Are Regulatory PFAS Screening Levels Good Enough to Assess the Soil to Groundwater Pathway?

Jonathan Reeve (jreeve@eaest.com), Hannah Dennis (hdennis@eaest.com), and
Michael Hertz (mhertz@eaest.com)
(EA Engineering, Science, and Technology Inc, PBC, Hunt Valley, MD, USA)

Background/Objectives. Remediation goals for soil are based on three potential exposure routes. The primary exposure pathways include soil to human and ecological receptors and are based on well-established CERCLA or CERCLA-like site-specific risk assessments. The third exposure pathway is the soil to groundwater pathway, where soil, through water infiltration and leaching, can generate groundwater concentrations in excess of the groundwater standards. For most organics contaminants, environmental practitioners and regulators have used the following in order of complexity to derive the soil to groundwater remediations standards in regulatory programs such as CERCLA or state-based remediation programs 1) conservative 'look-up' concentrations based on linear equilibrium soil/water portioning equations or 2) site-specific soil to groundwater leaching models such as VLEACH or SESOIL/AT123D. PFAS is a unique contaminant class in where 'retardation of nonpolymeric PFAS within vadose zone soils is a complex combination of multiple retention mechanisms and processes' (Anderson, 2021). Given these unique sorption properties are not seen with most hydrophobic contaminants, the linear equilibrium-based equations, which are used by some states to generate screening level soil to groundwater values, and analytical models likely overestimate the leaching of PFAS from soil to groundwater and may not be appropriate. Therefore, more direct measurements including lysimeters and/or synthetic precipitation leaching procedure (SPLP) are underway at many sites to help practitioners and regulators refine the soil to groundwater pathway and estimate the final site-specific soil remediation standards.

Approach/Activities. EA is performing a Remedial Investigation at a DoD facility located in the Pacific Northwest. To assess the soil-to-groundwater pathway, a total of 30 SPLP soil samples (with co-located soil samples with total PFAS sampling results) have been collected. These 30 SPLP sample locations and depths were based on a review of the total PFAS sampling results from 300 soil samples from 60 borings with 5 depth intervals above the observed water table in likely source areas. Each boring was characterized for grain size (particular attention was paid to the finer grained materials) and soil type include natural organic material assessments. Each SPLP sample was homogenized in the field prior to analysis. Approximately 100 grab groundwater samples have also been collected and are located both beneath sources and outside source areas for groundwater delineation purposes. Twenty groundwater wells have also been installed for additional groundwater PFAS sampling and for aquifer characterization including hydraulic conductivity assessments.

Results/Lessons Learned. The results of the SPLP investigation will refine the site-specific soil to groundwater pathway and site-specific remediation goals for soil versus the current modeling and regulatory accepted techniques, which do not account for the unique properties for PFAS that reduce PFAS mass flux to groundwater versus traditional hydrophobic contaminants such as petroleum and chlorinated hydrocarbons. One of the project goals is to assess the source area(a) mass flux from soil to groundwater and to assess the groundwater dilution rates assuming area-specific groundwater hydraulic conductivity and velocities. Comparisons of PFAS mass flux from soil to groundwater from source areas is estimated to be significantly lower than mass flux of PFAS in ground up to water along groundwater flow

direction. This would indicate minor leaching of PFAS to groundwater. However, using generic EPA SSL equations and the draft MCLs for PFOA and PFOS result in subpart per billion soil concentrations for potential remediation. Data analyses performed on the soil, SPLP, and groundwater data suggests these generic SSL concentrations are significantly overestimated and chemical and site-specific factors, when considered, can significantly reduce the total soil volume required for remediation. This project (along with others across the US) will assist the DoD in understanding the magnitude of PFAS leaching to groundwater.