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Land Disposal of PFAS-Contaminated Soils: A Mathematical Modeling Framework for Site-Specific Risk Assessment

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Per- and polyfluoroalkyl substances (PFAS), a class of some 12,000 chemicals, are recognized as contaminants of emerging concern by the US Environmental Protection Agency, which has recently promulgated stringent (part per trillion) nationwide drinking water standards for a few of the most prevalent of these compounds. Historically, PFAS were essential ingredients of aqueous film forming foams (AFFFs), and their use for fire mitigation has led to widespread PFAS contamination of soils and groundwater at airports, fire stations, and military bases across the United States.

This presentation provides an overview of recent work designed to formulate and demonstrate a mathematical modeling approach that will support the development of site-specific screening levels for PFAS-contaminated soil disposal. Mathematical modeling of PFAS transport in soils presents some unique challenges, due to the amphiphilic properties of PFAS which facilitate air-water interfacial accumulation that can affect both water flow and contaminant retention in the soil profile. The laboratory-validated multiphase flow and transport model used in this study incorporates: (a) natural recharge, (b) PFAS leaching from contaminated soils, (c) PFAS sorption/desorption in the underlying soil profile, (d) competitive PFAS accumulation at air-water interfaces, and (e) vertical advective and dispersive fluxes of constituents through the soil to the underlying groundwater.

The site selected for model demonstration is a US military base in a semi-arid region subject to long periods of cold climate conditions, necessitating the modeling of the effects of snow accumulation and snowmelt on recharge. PFAS-impacted soil, attributed to the historic use of AFFFs, was emplaced in a lined stock-pile and sampled to characterize hydrogeochemical properties and quantify contamination levels. Soil borings of the native soil within the vadose zone underlying the stockpile were also retrieved for characterization. To quantify PFAS desorption kinetics and sorption isotherms for the PFAS-contaminated and underlying soils, a series of batch experiments was undertaken. Column experiments were also conducted to investigate PFAS leaching and subsequent transport within the underlying native soil. Data derived from these experiments were then used to parameterize the simulator for site-specific application.

Results of laboratory analyses revealed detectable concentrations of five EPA-regulated PFAS (PFOA, PFNA, PFBS, PFHxS, and PFOS) and provided information to characterize sorption/desorption and interfacial accumulation behavior. A suite of simulations was conducted for alternative site scenarios, encompassing varying contamination levels, sorption characteristics, hydraulic soil properties, and projected climatic conditions over a one-hundred-year time frame. These simulations provide site-specific estimates of projected PFAS arrival times, concentrations, and mass fluxes at the water table, as well as their ranges of uncertainty. Model-predicted PFAS fluxes are now being employed to explore the potential implications of contaminated soil leaching on groundwater quality and risk to human and ecological receptors.

Country

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References

[1] Arshadi, M., Garza-Rubalcava, U., Guedes, A., Cápiro, N. L., Pennell, K. D., Christ, J., & Abriola, L. M. (2024). Modeling 1-D aqueous film forming foam transport through the vadose zone under realistic site and release conditions. Science of the Total Environment, 170566. https://doi.org/10.1016/j.scitotenv.2024.170566
[2] Garza-Rubalcava, U., Klevan, C., Pennell, K. D., & Abriola, L. M. (2025). Transport and competitive interfacial adsorption of PFOA and PFOS in unsaturated porous media: Experiments and modeling. Water Research, 268B, 122728. https://doi.org/10.1016/j.watres.2024.122728

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