

TREATMENT OF A PFAS-IMPACTED SOIL PILE BY THERMAL CONDUCTION HEATING

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Background/Objectives:

The remediation of per- and polyfluoroalkyl substance (PFAS)-impacted soils presents significant challenges, requiring alternatives to excavation and disposal to reduce costs and environmental risks, including impacts to groundwater. Thermal desorption via thermal conduction heating (TCH) is an ideal remediation strategy applicable in situ or ex situ. TCH involves heating soil using narrow-diameter steel casings installed vertically, horizontally, or diagonally to temperatures exceeding 400 degrees Celsius (°C), and volatilizing PFAS for ex situ treatment via vapor extraction. This abstract summarizes results from three demonstrations of TCH for PFAS remediation funded by the Environmental Security Technology Certification Program (ESTCP): a 134 cubic yard (cy) ex situ soil pile pilot study at Eielson Air Force Base (AFB) in 2021, a 119 cy in situ vadose zone pilot study at Beale AFB in 2023, and a commercial scale 2,000 cy ex situ soil pile at Joint Base Elmendorf-Richardson (JBER) in 2024, with a focus on extracted vapor management and treatment.

Approach/Activities:

The Eielson and JBER demonstrations utilized ex situ soil piles, while the project team implemented the Beale demonstration in situ. Key components of each demonstration included heaters, temperature monitoring points, vapor tight covers, vapor extraction, and granular activated carbon (GAC) for extracted vapor treatment. For each demonstration, the team conducted baseline and confirmation soil sampling and sampled the vapor and condensate process water throughout the heating period for analysis by target PFAS analysis. At JBER, the team and stakeholders considered changes in regulatory frameworks and analytical methods, including using United States Environmental Protection Agency (EPA) Method 1633, total oxidizable precursor assay, and extractable organic fluorine analysis. The team sampled the generated vapors applying Other Test Method (OTM)-45, -50, and -55. All demonstrations used granular activated carbon (GAC) for vapor and condensate process water treatment of extracted PFAS.

Results/Lessons Learned:

The team observed high PFAS removal efficiencies at the pilot and commercial scale, demonstrating the technology's effectiveness. Moisture impacted heating efficiency at Beale, while the Eielson project experienced faster cooling at the soil pile edge due to vacuum effects, contributing to scaling considerations for future applications. At JBER, the technology reduced PFAS concentrations below reporting limits for target compounds in EPA Method 1633. Vapor emissions and process water discharge were compliant with project limits for Eielson, Beale, and JBER. Oil in the soil pile, evidenced by non-aqueous phase liquid in the water tank and measurable hydrophobic organic compounds, impeded GAC performance at JBER. These hydrophobic contaminants likely interfered with GAC's ability to sorb PFAS effectively.

Future TCH designs should include an oil-water separator for successful extracted vapor treatment, even if oil impacts are not anticipated. Additionally, other ex situ treatment methods, such as destructive technologies, could be explored to achieve on-site PFAS destruction, eliminating concentrated waste streams requiring disposal. Future work will focus on advanced characterization and experimentation to optimize PFAS removal, mass recovery, and vapor treatment.

About The Author

Emily Crowover has over 20 years of engineering experience, with areas of expertise in thermal treatment design and implementation, including thermal conduction heating (TCH) and electrical resistance heating (ERH) technologies. She has led the design, implementation, and optimization of thermal remediation systems at sites across the United States and Canada. As Managing Principal Engineer, she manages engineering staff and leads the research and development program for TRS, a Parsons Company, advancing innovation in the thermal remediation industry. She holds a Ph.D. in Bioengineering from the University of Washington-Seattle.

