2026 ITRC Project Team Proposal

Environmental Topic: Sorption Technology

Project Title: Novel Adsorption Media for Remediation of PFAS in Water Systems

Project Deliverables:
This work will result in various deliverables in order to educate engineers, municipalities, etc. on the suite of options available or in development for per- and polyfluoroalkyl substance (PFAS) remediation. This will include the guidance document which will highlight strengths and weaknesses of novel media as was done for granular activated carbon (GAC) and anion exchange resins (AER) in the previous guidance document in order to create easy access resources for these lesser-known adsorbents. GAC and AER are strong tools for remediation, but other options are available that can close the gaps left by these sorbents. The goal of this work is to provide a deeper understanding of these novel adsorbents therefore strengthening the efforts of PFAS treatment across the United States.

It is hoped that ITRC will select one or more PFAS topic proposals as well as the Updating ITRC PFAS-1 proposal for the 2026-2027 project cycle. The team intends that any PFAS proposals selected by the Board would be implemented cooperatively by one PFAS Team.

Problem Statement:
Environmental contamination of PFAS has gained widespread recognition in the past decade due to the significant human and environmental health implications associated with the contaminant class. This has led to the implementation of several regulatory limits, both at the state and federal levels, including the United States Environmental Protection Agency (USEPA) PFAS drinking water maximum contaminant levels (MCL). Current requirements state that these MCLs must be met by drinking water providers by 2031, therefore creating a significant demand for water remediation techniques. Development of technology for water treatment and remediation of PFAS contamination is critical in order to meet USEPA PFAS MCLs by the deadline. Current treatment technologies typically include sorption-based remediation with GAC and AER. Though these sorbents are tried and true for PFAS removal, there remains a necessity for alternative sorbents which can efficiently remove PFAS from water in order to address the entirety of the problem. These adsorbents are commonly used because they have been demonstrated as strong tools for PFAS removal from water, but neither option is universally compatible with all water treatment designs. With this consideration, it is critical to also highlight novel adsorbents that can help to fill gaps and address the widespread issue of PFAS water contamination.

There are some drawbacks with GAC and AER for water treatment. Though the drawbacks are not universal issues that apply to all treatment facilities, there are several treatment plant designs that do not operate efficiently with these media. This can include, but is not limited to, plants that have small spatial footprint where GAC utilization is challenging, with high salt content or use of chlorination which is not compatible with AER. It is well known that GAC is widely impacted by organic co-contaminants and complex matrices in source water. This often leads to fouling of the media, clogging of the micropore structures that characterize GAC, as well as decreased bed life due to competitive sorption with the other contaminants in source water. Additionally, the sorption kinetics of GAC are slow therefore requiring long contact times, i.e. empty bed contact time, which requires a significant volume of media and a large spatial footprint. Many treatment plants do not have the ability to expand the size of their facilities as they are in urban or densely populated areas, meaning they are often not conducive to GAC for PFAS remediation. Matrix impacts on AER can also have an impact on media performance. Source water with significant salt concentrations or co contaminants such as nitrates face effects of competitive sorption which can reduce the bed life of the resins. In addition, the possibility of carcinogenic nitrosamines leaching from AER as a result of the production process or as a reaction product of chlorination disinfection processes, which poses a potential risk to consumers. Also, though AER is highly effective at PFAS removal from water, it is often a more expensive option compared to other adsorbents. The AWWA recently determined that the annual cost of treating PFAS to USEPA MCLs will cost between 2.7 to 3.5 billion dollars annually, of which the burden will fall primarily on the public. With this in mind, efforts to make water treatment processes as cost effective as possible are critical.

This proposal is for the development of a second sorption document which pivots the focus to novel adsorbents. Novel adsorbents were briefly discussed in the 2024 ITRC sorption technologies proposal, but the focus of the final document was decided to be on GAC, AER, and foam fractionation. This decision was made based on the proven readiness of the technologies. Since this time, novel sorbents including surface modified clay (FLUORO-SORB® Adsorbent), cyclodextrin based adsorbents (DEXSORB®), membrane reactors (NanoSORB™), etc. have been demonstrated as viable options for water treatment and can address some of the needs discussed earlier. The guidance produced from this proposal will highlight novel adsorbents that are on the market, discuss their capabilities and drawbacks, as well as discuss their technology readiness levels.

Proposal Supporters:

Rebecca Dickman, Ph.D., Technical Services Manager, CETCO, Rebecca.Dickman@mineralstech.com
Levi Haupert, Ph.D., Physical Scientist, USEPA, haupert.levi@epa.gov
Andrew Safulko, Brown and Caldwell, asafulko@brwncald.com

References

1. Saeidi, Navid, Adelene Lai, Falk Harnisch, and Gabriel Sigmund. "A FAIR comparison of activated carbon, biochar, cyclodextrins, polymers, resins, and metal organic frameworks for the adsorption of per-and polyfluorinated substances." *Chemical Engineering Journal* 498 (2024): 155456.
2. Liu, Fuqiang, Joseph J. Pignatello, Runze Sun, Xiaohong Guan, and Feng Xiao. "A comprehensive review of novel adsorbents for per-and polyfluoroalkyl substances in water." *ACS ES&T Water* 4, no. 4 (2024): 1191-1205.
3. Burkhardt, Jonathan, Thomas F. Speth, Stanley Gorzelnik, Alexander S. Gorzalski, Orlando Coronell, Ahmed Rachid El-Khattabi, and Mohamed Ateia. "How Do Novel PFAS Sorbents Fit into Current Engineering Paradigm?." *ACS ES&T Engineering* 5, no. 4 (2025): 830-838.

2026 ITRC Project Team Proposal

Environmental Topic
PFAS

Proposed Project Title
PFAS Treatment Performance Verification– Practical Strategies to Address PFAS Contaminated Sites

Project Deliverables
The deliverable will include a fact sheet and a new treatment/remediation chapter in PFAS tech guidance.

It is hoped that ITRC will select one or more PFAS topic proposals as well as the Updating ITRC PFAS-1 proposal for the 2026-2027 project cycle. The team intends that any PFAS proposals selected by the Board would be implemented cooperatively by one PFAS Team.

Problem Statement
ITRC PFAS treatment team has identified, interpreted and shared PFAS treatment technologies for practitioners in the remediation communities to understand the developing, demonstrated and commercially available technologies that treat and destroy PFAS. As treatment technologies continue to advance, more PFAS removal and destruction mechanisms are discovered and explored. However, better technical certainty and clarity are needed for remediation practitioners and stakeholders to better understand PFAS treatment mechanisms, particularly in light of the current understanding of PFAS fate and transport in the environment. Additionally, technical clarity and assurance are needed before emerging PFAS remediation technologies can be considered reliable, scalable, and demonstrably successful at achieving short- and long-term remedial objectives. PFAS treatment technologies verification is particularly important as a result of these conditions in the PFAS remediation industry. The verification approaches of PFAS destruction and removal efficiency (DRE) could range from monitoring of only a few regulatory PFAS, to comprehensive monitoring of nontarget PFAS (intermediates), to total fluorine mass balance, and to understanding of destruction mechanisms. The PFAS remediation communities are lacking technical guidance on determining the DRE and which tools and methods should be considered to determine technology readiness. A greater understanding of mechanisms, pathways and kinetics is needed in addition to DRE to avoid generation of harmful discharges. The speed of introducing emerging technologies to the remediation communities increased the global needs of technical guidance on verifying the readiness and acceptance of different technologies as well as strategies to apply them to different site conditions. While USEPA PFAS technology evaluation framework (TEF) identified the key factors to verify PFAS treatment technologies, it has not introduced the methods, tools, approaches and strategies that can be used to guide the evaluation, selection, and ultimately the application of PFAS treatment technologies for cleanup of PFAS contaminated sites.

Additional Information

Objectives. PFAS treatment evaluation, remedy selection, and site management strategies can be complex. For a wide range of technologies "available" to the practitioners, the technology readiness, maturity and technology assessment at different stages of development should be better defined, combining the latest knowledge on advancement of analytical tools, regulatory development and community perspectives. Practical strategies to address PFAS contamination should be developed based on site-specific conditions and the effectiveness and limitations of available technologies. The objectives of this team are to (1) organize the current methods/programs used to verify PFAS treatment effectiveness and regulatory acceptance, (2) identify parameters that are found most and least critical to demonstrate treatment effectiveness and regulatory acceptance, (3) summarize the latest development of tools/methods/strategy that confirm the readiness levels of treatment technologies, and (4) develop a framework to apply different strategies to the management and remediation of PFAS contaminated sites using verified technologies.

Approach. For achieving the objectives, the proposed team will

- Conduct a state survey on PFAS treatment technology approval criteria for both separation and destruction technologies
- Identify and summarize the published literature on common methods and approaches to demonstrate the success of PFAS treatment technologies (i.e., DRE, mass balance, TOF, 19F-NMR, 2 MCL regulated PFAS, management of waste streams, etc),
- Summarize the source, availability, and limitations of promising methods and tools,
- Promote the awareness of differences in performance verification when evaluating different stages of technology development and for different treatment matrices (drinking water, WW, residual, groundwater, soil, spent media, air),
- Establish treatment performance monitoring purposes and strategies for experimental, pilot and full-scale studies, and
- Develop a practical strategy framework to manage and remediate PFAS contaminated sites.

Benefits. With a fast-growing number of treatment technologies and analytical methods, this protocol will give remediation practitioners guidance on how to evaluate PFAS treatment data and thereafter select technologies that are science-based and have a better chance for acceptance by regulatory agencies and communities. The framework of practical strategies will provide a toolbox on alternatives evaluation and remedy selection for PFAS contaminated sites.

Duration. 24 months

Proposal Supporters

Li Wang, DTSC, Li.Wang@dtsc.ca.gov
Dora Chiang, Jacobs, dora.chiang@jacobs.com
Rebecca Higgins, AECOM, rebecca.higgins@aecom.com
Jeff Wenzel, Missouri Dept of Health and Senior Services, Jeff.Wenzel@health.mo.gov
Kristi Herzer, Vermont Department of Environmental Conservation, kristi.herzer@vermont.gov

2026 ITRC Project Team Proposal

Environmental Topic
PFAS

Proposed Project Title
Management of PFAS treatment residuals

Project Deliverables

The deliverables will consist either of a new chapter in the PFAS-1 or can be a standalone deliverable outside of PFAS-1 along with standardized table that can be updated periodically.

The proposed team will conduct the following:

- Reach out to USEPA and Water Research Foundation to discuss status and direction of existing projects involving management of treatment residuals.
- Compile available state and federal guidance pertaining to managing treatment residuals or similar waste products.
- Survey states as to status of guidance or plans to develop guidance for managing treatment residuals.
- Compile list of destructive technologies that are applicable to treatment residuals.
- Compile sustainability metrics from peer-reviewed published sources that can be used to develop a standardized list of end-of-life metrics.
- Develop a standardized table to track existing and planned state and federal guidance on commercially available residual treatment management alternatives.

It is hoped that ITRC will select one or more PFAS topic proposals as well as the Updating ITRC PFAS-1 proposal for the 2026-2027 project cycle. The team intends that any PFAS proposals selected by the Board would be implemented cooperatively by one PFAS Team.

Problem Statement

The ITRC guidance document and recent draft Sorption-Based Technologies for Separation and Concentration of PFAS from Water provide information on different technologies to treat PFAS in water but only briefly presents management alternatives for the associated treatment residuals.

Given the scale of PFAS impacts in the United States drinking water supply and the tightening of regulatory standards, there is a focus on rapid deployment of commercially available treatment technologies to minimize human exposure to PFAS. In 2025, the USGS completed the National Integrated Water Availability Assessment for Water Years 2010–20 which indicated that the United States uses more the 35,800 million gallons of water per day for public water supply. In 2023, AWWA prepared a PFAS national cost model report which estimated that PFOS and/or PFOA treatment could be required for between approximately 4 and 12 percent of the water supply depending on whether state or federal maximum contaminant levels apply.

Currently the commercially available treatment technologies for PFAS in drinking water include adsorptive media, either granular activated carbon (GAC) or anion exchange resins (AER), and/or pressure-drive membrane separation processes such as nanofiltration (NF)/reverse osmosis (RO). All these treatment technologies generate substantial waste streams (treatment residuals) containing concentrated PFAS. Management of these wastes is influenced by the rapidly evolving regulatory framework that limits alternatives for managing treatment residuals.

In 2024, USEPA prepared the Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances which identified three large-scale capacity technologies that can destroy PFAS or control PFAS release into the environment: thermal destruction, landfills, and underground injection. The study also discussed emerging technologies for PFAS destruction and disposal. USEPA and others are in the process of conducting studies to evaluate treatment residual management requirements. The studies include some relevant guidance and end-of-life considerations, but do not present integrated state and federal guidance or a standard set of metrics to assess end-of-life sustainability on a consistent basis.

Continued operation of existing PFAS drinking water treatment systems and deployment of new systems will increase the volume of treatment residuals that require management. An integrated summary of state and federal guidance along with standard metrics for long-term sustainability assessments will streamline and standardize stakeholder selection of treatment residual alternatives until the process matures with time/lessons learned. While not specifically designed for remediation projects, certain aspects of this project are transferable.

The objectives of this team are to provide tools that can be used by stakeholders to: (1) manage treatment residuals that are consistent with evolving federal and state guidance; and (2) be able to assess the long-term sustainability of the treatment residual disposal alternatives available today using consistent metrics.

Additional Information

There are substantial efforts being put forth to test, evaluate and select appropriate treatment technologies whether they are applied to the drinking water supply or the resulting treatment residuals. Currently, treatment technologies for PFAS in drinking water are commercially available and mature given the current drinking water Maximum Contaminant Levels. However, the ability to destroy PFAS in the treatment residuals is not as mature and evolving. The lack of mature PFAS destructive technologies can increase reliance on containment disposal alternatives such as landfills. Containment disposal strategies such as landfills require long-term care and management and may also require future action.

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United States Environmental Protection Agency, 2024. Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing PFAS. April 8, 2024

United States Geological Survey, 2025. Water Availability and Use Science Program and National Water Quality Program, Status of Water-Quality Conditions in the United States, 2010–20. February 2025.

Duration. 18 months

Proposal Support from Team Members

Christopher Ross, Engineering Analytics, Inc. cross@enganalytics.com
Levi Haupert, US EPA, haupert.levi@epa.gov