Management of PFAS in the Environment: SERDP & ESTCP Strategic Approach

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DoD's Environmental Technology Programs

Science and Technology

- Statutory program established 1991
- DoD, DOE, EPA partnership
  - ♦ Advanced technology development to address near-term needs
  - ♦ Fundamental research to impact real world environmental management

Demonstration and Validation

- Demonstrate innovative cost-effective environmental and energy technologies
  - ♦ Transition technology out of the lab
  - ♦ Establish cost and performance
  - ♦ Partner with end user and regulator
  - ♦ Technology transfer
    - ▪ Accelerate commercialization or broader adoption
    - ▪ Direct technology insertion

Latest Accomplishments

$1M SERDP MR investment avoided estimated $40M cost for 2023 Pearl Harbor dredging project

1st PFAS free firefighting foam qualified building off work from over 70 SERDP ER and WP projects

Through an interagency effort with the EPA, a final method for measuring PFAS in waters was published in 2023, meeting an issue of critical national importance

Received approval to reconstitute SERDP Scientific Advisory Board for first time since 2017. Held first meeting in Sept 2023.

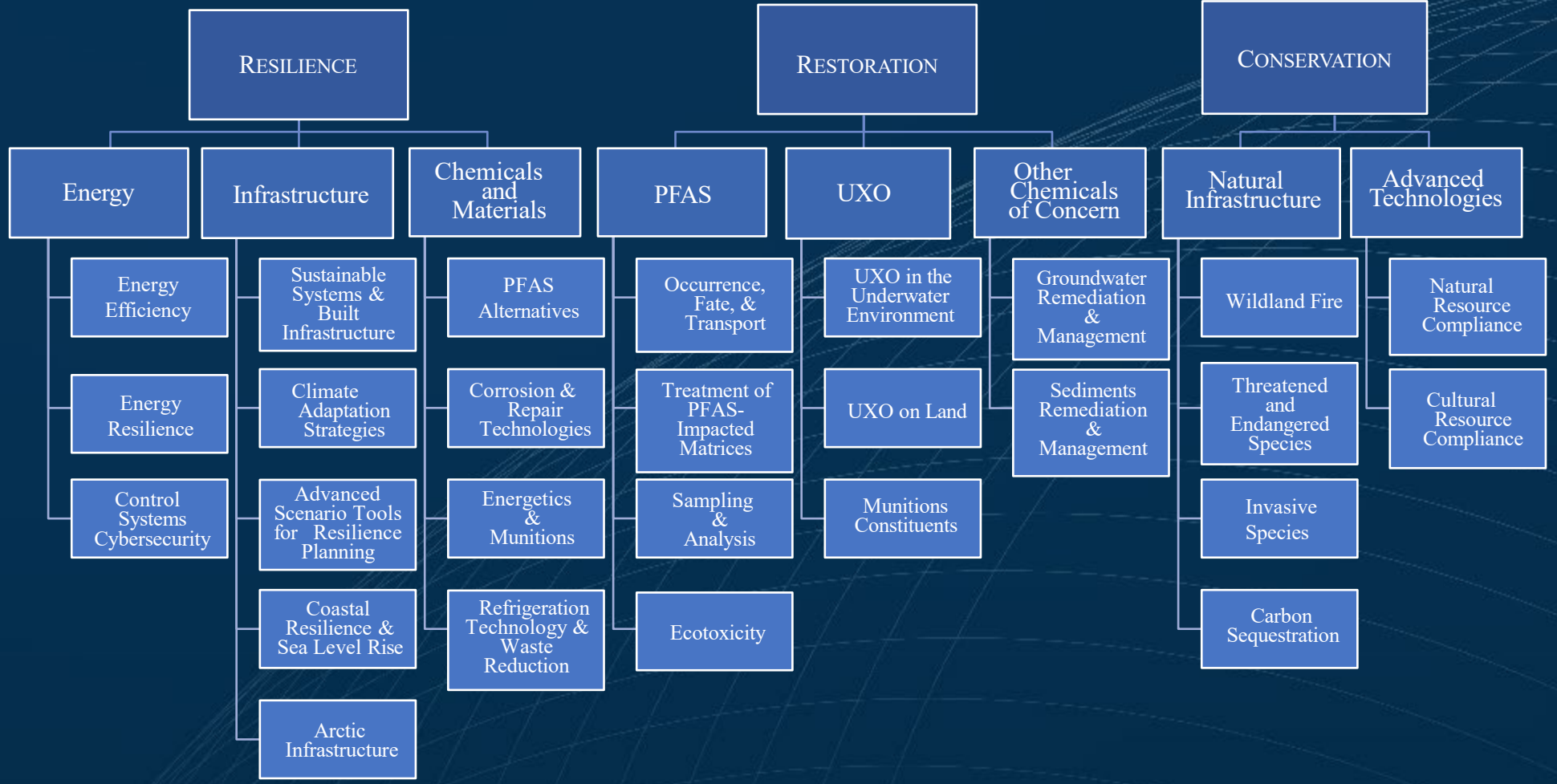
7 species delisted or downlisted in FY23 following 10 years of investment from SERDP Resource Conservation projects

Awarded $30M in FY23 Congressional adds for PFAS/AFFF replacement, remediation, disposal, and cleanup

SERDP & ESTCP hosted 9 strategic workshops during 2023, promoting interagency cooperation and strategic planning on mission critical issues

SERDP ESTCP-funded work is cited *10x more than average publication.*

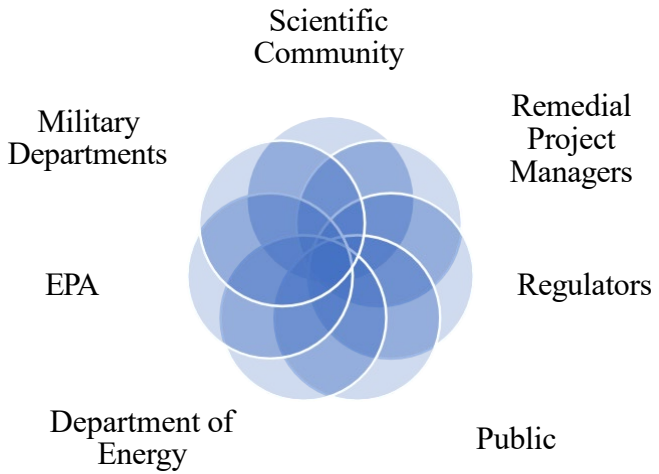
Focus Areas

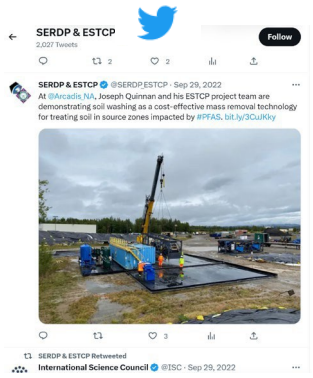

RESILIENCE
RESTORATION
CONSERVATION
Energy
Infrastructure
Chemicals and Materials
PFAS
UXO
Other Chemicals of Concern
Natural Infrastructure
Advanced Technologies
Energy Efficiency
Energy Resilience
Control Systems Cybersecurity
Sustainable Systems & Built Infrastructure
Climate Adaptation Strategies
Advanced Scenario Tools for Resilience Planning
Coastal Resilience & Sea Level Rise
Arctic Infrastructure
PFAS Alternatives
Corrosion & Repair Technologies
Energetics & Munitions
Refrigeration Technology & Waste Reduction
Occurrence, Fate, & Transport
Treatment of PFAS-Impacted Matrices
Sampling & Analysis
Ecotoxicity
UXO in the Underwater Environment
UXO on Land
Munitions Constituents
Groundwater Remediation & Management
Sediments Remediation & Management
Wildland Fire
Threatened and Endangered Species
Invasive Species
Carbon Sequestration
Natural Resource Compliance
Cultural Resource Compliance

SERDP & ESTCP: Stakeholder Outreach

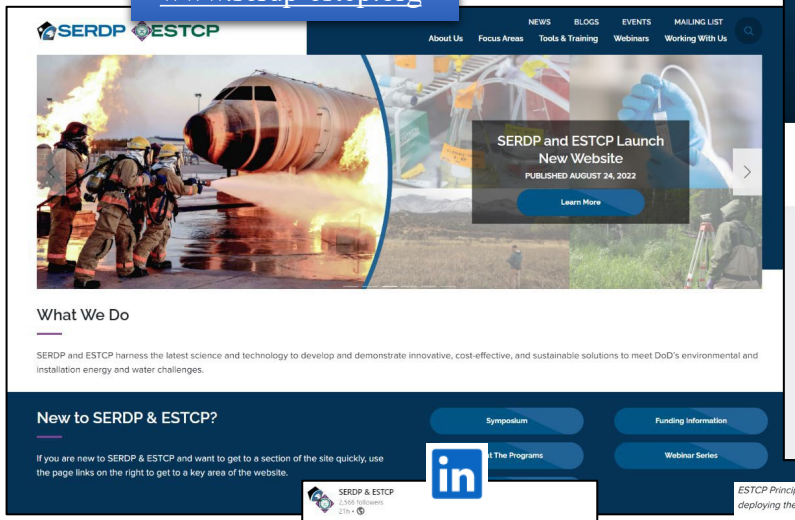
KEY TAKEAWAY

SERDP & ESTCP prioritize tailored, robust, and transparent communications with a diverse stakeholder community

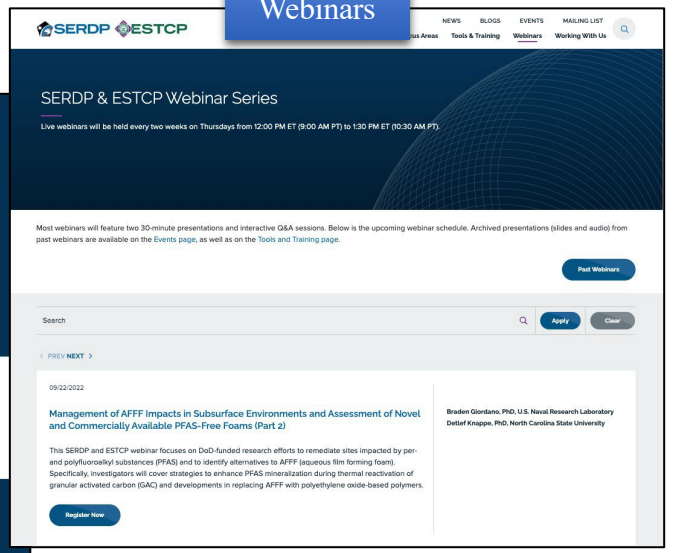


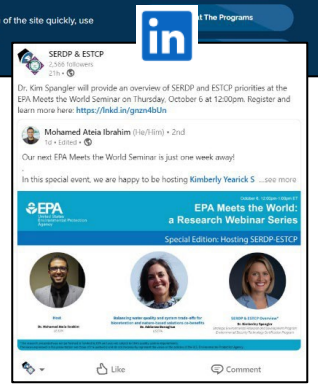


www.serdp-estcp.org



Webinars





News Stories

ESTCP Principal Investigators facilitated the use of drones for natural resource management at Marine Corps installations by developing a strategic framework for deploying the technology regionally.

By Laura Mack

Drones can substantially enhance natural resource management on Department of Defense (DoD) install reas that might otherwise be inaccessible, allowing personnel to closely monitor critical habitats and compare cha bstacles remain in gaining acceptance for drone usage by federal civilians at installations.

"We saw this great technology that was maturing to the point where it could be used for management and research, and I just knew that it was going to be a really big lift for installations to take it on individually," said Dr. Susan Cohen, a co-Principal Investigator for an ESTCP project that oversaw the integration of unoccupied aircraft system (UAS) technology into natural resource management for U.S. Marine Corps Installations EAST (MCIEAST). She previously flew drones as part of another SERDP project at Camp Lejeune and found that there was no ability for on-demand drone usage. Every time her team wanted to fly drones, they had to submit special range requests up the chain of command.

Dr. Cohen, who had previously worked at Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) as a biologist, teamed up with Mr. Joey Trotsky, an environmental engineer at NAVFAC EXWC, to facilitate the adoption of drones at six MCIEAST installations and MCRD Parris Island, and provide a framework for the use of drones as part of natural resource management activities. Most of these installations face the same climate resilience issues, including storm surge, sea level rise, and eroding shorelines. This approach allowed the project team to address similar issues on multiple installations, while still allowing them to develop their own guidelines and needs.

The Regional Drone Demonstration for Installations and Environment (REDDIE) framework consists of four main components: training, mission kits, protocols, and demonstrations. For training, drone operators are already required to take a Federal Aviation Administration (FAA) paper test, but Dr. Cohen and Mr. Trotsky wanted to add an applied requirement. They assembled a team of professional instructors to design an intensive 2-week long training. Dr. Cohen added that the hands-on element of the course bolstered installation leadership's confidence in civilian drone

PFAS in the Environment

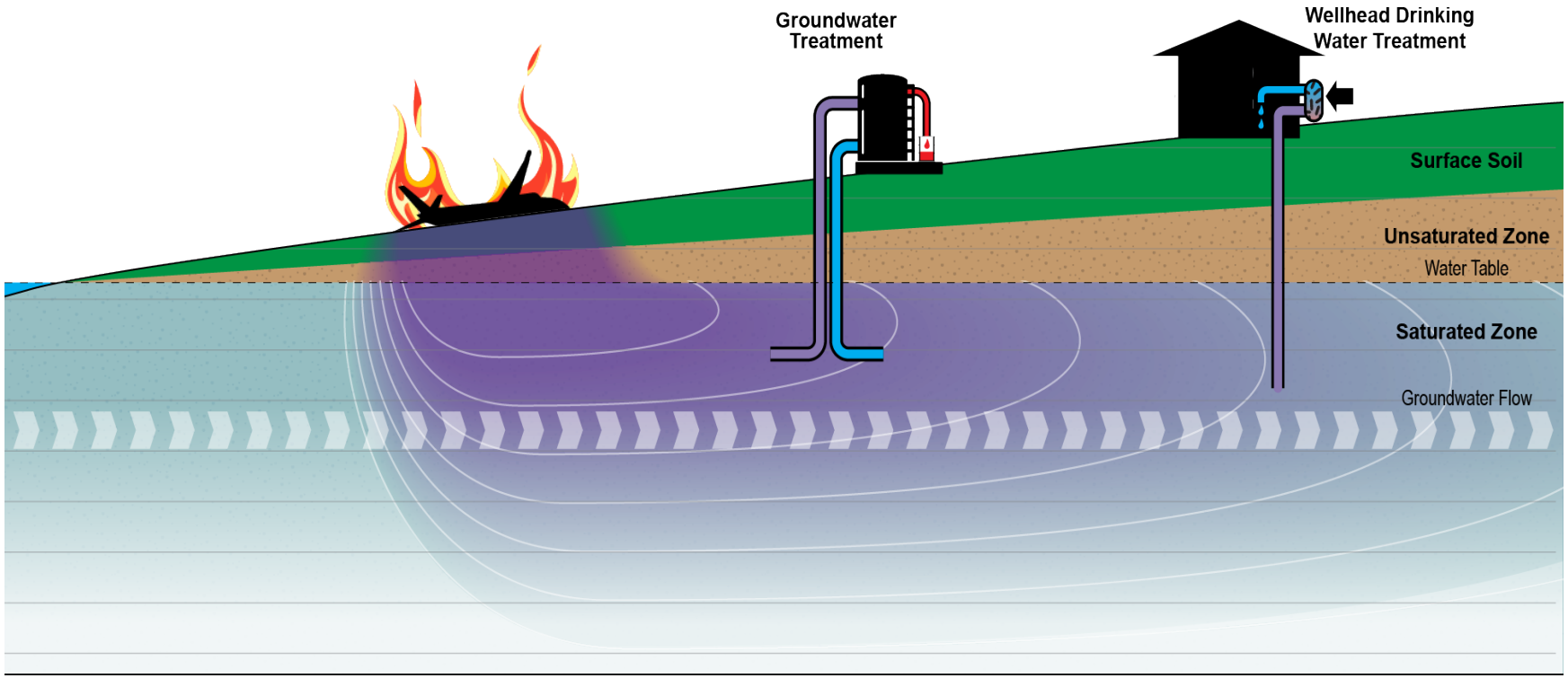
Major Lines of R&D & Demonstration Efforts on PFAS

- **Cleanup of PFAS**
  - Treatment technology development & assessment
  - Sampling and analysis
  - Fate and transport
  - Ecotoxicity
- **AFFF Replacement**
  - Development & demonstrations of PFAS-free firefighting formulations
  - Ecotoxicity

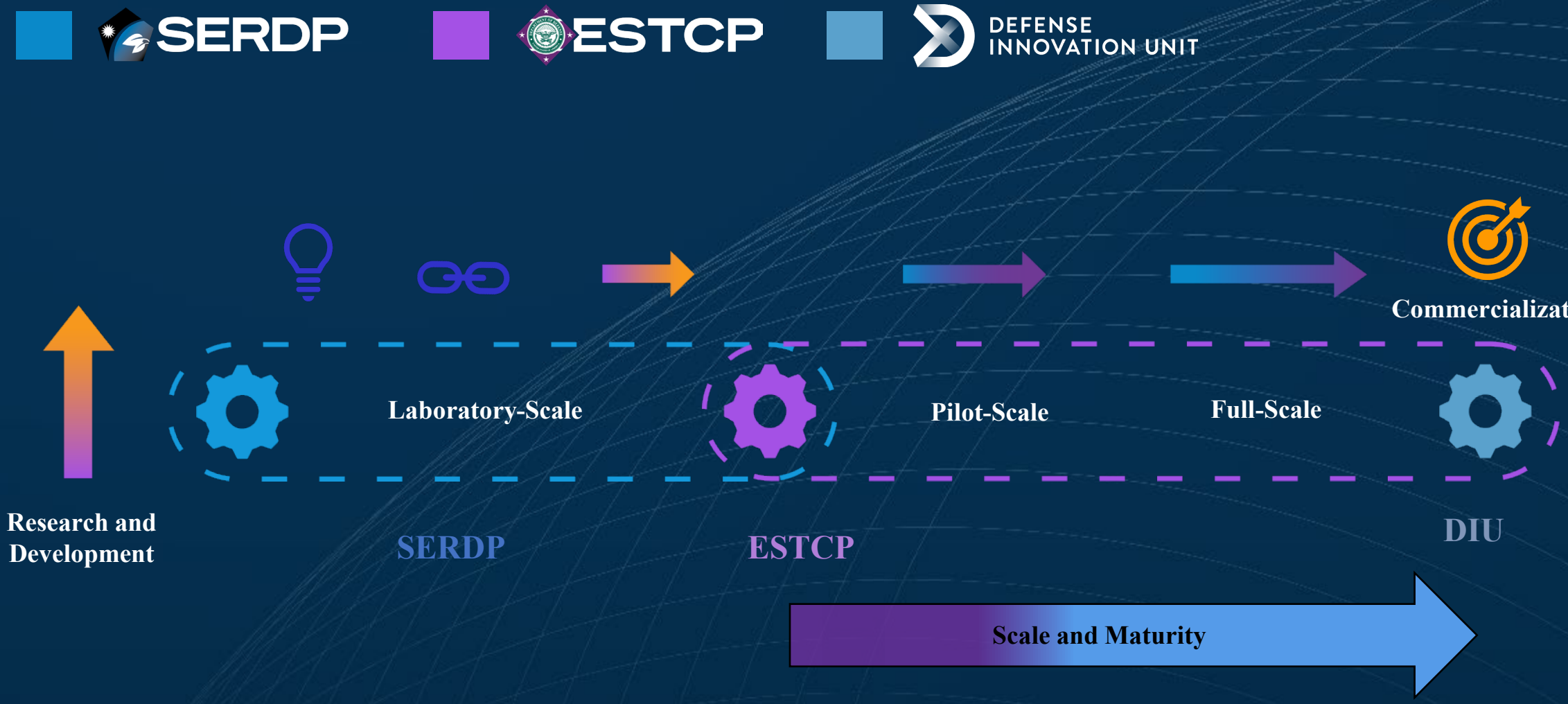
Research Impetus

- Develop, validate, and commercialize technologies to improve management and treatment of PFAS in the environment
- Successful projects implement cost-effective and efficient approaches

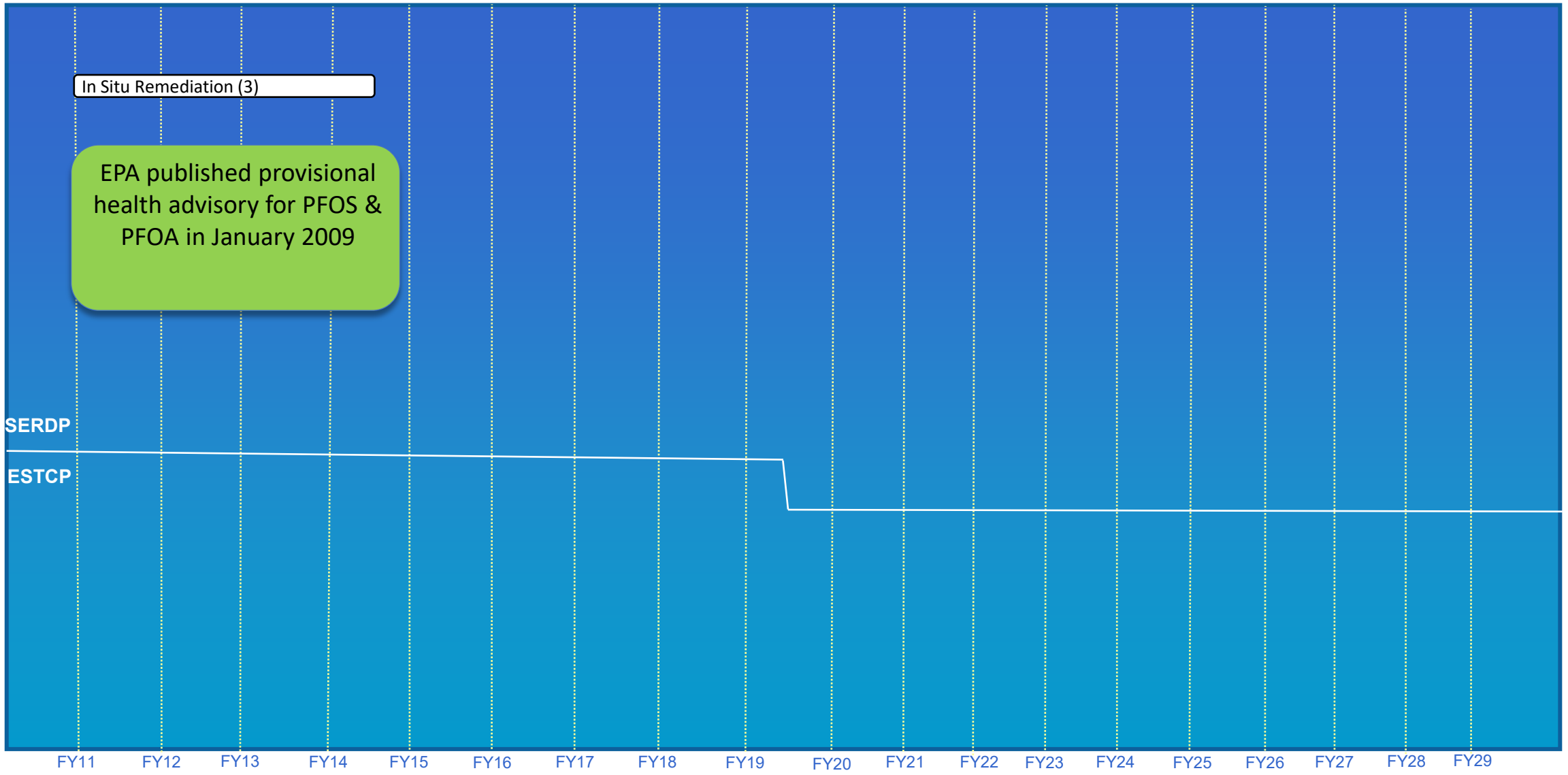
Conceptual Site Model



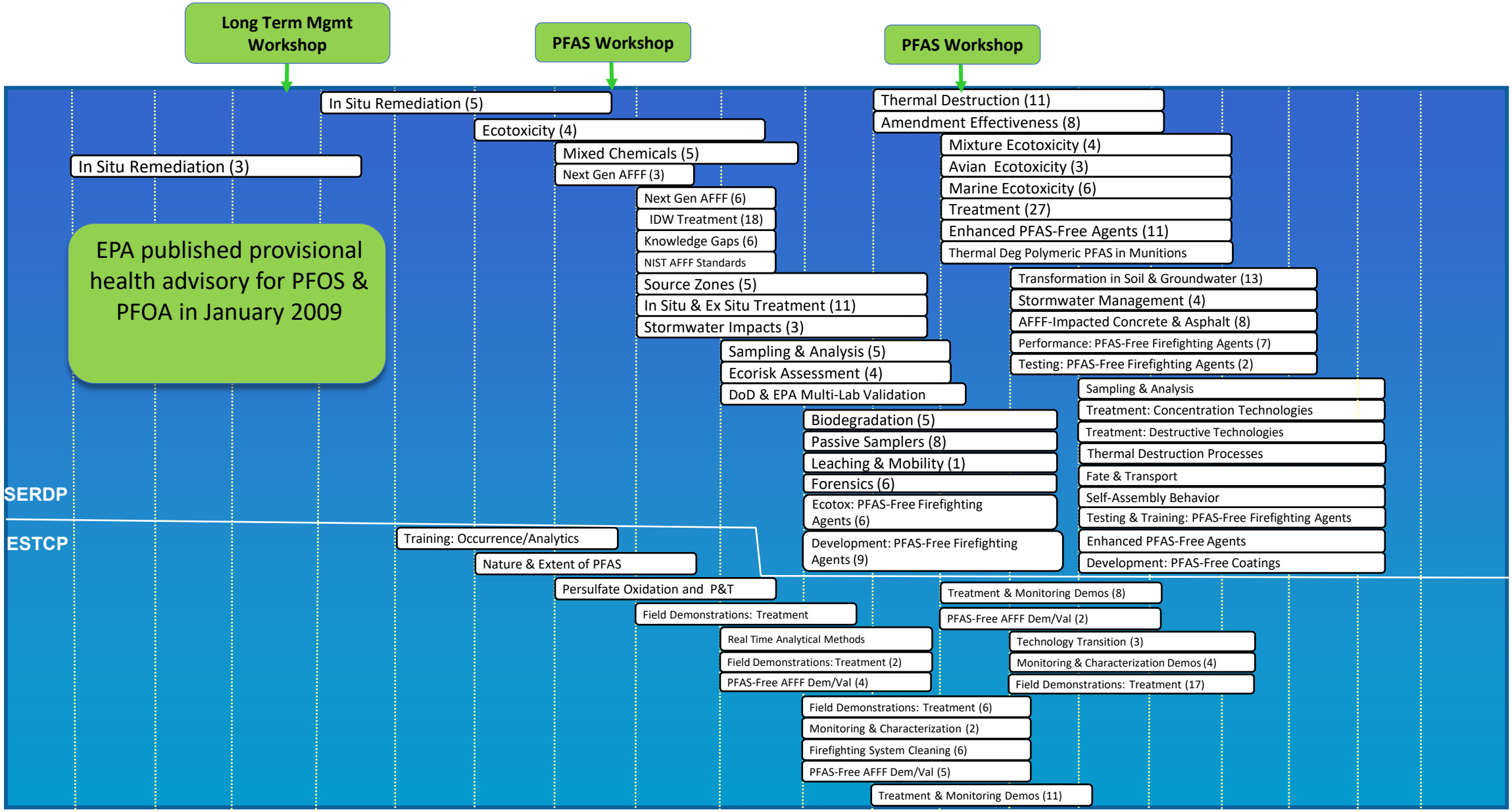
Systematic Efforts on PFAS Management



SERDP & ESTCP Efforts on PFAS



SERDP & ESTCP Efforts on PFAS



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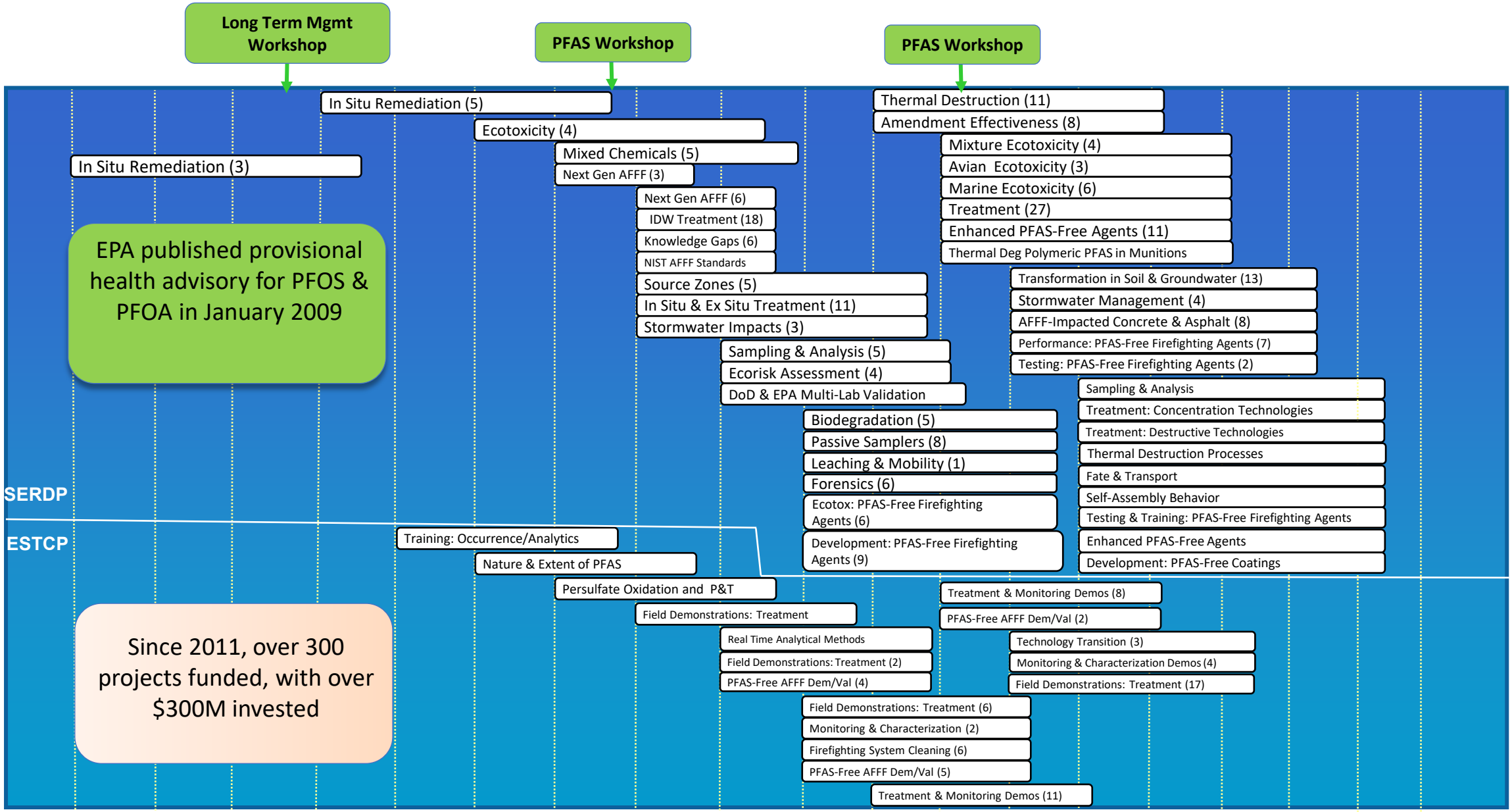


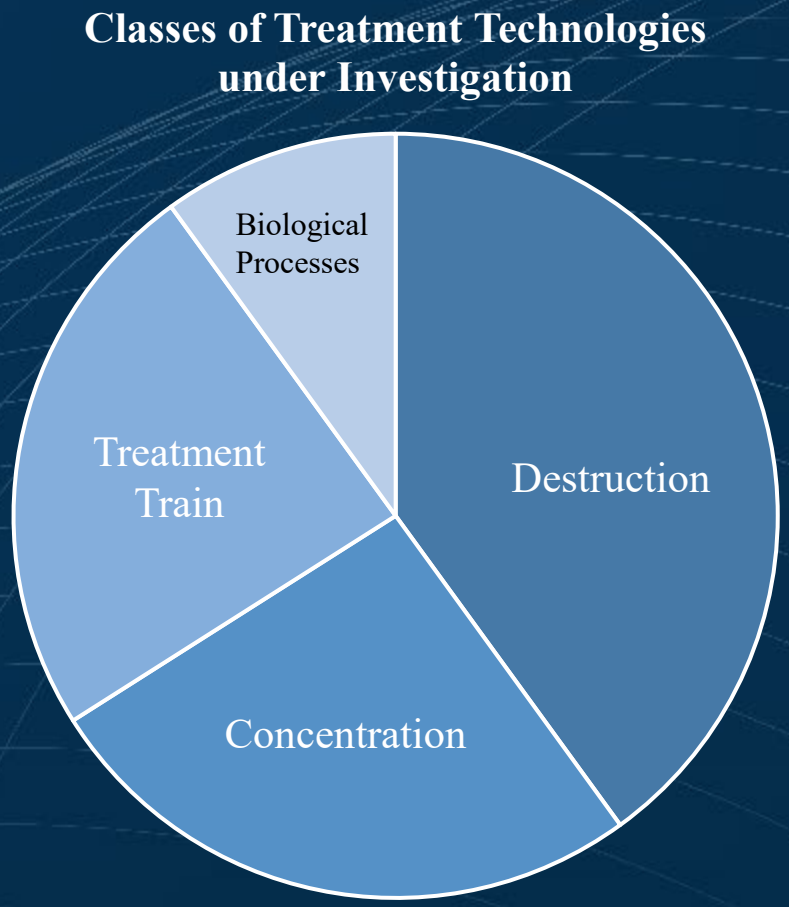
Management Approach

- **Formation of PFAS Technical Workgroup**
  - Comprised of representatives from Army, Air Force, Navy, EPA as well as technical consultants
  - Assist with selection and review of PFAS related projects
  - Assist with common location for collection of impacted soils and waters
  - Developed standardized documents to track QA for all projects
- **Annual in progress review required to PFAS Technical Workgroup and Technical Committee**
- **Annual project meeting**
  - All funded projects are represented via panel and poster presentations
  - Other federally funded projects also represented
  - Primary purpose is to provide time for investigators to view other research, form collaborative efforts, etc.
- **Annual Symposium**

SERDP & ESTCP PFAS Treatment Projects

- Over 50 PFAS treatment technologies have passed proof of concept & are further in development and/or demonstration phase.
- All treatment projects are ultimately designed to reduce the amount of impacted material that must be landfilled or incinerated.
- Treatment projects are discussed in terms of the four categories shown.

**More than one project possible for some technologies.*



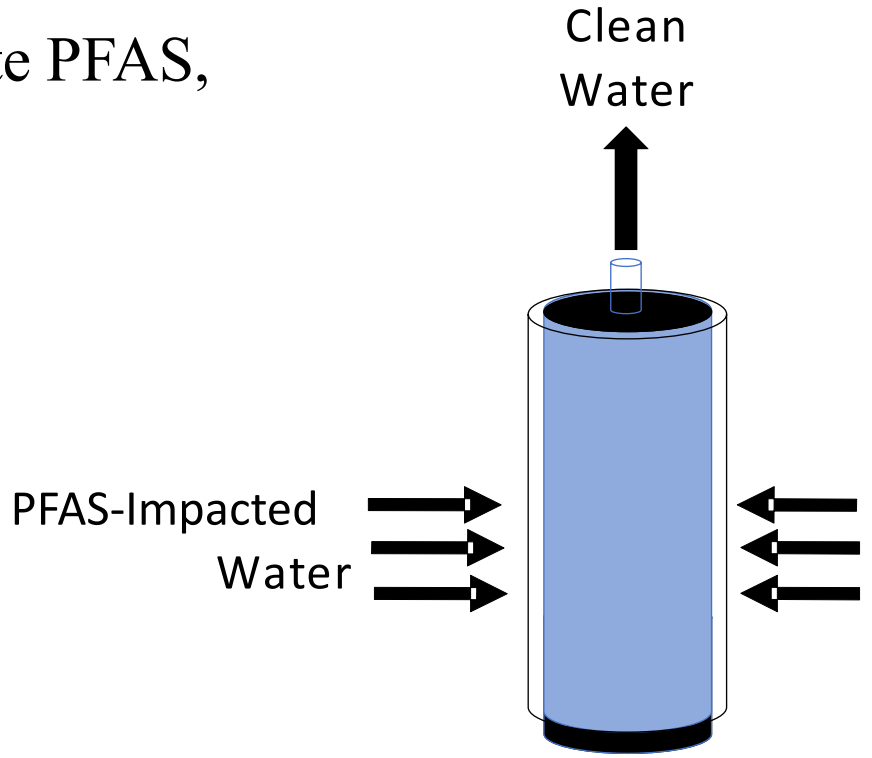
Destruction Technologies Under Investigation by SERDP & ESTCP

- **Thermal processes**
  - Low temperature thermal
    - Less energy intensive
    - Flexible application
  - Hydrothermal treatment
    - Liquid wastes
    - Less energy intensive
  - Smoldering combustion
    - Solid wastes
    - Less energy intensive

- **Non-thermal processes**
  - SCWO (super critical water oxidation)
    - High temperature, high pressure
    - Liquid wastes, potentially solids and concentrates
  - Plasma
    - Liquid and AFFF concentrate (testing)
  - Chemical & Catalytic Processes
    - Widely applicable to liquids and solids depending on process

Concentration Technologies Under Investigation by SERDP & ESTCP

- Not efficient to run destruction on low concentration wastes
- Often used as part of a treatment train, to concentrate PFAS, then use another process to destroy
- Concentration technologies include:
  - Modified GAC
  - New sorbents
  - Foam technologies



Larger-Scale Demonstrations

Ex Situ Soil Treatment
Joint Base Elmendorf-Richardson, AK
(Field Effort Summer 2024)

- ACES Mobile Remediation System (MRS-1) (Thermal desorption/thermal oxidation) (**ASRC**)
- STARx (smoldering combustion) (**Savron**)
- Thermal conduction heating (**TRS Group**)

Ex Situ Groundwater Treatment
NASJRB Willow Grove, PA
(Demonstration Day, August 2024)

- Regenerable anion exchange treatment (**ECT2**)
- Surface active foam fractionation (SAFF) (**Allonia**)
- Cyclodextrin adsorbent (DEXSORB) (**Cyclopure**)

Excavated Sediments Colorado

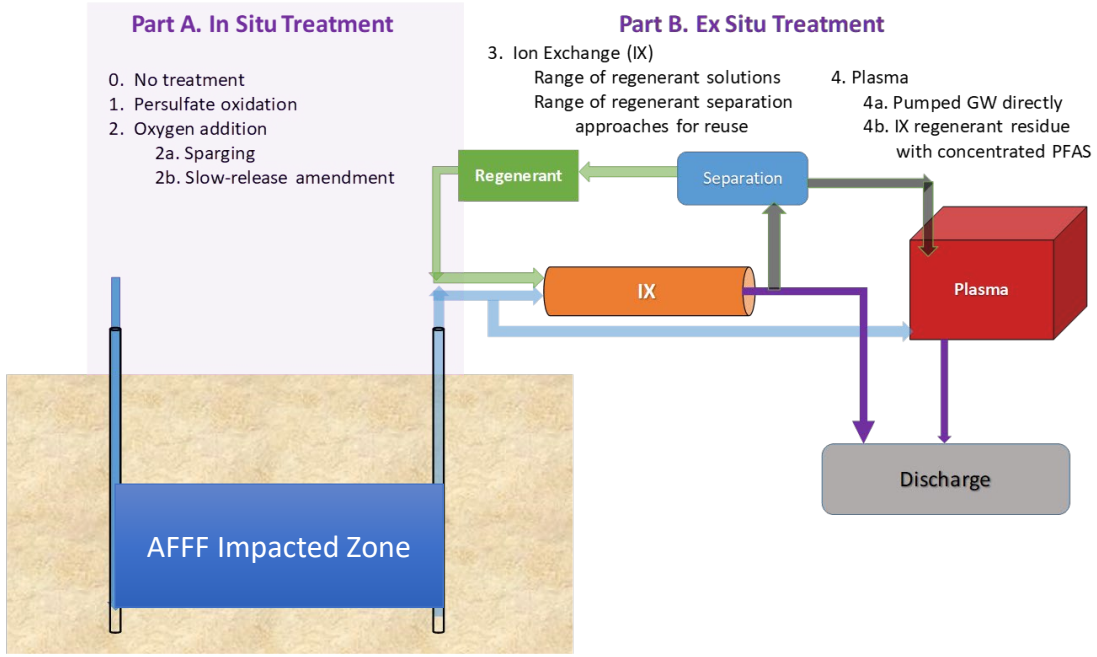
- Treatment train (**Colorado School of Mines**)
  - PFAST (**Allonia**); Smoldering combustion (**Savron**); Thermal desorption (**TerraTherm**)
    - HALT (**Aquagga**), SCWO (**374Water**); UV-activated silica-based granular media (**University of Missouri**)
- Thermal desorption (**EA Engineering**)
- Ebeam (**TetraTech**)
- Treatment train (ball milling, soil washing, plasma) (**Clarkson University**)

Concentrated Aqueous (Foam fractionate, still bottoms, IX regenerant) Clean Earth Facility, MI and NC

- SCWO (PFAS Annihilator) (**Battelle/Revive**)
- SCWO (iSCWO) (**General Atomics**)
- SCWO (AirSCWO) (**374Water**)
- Hydrothermal alkaline treatment (HALT) (**Aquagga**)

Treatment Trains Likely to be Necessary at Most Sites

- Treatment trains typically combine concentration and destruction technologies to achieve the best result
- Research is looking at best combination of technologies based on location (i.e., liquid, solids, etc.) and concentration of PFAS

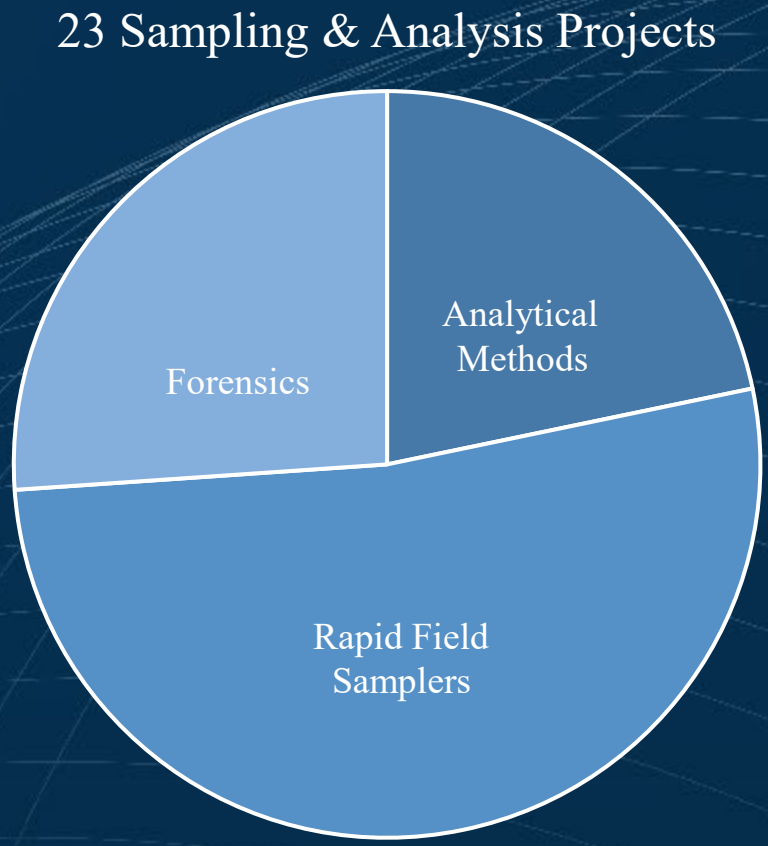


Treatment Summary

- PFAS treatment market is exploding (with many marketing claims)
- No one technology will meet the needs of all PFAS-impacted materials
- Technology assessment MUST evaluate several critical questions (i.e., destruction and removal efficiency, mass balance)
- Concentration most efficient for large dilute groundwater applications with residuals management
- Treatment trains are likely to offer best options for concentration and destruction

Sampling & Analysis Efforts

- Sampling & analysis efforts were initiated in FY18 to improve measurement of PFAS
- Focus has been on improving analytical methods, development of rapid field samplers, and forensics



Development of EPA Method 1633 for PFAS Analysis

- Previous published analytical methods for PFAS were only for drinking water matrix
- Expansion to include other matrices:
  - Aqueous (groundwater, surface water, wastewater, landfill leachate)
  - Solids (soils, sediments, biosolids)
  - Tissues
- Draft method published in 2021; recently updated in January 2023
  - Involves developing then testing method at a commercial analytical lab
  - Commercial labs are adopting these methods now
- Next step – test method at multiple commercial labs
  - In process
  - Validation reports for each matrix will be published as they are completed, beginning in 2022

Status and Future Directions

- Joint effort with EPA on additional analytical methods has cleared the first objective with the next step in progress.
- Additional field sampling methods are in process with some validated.
- Forensics techniques showing promise for differentiating between AFFF and non-AFFF sources.
- Dozens of treatment options are under investigation with many having passed the proof-of-concept phase and others moving into field demonstrations.
- Future focus will be on demonstrating more treatment technologies in the field under actual site conditions.

Additional Resources

- For more information on PFAS-related projects funded by SERDP & ESTCP:
  - https://serdp-estcp.mil/focusareas/e18ec5da-d0de-47da-99f9-a07328558149/pfas
- PFAS Project Meeting
  - All SERDP and ESTCP-funded projects present at workshop
  - July 2024, Long Beach, CA
- Annual Innovations Symposium
  - Five technical sessions highlighting SERDP & ESTCP efforts on PFAS
  - December 3 – 6, 2024
  - https://www.dodinnovationsymposium.org/