Setting PFAS-Based Fish Consumption Advisories for Virginia Waterways

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Executive Summary: This policy memo is intended for the Commissioner of Health at the Virginia Department of Health (VDH). The memo provides recommendations when assessing the need for per- and polyfluoroalkyl substances (PFAS)-based fish consumption advisories in Virginia waterways. High-frequency fish consumers and sensitive populations face a greater risk of negative health effects from exposure to PFAS through eating local freshwater fishes. By performing state-wide fish screening assessments for relevant PFAS, the VDH can determine if the nutritional benefits from eating fish outweigh the health risks from PFAS exposure. The following memo recommends that VDH update their PFAS fish tissue screening assessment to include PFUnA and PFDA and release final fish tissue screening recommendations for PFOA and PFOS.

I. Status of PFAS regulations and advisories in the United States

Per- and polyfluoroalkyl substances (PFAS) are a family of over twelve thousand synthetic compounds made up of a carbon-fluorine (C-F) chain attached to a functional group. The C-F bonds are very strong, making PFAS durable when used in manufacturing processes. Their functional groups can be negatively charged, which makes PFAS effective in firefighting foams, food packaging, and nonstick and waterproof coatings. The wide application of PFAS in industry and household products creates many opportunities to enter the environment from the production line and waste streams, for example, landfills and wastewater treatment plants (WWTP). The latest nationwide effort to monitor and regulate PFAS has been centered around drinking water since that is predicted to be the most common exposure pathway for humans. In the first federal regulations for PFAS, the US Environmental Protection Agency (US EPA) released finalized enforceable Maximum Contamination Levels (MCLs) and non-enforceable Maximum Contaminant Level Goals (MCLGs) for six compounds in drinking water in April 2024 (US EPA 2024e). The US EPA's finalized MCLGs for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are each 0 parts per trillion (ppt), while their proposed MCLs are each 4.0 ppt (US EPA 2024e). The four other PFAS in the regulation (perfluorononanoic acid, PFNA; perfluorohexane sulfonic acid, PFHxS; perfluorobutane sulfonic acid, PFBS; and hexafluoropropylene oxide-dimer acid, HFPO-DA or GenX) were assessed as a combined mixture and have a MCLG and MCL as a unitless hazard index of 1.0 (US EPA 2024e). PFHxS, HFPO-DA, and PFNA also each have an individual MCLG and MCL of 10 ppt. Although the MCLs are based on the relative PFAS exposure from drinking water and the detection limits of current technology, the MCLGs are based on modeled health effects. PFOA and PFOS MCLGs set to 0 ppt implies that any ingestion of these compounds should be avoided. Indeed, PFAS have been linked to reduced vaccine response in children, lower birth weights, liver damage, elevated cholesterol levels, thyroid disease, and testicular cancer, making it critical to consider the increased risk to children, pregnant women, and persons with underlying health conditions (EEA 2019; Scherer et al. 2008).

Food consumption is yet another route that people are exposed to PFAS. Processed foods may contain

PFAS that leaches from packaging and processing equipment, while meat, dairy, and produce can bioaccumulate (i.e., the buildup of chemicals in animal or plant tissue that is consumed) PFAS from environmental contamination (Consortium 2019). For some communities, fishing in local water bodies is a low-cost alternative to feed their families (von Stackelberg, Li, and Sunderland 2017). In Washington, D.C. and Northern Virginia angler surveys, the majority of those who relied on local self-caught fishes for food security had a high school education or lower and were African American or Hispanic (Fiske and Callaway 2020; Gibson 2005). This highlights the need for relevant fish consumption guidance to lessen potential health disparities from PFAS exposure. Nationwide fish [muscle] tissue surveys have shown that across tested species, there are typically five PFAS chemicals found in freshwater fish filets, with PFOS found in over 90% of the fish tested (US EPA 2020; 2023a; Barbo et al. 2023). Thus far, the release of fish consumption advisories has been done on a state-by-state basis under the direction of their respective state health and environmental agencies (ECOS 2020). The basis for investigating whether PFAS-based fish consumption advisories are needed varies based on the known occurrence of a PFAS spill, high background PFAS levels, and available financial and research capacity. One of the key components of establishing PFAS health advisories is knowing the chronic reference dose (RfD) (i.e., the daily exposure level that a person can be exposed to over their lifetime without experiencing adverse health effects). As of April 2024, the US EPA has finalized RfDs for PFBS (3×10^{-4} mg/kg/day), GenX (3×10^{-6} mg/kg/day), PFOA (3×10^{-8} mg/kg/day), and PFOS (1×10^{-7} mg/kg/day) (US EPA 2021a; 2021b; 2024a; 2024b).

II. Virginia's PFAS regulatory efforts

In December 2023, the VDH completed the Virginia PFAS Sampling Program through the Office of Drinking Water (VDH 2023). At the time of Virginia's program, other states (e.g., California, Connecticut, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, and Vermont) had begun setting their own limits on PFAS based on their health agencies' respective toxicological studies, use of the US EPA's former PFAS health advisories, or choice to regulate PFAS as individual compounds or a summation. At that time, the VDH stated that they will use the US EPA's non-enforceable advisories when PFAS contamination was detected (VDH 2023). The Virginia PFAS Sampling Program was initiated under the direction of the General Assembly of Virginia (House Bill 586, Chapter 611 (2020)), which requires that the Commissioner of Health create a state working group to investigate the presence of the six PFAS (those in the US EPA's MCLs) in public drinking water sources. The VDH program was funded by a portion of the money allocated from the Bipartisan Infrastructure Law to improve drinking water infrastructure for disadvantaged communities nationwide. Testing sites were selected from drinking water sources in proximity to potential PFAS sources (e.g., unlined landfills, military or commercial airports, discharge points of WWTPs, and other point source discharges to surface waters), waterworks size and population, or whether they were part of a major Virginia river network (VDH 2021; 2023). This program tested PFAS levels in drinking water supplies (i.e., surface water and groundwater sources for drinking water plants) and found that 16 of the 274 waterworks sampled exceeded the US EPA's proposed, and now finalized, MCLs (VDH 2023). The results indicated where VDH should apply funding to mitigate drinking water PFAS contamination. Available funding for PFAS water testing was a limiting factor in the extensiveness of Virginia PFAS Sampling Program. Although the VDH has not yet released formal plans for additional water testing, it is anticipated that these analyses will continue as funding is available. Now that the US EPA has finalized the National Primary Drinking Water Regulation, they will be able to enforce the PFAS MCLs.

With the absence of Federal regulation development on dietary PFAS exposure limits, there is less political pressure for the state to invest resources into assessing PFAS contamination in its fish populations. Unlike drinking water, the consumption of local freshwater fishes is relevant to a subset of Virginia residents. For example, African American and Hispanic residents tend to have higher rates of self-caught fish consumption than white and Asian residents in the Washington, D.C. metropolitan area (including Northern Virginia) (Fiske and Callaway 2020). Subsistence anglers in this region experience some level of food insecurity almost 3.5 times

greater than the national average. With the observed bioaccumulation of PFAS in fishes, it is putting anglers and other consumers (i.e., those who anglers share their catches with) at an even greater health risk (von Stackelberg, Li, and Sunderland 2017). The Virginia Department of Environmental Quality (DEQ) oversees the routine fish tissue sampling conducted to monitor for other contaminants with advisories (e.g., mercury, PCBs) (Browder 1998). The DEQ conducted its first assessment of PFAS fish tissue concentrations in 2021 as a case study on the Middle Chickahominy River due to reports of elevated PFAS concentrations by Newport News Waterworks (DEQ 2022). The findings included recommended screening thresholds for PFOA, PFOS, PFBS, and HFPO-DA in drinking water, recreational water activities, fish consumption, and fish tissue in the Middle Chickahominy River. However, no fish-related advisories were calculated for PFOA and PFOS since at that time, the US EPA had not finalized their respective RfDs. Since the study was conducted prior to the US EPA's release of final RfDs for PFOA and PFOS, the DEQ recommended that sensitive populations (e.g., children and pregnant women) should avoid eating *any* fishes from the Middle Chickahominy watershed (DEQ 2022). In 2022 the DEQ announced plans to test fish tissue for PFAS in the Roanoke River after reports of GenX (HFPO-DA) being detected in the Spring Hollow Reservoir, a drinking water source for three counties (Western Virginia Water Authority 2022).

More action should be taken in Virginia to assess the extent of PFAS contamination in game fishes found in state waters, especially now that the US EPA has finalized an RfD for PFOS. Two policy options are presented in this memo: 1) update the fish tissue screening levels from DEQ's Middle Chickahominy PFAS Project and 2) use toxicity values accepted by other jurisdictions as the basis for Virginia's RfD selection for other relevant PFAS in fish tissue.

III. Policy options

i. Option 1: Update the fish tissue screening levels from the DEQ's Middle Chickahominy River PFAS Project to assess fish tissue across Virginia.

When the DEQ conducted its first fish tissue assessment of PFAS in the Middle Chickahominy River, they used the interim drinking water health advisories to calculate screening thresholds for four PFAS compounds (DEQ 2022). The US EPA determined these thresholds based on toxicological studies predicting the value at which non-cancerous (e.g., high cholesterol, thyroid disease) and cancerous health effects would not occur in humans (Seyyedsalehi and Boffetta 2023; Zheng et al. 2023; US EPA 2022). The 2022 interim drinking water health advisory levels for PFOA and PFOS are 0.004 and 0.02 ppt, respectively (US EPA 2022). Now that the US EPA has released finalized RfDs for PFOA (3×10^{-8} mg/kg/day) and PFOS (1×10^{-7} mg/kg/day), the DEQ can calculate recommended Middle Chickahominy River watershed screening values for fish tissue. For the DEQ, a fish tissue screening value is the chemical concentration in fish muscle tissue at which a person can eat 2, 8-ounce servings a month without experiencing adverse health effects. Using the DEQ's equation and the US EPA's finalized RfDs, the fish tissue screening values for PFOA and PFOS would be about 200 and 550 ppt, respectively (DEQ 2022). At the time of the DEQ study, the finalized RfDs for PFBS and HFPO-DA were already available, so their fish tissue screening values were 2,000,000 and 20,000 ppt, respectively (DEQ 2022).

Advantages

The equation used to determine the fish tissue screening values in the Middle Chickahominy River PFAS Project is readily available in the project's technical document, ensuring repeatability and consistency in data analysis (DEQ 2022). As of April 2024, the RfD values for the four PFAS in the Middle Chickahominy River PFAS Project are finalized and readily available. At least 11 other states and the Great Lakes Consortium have focused on issuing PFOS fish consumption advisories since it is the most detected PFAS in fish tissue across the US (ECOS 2020; US EPA 2023b). The method by which fish tissue is collected and processed for PFAS analysis is sensitive to contamination from equipment, handling practices, and varying instrument sensitivity (US EPA 2023c, 2024d). State and federal agencies in charge of sample collection (e.g., DEQ and the US Geological Survey) are trained on how to properly collect and prepare samples for PFAS analysis using US EPA Method 1633 (US EPA 2024d). By deploying officials from these agencies to collect state-wide fish tissue samples, the VDH would be ensuring consistent practices and data outputs. In addition, the high potential for laboratory sample contamination prompts these agencies to use

contracted labs to perform the sample extractions and instrumental analysis. These contract lab facilities have gone through rigorous quality assurance and quality control measures to ensure they are not introducing contamination, and are adequately following US EPA Method 1633, which is the current Federal protocol for testing PFAS in fish tissue (US EPA 2024d). This practice provides an additional level of consistency, and reduced uncertainty, in the results.

Disadvantages

The Middle Chickahominy River PFAS Project was limited to calculating fish tissue screening values for the four PFAS in the US EPA's interim drinking water health advisory. Out of the four compounds, PFOS and PFOA are the most relevant to fish tissue analyses. This is because PFAS with a short C-F chain length (e.g., PFBS and HFPO-DA) have low bioaccumulation rates (i.e., are less likely to build up in tissues) (Brendel et al. 2018). This is potentially a significant barrier to assess whether PFAS fish consumption advisories are needed in a waterway since there are other PFAS with high (>80%) national detection rates (e.g., perfluorodecanoic acid, PFDA; perfluoroundecanoic acid, PFUnA) in fish tissue that are not listed in the US EPA's interim drinking water health advisory (US EPA 2022; 2023b). The DEQ has not yet indicated the inclusion of other PFAS in their calculations of fish tissue screening values. One way to proceed is to stick with creating screening values for the original four PFAS of focus – PFBS, HFPO-DA, PFOA, and PFOS – as was done in the Middle Chickahominy River case study (DEQ 2022). However, this would limit Virginia's fish tissue risk assessment scope to primarily PFOS, which has been found in 73% of the DEQ's fish tissue samples (DEQ 2023). The detection rates of PFOA, PFBS, and HFPO-DA have only been found in 3% (PFOA) and 0% (PFBS and HFPO-DA) of DEQ fish tissue samples (DEQ 2023). Meanwhile, PFDA and PFUnA had detection rates of 38% and 43% in fishes, respectively (DEQ 2023). For food-insecure families with children and pregnant women who rely on local freshwater fishes as a primary source of protein, it is important to have comprehensive risk assessments.

ii. Option 2: Use toxicity values accepted by other jurisdictions as the basis for Virginia's RfD selection for other relevant PFAS in fish tissue.

Other states such as New Jersey and Illinois have identified a need for other PFAS (e.g., PFUnA) to be included in their states' calculation of fish tissue screening values (IDPH 2024; TIBC Risk Subcommittee 2022). In 2022, New Jersey's Toxics in Biota Committee Risk Subcommittee evaluated available research to determine an RfD value of 1.3×10^{-6} mg/kg/day for PFUnA (TIBC Risk Subcommittee 2022). Illinois uses the same RfD in their current state fish consumption advisory of PFUnA (IDPH 2024). Although the US EPA has released guidance on analytical methods to detect PFUnA in water, sediment, and tissue, it has not begun the toxicity assessment process to release a federal RfD value (US EPA 2024d).

Although PFDA has been identified as one of the top four PFAS found in fish tissue, no states have determined an RfD value to include it in risk assessments. The US EPA is currently undergoing a toxicity assessment of PFDA. As of April 2024, the assessment draft has undergone an agency review, interagency science consultation, public comment period, and external peer review (US EPA 2023a). The assessment draft is now being revised and will then have a final review before the final assessment is released. The final assessment is projected to be released in the third quarter of 2024 (US EPA 2024c).

Advantages

With other states conducting toxicity assessments of PFUnA and creating their own RfD values, there is a wealth of toxicological data that the VDH can review (IDPH 2024; TIBC Risk Subcommittee 2022). The VDH can use this evaluation to update and add to their provisional fish consumption advisory for the Middle Chickahominy River, and other Virginia waterways. Since PFOS and PFUnA are the most prevalent PFAS compounds found in fishes, they can serve as indicators for total PFAS contamination in Virginia fish populations (US EPA 2023b). By using the toxicity values released by US EPA (PFOS) and other states (PFUnA), VDH would be able to apply more of its resources to testing fish tissue instead of investing in additional toxicological research. Another factor that would allow the VDH to easily add other PFAS to their screening value

recommendations is that they have already been testing their fish tissue samples for other PFAS, including PFUnA. This means that the VDH has fish tissue data ready as PFAS toxicity is better understood.

Disadvantages

Although the states considering and implementing PFUnA advisories are consistent in their choice of a PFUnA RfD, there is no draft RfD to use for PFDA. This leaves the VDH in a similar situation as when the 2021 Middle Chickahominy River PFAS Project was released – unable to determine final fish tissue screening values – but this time for PFDA. The US EPA's toxicity assessment process for individual PFAS is extensive, often taking over four years to complete. Since the US EPA's evaluation of PFDA is nearing completion, the VDH can start preparing to include the compound in their PFAS fish tissue risk assessments.

Aside from not yet having an RfD value for some PFAS (e.g., PFDA), there are no significant disadvantages for the VDH to include other PFAS in their determination of fish tissue screening values. As mentioned before, the fish tissue being tested for the original four compounds (PFOA, PFOS, PFBS, and HFPO-DA) is also being analyzed for numerous other PFAS. Although the RfD for PFUnA has only been accepted at the state level in New Jersey and Illinois, their uniformity in RfD choice should enable the VDH to accept it as an interim RfD value until the US EPA releases a final assessment. Since a federal assessment has not begun for PFUnA, it is likely to not be completed until after 2028. After VDH adds to the list of PFAS in their fish tissue screening assessment, DEQ will still need to have the necessary financial and personnel capacity to test additional fishes across Virginia to identify priority areas. As of April 2024, state led PFAS fish tissue testing in Virginia has only occurred in the Middle Chickahominy, Rappahannock, and Roanoke Rivers (DEQ 2023). This leaves many fishes in other Virginia waterways untested. Priority areas can vary based on proximity to PFAS sources (known, suspected, or unknown), geologic factors influencing water transport (e.g., karst topography), and regional game fishes of interest (influenced by salinity and surface water connectivity). Allocating resources to areas more heavily contaminated with PFAS will de-prioritize some regions but would give residents at greatest risk the agency to avoid eating certain species as necessary.

IV. Policy recommendation

We recommend Option 2, for the VDH to consider the toxicity values for additional PFAS (e.g., PFUnA) accepted by other states to establish interim fish tissue screening thresholds in Virginia waterways. We also recommend that Virginia applies the US EPA's final RfD values for PFOA and PFOS to their provisional recommendations in the 2021 Middle Chickahominy River PFAS Project. One of the key components of creating fish tissue screening levels is knowing the appropriate RfD values to assess risk. Two states considering or implementing PFUnA fish consumption advisories have adopted the RfD value 1.3×10^{-6} mg/kg/day (IDPH 2024; TIBC Risk Subcommittee 2022). Using the PFUnA RfDs accepted by other states and the final RfDs for PFOA and PFOS from the US EPA will allow Virginia to create formal guidance to residents and communicate any issued PFAS fish consumption advisories. As capacity allows, the VDH and DEQ should invest in conducting statewide fish consumption behavior surveys and expanded PFAS fish tissue testing. The results of this assessment would identify any region-specific fish consumption behavior (e.g., favored species, demographics of high-frequency fish consumers), and priority areas that should be considered in any upcoming guidance or risk modeling. This step would also inform the VDH on how to communicate any future PFAS fish consumption advisories. Public hearings, town halls, and informational sessions with community leaders would be just a few ways for VDH officials to spread awareness to individuals. The bottom line is for VDH to make informed, timely recommendations for Virginia residents to reduce elevated PFAS exposure from fish consumption.

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