

How long do you need to plan for PFAS groundwater remediation? 100 years or 1,000 years?

This study presents a numerical model developed to quantify the timescale of matrix back-diffusion, the primary mechanism responsible for this long-term plume persistence, and to evaluate relative performance of remediation optimization methods. The model simulates the multi-species transport of key PFAS compounds, including Perfluorooctanoic Acid (PFOA), from representative low-permeability soils (silty clay) into adjacent permeable aquifers and compares to Tetrachloroethylene (TCE).

The model incorporates Fickian diffusion and linear sorption, constrained by published physical and chemical parameters. Scenarios were modeled assuming complete remediation of the adjacent permeable aquifer to create a maximum diffusive concentration gradient (dependent on selected remedial technology). Model simulations consistently predict that the timeframe for back-diffusion from a clay lens to meet stringent regulatory standards is in excess of 500 years when silty clay treatment zone is greater than 10 ft, demonstrating that the sorbed mass acts as a performance-limiting, non-degrading secondary source zone.

This analysis demonstrates that the millennial timescale predicted for PFAS back-diffusion renders passive remediation strategies ineffective for achieving timely site closure. The only viable approach is to actively enhance and capture the mass flux from low-permeability, secondary source zones. This methodology is not theoretical; it adapts proven engineering principles from recalcitrant chlorinated solvent sites, where techniques to enhance mass flux have successfully overcome decades-long back-diffusion challenges. This presentation will showcase these examples and demonstrate how coupling aggressive mass removal with either advanced sequestration technologies, such as engineered carbons, or emerging destructive technologies can collapse the PFAS remediation timeframe from millennia to manageable periods. This proactive strategy provides a technically defensible and predictable pathway to achieving permanent risk reduction and site closure.

Biography for Lowell Kessel

Mr. Kessel is President of CERES Remediation Products, a technology developer and manufacturer of chemicals and reagents for soil and groundwater remediation as well as industrial and mining waste, residues and tailings. Mr. Kessel is a geochemical specialist in remediation technologies with work experience at multinational environmental engineering consulting firms and multiple environmental technology developers for more than 25 years.