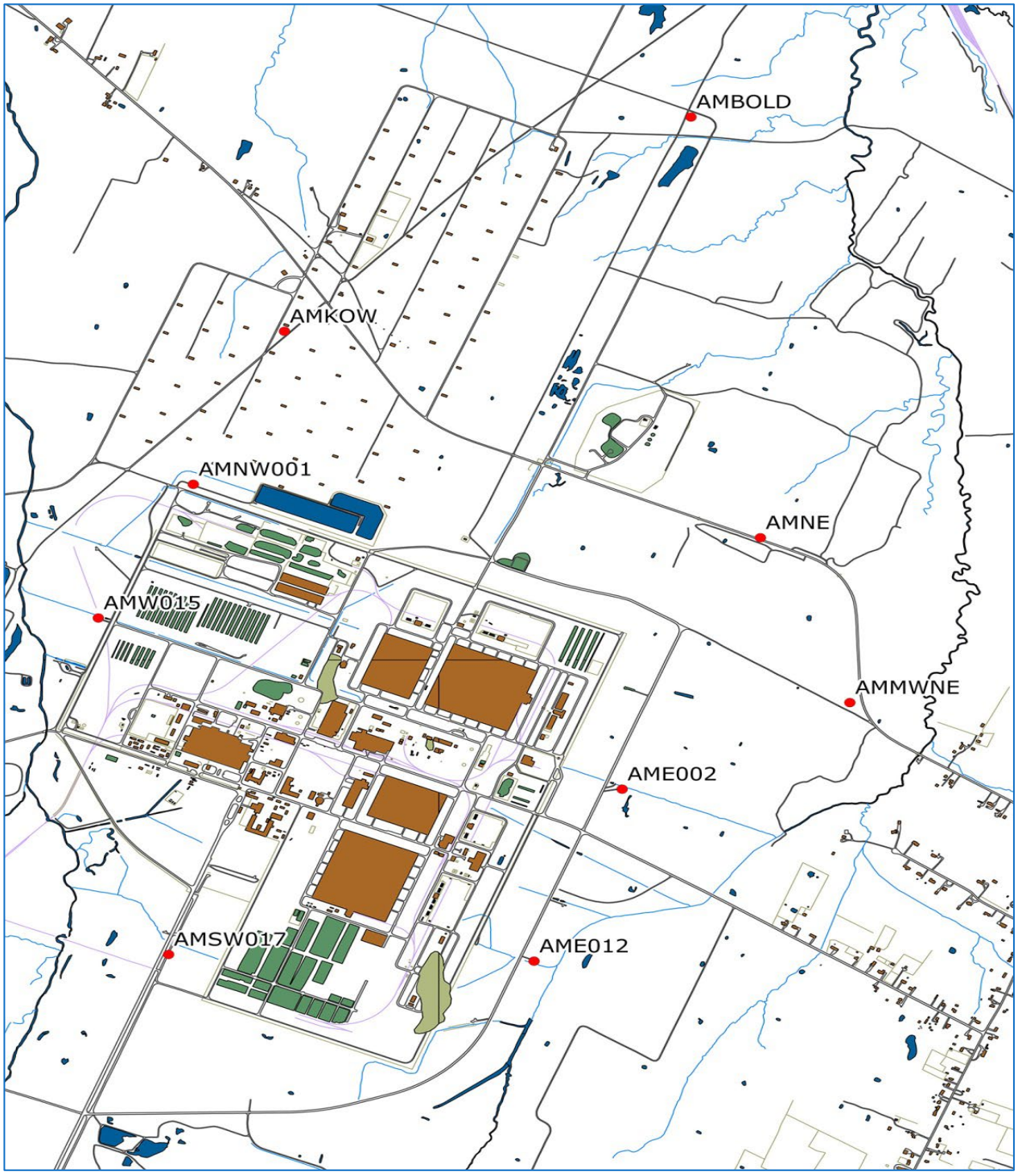

Figure 13. RHB AIP 2022 Air Monitoring Locations

Additional Oversight Activities

During 2022, DWM AIP staff routinely observed portions of the PGDP reservation on a weekly basis. Locations within the Limited Area that were routinely observed included areas adjacent to the process buildings (C-310, C-331, C-333, C-335, C-337), the C-400 Maintenance Facility and groundwater treatment unit, the C-600 Steam Plant and natural gas boilers, former scrap metal yards, cylinder yards, process and sanitary wastewater treatment facilities, the C-404 Landfill, and burial grounds. Areas outside of the Limited Area observed weekly included wastewater lagoons, the Northeast and Northwest Plume Pump-and-Treat Units, the C-613 Sedimentation Basin, the K-Landfill, the water treatment plant and sedimentation ponds, and plant outfalls (001, 002, 006, 008, 009, 010, 011, 012, 013, 015, 016, 017). No significant issues requiring DOE's attention were noted during any oversight activity in 2022. The following is an abbreviated list of oversight activities completed in 2022:

- Approximately 6,875 nickel ingots are stored on-site near the C-746-A Warehouse. About 50 of the ingots contain trace amounts of asbestos. The nickel ingots were observed twice in 2022 to ensure that they are completely covered with the required tarps.
- The C-746-U Landfill was visited on a weekly basis during the year. The specific areas of the landfill that were observed included the landfill working face, the leachate collection building, the sedimentation basin, Outfalls 019 and 020, and the closed S & T Landfill.
- A total of 7,705 monitoring well evaluations were completed. The components assessed during an evaluation include the well padlock, outer casing condition, protective bollards, the concrete pad and overall accessibility.
- 24 Regulatory Notifications were submitted to the Division and were acknowledged by the KDWM in 2022. Surveillances of activities in the SWMUs designated in the submitted Regulatory Notifications were routinely conducted on a weekly basis for proper management of SWMU material and spoils.

- Construction activities of a new TVA switchyard at C-755-N and associated transmission lines into the limited area were observed to ensure proper storm water runoff controls were installed and maintained throughout the project to minimize offsite mobilization of sediments.
- Monitoring of equipment removal from C-331, C-333, C-335, and C-337 associated with the deactivation of the process buildings was conducted as part of the weekly observation activities.

Kentucky FFA Program Elements for 2022

Surface Water Operable Unit

Surface Water Operable Unit (SWOU)

DOE reprioritized the Surface Water Operable Unit to an out-year activity after DOE's near-term priority became the C-400 Complex OU. The SWOU is comprised of thirty (30) Solid Waste Management Units (SWMUs) and Others (Outfalls 017, 018, 019/020 and SWMU 526 and associated ditches). These SWMUs have likely contributed significant contamination to the creeks and outfalls that receive surface water runoff from the PGDP. This potential to affect off-site waterways is one of the main reasons for the prioritization of investigative and removal actions.

During uranium enrichment operations, the Paducah Site used approximately 20 million gallons of water daily which was pumped from the Ohio River. After active enrichment operations ceased on July 25, 2013, the PGDP began using significantly less water. After use, water is discharged via unlined ditches through outfalls and into Little Bayou and Bayou Creeks. These two creeks converge and ultimately discharge back into the Ohio River. The Kentucky Division of Water regulates these outfall discharges under one Kentucky Pollutant Discharge Elimination System (KPDES) permit. Waters discharged through these Outfalls include storm water runoff, treated groundwater from pump-n-treat systems, process wastewater, cooling wastewater, sediment basin discharge water and sanitary wastewater.

DOCUMENTS REVIEWED IN 2022

No Surface Water Operable Unit documents were received or reviewed in 2022.

C-400 Complex Operable Unit (C-400 OU)

The C-400 Complex (C-400 OU) is a new OU established in a *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the PGDP*, which was signed on August 8, 2017. This agreement was incorporated into the 2020/2021 Site Management Plan (SMP). The C-400 OU is comprised of seven SWMUs, of which more may be added if new SWMUs are discovered during investigation, deactivation or demolition activities.

Field work commenced with drilling activities which began on March 2, 2020, but were ceased on March 25, 2020, due to the COVID-19 pandemic. Field work was resumed on August 3, 2020, and boring and sampling activities were completed on December 2, 2021.

C-400 Investigatory work was shared and discussed during weekly groundwater update calls. Work performed during the previous week was shared via virtual meetings. Analytical results, along with Membrane Interface Probe (MIP) and DyeLIF (Light Induced Fluorescence) graphs, were routinely posted to a shared website as soon as data was received by DOE. This information was used to update shared maps and figures which could be shared with the group. Typically, DOE would propose the location and sampling intervals of contingency borings for the next week's allotment of work, and the proposals would be approved or discussed and revised as agreed upon by all three FFA parties. A set number of contingency borings had been included within the RI/FS Work Plan for utilization once the primary phase of investigation was completed.

DOCUMENTS REVIEWED IN 2022

No C-400 Complex Operable Unit documents were received or reviewed in 2022.

Originally, the C-400 Complex RI/FS Report was to be submitted in the latter part of 2021, but it was agreed to postpone submittal until January 5, 2023, to allow for incorporation of information related to demolition of the building.

Groundwater Operable Unit

Northeast Plume Containment System (Pump-and-Treat)

The Northeast Plume Containment System was installed to remove and treat groundwater from the higher concentration portions of the Northeast Plume. The system consists of extraction wells EW234 and EW235 and their respective water treatment units C-765 and C-765A. The treatment units each contain an air stripper, which treats the water to less than the effluent concentration goal of 30 ppb TCE. Once treated, the water from each unit is piped to a reservoir and discharged to KPDES Outfall 001, which flows to Little Bayou Creek.

In 2022, the Northeast Plume extraction wells EW234 and EW235 pumped 79,158,639 gallons of water, which resulted in the removal of 11.0 gallons of TCE. Northeast Plume pumping operations began on February 28, 1997. As of December 31, 2022, the system had extracted approximately 2,175,384,677 gallons of groundwater, and 371 gallons of TCE has been cumulatively removed. An operational chart of the Northeast Plume Containment System reports both the operational efficiency and gallons of water treated during each month in 2022 is presented below.

Month	Percent Operational		Gallons	Month	Percent Operational		Gallons
	C-765	C-765-A			C-765	C-765-A	
January	0.0	100.0	3,344,838	July	99.9	100.0	7,809,910
February	0.0	100.0	3,026,582	August	99.6	99.8	7,785,704
March	11.7	99.9	3,759,716	September	100.0	92.5	7,431,897
April	99.8	99.9	7,606,603	October	99.2	99.9	7,771,523
May	99.7	98.9	7,766,660	November	99.9	99.9	7,552,713
June	99.9	99.9	7,551,206	December	99.8	100.0	7,751,287

Table 6. 2022 Northeast Plume Containment System Operation Data

During 2022, the Northeast Plume Interim Remedial Action Optimization Project continued, with the adjustment of extraction well pumping rates and quarterly monitoring of seven (C-400) transect wells. Each sentinel transect well is spaced ~200 feet apart and located approximately 800 feet east of the C-400 building. Transect wells are monitored quarterly for volatile organic compounds (VOCs) and Tc-99 and results are compared to background (pre-pumping) concentrations to provide an early warning if TCE or Tc-99 is pulled east (away) from the C-400 area by the two optimized extraction wells. If concentration trends significantly increase over time, the FFA parties will meet to develop a solution before TCE or Tc-99 can spread by migrating eastward toward the two new extraction wells.

The FFA senior parties signed an MOA in 2015 which outlined actions that would be taken to prevent the extraction wells from causing or contributing to the undesirable expansion of TCE and Tc-99 from C-400 within the NE Plume. The quarterly 2022 sampling results for TCE concentrations continued to increase in some transect wells. Quarterly sampling of the transect wells will continue to monitor if optimization efforts are mobilizing contaminants away from the C-400 area.

Northeast Plume Optimization Documents Reviewed In 2022:

Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action (DOE/LX/07-2470&D1). Both the EPA and KDWM approved the D1 version on March 10, 2022.

Northwest Plume Containment System (Pump-and-Treat)

The Northwest Plume Containment System was installed to remove and treat groundwater from higher-concentration portions of the Northwest Plume. The system is located at the plant's northwest corner and consists of two extraction wells and the C-612 water treatment facility. The Northwest pump-and-treat system was optimized in 2010 and a major refurbishment and upgrade of the C-612 water treatment system was completed in early 2016. In 2022, the Northwest Plume System pumped 92,250,274 gallons of water from extraction wells EW232 and EW233, which resulted in the removal of 59.7 gallons of TCE. Northwest Plume pumping operations began on August 28, 1995.

During that time, the system has extracted 2,728,368,258 gallons of groundwater, and approximately 3,992 gallons of TCE has been cumulatively removed. An operational chart of the Northwest Plume Containment System reports both the operational efficiency and gallons of water treated during each month in 2022 is presented below:

Month	Percent Operational	Gallons	Month	Percent Operational	Gallons
January	99.5	8,731,196	July	97.5	8,321,270
February	74.4	5,954,840	August	99.9	4,916,230
March	97.2	8,647,070	September	99.5	4,720,130
April	99.0	8,539,212	October	100.0	8,398,478
May	97.5	8,743,838	November	97.8	8,275,670
June	99.8	8,441,520	December	98.7	8,560,820

Table 7: 2022 Northwest Plume Groundwater System Operation Data

Northwest Plume Groundwater System Documents Reviewed In 2022:

No Northwest Plume documents were received or reviewed in 2022.

Southwest Plume Sources

SWMU 1 C-747-C Oil Landfarm

A deep soil mixing remedial action using a large (8-ft) diameter auger, followed by steam with vapor extraction/treatment and zero-valent iron injection was completed in 2015 at the SWMU 1 Oil Landfarm. The purpose of the project was to remove organic solvents (primarily TCE) from 258 soil columns to a depth of approximately 60 feet bgs. The remedial action recovered 24 +/-12 gallons of VOCs during operation. Passive treatment using zero-valent iron (ZVI) may still be occurring. Semi-annual sampling of SWMU 1 monitoring wells was performed to monitor the continuing effects of the ZVI. Table 8 displays trend analysis of several VOCs. Trend determinations were made by evaluating data from samples collected during 2020, 2021 (both not shown on Table), and 20221. Determinations are somewhat subjective, especially when considering the limited time

span and data set. Concentrations of TCE in samples collected from MW161 have primarily ranged between 200-300 µg/L, but have fluctuated between a low of 77.9 and a high of 407 µg/L during the three-year period. Concentrations of 1,1-DCE have consistently remained below the MCL, while Vinyl Chloride (VC) has not been detected at detection limits of either 1 or 5 µg/L. Concentrations of TCE in MW542 were below 2 µg/L in all samples collected during the three-year period with the exception of a result of 38.6 µg/L from one sample collected during 2022. Concentrations of 1,1-DCE have all been non-detect (ND) during the three-year period. Vinyl Chloride concentrations are labeled as "Stable" as concentrations during the last four sampling events have been non-detect, while concentrations in the two samples collected during 2020 were less than 2 µg/L. Concentrations of TCE during the period from 2020-2022 were all under 4 ppb with the exception of one sample obtained during 2022 having a concentration of 70.3 ppb, a significant temporary rise. Samples of 1,1-DCE remained non-detect at a detection limit of 1 ppb in 2022, while concentrations of VC continued a declining trend.

TCE concentrations in MW544 continued a fluctuating trend in 2022, with one sample being nearly seven times higher than the other sample. Concentrations began at 105 µg/L, more than doubled to 236 µg/L, then ranged between 129-116 µg/L for three events before falling to a low of 23.5 µg/L. Concentrations of 1,1-DCE remained stable, as both samples collected during 2022 were non-detect at a detection limit of 1 ppb. Five consecutive samples collected from the start of the three-year period were between 2 and 3 ppb, so the trend could also be described as reducing, albeit a small numerical difference. Concentrations of VC in 2022 ranged from 9.83 ppb to non-detect at 1 ppb, a nearly identical pattern to the two previous samples collected in 2021. Of the two samples collected from MW545 and analyzed for TCE, concentrations from one event were similar to results from the previous two years. However, one sample was an anomaly at 18 ppb. Concentrations of 1,1-DCE and VC were all non-detect at a detection limit of 1 ppb. Both TCE samples collected from MW546 were within the range of the highest and lowest detections from the 2020 and 2021 sampling events. One sample was the next to lowest detection during the three-year evaluation period, while the other sample was over twice the concentration of the first sample. Thus, the patten is considered as still fluctuating. Concentrations of 1,1-DCE were similar to the previous two years sampling results, while

the two VC samples were outside the range of concentrations detected during sampling in 2021. Thus, concentrations of VC in MW546 are considered as fluctuating. The first sample collected from MW547 in 2022 contained the lowest concentration of TCE found during the 2020-2022 period. However, the second sample contained TCE at a higher concentration than both samples collected during 2021. Concentrations of 1,1 -DCE remained within several (less than 8) ppb of samples collected since the beginning of 2020, while concentrations of VC remained non-detect.

Well #	Sample Date	TCE µg/L	TCE[1] Conc. Trend	1,1-DCE µg/L	1,1-DCE[1] Conc. Trend	VC µg/L	VC[1] Conc. Trend
MW161 (DG)	5/9/22	216.0	Fluctuating	1.12	Stable	1 U	Stable
	6/5/22	407.0		5 U		5 U	
	12/11/22	77.9		0.76 J		1 L, U	
MW 542 (DG)	6/5/22	38.6 Y1	Stable	1 U	Stable	1 U	Stable
	12/11/22	1.31		1 U		1 L, U	
	12/11/22	1.81		1 U		1 L, U	
MW 543 (UG)	6/5/22	70.3 Y1	Fluctuating	1 U	Stable	3.93	Reducing
	12/11/22	1.68		1 U		1 L	
MW544 (UG)	6/5/22	113 Y1	Fluctuating	1 U	Stable	9.83	Stable
	12/11/22	15.8		1 U		1 L, U	
MW545 (DG)	6/5/22	18 Y1	Stable	1 U	Stable	1 U	Stable
	12/11/22	1.49		1 U		1 L, U	
MW546 (SG)	6/5/22	170 Y1	Fluctuating	2 U	Stable	110.0	Fluctu-ating
	12/11/22	82.8		2.06		223.0	

MW 547 (DG)	6/5/22	743 Y1	Fluctuating	10.2 J	Stable	20 U	Stable
	12/11/22	914.0		7.1		1 L, U	

Table 8. SWMU 1 C-747-C Oil Landfarm TCE, 1,1-DCE and VC Concentrations

[1]Trend determinations were made by evaluating all sampling data collected from January 2020 through December 2022

Bold red numbers = result above MCL of 5 ppb for TCE, 7 ppb for 1,1-DCE and 2 ppb for VC

Bold blue numbers = laboratory detection limit above MCL

U = Not detected above listed detection limit
D = Analyzed at higher dilution
DG = Downgradient
J = Estimated
L = LCS and/or LCSD recovery outside of control limits
SG = Sidegradient
UG = Upgradient
Y1 = MS/MSD recovery outside acceptance criteria

SWMU 211-A and 211-B (C-720 sites)

An investigation of RGA groundwater conducted in 2015 found TCE concentrations at SWMU 211-A in the upper RGA, indicating an upgradient UCRS source that possibly originating under the C-720 building or from SWMU 211-B. The investigation concluded that the conceptual site model (CSM) for SWMU 211-A is valid, and the DOE recommended implementing bioremediation and long-term monitoring. The CSM for SWMU 211-B was found to be invalid because of analytical results indicating that DNAPL is likely nearby. The Southwest Plumes Sources ROD only addresses VOCs in UCRS soils and corresponding shallow groundwater. The three parties agreed that enhanced bioremediation would be effective even against higher VOC concentrations associated with DNAPL-like concentrations known to exist in the upper RGA.

The *Remedial Action Work Plan for SWMU 211-A Enhanced* In Situ *Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume* (DOE/LX/07-2443&D2/R2) was approved by EPA and KDEP in December of 2021.

Remedial action work at SWMU 211-A began on March 8, 2022, and was completed by October 10, 2022. Thirty-three injection wells were installed in SWMU 211-A. Hydraulic fracturing was conducted within each well at numerous intervals approximately 3-4 feet apart. Each fracture was filled with sand, zero-valent iron, and guar gel. Following installation of the injection wells, secondary injection wells (generally three) were installed within five feet of each well. Emulsified vegetable oil and dehalococcoides bacteria were injected into each secondary injection point to promote degradation of TCE and other VOCs. Performance monitoring wells and long-term monitoring wells were also installed as part of the project and will be periodically sampled to assess remedial performance.

While field work activities were being conducted, DOE provided weekly updates to KY and EPA so the FFA partners could stay informed on progress, approve of any necessary deviations from the work plan, and discuss any problems or issues that arose during the work.

An issue reoccurring during this project was injection materials coming to the surface during fracturing at some of the well locations. In those cases, the well locations were moved slightly or additional material was injected into an adjacent well to ensure proper

coverage of the treatment area. In one instance, emulsified vegetable oil entered the storm sewer system during injection and caused white discoloration of the water draining through the Outfall 008 ditch. The EVO was contained by the oil control structures of the Outfall 008 drainage system prior to discharge into Big Bayou Creek.

While field work activities were being conducted, DOE provided weekly updates to KY and EPA so the FFA partners could stay informed on progress, approve of any necessary deviations from the work plan, and discuss any problems or issues that arose during the work.

Southwest Plume Sources Documents Reviewed in 2022:

Due to field activities extending into October, the Remedial Action Completion Report was not due and received until January, 2023.

Remedial Action Work Plan for SWMU 211-A Enhanced In Situ *Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume* (DOE/LX/07-2443&D2/R2), Public Notice, dated January 24, 2022. DOE Notification of Field Start was received on March 8, 2022.

Burial Grounds Operable Unit

The historic generation of various types of waste materials at the PGDP led to on-site subsurface disposal in areas referred to as Burial Grounds (Figure 14). The Burial Grounds Operable Unit is comprised of 10 such areas that are designated by their respective SWMU numbers: the C-749 Uranium Burial Ground (SWMU 2); the C-404 Low-Level Radioactive Waste Burial Grounds (SWMU 3); the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4); the C-746-F Burial Yard (SWMU 5); the C-747-B Burial Grounds (SWMU 6); the C-747-A Burial Grounds and Burn Area (SWMU 7); the C-746-S Landfill (SWMU 9); the C-746-T Landfill (SWMU 10); the C-747-A Burial Grounds and Burn Area (SWMU 30) and the Residential/Inert Landfill Borrow Area (P-Landfill) (SWMU 145).

BGOU Documents Reviewed in 2022:

No Burial Ground Operable Unit documents were reviewed in 2022.

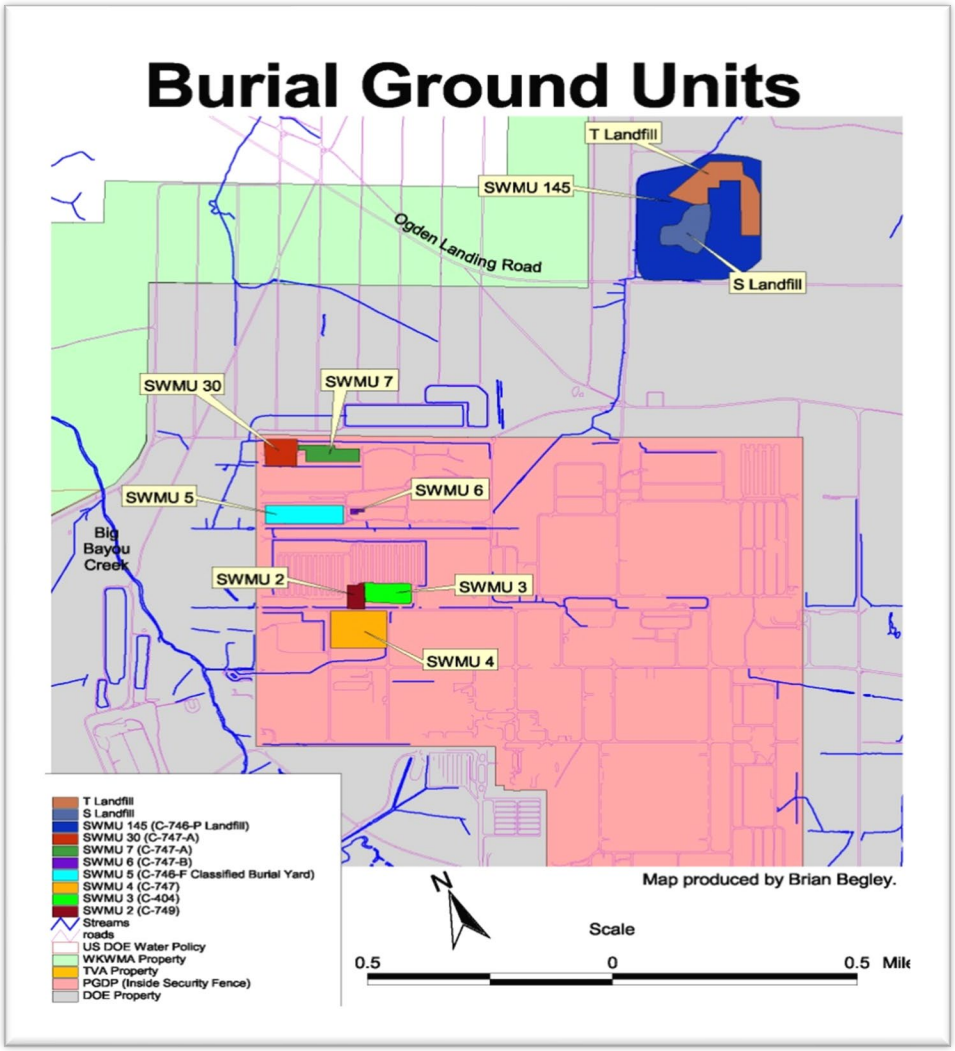

Figure 14. Burial Ground SWMUs

Soils Operable Unit

There are currently 72 SWMUs in the Soils Operable Unit. A major objective of the Soils OU investigations is to determine the nature and extent of contamination in the soils to a depth of 10 feet below grade surface.

Soils Operable Unit Documents Reviewed in 2022:

No Soils Operable Unit documents were reviewed in 2022.

Decontamination and Decommissioning Operable Unit

The pre-GDP D&D OU has addressed 17 inactive facilities at the Paducah site, some of which have been out of service for decades. The C-410/420 Complex was the last of the inactive facilities to be addressed under this OU. The scope of the pre-GDP shutdown D&D OU has been completed.

No D&D Operable Unit documents were reviewed in 2022.

Waste Management

Waste Disposition Alternatives (WDA) Project

Over the next several decades, large quantities of waste will be generated at the Paducah Site. Much of this waste will be in the form of concrete, structural steel and decommissioned equipment that will require disposal following decontamination and decommissioning of large process buildings. Lesser volumes of waste will be created as contaminated soils and burial grounds are remediated. As much as 4.6 million cubic yards of waste are projected to be generated at the Paducah site during the remaining course of site cleanup. Where this waste will eventually be disposed of is the subject of a CERCLA waste disposal alternatives feasibility study.

The WDA Feasibility Study evaluates two general disposal options, on-site versus off-site disposal. Since it is somewhat uncertain how much waste will actually require disposal, both the on-site and off-site alternatives are further broken down into subcategories based upon certain assumptions. The base case sub-category assumes that some of the waste generated will go to an existing on-site solid waste landfill. The high-volume sub-category

assumes that this landfill will not be available for use and that all waste will require disposal in a new on-site cell or disposition in an off-site landfill. An on-site repository would allow for safe disposal of non-hazardous, hazardous, TSCA, low-level radioactive and low-level radioactive mixed wastes on-site, thereby avoiding more expensive off-site disposal options. However, the option to ship a portion or all the waste off-site to a DOE owned or commercial waste facility still exists.

Waste Disposition Alternatives Documents Reviewed in 2022:

No CERCLA Waste Disposal Alternatives Evaluation documents were reviewed in 2022.

Solid Waste Management Units (SWMUs)

During the reporting period from January 1 to December 31, 2022, Kentucky received one newly discovered SWMU and four revised Solid Waste Management Unit Assessment Reports (SARs).

SWMU Number	Description	OU Location	Sub-project	Status	SAR Report Date	Date(s) SAR Amended	Date of RFI
7	C-747-A Burial Ground	BGOU	Remedial	RFI	8/24/1987	11/17/2022	8/24/1987
88	C-635 Pumphouse and Cooling Tower	Soils & Slabs OU	N/A	RFI	8/24/1987	12/23/2022	8/24/1987
220	OS-09	Soils & Slabs OU	N/A	RFI	12/6/2000	7/29/2022	4/14/2004
419	G-752-C Decontamination Facility	N/A	N/A	NFA	11/6/2000	4/14/2022	N/A
574	C-709-A Acid Neutralization Vault	Soils & Slabs OU	N/A	RFI	1/10/2022	N/A	1/13/2022

Table 9. Revised and Newly Discovered SWMU Assessment Reports Submitted to Kentucky Between January 1 and December 31, 2022

SWMU Number	Description	(Former) OU Location	(Former) Sub-project	Status	SAR Report Date	Date(s) SAR Amended	Date of NFA
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 10. Solid Waste Management Units that Kentucky Granted No Further Action Status Between January 1 and December 31, 2022

SWMU DOCUMENTS REVIEWED IN 2022

In 2022, four SAR Revisions and one newly-discovered SWMU was submitted. The newly discovered SWMU was assigned to the Soils and Slabs OU. At the end of the reporting period, no SARs were under review by the Division.