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Following EPA's PFAS Roadmap to Human Health Ambient Water Quality Criteria

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Per- and polyfluoroalkyl substances (PFAS) are a synthetic class of chemicals comprising thousands of fluorinated compounds used in a myriad of consumer products including food wrappers, cookware, and fabrics. Significant regulatory changes related to PFAS continue to be made as the science related to the toxicology, fate and transport, and occurrence of these compounds advances and as public concern grows. The potential impacts to industrial and public entities resulting from regulatory changes are likely to result in significant modifications to wastewater treatment processes and surface water source control efforts as these entities comply with the future PFAS regulatory landscape.

In October 2021, the U.S. Environmental Protection Agency (EPA) released its comprehensive plan, referred to as the *PFAS Strategic Roadmap*, to address PFAS in the nation's water, soil, and air. The *Roadmap* outlines EPA's planned actions to manage PFAS, including monitoring and regulation, through 2024. Since EPA's issuance of the *Roadmap*, the U.S. government has taken many actions related to PFAS, such as adding PFAS to the Toxics Release Inventory Program (TRI); updating health effects levels for certain PFAS; proposing the designation of PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), as hazardous substances under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA); and proposing recommended aquatic life ambient water quality criteria (AWQC) for PFOA and PFOS.

As discussed further below, future changes could lead to the development of freshwater human health AWQC in the very low parts per quadrillion range. AWQC have implications for permitted dischargers and their upstream inputs, fish consumption advisories or 303(d) listing of waters, and CERCLA or state sediment remediation.

Looking Down the Road to Additional Water Quality Criteria

While the actions taken by EPA have importance in their own right, the information underlying those actions can be used to prognosticate about future *Roadmap* destinations.

EPA's stated goal to develop national recommended AWQC for PFAS to protect human health by the fall of 2024 will require that EPA develop parameters to model PFAS intake through water and fish consumption.

Human health AWQC are specific concentrations of chemicals or conditions in a water body computed by EPA below which adverse effects to human health are not expected. Typically, EPA computes recommended human health AWQC for freshwater or marine/estuarine water, with the distinction being that exposure to chemicals in freshwater could occur from both the consumption of water and the consumption of aquatic organisms (e.g., fish and shellfish), whereas in a marine/estuarine environment, exposure is limited to consumption of organisms.

The primary considerations in developing a human health AWQC include the drinking water rate, the organism (or fish) consumption rate, the chemical bioaccumulation factor, the chemical's toxicity, the relative source contribution (i.e., the percent of chemical exposure from other sources), and the risk threshold (in the case of PFOA and PFOS, a noncarcinogenic hazard quotient of 1 would be used).

The idea of exposure to chemicals in water through consumption of water is straightforward, but the concept of being exposed to chemicals in water via consumption of fish and shellfish is more complex; it is chemical-specific. For some chemicals, there is little to no exposure through fish consumption, yet for others, greater exposure occurs through eating fish than drinking water. All other factors being equal, the exposure to waterborne chemicals through aquatic organism consumption is dependent upon a chemical's bioaccumulation factor (BAF). From a relational standpoint, chemicals with higher BAFs (more uptake into fish) will have lower AWQCs (lower criteria are needed to protect humans consuming fish).

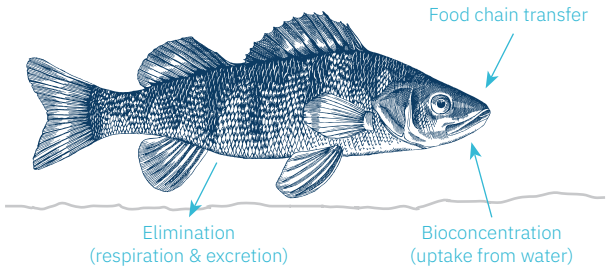
EPA's recent actions for PFOA and PFAS contain information that can be used to estimate the potential human health AWQC for PFOA and PFAS. For example, toxicity information can be gleaned from EPA's June 2022 Interim Updated Health Advisories Levels (HALs) for PFOA and PFAS, and BAFs for these compounds are included in the April 2022 Draft 2022 Aquatic Life Ambient Water Quality Criteria for PFOA and PFAS.

Extremely Low Calculated Water Quality Criteria

Relying on EPA's information, much of which is undergoing review and comment and thus may change, human health AWQC for PFOA and PFOS could be in the single digit parts per quadrillion (pg/L) range. Using standard risk assumptions (a relative source contribution of 20%, a fish consumption rate of 17.5 g day, and a water consumption rate of 2 L/day) and the median BAF for whole body fish published by EPA for the determination of tissue-based aquatic life criteria, the calculated freshwater human health AWQC for PFOA and PFOS could be as low as 4 pg/L and 1 pg/L, respectively. For PFOA, the estimated freshwater human health AWQC is similar to EPA's proposed HAL (due to a lower BAF), but for PFOS, the estimated AWQC is 20 times lower that its respective HAL.

The implications of such low AWQC for PFOA and PFOS could, at a minimum, result in issuance of new National Pollutant Discharge Elimination System (NPDES) permit limits, as well as additional 303(d) listings for impaired waters. Permit limits could pose increased costs to treat and monitor effluent and possibly impact a discharger's ability to comply with its permit. Such low criteria would also influence sediment remediation projects that are targeting PFOA, PFAS, or both. The practicality of such low AWQC is questionable given that detection levels for approved analytical methods are higher than the concentrations that EPA may derive. However, this would not be a situation unique to PFAS. Ultimately, should we reach this destination on the *Roadmap* and find that the AWQC proposed by EPA are as low as that suggested here, new treatment options and effective risk management efforts will be needed to navigate these regulatory waters.

PFAS uptake and elimination in aquatic biota:



Bioaccumulation = bioconcentration + food chain transfer - (elimination + growth dilution)