PFAS Strategic Roadmap:

DOE Commitments to Action 2022-2025

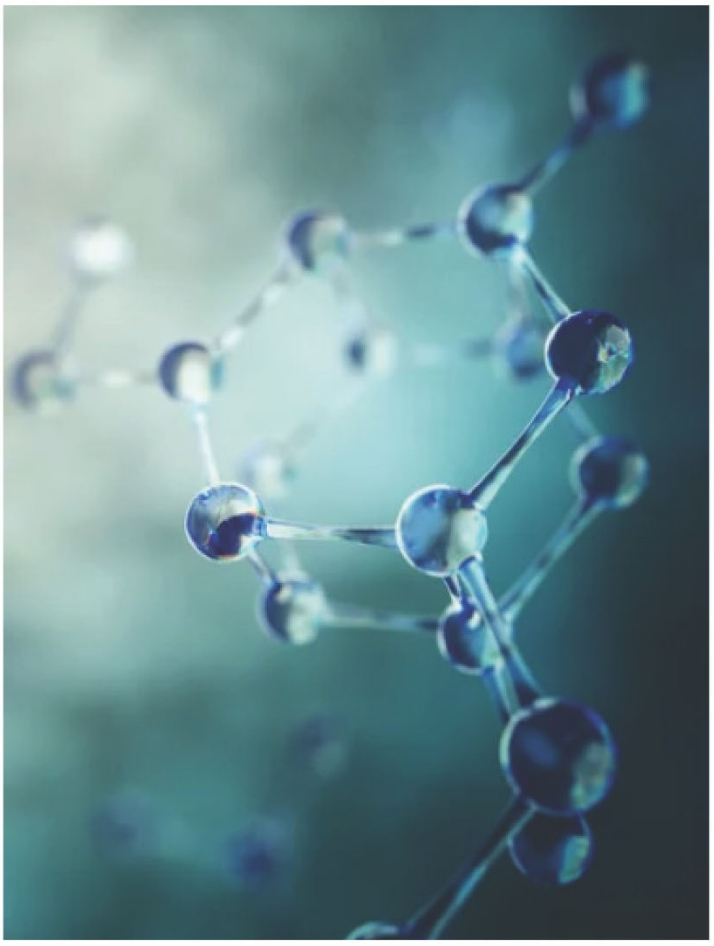

TABLE OF CONTENTS

TABLE OF ACRONYMS 1
INTRODUCTION 2
DEPARTMENTAL PILLARS AND GOALS 3
OBJECTIVES AND PLANNED ACTIONS 4
CONCLUSION 11
ATTACHMENT 1: PFAS COORDINATING COMMITTEE 12
ATTACHMENT 2: RESEARCH AND DEVELOPMENT EFFORTS 13

TABLE OF ACRONYMS

AFFF	Aqueous Film Forming Foam
AI	Artificial Intelligence
ANL	Argonne National Laboratory
BES	Office of Basic Energy Sciences
BNL	Brookhaven National Laboratory
CI	Office of Congressional and Intergovernmental Affairs
CRESP	Consortium for Risk Evaluation with Stakeholder Participation
DOD	Department of Defense
DOE	Department of Energy
ED	Office of Economic Impact and Diversity
EHSS	Office of Environment, Health, Safety and Security
EM	Office of Environmental Management
EMS	Environmental Management System
EPA	Environmental Protection Agency
ESV	Ecological Screening Value
FECM	Office of Fossil Energy and Carbon Management
FY	Fiscal Year
LM	Office of Legacy Management
NE	Office of Nuclear Energy
NNSA	National Nuclear Security Administration
PCC	PFAS Coordinating Committee
PFAS	Per- and Polyfluoroalkyl Substances
PNNL	Pacific Northwest National Laboratory
SC	Office of Science
TJNAF	Thomas Jefferson National Accelerator Facility

INTRODUCTION

The release of per- and polyfluoroalkyl substances (PFAS) into the environment is a topic of growing public health and environmental concern. PFAS are a class of man-made chemicals that have been manufactured and used in a variety of industries since the 1940s. Since then, thousands of chemical formulations have been developed and widely used in manufacturing and processing facilities due to their resistance to grease, water, oil, and heat. PFAS are often found in commercial products such as stain-resistant carpeting, water-resistant clothing, non-stick and grease-resistant food contact materials (e.g., cookware and food packaging), and firefighting foams.

PFAS are exceptionally long-lasting due to the strength of the carbon-fluorine bond. These "forever chemicals" are very persistent in the environment and tend to bioaccumulate in food chains. Because of their breadth of use and environmental longevity, PFAS can be found in surface water, groundwater, soil, and air—from remote rural areas to densely-populated urban centers. A growing body of scientific evidence shows that exposure at certain levels to specific PFAS can adversely impact human health and other living things.

The Department of Energy (DOE) has a unique historic relationship to PFAS, which were first produced on an industrial scale for use in uranium separation activities during the Manhattan Project. PFAS are found in commercial products (notably in firefighting foams) that have been used at DOE sites. The Department is actively researching historic and current uses in its production, research, and fire safety activities to identify applications that may have involved environmental release of PFAS.

Departmental PFAS Mission Statement

Protect human health and the environment by assessing and addressing PFAS at DOE sites while deploying the Department's scientific expertise to solve PFAS challenges.

In recognition of the need for a comprehensive Departmental approach to PFAS, the Deputy Secretary of Energy issued a Departmental policy (Policy) in September 2021. The Policy informs DOE's efforts to minimize or eliminate the use and release of PFAS, to assess, contain, reduce, and/or remove PFAS from the environment, and to protect workers and the public from exposure to PFAS as a result of Departmental operations. The Policy also directs DOE to leverage the expertise of the National Laboratories to advance knowledge about PFAS, its fate and transport in the environment, and innovative research and technology approaches.

This DOE PFAS Strategic Roadmap outlines the Department's overall approach, goals and objectives, and planned actions to assess and manage PFAS risk at DOE sites, and in so doing, to help ensure the protection of human health and the environment.

DEPARTMENTAL PILLARS AND GOALS

All work at DOE begins with a fundamental commitment to protecting human health and the environment. This commitment guides the Department's approach to PFAS, which rests on four pillars and their associated goals:

- **Understand.** Develop information concerning PFAS uses and environmental releases to characterize and assess the Department's potential liabilities and risks.
- **Manage and Protect.** Safeguard the health and well-being of our employees, the public, and the environment by minimizing exposure to PFAS and addressing PFAS releases.
- **Advance Solutions.** Leverage expertise at DOE's National Laboratories and collaborate with research partners to enhance PFAS knowledge and develop technological solutions.
- **Communicate and Collaborate.** Engage with regulators, Tribal nations, local communities, and stakeholders to ensure transparency on DOE's PFAS progress and develop effective PFAS strategies.

OBJECTIVES AND PLANNED ACTIONS

The Department's supporting objectives and actions flow directly from the four pillars of the Roadmap.

Pillar 1: Understand	Goal: Develop information concerning PFAS uses and environmental releases to characterize and assess the Department's potential liabilities and risks

- **Obj. 1 –** Understand the Manhattan Project and Cold War-era sources and volumes of PFAS used and disposed of, with initial focus on uranium processing operations.
- **Obj. 2 –** Assess Aqueous Film Forming Foam (AFFF) releases to the environment from fire suppression systems, firefighter training operations, and emergencies resulting in AFFF use.
- **Obj. 3 –** Identify other PFAS uses and disposal activities associated with research, operations, and equipment maintenance.
- **Obj. 4 –** Understand the presence of PFAS in drinking water and the environment.
- **Obj. 5 –** Catalogue and track current PFAS inventories and uses.

- Action 1.1: Publish "Initial Assessment of PFAS at DOE Sites" (Initial Assessment Report). (Supports all objectives)

  This report is DOE's first broad investigation into the presence of PFAS at DOE sites. Results from this report will inform future data collection activities.

  - Completion date: 4th quarter Fiscal Year (FY) 2022.

- Action 1.2: Publish DOE guidance on historical and current use searches. (Supports all objectives)

  The Initial Assessment Report offers a cursory look at historical and current uses. This action will support the execution of expanded DOE records search efforts described in Actions 1.4 and 1.5. This action also supports completion of Action 1.7.

  - Completion date: 1st quarter FY 2023.

- Action 1.3: Test for PFAS at all DOE-owned water systems, where DOE supplies drinking water to a site, using the most recent U.S. Environmental Protection Agency (EPA) test method (537.1). (Supports Objectives 1 and 4)

Understanding the presence of PFAS in drinking water at all DOE sites is a critical action. Ingestion of drinking water is a primary exposure pathway of PFAS. This action should include periodicity for re-testing when PFAS are detected or as otherwise appropriate.

- Completion dates: Initial testing will be completed 1st quarter FY 2023 (most sites have already completed initial sampling); guidance on retesting to be developed by 4th quarter FY 2023.

- Action 1.4: Complete initial assessment of classified records held at DOE-Germantown and the National Archives-College Park for information regarding PFAS use in nuclear production and research activities in Manhattan Project facilities during the early Cold War. (Supports Objectives 1 and 3)
  - Completion date: 4th quarter FY 2022.

- Action 1.5: Identify relevant records (classified and unclassified) held at DOE sites and Federal Records Centers and complete initial efforts to identify likely PFAS use in historical and current DOE production and research activities. (Supports all objectives)
  - Completion date: Initial effort will be completed 2nd quarter FY 2023. Additional research efforts will continue as needed.

- Action 1.6: Publish environmental sampling guidance to support determining the nature and extent of PFAS releases at DOE sites, following the Data Quality Objectives process. This will establish consistency and robustness when executing site assessments described in Action 1.7. (Supports Objective 4)
  - Completion date: 2nd quarter FY 2023.

- Action 1.7: Perform Site field assessments, as appropriate, and provide an annual site-specific status update to the PCC. (Supports Objective 4)

  As needed and in coordination with their regulatory partners, DOE sites will conduct environmental investigations based on information collected from the Initial Assessment Report and records searches.
  - Completion dates: Initial site status reports completed January 2022, with additional investigations ongoing as appropriate.

- Action 1.8: Publish DOE PFAS Updated Status Report. (Supports all objectives)

  The Updated Status Report will provide a consolidated representation of DOE's potential risk associated with the presence of PFAS at its sites and include updates on addressing the actions identified in this Roadmap. The report will inform future decisions to manage PFAS contamination and protect human health and the environment.
  - Completion date: 1st quarter FY 2025, with additional updates as needed.

Pillar 2: Manage and Protect	Goal: Safeguard the health and well-being of our employees, the public, and the environment by minimizing exposure to PFAS and addressing PFAS releases

- **Obj. 1 –** Minimize risks to the DOE workforce from exposure to PFAS.
- **Obj. 2 –** Reduce potential risk to the public and environment.
- **Obj. 3 –** Restrict procurement and use of PFAS-containing products and identify alternatives.

- Action 2.1: Provide alternative drinking water supply to DOE sites where PFAS is detected in on-site drinking water at concentrations exceeding federal or state regulatory limits. (Supports Objective 1)

  The health of our workforce is a fundamental priority for DOE. Action 2.1 is DOE's response to drinking water information collected as part of Action 1.3.

  - Completion dates: Immediately as needed as drinking water data (Action 1.3) become available.

Remediation at Brookhaven National Laboratory (BNL)

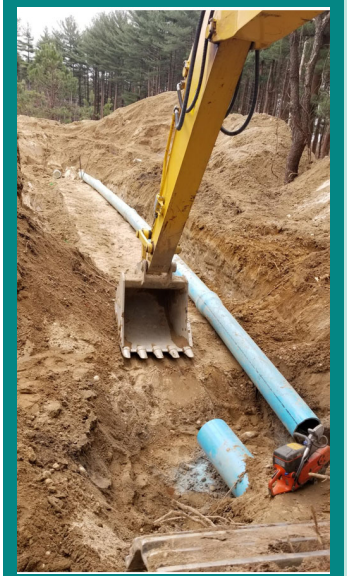

Photo: Installation of underground piping connecting groundwater extraction wells to a PFAS treatment system at BNL.

(Supports Objectives 1 and 2) BNL began addressing PFAS following its detection in three BNL potable water supply wells in 2017. The site has worked closely with regulators and the surrounding community to understand and address PFAS contamination. Recently, a Time Critical Removal Action project was developed to address groundwater contaminated with PFAS that is migrating downgradient of the current and former Firehouse areas. Two groundwater treatment systems are under construction to capture and treat the high concentration plume segments associated with these two source areas. The contaminated water, withdrawn from the aquifer via a series of extraction wells, will be treated using granular activated carbon. The treated water will be discharged into two existing recharge basins. A network of monitoring wells will be installed to monitor the performance of the treatment system and track remediation of the plumes over time.

- Action 2.2: Establish requirements to restrict any non-emergency use of PFAS-containing AFFF, suspend disposal actions unless approved by the head of the program element, require PPE for operations with known PFAS exposure, and report PFAS spills and releases. (Supports Objectives 1 and 2)

  This Action implements the DOE PFAS Policy Memorandum.

  - Completion dates: Memorandum with requirements issued September 2021; reporting guidance issued December 2021.

- Action 2.3: Properly manage and dispose of PFAS-contaminated materials and wastes. (Supports Objectives 1 and 2)

  Support the effective implementation of the Policy by developing internal guidance to inform the ongoing maintenance and use of PFAS-containing systems at DOE facilities, and to support the handling, storage, and disposal of PFAS-contaminated materials and wastes. This will ensure protection of workers, the public, and the environment and reduce potential Departmental liabilities and risks.

  - Completion date: Internal guidance developed 2nd quarter FY 2023 and updated as needed to align with formal regulatory requirements as they are promulgated.

- Action 2.4: Compile, maintain, and share a set of applicable resources to assist DOE sites with identifying and minimizing PFAS risks. (Supports Objectives 1 and 2)

  The Department will identify resources to inform risk management approaches appropriate for use at sites where the presence of PFAS in the environment is found or suspected. The resources will describe tools and methods that are appropriate for characterizing the extent of contamination, assessing the possibility for imminent hazards, and exploring potential means for containment and/or remediation. These resources may also support notification and dialogue with regulators. This action is expected to evolve as regulatory requirements are proposed or issued and as research and approvals advance on PFAS toxicology, treatment, and disposition methods.

  - Completion dates: Initial resource list available 4th quarter 2022, with updates as PFAS technologies and policies evolve.

- Action 2.5: Develop/update procurement guidance to restrict the purchase of PFAS-containing products. (Supports Objective 3)

  The DOE GreenBuy Program[1] provides specific guidelines for avoiding the purchase of PFAS-containing products. The latest guidance is updated to strengthen the PFAS restrictions and align with Executive Order and EPA requirements for purchase of PFAS-containing products.

  - Completion date: GreenBuy Guidance issued 2nd quarter FY 2022, with continued annual updates; additional actions with EPA and Office of Management and Budget ongoing.

- Action 2.6: Issue Departmental Guidance on identifying PFAS and other emerging contaminants as a significant aspect within site Environmental Management Systems (EMSs) as appropriate, perhaps in the framework of the policy/directives changes identified by the PCC. (Supports Objectives 1, 2, and 3)

[1] DOE GreenBuy Award Program for FY 2023 can be found on the FedCenter website under DOE's Sustainable Acquisition Workgroup page: https://www.fedcenter.gov/Documents/index.cfm?id=39200

- Completion date: Coordination with DOE Directives Review Board to begin 4th quarter FY 2022. Specific timelines and tasking are dependent on the identification of final needs.

Pillar 3: Advance Solutions	Goal: Leverage expertise at DOE's National Laboratories and collaborate with research partners to enhance PFAS knowledge and develop technological solutions

- **Obj. 1 –** Leverage the expertise of DOE National Laboratories and research partners to identify and advance research objectives.
- **Obj. 2 –** Coordinate with Federal agencies and research partners to solve challenges.
- **Obj. 3 –** Conduct research and adapt resultant strategies, as needed.
- **Obj. 4 –** Support Department-wide collaboration to enable deployment of solutions for PFAS-related challenges.

- Action 3.1: Publish a PFAS Research Plan that identifies research gaps and establishes DOE research priorities to ensure a coordinated effort across DOE laboratories and other federal research partners. (Supports Objectives 1, 2, and 4)

  Enable coordination and provide direction for DOE's research and development activities led by the national laboratories and other research institutions focused on evaluating promising technological approaches for PFAS detection, separation, destruction, and disposal. Identify deployment opportunities for promising technologies.

  - Completion dates: Initial research plan published 1st quarter FY 2023, with next update by 1st quarter 2025.

- Action 3.2: Engage with interagency partners and external organizations to inform the Department's PFAS research activities and strategy. (Supports Objectives 2 and 4)

  DOE will remain involved with interagency processes coordinated through the White House, collaborate with other appropriate agencies and organizations, and maintain its close coordination with the Department of Defense (DOD), especially on analytical chemistry.

  - Completion date: Ongoing.

- Action 3.3: Advance technologies and applied research at DOE National Laboratories and affiliate research programs. (Supports Objectives 1, 3, and 4)

  DOE National Laboratories and Research Partners are engaged in a range of applied technology development efforts to identify and deploy solutions to PFAS challenges. Some of these efforts are described in Attachment 2.

  - Completion date: Ongoing.

Pillar 4: Communicate and Collaborate	Goal: Engage with regulators, Tribal nations, local communities, and stakeholders to ensure transparency on DOE's PFAS progress and develop effective PFAS strategies

- **Obj. 1 –** Develop publicly-available resources to provide timely updates on Departmental progress in assessing and managing PFAS risks.
- **Obj. 2 –** Ensure effective engagement with community stakeholders, Tribal, state and local governments, regulatory entities, and others.

- Action 4.1: Release a publicly available platform to serve as a central hub and resource center. (Supports Objective 1)

  Establish a centralized DOE PFAS website conveying Departmental information including policies, practices, and updates on engagement opportunities.

  - Completion date: 4th quarter FY 2022.

- Action 4.2: Develop informational materials conveying DOE-wide and site-specific information, including updates on PFAS developments. (Supports Objective 1)

  Identify content to provide timely, substantive updates on PFAS developments at the Department to support site-level and corporate communications efforts.

  - Completion date: Ongoing.

- Action 4.3: Identify opportunities at the enterprise and site level to discuss PFAS issues with Tribal, state and local governments, and interagency and external stakeholders. (Supports Objective 2)

  Engage with interested parties to hear concerns, gather input, and identify environmental justice considerations. Opportunities may include joining ongoing Tribal consultation processes, scheduling virtual and in-person public meetings and other forums, etc.

  - Completion date: Ongoing.

- Action 4.4: Establish open communication channels to receive stakeholder-provided information and answer public inquiries, to support transparency in Departmental PFAS posture, policy and actions. (Supports Objective 2)

  Incorporate PFAS concerns and information into site and program communications and public engagement efforts.

  - Completion date: 4th quarter FY 2022.

Implementation Framework

The Deputy Secretary established the Department's implementation framework and initial policy, underscoring the urgency of addressing PFAS in the September 2021 memorandum, "Addressing Per- and Polyfluoroalkyl Substances at the Department of Energy." The Deputy Secretary tasked a new DOE-wide PFAS Coordinating Committee (PCC) with the responsibility for meeting the Policy objectives and coordinating with key stakeholders. The PCC is comprised of senior-level members from all DOE program offices with PFAS equities. It tracks progress and provides strategic guidance in implementing the Policy requirements, identifies necessary changes to Departmental orders and directives or regulations, establishes task teams to further develop department-wide approaches and Roadmap deliverables, and discusses opportunities for DOE laboratories to work with interagency and external partners. The PCC led the development of and will continue to guide updates to the DOE PFAS Roadmap.

DOE relies on its line programs (i.e., offices and sites responsible for DOE mission execution) to manage facilities and operations where PFAS are present or may have been used in the past. These DOE programs execute the Department's mission activities and will be expected to implement site actions identified in this Roadmap using a risk-based approach, recognizing the regulatory and programmatic frameworks that the respective site(s) operate under.

All DOE sites operate under formal EMSs, which provide a structured framework for identifying and addressing environmental issues. EMSs are aligned with the site's Integrated Safety Management System, with both systems clearly emphasizing DOE's commitment to ensuring worker safety, public health, and environmental protection while executing mission-related activities.

DOE's Office of Environment, Health, Safety and Security (EHSS) leads the Department's PFAS coordination efforts, including chairing the PCC and issuing DOE-wide PFAS-related documents. EHSS maintains Departmental policies supporting the Department's overarching programs and directives on environmental and safety management systems, with DOE's line programs overseeing the execution of these processes at the site level. Further, EHSS convenes the PFAS Working Group, a community of practice open to Federal and contractor staff from across the DOE enterprise, which has, since 2019, provided a valuable forum for internal communication and information exchange. EHSS also operates the DOE GreenBuy Program, which incentivizes DOE to adopt more sustainable acquisition practices, and has recently updated its guidance to further expand PFAS-free purchasing expectations.

DOE actively participates in government-wide efforts to assess and understand the impacts of PFAS on human health and the environment, including developing policies on cleanup and disposal, evaluating innovative technologies related to treatment and destruction of PFAS in the environment, and considering alternatives to PFAS-containing AFFF in support of firefighting capabilities. Departmental representatives engage with Federal interagency policy and technical task teams working to identify and implement solutions that address PFAS presence and risks.

CONCLUSION

DOE is committed to understanding the presence of PFAS at its sites and taking the steps needed to safeguard the health and well-being of its employees, the public, and the environment. DOE will leverage its scientific expertise and the broader research community to identify solutions to PFAS challenges, and engage with regulatory partners, state and Tribal governments, and community stakeholders to share information and gather feedback on our approaches.

This Roadmap reflects the Department's current understanding of PFAS at its sites. DOE will be releasing a subsequent report, "Initial Assessment of PFAS at DOE Sites," following the issuance of this Roadmap. This report will serve as the first step in understanding the use and presence of PFAS at DOE sites. Information from this report will guide further PFAS characterization and risk management efforts.

This Roadmap identifies actions to be accomplished over the next few years. These include efforts to inventory current PFAS use and characterize the types of PFAS and the extent of their presence in the environment as a result of DOE activities; mitigate risk to workers, the public and the environment from PFAS at DOE facilities; ensure compliance with federal, state, and local regulations, as well as DOE Directives and Orders; assess and responsibly manage PFAS-containing products and wastes; advance technological solutions to solve PFAS issues; and engage and coordinate with a range of interested parties about the Department's efforts.

The Department recognizes the regulatory and scientific uncertainties and dynamism surrounding PFAS, which make it likely that priorities and approaches will change as new information emerges and new requirements are promulgated. As such, DOE may update this Roadmap when necessary. Regardless, DOE will be guided by this Roadmap to demonstrate the fundamental commitment to protecting human health and the environment.

ATTACHMENT 1: PFAS COORDINATING COMMITTEE

Office of Environment, Health, Safety and Security (EHSS)

Michael (Josh) Silverman, Chair, Director, Office of Environmental Protection and ES&H Reporting

Office of Congressional and Intergovernmental Affairs (CI)

Jennifer Kramb, Intergovernmental and External Affairs Specialist

Office of Economic Impact and Diversity (ED)

Andre Sayles, Senior Advisor

Office of Environmental Management (EM)

Jay Mullis, Acting Associate Principal Deputy Assistant Secretary for Regulatory and Policy Affairs

Office of Fossil Energy and Carbon Management (FECM)

Paul Oosterling, Project Manager, Strategic Petroleum Reserve Project Management Office

Office of General Counsel (GC)

Steven Miller, Deputy Assistant General Counsel for Environment

Office of Legacy Management (LM)

Tracy Ribeiro, Environment, Safety, Health, and Quality Team Supervisor

National Nuclear Security Administration (NNSA)

Ahmad Al-Daouk, Deputy Associate Administrator, Office of Enterprise Stewardship

Office of Nuclear Energy (NE)

Nicole Hernandez, Director, Environment and Sustainability Division, Idaho Operations Office

Office of Science (SC)

Bob Gordon, Brookhaven Site Office Manager

ATTACHMENT 2: RESEARCH AND DEVELOPMENT EFFORTS

1. In Illinois, Argonne National Laboratory (ANL) has developed the Ecological Screening Values (ESVs) for eight PFAS for surface water and soil for the Air Force and other DOD services. ESVs were developed for ecological receptors with the participation of EPA, Army, Navy, and Air Force ecological risk experts. An Artificial Intelligence (AI) workflow using deep learning methods has also been developed for PFAS toxicity predictions and tested for 8163 PFAS. ANL is currently developing a field-effect transistor platform for rapid electronic detection of PFAS in water, including the use of AI/machine learning for the design of molecular probes toward selective detection and separation of PFAS. These efforts are ongoing.
2. ANL is also pursuing a design of treatment train to combine multiple ANL technologies including selective adsorbent sponges for PFAS capture, resin-wafer electrodeionization for waste-stream reduction, and low-temperature atmospheric pressure plasma for decontamination and destruction of PFAS in an adsorbent medium. The selective adsorbents used in treatment train build off two patented Argonne technologies: (i) the OleoSponge and (ii) a new class of nanostructured adsorbents called xerogels. Both technologies afford direct control over the adsorbent surface chemistry to specifically target PFAS, but individually cover a range of physical characteristics such as surface area and porosity to enhance separation performance metrics such as adsorption capacity. Research continues on the development of additional PFAS selective sensors and sorbents. Research on synthesis of catalysts using atomic layer deposition to degrade PFAS was also recently funded as a collaborative effort. These efforts are ongoing.
3. At Fermi National Accelerator Laboratory in Illinois, research is being conducted on the degradation of PFAS in water via a high power, energy-efficient electron beam accelerator. Results to date have established that an electron beam is effective at breaking down PFAS compounds and work continues on how to best incorporate this technology in water treatment. These efforts are ongoing.
4. At Pacific Northwest National Laboratory (PNNL) in Washington, DOE created a PFAS capture probe that is tailored for highly selective analyte recognition and detection which can also be used for quantification. PNNL's capture and sensor efforts were patented. PNNL is also pursuing a research focus area on PFAS destruction. PNNL is part of a recent DOD Environmental Security Technology Certification Program project award with ARCADIS and New Jersey Institute of Technology on "Field-Scale Demonstration of a Novel Real-Time Sensor for PFAS," where PNNL is working on detecting six different PFAS molecules using the PFAS sensor. These efforts are ongoing.
5. BNL is developing a plasma-based technique to destroy PFAS and related components in water. The main advantage of the plasma-based technique is that the energy requirements are very favorable. BNL is also supporting the Fermi National Accelerator Laboratory effort that is exploring an electron-beam technique. These efforts are ongoing.

6. SC provides foundational knowledge and state-of-the-art capabilities (including user facilities) in support of DOE's mission with a focus on innovation. SC's Office of Basic Energy Sciences (BES) stewards capabilities that can be used to provide foundational knowledge for design of new approaches for PFAS capture and conversion, though BES does not support research specifically focused on PFAS. Capabilities in experimental and computational chemical sciences relevant to PFAS research include research programs in separation science, with a focus on understanding the molecular mechanisms of selective separation processes, and catalysis science, with a focus on mechanistic understanding of catalytic transformations that produce targeted products. Major scientific tools include SC x-ray, neutron, nanoscience, and high-performance computing user facilities that provide advanced synthesis, fabrication, characterization, and computational capabilities to scientific communities in basic, applied, and industrial research.
7. A collaboration between Thomas Jefferson National Accelerator Facility (TJNAF) and Hampton Roads Sanitation District (a local wastewater utility company) includes tests using electron beam irradiation of PFAS-contaminated water samples. Preliminary results have successfully demonstrated the breakdown of long-chain PFAS compounds in wastewater effluent matrices following electron beam irradiation at relatively low dose. Opportunities for further studies are being sought. The current efforts have been funded through TJNAF's Laboratory Directed Research and Development Program.
8. DOE is supporting PFAS research activities through the Consortium for Risk Evaluation with Stakeholder Participation (CRESP), based at Vanderbilt University in Tennessee. CRESP researchers are investigating techniques to mobilize PFAS to facilitate more efficient recovery from the vadose zone and groundwater; membrane separation approaches to concentrate PFAS from groundwater to make subsequent destruction technologies more efficient by providing a smaller volume and more concentrated feed; development and demonstration of EPA leaching test and evaluation methods; and testing the efficacy of liners for retaining PFAS when used in landfill disposal containment/leachate systems.