December 5, 2022

Dr. Mary Bassett
Commissioner
New York State Department of Health
Corning Tower, Empire State Plaza
Albany, NY 12237

Dear Commissioner Bassett,

We appreciate the opportunity to submit comments on the New York State Department of Health's ("DOH" or the "Department") proposed regulations to establish Maximum Contaminant Levels ("MCLs") and Notification Levels ("NLs") for twenty-three per- and polyfluoroalkyl substances ("PFAS") in drinking water. PFAS pose one of the greatest threats to drinking water and public health in New York. Bold action is needed to get these toxic chemicals out of our water and notify the public about any risks to their health.

Unfortunately, the proposed regulations are simply not adequate to protect New Yorkers' health. The proposed MCLs and NLs are not in line with the latest science, and in some instances are weaker than what states like Massachusetts, Maine, Rhode Island, and Michigan have established or are preparing to establish. They would cede New York's status as a national leader on PFAS at a time when our leadership is more important than ever.

We urge you to establish PFAS standards at the lowest level technologically feasible and protective of human health based on the best available science, and regulate this dangerous group of chemicals as a class.[1] Specifically, we urge you to:

1. Lower New York's perfluorooctanoic acid ("PFOA") and perfluorooctane sulfonate ("PFOS") MCLs of 10 ppt each. Set MCLs as close to 2 ppt as technologically feasible, and no higher than 4 ppt;
2. Lower the proposed MCLs of 10 ppt each for perfluorohexane sulfonate ("PFHxS"), perfluoroheptanoic acid ("PFHpA"), perfluorononanoic acid ("PFNA"), and perfluorodecanoic acid ("PFDA"). Based on their similarities to PFOA and PFOS, set MCLs as close to 2 ppt as technologically feasible, and no higher than 4 ppt;
3. Establish an MCL for GenX, rather than an NL as proposed. Set the MCL at the lowest technologically feasible level, and no higher than 10 ppt;
4. Lower the proposed combined PFAS MCL of 30 ppt. Set the most stringent combined MCL in the nation, for the 7 PFAS listed above, lower than 20 ppt and at the lowest technologically feasible level for any of the 7 PFAS;
5. Lower the proposed combined NLs of 30 ppt for 6 PFAS and 100 ppt for 13 PFAS. Set a single combined NL lower than 20 ppt and at the lowest technologically feasible level for any of the 19 PFAS;

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[1] *See* N.Y. Env't Conservation L. § 27-1205.

6. Review the above PFAS standards at least once every 3 years. As detection capabilities for PFAS improve, DOH should lower these standards towards 0 ppt. DOH should also invest resources into furthering advancements in detection technology; and
7. Strengthen proposed testing and notification requirements for MCLs and NLs, to ensure Public Water Systems ("PWSs") conduct swift, regular, and comprehensive monitoring and that New Yorkers are directly notified about exceedances.

PFAS are a class of bioaccumulative, persistent, and toxic chemicals. Exposure to PFAS has been linked to liver disease, immune system damage, kidney and testicular cancer, and other harmful illnesses. We have seen the damage these chemicals have caused in Hoosick Falls, Newburgh, Long Island, and many other parts of our state.

In June, the U.S. Environmental Protection Agency ("EPA") released new Health Advisory Levels ("HALs") for two PFAS, PFOA and PFOS, declaring that there is essentially no safe level of exposure to those chemicals. Instead of acting on this groundbreaking determination and the most up to date scientific evidence, DOH failed to propose lowering New York's current MCLs for PFOA and PFOS, which are hundreds of times higher than EPA's advisories, and did not strengthen newly-proposed standards for other, similar PFAS.

Without stronger standards, there are likely over a million New Yorkers currently exposed to dangerous levels of PFAS who will not have their drinking water cleaned up. Their health will continue to be put at risk when they turn on the tap.

We are also concerned by DOH's proposal to, for the first time, implement the Emerging Contaminant Monitoring Act ("ECMA"), which will establish important precedents for future testing of toxic chemicals. Under the proposal, PWSs could take as long as three years to collect a single sample that would determine whether their drinking water exceeds the NLs. New Yorkers have already waited years for this testing; they should not have to wait any longer to learn if there are concerning levels of PFAS in their water.

In addition, DOH's proposal would, in certain circumstances, allow PWSs to bury NL exceedances in lengthy, technical Annual Water Quality Reports ("AWQRs"). An NL exceedance is a serious issue. Whenever it occurs, PWSs should be required to send a separate letter in the mail to every one of their customers. That is how other potential threats to our drinking water are treated – PFAS should be no different. We urge DOH to remove this loophole and be fully transparent with the public about what's in their water.

On November 4, New Yorkers voted overwhelmingly in favor of the $4.2 billion Clean Water, Clean Air, and Green Jobs Environmental Bond Act. A year ago, voters approved adding a right to clean water, clean air, and a healthful environment to our state's constitution by even greater margins. A vast, bipartisan majority of New Yorkers, from Long Island to Buffalo, have consistently declared that they want stronger environmental protections, not weaker ones. We urge you to listen to these New Yorkers, as well as PFAS-impacted communities and scientists across the nation, and enact the most health-protective PFAS standards.

New York has more funding than ever to enact stronger protections against PFAS, with hundreds of millions in grants available through the Clean Water Infrastructure Act ("CWIA"), federal Bipartisan Infrastructure Law, and Environmental Bond Act to help PWSs install treatment technology. It may be a long time before our state has access to such a confluence of resources again. We urge you to seize the opportunity presented by these historic investments to eliminate PFAS pollution and keep drinking water affordable for all. New tools to hold polluters accountable will also help ensure that they, and not the public, pay the costs of contamination.

Once enacted, these regulations will likely be in place for years or decades to come. It is imperative that you set the strongest possible standards now and prevent New Yorkers' continued exposure to these "forever chemicals." As New York will be the first state to regulate many of these PFAS, DOH's standards will set a powerful precedent for how other states and the federal government should protect the public from these toxic chemicals.

Every New Yorker deserves clean drinking water. It is both technologically feasible and morally imperative to strengthen the proposed PFAS standards in your final regulations and ensure dangerous contamination is eliminated.

1. The Weight of Scientific Evidence Points to the Need for Stringent, Class-Based Drinking Water Standards for PFAS

It is critical that DOH update its drinking water regulations to account for the latest science concerning the health effects of PFAS. Advocates and DOH agree that PFAS have unique characteristics that make them particularly concerning from a public health standpoint. In evaluating the recent literature on PFAS health effects, what has emerged is a consensus view: all PFAS share key characteristics that make them potentially capable of posing serious threats to human health and the environment.

PFAS' unique characteristics call for an innovative regulatory approach. Experts note that "traditional approaches have failed to control widespread exposures to PFAS and resulted in inadequate public health protection."[2] As the federal government's own scientists have recognized, the entire class of PFAS is comprised of structurally similar compounds that scientists can "reasonably expect to act through the same pathways and have similar effects."[3] Thus, the authors of the 2020 peer-reviewed study concluded that "the high

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[2] Carol F. Kwiatkowski et al., *Scientific Basis for Managing PFAS as a Chemical Class*, 7 Env't Sci. & Tech. Letters 532, 536 (2020) https://pubs.acs.org/doi/pdf/10.1021/acs.estlett.0c00255.

[3] *See Examining the Federal Response to the Risks Associated with Per- and Polyfluoroalkyl Substances (PFAS): Hearing Before the S. Comm. on Env't & Pub. Works,* 116th Cong. 2 (Mar. 28,

persistence, accumulation potential, and/or hazards (known and potential) . . . *warrant treating all PFAS as a single class.*"[4]

DOH has for years acknowledged the health impacts of the two most widely-studied PFAS: PFOA and PFOS. In promulgating its 2020 MCLs for PFOA and PFOS, DOH cited a range of adverse effects including: cancer; effects on the liver, immune system, thyroid, and on developing fetuses; increases in cholesterol, triglycerides and uric acid; and reproductive and development abnormalities.[5] More recently, DOH has suggested that four additional PFAS – PFHxS, PFNA, PFHpA, and PFDA – should be regulated, based in part on "[h]alf-life, toxicology, and structural similarities to PFOA and PFOS."[6] This is a step in the right direction, but DOH must go much further by setting more stringent standards that better align with the need to treat all PFAS as a class.

DOH has explained that MCLs should be "protective of public health" and "science-based."[7] Yet even at the time the prior regulations were issued, there were concerns that DOH's proposal was insufficiently protective of public health. DOH's claims that the 2020 MCLs would "provide a sufficient margin of protection" for sensitive populations and for the general public were dubious then, and deserve even more scrutiny now in light of the latest science.[8]

Studies published in the last year-plus further underscore the fact that many PFAS to be studied to date are associated with humanlinked to adverse health outcomes and ecosystem harm. The newer studies also suggest that there is a broader range of negative health consequences associated with PFAS exposures, even at low levels. Since October 2021, more than forty new peer-reviewed studies have been published, citing associations between PFAS exposure and a range of adverse health outcomes, including: liver, metabolic, developmental, reproductive, and immuno-toxicity; cancer; thyroid disruption; epigenetic alterations; and ecotoxicity.[9] This recent literature corroborates and adds to the weight of scientific evidence

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2019) (testimony of Linda S. Birnbaum, Fmr. Dir., Nat'l Inst. Env't Health Sci. & Nat'l Toxicology Program, Nat'l Ins. Health), https://www.govinfo.gov/content/pkg/CHRG-115shrg33955/html/CHRG-115shrg33955.htm.

[4] Kwiatkowski et al., *supra* note 2, at 532 (emphasis added).

[5] N.Y. DOH, *Maximum Contaminant Levels: Regulatory Impact Statement* ("DOH July 2019 Proposal"), 21–22 (2020) https://regs.health.ny.gov/sites/default/files/proposed-regulations/Maximum%20Contaminant%20Levels%20%28MCLs%29.pdf.

[6] Daniel Lang, N.Y. DOH, *Emerging Contaminants Public Health Law 1112 Amendments and Regulatory Approaches* 18 (2022).

[7] *See, e.g.*, N.Y. DOH, *Maximum Contaminant Level (MCL) Discussion: PFOA, PFOS and 1,4-Dioxane* 4 (Dec. 18, 2018) (presentation during DWQC meeting).

[8] DOH July 2019 Proposal, *supra* note 5, at 10.

[9] *See, e.g.*, Brian J. Tornabene et al., *Relative Acute Toxicity of Three Per- And Polyfluoroalkyl Substances on Nine Species of Larval Amphibians*, 17 Integrated Env't Assessment & Mgmt. 684 (2021) https://doi.org/10.1002/ieam.4391; Lina Birgersson et al., *Thyroid Function and Immune Status in Perch (Perca Fluviatilis) from Lakes Contaminated with PFASs Or PCBs*, 222 Ecotoxicology and Env't Safety 112495 (2021) https://doi.org/10.1016/j.ecoenv.2021.112495; Jiachen Sun et al., *Influence of Perfluoroalkyl Acids and Other Parameters on Circulating Thyroid*

for these endpoints. Some studies have also enhanced the links to adverse health effects from "environmentally-relevant" PFAS exposures.[10]

The federal government has recognized the need to update its standards and findings on toxicity and exposure in light of this growing body of scientific evidence. In May 2021, the Agency for Toxic Substances and Disease Registry strengthened its conclusions regarding twelve PFAS, citing hepatic effects, cardiovascular effects, immune effects, and developmental effects.[11] In October 2021, EPA established subchronic and chronic reference dose values for GenX – a short-chain replacement compound for PFOA – based on the mounting scientific evidence linking GenX exposure to many of the same adverse health outcomes caused by PFOA exposure.[12]

Hormones and Immune-Related Microrna Expression in Free-Ranging Nestling Peregrine Falcons, 770 Sci. of The Total Env't 145346 (2021) https://doi.org/10.1016/j.scitotenv.2021.145346; Robert Wesley Flynn et al., *Comparative Toxicity of Aquatic Per- and Polyfluoroalkyl Substance Exposure in Three Species of Amphibians*, 41 Env't Toxicology & Chemistry 1407 (2022) https://doi.org/10.1002/etc.5319; Carolyn Sonter et al., *Biological and Behavioral Responses Of European Honey Bee (Apis Mellifera) Colonies To Perfluorooctane Sulfonate Exposure*. 17 Integrated Env't Assessment & Mgmt. 673 (2021) https://doi.org/10.1002/ieam.4421.

[10] Xin Liu et al., *Identification and Prioritization of the Potent Components for Combined Exposure of Multiple Persistent Organic Pollutants Associated with Gestational Diabetes Mellitus*. 409 J. of Hazardous Materials 124905 (2021) https://doi.org/10.1016/j.jhazmat.2020.124905; Guoqi Yu et al., *Environmental Exposure to Perfluoroalkyl Substances in Early Pregnancy, Maternal Glucose Homeostasis and the Risk of Gestational Diabetes: A Prospective Cohort Study (2021)*, 156 Env't Int'l 106621 (2021) https://doi.org/10.1016/j.envint.2021.106621; Rahel Birru et al., *A Pathway Level Analysis of Pfas Exposure and Risk of Gestational Diabetes Mellitus*, 20 Env't Health 63 (2021) https://doi.org/10.1186/s12940-021-00740-z; Blanca Sarzo et al., Maternal Perfluoroalkyl Substances, Thyroid Hormones, and DIO Genes: A Spanish Cross-sectional Study. 55 Env't Sci. & Tech. 11144 (2021) https://doi.org/10.1021/acs.est.1c01452; Arash Derakhshan et al., *Association of Per- and Polyfluoroalkyl Substances with Thyroid Homeostasis During Pregnancy in the Selma Study*, 167 Env't Int'l 107420 (2022) https://doi.org/10.1016/j.envint.2022.107420; Richard Jensen et al., *Higher Free Thyroxine Associated with PFAS Exposure in First Trimester. The Odense Child Cohort*, 212 pt. D Env't Research 113492 (2022) https://doi.org/10.1016/j.envres.2022.113492; Jianqiu Guo et al., *Umbilical cord serum perfluoroalkyl substance mixtures in relation to thyroid function of newborns: Findings from Sheyang Mini Birth Cohort Study*, 273 Chemosphere 129664 (2021) https://doi.org/10.1016/j.chemosphere.2021.129664; Qian Yao et al., *Prenatal Exposure to Per- and Polyfluoroalkyl Substances, Fetal Thyroid Hormones, And Infant Neurodevelopment*, 206 Env't Research 112561 (2022) https://doi.org/10.1016/j.envres.2021.112561; Sofia Hammarstrand et al., *Perfluoroalkyl Substances (Pfas) in Drinking Water and Risk for Polycystic Ovarian Syndrome, Uterine Leiomyoma, and Endometriosis: A Swedish Cohort Study*. 157 Env't Int'l 106819 (2021) https://doi.org/10.1016/j.envint.2021.106819; Crute et al., *Evaluating Maternal Exposure to an Environmental Per And Polyfluoroalkyl Substances (Pfas) Mixture During Pregnancy: Adverse Maternal and Fetoplacental Effects in A New Zealand White (Nzw) Rabbit Model*, 838 pt. 4 Sci. of The Total Env't 156499 (2022) https://doi.org/10.1016/j.scitotenv.2022.156499.

[11] ATSDR, *Toxicological Profile for Perfluoroalkyls*, U.S. Dep't HHS (2020) https://www.atsdr.cdc.gov/ToxProfiles/tp200.pdf.

[12] *See* EPA, *Technical Fact Sheet: Human Health Toxicity Assessment for GenX Chemicals* (Oct. 2021), https://www.epa.gov/system/files/documents/2021-10/genx-final-tox-assess-tech-factsheet-2021.pdf.

In June 2022, EPA updated its drinking water HALs for PFOS and PFOA based on increasing evidence of their extreme danger – ratcheting down the acceptable levels by 3,500 and 17,500 times, respectively.[13] EPA set its interim PFOA HAL at 0.004 ppt and its interim PFOS HAL at 0.02 ppt, far below the current levels of detection for these two chemicals. This is EPA's second adjustment to its HALs for PFOA and PFOS, which were first set in 2009 at 400 ppt for PFOA and 200 ppt for PFOS, and then revised downward again in 2016 to 70 ppt individually and in combination. EPA's HALs reflect the fact that the scientific consensus that "the levels at which negative health effects could occur are much lower than previously understood" and continue to suggest that there is no known safe level of exposure.[14] EPA's findings on PFOA and PFOS also support the conclusion of one of the leading experts in the field, who has suggested that a health-protective drinking water standard for all PFAS could be as low as 0.1 ppt.[15]

In addition, the National Academies of Sciences, Engineering, and Medicine ("NASEM") issued a recent report on PFAS intended to inform clinical care, and found evidence linking PFAS exposure to many of the health outcomes mentioned above.[16] The NASEM Report recommended that clinicians consider the combined sum of PFAS levels, reflecting the reality that real-world PFAS exposures are often in mixtures, and offering further evidence for a class-based regulatory approach. Moreover, the NASEM Report concluded that adverse health effects can be expected at serum or plasma concentrations as low as 2 ng/mL.

Opponents of more stringent PFAS regulation have pointed to recent proposed Guidelines on Drinking Water Quality from the World Health Organization ("WHO"), which argues for less protective PFAS standards than what EPA and many states have adopted. These guidelines, however, have been refuted by over 115 scientists, who have noted that the WHO's approach was not based on the latest science.[17] Over the last two decades, the scientists found that the WHO "omit[ted] or obscure[d]" evidence linking PFAS exposure to adverse health outcomes.[18] Reporting also suggested the role that industry-friendly authors played in

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[13] EPA, *Technical Fact Sheet: Drinking Water Health Advisories for Four PFAS (PFOA, PFOS, GenX Chemicals, and PFBS)* (June 2022), https://www.epa.gov/system/files/documents/2022-06/technical-factsheet-four-PFAS.pdf.

[14] Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances, 87 Fed. Reg. 171 (proposed Sept. 6, 2022) (to be codified at 40 C.F.R. pt. 302) https://www.govinfo.gov/content/pkg/FR-2022-09-06/pdf/2022-18657.pdf.

[15] *See* Sharon Lerner, *Teflon Toxin Safety Level Should be 700 Times Lower than Current EPA Guideline*, The Intercept (June 18, 2019 11:54 am), https://theintercept.com/2019/06/18/pfoa-pfas-teflon-epa-limit/.

[16] Nat'l Academies of Scis., Eng'g, and Med., Guidance on PFAS Exposure, Testing, and Clinical Follow-Up: Summary, Nat'l Academies Press (2022) https://nap.nationalacademies.org/read/26156/chapter/2#7.

[17] Letter from Green Science Policy Institute to Bruce Gordon, Unit Head, Water, Sanitation, Hygiene and Health at the World Health Organization (Nov. 10, 2022). https://greensciencepolicy.org/docs/General/pfas-scientists-letter-to-who-20221110.pdf

[18] *Id*. at 1.

shaping the WHO's proposal,[19] and other regulators have pushed back on it.[20] Given the controversy, and the apparent insufficiency of the scientific basis underpinning the WHO's recommendation, there is no basis for DOH to give it any consideration.

There is a growing scientific consensus regarding the importance of considering cumulative PFAS exposures, and DOH's regulatory approaches should follow. EPA's methodology for assessing noncancer risk from PFAS mixtures in water concludes that "any detectable level of PFOA or PFOS will result in a [hazard index] greater than one for the whole mixture" – meaning there would be an exceedance of what the agency deems to be a health-protective level.[21] As DOH's sampling shows, New Yorkers with PFAS in their water are generally exposed to multiple PFAS. EPA's analysis confirms what advocates told DOH in 2020: that non-cumulative toxicity assessments, as DOH has relied on, "could be significantly underestimating the real-world effects of PFAS."[22] A class-based approach, as DOH has done with polychlorinated biphenyls ("PCBs"), is the most health-protective regulatory option available.

In order to fulfill DOH's stated objective of developing science-based, health-protective regulations that protect vulnerable populations, the current proposal must be revised in numerous ways, as described throughout these comments.

2. History of PFAS Laws and Regulations in New York State Relating to Drinking Water

Polluters have contaminated New York's drinking water with PFAS for decades, but it is only in the last decade that this contamination has gained significant public attention. Laws and regulations to identify and eliminate PFAS from drinking water have lagged behind the rapidly-expanding body of scientific evidence about the dangers of these chemicals.

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[19] Tom Perkins, *More Than 110 Experts Raise Alarm Over WHO's 'weak' PFAS Limits for Drinking Water*, The Guardian (Nov. 19, 2022, 5:00 AM), https://www.theguardian.com/environment/2022/nov/19/pfas-world-health-organization-who-drinking-water.

[20] N.J. Dep't of Envtl. Prot., *Summary of NJDEP Comments on "PFOS and PFOA in Drinking-water Background Document for Development of WHO Guidelines for Drinking-water Quality; 29 September 2022. Version for Public Review"* (undated), https://www.nj.gov/dep/dsr/who-comment-summary.pdf; Gloria Post, N.J. Dep't of Envtl. Prot., *Comments on WHO Draft Background Document* (2022), https://dep.nj.gov/wp-content/uploads/dsr/njdep-comments-who-pfas-guidelines.pdf.

[21] EPA, *Interim Drinking Water Health Advisory: Perfluorooctanoic Acid (PFOA) CASRN 335-67-1* at 17, (2022) https://www.epa.gov/system/files/documents/2022-06/interim-pfoa-2022.pdf; EPA, *Interim Drinking Water Health Advisory: Perfluorooctane Sulfonic Acid (PFOS) CASRN 1763-23-1* at 18 (2022), https://www.epa.gov/system/files/documents/2022-06/interim-pfos-2022.pdf.

[22] Letter from Kimberly Ong, Natural Resources Def. Council et al., to Katherine Ceroalo, N.Y. DOH at 21 (Sept. 23, 2019) (attached hereto as Exhibit A).

The first required monitoring for PFAS in New York occurred under EPA's Third Unregulated Contaminant Monitoring Rule ("UCMR") between 2013 and 2015.[23] PWSs serving more than 10,000 people were required to test for PFOA, PFOS, PFHpA, PFHxS, PFNA, and PFBS, and were required to report their results to EPA, though only if those results exceeded EPA's Minimum Reporting Levels (MRLs), which ranged between 10 ppt and 90 ppt. Due to these exceptionally high MRLs, the lack of testing in small communities, and the limited number of PFAS listed under UCMR 3, both EPA and the public remained in the dark about a significant amount of PFAS contamination in New York. Even the data that was reported to EPA led to little immediate impact in the communities affected, due to UCMR's lack of requirements to directly notify the public or reduce contamination.

Because of these loopholes, it took an individual resident of Hoosick Falls testing his water in 2014, after seeing family members and neighbors become sick with rare illnesses, to discover astronomically high levels of PFOA in the small village's drinking water.[24] Yet the village government and DOH, after being informed of the contamination in August 2014, waited months to notify residents about the contamination, and even then advised that the water "constituted no immediate health hazard" in January 2015. After learning of the contamination in October 2015, EPA Region 2 Administrator Judith Enck advised the mayor of Hoosick Falls not to allow residents to drink the water, and directed Region 2 to communicate this directly to residents in January 2016.

The public outcry and community organizing that resulted from the revelation that Hoosick Falls residents had been subjected to decades of harmful exposure and that the village government and DOH had failed to be transparent with residents and proactive in protecting human health led to a greater awareness of and organizing in other PFAS-impacted communities like Newburgh and on Long Island. The growing public pressure for action on PFAS delivered major state-level policy change. In 2016, DEC designated PFOA and PFOS as state hazardous substances.[25] In 2017, the State Legislature and former Governor Cuomo enacted a suite of new policies in the state budget, including the CWIA,[26] the ECMA, and the NYS Drinking Water Quality Council ("DWQC").

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[23] *See* EPA, *Third Unregulated Contaminant Monitoring Rule*, https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule (last updated Dec. 27, 2021).

[24] *See* Brendan J. Lyons, *Emails Show Early Confusion Over Hoosick Falls Water Pollution*, Albany Times-Union (Feb. 6, 2016), https://www.timesunion.com/local/article/EPA-and-state-warned-of-Hoosick-Falls-water-6812774.php.

[25] N.Y.S. Dep't of Env't Conservation*, Per- and Polyfluoroalkyl Substances (PFAS)*, https://www.dec.ny.gov/chemical/108831.html (last accessed Dec. 5, 2022).

[26] Since 2017, the State Legislature and Governor have invested a total of $4.5 billion into the Clean Water Infrastructure Act ("CWIA"). The CWIA includes funding for the Water Infrastructure Improvement Act, which provides grants for PFAS treatment technology installation. The CWIA also includes funding for the State Superfund Program and created DEC's Inactive Landfill Initiative, which is investigating PFAS and 1,4-dioxane contamination at inactive landfills across the state. *See* N.Y.S. Dep't of Env't Conservation, *New York State Inactive Landfill Initiative* at 6-7 (July 2022), https://www.dec.ny.gov/docs/materials_minerals_pdf/inactivelandfillreportfinal202207.pdf.

DWQC was created to provide recommendations to DOH on emerging contaminants in drinking water, including what MCLs and NLs to set for emerging contaminants. DWQC's membership, defined in state statute, includes state agency staffers, PWS operators, and members of the public with scientific and engineering backgrounds, though conspicuously missing is representation from communities impacted by emerging contaminants.[27] DWQC held its first meeting in October 2017, and made its first recommendation in December 2018, when it recommended that DOH establish MCLs of 10 ppt each for PFOA and PFOS and an MCL of 1 part per billion ("ppb") for 1,4-dioxane.[28]

In July 2019, DOH proposed draft regulations to adopt DWQC's recommendations.[29] Despite advocacy by impacted communities, public health professionals, and clean water advocates to lower the proposed PFOA, PFOS, and 1,4-dioxane MCLs,[30] DOH finalized the MCLs as proposed in August 2020.[31] The final regulations included a new ability for certain PWSs with PFOA, PFOS, and 1,4-dioxane levels above the MCLs to access a "deferral" of a formal violation as they took steps to reduce their contaminant levels.

While DOH advanced MCLs in 2020, no progress had been made towards implementing the ECMA, enacted over three years prior. Intended to close many of the loopholes identified by the Hoosick Falls crisis, the ECMA directs DOH to publish lists of "emerging contaminants" that every PWS in the state, regardless of size, is required to test for.[32] These PWSs are also required to notify the public if their contaminant levels exceed NLs established by DOH.

In response to DOH's failure to publish a first list of emerging contaminants, and recognizing the urgent need to regulate other PFAS beyond PFOA and PFOS, the State Legislature passed a bill in June 2021 directing DOH to list 27 PFAS and 13 other chemicals on its first list of emerging contaminants, as well as requiring DOH to create a new list of emerging contaminants for testing at least once every three years.[33] The 27 PFAS, in addition to PFOA and PFOS, comprise all of the PFAS chemicals that can currently be detected in drinking water using EPA-approved methods (EPA Methods 537.1 and 533).

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[27] N.Y. Pub. Health L. § 1113(1)-(2).

[28] The video recordings of all DWQC meetings are archived on the DWQC website. N.Y. DOH, *Drinking Water Quality Council, Past Meetings* https://www.health.ny.gov/environmental/water/drinking/dwqc/#f (last updated Nov. 2022).

[29] Proposed Maximum Contaminant Levels (MCLs), 41 N.Y.S. Reg. at 19 (proposed July 24, 2019) (amending 10 N.Y.C.R.R. Subpart 5-1), https://dos.ny.gov/system/files/documents/2019/11/072419.pdf.

[30] Letter from Maureen Cunningham & Robert Hayes, Environmental Advocates of New York, et al., to Howard Zucker, Comm'r, N.Y. DOH (Sept. 23, 2019), https://eany.org/eanypdfs/joint_mcl_comments_092319.pdf (attached hereto as Exhibit B).

[31] Notice of Adoption, Maximum Contaminant Levels (MCLs), 41 N.Y.S. Reg. at 6 (adopted Aug. 26, 2020) (amending 10 N.Y.C.R.R. Subpart 5-1), https://dos.ny.gov/system/files/documents/2020/10/082620.pdf.

[32] *See* N.Y. Pub. Health L. § 1112(3).

[33] *See* An Act to Amend the Public Health Law, in Relation to Establishing a List of Emerging Contaminants, L.2021, ch. 716. § 1 (adopted Dec. 22, 2021) (codified at N.Y. Pub. Health L. § 1112).

In response, DOH proposed and DWQC recommended establishing 7 PFAS as emerging contaminants at an October 2021 DWQC meeting (PFNA, PFHxS, PFHpA, PFHxA, PFPeA, PFBA, and PFBS). At a December 2021 DWQC meeting, DOH proposed NLs of 20 ppt each for PFNA, PFHxS, and PFHpA, and NLs of 200 ppt each for PFHxA, PFPeA, PFBA, and PFBS. Advocates, however, continued to urge newly-elevated Governor Hochul to sign the Legislature's more comprehensive testing bill.

On December 23, 2021, Governor Hochul signed the bill to establish New York's first emerging contaminant testing list. The Governor and the State Legislature agreed to changes to the bill, enacted in February 2022, which required DOH to list 23 PFAS on its first list of emerging contaminants, with the remaining 17 contaminants in the bill to be considered by DWQC for potential future listing.[34] The 23 PFAS, in addition to PFOA and PFOS, comprise the PFAS chemicals that can be detected with EPA Method 533. The enacted bill required DOH to propose draft regulations establishing the first list by June 19, 2022, 180 days after December 23, 2021.

At a March 2022 DWQC meeting, DOH proposed establishing MCLs, rather than NLs, of 10 ppt each for 4 of the 23 PFAS that were to be included on the first list of emerging contaminants (PFNA, PFHxS, PFHpA, and PFDA). At the following DWQC meeting in May 2022, DOH proposed establishing NLs for the remaining 19 PFAS. DOH proposed a combined NL of 30 ppt for 6 PFAS (PFHpS, PFUnA, PFDoA, GenX, 9Cl-PF3ONS, and 11Cl-PF3OUdS) and a combined NL of 100 ppt for 13 PFAS (PFBA, PFBS, PFPeA, PFPeS, PFHxA, ADONA, 4:2FTS, 6:2FTS, 8:2FTS, NFDHA, PFEESA, PFMPA, PFMBA).

At the May 2022 DWQC meeting, DWQC recommended that DOH establish the MCLs and NLs as proposed, and also recommended that DOH establish a combined MCL to cover 6 PFAS (PFNA, PFHxS, PFHpA, PFDA, PFOA, and PFOS). DWQC did not recommend a specific level for the combined MCL that DOH should adopt. It is important to note that DWQC's recommendations were made before EPA proposed new HALs for PFOA and PFOS and finalized a HAL for GenX. As of the writing of these comments, DWQC has not held a meeting since the publication of EPA's PFAS HALs. DWQC has therefore not been able to deliberate on whether to revise their recommendations in light of EPA's determinations.

On October 5, 2022, over three months after the statutory deadline had passed, DOH proposed the current draft regulations to adopt DWQC's recommendations, as well as establish a combined PFAS MCL of 30 ppt and an individual NL of 10 ppt for GenX.

3. Overview of PFAS Contamination in New York State's Drinking Water

The PFAS monitoring that PWSs have conducted in compliance with New York's PFOA and PFOS MCLs since August 2020 has produced a wealth of PFAS occurrence data, though

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[34] *See* An Act to Amend the Public Health Law, in Relation to Establishing a List of Emerging Contaminants, L.2022, ch. 69. § 1 (approved Feb. 24, 2022).

only some of this data is accessible to the public. There are three main ways that New Yorkers can currently learn what levels of PFAS are being detected in PWSs, outside of testing their own drinking water.

First, DOH has presented summaries of PFAS sampling data that Local Health Departments ("LHD") have submitted to DOH's Safe Drinking Water Information System ("SDWIS") database at several DWQC meetings since 2021. The summaries have included information such as the number of samples across the state that have detected various PFAS and the maximum result reported for each PFAS. The data presented, however, has never identified which specific PWSs are associated with elevated PFAS levels.

Second, DOH has incorporated data on PFOA and PFOS into its online, interactive Environmental Public Health Tracker.[35] The tracker provides the maximum and average level of PFOA and PFOS for a subsection of the PWSs that have reported data to SDWIS. The tracker includes PFOA and PFOS results from 402 PWSs from 2020, and PFOA and PFOS results from 1,772 PWSs from 2021.

There are many shortcomings to the tracker, however, which make it nearly impossible to ascertain what PFAS levels New Yorkers are actually exposed to when they turn on the tap. First, the tracker only includes PFOA and PFOS results, and therefore underestimates the total PFAS contamination to which New Yorkers are exposed. Second, it only includes sampling results from a fraction of New York's approximately 3,500 PWSs, leaving some New Yorkers unable to see results from their PWS. Third, some of the sampling results may have been taken from water sources that have been removed from service or have installed treatment to remove PFAS from drinking water before reaching the distribution system (for example, a maximum PFOA result of 650 ppt for 2021 is listed for Hoosick Falls, despite the fact that the village has had treatment technology in place for years). Fourth, some of the results do not align with PWS's public declarations, raising questions about the accuracy of the data. For example, the Village of Nyack informed customers that it exceeded New York's PFOA MCL in 2020.[36] The database, however, reports Nyack having PFOA and PFOS levels below 10 ppt in both 2020 and 2021. From looking only at DOH's database, New Yorkers would not know that Nyack had exceeded the MCL. This leads directly into the fifth shortcoming of the database, which is that it does not specifically identify which PWSs have exceeded the PFOA and PFOS MCLs.

Third and finally, PWSs are required to report results for PFOA, PFOS, and any other PFAS detected over the previous year in their AWQR (PWSs were required to publish their 2021 AWQR and provide it to all customers by May 2022). However, as will be described later in these comments, AWQRs can be unreliable sources of information, with some PWSs

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[35] *See* N.Y. DOH, *Drinking Water Contaminants*, https://apps.health.ny.gov/statistics/environmental/public_health_tracking/tracker/index.html#/waterMaps (last updated Dec. 2022).

[36] Vill. of Nyack Bd. of Commissioners, *Deferral Issued for PFOA and PFOS at the Nyack Village Water Supply* (Dec. 10, 2020), https://www.nyack-ny.gov/media/Water/Public%20Notification%20Statement_Nyack%20(with%20links).pdf.

providing incomplete information on PFAS. In addition, many small PWSs do not publish their AWQRs online, making it difficult for New Yorkers to access results for those PWSs. DOH's Know Your NY Water database only compiles AWQRs from PWSs serving more than 3,300 people.[37]

Due to the flaws in each of these three data sets, the public still does not have access to a comprehensive, up-to-date database of each PWS's PFAS levels in each of its water sources as well as its finished drinking water. DOH has also never publicly disclosed the full list of PWSs that have exceeded the PFOA and PFOS MCLs. It is long past time for DOH to make both of these datasets publicly available, in order to inform current and future PFAS regulation, ensure New Yorkers know what's in their water, and allow the public to watchdog PWSs' compliance with MCLs and NLs. The fragmented data currently produced is simply insufficient.

Despite the above, two important conclusions regarding the scale and extent of PFAS in New York's drinking water can still be drawn:

A. PFAS are widespread in New York's drinking water

According to a DOH presentation at the October 2021 DWQC meeting, 38.4% of PWSs had detected PFOA or PFOS as of September 2021, out of the 89% of PWSs with results in SDWIS. Among large PWSs serving more than 10,000 people, 60% had detected PFOA or PFOS. 24 out of the 29 PFAS currently detectable using EPA-approved methods had been detected in drinking water, with PFOA, PFOS, and the other PFAS being proposed for new MCLs being detected the most frequently and at the relatively highest levels. PFOA and PFOS were detected at levels as high as 9,500 ppt and 748 ppt, respectively.

According to that same presentation, 152 PWSs had violated or received a deferral for New York's PFOA, PFOS, or 1,4-dioxane MCLs, approximately 5% of the PWSs with results in SDWIS. In addition, 26 potential violations were still pending. Of the 152 PWSs, 39 had violated the PFOA MCL, 34 had violated the PFOS MCL, 44 had violated both the PFOA and PFOS MCLs, 28 had deferrals for PFOA, PFOS, or 1,4-dioxane, and 7 had violated the 1,4-dioxane MCL. The approximate geographic locations of these PWSs can be seen in Figure 1. PFAS contamination is especially prevalent on Long Island and in the Hudson Valley.

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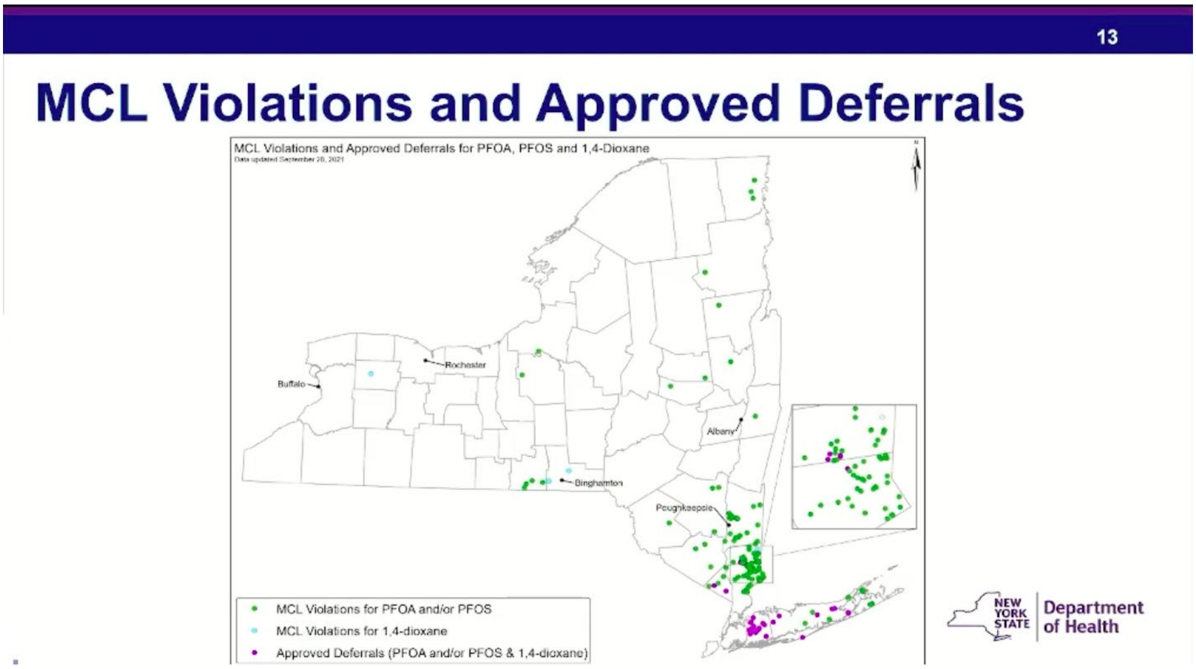
[37] *See* N.Y. DOH, *Drinking Water Reports*, https://water.ny.gov/doh2/applinks/waterqual/#/waterSystems (last accessed Dec. 5, 2022) (Pop-up notification states "[p]ublic water system information shown are those serving greater than 3,300 people.").



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MCL Violations and Approved Deferrals

Figure 1

<u>B. Many PWSs have detected dangerous PFAS contamination, but at levels below New York's current or proposed standards</u>

DOH estimates that 2.14% of PWSs will either exceed the proposed MCL of 10 ppt for PFHxS, PFHpA, PFNA and PFDA or the PFAS6 MCL, for a total of 64 PWS. However, many more PWSs have detected dangerous PFAS levels but will not be required to clean up their water. There are likely over a million New Yorkers currently drinking polluted water and in need of stronger standards.

The following PWSs did not report a PFOA or PFOS MCL violation on their 2021 AWQR, and therefore have not been required to remove their significant PFAS contamination. All of these PWSs detected PFOA at levels at least 1,000 times higher than EPA's HAL, or detected PFOS at levels at least 100 times higher than EPA's HAL. None of these PWSs would exceed DOH's proposed PFAS MCLs. The following levels are the maximum detected by each PWS in 2021, and have been rounded for readability.

Public Water System	**Population Served**	**PFOA (2021)**	**PFOS (2021)**	**Other PFAS Reported (2021)**

Village of Ossining (Indian Brook Reservoir)[38]	30,000	7 ppt	3 ppt	PFHpA (2 ppt), PFNA (2 ppt), PFHxA (2 ppt), PFHxS (1 ppt), PFBS (1 ppt)
Peekskill City[39]	24,272	6 ppt	3 ppt	
Newburgh Water District[40]	23,000	4 ppt	4 ppt	
Vestal Water District (Wellfield #4)[41]	20,950	1 ppt	8 ppt	
United Wappinger Water District (Hilltop Wellfield)[42]	14,000	5 ppt	8 ppt	
Mount Kisco Village (Leonard Park Wells)[43]	9,600	5 ppt	2 ppt	PFBS (5 ppt), PFHxA (2 ppt), PFHpA (2 ppt), PFHxS (1 ppt)
Bedford Water District[44]	9,056	3 ppt	4 ppt	PFHxS (6 ppt), PFHxA (2 ppt), PFBS (1 ppt), PFHpA (1 ppt)
Chenango Water District (Applewood Well)[45]	9,000	5 ppt	3 ppt	PFBS (5 ppt), PFHxA (5 ppt), PFHpA (2 ppt)

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[38] Karen D'Attore et al., Village of Ossining Water System, *Annual Drinking Water Quality Report for 2021* (2021) https://www.villageofossining.org/sites/g/files/vyhlif4821/f/uploads/ossing_2021_awqr.pdf.

[39] Water Dep't, City Of Peekskill, *Annual Drinking Water Quality Report for 2021* (2021) https://www.cityofpeekskill.com/sites/g/files/vyhlif3656/f/uploads/awqr_2021_for_doh_final_05192022_0.pdf.

[40] Consol. Water Dist., Town of Newburgh, *Annual Drinking Water Quality Report: Reporting Year 2021* (2021) https://www.townofnewburgh.org/documents/pdf%20documents/2021%20web%20ready%20awqr.pdf.

[41] Water Dep't, Town of Vestal, *Annual Water Quality Report* (2021) https://cms1files.revize.com/vestal/2021%20ANNUAL%20WATER%20QUALITY%20REPORT.pdf.

[42] United Wappinger Water Dist., *Annual Drinking Water Quality Report for 2021* (2021) https://townofwappingerny.gov/wp-content/uploads/2022/05/UWW-AWQR-2021-APPROVED-FINAL..pdf.

[43] Village of Mount Kisco, *2021 Annual Drinking Water Quality Report* (2021) https://cms6.revize.com/revize/mountkisco/departments/water_and_sewer_department/docs/Mount_Kisco_NY_CCR-2021_WEB.pdf.

[44] https://townofbedford.wpenginepowered.com/wp-content/uploads/2022/05/Consolidated-2021-awqr.pdf.

[45] Town of Chenango, *Annual Drinking Water Quality Report for 2021* (2021) https://townofchenango.com/wp-content/uploads/Annual-Water-Quality-Report-for-2021-1.pdf.

Croton-on-Hudson Village[46]	8,000	7 ppt	8 ppt	PFBS (8 ppt), PFHxS (5 ppt), PFHxA (2 ppt), PFNA (2 ppt)
South Glens Falls Village[47]	3,900	6 ppt	7 ppt	PFHxA (5 ppt), PFHpA (3 ppt), PFHxS (2 ppt)
Village of Delhi[48]	3,833	5 ppt	5 ppt	
Village of Sidney[49]	3,800	5 ppt	4 ppt	
Brinkerhoff Water District[50]	3,788	9 ppt	9 ppt	
Chester Village[51]	3,448	6 ppt	2 ppt	
Greenwood Lake Village[52]	3,083	6 ppt	7 ppt	
Wolcott Village (Springs Plant)[53]	2,200	Non-Detect	Non-Detect	**PFHxS (9 ppt)**, PFBS (3 ppt), PFHxA (2 ppt)
Rotterdam Water Districts 3 and 4[54]	1,900	5 ppt	6 ppt	
Town of Warwick Westside Water District[55]	1,700	7 ppt	7 ppt	PFBA (3 ppt), PFBS (3 ppt), PFPeA (2 ppt), PFHxA (2 ppt), PFHxS (2 ppt), PFNA (1 ppt), PFHpA (1 ppt)
Carmel Water District	1,600	9 ppt	3 ppt	

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[46] Village of Croton-on-Hudson Water Sys., *Annual Drinking Water Quality Report for 2021* (2021) https://www.crotononhudson-ny.gov/sites/g/files/vyhlif441/f/uploads/2021-water-quality-report.pdf.

[47] Village of South Glens Falls, *Annual Water Quality Report for 2021* (2021) https://sgfny.com/wp-content/uploads/South-Glens-Falls-2021-AWQR.pdf.

[48] Village of Delhi, *Annual Water Quality Report for 2021* (2021) https://villageofdelhi.com/sites/default/files/documents/2021%20Water%20Report.pdf.

[49] Village of Sydney, https://www.villageofsidney.org/index.php (select "2021 AWQR" icon).

[50] Brinkerhoff Water Dist., *Annual Water Quality Report for 2021* (2021) https://www.fishkill-ny.gov/uploads/3/8/0/7/38072219/brinkerhoff_awqr2021_-_approved_final.pdf.

[51] Village of Chester, *Drinking Water Quality Report Annual for 2021* (2021) https://villageofchesterny.org/wp-content/uploads/2022/04/WATER-REPORT-2021.pdf

[52] Village of Greenwood Lake N.Y., Inc 1924, *Annual Drinking Water Quality Report* (2021) https://www.villageofgreenwoodlake.org/awqr/.

[53] Water Dep't, Village of Wolcott, *Annual Water Quality Report for 2021* (2021) https://www.wolcottny.org/uploads/1/1/6/1/116133623/img-519104427-0001.pdf.

[54] Town of Rotterdam, *Annual Water Quality Report for 2021* (2021) https://www.rotterdamny.org/blob/files.ashx?ID=41745.

[55] Town of Warwick, *Annual Drinking Water Quality Report for 2021* (2021) https://www.townofwarwick.org/wp-content/uploads/2022/05/Westside-1-AWQR-2021.pdf.

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It is important to note that the 170,000 New Yorkers served by the above PWSs (in addition to the 270,000 New Yorkers served by Suez/Veolia Company described below) are an underestimate of the New Yorkers exposed to harmful PFAS contamination. It is impossible to review the full suite of 2,500 PWS AWQRs to determine their PFAS levels; many of these AWQRs, including those for PWSs like Newfield, Fallsburg, Millerton, and Hunter, are not even available online. Moreover, the amount of contamination in the chart is also an underestimate; many of these PWSs may have detected other PFAS beyond PFOA and PFOS but did not report them, or may not have tested for the full suite of 29 PFAS currently detectable with EPA methods. It has been estimated that 800,000 households just on Long Island are exposed to PFAS below the current and proposed state standards.

In Rockland County, many wells operated by the Suez/Veolia Water Company have detected significant levels of total PFAS in their water.[57] None of these wells have exceeded DOH's MCLs of 10 ppt each for PFOA and PFOS, nor would they exceed the proposed individual or combined MCLs. Every day that New Yorkers served by these wells continue to be exposed to these toxic chemicals in their water, the greater the risk to their health:

Suez/Veolia Well Number	**Combined Level of PFOA, PFOS, PFNA, PFHxS, PFHpA, and PFDA**	**Total PFAS**
#78	18 ppt (PFOA, PFOS, PFNA, PFHpA)	32 ppt (PFOA, PFOS, PFNA, PFHpA, PFBS, PFHxA)
#97	18 ppt (PFOA, PFOS, PFNA)	20 ppt (PFOA, PFOS, PFNA, PFHxA)
#28	17 ppt (PFOA, PFOS, PFHpA)	24 ppt (PFOA, PFOS, PFHpA, PFHxA, PFBS)
#106	16 ppt (PFOA, PFOS, PFNA, PFHpA)	21 ppt (PFOA, PFOS, PFNA, PFHpA, PFBS, PFHxA)
#66	15 ppt (PFOA, PFOS, PFHpA, PFHxS)	17 ppt (PFOA, PFOS, PFHpA, PFHxS, PFHxA)
#55	13 ppt (PFOA, PFOS, PFHpA)	17 ppt (PFOA, PFOS, PFHpA, PFHxA)

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[56] Town of Carmel, Annual Drinking Water Quality Report For 2021, https://www.ci.carmel.ny.us/sites/g/files/vyhlif371/f/pages/cwd_8_mahopac_ridge_awqr_2021.pdf.

[57] *See* SUEZ Water New York - Rockland County, *PFAS Sample Test Results - August 2020 - March 2021* (undated) (attached hereto as Exhibit C); *see also* Riverkeeper, *Rockland County PFAS Drinking Water Contamination: Analysis of 2019 Testing Data* (Jan. 2021), https://www.riverkeeper.org/wp-content/uploads/2021/01/Public-Report-2019-Rockland-PFAS-data-Analysis-and-Observations.pdf.

The scale of New Yorkers exposed to dangerous contamination shows the urgent need to strengthen the state's current and currently proposed PFAS standards.

4. Deficiencies in DOH's Proposed Regulations

A. The Need for Stronger, Health-Based MCLs

EPA's new PFOA and PFOS HALs are especially alarming for communities that have detected PFOA or PFOS in their drinking water but not at levels that exceeded New York's MCLs. There is now no doubt that DOH's current PFOA and PFOS MCLs allow these communities to be exposed to unacceptable levels of PFAS contamination. PWSs that have detected between 2 and 10 ppt of these chemicals have not been required to directly notify customers about the contamination, and have not been required to clean up their water. Yet the science now clearly shows that their customers face an increased risk of developing illnesses like immune disruption, cancer, liver and cholesterol effects, and more, by drinking their water.

EPA's HALs and other recent science provide strong support for completely removing other, similar PFAS from drinking water. DOH has stated how toxicologically similar PFHpA, PFHxS, PFNA, and PFDA are to PFOA and PFOS, and that these four PFAS were chosen for MCLs because of those similarities. The proposed MCLs of 10 ppt for each of these four PFAS, the same level as the current PFOA and PFOS MCLs, signal DOH's belief in their similar risk potential.

DOH claims that the proposed MCLs for PFHxS, PFHpA, PFNA, and PFDA fall within a range of "health-based drinking water values" and offer an adequate margin of protection for sensitive populations.[58] Yet despite the chemical similarities mentioned above, DOH toxicologists did not use EPA's most up-to-date reference doses for PFOA and PFOS when deriving its "health-based drinking water values." Instead, DOH sourced reference doses from other states or itself, many of which are significantly out of date (for its reference dose for PFHpA, DOH used a reference dose it had developed for PFOA in 2018, over three years ago).[59]

Published in November 2021, EPA's PFOA and PFOS reference doses were available to DOH for use, but DOH did not reference them either during DWQC proceedings or in its Regulatory Impact Statement.[60] EPA's reference doses are orders of magnitude lower than the ones that DOH; had they been used, DOH's proposed MCLs would be drastically outside the

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[58] N.Y. DOH, Regulatory Impact Statement: Maximum Contaminant Levels, 2022, 55–56, https://regs.health.ny.gov/sites/default/files/proposed-regulations/Maximum%20Contaminant%20Levels%20%28MCLs%29_1.pdf

[59] *Id.* at 53.

[60] US EPA, EPA Advances Science to Protect the Public from PFOA and PFOS in Drinking Water, November 16, 2021, https://www.epa.gov/newsreleases/epa-advances-science-protect-public-pfoa-and-pfos-drinking-water

range of "health-based drinking water values" and would not offer an adequate margin of protection for sensitive populations. The following chart compares the reference doses used by DOH to EPA's new reference doses.

PFAS Studied	Reference Dose (ng/kg/day)
DOH Reference Dose for PFNA	2.2
DOH Reference Dose for PFHpA	1.5
DOH Reference Dose for PFHxS	4.0
DOH Reference Dose for PFDA	2.2
EPA Reference Dose for PFOA	**0.0015**
EPA Reference Dose for PFOS	**0.0079**

With no acceptable level of exposure to PFOA or PFOS, there is now also no acceptable level of exposure to PFHpA, PFHxS, PFNA, or PFDA. DOH's proposed MCLs for the four PFAS must be revised, just as New York's current MCLs for PFOA and PFOS must be revised. PFOA, PFOS, PFNA, PFHxS, PFHpA, and PFDA must all be regulated at the lowest possible level. Wherever these PFAS are reliably detected, PWSs should be required to eliminate them from drinking water.

In addition, we urge you to establish an MCL, rather than an NL, for GenX, based on the links between GenX exposure and harm to the liver, kidney, immune system, and other adverse health impacts. Now that EPA has also finalized a HAL for GenX, it is important that New Yorkers receive the same protections from GenX that they receive for the six PFAS above.

Finally, it is deeply concerning that DOH is proposing to establish weaker PFAS standards than those established or in the process of being established by other states. The proposed combined PFAS MCL of 30 ppt is weaker than combined MCLs covering the same group of PFAS in other Northeastern states. Massachusetts has established a combined MCL of 20 ppt for the same six PFAS (PFOA, PFOS, PFNA, PFHxS, PFHpA, and PFDA), and Maine and Rhode Island are in the process of following the same course. Vermont currently has a combined MCL of 20 ppt for five PFAS. In addition, Michigan has established stronger individual PFAS MCLs than what New York is proposing, including a 6 ppt MCL for PFNA and an 8 ppt MCL for PFOA.

The lowest level at which nearly all laboratories can report PFOA, PFOS, PFNA, PFHpA, PFHxS, and PFDA is 2 ppt; some labs can report even lower than 2 ppt. At the last DWQC meeting, Dr. Patrick Parsons, from DOH's Wadsworth Laboratory, argued that setting MCLs at reporting limits could lead to an erroneous MCL violation due to errors in the sampling results. We urge DOH to conduct an investigation of test method performance and errors at reporting limits, considering the experience of other states which have set MCLs below 10 ppt, and provide a public explanation, and justification, for the lowest level at which MCLs could be actually set.

There is certainly no doubt that is it feasible to set PFAS MCLs, including the combined PFAS MCL, below 10 ppt. Michigan, for example, has for several years enforced their PFNA MCL of 6 ppt, currently the lowest individual MCL on a PFAS in the nation. Moreover, under DOH regulations, a single sample from a PWS exceeding an MCL does not immediately trigger an MCL violation. A PWS must collect additional samples, and if the average of those samples still exceeds the MCL, only then does a violation occur. This added precaution significantly reduces the risk that a PWS would be forced to unnecessarily install treatment technology. Ultimately, the Wadsworth presentation did not cast any doubt that 4 ppt, double the reporting limit, was a technologically sound level for an MCL.

B. The Need for Stronger, Health-Based Notification Levels

Wherever PFAS are reliably detected in the drinking water, the public deserves to know about it. We are concerned, however, that concerning levels of the nineteen PFAS to be designated as "emerging contaminants" will not trigger NL requirements under the standards that DOH has proposed.

You have an obligation to set a single combined NL for these nineteen PFAS, rather than two combined MCLs, due to PHL 1112's requirement to base notification levels "upon the available scientific information." Scientists have concluded that PFAS must be regulated together due to their key shared characteristics, including high mobility in water, extreme persistence in the environment, bioaccumulation in the human body, and links to similar harmful health effects. The *PFAS-Tox Database*, a searchable literature review of PFAS science created by a groundbreaking research collaborative, has coalesced over a thousand health and toxicological studies of more than two dozen different PFAS.[61] The database has recorded hundreds of studies linking harmful health effects on a wide range of biological systems with almost all of the PFAS on the NL list.

The more we learn about PFAS, the more dangerous we realize they are. With thousands of PFAS being used in industry and present in our environment, it is essential that you adopt the most precautionary approach to the PFAS we can currently detect in drinking water. Many scientists, including national PFAS experts such as Dr. Linda Birnbaum, have called for the adoption of the lowest possible standards for all PFAS given the risks posed by the entire class of chemicals.[62] We therefore urge you to set a single combined NL for the 19 PFAS lower than 20 ppt and at the lowest technologically feasible level.

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[61] *See* PFAS-Tox Databse, https://pfastoxdatabase.org/ (last updated Aug. 9, 2022).

[62] Linda S. Birnbaum et al, Re: Regulating PFAS in Drinking Water, April 28, 2022, https://eany.org/wp-content/uploads/2022/04/PFAS-Public-Health-Professional-Letter.pdf.

DOH has justified their high NLs by claiming that a PWS will be required to report these nineteen PFAS on its AWQR, and that this will adequately inform customers of what's in their water. They have stated that any PFAS chemical detected through the MCL testing is already required to be listed on the AWQRs.

But a review of a sample of AWQRs reveals significant noncompliance with current reporting requirements. Many PWSs are failing to properly inform the public about the PFAS in their drinking water. Of approximately 50 AWQRs reviewed, 11 AWQRs demonstrated significant noncompliance, with problems concentrated among medium and small-sized systems:

- The Town of Glenville, City of Hornell, Village of Brewster, and Village of Voorheesville all failed to report PFOA or PFOS results on their 2021 AWQR; DOH's Environmental Public Health Tracker confirmed that all 4 PWSs had PFOA or PFOS detections in 2021.[63]
- The Village of Warwick, Town of Wallkill, Village of Chester, Village of Greenwood Lake, and Village of Maybrook all stated on their 2021 AWQRs that they detected multiple other PFAS, besides PFOA and PFOS, but failed to include which additional PFAS were detected and their respective levels.[64]
- The Town of Newburgh and United Wappinger Water District list PFOA and PFOS as "Unregulated Contaminants" in their AWQRs, misinforming customers and giving the false impression that these chemicals are not dangerous enough to warrant formal regulation.[65]

In addition to this concerning lack of transparency, the majority of AWQRs reported only PFOA and PFOS results. It is highly likely those PWSs also detected other PFAS but simply failed to report them. It is also difficult to check many AWQRs for compliance since so few,

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[63] Town of Glenville, *Annual Drinking Water Quality Report for 2021* (2021) https://www.townofglenville.org/sites/g/files/vyhlif3161/f/uploads/2021_annualwaterqualityreport-4.20.22.pdf; City of Hornell, *Annual Drinking Water Quality Report for 2021* (2021) https://irp.cdn-website.com/7937b567/files/uploaded/City%20of%20Hornell%20Annual%20Water%20Quality%20Report%202021-revised.pdf; Village of Brewster Water Supply, Annual Water Quality Report (2022) https://www.brewstervillage-ny.gov/images/stories/pdfs/AWQR2021.pdf; Voorheesville Water System, *Annual Drinking Water Quality Report for 2021* (2021) https://www.villageofvoorheesville.com/DocumentCenter/View/1421/Water-Quality-Report-2021.

[64] Village of Warwick, *Annual Drinking Water Quality Report for 2021* (2021) https://villageofwarwick.org/wp-content/uploads/2021-AWQR-Final-2022_07_13_v1-English-1.pdf; Town of Wallkill, *Annual Drinking Water Quality Report for 2021* (2021) https://www.townofwallkill.com/documents/dpw/water-and-sewer/annual-quality-water-reports/5770-2021-awqr-for-water-district-1/file.html; Village of Chester, *Drinking Water Quality Report Annual for 2021* (2021) https://villageofchesterny.org/wp-content/uploads/2022/04/WATER-REPORT-2021.pdf ; https://www.villageofgreenwoodlake.org/awqr/; Dennis Leahy, *Annual Drinking Water Report*, Village of Maybrook (May 25, 2022) https://www.villageofmaybrook.com/?s=Annual+Water+Report (select "Maybrook-AWQR-2021-Accepted-2: Download" icon).

[65] Town of Newburgh, *supra* note 40; United Wappinger Water Dist., *supra* note 42.

especially from small PWSs, are posted online. DOH’s Know Your NY Water database only includes AWQRs from PWSs serving more than 3,300 people.

New Yorkers clearly cannot rely on AWQRs to access basic information about their drinking water. If PWSs cannot comply with current PFAS reporting requirements, they will likely fail to comply with requirements to list emerging contaminant results, depriving the public of their right to know what’s in their water. Even if PFAS are listed on some AWQRs, New Yorkers should not have to wait months after sampling is conducted to access information about the level of contamination to which they are exposed.

Direct public notification soon after contamination is detected, followed by online posting and outreach to relevant news media and community institutions, will ensure that PWSs clearly communicate key information to their customers.

C. The Need to Strengthen Monitoring and Notification Requirements for MCLs and NLs

Frequent and comprehensive monitoring for PFAS is essential to identify dangerous contamination and ensure the public knows what's in their drinking water. The monitoring requirements for the 19 PFAS proposed as emerging contaminants are especially important because they mark the first time that DOH is proposing to implement the ECMA; the 19 PFAS will be the first list of emerging contaminants tested for under that law. The precedents that DOH sets will therefore have long-lasting repercussions for future testing of harmful contaminants under the ECMA.

DOH is proposing to require all PWSs to monitor for PFNA, PFHxS, PFHpA, PFDA and the combined PFAS MCL beginning April 1, 2023, with the exception that a PWS that has conducted monitoring prior to that date as a result of the PFOA and PFOS MCLs may count that monitoring towards this requirement, as long as the monitoring meets all the requirements of the proposed regulation (such as having at least two quarters of monitoring with all of the compounds in the analytical method reported, using Methods 537.1 or 533, and having an ELAP approved laboratory perform the analysis). PWSs may use either Method 537.1 or 533 for their MCL compliance sampling. PWSs are required to be in full compliance with the MCLs by January 1, 2025.

DOH is also requiring PWSs to sample for the 19 PFAS proposed as emerging contaminants within three years after April 1, 2023. Any PWS that exceeds the proposed NLs in any of its samples after April 1, 2023 is required to provide public notification. Sampling conducted in compliance with EPA's UCMR 5 can be used to meet DOH's emerging contaminant testing requirements.

Unfortunately, there are significant problems with both the proposed MCL and NL testing requirements:

1) Deficiencies in Monitoring Frequency

Under DOH's proposal, a PWS could avoid using Method 533, which is necessary to detect all 19 PFAS proposed as emerging contaminants, for almost three years (given that Method 537.1 can be used for MCL compliance and emerging contaminant monitoring can be conducted as far as three years after April 1, 2023). This scenario seems especially probable given that DOH has previously acknowledged that most PWSs have utilized Method 537.1 for their PFOA and PFOS compliance sampling. While DOH's regulatory impact statement states that "a PWS that is not required to participate in UCMR5 will have a monitoring schedule [for emerging contaminants] issued by the Department," none of DOH's proposed changes to the text of the State Sanitary Code identify any such schedule.[66]

This would allow PWSs, especially PWSs serving fewer than 3,300 people, to keep customers in the dark about a potential NL exceedance in their drinking water for far too long. New Yorkers have already waited over 5 years since the enactment of the ECMA for emerging contaminant testing to occur; they should not have to wait another two years. The intent of the ECMA is for New Yorkers to be swiftly and proactively informed about potential health risks in their drinking water; DOH's proposal does not align with that intent.

DOH argues that allowing three years to test for the proposed emerging contaminants provides certain PWSs with the ability to time their testing with required monitoring under EPA's UCMR 5, which includes many of the same PFAS. UCMR 5, however, only applies to a small subset of PWSs serving more than 3,300 people; New Yorkers served by small PWSs should not be made to wait longer to learn about what's in their water. PWSs serving more than 3,300 people are generally better able to financially cover the costs associated with slightly more frequent testing.

There is another key way that New Yorkers served by small water systems are unfairly disadvantaged by DOH's proposed monitoring system. Under UCMR 5, PWSs serving more than 3,300 people will be required to test each entry point either two or four times using Method 533 during a consecutive 12 month period. DOH, however, is proposing that all PWSs take only a single sample per entry point using Method 533 for NL compliance, meaning that New Yorkers served by small systems will benefit from less testing. The ECMA was intended to provide New Yorkers served by small PWSs the same protections given to large PWSs; DOH proposal instead adds to the divide.

The most efficient and effective solution to these problems is to require all PWSs to test their drinking water for at least two quarters with Method 533 in 2023. This will allow systems to meet their MCL and NL compliance requirements at the same time, delivering the cost savings that DOH is seeking, while ensuring that New Yorkers are more swiftly notified of MCL and NL exceedances.

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[66] N.Y. DOH, *Regulatory Impact Statement: Maximum Contaminant Levels*, 2022, 81, https://regs.health.ny.gov/sites/default/files/proposed-regulations/Maximum%20Contaminant%20Levels%20%28MCLs%29_1.pdf.

2) Deficiencies in Public Notification

If a PWS exceeds an NL, it may include its public notification in its AWQR if the AWQR is provided to customers within 90 days of the determination of an exceedance. This does not align with the intent of the ECMA to provide public notification to all customers of an NL exceedance. No other public notice issued for any other PWS violation is allowed to be included in an AWQR rather than separately provided to customers. An NL exceedance is a serious issue; burying it in a lengthy, technical AWQR conveys the opposite. Moreover, as described above, PWSs have routinely failed to comply with AWQR reporting requirements. It is highly likely that PWSs would also fail to properly post NL exceedances via AWQRs.

Whenever an NL exceedance occurs, water utilities should be required to send a separate letter in the mail to every one of their customers. That is how other potential threats to our drinking water are treated – PFAS should be no different. We urge DOH to remove this loophole and be fully transparent with the public about what's in their water.

5. Resources Available to Address Costs of PFAS Testing and Treatment

It is important to note that strengthening the state's recommended MCLs would place additional compliance costs on only a fraction of New York's approximately 3,500 PWSs. Even as stronger MCLs lead to corrective action by more PWSs, New York has to have the resources to ensure that these systems can install treatment without drastically raising rates for their customers.

Thanks to the federal Bipartisan Infrastructure Law, New York is set to receive approximately $150 million over the next five years to test and treat emerging contaminants in drinking water, with a special focus on PFAS.[67] New York has also made a historic investment of $4.5 billion in the Clean Water Infrastructure Act since 2017, much of which can be used to eliminate PFAS through Water Infrastructure Improvement Act ("WIIA") grants.

Governor Hochul and DOH have already successfully provided a significant number of grants to PWSs to treat PFOA, PFOS, and 1,4-dioxane, demonstrating that the state has the processes in place to handle new requests to eliminate additional PFAS contamination. Since 2018, $400 million from the Clean Water Infrastructure Act has been allocated to efforts to bring PWSs into compliance with New York's PFOA, PFOS, and 1,4-dioxane MCLs, $238 million of this funding provided in 2022 alone.[68] In addition, the state accepted project

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[67] Letter from Radhika Fox Assistant Administrator, EPA Office of Water, to EPA Regional Water Division Directors State and SRF Program Managers (Mar. 8, 2022), ("*Memorandum: Implementation of the Clean Water and Drinking Water State Revolving Fund Provisions of the Bipartisan Infrastructure Law*"), https://www.epa.gov/system/files/documents/2022-03/combined_srf-implementation-memo_final_03.2022.pdf.

[68] *Governor Hochul Announces $638 Million in Grants for Water Infrastructure Improvements Across New York State*, Offic. Website of N.Y., (Apr. 19, 2022), https://www.governor.ny.gov/news/governor-hochul-announces-638-million-grants-water-

applications for the first $30 million of Bipartisan Infrastructure Law Emerging Contaminant funds, which will soon be awarded.[69]

Along with state and federal grants, New York has new tools available to hold polluters accountable for the costs of contamination. In October, Governor Hochul signed legislation extending the statute of limitations to enable PWSs to commence legal action against polluters to recoup treatment costs.[70] In addition, EPA recently proposed designating PFOA and PFOS as hazardous substances, which will allow New York pollution zones to be listed as federal Superfund sites.[71] By unlocking federal resources to conduct PFAS cleanup and make polluters pay, EPA's action will reduce the financial burden placed on PWSs.

Finally, new evidence has demonstrated that the long-term costs of exposure to PFAS vastly outweigh the short-term costs of drinking water cleanup. A study published in the journal Exposure and Health in July calculated that the health costs of exposure to PFOA and PFOS alone ranged between $5.5 billion and $63 billion a year, depending on how many health effects were considered.[72] The study's findings are quite conservative; other PFAS were not evaluated, and a number of health effects linked to PFOA and PFOS were not included in the analysis. These costs provide compelling evidence for the need for New York to adopt the most health-protective standards on these chemicals.

6. Urgent Need to Revise DOH's PFAS Public Education Materials

Underprotective MCLs are not the only statewide danger New Yorkers are facing from PFAS. DOH is also affirmatively and intentionally misleading New Yorkers about the meaning of an MCL exceedance—namely, that the level at which the chemical was found in the water is a level that is known or expected to present health risks. All New Yorkers, especially the hundreds of thousands from the approximately 150 communities whose water

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infrastructure-improvements-across-new-york; *Governor Hochul Announces Nearly $300 Million in State Grants for Local Water Infrastructure Improvements*, Offic. Website of N.Y., (Nov. 4, 2022), https://www.governor.ny.gov/news/governor-hochul-announces-nearly-300-million-state-grants-local-water-infrastructure.

[69] Env't Facilities Corp., *Types of Funding & Deadlines - Bipartisan Infrastructure Law*, Offic. Website of N.Y., https://efc.ny.gov/types-funding-deadlines-bipartisan-infrastructure-law (last visited Dec. 5, 2022).

[70] *Governor Hochul Signs Legislation to Hold Drinking Water Polluters Accountable*, Offic. Website of N.Y., (Apr. 19, 2022), https://www.governor.ny.gov/news/governor-hochul-signs-legislation-hold-drinking-water-polluters-accountable#:~:text=Governor%20Hochul%20Signs%20Legislation%20to%20Hold%20Drinking%20Water%20Polluters%20Accountable,-Legislation&text=Governor%20Kathy%20Hochul%20today%20signed,to%20the%20statute%20of%20limitations.

[71] *EPA Proposes Designating Certain PFAS Chemicals as Hazardous Substances Under Superfund to Protect People's Health*, EPA https://www.epa.gov/newsreleases/epa-proposes-designating-certain-pfas-chemicals-hazardous-substances-under-superfund (last updated Aug. 31, 2022).

[72] Between - News Hub, Daily Exposure to 'Forever Chemicals' Costs United States Billions in Health Costs, N.Y.U. Langone Health, (July 26, 2022), https://nyulangone.org/news/daily-exposure-forever-chemicals-costs-united-states-billions-health-costs.

sources have exceeded PFAS MCLs, deserve better. Unfortunately, this follows a troubling historic pattern of the Department downplaying health threats or outright providing false information to the very people it is charged with protecting.

By definition, an MCL exceedance—which triggers notification to residents—means the levels at which a PFAS was detected in a water source is known or expected to present risk. Setting an MCL begins first with the setting of a maximum contaminant level goal ("MCLG"). An MCLG is "[t]he level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety." N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.72(e),(f); *see also* 42 USC § 300g-1(b)(4)(D); 40 C.F.R. § 141.2. An MCL, "the maximum permissible level of a contaminant in water which is delivered to any user of a public water system," is then established. MCLs are set as close to the MCLGs as feasible. *See* N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.72 (e),(f); *see also* 42 USC § 300g-1(b)(4)(D) (explaining that feasibility takes into account the best available treatment technology and cost). Indeed, New York law *requires* PWSs to include the definitions of those terms set forth above in their annual reports. N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.72(e),(f). Thus, based on those definitions, an MCL is set *at or higher than* the level at which there are known or expected health risks. Indeed, levels of a contaminant in drinking water often are known or expected to present health risks even at levels *lower than* an MCL because an MCL is not based solely on healthy considerations. Indeed, EPA recently issued health advisories for PFOA and PFOS that are significantly below New York's MCLs for those PFAS, making it all that more important that consumers receive accurate information about health effects associated with an exceedance of New York's MCLs for those chemicals.

Yet the Department has drafted language for notices distributed to every consumer of water in the 150 communities with MCL exceedances that provides false, unsupported, and incomplete, information that is contrary to the very meaning of an exceedance. *See* 10 NYCRR 5-1.78 (public notices for MCL violations must contain sections on potential health effects developed by the Department). For example, the health effects section of the notices states: "At the level of [PFOA/PFOS] detected in your water, exposure from drinking water and food preparation is well below [PFOA/PFOS] exposure associated with health effects."[73] Many of the other statements in the section reinforce that it is only "high levels" of PFAS, sometimes "over [an] entire lifetime" that cause health effects, unlike the "lower levels" prompting the notice. *Id.* The notices also contain identical wording in other sections providing similar misinformation. For example, the very first notice section entitled "Why are you receiving this notice/information?" contains some or all of the following false statements:

- "The MCL is set well below levels known or estimated to cause health effects."

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[73] Vill. of Valatie, *Important Information about your Drinking Water PFOS MCL: Exceedance at Valatie Village Water System* (Jan. 31, 2022), https://www.valatievillage.com/_files/ugd/d2cb09_6ad526a61f3b49bbba62072ca3cc5776.pdf; SUEZ Water New York, *Important Information about your Drinking Water: PFOA Exceedance at SUEZ Water New York* at 1 (Nov. 6, 2020), https://waterfrontonline.files.wordpress.com/2022/01/suezrocklandletternov2020.pdf.

- "Consuming drinking water with PFOA, PFOS or 1,4 dioxane at or somewhat above the MCL does not pose a significant health risk."

Most of the notices also fail to provide a link at which consumers can find scientifically accurate information about PFAS.

The reach of this misinformation is not limited to the tens of thousands of people who receive notices about an exceedance. It is also included in a fact sheet on the Department's website for any or all of the twenty million New Yorkers who will look to the Department to better understand the risks PFAS pose to them to see.[74] The fact sheet about the state's PFOA and PFOS MCLs claims that "the risk for health effects if someone drinks water at or below the MCL is minimal. In most cases, an exceedance of an MCL also does not mean that water is unsafe for use while the public water system takes actions to reduce the levels." It also appears that the Department has gone to great lengths to make sure that readers of the fact sheet *cannot* find current, scientifically accurate information about the health effects associated with PFAS. The fact sheet does not list even one of the many health effects associated with PFOA and PFOS, and "for more information" about the chemicals, it links to a DEC webpage about PFAS, which in turn links to two DOH documents, one of which is a twenty-eight-page "regulatory impact statement" from 2016 and the other a 2017 fact sheet about PFAS by the federal Agency for Toxic Substances and Disease Registry ("ATSDR") that is outdated and contains health effects language no longer used by ATSDR.[75]

This intentional misinformation undermines one of the very purposes of setting MCLs — to ensure that residents know that drinking water with PFAS levels that exceed MCLs is known or expected to present health risks — so that they can take measures to protect their families. The Department must immediately change its fact sheet, rewrite the mandatory health language for exceedance notices to make it accurate, include links to scientifically authoritative sources for information about PFAS, and send a correction about the former notices to the residents of all affected communities.

New Yorkers deserve more than just accurate information, which is the bare minimum the Department should provide. The mandatory health effects language in notices and the Department's fact sheet also should contain information about subpopulations that are more vulnerable to the adverse health effects of PFAS exposure due to either greater exposure or greater susceptibility to harm than the general population, so that those populations can take extra precautions. These populations include occupational workers, firefighters, communities living near facilities that release PFAS, children, infants, and the developing fetus. For

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[74] Ctr. for Env't Health, N.Y. DOH, Public Water Systems and NYS Drinking Water Standards for PFAS and Other Emerging Contaminants (2022), https://www.health.ny.gov/environmental/water/drinking/docs/water_supplier_fact_sheet_new_mcls.pdf.

[75] *Compare* Div. Cmty. Health Investigations, ATSDR, Per- and Polyfluoroalkyl Substances (PFAS): Frequently Asked Questions (2017) https://www.health.ny.gov/environmental/investigations/drinkingwaterresponse/docs/atsdr_pfas_factsheet.pdf with ATSDR, Per- and Polyfluoroalkyl Substances (PFAS) and Your Health (2022) https://www.atsdr.cdc.gov/pfas/resources/pfas-faqs.html.

example, children, infants, and the developing fetus are exposed to higher levels of PFAS and are more susceptible to harm from these exposures. PFOA and PFOS can transfer across the placenta, and exposure to even low levels of these PFAS during pregnancy has been linked to decreased birth weight, and altered growth, learning, and/or immune responses in infants and older children. Such notices should also provide or direct consumers to information about steps they can consider to protect themselves.

The Department can look to other states that have enacted PFAS MCLs for appropriate and accurate information to distribute to its residents about the health effects of PFAS, the meaning of MCLs, and steps residents exposed to MCL exceedances may want to take to protect their families. For example, the attached notice issued in September 2022 about a PFAS MCL exceedance from Livingston Township in New Jersey[76]:

- Sets forth the health effects associated with PFAS in a straightforward manner
- Provides information about susceptible subpopulations
- Does not include unsupported and misleading language about the potential risks associated with continuing to drink the water
- Contains a “What Should I Do?” section that provides practical advice for consumers
- Provides links to state issued documents and webpages that expand upon the information in the notice, provides numerous links to authoritative sources, and contains current PFAS information — including EPA’s recent health advisory levels (which are lower than New York’s MCLs).

The danger of the Department’s disinformation also is compounded by its lack of transparency about which communities are drinking water that contain PFAS at levels higher than the MCLs. Despite advocates’ requests, thus far the Department has refused to release or post on its website a list of the communities whose PWSs had a PFAS MCL exceedance. The Department should be making it easy for New York residents to learn whether their PWS was one of the 150 that recently had a PFAS MCL exceedance. The lack of transparency also prevents advocacy groups from reaching out to affected communities to counter the misinformation the Department is distributing and advise people on steps they can take to protect their families.

7. Conclusion

PFAS pose one of the greatest threats to drinking water in New York. As DOH determines how to regulate these “forever chemicals,” it is legally and morally required to make the protection of public health its highest priority. We look forward to working with DOH to ensure that when New Yorkers turn on the tap, the water that comes out is safe to drink. We appreciate the consideration of these comments.

Sincerely,

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[76] Livingston Twp., Div. of Water, *Important Information about your Drinking Water: The Livingston Township Division of Water Has Levels of Perfluorooctanoic Acid (PFOA) Above a Drinking Water Standard* (Sept. 2022) (attached hereto as Exhibit D).

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NRDC

Exhibit A

NRDC

September 23, 2019

Katherine Ceroalo
New York State Department of Health
Bureau of Program Counsel, Reg. Affairs Unit
Room 2438, ESP Tower Building
Albany, NY 12237
regsqna@health.ny.gov

Re: Proposed Maximum Contaminant Level for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS), I.D. No. HLT-30-19-00006-P

Dear Ms. Ceroalo:

Thank you for the opportunity to comment on New York's proposed rulemaking to establish maximum contaminant levels (MCLs) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). We write on behalf of the undersigned organizations to, among other things, urge New York to implement final rules that would establish an enforceable MCL for PFOA and PFOS at a combined concentration of 2 parts per trillion (ppt).

We welcome the New York Department of Health's (the "Department's") proposed establishment of MCLs for PFOA and PFOS, two chemicals in the group of chemicals known as per- and polyfluoroalkyl substances (PFAS). PFAS contamination has become a serious public health crisis in New York and across the country. According to survey results from the Unregulated Contaminant Monitoring Rule ("UCMR3") program, more than 1.8 million people in New York are served drinking water with some level of PFAS present.[1] However, due to limitations in the national survey, the actual numbers are likely much larger, suggesting that there could be significantly more people drinking PFAS-contaminated water. With PFOA and PFOS contaminating drinking water sources across New York, and with numerous studies linking these contaminants to serious health risks at very low doses, we believe that New York should take additional affirmative steps to limit human exposure to PFOA and PFOS.

In April of this year, NRDC released a peer-reviewed assessment of the health effects of several PFAS and developed its own recommendations around, among other things, an

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[1] U.S. ENVTL. PROT. AGENCY, OCCURRENCE DATA FOR THE THIRD UNREGULATED CONTAMINANT MONITORING RULE (Jul. 2017), https://www.epa.gov/sites/production/files/2017-02/ucmr-3-occurrence-data.zip (last visited Sept. 1, 2019) [hereinafter OCCURRENCE DATA FOR UCMR 3].

appropriate MCL for PFOA and PFOS.[2] The full report is attached to this letter, and the report has formed the basis for the recommendations that follow.

In the remainder of this letter, we set forth the case for why New York State should set a combined MCL of 2 ppt for PFOA and PFOS. In Part I, we provide background on PFAS and explain why they are in special need of regulation. In Part II, we explain how existing regulations have failed to protect us from the harms of PFAS. And in Part III, we explain our recommendations to the Department in more detail.

Specifically, we make the following requests. **First**, to protect human health, the Department should amend their proposed MCLs for PFOA and PFOS to a combined level of 2 ppt. **Second**, the Department should include a public notification requirement in the final regulations. **Third,** once the Department finalizes its regulations for PFOA and PFOS, it should look to regulating PFAS as a class, as manufacturers have already begun substituting PFOA and PFOS with structurally similar chemicals that have similar health effects.

I. Per- and Polyfluoroalkyl Substances (PFAS)

PFAS are a group of synthetic chemicals estimated to contain between approximately 3,000[3] to 5,000[4] industrial chemicals. Some of the most well-known PFAS include PFOA, PFOS, perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), and GenX. Three characteristics of PFAS make them especially dangerous to humans. First, they are extremely persistent, resistant to breaking down naturally in the environment and able to remain in people's bodies for years. Second, they are highly mobile, spreading quickly throughout our environment. Finally, they can be toxic at very low doses—even at parts per trillion levels, they have been associated with a variety of severe health effects, including cancer and developmental harm. Because PFAS are so persistent, prevalent, and toxic, they must be regulated.

A. PFAS are Prevalent and Persistent

1. PFAS are widely used in consumer and industrial products

Since the 1940s, PFAS have been widely used in consumer products and industrial settings, including in nonstick cookware (e.g., Teflon), stain-resistant repellents used on carpets and fabric (e.g., Scotchgard and Stainmaster), paper and cardboard food packaging (e.g., fast food wrappers), textiles (e.g., Gore-Tex), toothpaste, shampoos, cosmetics, polishes and waxes,

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[2] ANNA READE ET AL., NRDC, SCIENTIFIC AND POLICY ASSESSMENT FOR ADDRESSING PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) IN DRINKING WATER (2019), available at https://bit.ly/2LN1T4f [hereinafter NRDC REPORT] (attached to this letter as Attachment 1).

[3] SWEDISH CHEMICALS AGENCY (KEMI), OCCURRENCE AND USE OF HIGHLY FLUORINATED SUBSTANCES AND ALTERNATIVES (2015), https://www.kemi.se/en/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf (accessed Sept. 4, 2018).

[4] Organization for Economic Co-operation and Development, TOWARD A NEW COMPREHENSIVE GLOBAL DATABASE OF PER-AND POLYFLUOROALKYL SUBSTANCES (PFASS): SUMMARY REPORT ON UPDATING THE OECD 2007 LIST OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFASS), 39 Series on Risk Management, (2018), http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV-JM-MONO(2018)7&doclanguage=en (accessed Sept. 4, 2018).

pesticides and herbicides, windshield wipers, firefighting foam, and many products for the aerospace, automotive, construction, and electronic industries.[5] These uses have resulted in multiple routes of exposure, including through drinking water, food, house dust, indoor and outdoor air, and workplaces where PFAS are made or used.[6]

2. PFAS Linger in the Environment and in People's Bodies

PFAS are "forever chemicals"—they are extremely long-lived in the environment, and can build up in our bodies and in those of animals.[7] They can move through the soil and into groundwater and remain there for many years.[8] That, combined with their widespread use, means that PFAS are ubiquitous across the planet—present in rivers, soil, air, house dust, food and drinking water. For these reasons, while American manufacturers have stopped producing PFOA and PFOS, they remain in the environment until they are removed.

Both PFOA and PFOS are known to bioaccumulate in the body of people of all ages, even before birth. Once ingested or inhaled, PFOA and PFOS accumulate in the blood serum for long periods of time, as PFOA and PFOS have half-lives of several years.[9] Even relatively low PFOA and PFOS concentrations in drinking water are associated with substantial increases in

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[5] *See* Amy Martyn, *Anti-grease Chemicals Used in Fast Food Wrappers Can Accumulate in Organs, Study Finds*, CONSUMER AFFAIRS (Mar. 30, 2017), https://www.consumeraffairs.com/news/anti-grease-chemicals-used-in-fast-food-wrappers-can-accumulate-inorgans-study-finds-033017.html; INTERSTATE TECH. & REG. COUNCIL, HISTORY AND USE OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) (2017), https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf; EPA, DRINKING WATER HEALTH ADVISORY FOR PERFLUOROOCTANOIC ACID (PFOA), EPA DOC. NO. 822-R-16-005, at 24 (2016), https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf [hereinafter DRINKING WATER HEALTH ADVISORY FOR PFOA]; EPA, DRINKING WATER HEALTH ADVISORY FOR PERFLUOROOCTANE SULFONATE (PFOS), EPA DOC. NO. 822-R-16-004, at 24-25 (May 2016), https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf [hereinafter DRINKING WATER HEALTH ADVISORY FOR PFOS].

[6] N.J. DEP'T OF HEALTH, ENVTL. & OCCUPATIONAL HEALTH SURVEILLANCE PROGRAM, DRINKING WATER FACTS: PERFLUORINATED CHEMICALS (PFCS) IN DRINKING WATER (2016), at 2, https://eohsi.rutgers.edu/wp-content/uploads/NJ_pfc_factsheet.pdf [hereinafter NJ DOH FACT SHEET]; EPA, EMERGING CONTAMINANTS – PERFLUOROOCTANE SULFONATE (PFOS) AND PERFLUOROOCTANOIC ACID (PFOA), at 2, (Mar. 2014), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100LTG6.PDF?Dockey=P100LTG6.PDF [hereinafter EMERGING CONTAMINANTS FACT SHEET].

[7] EMERGING CONTAMINANTS FACT SHEET, *supra* note 6, at 1; *see also* DRINKING WATER HEALTH ADVISORY FOR PFOA, *supra* note 5, at 24; DRINKING WATER HEALTH ADVISORY FOR PERFLUOROOCTANE SULFONATE (PFOS), *supra* note 5, at 25.

[8] EMERGING CONTAMINANTS FACT SHEET, *supra* note 6, at 1-2.

[9] EPA estimates that the half-life of PFOA is 2.3 years. (The half-life is the time it takes to reduce the concentration by half.) For PFOS, the half-life is estimated to be more than 8 years. *See* DRINKING WATER HEALTH ADVISORY FOR PFOA, *supra* note 5, at 25; DRINKING WATER HEALTH ADVISORY FOR PFOS, *supra* note 5, at 25-26. *See also* U.N. ENV'T PROGRAMME, STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS, REP. OF THE PERSISTENT ORGANIC POLLUTANTS REVIEW COMM. ON THE WORK OF ITS TWELFTH MEETING, U.N. Doc. UNEP/POPS/POPRC.12/11/Add.22, at 1919-21 (Nov. 18, 2015) (discussing bioaccumulation of PFOA); ORG. FOR ECON. CO-OPERATION AND DEV., ENV'T DIRECTORATE, , HAZARD ASSESSMENT OF PERFLUOROOCTANE SULFONATE (PFOS) AND ITS SALTS, Doc. No. ENV/JM/RD(2002)17/FINAL, at 5 (Nov. 21, 2002) (discussing bioaccumulation of PFOS). *See also Bioaccumulation*, OXFORD ENGLISH DICTIONARY, http://www.oed.com/view/Entry/273970 (last accessed Oct. 1, 2017).

blood serum levels.[10] Because of these chemicals' prevalence and persistence, PFOA and PFOS are present in the blood serum of almost every human around the world. Between 1999 and 2012, one or both of the chemicals were detected in 99 percent of the general population.[11]

3. PFAS Are Found in Drinking Water Systems Across the United States, Including in New York

In communities with PFAS-contaminated drinking water supplies, drinking water is the overwhelming source of exposure to PFAS. Drinking water with PFOA concentrations of 100 ppt and 400 ppt, for example, are predicted to contribute 71 percent and 91 percent of total PFOA exposure, respectively; and are estimated to increase PFOA blood serum levels, on average, by 250 percent and 1,000 percent, respectively.[12] This is because the elimination of PFOA from the body is slow, causing these contaminants to accumulate in blood—after a long period of exposure, a person's PFOA levels in blood serum will be about 100 times greater than the PFOA concentration ingested via drinking water.[13]

Elevated levels of PFAS in drinking water are strongly associated with proximity to major industrial sites, civilian airports, and military fire training areas.[14] As such, there are likely hundreds, or more likely thousands, of PFAS contamination sites nationally, including over 400 military installations with known or suspected releases.[15] As is illustrated in Figure 1, there are over 600 known PFAS contamination sites in the United States:[16]

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[10] NRDC REPORT, *supra* note 2, at 9.

[11] DRINKING WATER HEALTH ADVISORY FOR PFOA, *supra* note 5, at 9; DRINKING WATER HEALTH ADVISORY FOR PFOS, *supra* note 5, at 10.

[12] Robin Vestergren & Ian T. Cousins, *Tracking the Pathways of Human Exposure to Perfluorocarboxylates*, 43 ENVTL. SCI. TECH. 15, 5565-5575 (2009).

[13] Gloria B. Post et al., *Perfluorooctanoic acid (PFOA), An Emerging Drinking Water Contaminant: A Critical Review of Recent Literature*, 16 ENVTL. RES. 93, 116 (July 2012) [hereinafter Post et al., *Review of Recent Literature*].

[14] Hu *et al.*, *supra* note 1, at 345.

[15] Maureen Sullivan, Deputy Assistant Secretary of Defense (Environment, Safety & Occupational Health, Department of Defense), *Addressing Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)*, EPA PFAS Summit, March 2018, https://www.epa.gov/sites/production/files/2018-05/documents/dod_presentation_epa_summit_pfos_pfoa_may2018_final.pptxx_.pdf.

[16] EWG & Northeastern University Social Science Environmental Health Research Institute, PFAS CONTAMINATION INTERACTIVE MAP (May 2019), available at https://www.ewg.org/interactive-maps/2019_pfas_contamination/map/.

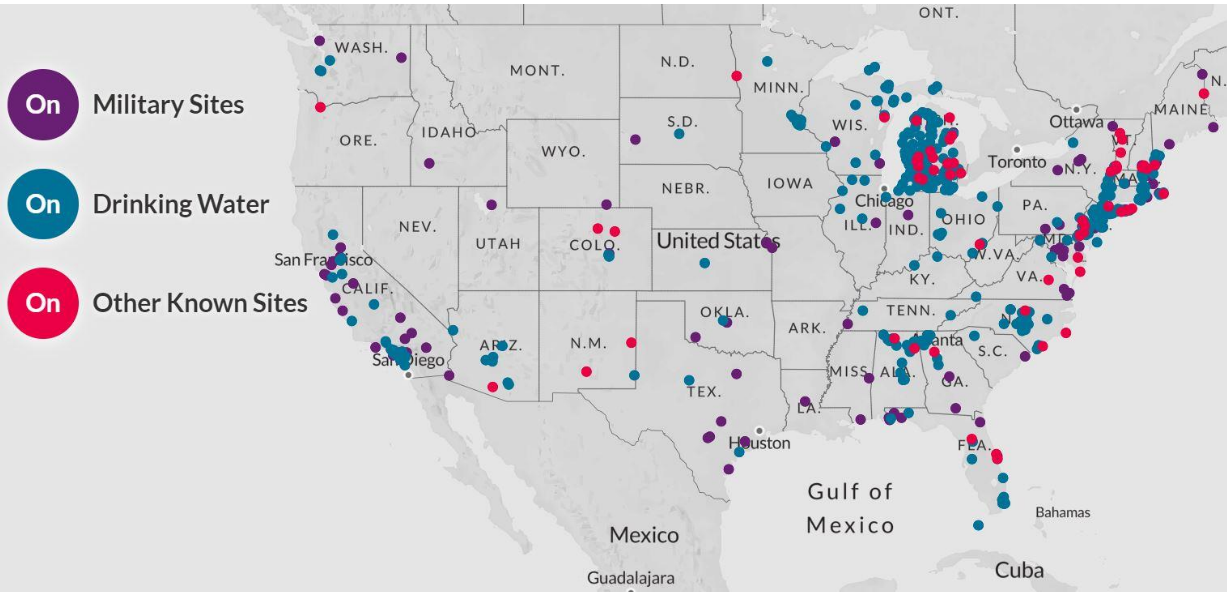

Fig. 1. Over 600 known PFAS contamination sites likely represent the tip of the iceberg

Source: EWG & Northeastern University Social Science Environmental Health Research Institute, PFAS CONTAMINATION INTERACTIVE MAP (May 2019), available at https://www.ewg.org/interactive-maps/2019_pfas_contamination/map/.

PFOA and PFOS have been found at levels that exceed the U.S. Environmental Protection Agency's (EPA's) lifetime health advisory limit of 70 ppt in New York, New Jersey, Alaska, Arizona, California, Colorado, Florida, Illinois, Indiana, Kentucky, Massachusetts, New Hampshire, Ohio, Pennsylvania, Texas, and Vermont, among other states.[17] More recent surveys suggest that PFAS contamination is even more widespread, showing up in as many as 43 states.[18]

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[17] Hu et al., *supra* note 1, at 344 - 346, fig.1 (using data from EPA's third Unregulated Contaminant Monitoring Rule in order to create maps to display where PFOS and PFOA have been found in water supplies).

[18] Monica Amarelo, Mapping the PFAs Contamination Crisis: New Data Shows 610 Sites in 43 States, ENVIRONMENTAL WORKING GROUP (May 6, 2019), https://www.ewg.org/release/mapping-pfas-contamination-crisis-new-data-show-610-sites-43-states.

New York is especially hard-hit by PFOA and PFOS contamination—1.8 million New York residents are served water with PFAS at levels that exceed EPA minimum reporting levels ("MRLs") for UCMR 3.[19] Elevated levels of PFOA and PFOS have been found across the state, including in Hoosick Falls,[20] New Windsor,[21] Fort Drum,[22] Hempstead,[23] Petersburgh,[24] Newburgh,[25] Hampton Bays,[26] Cambridge,[27] and Yaphank.[28] Figure 2 illustrates PFAS levels in New York water supplies as detected pursuant to EPA's Third Unregulated Contaminant Monitoring Rule ("UCMR 3"):

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[19] EPA, *UCMR 3 (2013-2015) Occurrence Data* (2015), https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3. Reporting limits for UCMR3 were: PFOA - 20 ppt, PFOS - 40 ppt, PFHxS - 30 ppt, PFNA - 20 ppt, perfluorohepatanoic acid (PFHpA) - 10 ppt, and perfluorobutane sulfonic acid (PFBS) - 90 ppt. EPA, The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data Summary (2017), https://www.epa.gov/sites/production/files/2017-02/documents/ucmr3-data-summary-january-2017.pdf.

[20] EPA, Hoosick Falls Water Contamination, https://www.epa.gov/ny/hoosick-falls-water-contamination (last visited Oct. 1, 2017).

[21] U.S. ENVTL. PROT. AGENCY, OCCURRENCE DATA FOR THE THIRD UNREGULATED CONTAMINANT MONITORING RULE (Jul. 2017), https://www.epa.gov/sites/production/files/2017-02/ucmr-3-occurrence-data.zip (last visited Oct. 2017), https://www.epa.gov/sites/production/files/2017-02/ucmr-3-occurrence-data.zip (last visited Oct. 1, 2017) [hereinafter OCCURRENCE DATA FOR UCMR 3]; *see also* Teflon Chemical Harmful at Smallest Doses: PFOA Found in 94 Public Water Systems in 27 States, ENVTL. WORKING GRP. (Aug. 20, 2015,), http://www.ewg.org/research/teflon-chemical-harmful-smallest-doses/pfoa-found-94-public-water-systems-27-states [hereinafter PFOA Found in 94 Public Water Systems in 27 States].

[22] OCCURRENCE DATA FOR UCMR 3, *supra* note 21; *see also* PFOA Found in 94 Public Water Systems in 27 States, *supra* note 21.

[23] PFOA Found in 94 Public Water Systems in 27 States, *supra* note 21; Brendan J. Lyons, EPA Sets New Level for Chemical PFOA in Drinking Water, TIMES UNION (May 20, 2016), http://www.timesunion.com/local/article/EPA-sets-new-level-for-chemical-in-local-water-7716825.php [hereinafter Lyons, *EPA Sets New Level*].

[24] Kenneth C. Crowe II & Lindsay Ellis, *Petersburgh Water Tainted with PFOA, Tests Show*, TIMES UNION (Feb. 20, 2016), http://www.timesunion.com/local/article/Petersburgh-water-tainted-with-PFOA-tests-show-6844326.php (noting the existence of PFOA levels of 93.3 and 95.9 ppt); *see also* Lyons, *EPA Sets New Level*, *supra* note 23.

[25] OCCURRENCE DATA FOR UCMR 3, *supra* note 21.

[26] Joan Leary Matthews, *Undrinkable Water—Hampton Bays, NY Edition*, NAT'L RES. DEF. COUNCIL (Sept. 29, 2017), https://www.nrdc.org/experts/joan-leary-matthews/undrinkable-water-hampton-bays-ny-edition.

[27] *New York State's Water Quality Rapid Response Team Announces New Actions to Address Water Contamination in Washington County*, N.Y. STATE DEP'T OF HEALTH (Mar. 13, 2017), https://www.health.ny.gov/press/releases/2017/2017-03-13_water_contamination_in_washington_county.htm [hereinafter *Water Contamination in Washington County*]; Jorja Roman, *PFOA, PFOS Discovered at Paper Composting Facility in Washington County*, SPECTRUM NEWS (Mar. 13, 2017, 7:34 PM), http://www.twcnews.com/nys/capital-region/news/2017/03/13/washington-county-water-contamination-pfos-pfoa-agri-cycle.html.

[28] *Id.*

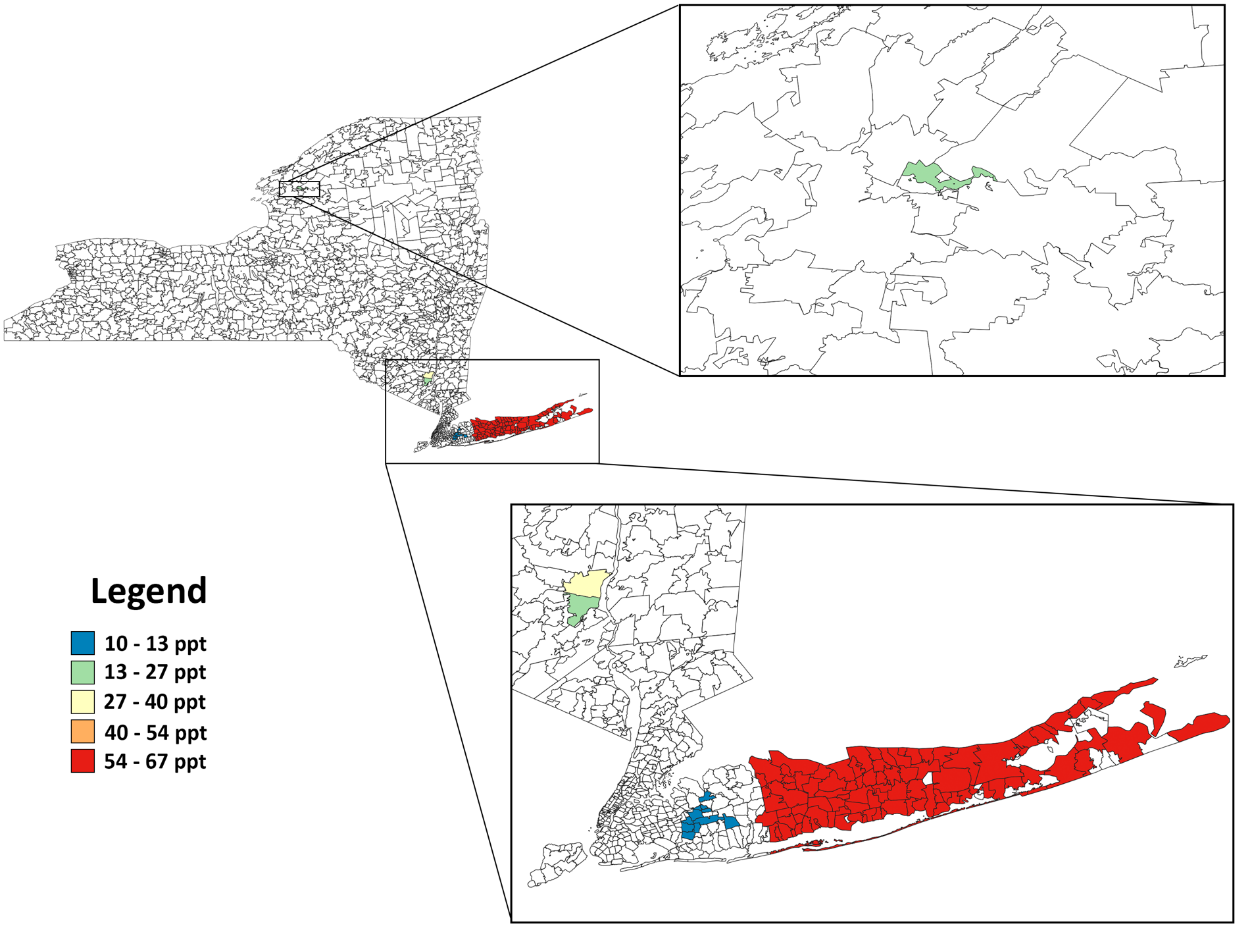

Figure 2. PFAS levels in New York water supplies.

Source: EPA, *UCMR 3 (2013-2015) Occurrence Data* (2015), https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3.

This map is likely an under-representation of PFAS levels in the state, due to limitations in the national survey, including high reporting limits, a focus on large public water systems, and the limited number of PFAS tested. Indeed, the Department has acknowledged that 21 percent of all public water systems, including privately-owned public water systems, likely have levels of PFOA or PFOS that exceed 10 ppt.[29]

And while PFOA and PFOS levels were among the most frequently detected PFAS chemicals in drinking water, they were not the only PFAS chemicals detected—indeed, UCMR 3 also detected PFHxS, PFNA, PFHpA, and PFBS in New York State drinking water supplies,[30] and the detection rates for PFHxS and PFHpA were comparable to those of PFOA and PFOS.[31]

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[29] 41 N.Y. Reg. 22 (Jul. 24, 2019).
[30] OCCURRENCE DATA FOR UCMR 3, *supra* note 1.
[31] *Id.*

4. PFAS Are Harmful to Human Health

The human health impacts of exposure to PFOA and PFOS is beyond question—PFOA and PFOS have profound effects on the young, are extremely persistent, are highly bioaccumulative, and are likely carcinogens.[32] PFOA and PFOS are associated with many serious health effects such as cancer, hormone disruption, liver and kidney damage, developmental and reproductive harm, changes in serum lipid levels, and immune system toxicity—some of which occur at extremely low levels of exposure. Additionally, because PFAS are chemically related to one another, PFOA, PFOS and other PFAS we are exposed to may have additive or synergistic effects on target biological systems within our bodies.

B. PFOA and PFOS are likely carcinogens

Epidemiological and toxicological studies have found associations between exposure to PFOA and PFOS and increased cancer risk, particularly kidney and testicular cancer. EPA has found that PFOA and PFOS demonstrate "suggestive" carcinogenic potential.[33] The C8 Science Panel and the International Agency for Research on Cancer have identified PFOA as a "probable" or "possible" carcinogen, respectively.[34]

C. PFOA and PFOS are associated with other serious health effects

In addition to several types of cancers, PFOA and PFOS have been linked to an array of other serious health effects. The federal Agency for Toxic Substances and Disease Registry ("ATSDR"), part of the U.S. Centers for Disease Control and Prevention ("CDC"), performs risk assessments and evaluates chemicals. ATSDR conducted an exhaustive assessment of fourteen PFAS in a draft Toxicological Profile for Perfluoroalkyls in June 2018.[35] Their assessment found that there is consistent association between PFAS exposure and several health outcomes. Table 1, below, summarizes some of the health effects ATSDR found to be linked to the PFAS reviewed in the profile:

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[32] NRDC REPORT, *supra* note *2*, at 9, 18.

[33] DRINKING WATER HEALTH ADVISORY FOR PFOA, *supra* note 5, at 24; DRINKING WATER HEALTH ADVISORY FOR PFOS*, supra* note 5, at 24-25.

[34] *See* C8 Science Panel, *The Science Panel Website* (last updated Jan. 4, 2017), http://www.c8sciencepanel.org/index.html; Int'l Agency for Research on Cancer, Monograph: Perfluorooctanoic Acid (updated Dec. 22, 2016), 110 IARC MONOGRAPHS on the EVALUATION of CARCINOGENIC RISKS to HUMANS, https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-6/.

[35] AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, TOXICOLOGICAL PROFILE FOR PERFLUOROALKYLS: DRAFT FOR PUBLIC COMMENT (June 2018), https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf [hereinafter ATSDR REPORT].

Table 1. Summary of ATSDR’s Findings on Certain Health Effects from PFAS Exposure

	Immune e.g., decreased antibody response, decreased response to vaccines, increased risk of asthma diagnosis	**Developmental & Reproductive** e.g., pregnancy-induced hypertension/pre-eclampsia, decreased fertility, small decreases in birth weight, developmental toxicity	**Lipids** e.g., increases in serum lipids, particularly total cholesterol and low-density lipoprotein	**Liver** e.g., increases in serum enzymes and decreases in serum bilirubin levels	**Endocrine** e.g., increased risk of thyroid disease, endocrine disruption	**Body Weight** e.g., decreased body weight	**Blood** e.g., decreased red blood cell count, decreased hemoglobin and hematocrit levels
PFOA	✓	✓	✓	✓	✓	✓	✓
PFOS	✓	✓	✓	✓	✓	✓	✓
PFHxS	✓			✓			✓
PFNA	✓		✓			✓	
PFDeA	✓	✓	✓	✓	✓	✓	
PFDoA	✓	✓				✓	
PFUA	✓	✓				✓	✓
PFHxA		✓					✓
PFBA		✓		✓	✓		✓
PFBS				✓			✓

Table 1 summarizes ATSDR’s findings on the associations between PFAS exposure and health outcomes in human and animal studies (not an exhaustive list of health outcomes).

Source: NRDC REPORT, *supra* note 2, at 17.

ATSDR has found that certain PFAS may increase the risk of: thyroid and liver disease; asthma; lower fertility in women; high blood pressure or pre-eclampsia in pregnant women; increased cholesterol levels; decreased ability to respond to vaccines; and lower infant birth weights.[36] Animal studies have found that PFOA and PFOS can cause damage to the liver and the immune system, birth defects, delayed development, and newborn deaths.[37] Notably, delayed mammary gland development has been found to occur at very low levels of PFOA, which may indicate that other hormonally-related effects may also occur at these low levels.[38]

D. PFAS may especially be harmful to fetuses, infants, and children

Fetuses and infants likely have greater exposure to PFAS than adults, and are also more sensitive to the effects of these contaminants. Almost all fetuses and infants will have some degree of exposure,[39] including exposure as fetuses during pregnancy through placental transfer.[40] For infants, exposure may be further elevated due to ingestion of contaminated breastmilk (a result of the mothers' ingestion of contaminated water and other sources) or infant formula prepared with contaminated drinking water.[41]

Infant blood serum levels of PFOA and PFOS are often the highest compared to people in other stages of life.[42] Levels of PFOA and PFOS in breastmilk are much higher than what is typically found in drinking water, as PFOA and PFOS bioaccumulate in the body and are then transferred into the breastmilk.[43] Moreover, since infants consume approximately five times more water per body weight than adults,[44] their exposure is likely higher than adults regardless of whether they are breastfed or are fed infant formula prepared with PFOA- and PFOS-contaminated drinking water.[45]

Compounding this factor, fetuses, infants, and children are also more vulnerable to exposure-related health effects than adults. The young may be more sensitive to the effects of PFOA and PFOS due to their immature, developing biological systems (such as the immune system), and rapid body growth during development.[46] For example, as discussed in the attached

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[36] *Id.* at 5 – 6, 628 – 30.

[37] ATSDR REPORT, *supra* note 35, at 6.

[38] *See* NRDC REPORT, *supra* note 2, at 21. *See also* JUDITH SCHREIBER, NATURAL RESOURCES DEFENSE COUNCIL, RE: SETTING A MAXIMUM CONTAMINANT LEVEL FOR PERFLUOROOCTANOIC ACID (PFOA) AND PERFLUOROOCTANESULFONIC ACID (PFOS) 26, 28 (Feb. 2018), https://www.nrdc.org/sites/default/files/pfoa-exposure-health-risk-analysis-20180226.pdf.

[39] Post et al., *Review of Recent Literature*, *supra* note 13, at 100; NJ DOH FACT SHEET, *supra* note 6, at 1.

[40] ATSDR REPORT, *supra* note 35.

[41] *Id.*

[42] Goeden, H.M et al., *A transgenerational toxicokinetic model and its use in derivation of Minnesota PFOA water guidance*, 29 J. EXPOSURE SCI. & ENVTL. EPIDEMIOLOGY 183-195 (2019), https://www.ncbi.nlm.nih.gov/pubmed/30631142.

[43] *See* NRDC REPORT, *supra* note 2, at 14; Debapriya Mondal et al., *Relationships of Perfluorooctanoate and Perfluorooctane Sulfonate Serum Concentrations between Mother–Child Pairs in a Population with Perfluorooctanoate Exposure from Drinking Water*, 120 ENVTL. HEALTH PERSP 5, 752-57 (May 2012).

[44] EPA, EXPOSURE FACTORS HANDBOOK 2011 EDITION (FINAL REPORT)., https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252.

[45] NRDC REPORT, *supra* note 2, at 13. *See also* Judith Schreiber, *supra* note 38, at 15.

[46] Benjamin J. Apelberg et al., *Cord Serum Concentrations of Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoate (PFOA) in Relation to Weight and Size at Birth*, 115 ENVTL. HEALTH PERSP. 11, 1670-76

NRDC report, exposure to PFAS before birth or in early childhood may result in decreased birthweight, decreased immune responses, and hormonal effects later in life.[47]

E. PFAS Likely Have Additive or Synergistic Effects on the Human Body

The health effects of exposure to multiple PFAS may be additive—In other words, the health effects may be determined by the sum of total PFAS concentrations, rather than the measure of each PFAS concentration individually. It is also possible that concurrent exposure to multiple PFAS may be synergistic, meaning that the effects are greater than the sum of each of the chemicals' effects alone. For example, it may be the total dose of all PFAS in a solution, rather than the individual level of any single PFAS, that is predictive of adverse effects on the immune system. It is also possible that the combined presence of multiple PFAS may cause even greater adverse health effects than the same level of just one PFAS alone.

Moreover, biomonitoring studies demonstrate that Americans are chronically exposed to multiple PFAS throughout their lifetimes. The Center for Disease Control's national biomonitoring studies, the National Health and Nutrition Examination Survey ("NHANES"), reveal that nearly every American has PFOS, PFOA, PFHxS and PFNA detected in their blood stream, including young children.[48] And NHANES detected at least eight other PFAS in blood serum: MeFOSAA, PFDeA, PFUA, PFHpA, PFBS, FOSA, EtFOSAA, PFDoA, and PFHpA.[49] Alternative methods in biomonitoring suggest that exposure is not limited to the few PFAS that are tested for—rather, humans are continuing to be exposed to new and unidentified PFAS.[50]

(2007), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2072847/pdf/ehp0115-001670.pdf; Virginia Ballesteros et al., *Exposure to Perfluoroalkyl Substances and Thyroid Function in Pregnant Women and Children: A Systematic Review of Epidemiologic Studies*, 99 ENVT. INT'L 15 (Feb. 2017), http://www.sciencedirect.com/science/article/pii/S0160412016306195?via%3Dihub; Paula I. Johnson et al., *The Navigation Guide—Evidence-Based Medicine Meets Environmental Health: Systematic Review of Human Evidence for PFOA Effects on Fetal Growth*, 122 ENVTL. HEALTH PERSP. 10, 1028-39 (Oct. 2014), https://ehp.niehs.nih.gov/wp-content/uploads/122/10/ehp.1307893.alt.pdf; Kristen M. Rappazzo et al., *Exposure to Perfluorinated Alkyl Substances and Health Outcomes in Children: A Systematic Review of the Epidemiologic Literature*, 14 INT'L J. ENVTL. RES. & PUB. HEALTH 7, at 691 (Jun. 27, 2017), http://www.mdpi.com/1660-4601/14/7/691/htm.

[47] NRDC REPORT, *supra* note 2, at 20.

[48] DEPARTMENT OF HEALTH AND HUMAN SERVICES, CENTERS FOR DISEASE CONTROL AND PREVENTION, FOURTH NATIONAL REPORT ON HUMAN EXPOSURE TO ENVIRONMENTAL CHEMICALS: UPDATED TABLES, MARCH 2018, https://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Volume1_Mar2018.pdf.

[49] *Id.*

[50] Leo W. Y. Yeung et al., *Perfluorinated Compounds and Total and Extractable Organic Fluorine in Human Blood Samples from China*, 42 ENVTL. SCI. TECHNOLOGY 21, 8140-8145 (2008), https://pubs.acs.org/doi/abs/10.1021/es800631n; Leo W. Y. Yeung and Scott A. Marbury, *Are humans exposed to increasing amounts of unidentified Organofluorine?*, 13 ENVTL. CHEM, 102-110 (2015), http://www.publish.csiro.au/en/EN15041.

II. THE EXISTING REGULATORY FRAMEWORK IS INSUFFICIENT TO SAFEGUARD PUBLIC HEALTH

In light of the serious health risks posed by PFAS contamination and the dearth of federal regulation of PFOA and PFOS, New York should implement an MCL for these two dangerous chemicals as quickly as possible at a level that is health-protective.

A. EPA's efforts to regulate PFOA and PFOS have been inadequate to safeguard public health

There is an urgent need for EPA and states to act. Unfortunately, to date, EPA has moved exceedingly slowly and has not even made a regulatory determination that a drinking water standard is necessary for any PFAS. This complete absence of meaningful regulation by the federal government cries out for action at the state level.

For more than a decade, EPA has acknowledged the potential health risks of PFOA and PFOS. In 2009, the agency placed PFOA and PFOS on its drinking water Contaminant Candidate List, a list of unregulated contaminants that are known or anticipated to occur in public water systems and that may require regulation under the Safe Drinking Water Act.[51] It also issued preliminary "health advisory" values for PFOA and PFOS in drinking water of 400 ppt and 200 ppt, respectively.[52]

In 2012, EPA listed PFOA and PFOS as "unregulated contaminants"[53] under EPA's Third Unregulated Contaminant Monitoring Rule,[54] and as such, large public water systems were required to conduct some monitoring for PFOA, PFOS, and four other PFAS in their drinking water supply from 2013 to 2015, and, if levels exceeded certain reporting limits for the six PFAS, they were required to notify EPA.[55] While a low percentage of small water systems also did EPA-funded monitoring,[56] only 800 total public wells serving less than 10,000 people were selected for random PFAS testing by EPA. The majority of villages and small towns were not tested for PFAS under this rule, including areas that served as PFAS manufacturing sites.[57] Notably, public water systems that found PFAS contamination were not required by EPA's rule

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[51] 42 U.S.C. § 300g-1(b)(B)(i)(I); *see also Contaminant Candidate List 3 - CCL 3*, EPA, http://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3 (last visited Oct. 1, 2017).

[52] NEW YORK STATE DEPARTMENT OF HEALTH, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, FAQ: CITY OF NEWBURGH PFOS CONTAMINATION (2016), https://www.health.ny.gov/environmental/investigations/newburgh/docs/faq.pdf.

[53] *Third Unregulated Contaminant Monitoring Rule*, EPA, http://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule (last visited Oct. 1, 2017).

[54] *Id.*

[55] Monitoring Requirements for Unregulated Contaminants, 40 C.F.R. § 141.40 (2017). *See also* Revisions to the Unregulated Contaminant Monitoring Regulation (UCMR 3) for Public Water Systems, 77 Fed. Reg. 26072-01 (May 2, 2012).

[56] 40 C.F.R. § 141.40(a)(ii)(A)(as in effect in 2012, *see* 77 Fed. Reg. 26072, May 12, 2012, available online at https://www.gpo.gov/fdsys/pkg/FR-2012-05-02/pdf/FR-2012-05-02.pdf; subsequently amended to add different unregulated contaminants).

[57] Rachel Yonkunas, *PFOA by the Numbers: A Widespread Contamination and How It Affects Your Health*, ABC NEWS10, June 2, 2016, http://news10.com/2016/06/02/pfoa-by-the-numbers-a-widespread-contamination-and-how-it-affects-your-health/ (last updated Jun. 8, 2016, 9:04 PM).

to either notify the public of the contamination, nor were they required by the rule to remediate the contamination. The six PFAS were subsequently excluded from EPA's Fourth Unregulated Contaminant Monitoring Rule in 2017,[58] removing PFOA and PFOS from even these tepid directives.

By 2015, EPA worked with manufacturers of PFOA and PFOS to phase out the production of these two contaminants.[59] While we believe PFOA and PFOS are not currently being manufactured or used in manufacturing in the United States, PFOA and PFOS are still present at dangerous levels in the environment—the manufacturing and use of these two contaminants is still not prohibited,[60] and the two contaminants may still enter the country through imported goods. Additionally, many other PFAS, such as PFBS and GenX, are used as PFOA and PFOS substitutes within the United States.

In May 2016, EPA set a non-binding lifetime drinking water health advisory for PFOA and PFOS of 70 ppt.[61] This advisory prompted some public water suppliers around the country to begin testing their water for the presence of the compound, leading to numerous additional discoveries of dangerous levels of PFOA and PFOS in public drinking water.[62] However, like all such advisories, this one serves only as guidance and is not a legally enforceable standard.[63]

In May 2018, EPA reportedly worked with the White House to block release of a critical report by ATSDR showing adverse effects of PFAS at levels far lower than the EPA's health advisory, out of fear of a "public relations nightmare."[64] While the report was finally released after a public uproar, EPA has still failed to meaningfully regulate PFAS manufacture and use or the contamination of drinking water with these chemicals. Because compliance with the EPA health advisory is purely voluntary and is taking place on an ad hoc basis, we still do not know just how systematic PFOA and PFOS contamination really is.

Amidst growing knowledge about the harms of PFAS, the agency has failed to issue standards to protect our drinking water and failed to protect our health and the environment from

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[58] Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 4) for Public Water Systems and Announcement of Public Meeting, 81 Fed. Reg. 92,666 (December 20, 2016).

[59] *See generally 2010/2015 PFOA Stewardship Program – 2014 Annual Progress Reports*, EPA: ASSESSING AND MANAGING CHEMICALS UNDER TSCA (Apr. 10, 2017), https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/20102015-pfoa-stewardship-program-2014-annual-progress (last visited Oct. 1, 2017).

[60] *See* Certain Perfluoroalkyl Sulfonates, 40 C.F.R. § 721.9582 (2017); *see also 2010/2015 PFOA Stewardship Program – 2014 Annual Progress Reports*, EPA: ASSESSING AND MANAGING CHEMICALS UNDER TSCA (Apr. 10, 2017), https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/20102015-pfoa-stewardship-program-2014-annual-progress (last visited Oct. 1, 2017).

[61] DRINKING WATER HEALTH ADVISORY FOR PFOA, *supra* note 5, at 9; DRINKING WATER HEALTH ADVISORY FOR PFOS, *supra* note 5, at 10.

[62] For example, the new PFOA HA has led to water contamination discoveries in Arizona, *see* Daniel Ochoa, *Tempe Takes Corrective Action To Meet EPA Water Regs*, WRANGLER NEWS (Jun. 3, 2016), http://www.wranglernews.com/2016/06/03/tempe-takes-corrective-action-meet-epa-water-regs, and Alabama, *see* Andy Szal, *100,000 Ala. Residents Told Not to Drink Water Due to Chemical Contamination*, CHEM.INFO (Jun. 4, 2016), http://www.chem.info/news/2016/06/100000-ala-residents-told-not-drink-water-due-chemical-contamination.

[63] DRINKING WATER HEALTH ADVISORY FOR PFOS, *supra* note 5, at 12.

[64] Annie Snider, *White House, EPA headed off chemical pollution study*, POLITICO (May 14, 2018), https://www.politico.com/story/2018/05/14/emails-white-house-interfered-with-science-study-536950 (accessed September 4, 2018).

PFAS contamination. It has failed to ensure that PFAS-contaminated sites are cleaned up. The absence of a drinking water standard allows government agencies, public water suppliers, and companies to defend their actions by simply saying that, even after the discovery of PFOA and PFOS in the water supply, they did all that was required under federal law. It is clear that states cannot wait for EPA to act—they must step up to fill this regulatory gap.

B. In this regulatory vacuum, other states have taken steps to address PFOA and PFOS

In the absence of federal regulation, states have started to exercise their power to protect their citizens from PFAS exposure. Notably, New Jersey recently adopted a Maximum Contaminant Level for PFNA at 13 ppt,[65] and has proposed MCLs for PFOA and PFOS at levels of 14 ppt and 13 ppt, respectively.[66]

Vermont has established a drinking water health advisory and enforceable groundwater cleanup level for combined concentrations of PFOA, PFOS, PFHxS, PFNA and PFHpA at 20 ppt.[67] In January 2019, Vermont announced it will initiate the process of adopting its health advisory for these five PFAS as an enforceable MCL.[68] And in May 2019, Vermont passed a law that requires managers of public water supplies to ensure levels of PFOA, PFOS, PFHxS, PFHpA and PFNA are below a combined 20 parts per trillion.[69] The law also requires the Vermont Agency of Natural Resources to start setting drinking water standards for the thousands of chemicals in the PFAS family by 2020.[70]

New Hampshire has adopted MCLs for several PFAS: 12 parts per trillion (ppt) for PFOA; 15 ppt for PFOS; 18 ppt for PFHxS; and 11 ppt for PFNA.[71] Minnesota has published groundwater guidance levels for PFOA and PFOS at 35 ppt and 15 ppt, respectively.[72]

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[65] Scott Fallon, *New Jersey Becomes First State to Regulate Dangerous Chemical PFNA in Drinking Water*, NORTHJERSEY.COM (Sept. 6, 2018), https://www.northjersey.com/story/news/environment/2018/09/06/new-jersey-first-state-regulate-dangerous-chemical-pfna-pfoa/1210328002/.

[66] 51 N.J. Reg. 437(a) (2019).

[67] Vt. Dep't of Health, Memorandum from Mark A. Levine, Commissioner, to Emily Boedecker, Commissioner, Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) (July 10, 2018), http://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf; Vt. Nat. Res. Agency, Dep't of Envtl. Conservation, Chapter 12 of the Environmental Protection Rules: Groundwater Protection Rule and Strategy, Emergency Rule (Jan. 8, 2019), https://dec.vermont.gov/sites/dec/files/documents/GWPR%26S%20Clean%20Version.pdf.

[68] Vt. Nat. Res. Agency, *Agency of Natural Resources Initiates Rulemaking Process to Adopt Maximum Contaminant Level for PFAS Compounds*, https://anr.vermont.gov/content/agency-natural-resources-initiates-rulemaking-process-adopt-maximum-contaminant-level-pfas (last accessed Jan. 19, 2019).

[69] *S.49 Bill Status*, VERMONT GENERAL ASSEMBLY, https://legislature.vermont.gov/bill/status/2020/S.49.

[70] *Id.*

[71] N.H. Code Admin. R. Env-Dw 701.03, *available at* https://www.des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-dw7-800amd-adpt-pstd.pdf.

[72] MINN. DEP'T OF HEALTH, TOXICOLOGICAL SUMMARY FOR: PERFLUOROOCTANOATE (Aug. 2018), https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/pfoa.pdf; MINN. DEP'T OF HEALTH, TOXICOLOGICAL SUMMARY FOR: PERFLUOROOCTANE SULFONATE (May 2019), https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/pfos.pdf.

California has set a notification level of 5.1 ppt for PFOA,[73] and 6.5 ppt for PFOS[74] in drinking water. Connecticut has adopted an action level for combined levels of PFOA, PFOS, PFNA, PFHxS and PFHpA of 70 ppt.[75] Michigan recently established recommended Public Health Drinking Water Screening Levels of 9 ppt for PFOA, 8 ppt for PFOS, 9 ppt for PFNA, 84 ppt for PFHxS, and 1000 ppt for PFBS.[76]

C. New York's attempts to remediate PFOA and PFOS drinking water contamination have been a step in the right direction but should go further

In light of recent drinking water contamination across the state, and in the absence of regulation at the federal level, New York State has taken steps to remediate the contamination on its own.[77]

In 2017, New York passed the Clean Water Infrastructure Act of 2017. Among other things, the Act established the Drinking Water Quality Council, which can recommend emerging contaminants and specific MCLs to the Department. The Act also required that the Commissioner of the Department of Health identify PFOA and PFOS as emerging contaminants. Moreover, the Act mandated PFOA and PFOS monitoring in all covered public water systems, and provided $3.5 million for assessments, testing, and abatement to address exposure to contaminants; and $500,000 for removal and disposal of PFOS foam.[78]

In December 2018, the New York State Drinking Water Quality Council recommended MCLs of 10 ppt for PFOA and 10 ppt for PFOS.[79] These levels were then adopted by the Department for this instant proposed regulation. If adopted, the proposed MCLs would be the strictest standards in the nation. For the reasons set forth below and in more detail in the attached assessment, in order to be protective of human health, New York should adjust their proposed MCLs to establish a combined standard of 2 ppt.

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[73] California Water Boards, Notification Level Issuance: Perfluorooctanoic Acid (PFOA) (2019), *available at* https://www.waterboards.ca.gov/drinking_water/programs/documents/pfoa_nl_issuance%20.pdf.

[74] California Water Boards, Notification Level Issuance: Perfluorooctanesulfonic Acid (PFOS) (2019), *available at* https://www.waterboards.ca.gov/drinking_water/programs/documents/pfos_nl_issuance%20.pdf.

[75] GARY GINSBERG & BRIAN TOAL, CT. DEP'T OF HEALTH, DRINKING WATER ACTION LEVEL FOR PERFLUORINATED ALKYL SUBSTANCES (PFAS): ENVIRONMENTAL AND OCCUPATIONAL HEALTH ASSESSMENT (Dec. 12, 2016), https://www.asdwa.org/wp-content/uploads/2018/01/CT-PFASActionLevel.pdf.

[76] Jamie Dewitt, et al., Michigan Science Advisory Workgroup, *Health-Based Drinking Water Value Recommendations for PFAS In Michigan* (2019), *available at* https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf.

[77] *See, e.g., Governor Cuomo Announces Immediate State Action Plan to Address Contamination in Hoosick Falls*, PRESS OFFICE, GOVERNOR ANDREW M. CUOMO (Jan. 27, 2017) https://www.governor.ny.gov/news/governor-cuomo-announces-immediate-state-action-plan-address-contamination-hoosick-falls.

[78] 2017 N.Y. Assemb. B., 2017 N.Y. S. B. A03007B, http://assembly.state.ny.us/leg/?default_fld=&leg_video=&bn=A03007&term=2017&Summary=Y&Text=Y.

[79] Press Release, N.Y. Dep't of Health, Drinking Water Quality Council Recommends Nation's Most Protective Maximum Contaminant Levels for Three Unregulated Contaminants in Drinking Water (Dec. 18, 2018), https://www.health.ny.gov/press/releases/2018/2018-12-18_drinking_water_quality_council_recommendations.htm.

III. RECOMMENDATIONS

Considering the presence of PFAS in drinking water supplies across New York State, the known health effects of PFAS at very low levels, and the unwillingness of the federal government to respond to this national drinking water crisis, we make the following recommendations.

A. The Department should finalize an MCL for PFOA and PFOS at a combined concentration of 2 parts per trillion.

In light of the urgent need to protect human health from the dangers associated with PFOA and PFOS exposure, we urge the Department to finalize MCLs for the two contaminants at a combined concentration of 2 ppt. Analyses from NRDC's PFAS report show that the Department's proposed MCLs for both PFOA and PFOS could result in unsafe exposures for infants and children.[80] We request that the Department amend the proposed MCLs in two primary ways:

First, rather than develop separate MCLs for PFOA and PFOS, we urge New York to develop a combined MCL for PFOA and PFOS. These structurally similar contaminants likely have additive and synergistic effects on human health. It is the combined level of PFOA and PFOS in our bodies that is relevant for human health, rather than the level of each contaminant individually.

Second, we request that the New York Department of Environmental Protection set lower MCLs for PFOA and PFOS than those proposed in the draft regulations and in the assessment of the New Jersey Drinking Water Quality Institute. In April of this year, NRDC released a peer-reviewed assessment of the health effects of several PFAS, recommending a combined MCL of 2 ppt. This standard is technologically feasible in terms of both testing and treatment capability. If New York adopted that standard, this would be the lowest, most protective standard in the nation.

1. Establishing a Maximum Contaminant Level (MCL)

A maximum contaminant level (MCL) is the maximum level of a contaminant allowed in public drinking water.[81] The MCL is an enforceable standard, and exceedance of the MCL requires water systems to take certain steps, including notifying consumers of the exceedance and adjusting treatment or making structural changes or repairs to come into compliance with the MCL.[82]

The State Sanitary Code does not provide for how the state should establish MCLs,[83] but EPA's method of establishing MCLs in accordance with the Safe Drinking Water Act is

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[80] *See supra* Part I.D.

[81] N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.1(bg); *see also* 42 U.S.C. § 300f; 40 C.F.R. § 141.2.

[82] 42 U.S.C. § 300f; N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.30.

[83] *Id.*; *see also* James R. Wedeking, *Maximum Contaminant Levels and Environmental Injuries*, 28 J. CONTEMP. HEALTH L. & POL'Y 183, 191 (2012) (noting that New York law contains no provisions regarding how to establish MCLs).

instructive.[84] Before establishing an MCL, EPA first establishes a maximum contaminant level goal (MCLG).[85] An MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effects on the health of persons would occur, allowing an adequate margin of safety.[86] MCLGs are non-enforceable health goals and consider only public health and not the limits of detection and treatment technology effectiveness. Therefore, they are sometimes set at levels that water systems cannot meet because of technological limitations.

An MCLG is derived by first identifying the "most sensitive endpoint," or the health effect that occurs at the lowest exposure level. This level is then adjusted by selecting and applying "uncertainty factors" to establish an appropriate margin-of-safety. For example, uncertainty factors are applied to provide an adequate safety margin to account for possible differences between effects that are seen in animals and effects that may be experienced in humans. Finally, a drinking water-specific dose, or maximum allowable dose from drinking water, is generated through application of drinking water exposure parameters such as amount of water ingested per body weight per day and the relative source contribution of drinking water to a person's total exposure (versus from food, consumer products, etc.). When determining a MCLG, EPA considers adverse health risks to sensitive subpopulations, such as infants, children, the elderly, and those with compromised immune systems and chronic diseases.[87] For known cancer-causing contaminants, EPA typically sets the MCLG at zero.[88] This is because any chemical exposure could present a cancer risk.

An MCL is based on the concentration established by its corresponding MCLG but may be adjusted for feasibility reasons, reflecting difficulties in measuring small quantities of a contaminant, or a lack of available, adequate treatment technologies.[89]

2. New York Should Set a Combined Standard for PFOA and PFOS

As explained above in Part I.E., exposures to PFOA and PFOS do not occur in isolation. A person is concurrently exposed to dozens of PFAS daily, and their exposures extend throughout their lifetimes. In addition, the health effects of PFOA and PFOS may be additive or synergistic, meaning that it is the combined concentrations of PFAS that is relevant to health, not the individual levels considered in isolation. For these reasons, health evaluations should consider the impacts of multiple PFAS that target the same body systems regardless of detailed knowledge of the underlying mechanism of action.

While, as explained below, we recommend a combined standard of 2 ppt for PFOA and PFOS, even a combined MCL of 10 ppt for these two contaminants would be an improvement over the proposed regulations, which evaluate the concentrations of PFOA and PFOS separately.

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[84] DOH has promulgated regulations designed to implement the SDWA's requirements. *See* Public Water Supply Supervision Program, 10 N.Y.C.R.R. §§5.1 et seq.

[85] *How EPA Regulates Drinking Water Contaminants*, EPA, https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants (last visited May 30, 2019).

[86] 40 C.F.R. § 141.2.

[87] *How EPA Regulates Drinking Water Contaminants*, EPA, https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants (last visited May 30, 2019).

[88] S. Rep. No. 104-169, at 31.

[89] *Id.*

3. New York Should Adopt MCLs for PFOA and PFOS at a combined level of 2 parts per trillion

New York should develop a Maximum Contaminant Level for PFOA and PFOS in drinking water at a combined level of 2 ppt. The weight of evidence demonstrating adverse effects at very low levels of exposure supports setting the MCL at this level. As detailed in NRDC's attached report, even extremely low levels of exposure to PFOA and PFOS may cause health effects, such as immune suppression and serious adverse developmental effects.[90] None of the federal and state assessments dispute the very serious effects associated with exposure to PFOA and PFOS at very low levels of exposure.

a) The Maximum Contaminant Level Goal for PFOA and PFOS Should Be Set to 0 ppt

In order to be protective of the most vulnerable populations, New York should set its Maximum Contaminant Level Goals for PFOA and PFOS at zero. To arrive at this conclusion, NRDC conducted its own toxicity assessment that is based on the most sensitive health effects, protective of the most vulnerable population, and that fully acknowledges uncertainties in the toxicity assessment process. NRDC's calculations show that the MCLGs for PFOA and PFOS should be below 1 ppt individually.[91] And because PFOA and PFOS share similar structure and properties and are associated with similar health endpoints, many at extremely low levels of exposure, because they often co-occur in our environment, and because there is significant potential for additive or synergistic toxicity among these PFAS, we recommend a combined MCLG of zero for PFOA and PFOS.

b) Based on Limits in Detection Sensitivity, New York Should Set a Combined Maximum Contaminant Level of 2 ppt for PFOA and PFOS

Once the MCLG is set, the MCL should be as close to that level as feasible technology allows. A combined MCL of 2 ppt is both appropriate and technologically feasible in light of both detection and treatment limitations.

First, pre-existing filtration technology, i.e., filtration using granulated activated carbon ("GAC"), has been demonstrated to achieve PFOA and PFOS concentrations at concentrations below 2 ppt.[92] GAC is both listed as feasible technology under the federal Safe Drinking Water Act[93] and is already being used to filter PFOA and PFOS at levels to below 2 ppt,[94]

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[90] NRDC REPORT, *supra* note 2, at 20, 21.

[91] *Id.,* App. C.

[92] NEW JERSEY DRINKING WATER QUALITY INSTITUTE, RECOMMENDATION ON PERFLUORINATED COMPOUND TREATMENT OPTIONS FOR DRINKING WATER 3 – 6 (2015) *available at* http://www.nj.gov/dep/watersupply/pdf/pfna-pfc-treatment.pdf.

[93] The Safe Drinking Water Act states that "granular activated carbon is feasible for the control of synthetic organic chemicals, and any technology, treatment technique, or other means found to be the best available for the control of synthetic organic chemicals must be at least as effective in controlling synthetic organic chemicals as granular activated carbon." 42 U.S.C. §300g-1.

demonstrating its practicability. Other techniques such as reverse osmosis have also been shown to filter PFOA and PFOS to levels below 2 ppt.[95]

Second, PFOA and PFOS can be detected at concentrations of below 2 ppt. Specifically, EPA Method 537.1 has a detection sensitivity of below 1 ppt and a reporting limit of 2 ppt.[96]

As such, we recommend a Maximum Contaminant Level of 2 ppt for combined concentrations of PFOA and PFOS, consistent with the federal framework for promulgating Maximum Contaminant Levels at a level as close as possible to the Maximum Contaminant Level Goal.

B. New York Should Amend the Proposed Regulations to Include a Public Notification Requirement

We agree with other commenters who recommend that, in addition to adopting an MCL for PFOA and PFOS, the Department should include a public notification requirement in the event a public water supply exceeds the MCL for these contaminants. A public notification requirement would ensure that affected members of the public are promptly notified if an exceedance of an MCL for PFOA or PFOS is discovered.

The State Sanitary Code already contains public notification requirements for certain code violations, including in the event of "public health hazards," and MCL, treatment technique, monitoring, and testing procedure violations.[97] Violations are subject to one of three tiers of public notification, which are tiered to reflect the seriousness of the violation and any potential adverse health effects that may result.[98] Tier 1 notification requirements—applied to the most serious violations and health risks—are the most stringent, requiring, among other things, that an owner or operator of a public water system provide public notification no later than 24 hours after the system learns of a violation.[99] "Public health hazards," defined in the Sanitary Code as "an existing or imminent condition which can be responsible for or cause illness, injury or death and for which immediate corrective or remedial action is required,"[100] are one class of violation for which Tier 1 public notification is required.[101]

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[94] New Jersey Drinking Water Quality Institute, Treatment Subcommittee, *Recommendation on Perfluorinated Compound Treatment Options for Drinking Water*, 4 – 5 (2015), https://www.nj.gov/dep/watersupply/pdf/pfna-pfc-treatment.pdf.

[95] NRDC REPORT, *supra* note 2, at 54 – 55.

[96] *See* Eurofins, *A Further Examination of a Subset Of UCMR 3 PFAS Data Demonstrates Wider Occurrence*, http://greensciencepolicy.org/wp-content/uploads/2017/12/Andy_Eaton_UCMR3_PFAS_data.pdf (last visited May 31, 2019); EPA, *EPA Drinking Water Research Methods* (updated Nov. 27, 2018), https://www.epa.gov/water-research/epa-drinking-water-research-methods.

[97] N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.78(a).

[98] *Id.*

[99] *Id.* at § 5-1.78(c).

[100] *Id.* at § 5-1.1(bz).

[101] *Id.* at § 5-1.78.

We recommend that an exceedance of the MCL for PFOA and PFOS be classified at minimum as a "public health hazard,"[102] as such an exceedance could lead to illness, injury, or death, and would require immediate corrective action. But these public notification requirements should not be limited to the owners and operators of public water systems. Whenever an employee, contractor or any representative of a state, or county, or city, or town or village government, authority or commission becomes aware of an exceedence of an MCL, he or she should be required to report the violation within 48 hours to the chief executive officer of the body. The chief executive officer should then in turn be required to comply with Tier 1 public notification requirements.

Public notification requirements are an important tool that allows affected drinking water customers to protect themselves at the first sign of contamination. Such notification is especially helpful to protect the most vulnerable populations, such as pregnant and nursing women and small children, from unnecessary PFOA and PFOS exposure. For these reasons, we recommend that a public notification requirement be included in the new regulations.

C. Once New York finalizes its regulations for PFOA and PFOS, it should look to regulating PFAS as a class

Finally, once New York finalizes its regulations for PFOA and PFOS, it should work to regulate PFAS as a class, since manufacturers have already begun substituting PFOA and PFOS with structurally similar chemicals with similar health effects. If we neglect regulating the entire PFAS class, New York residents risk experiencing the same health effects from very similar, but unregulated, chemicals.

PFAS are a class of chemicals estimated to contain between 3,000[103] to 5,000[104] synthetic chemicals, and new subclasses of PFAS are still being discovered in products and in the environment.[105] Multiple PFAS are found in drinking water, food, dust, personal care products and a variety of different environmental media. In drinking water, PFOA, PFOS, PFNA, PFHxS, PFBS, PFHpA, and other PFAS are often found in conjunction.[106] Food contact materials (all materials and articles intended to come in contact with food) and packaging in the United States

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[102] *Id.* at § 5-1.1(bz).

[103] Swedish Chemicals Agency (KEMI), *Occurrence And Use Of Highly Fluorinated Substances And Alternatives: Report From A Government Assignment* (2015), https://www.kemi.se/en/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf.

[104] Organization for Economic Co-operation and Development, *Toward a New Comprehensive Global Database of Per-and Polyfluoroalkyl Substances (PFASs): Summary Report on Updating the OECD 2007 List of Per- and Polyfluoroalkyl Substances (PFASs)* (2018), http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV-JM-MONO(2018)7&doclanguage=en.

[105] Krista A. Barzen-Hanson, et al., *Discovery of 40 Classes of Per- and Polyfluoroalkyl Substances in Historical Aqueous Film-Forming Foams (AFFFs) and AFFF-Impacted Groundwater*, 51 ENVIRON. SCI. TECHNOL. 2047 (2017), https://pubs.acs.org/doi/abs/10.1021/acs.est.6b05843.

[106] Xindi C. Hu, *Detection of PFASs In US Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Waste Water Treatment Plants*, 3 ENV. SCI. AND TECH LETTERS 344 (2016), https://pubs.acs.org/doi/pdf/10.1021/acs.estlett.6b00260.

has shown detectable levels of PFOA, PFHxS, PFDA, PFHpA, PFDoA, PFHxA, PFBA, PFPeA, PFUA, PFOS and 8:2 FTOH,[107] and likely contain other unknown PFAS. A single consumer product such as carpet, clothing, outdoor gear, or dental floss can contain up to nine different identifiable PFAS compounds[108] along with other undetermined PFAS. Samples of dust collected throughout homes and offices have shown high concentrations of 8:2 FTOH, PFDA, PFHpA, PFNA, 10:2 FTOH, PFDoA and PFTeDA.[109] Indeed, the prevalence of other PFAS chemicals in drinking water was borne out in the UCMR 3 data for New York State—UCMR 3 data found PFHxS, PFNA, PFHpA, and PFBS in New York State drinking water supplies,[110] and the detection rates for PFHxS and PFHpA were comparable to the detection rates of PFOA and PFOS.[111]

And there is growing evidence that PFAS as a class collectively pose similar threats to human health and the environment as PFOA and PFOS. The 2014 Helsingør and 2015 Madrid Statements, founded on extensive reviews of the scientific literature, provided consensus from more than 200 scientists on the potential for harm associated with the entire class of PFAS.[112] Several adverse health outcomes have been reported for other PFAS in both animal and human studies. These include increased serum lipids (PFDeA, PFNA), decreased antibody response (PFDeA, PFUA and PFDoA), liver and/or kidney damage (PFBS, PFHxA, PFHxS, and PFUA), decreased body weight (PFDoA, PFDeA, PFNA, and PFUA), endocrine disruption (PFDeA, PFBS, and PFBA), developmental toxicity (PFDeA, PFHxA, PFUA, PFDoA, PFBS, and PFBA), reproductive toxicity (PFBS), and effects on blood (PFUA, PFBS, PFBA, and PFHxS), similar to findings for PFOA and PFOS.

Because the entire PFAS class is characterized by extreme persistence, high mobility, and is associated with a multitude of different types of toxicity at very low levels of exposure, the entire class poses a threat to human health and the environment. In addition, exposures to PFAS most often occur as mixtures. With individual PFAS targeting many of the same biological systems, concurrent exposures to multiple PFAS likely have additive or synergistic effects. Therefore, traditional toxicity assessments that assume exposures to a chemical occur in isolation could be significantly underestimating the real-world effects of PFAS. Therefore, we recommend that the class be regulated as whole to protect public health and avoid a "whack a mole" problem whereby dangerous PFAS are swiftly replaced by one another and regulatory action fails to keep pace.

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[107] Xiaoyu Liu, et al., Concentrations and Trends of Perfluorinated Chemicals in Potential Indoor Sources From 2007 Through 2011 in the US, 98 CHEMOSPHERE 51 (2014), https://www.sciencedirect.com/science/article/pii/S0045653513013714?via%3Dihub.

[108] EPA, *Perfluorocarboxylic Acid Content in 116 Articles of Commerce* (2009), https://www.oecd.org/env/48125746.pdf.

[109] Alicia Fraser, et al., *Polyfluorinated Compounds in Dust From Homes, Offices, and Vehicles as Predictors of Concentrations in Office Workers' Serum*, 60 ENVIRON. INT. 128 (2013), https://www.sciencedirect.com/science/article/pii/S016041201300175X?via%3Dihub.

[110] EPA, *UCMR 3 (2013-2015) Occurrence Data* (2015), https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3

[111] *Id.*

[112] Martin Scheringer et al., *Helsingør Statement on Poly- and Perfluorinated Alkyl Substances (PFASs)*, 114 CHEMOSPHERE 337 – 39 (2014); Arlene Blum et al., *The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs)*, 123 ENVTL. HEALTH PERSP. 5, A107 (2015).

Regulation of PFAS as a class would not represent the first time that EPA or New York has regulated a class of toxic chemicals with a single standard for the entire class. Indeed, both the Safe Drinking Water Act and the New York State Sanitary Code regulate PCBs (polychlorinated biphenyls), a group of chemicals consisting of 209 individual compounds, as a class.[113]

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[113] 40 C.F.R. § 141.61(c)(15) (MCL for total PCBs); *see also* N.Y. Comp. Codes R. & Regs. tit. 10, § 5-1.52, t. 9C.

IV. CONCLUSION

We thank the Department for the opportunity to comment on this important public health issue. Setting an MCL for PFOA and PFOS is long overdue. In the absence of federal safeguards, New York must act to protect drinking water, reduce risks to the public, and remediate the contaminated drinking water sources. The widespread presence of these chemicals in New York drinking water, the profound effects related to exposure, the very long periods that PFOA and PFOS are present in water absent filtration, and the very long half-lives that result in continued elevated blood serum levels even after exposure ceases all call for swift adoption of a combined MCL for PFOA and PFOS at 2 ppt.

Sincerely,

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ATTACHMENT 1

PFAS in Drinking Water 2019

Scientific and Policy Assessment for Addressing Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water

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EXECUTIVE SUMMARY

Over the past few decades per- and poly-fluoroalkyl substances (PFAS) contamination has grown into a serious global health threat. PFAS are a large class of several thousand chemically-related synthetic chemicals that are widely used for their water- and oil-repellant properties in a variety of industrial processes and consumer goods. A defining feature of PFAS is their carbon-fluorine bonds, which impart high thermal stability and resistance to degradation. PFAS are also highly mobile in the environment and many have been found to bioaccumulate, or build up, in humans and animals. People are concurrently exposed to dozens of PFAS chemicals daily through their drinking water, food, air, indoor dust, carpets, furniture, personal care products, and clothing. As a result, PFAS are now present throughout our environment and in the bodies of virtually all Americans.

PFAS are associated with many serious health effects such as cancer, hormone disruption, liver and kidney damage, developmental and reproductive harm, changes in serum lipid levels, and immune system toxicity - some of which occur at extremely low levels of exposure. Additionally, because PFAS are chemically related, they may have additive or synergistic effects on target biological systems within our bodies.

Despite the known health impacts and known contamination in people's homes and in the environment, no enforceable national drinking water standards have been set. The few, mostly non-enforceable, advisories or guidelines that do exist at the federal and state levels are mainly for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). PFOA and PFOS are the most extensively studied PFAS to-date and, as such, their toxicity has been well characterized in humans and animal models. Although the database for other PFAS is not as robust as for PFOA and PFOS, evidence is growing quickly that indicates they collectively pose similar threats to human health and the environment, often at exceedingly low doses. These toxicity data, combined with concerns over their similar environmental mobility and persistence and widespread human and environmental exposure, have led independent scientists and other health professionals from around the globe to express concern about the continued and increasing production and release of PFAS.

The purpose of this report is to provide relevant scientific information which will help states make informed decisions about how to protect its citizens. This report discusses the most critical health effects known to be associated with PFAS, the risk of additive/synergistic effects from concurrent exposure to multiple PFAS, existing or proposed standards and advisories, and detection and treatment technologies available. Special attention has been given to comparing and analyzing existing or proposed standards and advisories, from which our recommendations arise. For this analysis, we focused on PFOA and PFOS, and two additional PFAS, perfluorononanoic acid (PNFA), and perfluorohexane sulfonic acid (PFHxS), because the Agency for Toxic Substances and Disease Registry has generated minimal risk levels for all four. GenX chemicals, used as a replacement for PFOA, were also analyzed in this report, as their toxicity was recently assessed by the US Environmental Protection Agency (EPA).

Our analysis of current literature and standards/advisories for PFOA, PFOS, PFNA, PFHxS, and GenX show that existing standards and advisories are not health protective. For example, Michigan's PFAS Science Advisory Panel concluded that, "*the research supports the potential for health effects resulting from long term exposure to drinking water with concentrations below 70 ppt*" (the EPA's lifetime health advisory for PFOA and PFOS). If toxicity assessments were based on the most sensitive health effect, protective of the most vulnerable population, and fully acknowledged uncertainties in the toxicity assessment process, maximum contaminant level goals (MCLGs)[a], which are to be set at a level fully protective of human health, would range from 0 to 2 ppt for drinking water. As technology for detection and water treatment do not currently allow for the complete removal of PFAS from drinking water, maximum contaminant levels (MCLs)[b] for PFOA, PFOS, PFNA, PFHxS, and GenX should be based on the best detection and treatment technologies available. Our review of detection and treatment capabilities suggests, a combined MCL of 2 ppt is feasible for PFOA, PFOS, PFNA, and PFHxS, with a separate MCL of 5 ppt for GenX.

However, we conclude that setting a MCLG of zero for the class is needed to provide an adequate margin of safety to protect public health from a class of chemicals that is characterized by extreme persistence, high mobility, and is associated with a multitude of different types of toxicity at very low levels of exposure. If only a handful of PFAS are regulated, there will be swift regrettable substitution with other, similarly toxic PFAS - creating an ongoing problem where addressing one chemical at a time incentivizes the use of other toxic chemicals and we fail to establish effective safeguards to limit this growing class of dangerous chemicals.

The problems with PFAS as a class are highlighted by the fact that many complex PFAS have the potential to break down into less complex perfluoroalkyl acids (PFAAs), a subgroup of PFAS that includes PFOA and PFOS, for which there are substantial known health risks. These problems are compounded by the fact that the production of certain PFAS, such as fluoropolymers, requires the use of PFAAs in their manufacture. This use increases total PFAA contamination and exposure through industrial discharge, as was seen with the production of Teflon®, as well as through impurities in PFAS-containing products.

At present, there is no single methodology for isolating, identifying, and quantifying all PFAS compounds in drinking water. We recommend that the state explore an analytical method, such as total oxidizable precursor assay (TOPA)[c], or combination of methods, that can be used as a surrogate for total PFAS. Until a comprehensive analytical method has been approved to

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[a] An MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, allowing an adequate margin of safety. MCLGs are non-enforceable health goals and consider only public health and not the limits of detection and treatment technology effectiveness.

[b] An MCL is the legal threshold of the amount of a chemical that is allowed in public water systems under the Safe Drinking Water Act. An MCL is based on the concentration established by its corresponding MCLG, but may be adjusted up for feasibility reasons, reflecting difficulties in measuring small quantities of a contaminant, or a lack of available, adequate treatment technologies.

[c] TOPA estimates the full array of potential polyfluoroalkyl acid (PFAA) precursors in a sample. TOPA replicates what micro-organisms in the environment would achieve after many years by rapidly converting precursors into PFAAs such as PFOA, using a hydroxyl radical-based chemical oxidation method.

quantify PFAS compounds as a class, we recommend reverse osmosis, or other treatment method at least as effective as reverse osmosis, as a treatment technique – an enforceable treatment procedure to ensure contamination control - for public water supplies. Reverse osmosis is the preferred treatment technology because it has been demonstrated to effectively remove a broad range of PFAS compounds, it is the most robust technology for protecting against unidentified contaminants, and it does not require frequent change out of treatment media or release elevated concentrations of pollutants after media is spent. We recommend the evaluation of the safest disposal method for high-strength waste streams and spent/used membranes, and that disposal require full destruction of PFAS compounds before entering the environment.

In summary, this report finds that the current available scientific evidence supports the need for:

1) comprehensive testing of drinking water;

2) a maximum contaminant level goal of zero for total PFAS;

3) a combined maximum contaminant level of 2 parts per trillion (ppt) for PFOA, PFOS, PFNA, and PFHxS, and a maximum contaminant level of 5 ppt for GenX; and

4) the setting of a Treatment Technique – an enforceable treatment procedure to ensure contamination control – for the PFAS class based on the best available detection and treatment technologies.

INTRODUCTION

Per- and poly-fluoroalkyl substances (PFAS) are synthetic chemicals that are widely used in a variety of industrial processes and consumer goods. The carbon-fluorine bonds in PFAS impart high thermal stability and resistance to degradation. While useful chemicals, PFAS are highly resistant to environmental degradation and persist in the environment. As a result, PFAS are now present throughout our environment and in the bodies of virtually all people.

PFAS have been associated with a wide variety of adverse health effects including cancer, hormone disruption, liver damage, developmental harm, and immune system toxicity - some of which occur at extremely low levels of exposure. PFAS are widely prevalent in drinking water sources across the country. Consequently, there is an urgent need to take action to address this growing health threat. Yet, there are still no enforceable regulations for PFAS in drinking water at the federal level, and very few regulations addressing PFAS in drinking water at the state level.

In response to a national PFAS contamination crisis in drinking water, this report provides a summary of relevant scientific information on PFAS, including information on PFAS exposure, their effects on human health, and how existing or proposed standards and advisories have been developed. Based on this information, we make recommendations on how states can protect the health of their citizens by addressing PFAS contamination in its drinking water.

This report is organized into six parts: Part I is an introduction to the PFAS class of chemicals. Part II provides an overview of the widespread presence of PFAS in drinking water and in people. Part III discusses the health risks associated with PFAS exposure. Part IV compares and analyzes existing health thresholds set or recommended for levels of certain PFAS (PFOA, PFOS, PFNA, PFHxS and GenX chemicals[d]). Part V provides an overview of detection/analytical methods and treatment technologies for PFAS removal from water. Part VI offers conclusions and recommendations on how PFAS contamination in drinking water can be addressed.

PART I: WHAT ARE PFAS

PFAS are a large class of synthetic fluorochemicals that are widely used for their water- and oil-repellant properties. PFAS can be found in consumer products such as non-stick cookware, clothing, leather, upholstery, and carpets; in paints, adhesives, waxes and polishes; in aqueous

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[d] As explained by the U.S. Environmental Protection Agency, “GenX is a trade name for a processing aid technology developed by DuPont (now Chemours). In 2008, EPA received new chemical notices under the Toxic Substance Control Act from DuPont (which is now Chemours) for two chemical substances that are part of the GenX process (Hexafluoropropylene oxide (HFPO) dimer acid and the ammonium salt of HFPO dimer acid).” See EPA, GenX Chemicals Studies, available online at https://www.epa.gov/pfas/genx-chemicals-studies, visited December 4, 2018.

fire-fighting foams; and industrially as surfactants, emulsifiers, wetting agents, additives and coatings.[1,2,3]

A defining feature of PFAS are their carbon-fluorine bonds, which impart high thermal stability and resistance to degradation.[4,5] As a result, PFAS are highly resistant to environmental degradation and persist in the environment. They are relatively water-soluble and have been detected in drinking water sources and in finished (treated) drinking water. Due to their water solubility, after exposure by any route, these chemicals are found in human blood serum rather than in body fat where fat-soluble persistent organic pollutants such as PCBs reside. With half-lives of years, PFAS persist in humans and are found in the blood serum of almost all US residents and populations worldwide.[2,6] PFAS are commonly found together in samples from contaminated water[7] and are identified as co-contaminants in blood serum.[6]

The two most well-known PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), were manufactured between the 1940s and mid-2010 when they were voluntarily phased out from U.S. manufacturing due to health concerns.[8] However, PFOA and PFOS are still manufactured and used internationally and may enter the U.S. through imported goods.[9] There is widespread contamination of PFOA and PFOS in the environment and their toxicity has been well characterized in humans and animal models.[5] PFOA and PFOS are the most extensively studied PFAS to-date, and as such, they are often the only PFAS chemicals with exposure guidelines in drinking water or other environmental media.

However, issues related to the entire PFAS class, which has now grown to an estimated 4,700 chemicals, have been of increasing concern for researchers and health authorities.[10,11,12] Although there is not a robust toxicity database for the suite of PFAS, it is generally recognized that these chemicals are structurally similar, and it is reported that the health risks associated with one PFAS are expected for other PFAS as well.[2,10,13,14] Moreover, as discussed below, many PFAS have the potential to convert into perfluoroalkyl acids (PFAAs), a subgroup of PFAS that includes PFOA and PFOS, for which there are substantial known health risks. Health risks of PFAS include cancer, immune system disfunction, liver damage, hormone disruption, low birth weight and other developmental effects, changes in serum lipid levels, and reproductive harm.[5] While some scientific uncertainties exist, the weight of scientific evidence is substantial: in experimental animals, in exposed residential populations drinking contaminated water, and in occupational studies, PFOA, PFOS, and related PFAS cause adverse health effects, particularly on the young, and increase cancer risks[15] in exposed populations (discussed further in Part III).

PFAS Classification

PFAS can be classified into various subgroups (see Figure 1 below for a simplified classification diagram).[10] The PFAS subgroup with the most toxicological information is perfluoroalkyl acids (PFAAs), which includes PFOA and PFOS.[5] Another PFAS subgroup is PFAA precursors, which consists of PFAS that can be converted into PFAAs.[16,17] PFAA precursors include fluorotelomer-based substances and PASF (perfluoroalkane sulfonyl fluoride)-based substances.

In a recent review of the global distribution of PFAS, authors concluded that PFAA precursors should be given attention in addition to PFOA, PFOS and other PFAAs.[18] For example, one PFAA precursor subgroup, polyfluorinated phosphate esters (PAPs), are not routinely measured or widely investigated, however recent studies show that they are present in house dust, sometimes at extremely high levels that exceed other PFAS subgroups.[19] Additionally, PAPs were found to be incorporated into produce, such as pumpkin, grown on contaminated soils.[20] PFAA precursors can pose health risks associated with their precursor form and when broken down into PFAAs. Germany and Sweden have proposed a restriction under REACH (a 2006 European regulation that addresses the registration and production of chemical substances) to cover six PFAS and any substance that can degrade into one of the six. The Swedish Chemicals Agency estimates that the restriction will cover a group of about 200 PFAS.[21]

Figure 1: Simplified Classification of PFAS Class

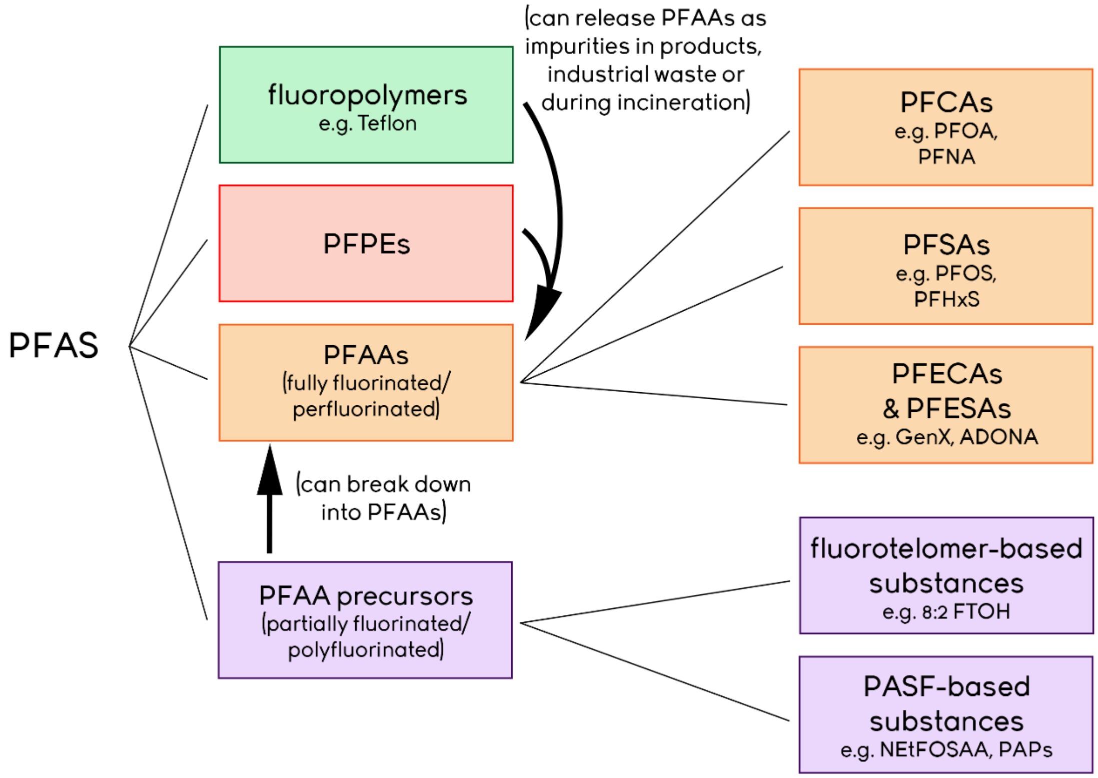

Figure 1 shows the relationship between various subgroups within the PFAS class. This classification scheme is not inclusive of all PFAS subgroups. PFAS (per- and polyfluoroalkyl substances), PFPEs (perfluoropolyethers), PFAAs (perfluoroalkyl acids), PFCAs (perfluoroalkyl carboxylic acids), PFSAs (perfluoroalkyl sulfonic acids), PFECAs (perfluoroether carboxylic acids), PFESAs (perfluoroether sulfonic acids), PASF (perfluoroalkane sulfonyl fluoride).

Perfluoropolyethers (PFPEs) are large molecular sized PFAS with ether linkages and fluoropolymers are composed of multiple repeating units of PFAS.[10,17] While neither are known to actively degrade into PFAAs, they are highly persistent and PFAAs are used in their manufacture, can occur as impurities in the final product, and can be formed when the polymers are heated or incinerated. A well-known fluoropolymer is polytetrafluoroethylene, also known as Teflon. The use of PFAAs such as PFOA and GenX chemicals in the manufacture of perfluoropolyethers and fluoropolymers has resulted in severe environmental contamination around manufacturing and processing plants.[22]

There is concern that simply substituting one PFAS that has been shown to be toxic for another, often less studied PFAS, will result in a regrettable substitution that is not protective of public health. Regrettable substitutions of certain PFAS compounds with others demonstrating similar toxicological characteristics have already occurred. For example, GenX is a replacement technology for PFOA and perfluorobutane sulfonic acid (PFBS) is a replacement for PFOS. The US Environmental Protection Agency (EPA) released draft toxicity assessments in November of 2018 on two GenX chemicals (hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt) and PFBS confirming that GenX chemicals are associated with liver and pancreatic cancers and adverse effects on the kidneys, blood, liver, immune system, and development.[23] In addition, PFBS is associated with thyroid and kidney effects and reproductive and developmental toxicity.[24]

Table 1: Replacements for PFOA and PFOS are Associated with Similar Health Effects

	Cancer	**Immune**	**Liver or Kidney**	**Developmental & Reproductive**	**Endocrine**
PFOA	●	●	●	●	●
GenX	●	●	●	●	
PFOS	●	●	●	●	●
PFBS		○	●	●	●

Table 1 compares several health effects associated with exposure to PFOA and its replacement GenX, and PFOS and its replacement PFBS. Based on human and animal evidence (not inclusive of all associated health effects).[e,f,g]

Indeed the EPA, in an evaluation of alternative PFAS to PFOA and PFOS, stated that there is, *"concern that these … substances will persist in the environment, could bioaccumulate, and be toxic ("PBT") to people, wild mammals, and birds."*[25] The Michigan PFAS Science Advisory

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[e] ATSDR, 2018. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Perfluoroalkyls. Draft for Public Comment, June 2018.

[f] U.S. Environmental Protection Agency, 2018. Toxicity Assessment: Human Health Toxicity Values for Hexafluoropropylene Oxide (HFPO) Dimer Acid and Its Ammonium Salt (CASRN 13252-13-6 and CASRN 62037-80-3). November 2018. EPA 823-P-18-001.

[g] U.S. Environmental Protection Agency, 2018. Toxicity Assessment: Human Health Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). November 2018. EPA 823-R-18-0307.

Panel has recommended that, although there is limited data on PFAS other than PFOA and PFOS, Michigan should "consider setting advisory limits for these additional PFAS in light of their similar chemical structures and toxicity."[26] Vermont is in the process of setting a combined standard for drinking water for 5 PFAS based on their structural and chemical similarity. Furthermore, the 2014 Helsingør[11] and 2015 Madrid Statements,[12] founded on extensive reviews of the scientific literature, provide consensus from more than 200 scientists on the potential for harm associated with the entire class of PFAS.

PART II: HOW ARE PEOPLE EXPOSED TO PFAS

Almost all Americans tested have one or more PFAS in their bodies.[6,27] Widespread use of PFAS has resulted in the ubiquitous presence of these chemicals in the environment including in rivers, soil, air, house dust, food and drinking water from surface water and groundwater sources. We are exposed to PFAS by inhaling house dust contaminated with PFAS due to their use in consumer products, such as treated upholstery and carpet, and from ingesting small amounts in drinking water, food and food packaging.

PFAS in People

Persistent, bioaccumulative chemicals such as those in the PFAS family are characterized by long periods during which the body retains these chemicals after exposure ceases.[3,5,28] PFOA, PFOS, PFNA, PFHxS, and related PFAS are known to bioaccumulate in the bodies of people of all ages, even before birth. Government agencies estimate the human adult half-life (the time it takes to reduce the concentration of a chemical by half) of various PFAS to be on the order of years. Half-life estimates for the PFAS discussed in this report are: 2.3 to 3.8 years for PFOA; 5.4 years for PFOS, 8.5 years for PFHxS, and 2.5 to 4.3 years for PFNA.

The use of PFOA and PFOS in manufacturing has been phased out in the United States, and levels in blood serum have started to decrease as reported in national surveys.[6] However, PFOA and PFOS bioaccumulate and do not degrade in the environment, therefore they will persist in the environment and continue to be a source of exposure for many years in the future.

Blood serum can be used as a long-term measure of exposure for some PFAS and can indicate an increase in risk of disease at the population level. Blood serum concentrations of several PFAS have been evaluated in a large representative sample of the US populations age 12 and older by the National Health and Nutrition Examination Survey (NHANES).[6] The table below (Table 2) summarizes the geometric mean blood serum concentration in ng/L, or parts per trillion (ppt), of different PFAS measured by NHANES since 1999. Note that blood serum concentration is usually expressed in ppb (ug/L or ng/mL) but was converted to ppt in this report to facilitate comparisons to drinking water levels, usually reported in ppt for PFAS.

Table 2: Results of NHANES Biomonitoring Data

Survey Year	PFBS	PFDA	PFDoA	PFHpA	PFHxS	PFNA
1999-2000	NA	*	*	*	2130	551
2003-04	*	*	*	*	1930	966
2005-06	*	355	*	*	1670	1090
2007-08	*	286	*	*	1950	1220
2009-10	*	279	*	*	1660	1260
2011-12	*	199	*	*	1280	881
2013-14	*	185	*	*	1350	675
Survey Year	**PFOA**	**PFOS**	**PFOSA**	**EtFOSAA**	**MeFOSAA**	**PFUA**
1999-2000	5210	30400	355	642	846	*
2003-04	3950	20700	*	*	*	*
2005-06	3920	17100	*	*	410	*
2007-08	4120	13200	*	*	303	*
2009-10	3070	9320	*	*	198	172
2011-12	2080	6310	*	*	*	*
2013-14	1940	4990	NA	NA	*	*

Table 2 shows the geometric mean levels in blood serum in ng/L (ppt) from NHANES biomonitoring data. "" indicates mean was not calculated, proportion of results below limit of detection was too high to provide a valid result. "NA" indicates the PFAS was not measured in that round of NHANES.*

State and regional biomonitoring trends, as well as trends among different age groups and sexes can differ from the national trends represented in NHANES. For example, one study found that children 2 to 5 years old and adults over 60 had a higher blood serum PFOA (median 600 ppb) in the Little Hocking Water Association district compared with residents in all other age groups (median 321 ppb).[29] The authors note that infants and children proportionally drink more water per unit of body weight than adults, and children and the elderly tend to spend more time at home with exclusive use of residential water than other age groups. Additionally, NHANES biomonitoring measures a limited number of PFAS and is likely not reflective of current exposures to PFAS. Alternative methods for detecting PFAS in blood serum are showing an increasing trend of unidentified organofluorine in blood serum samples, which suggest that people are being exposed to new and unidentified PFAS.[30,31]

Fetal and Infant Exposure to PFAS

Fetuses, infants and children are particularly susceptible to the impacts of exposure to toxic chemicals due to their rapidly growing and developing bodies. As such, they are at increased risk of harmful health effects due to PFAS exposure (discussed in further detail in Part II of this report). Almost all fetuses and infants will have some degree of exposure to PFAS, including fetal exposure during pregnancy through placental transfer.[2,5] For infants, PFAS exposure may be further elevated due to ingestion of contaminated breast milk (a result of the mother's ingestion of contaminated water, and other sources) or infant formula contaminated by PFAS-containing food packaging and/or prepared with contaminated drinking water.[32,33] Fetuses and nursing infants' exposures are influenced by the mother's past exposures or "body burden," as measured by blood serum concentrations.

PFAS have been detected in virtually all umbilical cord blood tested, indicating that PFAS can cross the placental barrier, exposing fetuses *in utero*.[5] Researchers have studied the transfer of PFAS during pregnancy and found a positive correlation between maternal plasma and serum with cord serum levels, concluding that either maternal plasma or serum could be used to estimate fetal exposure to PFAS.[34]

Infant formula can be contaminated with PFAS through the use of PFAS-contaminated water when reconstituting powdered formula. PFAS has also been detected in infant formula itself. For example, one study detected PFAS in all infant milk formulas and baby cereals tested, with the highest levels coming from PFOA, PFOS, PFNA, and PFDA.[33] Contamination of infant formula and cereal could be due to migration from food packaging and/or from containers during production.[35]

ATSDR summarizes reports on breast milk concentrations of PFAS found in the general population.[5] Numerous PFAS, including PFOS, PFOA, PFBS, PFHxS, PFNA, perfluorodecanoic acid (PFDeA), perfluorododecanoic acid (PFDoA), perfluoroundecanoic acid (PFUA), and perfluorooctanesulfonamide (PFOSA), have been detected in breast milk samples in women in China, Korea, Japan, Malaysia, Cambodia, India, Korea, Vietnam, Indonesia, Norway, Philippines, Sweden, and the United States.

PFAS levels in breast milk are higher than what is typically found in drinking water, due to the mothers' past accumulated exposures and transfer to breast milk. For example, in biomonitoring studies average concentrations of PFOA in breast milk range from 2.5%[36] to 9%[37] of the concentration of PFOA in mothers' blood serum. Therefore, breast milk concentrations can be up to an order of magnitude higher than drinking water concentrations because PFOA maternal blood serum levels are approximately 100 times greater than the drinking water she ingested over time.

PFAS in Drinking Water

Drinking water is the dominant source of exposure to PFAS for people living in communities with drinking water highly contaminated with these chemicals, far exceeding exposure from other sources.[38] Even relatively low PFAS concentrations in drinking water can be associated with substantial increases in blood serum levels. For example, since the clearance of PFOA is slow and because it accumulates in blood, after a long period of exposure, a person's blood serum PFOA level will be about 100 times greater than the PFOA concentration ingested via drinking water.[2]

In 2009, researchers evaluated the contribution of water, diet, air and other sources for various exposure scenarios to PFOA.[38] They found that when drinking water concentrations of PFOA are low, dietary exposure is the dominant source of exposure. However, as drinking water concentrations increase, the ingestion of contaminated water becomes the predominant source of exposure. Drinking water concentrations of 100 ppt and 400 ppt are predicted to contribute 71% and 91%, respectively, of total exposure; and are estimated to increase blood serum levels, on average, by 250% and 1000%, respectively.[2]

Analysis of EPA's Unregulated Contaminant Monitoring Rule (UCMR3) data shows that about 4% of tested public water supplies in the U.S. (about 200 of 5,000 public water supplies studied), serving 16.5 million Americans in 33 states, 3 territories and an American Indian community, have levels of PFAS above the EPA-specified reporting limits[h] for UCMR3.[7] Sixty-six tested public water supplies, serving six million Americans, had at least one sample above EPA's 2016 PFOA and PFOS non-enforceable lifetime health advisory of 70 ppt.[3,28] PFOA was the most frequently detected PFAS in drinking water, followed by PFOS. Exceedances of the EPA's health advisory have been detected in California, New Jersey, North Carolina, Alabama, Florida, Pennsylvania, Ohio, New York, Georgia, Minnesota, Arizona, Massachusetts and Illinois. High levels of PFAS in drinking water were strongly associated with proximity to major PFAS industrial sites, civilian airports, and military fire training areas.

As concerning as the UCMR3 data are, they significantly underestimate how many drinking water sources are contaminated by PFAS. This is in part because the lowest levels of PFAS that are required to be reported to EPA, sometimes referred to as the "Minimum Reporting Levels" or "Method Reporting Levels" under the UCMR3 were very high, meaning that even if PFAS were detected at levels below these cutoffs, they are not required to be reported to EPA. Indeed, these cutoffs are significantly higher than the limit of quantitation reported in most published studies and by a prominent laboratory using the same method, which completed about one-third of the PFAS monitoring under the UCMR3.[39] The UCMR3's overall limitations have been well described:

> *"The [Minimum Reporting Levels] (10−90 ng/L) in the UCMR3 database are up to 2 orders of magnitude higher than the limit of quantitation in most published studies, and more than 10 times higher than the drinking water limit (1 ng/L) suggested by human and animal studies. Because PFASs are detectable in virtually all parts of the environment, we infer that the large fraction of samples below reporting limits is driven in part by high [Minimum Reporting Levels]."* [7]

Moreover, the UCMR3 only required testing for 6 PFAS out of the several thousand PFAS that have been cleared for use in the United States.[40] The UCMR3 data are further limited by the

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[h] Reporting limits for UCMR3 were: PFOA - 20 ppt, PFOS - 40 ppt, PFHxS - 30 ppt, PFNA - 20 ppt, perfluorohepatanoic acid (PFHpA) - 10 ppt, and perfluorobutane sulfonic acid (PFBS) - 90 ppt

inclusion of only 0.5 % of the nation's small public water supplies and no testing results for private wells.

PART III: HEALTH RISKS ASSOCIATED WITH EXPOSURE TO PFAS

There is a sufficiently robust body of scientific research to evaluate the adverse health effects of several PFAS, with the most highly studied being PFOA, PFOS, PFNA and PFHxS. Both human studies and animal studies should be used to evaluate adverse effects of chemical exposures (see Box 8 for further discussion). Animal and human studies show similar adverse effects and cancer risks.

Due to the structural similarity and the co-occurrence of PFOA and PFOS in the environment and in people, public health protection and guidance usually address both PFOA and PFOS. In June 2018, minimal risk levels were also generated by the Agency for Toxic Substances and Disease Registry (ATSDR) for PFNA and PFHxS, which are chemically related and often co-occur with PFOA and PFOS.[5] In November of 2018, the EPA released human health toxicity values (reference doses) for PFBS and hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt, also known as GenX chemicals.[23,24] PFBS is a replacement chemical for PFOS and GenX is a replacement technology for PFOA, and both were found to be associated with a variety of adverse health effects. Considerably less information is available for the larger group of PFAS, however, as stated above, due to the structural similarity of these contaminants, it is expected that many PFAS will have similar health effects. [2,13,14]

Several reviews of the scientific literature on the health effects associated with PFAS exposure have recently been published.[1,2,5,14,15,41,42,43] ATSDR has performed the most recent and comprehensive review. This review is summarized below, as an overview of health effects associated with PFAS exposure. This summary is followed by sections that discuss in further detail cancer risk and two of the most common and sensitive health effects for PFAS, development harm and immunotoxicity. Understanding these health effects is particularly important to determining how to best protect the public from PFAS contamination.

ATSDR Draft Toxicological Profile for Perfluoroalkyls

ATSDR performs risk assessment and evaluation of chemicals as part of the U.S. Centers for Disease Control and Prevention (CDC). ATSDR released a draft Toxicological Profile for Perfluoroalkyls in June 2018.[5] The toxicological profile on perfluoroalkyl compounds included the suite of chemicals in that group that have been measured in the blood serum collected as part of the NHANES 2003-2004 survey, and other monitoring studies. The 14 perfluoroalkyl compounds included in the toxicological profile are:

Perfluorobutyric acid (PFBA, CAS 375-22-4)
Perfluorohexanoic acid (PFHxA, CAS 307-24-4)

Perfluoroheptanoic acid (PFHpA, CAS 375-85-9)
Perfluorooctanoic acid (PFOA, CAS 335-67-1)
Perfluorononanoic acid (PFNA, CAS 375-95-1)
Perfluorodecanoic acid (PFDeA, CAS 335-76-2)
Perfluoroundecanoic acid (PFUA, CAS 2058-94-8)
Perfluorododecanoic acid (PFDoA, CAS 307-55-1)
Perfluorobutane sulfonic acid (PFBS, CAS 375-73-5)
Perfluorohexane sulfonic acid (PFHxS, CAS 355-46-4)
Perfluorooctane sulfonic acid (PFOS, CAS 1763-23-1)
Perfluorooctane sulfonamide (PFOSA, CAS 754-91-6)
2-(N-Methyl-perfluorooctane sulfonamide) acetic acid (Me-PFOSA-AcOH, CAS 2355-31)
2-(N-Ethyl-perfluorooctane sulfonamide) acetic acid (Et-PFOSA-AcOH, CAS 2991-50-6)

ATSDR provided an exhaustive assessment of these 14 PFAS in their Toxicological Profile for Perfluoroalkyls. Their assessment found that there is consistent association between PFAS exposure and several health outcomes. The table (Table 3) below summarizes health effects ATSDR found linked to the 14 PFAS reviewed in the profile.

Table 3: Summary of ATSDR's Findings on Health Effects from PFAS Exposure

	Immune e.g. decreased antibody response, decreased response to vaccines, increased risk of asthma diagnosis	**Developmental & Reproductive** e.g. pregnancy-induced hypertension/pre-eclampsia, decreased fertility, small decreases in birth weight, developmental toxicity	**Lipids** e.g. increases in serum lipids, particularly total cholesterol and low-density lipoprotein	**Liver** e.g. increases in serum enzymes and decreases in serum bilirubin levels	**Endocrine** e.g. increased risk of thyroid disease, endocrine disruption	**Body Weight** e.g. decreased body weight	**Blood** e.g. decreased red blood cell count, decreased hemoglobin and hematocrit levels
PFOA	✗	✗	✗	✗	✗	✗	✗
PFOS	✗	✗	✗	✗	✗	✗	✗
PFHxS	✗			✗			✗
PFNA	✗		✗			✗	
PFDeA	✗	✗	✗	✗	✗	✗	
PFDoA	✗	✗				✗	
PFUA	✗	✗				✗	✗
PFHxA		✗					✗
PFBA		✗		✗	✗		✗
PFBS				✗			✗

Table 3 summarizes ATSDR's findings on the associations between PFAS exposure and health outcomes in human and animal studies (not an exhaustive list of health outcomes).

ATSDR determined that there was sufficient data to support generating minimal risk levels for PFOA, PFOS, PFNA, and PFHxS. Our maximum contaminant level recommendations are, in part, based on these minimal risk levels, which is discussed in Part III of this report.

Cancer Risks from PFOA, PFOS, PFNA, PFHxS, and GenX Exposure

Chemical exposures that contribute to an increase in cancer risk have a significant impact on public health. As the National Cancer Institute states, "*the years of life lost due to premature deaths, the economic burden due to lost productivity and the costs associated with illness and therapy, and the long-term effects of cancer and its treatment on the quality of life of survivors take a toll at a population level*."[44]

Toxicological studies in humans and animals have found associations between increased cancer risk and PFOA and PFOS exposure, and several authoritative bodies have made findings on their carcinogenic potential. PFNA, PFHxS, and GenX are less well studied, however, their chemical similarity to PFOA and PFOS and the data that is available suggests that there is reason to be concerned about increased cancer risk.

PFOA and PFOS

Carcinogens are chemicals that cause cancer. The C8 Science Panel[i] has identified PFOA as a probable carcinogen[15], and the International Agency for Research on Cancer (IARC) has classified PFOA as a possible[45] carcinogen. The EPA Science Advisory Board and the EPA Office of Water have concluded that PFOA and PFOS demonstrate likely[46] or suggestive[3] evidence of carcinogenic potential, respectively.

From 2005-2013 the C8 Science Panel determined blood levels and collected health information from communities in the Mid-Ohio Valley that had been potentially affected by the release of PFOA emitted from a DuPont plant since the 1950s.[15,47,48] They then assessed the links between PFOA exposure and a number of diseases. Based on epidemiologic and other data available to the C8 Science Panel, they concluded that there is a probable link between exposure to PFOA and testicular and kidney cancer (as well as high cholesterol, ulcerative colitis, thyroid disease and pregnancy-induced hypertension). Because these studies relied largely on a survivor cohort, results regarding associations with PFOA may be biased toward the null (i.e. a greater chance of failing to identify an association) for highly aggressive cancers like pancreatic, lung and kidney cancers, which should not be ruled out based on this study.

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[i] The C8 Science Panel was established as a result of a class action lawsuit against DuPont and charged with assessing probable links between PFOA (also called C8) exposure and disease in communities near the DuPont Washington Works plant in Parkersburg, West Virginia.

IARC, the specialized cancer agency of the World Health Organization, has classified PFOA as "possibly carcinogenic to humans" (Group 2B) based on limited evidence that PFOA causes testicular and renal cancer, and limited evidence in experimental animals."[45] IARC considers human, animal, and mechanistic data in making its determinations of evidence for cancer risk to humans. The human data considered by IARC in making this determination included increases in cancer among highly exposed members of the C8 Health Project study population[47,48] discussed above, and among workers in the DuPont Washington Work plant in Parkersburg, WV.[49] Researchers studied the mortality of 5,791 workers at the DuPont chemical plant in Parkersburg, West Virginia from 1952-2008. The authors found exposure-response relationships with PFOA for chronic renal disease, both malignant and non-malignant.[49]

The EPA Office of Water concluded that there is suggestive evidence of carcinogenic potential of PFOA in humans.[3] This conclusion was based on Leydig cell testicular tumors in rats, and the reported probable link to testicular and renal tumors among the members of the C8 Health Project. EPA also concluded that there is suggestive evidence of carcinogenic potential of PFOS in humans based on liver and thyroid adenomas observed in a chronic rat bioassay.[28,50]

Cancers other than kidney and testicular cancer have also shown positive associations in studies of occupational exposure, though they have not reached statistical significance. One study reported a non-significant positive association between PFOA and prostate cancer in employees of DuPont in West Virginia.[51] Another study reported modestly elevated risk of prostate and bladder cancer in employees of 3M in Minnesota.[52]

Two small studies of the Inuit population in Greenland found significantly increased risk of breast cancer associated with certain PFAS, including PFOA and PFOS,[53] and a greater elevated odds ratio for breast cancer in women with both high PFAS levels and specific genetic variations that affect levels of hormones such as estrogens.[54] A later, larger study evaluated the association between PFAS serum levels in pregnant Danish women and the risk of premenopausal breast cancer.[55] This study did not find convincing evidence establishing a causal link between PFAS exposures and increased risk of breast cancer 10 to 15 years later. These data suggest the need for further research on this topic, especially considering the effects PFAS exposure can have on mammary gland development (see Box 6).

While there have been some studies that do not support a relationship between PFAS exposure and cancer, those studies have notable limitations. For example, New York State Department of Health (NYSDOH) conducted an evaluation of cancer occurrence in the Hoosick Falls population where residents' blood serum median levels were 23,500 ppt.[56] In that study, no relationship was found between PFOA exposure and testicular, kidney, prostate or bladder cancer. However, studies of community exposures have inherent limitations and are difficult to evaluate in low number populations. As noted by NYSDOH, limitations of this study include small population and incomplete inclusion of the potentially exposed populations.

PFNA, PFHxS, and GenX

PFNA and PFHxS have been studied to a lesser degree than PFOA and PFOS. One study reported a significantly higher risk for prostate cancer among subjects with a hereditary risk and blood serum PFHxS levels above the median, finding a significant odds ratio of 4.4 (1.7-12).[57] An increased, though non-significant, odds ratio of 2.1 (1.2-6.0) was also reported among subjects with a hereditary risk for prostate cancer and blood serum PFNA levels above the median.

Researchers evaluated participants in the C8 Health studies for associations between PFNA and PFHxS and elevated serum levels of prostate-specific antigen, a biomarker that can be used to screen for prostate cancer.[58,59] Their findings were non-significant, however, one limitation with this study is that changes in prostate-specific antigen levels are not exclusively due to cancer but can also be attributed to other factors such as prostate inflammation, urinary retention, local trauma and increase in age.

In EPA's draft toxicity assessment of GenX, the EPA determined that "*there is Suggestive Evidence of Carcinogenic Potential of oral exposure to GenX chemicals in humans, based on the female hepatocellular adenomas and hepatocellular carcinomas and male combined pancreatic acinar adenomas and carcinomas [in rats].*"[23] The EPA also notes that evidence suggest that mice are more sensitive to the effects of GenX than rats, and that a lack of data evaluating cancer in mice is a database deficiency. There are currently no studies evaluating cancer risk from GenX exposure in humans.

Further research is needed to understand the relationship between PFOA and PFOS exposure and various cancers other than kidney and testicular cancer, such as prostate, bladder, ovarian and breast cancer, which have limited, but suggestive evidence for association with PFAS exposure. Additionally, more research is needed to understand the carcinogenic potential of other PFAS, which, due to similar chemical characteristics to PFOA and PFOS, are likely to also increase the risk for certain cancers.

Risks to Fetal Development and the Young

Developing infants and children are particularly susceptible to the impacts of exposure to toxic chemicals. The impacts of PFAS exposure on fetal development and the young have been studied in both humans and animals. These studies find similar and profound adverse health effects.

Since infants and children consume more water per body weight than adults, their exposures may be higher than adults in communities with PFAS in drinking water. In addition, the young may also be more sensitive to the effects of PFAS due to their immature developing immune system, and rapid body growth during development.[1,5,60,61,62] Exposure to PFAS before birth or in early childhood may result in decreased birth weight, decreased immune responses, and hormonal effects later in life.

Recent literature has identified developmental effects of significance from exposure to PFAS. For a review of effects on children from PFAS exposure, sixty-four studies were evaluated for six categories of health outcome: immunity, infection, asthma, cardio-metabolic, neurodevelopmental/attention, thyroid, renal, and puberty onset.[62] The review found evidence of later age at menarche (menstruation), effects on renal function and lipid serum levels, and immunotoxicity (asthma and altered vaccine response).

A particularly significant developmental effect linked to PFAS exposure is alterations to mammary gland development. Prenatal exposure of mice to PFOA results in delays in mammary gland development in offspring of treated females, including reduced ductal elongation and branching, delays in timing and density of terminal end buds (developmental structures important for forming proper mammary gland ductal structure), and decreases in mammary epithelial growth.[63,64,65] These studies found that PFOA-induced effects on mammary tissue occur at extremely low doses - much lower than effects on liver weight. Due to the low-dose sensitivity of mammary glands to PFOA in mice, a no-observable adverse effect level for mammary gland developmental delays could not be determined. In other words, the studies found that all dose levels were associated with effects on mammary gland development. (see Box 6 for a discussion on the biological relevance of altered mammary gland development)

Risk to Immune System Function

Evidence from both animal and human studies suggest that the immune system is also highly sensitive to PFAS exposure. For instance, immunotoxicity is currently the most sensitive health endpoint identified for PFOS exposure and occurs at doses at least an order of magnitude less than other health endpoints. As documented in the ATSDR profile, both animal and epidemiology studies provide strong evidence linking PFAS exposure to immunotoxic effects.[5]

The strongest evidence of the PFAS-associated immunotoxicity in humans comes from epidemiology studies finding associations evaluating the antibody response to vaccines.[5] Associations have been found for PFOA, PFOS, PFHxS, and PFDeA; with limited evidence for PFNA, PFUA, and PFDoA. Increases in asthma diagnosis and effects on autoimmunity, specifically ulcerative colitis, have also been linked to PFAS exposure. Animal studies suggest the immune system is a highly sensitive target of PFAS-induced toxicity; observed effects include impaired responses to T-cell dependent antigens, impaired response to infectious disease, decreases in spleen and thymus weights, and in the number of thymic and splenic lymphocytes.[5,23]

The immunotoxic effects of PFAS could have significant detrimental impacts on public health. For example, PFAS is associated with reduced antibody titer rise in response to vaccines,[5,66] resulting in increased risk of not attaining the antibody level needed to provide long-term protection from serious diseases such as measles, mumps, rubella, tetanus and diphtheria. PFAS can also be transferred to fetuses *in utero*, and to infants via breast milk[67] or PFAS-contaminated infant formula, which presents a particular hazard to the adaptive immune system during this critical window of development. As noted by the Michigan PFAS Science Advisory Panel, "*the developing immune system is especially sensitive to environmental stressors… Disruption of immune development is likely to have broader impacts than the antibody changes that are directly measured in these studies and may have long lasting consequences.*"[26]

Box 1: Immunotoxicity of PFOA, PFOS

In 2016, the National Toxicology Program conducted a systematic review to evaluate immunotoxicity data on PFOA and PFOS. It concluded that both are presumed to constitute immune hazards to humans based on a high level of evidence that they suppress antibody response in animal studies and a moderate level of evidence from studies in humans. They also identified additional evidence linking PFOA exposure to reduced infectious disease resistance, increased hypersensitivity-related outcomes, and increased autoimmune disease incidence (human studies), and PFOS exposure to suppressed disease resistance and lowered immune cell activity (animal studies).[66]

In 2018, the Michigan PFAS Science Advisory Panel recommended adding immunologic effects to ATSDR's list of health conditions of concern, "*particularly those that arise during prenatal exposure and childhood…based on strong toxicologic findings and supporting epidemiologic evidence.*"[26]

Short-chain PFAS

Short-chain PFAS (less than six or seven carbons, depending on the PFAS subclass) have been introduced as 'safer' alternatives due to their supposed shorter half-lives in humans, but little research is publicly available on the toxic effects related to exposure, retention, and persistence. The evidence that does exist suggests short-chain PFAS are associated with similar adverse health effects as the long-chain, legacy PFAS that they have replaced.[68,69] Importantly, short-chain PFAS are still highly persistent and are even more mobile in the environment than long-chain PFAS.[70]

Some short-chain PFAS are not detected frequently or detected at low levels in human blood; therefore, some industry groups have claimed that short-chain PFAS are readily eliminated from the body. However, recent research does not support this conclusion. Short-chain PFAS are found to accumulate in interior organs, some at concentrations that are higher than long-chain PFAS, such as PFOA and PFOS.[77] As Dr. Philippe Grandjean pointed out in his testimony to the Michigan State Legislature, "*Given the inability to assess organ concentrations in clinical studies, our understanding of the health risks associated with the short-chained compounds is extremely limited*." Biomonitoring programs are currently exploring other forms of media, such as urine, as more appropriate measures of short-chain PFAS exposure and retention.

Box 2: Persistence, Mobility, and Toxicity

The German Environment Agency has shifted the classification of emissions, registered under REACH, to specific intrinsic properties that indicate a hazard to sources of drinking water.[71] These properties include persistence (P) in the environment, mobility (M) in the aquatic environment, and toxicity (T) (PMT). Substances that are considered very persistent in the environment (vP) and very mobile in the aquatic environment (vM), regardless of their toxicity, must also be considered, due to their increased probability of reaching and accumulating in sources of drinking water.[72] Because very short chain PFAS are volatile and can be dispersed far from areas of direct exposure,[73,74] recent efforts have shifted the focus toward mobility as a key chemical parameter of concern, moving from the established criteria persistent (P), bioaccumulative (B), and toxic (T) (PBT) toward PMT.[71,75] This new criteria has prompted the designation of PFAS substances as posing an "equivalent level of concern" under REACH, thereby prompting the need for a new paradigm for chemical assessment and authorization.[76]

Additionally, developing science on short-chain PFAS metabolism indicates, "*that some fluorinated alternatives have similar or higher toxic potency than their predecessors when correcting for differences in toxicokinetics* [rate a chemical enters the body, is metabolized, and excreted]".[69] The rate a chemical will enter the body and the process of excretion and metabolism in the body may in fact be an inadequate measure of health threats to humans from chemicals with chronic exposure. The widespread use of short-chain PFAS in commerce and their persistence in the environment could lead to chronic exposures in people. Researchers find:

> "*Considering that the exposure to short-chain PFAAs is unlikely to be stopped shortly, there will be increasing continuous and poorly reversible environmental background concentrations of short-chain PFAAs. Consequently, organisms and humans will be permanently exposed to short-chain PFAAs, resulting in continuous and poorly reversible internal concentrations. The poorly reversible internal concentrations in organisms are caused by the persistence of short-chain PFAAs and their continuous presence in the environment. Therefore, the organismal elimination efficiencies are of secondary relevance*."[68]

Finally, it is important to acknowledge that exposure to short-chain and other replacement PFAS, is happening on top of a pre-existing health burden from historically used, long-chain PFAS, as discussed further in the following section.

Additive and Synergistic Effects of Exposure to Multiple PFAS

Importantly, exposures to PFAS do no occur in isolation. Biomonitoring studies demonstrate that Americans have chronic exposure to multiple PFAS chemicals throughout their lifetimes. CDC's national biomonitoring studies, NHANES, reveal that nearly every American has PFOS, PFOA, PFHxS and PFNA detected in their blood stream, including young children.[6] At least eight other PFAS are detected in blood serum by NHANES studies: MeFOSAA, PFDeA, PFUA, PFHpA, PFBS, FOSA, EtFOSAA, PFDoA, and PFHpA.[6] Most other PFAS chemicals are not routinely included in biomonitoring studies. As mentioned previously, alternative methods in biomonitoring suggest that humans are being exposed to new and unidentified PFAS.[30,31]

Multiple PFAS are found in drinking water, food, dust, personal care products and a variety of different environmental media. In drinking water PFOA, PFOS, PFNA, PFHxS, PFBS, PFHpA (measured in UCMR3), and other PFAS are often found in conjunction.[7] Food contact materials and packaging in the United States has shown detectable levels of PFOA, PFHxS, PFDA, PFHpA, PFDoA, PFHxA, PFBA, PFPeA, PFUA, PFOS and 8:2 FTOH,[78] and likely contain other unknown PFAS. A single consumer product such as carpet, clothing, outdoor gear, or dental floss can contain up to nine different identifiable PFAS compounds[79] along with other undetermined PFAS. Samples of dust collected throughout homes and offices have shown high concentrations of 8:2 FTOH, PFDA, PFHpA, PFNA, 10:2 FTOH, PFDoA and PFTeDA with detection frequencies over 70%.[80]

Figure 2: Possible Sources of PFAS Exposure

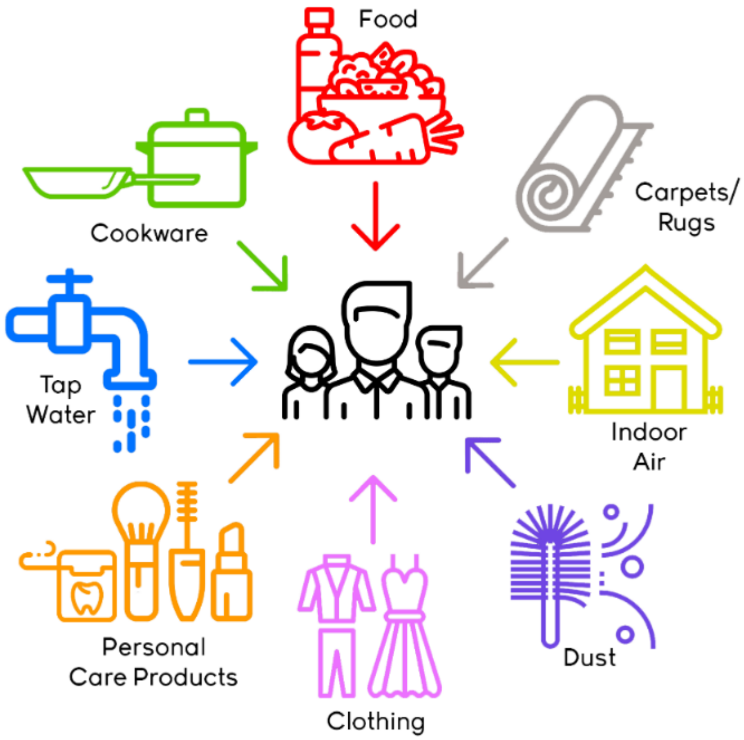

Figure 2 shows the most common pathways of PFAS exposure for humans. PFAS can be found in people's bodies as a result of exposure from multiple environmental sources. [j,k]

Therefore, risk and safety assessments cannot assume that exposures occur in isolation. A person is concurrently exposed to dozens of PFAS chemicals daily, and their exposures extend throughout their lifetimes. Health evaluations should consider the impacts of multiple PFAS chemicals that target the same body systems regardless of detailed knowledge of the underlying mechanism of action. Because PFAS are chemically related, they may have additive or synergistic effects on target systems. An additive effect is when the combined effect of multiple chemicals is the sum of each of the chemicals' effects alone. A synergistic effect is caused when concurrent exposure to multiple chemicals results in effects that are greater than the sum of each of the chemicals' effects alone. For example, many PFAS have been associated with immunological effects. Exposure to a mixture of PFAS could result in adverse effects on the immune system that represents the total dose of all PFAS in the mixture or even greater adverse effects than predicted by summing the dose of all PFAS in the mixture.

PART IV: COMPARISON AND ANALYSIS OF EXISTING HEALTH THRESHOLDS

A number of regulatory and non-regulatory health-based thresholds have been developed for PFAS (mainly PFOA and PFOS) by both federal and state agencies. The data used, and decisions made by these agencies are discussed in this section.

Health advisories issued by the EPA are non-enforceable and non-regulatory. Health advisories provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination.

Guidance values are state-specific values – used, for example, by the Minnesota Department of Health to evaluate potential human health risks from exposures to chemicals in groundwater – that are non-enforceable goals, benchmarks, or indicators of potential concern. There are three types of guidance values used by Minnesota, health risk limits which are guidance values that have been adopted, and health-based values and risk assessment advice which provide technical guidance but have not yet been formally adopted. In Minnesota, the state develops guidance values by considering health impacts to the most sensitive and most exposed populations across all stages of human development.

Notification levels are state-specific values. California's Division of Drinking Water, for example, has established advisory levels for chemicals in drinking water that lack maximum

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[j] ATSDR, 2018. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Perfluoroalkyls. Draft for Public Comment, June 2018.

[k] Guo, Z, et al., 2009. Perfluorocarboxylic acid content in 116 articles of commerce. *Research Triangle Park, NC: US Environmental Protection Agency*

contaminant levels (MCLs, see below). When these chemicals are detected at concentrations greater than their notification levels, state actions include consumer notification and, for larger exceedances, removal of the source water from the drinking water supply.

EPA defines a **Reference dose (RfD)** as "*an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is generally expressed in units of milligrams per kilogram of bodyweight per day (mg/kg/day)*."[81]

A **minimal risk level (MRL)** is an estimate made by ATSDR of the daily human total exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified route, including routes other than drinking water exposure, and a specified duration of exposure. MRLs serve as screening tools to help public officials decide where to look more closely and identify contaminants of concern at hazardous waste sites. Like EPA's health advisories, MRLs do not carry regulatory weight by requiring agency-initiated cleanup or setting of action or maximum contaminant levels. MRLs are based on noncancer effects only. These MRLs can be used, similar to reference doses, to generate maximum contaminant level goals for drinking water.

A **maximum contaminant level goal (MCLG)** is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, allowing an adequate margin of safety. When determining a MCLG under the federal Safe Drinking Water Act, the EPA considers adverse health risk to sensitive subpopulations, such as infants, children, the elderly, those with compromised immune systems and chronic diseases. MCLGs are non-enforceable health goals and consider only public health and not the limits of detection and treatment technology effectiveness. Therefore, they sometimes are set at levels which water systems cannot meet because of technological limitations.

A **maximum contaminant level (MCL)** is the legal threshold of the amount of a chemical that is allowed in public water systems under the federal Safe Drinking Water Act. A MCL is based on the concentration established by its corresponding MCLG but may be adjusted for feasibility reasons, reflecting difficulties in measuring small quantities of a contaminant, or a lack of available, adequate treatment technologies. The MCL is an enforceable standard and exceedance of the MCL requires water systems to take certain steps, including providing public education, notifying consumers, and adjusting treatment or making structural changes or repairs to come into compliance with the standard for public health protection.

Current or proposed state and federal health thresholds for PFOA and PFOS in drinking water range from 10 ppt to 70 ppt and higher. Although the health thresholds for PFOA and PFOS in drinking water vary, the thresholds cluster at low ppt levels, orders of magnitude lower than thresholds set for many other environmental contaminants. The thresholds are based on adverse health effects, such as developmental effects and cancer risks, and health authorities uniformly acknowledge the serious concerns related to exposure from consuming PFOA and/or PFOS contaminated drinking water. The selection of critical endpoints to use, uncertainty factors to apply, and estimates of exposure parameters are the major determinants for the variation in the concentrations developed as thresholds. However, none of the federal and state assessments dispute that very serious adverse health effects are associated with exposure to PFOA and PFOS at very low levels of exposure.

The generation of health thresholds by various agencies for PFOA, PFOS, PFNA, PFHxS, and GenX chemicals are **summarized and compared in Tables 4-7** and described in further detail below. Notably, advisories have become more stringent over time as more information becomes available on the exposure to and toxicity of these chemicals.

Table 4: Selected Thresholds for Drinking Water and/or Groundwater- PFOA

Author	Threshold type	Threshold (ppt)	Critical Dose includes UFs (mg/kg/day)	Total UFs	Study Endpoint 2	Drinking water exposure assumptions	Notes
				PFOA			
USEPA	health advisory	70	2 x 10^{-5}	300	Developmental effects on bone growth and male puberty (Lau, 2006)	0.054 L/kg/day, 90th percentile for lactating women, RSC = 20%	combined with PFOS
Minnesota	guidance value	35	2 x 10^{-5}	300	Developmental effects on bone growth and male puberty, increased liver weights (Lau, 2006)	modeled for breast- or formula-fed infants, including fetal exposure, RSC = 50%	adopted guidance value - health risk limit - for groundwater
Vermont	health advisory	20	2 x 10^{-5}	n/a	based on EPA	0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%	combined with PFOS, PFNA, PFHxS, PFHpA (also a ground water enforcement standard); to be adopted as a combined MCL
New Jersey	MCL	14	2 x 10^{-6}	300	Increased liver weights (Loveless, 2006) + UF for mammary gland effects	0.029 L/kg/day, default adult assumptions, RSC = 20%	proposed; groundwater criteria also proposed at 10 ppt
California	notification level	14	n/a	n/a	Developmental, immunotoxicity, liver toxicity, and cancer	n/a	interim notification levels based on NJ & ATSDR values
ATSDR	environmental media evaluation guide	21	3 x 10^{-6}	300	Developmental: altered activity, skeletal alterations (Onishchenko, 2011; Koskela, 2016)	0.143 L/kg/day for a infant, RSC = 100%	minimal details provided on calculation of drinking water concentrations from MRL
ATSDR - more protective	estimated MCL	3*	3 x 10^{-6}	300	Developmental: altered activity, skeletal alterations (Onishchenko, 2011; Koskela, 2016)	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	*threshold for water based on ATSDR's minimal risk level (for total exposure)
NJ - more protective	estimated MCL	0.1	1 x 10^{-7}	30	**altered mammary gland development**	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	using RfD calculated by New Jersey
Protective choices combined	**MCLG (goal)**	0.01	1 x 10^{-8}	300**	**altered mammary gland development**	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	****an additional UF of 10, to protect fetuses, infants, children added**

**An additional uncertainty factor of 10 to protect fetuses, infants and children is recommended by the National Academy of Sciences (NAS 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

More protective choices highlighted in bold

Table 5: Selected Thresholds for Drinking Water and/or Groundwater - PFOS

Author	**Threshold type**	**Threshold (ppt)**	**Critical Dose includes UFs (mg/kg/day)**	**Total UFs**	**Study Endpoint 2**	**Drinking water exposure assumptions**	**Notes**
USEPA	health advisory	70	2×10^{-5}	30	Developmental: decreased pup weight (Leubker, 2005)	0.054 L/kg/day, 90th percentile for lactating women, RSC = 20%	combined with PFOA
Minnesota	guidance value	27	5×10^{-6}	100	Developmental: decreased pup weight (Leubker, 2005)	modeled for breast- or formula-fed infants, including fetal exposure, RSC = 50%	health-based value, provides technical guidance for groundwater
Vermont	health advisory	20	2×10^{-5}	n/a	based on EPA	0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%	combined with PFOS, PFNA, PFHxS, PFHpA (also a ground water enforcement standard); to be adopted as a combined MCL
New Jersey	MCL	13	2×10^{-6}	30	Immunotoxicity: decreased plaque forming response (Dong, 2009)	0.029 L/kg/day, default adult assumptions, RSC = 20%	proposed; groundwater criteria also proposed at 10 ppt
California	notification level	13	n/a	n/a	Developmental, immunotoxicity, liver toxicity, and cancer	n/a	interim notification levels based on NJ & ATSDR values
ATSDR	environmental media evaluation guide	14	2×10^{-6}	300	Developmental: delayed eye opening, decreased pup weight (Leubker, 2005) + UF for immunotoxicity	0.143 L/kg/day for a infant, RSC = 100%	minimal details provided on calculation of drinking water concentrations from MRL
ATSDR - more protective	estimated MCL	2*	2×10^{-6}	30	Developmental: delayed eye opening, decreased pup weight (Leubker, 2005) + UF for immunotoxicity	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	*threshold for water based on ATSDR's minimal risk level (for total exposure)
NJ - more protective	estimated MCL	2	2×10^{-6}	30	Immunotoxicity (Dong, 2009)	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	
ATSDR - more protective	estimated MCL	0.02	2×10^{-8}***	30	**Immunotoxicity (Peden-Adams, 2008)**	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	***critical dose estimated by ATSDR's MRL method
Protective choices combined	**MCLG (goal)**	0.002	2×10^{-9}	300**	**Immunotoxicity**	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	****an additional UF of 10, to protect fetuses, infants, children added**

**An additional uncertainty factor of 10 to protect fetuses, infants and children is recommended by the National Academy of Sciences (NAS 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

More protective choices highlighted in bold

Table 6: Selected Thresholds for Drinking Water and/or Groundwater - PFNA

Author	**Threshold type**	**Threshold (ppt)**	**Critical Dose includes UFs (mg/kg/day)**	**Total UFs**	**Study Endpoint 2**	**Drinking water exposure assumptions**	**Notes**
Vermont	health advisory	20	n/a	n/a	based on class similarity to PFOA/PFOS, added to original PFOA/PFOS combined MCL	n/a	combined with PFOS, PFNA, PFHxS, PFHpA (also a ground water enforcement standard); to be adopted as a combined MCL
New Jersey	maximum contaminant level (MCL)	13	5 ng/mL ^	1000	Increased liver weights (Das, 2015)	RSC of 50% for 95th percentile general population	adopted; ^ internal serum level, not external dose
ATSDR	environmental media evaluation guide	21	3×10^{-6}	300	Developmental delays, decreased body weight (Das, 2015)	0.143 L/kg/day for a infant, RSC = 100%	minimal details provided on calculation of drinking water concentrations from MRL
ATSDR - more protective	estimated MCL	3*	3×10^{-6}	300	Developmental delays, decreased body weight (Das, 2015)	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	*threshold for water based on ATSDR's minimal risk level (for total exposure)
ATSDR - more protective	estimated MCL	2*	$2 \times 10^{-6\,\#}$	300	Developmental delays, decreased body weight (Das, 2015)	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	**# Using longer, more representative (men and older women) half-life estimate than ATSDR used (young women)**
Protective choices combined	**MCLG (goal)**	0.2	2×10^{-7}	3000**	Develomental toxicity	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	****an additional UF of 10, to protect fetuses, infants, children added**

**An additional uncertainty factor of 10 to protect fetuses, infants and children is recommended by the National Academy of Sciences (NAS 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

More protective choices highlighted in bold

Table 7: Selected Thresholds for Drinking Water and/or Groundwater - PFHxS

Author	Threshold type	Threshold (ppt)	Critical Dose includes UFs (mg/kg/day)	Total UFs	Study Endpoint 2	Drinking water exposure assumptions	Notes
ATSDR	environmental media evaluation guide	140	2 x 10^{-5}	300	Thyroid follicular cell damage (Butenhoff, 2009; Hoberman & York, 2003)	0.143 L/kg/day for a infant, RSC = 100%	minimal details provided on calculation of drinking water concentrations from MRL
Minnesota	guidance value	27	n/a	n/a	based on class similarity to PFOS	n/a	risk assessment advice - for ground water; use PFOS as surrogate for PFHxS until more data is available
ATSDR - more protective	estimated MCL	23*	2 x 10^{-5}	300	Thyroid follicular cell damage (Butenhoff, 2009; Hoberman & York, 2003)	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	*threshold for water based on ATSDR's minimal risk level (for total exposure)
Vermont	health advisory	20	n/a	n/a	based on class similarity to PFOA/PFOS, added to original PFOA/PFOS combined MCL	n/a	combined with PFOS, PFNA, PFHxS, PFHpA (also a ground water enforcement standard); to be adopted as a combined MCL
Protective choices combined	**MCLG (goal)**	2	2 x 10^{-6}	3000**	developmental and thyroid toxicity	**0.175 L/kg/day for a infants less than 1 year of age, RSC = 20%**	****an additional UF of 10, to protect fetuses, infants, children added**

**An additional uncertainty factor of 10 to protect fetuses, infants and children is recommended by the National Academy of Sciences (NAS 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

More protective choices highlighted in bold

PFOA

Comparison

In May 2016, the EPA issued a drinking water health advisory for PFOA of 70 ppt.[3] In the case of co-occurrence of PFOA and PFOS, the sum of the concentrations is not to exceed 70 ppt. The EPA applied a combined uncertainty factor of 300 (10 for human variability, 3 for animal to human toxicodynamic differences, 10 for use of a lowest-observed-adverse-effect-level (LOAEL) instead of a no-observed-adverse-effect-level (NOAEL)) on a LOAEL for decreased bone development in the fore and hind limbs, in pup mice (both sexes) and accelerated puberty in male mice[85] to generate a reference dose of 2 x 10^{-5} mg/kg/day.

The EPA used drinking water intake and body weight parameters for lactating women in the calculation of their lifetime health advisory due to the potential increased susceptibility during this time window. EPA assumed a drinking water ingestion rate of 0.054 L/kg-day, which represents the 90th percentile water ingestion estimate for a lactating woman, based on direct and indirect water intake of community water supply consumers.[86] The EPA also concluded that there are significant sources of PFOA and PFOS exposure other than drinking water ingestion. As information is not available to quantitatively characterize exposure from all of these different sources, the EPA used a default relative source contribution (RSC, discussed in Box 3) of 20% of daily exposure coming from drinking water and 80% from other sources.

Box 3: Uncertainty Factors

The use of uncertainty factors (UFs) has a long history in developing regulatory standards and guidance for chemicals. Uncertainty refers to our inability to know all the adverse effects related to a chemical, often due to incomplete data. When assessing the potential for risks to people, toxicology studies often involve exposing test animals (generally rats and mice) which are used as a surrogate for humans.[82] A thorough review of the development and use of science-based uncertainty factors is provided by the EPA and National Academy of Sciences.[82,83,84]

Risk assessment for public health protection must account not only for what is known about a chemical's adverse effects, but also what is not known about differences between toxic effects in animals compared to humans; children compared to adults; differences in absorption, metabolism and excretion; and other unknown factors. The selection of uncertainty factors is designed to account for the incomplete understanding or availability of studies upon which toxicity is appraised.

The EPA typically uses factors of 1, 3 (an approximation of √10), or 10, depending on the level of uncertainty for each factor.

In June 2016, Vermont published a health advisory for combined exposure to PFOA and PFOS not to exceed 20 ppt based on EPA's selected developmental effects.[87] It also applied combined uncertainty factors of 300 using EPA's rationale, however generated a lower health advisory due to selection of drinking water exposure parameters for a breastfeeding or formula-fed infant. Breastfeeding and formula-fed infants is a population that drinks the largest volume per body weight and is the most vulnerable to the toxic effects of exposure to PFAS. The 95th \percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kg-day.[86,89] Vermont also used a relative source contribution from drinking water of 20%.

In August 2018, Minnesota adopted a guidance value (health risk limit) of 35 ppt for PFOA in groundwater based the same critical health effect as the EPA.[90] Minnesota applied a combined uncertainty factor of 300 including: 10 for human variability, 3 for animal to human toxicodynamic differences, 3 for use of a LOAEL instead of a NOAEL, and 3 for database uncertainty. Like Vermont, Minnesota's more protective guidance values are due to the use of drinking water exposure estimates based on infants, but also the accounting of a pre-existing body burden through placental transfer (Minnesota calculated a placental transfer factor of 87% based on average cord to maternal serum concentration ratios). Minnesota estimated breastmilk concentrations by applying a breast milk transfer factor of 5.2%, which is an estimate of the amount of PFOA that is transferred from a mother's serum to her breastmilk. Minnesota published this transgenerational toxicokinetic model for PFOA in January 2019.[91] As serum levels for PFOA are approximately 100 times the concentration in a person's drinking water, a breast milk transfer factor of 5.2% would result in breast milk concentrations approximately 5 times higher than in the drinking water. However, Minnesota also used a less conservative relative source contribution of 50%, resulting in drinking water values approximately half of EPA's.

Box 4: Relative Source Contribution

One important factor that should be considered when generating a health-protective drinking water limit for a contaminant is the percentage of the total allowable dose (RfD or MRL) that comes from water, versus other exposure routes. The portion of a total daily dose that comes from a specific exposure route (such as drinking water) is represented by a relative source contribution (RSC).

EPA suggest RSC's for drinking water range from 0.2 to 0.8 (20% to 80% coming from drinking water). In the absence of complete data, the EPA's default RSC value is 0.2.

- Studies demonstrate that there are many other sources of PFAS exposure, including food and consumer products, though the relative contribution from each source is still poorly understood.
- For children, researchers estimated exposure to PFOA and PFOS from hand-to-mouth transfer from treated carpets to be 40–60% of the total uptake in infants, toddlers, and children.[88]
- Therefore, the RSC from drinking water for this vulnerable population should not exceed 0.4 (40%). Importantly, as we do not understand all the exposure sources for this population, the default value of 0.2 is the most protective and recommended.

In March 2017, New Jersey Drinking Water Quality Institute derived a recommended MCL in water for PFOA of 14 ppt based on increased liver weight in rodent studies.[92] Previously in 2007, New Jersey issued a preliminary drinking water guidance level for PFOA of 40 ppt, which was revised in 2016 to a more stringent level of 14 ppt based on chronic exposure from drinking water for cancer and non-cancer

endpoints. Non-cancer endpoints were derived based on increased liver weight with applied uncertainty factors of 300 (10 for human variability, 3 for animal to human toxicodynamic differences, and 10 to protect against more sensitive toxicological effects). The more protective health threshold is mainly due to the use of an additional uncertainty factor of 10 to protect against more sensitive toxicological effects (delayed mammary gland development), which is explained by New Jersey in the following excerpt:

> *"Delayed mammary gland development from perinatal exposure is the most sensitive systemic endpoint for PFOA with data appropriate for dose-response modeling. It is a well-established toxicological effect of PFOA that is considered to be adverse and relevant to humans for the purposes of risk assessment.*
>
> *To the knowledge of the Health Effects Subcommittee, an RfD for delayed mammary gland development has not previously been used as the primary basis for health-based drinking water concentrations or other human health criteria for environmental contaminants. Because the use of this endpoint as the basis for human health criteria is a currently developing topic, the Health Effects Subcommittee decided not to recommend a Health-based MCL with the RfD for delayed mammary gland development as its primary basis. However, the occurrence of this and other effects at doses far below those that cause increased relative liver weight (the endpoint used as the primary basis for the recommended Health-based MCL) clearly requires application of an uncertainty factor to protect for these more sensitive effects."*[92]

The recommended MCL based on cancer endpoints was derived from testicular tumor data from chronic dietary exposure in rats and also resulted in a MCL of 14 ppt. New Jersey used values for adult drinking water exposure (0.029 L/kg-day) and a relative source contribution of 20%. In January 2019, New Jersey announced a proposed specific ground water quality criteria based on the same reasoning for its proposed MCL, however, since interim ground water criteria are rounded to one significant figure in New Jersey, the proposed criteria for PFOA is 10 ppt (0.01 µg/L).[93] In April 2019, New Jersey announced a rule proposal to adopt the New Jersey Drinking Water Quality Institute's recommended MCL of 14 ppt.[94]

In June 2018, ATSDR generated a MRL for PFOA.[5] A MRL exposure scenario of 3×10^{-6} mg/kg/day was based on a LOAEL of 0.000821 mg/kg/day for neurodevelopmental and skeletal effects in mice[95,96] with an uncertainty factor of 300 (10 for use of a LOAEL instead of a NOAEL, 3 for extrapolation from animals to humans with dosimetry adjustments, and 10 for human variability). A MCLG based on ATSDR's MRL for PFOA would be 11 ppt, using the same assumptions and parameters the EPA used for calculating their health advisory (based on lactating mothers), or 3 ppt, using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix C for MCLG calculations).

Box 5: ATSDR's Environmental Media Evaluation Guides

In November 2018 ATSDR posted on its website a webpage entitled "ATSDR's Minimal Risk Levels (MRLs) and Environmental Media Evaluation Guides (EMEGs) for PFAS."[97] ATSDR provides the body weights and drinking water intake rates it would use for an average adult or child (under one year) and lists what the corresponding drinking water concentrations would be if converted from ATSDR's proposed MRLs: for an adult 78 ppt for PFOA, 52 ppt for PFOS, 517 ppt for PFHxS, and 78 ppt for PFNA; and for a child, 21 ppt for PFOA, 14 ppt for PFOS, 140 ppt for PFHxS, and 21 ppt for PFNA. ATSDR does not provide any details as to how it derived the values presented on the webpage. However, based on the information ATSDR did provide, drinking water values, body weight and intake rates, we were able to calculate the relative source contribution used by ATSDR. According to our calculations, ATSDR used a relative source contribution of 1, which assumes that 100% of a person's exposure comes from drinking water, not 20% or 50%, as all other agencies have adopted (see Appendix E for calculations).

Studies demonstrate that there are many other sources of PFAS exposure, including food and consumer products. For example, NHANES demonstrates that greater than 95 percent of Americans have detectable PFAS in their bodies, however many of these Americans do not have detectable PFAS in their drinking water. Therefore, the assumption that a person would be only exposed to PFAS from drinking water is not supported by the scientific literature.

In June 2018, at the request of the California State Water Resources Control Board, the California Office of Environmental Health Hazard Assessment (OEHHA) recommended an interim notification level of 14 ppt for PFOA in drinking water.[98] The notification level is based on developmental toxicity, immunotoxicity, liver toxicity, and cancer. OEHHA reviewed currently available health-based advisory levels and standards, including the documents and process used by New Jersey to derive its water advisory levels. OEHHA found New Jersey's process to be both rigorous and sufficient for establishing an interim notification level for PFOA. They note that this level is similar to that derived by ATSDR, whose minimal risk level equates to a drinking water advisory level of 13 ppt for PFOA, as calculated by OEHHA. OEHHA is currently completing its own derivation of a recommended drinking water notification level for PFOA.

In December 2018, the New York Drinking Water Quality Council recommended that the New York Department of Health adopt MCLs of 10 ppt each for PFOA and PFOS.[99] Although no supporting documentation is currently available in relation to this recommendation, the council notes that these levels "take into consideration the national adult population's "body burden," or the fact that all adults already have some level of exposure to these and other related chemicals."

Analysis

Although altered mammary gland development is the most sensitive endpoint for PFOA exposure,[63,64,65] both the EPA and ATSDR did not consider altered mammary gland development as the critical effect in their toxicity assessment of PFOA.

The EPA excluded the results of the mammary gland findings based on the agency's view that the effects were of "unknown biological significance," concern for variability in the sensitivity for these effects amongst mice strains,[65] the fact that the mode of action for these effects are unknown, and that mammary gland effects had not been previously used for risk assessment.[3] Similarly, ATSDR classified altered mammary gland development as not adverse due to uncertainty around the effect's biological significance.

However, experts in the field have concluded that changes in mammary gland growth and differentiation, including changes in developmental timing, are a health concern.[100] Studies have shown a relationship between altered breast development, lactational deficits and breast cancer (discussed further in Box 6). Therefore, unless it can be shown that this relationship does not exist for PFOA, altered mammary gland growth and differentiation should be considered an adverse health effect of PFOA exposure and the critical endpoint for PFOA.

Box 6: "Is altered mammary development an adverse effect?"

Both the EPA and ATSDR did not consider altered mammary gland development as the critical effect in their toxicity assessment of PFOA. However, in a 2009 a workshop of experts in mammary gland biology and risk assessment came to the consensus that changes in mammary gland growth and differentiation, including changes in developmental timing, are a health concern.[100] Altered mammary gland development may lead to difficulty in breastfeeding and/or an increase in susceptibility to breast cancer later in life.[101]

Only one animal study has assessed the effects of PFOA exposure on mammary gland growth and differentiation for multiple generations.[64] The authors saw striking morphological abnormalities in the lactating glands of dams (mothers) chronically exposed to environmentally relevant levels of PFOA; however, no effects on body weight of their pups were seen. It is possible that compensatory behavior, such as increased number of nursing events per day or longer nursing duration per event masked a decreased potential in milk production by the dams, however the authors did not evaluate these endpoints in the study. It is also possible that PFOA exposure could increase time to peak milk output through the reduction in number and density of alveoli available to produce milk.

For human mothers, low-level functional effects on lactation that cause even a short delay in substantial milk output might result in cessation in breastfeeding before the recommended time-frame. This is supported by a cohort study that found an inverse correlation between levels of maternal serum PFOA and duration of breastfeeding.[102]

Early life exposures to factors that disrupt development may influence susceptibility to carcinogens later in life. For example, hormone disruption is an important determinant of breast cancer susceptibility in humans and rodents.[103] Proliferating and undifferentiated structures, such as terminal end buds, display elevated DNA synthesis compared to other mammary gland structures; which is why terminal end buds are considered the most vulnerable mammary gland target structure of carcinogen exposure.[104] Delays in mammary gland development would result in a prolonged window of increased vulnerability to carcinogens. In humans, perturbations to the timing of menarche is linked to breast cancer.[105] This further raises the concern that changes in patterns of breast development in U.S. girls could be contributing to an increased risk of breast cancer or other adult diseases later in life.[106] However, an increase in susceptibility to breast cancer later in life was not explored in the multigeneration mammary gland development study.[64]

In general, "*developmental delay can reflect an overall detrimental effect of chemical exposure that lead to growth and developmental deficit in the offspring*."[26]

New Jersey did classify delayed mammary gland development as adverse, though, it stopped short of using it to generate their MCL for PFOA. However, New Jersey did calculate a reference dose, 1.1 x 10^{-7} mg/kg/day, based on delayed mammary gland development. If this more protective reference dose were used, the MCLG for PFOA would be less than 1 ppt, regardless of which population the drinking water parameters are based on (see Appendix D for calculation). The MCLG would be lowered even further below 1 ppt if an additional uncertainty factor of 10 was applied to ensure adequate protection of fetuses, infants and children, as recommended by the National Academy of Sciences and as required in the Food Quality Protection Act (see Box 7).

PFOS

Comparison

In May 2016, the EPA issued a drinking water health advisory for PFOS of 70 ppt,[28] with the sum of PFOA and PFOS concentrations not to exceed 70 ppt. The EPA applied combined uncertainty factors of 30 (10 for human variability, 3 for animal to human toxicodynamic differences) on a NOAEL of decreased pup weight in a two-generation rat study.[107] As with PFOA, the EPA used drinking water intake and body weight parameters for lactating women and a relative source contribution of 20%.

As mentioned above, in June 2016 Vermont published a health advisory for total concentrations of PFOA and PFOS in drinking water at 20 ppt based on EPA's selected developmental effects and drinking water exposure parameters for breastfeeding or formula-fed infants.[87]

In May 2017, Minnesota proposed a groundwater guidance value (health-based value) of 27 ppt for PFOS based the same critical endpoints as the EPA.[108] However, Minnesota applied a larger combined uncertainty factor than the EPA. Minnesota applied a total uncertainty factor of 100 including: 3 for animal to human toxicodynamic differences, 10 for human variability and an additional 3 for database uncertainty (based on the need for additional immunotoxicity data). Minnesota accounted for a pre-existing body burden through a placental transfer factor of 46%, used drinking water exposure estimates based on infants with an estimated breast milk transfer factor of 1.3%, and used a relative source contribution of 50%.

In June 2018, New Jersey derived a recommended MCL in water for PFOS of 13 ppt for chronic exposure from drinking water based on immune suppression in mice,[110] an endpoint that is significantly more sensitive than the endpoint used by EPA.[111] New Jersey applied a combined uncertainty factor of 30 (10 for human variability and 3 for animal to human toxicodynamic differences) to an internal NOAEL of 674 ng/ml of PFOS in animal serum to generate an human serum target level. This target level was then multiplied by a clearance factor to arrive at a reference dose of 1.8 x 10^{-6} mg/kg/day. New Jersey used values for adult drinking water exposure and a relative source contribution of 20%. Like for PFOA, in January 2019, New Jersey announced a proposed specific ground water quality criteria based on the same reasoning for its proposed MCL, however, since interim ground water criteria are rounded to one significant figure in New Jersey, the proposed criteria for PFOS is 10 ppt (0.01 µg/L).[112] In April 2019, New Jersey announced a rule proposal to adopt the New Jersey Drinking Water Quality Institute's recommended MCL of 13 ppt.[94]

Box 7: Additional Protection for Fetuses, Infants, and Children

The National Academy of Sciences has recommended the use of an additional uncertainty factor of 10 to ensure protection of fetuses, infants and children who often are not sufficiently protected from toxic chemicals such as pesticides by the traditional intraspecies (human variability) uncertainty factor.[109] Congress adopted this requirement in the Food Quality Protection Act for pesticides in foods. 21 U.S.C. 346a(b)(2)(C)(ii)(II)

Considering the many health effects linked to PFAS that affect this vulnerable population and the substantial data gaps on exposure and toxicity of these compounds in complex mixtures, we recommend the use of this uncertainty factor when deriving health-protective thresholds for PFAS.

In June 2018, ATSDR generated a MRL for PFOS based on delayed eye opening and decreased pup weight[107] in rats.[5] A MRL exposure scenario of 2 x 10^{-6} mg/kg/day was based on a NOAEL of 0.000515 mg/kg/day using an uncertainty factor of 300 (10 for concern that immunotoxicity may be a more sensitive endpoint than developmental toxicity, 3 for extrapolation from animals to humans with dosimetry adjustments, and 10 for human variability). A MCLG based on ATSDR's MRL for PFOS would be 7 ppt, using EPA's drinking water exposure assumptions, or 2 ppt, using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix C for MCLG calculations).

In June 2018, at the request of the California State Water Resources Control Board, OEHHA recommended an interim notification level of 13 ppt for PFOS in drinking water.[98] The notification level is based on the same analysis performed for PFOA, described above. OEHHA notes that this level is similar to that derived by ATSDR, whose minimal risk level equates to a drinking water advisory level of 9 ppt for PFOS, as calculated by OEHHA. OEHHA is currently completing its own derivation of recommended drinking water notification levels for PFOS.

As noted above, a MCL of 10 ppt each for PFOA and PFOS were recommended by the New York Drinking Water Quality Council.[99]

Analysis

Immunotoxicity is currently the most sensitive health endpoint known for PFOS exposure. As documented in the ATSDR's profile, both animal and epidemiology studies provide strong evidence linking PFOS exposure to immunotoxic effects (decreased antibody response to vaccines in humans, decreased host resistance to viruses, and suppressed immune response to antigens in animals). The National Toxicology Program also reviewed the immunotoxicity data on PFOA and PFOS in 2016 and concluded that both are presumed to constitute immune hazards to humans[66] (discussed further in Box 1).

Again, although immunotoxicity is the most sensitive endpoint for PFOS exposure, the EPA excluded immune system effects based on uncertainties related to mode of action, variation in dose effects between studies, differences in sensitivity between males and females, and lack of a *"demonstrated clinically recognizable increased risk of infectious diseases as a consequence of a diminished vaccine response."*[28]

ATSDR states concern that immunotoxicity is a more sensitive endpoint than developmental toxicity; however, it stops short of deriving a MRL from this endpoint. Instead, ATSDR posits that an additional modifying, or uncertainty factor of 10 is sufficient to address the doses where immunotoxic effects have been observed. However, this value is only consistent with the immunotoxicity study with the highest LOAEL.[113] The other immunotoxicity studies all result in MRLs approximately 2.5-100 times lower than those currently calculated (see Appendix A for MRL derivations). If a MCLG were generated from the most sensitive health endpoint (immunotoxicity) and from the study with the lowest LOAEL, as is normally done by ATSDR, it would be less than 1 ppt (see Appendix C for MCLG calculations). The MCLG would be lowered even further below 1 ppt if an additional uncertainty factor of 10 was applied to ensure adequate protection of fetuses, infants and children, as recommended by the National Academy of Sciences and as required in the Food Quality Protection Act. Additionally, a MCLG based on benchmark dose calculations for immunotoxicity in children would also be approximately 1 ppt.[114]

New Jersey did select immunotoxicity as its critical health effect, resulting in the lowest generated reference dose for PFOS. However, the use of adult drinking water assumptions results in a higher proposed MCL than what we have calculated using estimated MRLs based on immunotoxicity (see Appendix A and C).[1]

PFNA

Comparison

In July 2015, New Jersey proposed a MCL for PFNA of 13 ppt for chronic exposure from drinking water based on increased liver weight in rodents[115] with a total uncertainty factor of 1000 (10 for human variability and 3 for animal to human toxicodynamic differences, 10 for less than chronic exposure duration, and 3 for database uncertainty).[116] Extrapolation from animal to human dose levels were made on the basis of internal serum levels rather than administered dose and were based on an estimated 200:1 ratio between PFNA serum levels and drinking water concentration in humans. A chemical-specific relative source contribution of 50% was developed using the "subtraction" approach. A subtraction approach is used when other sources of exposure (air, food, consumer product, etc.) can be considered background, and can thus be subtracted from the total dose to arrive at the allowable limit or dose from drinking water.[117] New Jersey based their calculations on the 2011-12 NHANES biomonitoring data for the 95th percentile PFNA serum level in the U.S. general population. This MCL was adopted into law in September 2018.[118] As of January 2019, this is the only finalized, enforceable drinking water limit for a PFAS chemical. New Jersey also has a specific ground water quality criteria for PFNA set at 13 ppt, based on its MCL for PFNA.

In July 2018, Vermont updated its drinking water health advisory level to include (based on class similarity) PFOA, PFOS, PFHxS, PFHpA, and PFNA for a combined total not to exceed 20 ppt.[119] Based on its health advisory, Vermont updated its enforceable groundwater standard to include all 5 PFAS at a combined 20 ppt.[120] In January 2019, Vermont announced it will initiate the process of adopting its health advisory for these five PFAS as an enforceable MCL.[121]

For PFNA, ATSDR based its assessment on decreased body weight and developmental delays in mice pups.[5,115] A MRL exposure scenario of 3×10^{-6} mg/kg/day was based on a NOAEL of 0.001 mg/kg/day using an uncertainty factor of 300 (10 for database limitations, 3 for extrapolation from animals to humans with dosimetry adjustments, and 10 for human variability).[5] A MCLG based on ATSDR's MRL for PFNA would be 11 ppt, using EPA's drinking water exposure assumptions for PFOA and PFOS, or 3 ppt, using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix C for MCLG calculations).

Analysis

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[1] Additionally, there are a couple of differences between New Jersey's and ATSDR's approach to generating a RfD/MRL, including the use of slightly different clearance factors and ATSDR's use of the trapezoid rule to estimate a time weighted average serum concentration for the animal point of departure.

Importantly, ATSDR underestimated the half-life of PFNA in humans. In the paper used to estimate the half-life of PFNA,[122] two different half-life values were derived: one of 900 days for young women and one of 1,570 days for everyone else. Younger women of childbearing age have additional excretion pathways for PFAS than other populations, including through breastmilk and menstruation. ATSDR provided no rationale for why the shorter half-life was selected. The longer half-life represents a larger population with minimal excretion pathways for PFNA and would result in a more protective MRL value. Importantly, New Jersey's 200:1 estimated ratio between PFNA serum levels and drinking water concentration in humans is based on the longer, more representative half-life of 1,570 days.[116] When the longer half-life is used, the resulting MRL is 2×10^{-6} mg/kg/day (see Appendix B for MRL calculations). A MCLG based on this more protective MRL for PFNA would be 7 ppt, using EPA's drinking water exposure assumptions for PFOA and PFOS, or 2 ppt, using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix C for MCLG calculations). The MCLG would be below 1 ppt if an additional uncertainty factor of 10 was applied to ensure adequate protection of fetuses, infants and children, as recommended by the National Academy of Sciences and as required in the Food Quality Protection Act.

PFHxS

Comparison

As mentioned above, Vermont's drinking water health advisory and its groundwater standard now includes PFOA, PFOS, PFHxS, PFHpA, and PFNA for a combined total not to exceed 20 ppt and Vermont is now in the process of adopting the advisory as a MCL. [119,121]

Minnesota recently recommended using PFOS as surrogate for PFHxS until more data is available, setting a guidance value (risk assessment advice) of 27 ppt for PFHxS.[123]

For PFHxS, ATSDR based its assessment on thyroid follicular cell damage in rats.[124,125] A MRL exposure scenario of 2×10^{-5} mg/kg/day was based on a NOAEL of 0.0047 mg/kg/day using an uncertainty factor of 300 (10 for database limitations, 3 for extrapolation from animals to humans with dosimetry adjustments, and 10 for human variability).[5] A MCLG based on ATSDR's MRL for PFHxS would be 74 ppt, using EPA's drinking water exposure assumptions for PFOA and PFOS, or 23 ppt, using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix C for MCLG calculations). The MCLG would be lowered to 2 ppt if an additional uncertainty factor of 10 was applied to ensure adequate protection of fetuses, infants and children, as recommended by the National Academy of Sciences and as required in the Food Quality Protection Act.

GenX

Comparison

In 2017, North Carolina set a non-enforceable health goal for the GenX chemical, HFPO dimer acid, to 140 ppt in drinking water.[126] The health goal was based on a reference dose of 1 x 10^{-4} mg/kg/day, generated from a NOAEL for liver toxicity in mice (single-cell necrosis in hepatocytes and correlative increases in liver enzymes) with combined uncertainty factor of 1000 (10 for human variability, 10 for animal to human toxicodynamic differences, 10 for extrapolating from subchronic to chronic exposure duration). According to North Carolina Department of Human Health Services, their health goal for GenX is for "the most vulnerable population – i.e. bottle-fed infants, the population that drinks the largest volume of water per body weight."[126] The state used drinking water exposure assumptions based on bottle-fed infants (0.141 L/kg/day) and a relative source contribution of 20%.

In November 2018, the EPA proposed a chronic reference dose of 8 x 10^{-5} mg/kg/day for two GenX chemicals, HFPO dimer acid and its ammonium salt.[23] The EPA applied a combined uncertainty factor of 300 (10 for human variability, 3 for animal to human toxicodynamic differences, 3 for database limitations, and 3 for extrapolation from subchronic to chronic exposure duration) on a NOAEL for single-cell necrosis in livers of male mice from a DuPont study.[127] The EPA did not provide drinking water values in their toxicity assessment of GenX chemicals, however, using EPA's drinking water exposure assumptions for PFOA and PFOS, a MCLG would be 296 ppt, or 91 ppt using drinking water exposure assumptions based on breastfeeding and formula-fed infants (see Appendix F for calculations).

Analysis

The EPA notes that there are the following database deficiencies for GenX chemicals: no human data from epidemiological studies, limited testing for developmental toxicity and immunological responses, lack of a full two-generational reproductive toxicity study, and lack of a chronic study in mice (which appear to be more sensitive to GenX than rats). Additionally, of the studies considered for the development of the reference dose, only two were published in a peer-reviewed journal. These are significant limitations in the toxicity data available for GenX, and as such, an uncertainty factor of 3 is unlikely to be sufficient. Importantly, North Carolina does not apply an uncertainty factor for database limitations at all. In comparison, ATSDR used an uncertainty factor of 10 for database limitations for PFNA and PFHxS due to a lack of or limited testing of developmental and immunological effects, which ATSDR states are two of the most sensitive PFAS endpoints.[5]

To extrapolate from animal to human dose, the EPA used the Body Weight$^{3/4}$ allometric scaling approach, which is based on body surface area and basal metabolic rate in adults. This approach does not account for differences in toxicokinetics between animals and humans, which for PFAS are often vastly different. The Netherland's National Institute for Public Health and the Environment (RIVM) determined that although the elimination rates for GenX are faster than PFOA in animal models, without data in humans, it is not possible to make assumptions on the toxicokinetics of GenX chemicals in humans.[128] Due to the uncertainty from lack of human toxicokinetic data on GenX chemicals, RIVM calculated and applied an additional uncertainty factor to account for the potential kinetic difference between animals and humans.

This additional toxicokinetic factor used by RIVM is based on the difference in half-lives between cynomolgus monkeys and humans for PFOA. A half-life ratio was calculated using a half-life of 1378 days in humans[129] and of 20.9 days in male cynomolgus monkeys[130] resulting in an additional toxicokinetic factor of 66 (1378 / 20.9). This additional uncertainty factor to account for the potential kinetic difference between animals and humans is an example of an alternative approach to extrapolating animal doses to human doses for PFAS like GenX that do not yet have human toxicokinetic data. Considering the limitations of EPA's scaling approach, an uncertainty factor of 3 to account for interspecies toxicokinetic differences is likely to be insufficient.

Finally, North Carolina used an uncertainty factor of 10 to extrapolate from subchronic to chronic exposure duration, compared to the EPA's use of an uncertainty factor of 3. The EPA states that effects for the subchronic study it selected (performed in mice) are consistent with effects seen for the single chronic study available. However, the chronic study is in rats, a species that the EPA acknowledges is much less sensitive to the effects of GenX than mice. Therefore, this logic is not supported by the EPA's own findings.

If uncertainty factors that properly reflected the deficiencies in toxicity data (database, sub-chronic to chronic, children's vulnerability, human variability, animal to human differences) were used, the combined uncertainty factor could be as high as 100,000, which would result in a MCLG of less than 1 ppt for GenX chemicals (see Appendix F for calculations). This highlights the current considerable level of uncertainty in determining a safe level of exposure for GenX chemicals.

Box 8: Epidemiological Data in Risk Assessment

To generate accurate and relevant health thresholds, all toxicological information available should be evaluated. Epidemiological studies provide direct information on effects of chemical exposures in people. However, epidemiological data from human health studies are not always utilized. Human studies should be used in conjunction with animal studies to best inform risk assessment.

Use of epidemiology data in risk assessment is not a new approach, for example, epidemiological data was used quantitatively in an EPA evaluation of risk for methylmercury, as recommended by the National Academy of Sciences.[131] The EPA based the oral reference dose on lasting neurological effects in children exposed during early life.[132] In 2018, the European Food Safety Authority (EFSA) derived health-based guidance values for PFOA and PFOS based on epidemiological studies.[133] EFSA used benchmark modelling of serum levels to generate daily tolerable intakes (similar to a reference dose, a daily or weekly tolerable intake is an estimate of the amount of a substance in food or drinking water which can be consumed over a lifetime without presenting an appreciable risk to health) of 0.8 ng/kg/bw for PFOA based on increased serum cholesterol in adults and 1.8 ng/kg/bw for PFOS based on increased serum cholesterol in adults and decrease in antibody response at vaccination in children. These values are approximately 10-20 times stricter than the reference dose generated by the EPA, 20 ng/kg/bw.

Another powerful way of using epidemiological data is demonstrated by the Michigan PFAS Science Advisory Panel's use of epidemiology data to evaluate the EPA's health advisory level of 70 ppt for PFOA and PFOS.[26] The Panel estimated that drinking water with 70 ppt of PFOA over several years would result in serum concentrations around 10,000 ppt in adults and 16,500 ppt among those with higher consumption (such as nursing mother and infants). For adults, the Panel used a model[134] to estimate that 8,000 ppt would result from drinking water that contained 70 ppt PFOA, which is in addition to 2,000 ppt from background exposures (as estimated from NHANES national biomonitoring data).

A PFOA serum concentration of 10,000 ppt would represent the first quartile in the C8 study (contaminated community) and the top bracket in epidemiology studies of the general population. Many health effects have been seen in epidemiology studies at these blood serum concentrations. The Panel concludes, ***"…this evaluation places those with chronic exposure to 70 ppt or higher levels of PFOA in their drinking water well within the range at which credible associations with health effects were found by the C8 Science Panel studies."***[26] In other words, human data shows that the EPA's health advisory for PFOA and PFOS is not health protective.

Conclusions

Differences in the selection of critical endpoints and the application of uncertainty factors have led to the generation of different health thresholds for PFOA, PFOS, PFNA, PFHxS and GenX chemicals. Another source of variation in health thresholds comes from differences in exposure assumptions, such as drinking water intake rate, body weight and relative source contribution from drinking water. For example, the exposure levels of an average male adult versus a lactating mother versus a breastfeeding or formula-fed infant vary greatly. For an in-depth discussion of the main sources of variation in current health thresholds for PFOA and PFOS, including "*managing scientific uncertainty, technical decisions and capacity, and social, political, and economic influences from involved stakeholders*," see recently published article by researchers from Whitman College, Silent Spring Institute, and Northeastern University.[135]

Evidence shows that PFAS exposure poses a high risk to fetuses, infants, children and pregnant women. There is particular risk for sensitive members of the population from chemicals of such persistence and clear adverse effects at very low levels of exposure. Decisions made when developing a health threshold, such as evaluation of data gaps, the selection of uncertainty factors, and the choice of exposure parameters to use, should be made to be protective of the most vulnerable populations, particularly developing fetuses, infants, and children.[136]

Taking into consideration the above information, for risk assessment we recommend: 1) the use of the most sensitive health endpoint, regardless of whether the endpoint has been used in a risk assessment previously; 2) the use of drinking water exposure parameters that protect vulnerable populations, particularly breastfeeding or formula-fed infants; 3) the use of an additional uncertainty factor of 10 to protect fetuses, infants and children as recommended by the National Academy of Sciences[109] and as required in the Food Quality Protection Act (see Box 7); 4) the use of both human and animal data when assessing the toxicity of a chemical, or group of chemicals (see Box 8); and 5) the examination of possible additive or synergistic effects from exposure to mixtures of similar chemicals that target the same biological systems (see Box 9).

Box 9: Real-World Exposures

Fundamentally, exposures to PFAS occur as mixtures. With individual PFAS targeting many of the same biological systems, concurrent exposures to multiple PFAS likely have additive or synergistic effects. Therefore, traditional toxicity assessments that assume exposures to a chemical occur in isolation could be significantly underestimating the real-world effects of PFAS.

PART V: DETECTION/ANALYTICAL METHODS AND TREATMENT TECHNOLOGIES

As discussed in this section, PFOA, PFOS, PFNA, PFHxS, and GenX chemicals can be reliably quantified and treated to low levels, therefore, it is feasible for the state to establish strict MCLs for such PFAS. At present, there is no single methodology for isolating, identifying, and quantifying all PFAS in drinking water. Until total PFAS can be reliably quantified, the state should establish a treatment technique for the class of PFAS chemicals.

Analytical Methods for Detecting and Measuring Concentrations of PFAS

When a laboratory measures an chemical, the laboratory often reports the method detection limit (MDL) and the method reporting limit (also sometimes called the minimum reporting limit or limit of quantification).[137] The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the chemical is present in a concentration greater than zero; any concentration measured below the minimum detection limit is considered non-detect. The method reporting limit is the lowest chemical concentration that meets data quality objectives that are developed based on the intended use of this method; concentrations above this limit are considered quantified with statistical rigor. A laboratory may also report the single laboratory lowest concentration minimum reporting limit (LCMRL), a value between the method detection and reporting limits, which is the “lowest true concentration for which the future recovery is predicted to fall, with high confidence (99%), between 50 and 150% recovery."[137] Action levels, such as a MCL, should be set at or above the method reporting limit.

Figure 3: Detection, Quantification and Reporting Limits

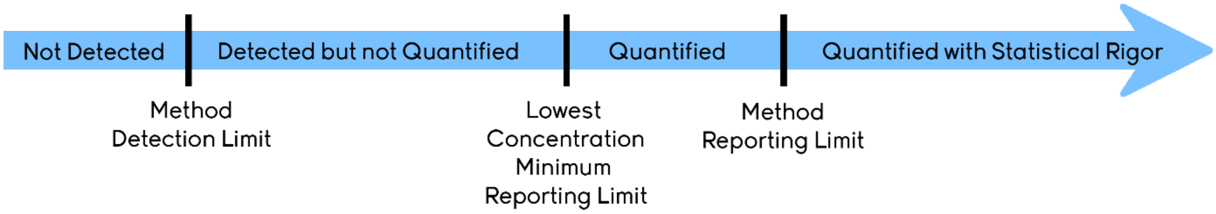

Figure 3 shows the relationship between the types of detection and quantification limits for laboratory testing. The method detection limit (MDL) is the lowest concentration that can be detected. The lowest concentration minimum reporting limit (LCMRL) is the lowest concentration that can be quantified and the method reporting limit, also known as the limit of quantification (LOQ), is the lowest concentration that can be reliably quantified and meets data quality objectives.[m]

The detection sensitivity of PFAS varies depending on the method of analysis used to quantify the results and the laboratory conducting the analysis. Historically, laboratories have used a liquid chromatography-tandem mass spectrometry method such as EPA Method 537, or a modified version,[138] with quantified reporting limits in the low single-digit ppt range. EPA Method 537, updated in November 2018 and referred to as Method 537.1, now includes detection limits ranging from 0.53 to 2.8 ppt for the 18 PFAS compounds included in the updated testing method.[139] In studies where an alternative method is used, researchers were able to achieve reporting limits below 1 ppt for PFOS, PFNA, and PFHxS. In Europe and Australia, reporting limits of less than 1 ppt for PFOA have been achieved.[140] Prominent laboratories that provide analytical detection services for PFAS have already established reporting limits of 2 ppt for at least 17 PFAS compounds including PFOA, PFOS, PFNA, and PFHxS, and a reporting limit of 5 ppt for GenX, using EPA Method 537 or Method 537.1; and one company confirms a 2 ppt reporting limit for the additional PFAS compounds in the updated EPA Method 537.1 will be achievable, except for GenX, which would typically be reported at 5 ppt, but can be lowered to a 2 ppt with an alternative analytical method.[141]

EPA Method 537.1

EPA Method 537.1 is a solid phase extraction (SPE) liquid chromatography/tandem mass spectrometry (LC/MS/MS) method for the determination of selected PFAS in drinking water.[139] This method can be used to quantify 18 PFAS compounds including PFOA, PFOS, PFNA,

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[m] Adapted from https://acwi.gov/monitoring/webinars/mpsl_qa_services_intro_rls_012517.pdf

PFHxS, and a GenX chemical, HFPO dimer acid. The EPA states that detection limits range from 0.53 to 1.9 ppt and single laboratory LCMRLs range from 0.53 – 2.7 ppt for PFOA, PFOS, PFNA, PFHxS, and HFPO-DA. We recommend that, at minimum, the state require the use EPA Method 537.1 with method reporting limits of 2 ppt, 5 ppt for GenX, when testing for PFAS in drinking water.

Table 8: Method Reporting Limits from three sources that use EPA Method 537 and/or 537.1

Contaminant	**CAS Registry Number**	**Method Reporting Limits (ppt)**			
		EPA 537.1[n]	**UCMR3**[o]	**Eaton Analytics**[p]	**Vista Analytical**[q]
PFOS	1763-23-1	2.7	40	2	2
PFOA	335-67-1	0.82	20	2	2
PFNA	375-95-1	0.83	20	2	2
PFHxS	355-46-4	2.4	30	2	2
HFPO-DA	13252-13-6	4.3	Not available	5	Not available

Table 8 shows the method reporting limits documented for the new EPA Method 537.1, the method reporting limits under the unregulated contaminant monitoring rule 3 (UCMR3) for EPA Method 537, and the method reporting limits reported by two laboratories that conduct testing of PFAS compounds, Eaton Analytical and Vista Analytical.

Alternative Analytical Methods

A Water Research Foundation report published in 2016[142] evaluated the ability of a wide spectrum of full-scale water treatment techniques to remove PFASs from contaminated raw water or potable reuse sources. One of the studies in the report was conducted at Southern Nevada Water Authority's Research and Development laboratory where researchers used a methodology that was able to achieve reporting limits below 1 ppt for several PFAS compounds, including PFOS, PFNA and PFHxS. The method used by researchers in this study is described as "*an analysis…via liquid-chromatography tandem mass-spectrometry (LC-MS/MS) using a previously reported method,*[143] *adapted and expanded to include all analytes of interest*". This method achieved minimum reporting limits below 1 ppt for PFOS, PFNA, and PFHxS.

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[n] LCMR from https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=537290&Lab=NERL

[o] https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule

[p] http://greensciencepolicy.org/wp-content/uploads/2017/12/Andy_Eaton_UCMR3_PFAS_data.pdf

[q] http://www.vista-analytical.com/documents/Vista-PFAS-rev3.pdf

Table 9: Minimum Reporting Levels Using Southern Nevada Water Authority Method

Contaminant	CAS Registry Number	Minimum Reporting Level (ppt)
PFOS	1763-23-1	0.25
PFOA	335-67-1	5
PFNA	375-95-1	0.5
PFHxS	355-46-4	0.25

Table 9 shows the minimum reporting levels achieved by the Southern Nevada Water Authority's analytical method for detecting selected PFAS.[r]

International Analytical Methods

A study conducted in Catalonia, Spain analyzed the concentrations of 13 perfluorinated compounds (PFBS, PFHxS, PFOS, THPFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUA, PFDoA, PFTeA, and PFOSA) in municipal drinking water samples collected at 40 different locations.[140] Detection limits ranged between 0.02 ppt (PFHxS) and 0.85 ppt (PFOA). Analysis was performed "*using an Acquity UPLC coupled to a Quattro Premier XE tandem mass spectrometer (Waters Corporation, Milford, CT, USA) with an atmospheric electrospray interface operating in the negative ion mode (ES-MS/MS)*". Reporting limits or limits of quantification were not reported for this study.

Another study, conducted in Germany, was aimed at determining concentrations of PFAS in various sources of water intended for human consumption.[144] The study analyzed up to 19 PFAS compounds, including PFOS, PFOA, PFNA, and PFHxS, and the limits of quantification, or reporting limits, for all 19 compounds were 1 ppt. The researchers note that the water samples were measured *"using UPLC-MS/MS (Aquity with a TQ-detector, both from Waters, Eschborn, Germany) on a Kinetex column (2.6 µm, C18, 100A, 100 × 2.1 mm; Phenomenex, Aschaffenburg, Germany).*"

A third study conducted in Australia evaluated the fate of perfluorinated sulfonates (PFSAs) and carboxylic acids (PFCAs) in two water reclamation plants.[145] For this study, instrumental detection limits ranged from 0.2–0.7 ppt and reporting limits were set at double this, ranging from 0.4–1.5 ppt. Authors describe the analysis as "*using a QTRAP 4000 MS/MS (AB/Sciex, Concord, Ontario, Canada) coupled with a Shimadzu prominence HPLC system (Shimadzu, Kyoto Japan) using a gradient flow of mobile phase of methanol/water with 5 mM ammonium acetate. A Gemini C18 column (50 mm _ 2 mm i.d. 3 lm 110 Å) (Phenomenex, Torrance, CA) was used for separation, and an additional column (Altima, C18, 150 mm _ 2 mm i.d. 5 lm, 100 Å)(Grace Davison, Deerfield, IL) was installed between the solvent reservoirs and sample injector to separate peaks consistently present in the system from those in the samples (e.g. small*

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[r] Dickenson ERV and Higgins C, 2016. Treatment Mitigation Strategies for Poly- and Perfluoroalkyl Substances. Water Research Foundation, Web Report #4322 http://www.waterrf.org/PublicReportLibrary/4322.pdf

peaks for PFDoDA (C12 PFCA), and for PFOA present in the mobile phase, and/or from fluoropolymer components in the LC system)."

Table 10: Detection and Reporting Limits for PFOA, PFOS, PFNA, PFHxS Internationally

Contaminant	Detection Limit (ppt)[s]	Reporting Limit (ppt)[t]
PFOS	0.12	1
PFOA	0.85	1
PFNA	0.15	1
PFHxS	0.02	1

Table 10 provides examples of detection and reporting limits achieved by two different international studies for PFOA, PFOS, PFNA, and PFHxS.

Comprehensive PFAS Assessment Techniques

At present, there is no single methodology for isolating, identifying, and quantifying all PFAS in drinking water. Current commercial laboratory methodologies are typically able to quantify between 14 and 31 PFAS compounds and only a very small number of PFAA precursors can be quantitatively analyzed by commercial laboratories.[146] For instance, N-ethyl perfluorooctanesulfonamidoacetic acid and N-methyl perfluorooctanesulfonamidoacetic acid are the only two precursors included in EPA Method 537.1. For classes other than PFCAs between 4-14 carbons long and PFSAs that are 4, 6, or 8 carbons long, methodologies are generally not available outside academic settings.[26] The Michigan PFAS Science Advisory Panel summarizes the advantages and disadvantages of some available analytical methodologies to quantify PFAS as a class. These are included in Table 11 below (with additional information as cited).[26]

We recommend states determine an analytical method, or combination of methods, that can be used as a surrogate for total PFAS. In particular, we recommend the evaluation of alternative detection methodologies, particularly TOPA, to measure the concentration of non-discrete and difficult to measure PFAS compounds that are not determined by conventional analytical methods.

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[s] Ericson I, et al., 2009. Levels of Perfluorinated Chemicals in Municipal Drinking Water from Catalonia, Spain: Public Health Implications. *Arch Environ Contam Toxicol* 57:631–638

[t] Gellrich V, et al., 2013. Perfluoroalkyl and polyfluoroalkyl substances (PFASs) in mineral water and tap water. *J Environ Sci Health* 48:129–135

Table 11: Comparison of Various Analytical Approaches to Quantifying PFAS

Method	Advantages	Limitations
Method 537 V 1.1 Liquid Chromatography-Tandem Mass Spectrometry LC- MS/MS	• commercially available • QA/QC extensive • UCMR3/Method 537/SW-846 8327&8328/ASTM based on instrument • Differentiates branched/linear • Suited for analysis of ionic compounds[u]	• expensive • approved for a limited number of PFAS (18 in drinking water)[v] • value for forensics depends on number of PFAS evaluated
Total Oxidizable Precursor (TOP) assay	• commercially available • QA/QC improving • some chain length & branched and linear isomer information • reveals presence of significant precursors in AFFF-contaminated water, sediment, soil, and wastewater • data sets obtained by this methodology are comparable between sites and across states	• twice as expensive • no information on individual PFAS • conservative (lower estimate) • limited comparative data at this time • results treated with caution, especially for health and ecological risk assessments[w] • limited value for forensics
Suspect screening (LC-HRMS)	• unlimited number of PFAS • stored data can be searched in future • value as a forensics tool • a reference standard is not needed, the exact mass and isotopic pattern calculated from the molecular formula is used to screen for substances[x]	• instruments available but PFAS analysis by LC-HRMS not commercially available in US (research tool) • expensive • no standards for the other PFAS • data are 'screening' level or semi-quantitative • limited comparable data - data obtained on different instruments, ratioing to various internal standards may not be comparable between sites and across states (generates lab- specific data until standardized)
Particle Induced Gamma Ray Emission (PIGE)	• quantifies fluorine • currently captures anionic PFAS, currently being adapted for cationic/zwitterionic PFAS • less expensive • availability through academic institutions	• only quantifies total fluorine (the atom) • no information on individual PFAS • small database (few comparative data) • cannot analyze different isotopes[y] • limited value for forensics • detection limits are in the µg/L range, regulatory standards are now increasingly at ng/L levels[z]

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[u] https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_site_characterization_3_15_18.pdf

[v] https://www.epa.gov/water-research/epa-drinking-water-research-methods

[w] https://www.alsglobal.com/-/media/als/resources/services-and-products/environmental/data-sheets-canada/pfas-by-top-assay.pdf

[x] https://link.springer.com/article/10.1007/s00216-018-1028-4

[y] https://www.sciencedirect.com/science/article/pii/0168583X86903812

[z] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5895726/

Total adsorbable organic fluorine (AOF)	• quantifies total fluorine • captures broad spectrum of PFAS • can be compared to individual PFAS analysis to determine presence of other PFAS (e.g., precursors)	• measures total fluorine (the atom) • no information on individual PFAS • not commercially available in US (or elsewhere) • must convert total fluorine in units of molar F to equivalents, assuming a specific PFAS to compare measurements • few comparable data • detection limits are in the μg/L range, regulatory standards are now increasingly at ng/L levels[aa]

Table 11 summarizes advantages and limitations of various analytical approaches to quantifying PFAS.[bb]

Treatment

There are a number of treatment options available to public water systems to address PFAS contamination.

On August 23, 2018, EPA published the results of its efforts to study a variety of technologies used to remove PFAS from drinking water.[147] The EPA's treatability analysis for PFAS compounds demonstrates that current treatment technologies can reduce concentrations of PFOA, PFOS, PFNA, and PFHxS to concentrations below 2 ppt. Full-scale treatment facilities in the U.S., Europe, and Australia have demonstrated effective removal of PFAS compounds through a variety of treatment technologies, most successfully with activated carbon or membrane filtration. The EPA's treatability analysis did not include data on the treatment of GenX, but pilot studies conducted in North Carolina have demonstrated reductions of GenX to below 2 ppt. [148]

Under federal law, standards for synthetic organic contaminants such as PFAS must be "feasible," and that term is defined to be a level that is at least as stringent as the level that can be achieved by Granular Activated Carbon (GAC). Specifically, the Safe Drinking Water Act provides, *"granular activated carbon is feasible for the control of synthetic organic chemicals, and any technology, treatment technique, or other means found to be the best available for the control of synthetic organic chemicals must be at least as effective in controlling synthetic organic chemicals as granular activated carbon."* Safe Drinking Water Act §1412(b)(4)(D). Therefore, states should establish MCLs for PFAS at levels at least as stringent as can be achieved by GAC.

In this report, we recommend MCLs for PFOS, PFOA, PFNA, PFHxS, and GenX that have been demonstrated to be achievable with GAC. However, for total PFAS, greater protections can be

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[aa] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5895726/

[bb] Michigan PFAS Science Advisory Panel, 2018. Scientific Evidence and Recommendations for Managing PFAS Contamination in Michigan. December 7, 2018.

achieved with reverse osmosis than GAC (discusses below), therefore we recommend a treatment technique of reverse osmosis, or other treatment method that has been demonstrated to be at least as effective as reverse osmosis for removing all identified PFAS chemicals.

Granular Activated Carbon (GAC) Treatment

According to the EPA, "*Activated carbon treatment is the most studied treatment for PFAS removal. Activated carbon is commonly used to adsorb natural organic compounds, taste and odor compounds, and synthetic organic chemicals in drinking water treatment systems. Adsorption is both the physical and chemical process of accumulating a substance, such as PFAS, at the interface between liquid and solids phases. Activated carbon is an effective adsorbent because it is a highly porous material and provides a large surface area to which contaminants may adsorb*."[147] Activated carbon is made from organic materials with high carbon contents and is often used in granular form called granular activated carbon but can also be used in a powdered form called powdered activated carbon.

Granulated active carbon has been used for more than 15 years to remove PFOA and PFOS from water. The most common carbonaceous materials include raw coal, coconut, and wood. According to the Rapid Scale Small Column Testing Summary Report by Calgon Carbon, *"bench scale studies have shown that reagglomerated bituminous coal-based GAC significantly out performs other GAC materials including direct activated coconut GAC.*"[149]

While the EPA notes that, "*GAC has been shown to effectively remove PFAS from drinking water when it is used in a flow through filter mode after particulates have already been removed*,"[147] it should be noted that GAC has only been demonstrated to be effective for a certain PFAS chemicals. Factors impacting the effectiveness of GAC treatment include:

- the type of carbon used,
- the depth of the bed of carbon,
- flow rate of the water,
- the specific PFAS to be removed,
- temperature, and
- the degree and type of organic matter as well as other contaminants, or constituents, in the water.

A report reviewing the effectiveness of emerging technologies for treatment of PFAS chemicals noted that "*GAC is a widely used water treatment technology for the removal of PFOS and PFOA, and, to a lesser extent, other PFAAs from water…It is an established technology that can be deployed at scales between municipal water treatment and domestic point of entry systems, either as a standalone technology or part of a treatment train*."[150] And while GAC can consistently remove PFOS at parts per billion concentrations with an efficiency of more than 90 percent, it can be inefficient at removing PFOA[151] and becomes progressively less effective for removing shorter chain PFCAs such as PFHxA, PFPeA, PFBS, and PFBA as the chain length diminishes.[152,153]

There are several examples of full-scale treatment systems using GAC to remove PFAS from drinking water sources. A report prepared for the New Jersey Department of Environmental Protection[154] included several case studies, two of which are included below.

Amsterdam, Netherlands - A study of the removal of a number of PFAS from several steps in the treatment process from raw water to finished water found that longer chain PFAA were readily removed by the GAC treatment step.[155] In this study, a final GAC adsorber was able to reduce both PFOS and PFNA measured in the raw samples at values of 6.7 to 10 ppt and 0.5 to 0.8 ppt, respectively to levels measured below the limits of quantitation (0.23 ppt and 0.24 ppt, respectively). PFOA concentrations in the influent ranged between 3.8 to 5.1 ppt and in the final GAC adsorber ranged between 3.6 to 6.7 ppt. GAC adsorption for this study was done in two stages with adsorbers operated in series, each with a 20-minute empty bed contact time. The GAC in the lag adsorber is placed in the lead position after 15 months of operation and replaced with fresh GAC. The GAC used in this study was Norit ROW 0.8S.

New Jersey American Water, Logan System Birch Creek - Water samples from the Logan System Birch Creek had detectable levels of PFNA (18 – 72 ppt) and of PFOA (33 – 60 ppt), in addition to three other PFAS.[154] GAC treatment removed all detectable PFAS below the reporting level of 5 ppt. GAC adsorbers were operated with an empty-bed contact time of approximately 15 minutes. The GAC used in this study was Calgon F-400.

Additionally, on-going pilot studies being conducted by engineering firm CDM demonstrates effective GAC treatment for GenX and other PFAS with reductions below detection limits of 2 ppt.[148] According to an April 2018 report by CDM for Brunswick County Public Utilities, long-term effective treatment with GAC requires media changeout to avoid breakthrough of compounds and the study indicates approximately 8,000 bed volumes (approximately 4 months at 20-minute contact time) is the appropriate frequency of media changeout for GenX and most PFAS.

GAC treatment can produce contaminated spent carbon or, if regenerated, contaminated air emissions, which require safe disposal. The Michigan PFAS Science Advisory Panel notes that, "*When regenerating PFAS-loaded activated carbon, the off-gases should be treated by high temperature incineration to capture and destroy any PFAS in the stack gases and to prevent the release of PFAS and/or partially oxidized byproducts to the atmosphere.*"[26] For example, for complete destruction of PFOS, researchers recommend that incineration be performed at temperatures over 1,000°C.[156] If an incinerator operates at temperatures below 1,000°C, it will likely result in incomplete destruction and the formation of byproducts, and therefore require stack treatment to prevent PFAS release.

In sum, use of GAC by multiple water utilities at scale have achieved reductions of greater than 90 percent to below detection limits for certain PFAS chemicals, including PFOS, PFOA, PFNA, PFHxS, and GenX. GAC has not been demonstrated to be effective for removing other PFAS chemicals, particularly short-chain PFAS.

Ion Exchange (IX) Treatment

Ion exchange resins essentially act as "magnets," attracting the contaminated materials as it passes through the water system.[147] Ion exchange resins can be cationic or anionic; positively charged anion exchange resins (AER) are effective for removing negatively charged contaminants, like PFAS. Ion exchange resins are made up of highly porous, polymeric hydrocarbon materials that are acid, base, and water insoluble.

As summarized by the EPA,

> *"AER has shown to have a high capacity for many PFAS; however, it is typically more expensive than GAC. Of the different types of AER resins, perhaps the most promising is an AER in a single use mode followed by incineration of the resin. One benefit of this treatment technology is that there is no need for resin regeneration so there is no contaminant waste stream to handle, treat, or dispose. Like GAC, AER removes 100 percent of the PFAS for a time that is dictated by the choice of resin, bed depth, flow rate, which PFAS need to be removed, and the degree and type of background organic matter and other contaminants of constituents*."[147]

Reverse Osmosis Treatment

According to the EPA, high-pressure membranes, such as nanofiltration or reverse osmosis (RO), have been effective at removing a broad array of PFAS compounds.[147] High-pressure membranes can be more than 90 percent effective at removing a wide range of PFAS, including shorter chain PFAS.

In a 2011 paper, researchers examined the fate of PFAS in two water reclamation plants in Australia.[145] The authors found that:

> "*Both facilities take treated water directly from wastewater treatment plants (WWTPs) and treat it further to produce high quality recycled water. The first plant utilizes adsorption and filtration methods alongside ozonation, whilst the second uses membrane processes and advanced oxidation to produce purified recycled water. At both facilities perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA) were the most frequently detected PFCs [perfluorinated compounds]. At the second plant, influent concentrations of PFOS and PFOA ranged up to 39 and 29 ppt. All PFCs present were removed from the finished water by reverse osmosis (RO) to concentrations below detection and reporting limits (0.4–1.5 ppt)*."[145]

Preliminary results of an on-going pilot study at Northwest Water Treatment Plant in North Carolina indicate that RO is expected to provide high level of removal (90 percent or greater) for the PFAS compounds, including GenX.[148] The RO membranes being proposed for this project and being tested in the pilot study are standard commercially available brackish water RO membranes rated for 99.3 percent rejection of a standard 2000 mg/L sodium chloride salt solution; this is considered a high rejection, broad spectrum RO membrane. The study also evaluated GAC, IX, and advanced treatment trains and concluded that low-pressure reverse osmosis was the preferred alternative for both removal efficiency and cost-effectiveness. The CDM report states:

> "*RO is recommended over the other options for the following reasons:*
>
> - *RO is the Best Technology for Removal of PFAS. Some PFAS, such as GenX, PFMOAA and PFO2HxA would require very frequent change-out of GAC and IX for removal.*
> - *GAC and IX would likely result in higher finished water concentrations of GenX, PFMOAA, and PFO2HxA than RO (technologies are not equal).*
> - *RO has the lowest net present worth costs for removing 90% or more of the Target Contaminants.*
> - *RO is the most robust technology for protecting against unidentified contaminants.*
> - *RO treated water concentrations will not vary as much with influent concentrations as with GAC and IX. RO treated water quality does not rely on frequent media change-out to protect from the spills and contaminants in the Cape Fear River.*
> - *RO does not release elevated concentrations after bed life is spent as can happen with GAC and IX if feed concentration drops."*[148]

Like GAC, RO treatment technology generates contaminated waste material including liquid concentrate and spent/used membranes. We recommend states evaluate the safest disposal method for contaminated waste, and that disposal require full destruction of PFAS compounds before entering the environment.

Furthermore, the EPA also suggests,

> "*Because reverse osmosis removes contaminants so effectively, it can significantly lower the alkalinity of the product water. This can cause decreased pH and increased corrosivity of the product water. The product water may need to have corrosion inhibitors added or to have the pH and alkalinity adjusted upwards by the addition of alkalinity. These actions may avoid simultaneous compliance issues in the distribution system such as elevated levels of lead and copper.*"[157]

Treatment Trains

A treatment train is a sequence of multiple treatment techniques designed to meet specific water quality parameters. According to the Water Research Foundation, when evaluating treatment trains,

> *"Quiñones and Snyder (2009) saw the best removal of PFOA, PFOS, PFNA, and PFHxS using an integrated membrane treatment consisting of microfiltration (MF) and RO and ultraviolet (UV) (medium pressure) followed by SAT [soil aquifer treatment]. This treatment train caused concentrations to drop from the low ng/L [ppt] range to below detection levels. Their success in removing these substances was most likely due to the use of RO. Takagi (2008) looked at the effectiveness of rapid sand filtration followed by GAC and then chlorination on PFOA and PFOS and measured a drop from 92 ng/L to 4.1 ng/L and 4.5 ng/L to <0.1 ng/L, respectively. GAC was most likely responsible for the majority of the removal. Snyder et al. (2014) detected >90% removal of PFOA and >95% removal of PFOS using a treatment train (70 MGD) consisting of MF/RO/UV-advanced oxidation process (AOP)/direct injection (DI). Again, their success was likely due to the RO membrane step using Hydranautics EPSA2 RO dismembranes."*[142]

Although there is still additional research that can be done, removal rates of greater than 90 percent and effluent concentrations of less than 2 ppt for PFOA, PFOS, PFNA, PFHxS, and GenX can be achieved currently with a combination of treatment technologies, along with careful monitoring.

Innovative Technologies

This section describes promising innovative technologies that are designed to treat and/or destroy PFAS chemicals.

- Diamond Technology – According to researchers at Michigan State University-Fraunhofer USA, Inc. Center for Coatings and Diamond Technologies (MSU-Fraunhofer), "*the MSU-Fraunhofer team has a viable solution to treat PFAS-contaminated wastewater that's ready for a pilot-scale investigation. The electrochemical oxidation system uses boron-doped diamond electrodes. The process breaks down the contaminants' formidable molecular bonds, cleaning the water while systematically destroying the hazardous compounds*."[158] While this treatment technology has been developed to treat wastewater, further research may demonstrate effectiveness for removing PFAS from drinking water or waste streams produced by membrane filtration as well.

- AECOM DE-FLUORO Technology – This technology was designed to destroy PFAS compounds concentrated on spent media after treatment.[159] According to AECOM's informational sheet:

> "*Mass transfer technologies (e.g., granular activated carbon, ion exchange resin, reverse osmosis) do not destroy PFAS but concentrate PFAS on the spent media. The spent media may require off-site incineration or regeneration for filtration media reuse that will produce regenerant wastes requiring further management and treatment ... As of today, electrochemical oxidation is one of the most documented PFAS destruction technologies. AECOM has successfully used a proprietary electrode to complete mineralization of C4 ~C8 perfluoroalkyl acids (PFAAs) with evidence of complete defluorination and desulfurization. PFAS are destructed via direct electron transfer on "nonactive" anodes under room temperature and atmospheric pressure with relatively low energy consumption. AECOM has also successfully used this proprietary electrode to treat PFAS in ion-exchange regenerant waste and other PFAS-impacted wastewater.*"[159]

In the information sheet, AECOM notes that this technology may also be effective for treating drinking water.

The available research demonstrates that both GAC and IX can be effective treatment techniques for certain PFAS compounds that have been studied, including PFOA, PFOS, PFNA, PFHxS, and GenX, when there is appropriate design, operation, and maintenance. RO has been demonstrated to be an effective treatment technology for removing all PFAS that have been studied and is the most effective treatment technique for effectively removing unknown contaminants. Due to the nature of GAC and IX treatment, water suppliers run the risk of releasing PFAS compounds back into the finished water after GAC bed life is spent or if IX feed concentration drops. Additionally, frequent changeout of GAC or IX to maintain removal efficiency can make the lifecycle costs more expensive than alternatives, such as RO. While GAC, IX, or RO can be effective at removing certain PFAS, RO is advantageous for treating total PFAS because it is the most robust technology for protecting against unidentified contaminants and provides greater protection from future unidentified PFAS. Potential considerations for RO are that it often has a higher capital cost, it can require a 10 to 20 percent higher treatment capacity because it produces a reject stream, and it requires safe disposal of the reject water which will have higher concentrations of contaminants than the source water.

PART VI: CONCLUSIONS AND RECOMMENDATIONS

Taking into consideration the information provided in this report, the following actions are recommended to address PFAS contamination in drinking water:

1. Comprehensive Monitoring of Drinking Water

Understanding the extent of PFAS contamination in drinking water is an important step in protecting people from exposure to these toxic chemicals. Based on national monitoring 4 years ago, there are approximately 16 million people drinking PFAS contaminated water. However, due to limitations in the national survey, including high reporting limits, a focus on large public water systems, and a limited number of PFAS chemicals tested, the actual numbers are likely much larger, suggesting that there could be significantly more people drinking PFAS contaminated water.

For reference, when expanded testing was carried out by Michigan, the estimates of affected population went from less than 200,000 people to approximately 1.5 million people. The national survey resulted in 3 detections in Michigan. However, once Michigan became aware that they had a PFAS contamination problem, they performed their own site investigations for sites deemed at risk and tested all of their public water systems serving over 25 people. Furthermore, Michigan tested for between 14-24 PFAS at lower health-relevant reporting limits (2 ppt). With this improved testing, they found over 40 contamination sites and over 100 of their public water systems were contaminated with PFAS. Importantly, there are sites of contamination that are not reflected in their public water system survey, and vice versa, public water system contamination not fully predicted through site investigation. The comparison of these two surveys highlights how important comprehensive testing is for understanding the extent of PFAS contamination of drinking water.

Therefore, states should perform both site investigations for at risk sites and a comprehensive statewide survey of public water systems. States should also offer testing of private water systems and private wells serving residences that are near known or suspected PFAS contamination sites, or as requested by a private well user. Priority for testing and monitoring should be sites near former PFAS manufacturing or processing facilities; near fire-fighting stations where PFAS was or continues to be used for training; near military bases and airports which may still use PFAS; and near landfills.

Periodic rounds of PFAS testing should be performed to account for testing variability, to ensure no additional discharges of PFAS are occurring, and to evaluate treatment effectiveness. The analyses should be conducted using the most sensitive detection methods for a comprehensive assessment, which at minimum should now include the expanded EPA 537.1 list at reporting limits of 2 ppt for all PFAS covered by the method, except for GenX, whose reporting limit should be no greater than 5 ppt. We also recommend that states evaluate newer methodologies, particularly the total oxidizable precursor assay, as an analytical technique to help measure the concentration of non-discrete and difficult to measure PFAS compounds that are not determinable by conventional analytical methods.

Data on PFAS in drinking water supplies should be provided to residents served by the tested water supplies, researchers, and the public. Where both biomonitoring data and water testing data are available, that information should be provided to individuals participating in the biomonitoring program so that participants are informed of their own body burden and drinking water exposures. Biomonitoring data and water testing data should also be provided to researchers (in matched pairs, if possible, and with identifying information removed to protect the confidentiality of participants) so that the contribution of PFAS-contaminated drinking water to total PFAS exposure can be studied further. Additionally, unique values for all detected levels of individual PFAS compounds should be publicly reported. All data should be provided in a timely manner and in a common format on a publicly-available database.

2. Set a MCLG of Zero for Total PFAS.

PFAS share similar structure and properties, including extreme persistence and high mobility in the environment. Many PFAS are also associated with similar health endpoints, some at extremely low levels of exposure. There is additionally potential for additive or synergistic toxicity among PFAS. Given the similarity among chemicals of the PFAS class and the known risk of the well-studied PFAS, there is reason to believe that other members of the PFAS class pose similar risk. Therefore, health-protective standards for PFAS should be based on the known adverse effects of the well-studied members of the PFAS class.

First, there is sufficient evidence to classify PFOA as a known or probable carcinogen. Therefore, a MCLG of zero should be promulgated for PFOA, consistent with EPA's approach to regulating known or probable carcinogens (see Box 10). Both IARC's and EPA's findings on PFOA's carcinogenic potential are based heavily on the C8 study, whose Science Panel determined that PFOA is a probable carcinogen. There is also significant additional animal and human evidence for an association between PFOA exposure and cancer, particularly kidney and testicular cancer.

Box 10: Maximum Contaminant Level Goals for Carcinogens

The EPA derives a MCLG under the Federal Safe Drinking Water Act by first considering the carcinogenic potential of the contaminant, or suite of contaminants. For known or probable carcinogens, EPA sets a MCLG of zero for the contaminant, or for the contaminant class, under the federal framework. This is because EPA assumes that, in the absence of other data, there is no known threshold at which no adverse health effects would occur. For chemicals suspected as carcinogens, the agency considers the weight of evidence, including animal bioassays and epidemiological studies. Information that provides indirect evidence, such as mutagenicity and other short-term test results, is also considered by the agency. Known human carcinogens, under EPA's classification scheme, are chemicals for which there exists sufficient evidence of carcinogenicity from epidemiological studies. Probable human carcinogens demonstrate either limited evidence of carcinogenicity in humans or sufficient evidence in animals without corresponding human data, under this classification scheme. See *56 Fed. Reg. 20, 3532* (Jan. 30, 1991).

In addition to being a carcinogen, PFOA causes adverse non-cancer health effects at exceedingly low doses. A MCLG based on altered mammary gland development would be well below 1 ppt for PFOA, further supporting our recommendation of zero for a MCLG (see Table 12 below).

Although the evidence of carcinogenic potential for PFOS is not as well established as PFOA, given the similarities in structure and toxicity of PFOS to PFOA, we recommend a MCLG of zero for PFOS as well. The weight of evidence indicates that PFOS also causes adverse non-cancer health effects at exceedingly low doses. A MCLG based on immunotoxicity would be well below 1 ppt for PFOS, further supporting our recommendation of zero for a MCLG (see Table 12 below).

There is less information on the carcinogenic potential of PFNA, PFHxS, and GenX, however, given the similarities in structure and toxicity of these PFAS to PFOA and PFOS, their potential for the carcinogenicity cannot be ruled out. Other shared health effects that occur at extremely low levels, such as immunotoxicity, developmental harm, and liver damage, along with their co-occurrence in our environment, must also be considered in setting a health protective MCLG for PFNA, PFHxS, and GenX.

A MCLG for PFNA based on developmental toxicity is below 1 ppt, approximately 2 ppt for PFHxS based on thyroid toxicity, and below 1 ppt for GenX based on liver toxicity (see Table 12 below).

Please see Appendices A, B, C, D and F for more detailed calculations.

Table 12: NRDC Recommended MCLGs for PFOA, PFOS, PFNA, PFHxS, and GenX

Threshold (ppt)	Threshold type	Study Endpoint	Total UFs	Critical Dose includes UFs (mg/kg/day)	Drinking water exposure assumptions	Notes
PFOA						
0	proposed MCLG (goal)	cancer and altered mammary gland development				
0.01		altered mammary gland development	300**	1×10^{-8}	0.175 L/kg/day for a infants, RSC = 20%	**additional UF of 10, to protect fetuses, infants, children
PFOS						
0	proposed MCLG (goal)	class similarity to PFOA (supported by immunotoxicity)				
0.002		Immunotoxicity	300**	2×10^{-9}	0.175 L/kg/day for a infants, RSC = 20%	**additional UF of 10, to protect fetuses, infants, children
PFNA						
0	proposed MCLG (goal)	class similarity to PFOA (supported by develomental toxicity)				
0.3		Develomental toxicity	3000**	3×10^{-7}	0.175 L/kg/day for a infants, RSC = 20%	**additional UF of 10, to protect fetuses, infants, children
PFHxS						
0	proposed MCLG (goal)	class similarity to PFOA (supported by developmental and thyroid toxicity)				
2		developmental and thyroid toxicity	3000**	2×10^{-6}	0.175 L/kg/day for a infants, RSC = 20%	**additional UF of 10, to protect fetuses, infants, children
GenX						
0	proposed MCLG (goal)	class similarity to PFOA (supported by liver toxicity)				
0.2		liver toxicity	$100000^{\#}$	2×10^{-6}	0.175 L/kg/day for a infants, RSC = 20%	# due to data limitations, uncertainty could be up to 100,000

**An additional uncertainty factor of 10 to protect fetuses, infants and children is recommended by the National Academy of Sciences (NAS 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

PFOA, PFOS, PFNA, PFHxS, and GenX share similar structure and properties and are associated with similar health endpoints, many at extremely low levels of exposure, across animal and epidemiological studies. Thus, because they often co-occur in our environment, there is potential for additive toxicity among these PFAS. New Jersey noted that the modes of action and health effects are generally similar for PFAS and acknowledged the possibility that the effects may be additive.[92] Given the above information we recommend a combined MCLG of zero for PFOA, PFOS, PFNA, PFHxS, and GenX.

However, this reasoning should be applied to the PFAS class as a well. Information on and lessons learned from these more extensively studied PFAS need to be used to guide regulations and ensure actions taken are adequately protective of human health in the long term. While there is limited toxicity data on many of the newer short-chain or other alternative PFAS replacing long-chain PFAS in various applications, evidence suggests that they collectively pose similar threats to human health and the environment. The rise in use of alternative PFAS and concerns with the environmental fate and persistence of these alternative PFAS have led to a call from independent scientists from around the globe to address PFAS as a class both in terms of their impacts and in limiting their uses.[12]

The structure of the fluorine-carbon bond and the impacts documented on the studied PFAS already available support concern over the health impacts of the entire class. This is supported by the constant exposure to short-chain chemicals, even if they have a relatively short presence in the body, as well as the fact that in many cases the use of these chemicals may be much higher than their long-chain cousins. Furthermore, many PFAS can convert into PFAAs (a PFAS subgroup, which includes PFOA and PFOS, that is linked to many adverse health effects) or PFAAs are used in their manufacture and can be contaminants in their final product.

Box 11: Regulating Classes in Tap Water - The PCB Precedent

There is precedent for regulating a group of chemicals as a class. For example, polychlorinated biphenyls (PCBs) are a class hundreds of man-made chlorinated hydrocarbons that are persistent in the environment, can bioaccumulate, and have a range of toxicity, including cancer and disruption of the immune, reproductive, endocrine, and nervous systems.[160] Drinking water standards and regulations regarding their clean up, disposal and storage apply to the class and are not set separately for each PCB in use.

In promulgating drinking water regulations for the large class of PCBs, EPA found that although statistically significant evidence of carcinogenicity had been demonstrated only in PCBs that were 60 percent chlorinated, the evidence justified regulation of the whole class of PCB compounds, given the structural complexity of the compounds, and the incomplete data regarding toxicity of the isomers in PCB compounds. EPA, 56 Fed. Reg. 3526, at 3546 (January 30, 1991)[161]

Setting a MCLG of zero for the class is needed to provide an adequate margin of safety to protect public health from a class of chemicals that is characterized by extreme persistence, high mobility, and is associated with a multitude of different types of toxicity at very low levels of exposure. If we regulate only a handful of PFAS, there will be swift regrettable substitution with other, similarly toxic PFAS - creating an ongoing problem where addressing one chemical at a time incentivizes the use of other toxic chemicals and we fail to ever establish effective safeguards to limit this growing class of dangerous chemicals.

3. Immediately Set a Combined MCL of 2 ppt for PFOA, PFOS, PFNA, and PFHxS, and a MCL of 5 ppt for GenX

As discussed in our second recommendation, NRDC's review of the toxicity studies for five PFAS compounds finds evidence that they are linked to cancer and other serious adverse health effects. Following conventional risk assessment protocols, we determine that the goal for PFOA, PFOS, PFNA, PFHxS and GenX should be zero exposure to these chemicals in drinking water.

As technologies for detection and water treatment do not currently allow for the complete removal of PFAS from drinking water, a MCL for PFOA, PFOS, PFNA, PFHxS, and GenX should be based on the best detection and treatment technologies available. Our review suggests a combined MCL of 2 ppt is feasible for PFOA, PFOS, PFNA, and PFHxS, with a separate MCL of 5 ppt for GenX.

Laboratory methods support a reporting limit of 2 ppt with EPA Method 537.1 (5 ppt for GenX), and therefore all water testing should be required to achieve this limit for the PFAS chemicals detectable with this method. Further, the removal of PFOA, PFOS, PFNA, PFHxS, and GenX has been demonstrated to be effective with technologies such as GAC and RO to below detection levels, supporting our determination that the MCL meets technological feasibility.

Residents who rely on private wells for drinking water depend on the safety of their state's groundwater, therefore a groundwater cleanup standard should also be set to 2 ppt for PFOA, PFOS, PFNA and PFHxS and to 5 ppt for GenX, consistent with the recommended MCL for public water systems.

4. Develop a Treatment Technique Requirement for the PFAS Class Within Two Years

As discussed in our second recommendation, setting a MCLG of zero for the class is needed to protect public health and the environment from all types of PFAS that share common negative qualities including extreme persistence, high mobility, and the association with a multitude of different types of toxicity at very low levels of exposure. The replacement of PFOA with GenX is a perfect example of regrettable substitution where a well-studied, toxic PFAS was replaced by a poorly-studied but structurally similar PFAS.

Technology for detection and treatment cannot achieve a MCLG of zero for total PFAS. In the absence of a reliable method that is economically and technically feasible to measure a contaminant at concentrations to indicate there is not a public health concern, the state should establish a treatment technique. A treatment technique is a minimum treatment requirement or a necessary methodology or technology that a public water supply must follow to ensure control of a contaminant.

At present, there is no single methodology for isolating, identifying, and quantifying all PFAS in drinking water. We recommend that states explore an analytical method, or combination of methods, that can be used as a surrogate for total PFAS. In particular, we recommend that states evaluate alternative detection methodologies, such as the total oxidizable precursor assay, to measure the concentration of non-discrete and difficult to measure PFAS compounds that are not determined by conventional analytical methods.

Furthermore, we recommend reverse osmosis, or other treatment method that has been demonstrated to be at least as effective as reverse osmosis for removing all identified PFAS chemicals, as the treatment technique for public water supplies. Reverse osmosis is currently the preferred treatment technology for the following reasons:

- Reverse osmosis has been demonstrated to effectively remove a broad range of PFAS compounds.[148]
- Reverse osmosis is the most robust technology for protecting against unidentified contaminants.[148]
- Reverse osmosis would likely result in lower finished water concentrations of GenX and other PFAS compounds such as PFMOAA and PFO2HxA.[148]
- Reverse osmosis does not require frequent change out of treatment media and does not release elevated concentrations after granular activated carbon bed life is spent or ion exchange feed concentration drops.[148]

Reverse osmosis requires considerations for the safe disposal of high-strength waste streams and spent/used membranes. We recommend states evaluate the safest disposal method for contaminated waste, and that disposal require full destruction of PFAS compounds before entering the environment.

UNITS AND DEFINITIONS

AER - anion exchange resins

ATSDR – Agency for Toxic Substances and Disease Registry

C8 - PFOA

CDC - Centers for Disease Control and Prevention

EPA – U.S. Environmental Protection Agency

EtFOSAA - 2-N-Ethyl-perfluorooctane sulfonamide

FOSE – perfluorooctane sulfonamide ethanol

FTOH - fluorotelomer alcohol

GAC – granular activated carbon

GenX – HFPO dimer acid and its ammonium salt

HFPO - hexafluoropropylene oxide

IARC – International Agency for Research on Cancer

IX - strong base anion exchange resin

LCMRL - lowest concentration minimum reporting limit

LC/MS/MS - liquid chromatography/tandem mass spectrometry

LOAEL – lowest-observable-adverse-effect-level

LOQ – limit of quantitation

MCL - maximum contaminant level

MCLG – maximum contaminant level goal

MDL – minimum detection level

MeFOSAA - 2-N-Methyl-perfluorooctane sulfonamide

MRL - minimal risk level

NAS – National Academy of Sciences

NHANES – National Health and Nutrition Examination Survey

NOAEL – no-observable-adverse-effect-level

OEHHA – California Office of Environmental Health Hazard Assessment

PBT – persistent bioaccumulative toxic

PFAA – perfluoroalkyl acid

PFAS – per- and polyfluoroalkyl substances

PFBS - perfluorobutane sulfonic acid, also known as PFBuS

PFCA – perfluorocarboxylic acid

PFDeA - perfluorodecanoic acid, also known as PFDeDA

PFDoA - perfluorododecanoic acid, also known as PFDoDA

PFHpA - perfluoroheptanoic acid

PFHxS - perfluorohexane sulfonic acid

PFNA - perfluorononanoic acid

PFOA - perfluorooctanoic acid

PFOS - perfluorooctane sulfonic acid

PFOSA - perfluorooctane sulfonamide

PFSA – perfluorosulfonic acid

PFTeA – perfluorotetradecanoic acid, also known as PFTDA

PFUA - perfluoroundecanoic acid, also known as PFUnDA or PFUnA

PMT – persistent mobile toxic

ppt - parts per trillion = nanograms per liter (ng/L) (usually used to express water concentration)

ppb - parts per billion = micrograms per liter (ug/L) (usually used to express blood serum concentration)

PWS – public water system

RfD - reference dose

RO – reverse osmosis

RSC – relative source contribution

THPFOS - 1H,1H,2H,2H-perfluorooctanesulfonic acid

TOP or TOPA – total oxidizable precursor assay

UCMR3 – EPA's Unregulated Contaminant Monitoring Rule 3

UF - uncertainty factor

APPENDIX A - MRL CALCULATIONS FOR PFOS USING IMMUNOTOXICITY ENDPOINT

Based on information from: https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

Immunotoxicity is currently the most sensitive health endpoint for PFOS exposure. Although ATSDR states concern that immunotoxicity is a more sensitive endpoint than developmental toxicity, it stops short of deriving a MRL from this endpoint. Instead, ATSDR claims that a modifying factor of 10 is sufficient to address the doses where immunotoxic effects have been observed. This statement is based on ATSDR calculating a candidate MRL for one of the four immunotoxicity studies in rodents identified by ATSDR, Dong et al., 2011, but not the other studies (ATSDR, 2018, see page A-43 of Appendix A).

However, Dong et al. 2011 is the immunotoxicity study with the highest LOAEL, which is not consistent with ATSDR's practice of choosing the study with the lowest LOAEL when selecting the principle study for MRL derivation. The other immunotoxicity studies all result in MRLs approximately 2.5-100 times lower than the MRL proposed by ATSDR (Table 1, calculations to follow, performed as described in ATSDR, 2018, Appendix A).

Table 13: Comparison of candidate MRLs for PFOS

Source	Year	Critical Endpoint	Minimal Risk Level (mg/kg/day)
ASTDR	2018	Developmental toxicity (delayed eye opening, decreased pup weight) + Modifying Factor	2 x 10-6 MRL
Dong et al.	2011	Immunotoxicity (impaired response to sRBC)	2.7 x 10-6 Estimated MRL[a]
Dong et al.	2009	Immunotoxicity (impaired response to sRBC)	7.8 x 10-7 Estimated MRL[a]
Guruge et al.	2009	Immunotoxicity (decreased resistance to influenza virus)	2.2 x 10-7 Estimated MRL[a]
Peden-Adams et al.	2008	Immunotoxicity (impaired response to sRBC)	2.1 x 10-8 Estimated MRL[a]

a – Calculated using the derivation method described on pg. A43 of the ATSDR profile

In equation A-6 from Appendix A, ATDSR defines an expression relating the external steady-state dosage and steady-state serum concentration:

$$D_{SS} = (C_{SS} \times k_e \times V_d) / AF$$

Where:

D_{SS} = steady-state absorbed dosage (mg/kg/day)

C_{SS} = steady-state serum concentration in humans (mg/L)

k_e = elimination rate constant (day-1)

V_d = assumed apparent volume of distribution (L/kg)

AF = gastrointestinal absorption fraction

ATSDR provided the following First Order One-Compartment Model Parameters for PFOS in Table A-4:

$K_e = 3.47 \times 10^{-4}$

$V_d = 0.2$

AF=1

ATSDR made the assumption that "humans would have similar effects as the laboratory animal at a given serum concentration." Therefore, the time weighted average serum levels from animal studies (C_{TWA}) are used to back-calculate D_{SS} by imputing C_{TWA} as C_{SS} in equation A-6.

The immunotoxicity studies, are the most sensitive endpoints, having NOAELs 6-625 times lower than the NOAEL for the developmental endpoint chosen for deriving the MRL. Though they did report serum levels, the immunotoxicity studies were performed in different strains/species of animals than those used for the pharmacokinetic modeling completed by Wambaugh et al. As such, they were not chosen for calculation of an MRL, though the ATSDR used other methods to calculate TWA concentrations for PFHxS and PFNA (the trapezoid rule) which were also lacking pharmacokinetic modeling.

From ATSDR (Appendix A, pg. A-43):

"A candidate MRL was calculated using the NOAEL of 0.0167 mg/kg/day identified in the Dong et al. (2011)...A TWA concentration was estimated using a similar approach described for

PFHxS and PFNA in the MRL approach section. The estimated TWA concentration was 1.2 µg/mL for the 0.0167 mg/kg/day; this estimated TWA concentration was used to calculate a human equivalent dose (HED) of 0.000083 mg/kg/day. A candidate MRL of 3x10-6 was calculated using an uncertainty factor of 30 (3 for extrapolation from animals to humans using dosimetric adjustments and 10 for human variability)."

Following this logic:

The time weighted average (TWA) serum levels for the other immunotoxicity studies can be predicted by using the trapezoid rule, as was done for PFNA, PFHxS, and the candidate PFOS MRL based on Dong et al., 2011.

Dong et al. 2009:

Measured serum level at NOAEL dose of 0.0083 mg/kg/day: 0.674 ug/mL

Estimated TWA = (0.674 ug/mL - 0 ug/mL) / 2 = 0.337 ug/mL = 0.337 mg/L

Guruge et al. 2009:

Measured serum level at NOAEL dose of 0.005 mg/kg/day: 0.189 ug/mL

Estimated TWA = (0.189 ug/mL - 0 ug/mL) / 2 = 0.0945 ug/mL = 0.0945 mg/L

Peden-Adams et al. 2008:

Measured serum level at NOAEL dose of 0.00016 mg/kg/day: 0.0178 ug/mL

Estimated TWA = (0.0178 ug/mL - 0 ug/mL) / 2 = 0.0089 ug/mL = 0.0089 mg/L

These estimated TWA serum levels can then be inputted into equation A6 as the steady state serum concentration, C_{SS}, using the same values used by ATSDR for the other parameters to generate candidate MRLs for these immunotoxicity studies.

$$D_{SS} = (C_{SS} \times 0.000347 \text{ day-1} \times 0.2 \text{ L/kg}) / 1$$

Dong et al. 2009:

D_{SS} = (0.337 mg/L x 0.000347 day-1 x 0.2 L/kg) / 1 = 2.34 x 10^{-5} mg/kg/day

Then, divide by UF of 30

MRL = 7.8 x 10^{-7} mg/kg/day

Guruge et al. 2009:

D_{SS} = (0.0945 mg/L x 0.000347 day-1 x 0.2 L/kg) / 1 = 6.56 x 10^{-6} mg/kg/day

Then, divide by UF of 30

MRL = 2.2 x 10^{-7} mg/kg/day

Peden-Adams et al. 2008:

D_{SS} = (0.0089 ug/mL x 0.000347 day-1 x 0.2 L/kg) / 1 = 6.2 x 10^{-7} mg/kg/day

Then, divide by UF of 30

MRL = 2.1 x 10^{-8} mg/kg/day

APPENDIX B - MRL CALCULATIONS FOR PFNA USING LONGER HALF-LIFE

Based on information from: https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

In equation A-6 from Appendix A, ATDSR defines an expression relating the external steady-state dosage and steady-state serum concentration:

$$D_{SS} = (C_{SS} \text{ x } k_e \text{ x } V_d) / AF$$

Where:

D_{SS} = steady-state absorbed dosage (mg/kg/day)

C_{SS} = steady-state serum concentration in humans (mg/L)

k_e = elimination rate constant (day-1)

V_d = assumed apparent volume of distribution (L/kg)

AF = gastrointestinal absorption fraction

ATSDR provided the following First Order One-Compartment Model Parameters for PFNA in Table A-4:

$k_e = 7.59 \text{ x}10^{-4}$

V_d=0.2

AF=1

The $k_e = 7.59 \text{ x}10^{-4}$ is based on a half-life estimate of 900 days for young women. Based on Eq. A-5, a half-life of 1570 days for all other adults would result in a k_e of $4.4 \text{ x}10^{-4}$ (k_e = ln(2) / half-life).

Thus, if the k_e representing the longer, more representative half-life for PFNA was used, along with ATSDR's estimated C_{SS} of 6.8 mg/L:

D_{SS} = (6.8 mg/L x 0.000441 day-1 x 0.2 L/kg) / 1 = $6 \text{ x}10^{-4}$ mg/kg/day

Then, divide by UF of 300

MRL = 2×10^{-6} mg/kg/day

APPENDIX C - MCLG CALCULATIONS

From EPA's Drinking Water Health Advisory for PFOA and PFOS (EPA, 2016 a and b)

The EPA used drinking water intake and body weight parameters for lactating women in the calculation of a lifetime health advisory for PFOA and PFOS. EPA used the rate of 54 mL/kg-day representing the consumers only estimate of combined direct and indirect community water ingestion at the 90th percentile for lactating women (see Table 3-81 in EPA 2011).

First, a Drinking Water Equivalent Level (DWEL) is derived from the reference dose (RfD) and assumes that 100% of the exposure comes from drinking water. The RfD is multiplied by body weight and divided by daily water consumption to provide a DWEL.

$$\text{DWEL} = (\text{RfD} \times \text{bw}) / \text{DWI} = \text{RfD} / (\text{DWI}/\text{bw})$$

Where:

RfD = critical dose (mg/kg/day)

bw = body weight (kg)

DWI = drinking water intake (L/day)

DWI/bw = 0.054 L/kg-day

Then, the DWEL is multiplied by the relative source contribution (RSC). The RSC is the percentage of total drinking water exposure, after considering other exposure routes (for example, food, inhalation). Following EPA's Exposure Decision Tree in its 2000 methodology (EPA, 2000), significant potential sources other than drinking water ingestion exist; however, information is not available to quantitatively characterize exposure from all of these different sources (Box 8B in the Decision Tree). Therefore, EPA recommends a RSC of 20% (0.20) for PFOA and PFOS.

Thus, the lifetime health advisory (HA) is calculated after application of a 20% RSC as follows:

$$\text{HA} = \text{DWEL} \times \text{RSC}$$

The two above equations can be combined to generate:

HA = (RfD / (DWI/bw)) x RSC

For these purposes, we can assume that ATSDR's MRL is equivalent to a RfD, and an HA equivalent to a MCLG.

MCLG = (MRL / (DWI/bw)) x RSC

The EPA used estimated drinking water parameters for lactating mothers, making the equation:

MCLG = (MRL / 0.054 L/kg-day) x 0.2

*NOTE:

DWI/bw for average adult = 0.029 L/kg-day, used by New Jersey;

DWI/bw for lactating mother = 0.054 L/kg-day, used by EPA; and

DWI/bw for breastfeeding or formula-fed infant = 0.175 L/kg-day, used by Vermont

This equation can be applied to proposed and candidate MRLs from ATSDR (final values are rounded):

Using ATSDR's proposed MRLs and drinking water assumptions for lactating women:

PFOA

MCLG = (3×10^{-6} mg/kg/day / 0.054 L/kg-day) x 0.2 = 1.11×10^{-5} mg/L = 11 ng/L or ppt

PFOS

MCLG = (2×10^{-6} mg/kg/day / 0.054 L/kg-day) x 0.2 = 7.41×10^{-6} mg/L = 7 ng/L or ppt

PFNA

MCLG = (3×10^{-6} mg/kg/day / 0.054 L/kg-day) x 0.2 = 1.11×10^{-5} mg/L = 11 ng/L or ppt

PFHxS

MCLG = (2×10^{-5} mg/kg/day / 0.054 L/kg-day) x 0.2 = 7.41×10^{-5} mg/L = 74 ng/L or ppt

Using NRDC's estimated MRLs for immunotoxicity studies and drinking water assumptions for lactating women:

In Appendix A we noted that ATSDR did not choose to use the most sensitive endpoint for PFOS. Here we show the MCLGs that would result if the studies with most sensitive endpoints were to be chosen for calculation of MRL as in Appendix A and translated to MCLGs using the drinking water assumptions for lactating women.

Dong et al. 2011

MCLG = (3×10^{-6} mg/kg/day / 0.054 L/kg-day) x 0.2 = 1.11×10^{-5} mg/L = 11 ng/L or ppt

Dong et al. 2009

MCLG = (8×10^{-7} mg/kg/day / 0.054 L/kg-day) x 0.2 = 2.96×10^{-6} mg/L = 3 ng/L or ppt

Guruge et al. 2009

MCLG = (2×10^{-7} mg/kg/day / 0.054 L/kg-day) x 0.2 = 7.41×10^{-7} mg/L, **0.7 ng/L (< 1 ppt)**

Peden-Adams et al. 2008

MCLG = (2×10^{-8} mg/kg/day / 0.054 L/kg-day) x 0.2 = 7.41×10^{-8} mg/L, **0.07 ng/L (< 1 ppt)**

In Appendix B we noted that ATSDR did not use the half-life for PFNA that was the most representative. Here we show the MCLG that would result if the longer, more representative half-life were to be chosen for calculation of the MRL as in Appendix B and translated to a MCLG using drinking water assumptions for lactating women.

MCLG = (2×10^{-6} mg/kg/day / 0.054 L/kg-day) x 0.2 = 7.41×10^{-6} mg/L = 7 ng/L or ppt

Using ATSDR's proposed MRLs and drinking water assumptions for infants:

Vermont used the drinking water assumptions for breastfeeding or formula-fed infants of 0.175 L/kg-day. If this value is used, the equation becomes:

MCLG = (MRL / 0.175 L/kg-day) x 0.2

This equation can be applied to proposed and candidate MRLs from ATSDR (final values are rounded):

PFOA

MCLG = (3×10^{-6} mg/kg/day / 0.175 L/kg-day) x 0.2 = 3.43×10^{-6} mg/L = 3 ng/L or ppt

PFOS

MCLG = (2×10^{-6} mg/kg/day / 0.175 L/kg-day) x 0.2 = 2.29×10^{-6} mg/L = 2 ng/L or ppt

PFNA

MCLG = (3×10^{-6} mg/kg/day / 0.175 L/kg-day) x 0.2 = 3.43×10^{-6} mg/L = 3 ng/L or ppt

PFHxS

MCLG = (2×10^{-5} mg/kg/day / 0.175 L/kg-day) x 0.2 = 2.29×10^{-5} mg/L = 23 ng/L or ppt

Using NRDC's estimated MRLs for immunotoxicity studies and drinking water assumptions for infants:

Candidate MRL's (rounded) for immunotoxicity studies identified by ATSDR, calculated in Appendix B:

Dong et al. 2011

MCLG = (3×10^{-6} mg/kg/day / 0.175 L/kg-day) x 0.2 = 3.43×10^{-6} mg/L = 3 ng/L or ppt

Dong et al. 2009

MCLG = (8×10^{-7} mg/kg/day / 0.175 L/kg-day) x 0.2 = 9.14×10^{-7} mg/L, **0.9 ng/L (< 1 ppt)**

Guruge et al. 2009

MCLG = (2×10^{-7} mg/kg/day / 0.175 L/kg-day) x 0.2 = 2.28×10^{-7} mg/L, **0.2 ng/L (< 1 ppt)**

Peden-Adams et al. 2008

MCLG = (2×10^{-8} mg/kg/day / 0.175 L/kg-day) x 0.2 = 2.28×10^{-8} mg/L, **0.02 ng/L (< 1 ppt)**

Candidate MRL's (rounded) for PFNA using longer half-life estimate, calculated in Appendix C:

MCLG = (2 x 10^{-6} mg/kg/day / 0.175 L/kg-day) x 0.2 = 2.28 x 10^{-6} mg/L = **2 ng/L or ppt**

****ALSO NOTE:** All estimated MCLGs presented here would be an order of magnitude lower/stricter if an additional UF of 10 was applied to the RfD or MRL to protect fetuses, infants and children as recommended by the National Academy of Sciences (NAS, 1993) for pesticides and as required in the Food Quality Protection Act. 21 U.S.C. §346a(b)(2)(C)(ii)(II).

APPENDIX D - MCLG CALCULATIONS FOR PFOA BASED ON REFERENCE DOSE CALCULATED BY NEW JERSEY FOR ALTERED MAMMARY GLAND DEVELOPMENT

Based on information from Gleason et al., 2017, found at:
https://www.nj.gov/dep/watersupply/pdf/pfoa-appendixa.pdf

Selected Study

The New Jersey Drinking Water Quality Institute selected the late gestational exposure study conducted by Macon et al. 2011[63] because it was the only developmental exposure study of mammary gland development that provides serum PFOA data from the end of the dosing period (PND 1) that can be used for dose-response modeling.

Determination of Point of Departure (POD)

EPA Benchmark Dose Modeling Software 2.1.2 was used to perform Benchmark Dose (BMD) modeling of the data for two endpoints, mammary gland developmental score and number of terminal endbuds, at PND 21 from Macon et al. 2011[63], using serum PFOA data from PND 1 as the dose. Continuous response models were used to obtain the BMD and the Benchmark Dose Lower (BMDL) for a 10% change from the mean for the two endpoints. The lowest significant BMDL, for decreased number of terminal endbuds, of 22.9 ng/ml in serum was used as the POD for reference dose (RfD) development.

Target Human Serum Level

Uncertainty factors (UFs) were applied to the POD to obtain the Target Human Serum Level. The Target Human Serum Level (ng/ml in serum) is analogous to a RfD but is expressed in terms of internal dose rather than administered dose. The total of the uncertainty factors (UFs) applied to the POD serum level was 30 (10 for human variation and 3 for animal-to-human extrapolation).

The target human serum level is: (22.9 ng/ml) / 30 = 0.8 ng/ml (800 ng/L).

Reference Dose (RfD)

EPA used a pharmacokinetic modeling approach to develop a species-independent clearance factor, 1.4×10^{-4} L/kg/day that relates serum PFOA level (µg/L) to human PFOA dose (µg/kg/day). The clearance factor can be used to calculate the RfD, as follows:

RfD = Target Human Serum Level x Clearance factor

RfD = 800 ng/L x 1.4 x 10^{-4} L/kg/day = 0.11 ng/kg/day

Where:

Target Human Serum Level = 800 ng/L

Clearance factor = 1.4 x 10-4 L/kg/day

RfD = Reference Dose = 0.11 ng/kg/day

Maximum Contaminant Level Goal (MCLG) for Drinking Water

Default relative source contribution (RSC) of 20% is used to develop the Health-based MCLG.

To calculate a Health-based MCLG based on mammary gland effects instead of hepatic effects:

MCLG = (RfD x bw x RSC) / DWI

MCLG = (0.11 ng/kg/day x 70 kg x 0.2) / (2 L/day) = **0.77 ng/L (< 1 ppt)**

Where:

RfD = Reference Dose for altered mammary gland development = 0.11 ng/kg/day

bw = assumed adult body weight = 70 kg

RSC = Relative Source Contribution from drinking water = 0.2

DWI = assumed adult daily drinking water intake = 2 L/day

***NOTE:** A MCLG based on mammary gland effects using EPA's drinking water exposure assumptions (for a lactating mother) or Vermont's drinking water exposure assumptions (breastfeeding infant) would result in an even lower MCLG than calculated above. (See Appendix C)

For example, if the drinking water exposure parameters for lactating mothers (EPA) is used:

MCLG = (0.11 ng/kg/day / 0.054 L/kg-day) x 0.2 = **0.41 ng/L (<1 ppt)**

If drinking water exposure parameters for infants under 1 year of age is used (as was done in Vermont):

MCLG = (0.11 ng/kg/day / 0.175 L/kg-day) x 0.2 = **0.13 ng/L (<1 ppt)**

APPENDIX E – APPROXIMATION OF RSC USED BY ATSDR FOR DRINKING WATER ENVIRONMENTAL MEDIA EVALUATION GUIDES

In November 2018 ATSDR published the webpage https://www.atsdr.cdc.gov/pfas/mrl_pfas.html, which stated:

"When ATSDR uses an average adult's or child's weight and water intake to convert these MRLs into drinking water concentrations, the individual PFOA, PFOS, PFHxS, and PFNA concentrations are

- PFOA: 78 ppt (adult) and 21 ppt (child)
- PFOS: 52 ppt (adult) and 14 ppt (child)
- PFHxS: 517 ppt (adult) and 140 ppt (child)
- PFNA: 78 ppt (adult) and 21 ppt (child)"

In posting this webpage, ATSDR provided minimal information as to how the proposed drinking water values were calculated and what assumptions were made and used in their derivation. According to ATSDR, their calculations were based on,

"…the guidelines published in the Public Health Assessment Guidance Manual, and the EPA 2011 Exposure Factors Handbook External. For example, for an estimate of a child's drinking water exposure, ATSDR bases this calculation on an infant (age birth to one year old) weighing 7.8 kg and an intake rate of 1.113 liters per day. For an adult's drinking water exposure, ATSDR bases this calculation on a body weight of 80 kg and an intake rate of 3.092 liters per day. Scientists may use different assumptions when calculating concentrations from dosages."

In this Appendix we back calculate to derive the missing information, namely the relative source contribution (RSC).

From Appendix C:

$$\text{MCLG} = (\text{MRL} / (\text{DWI}/\text{bw})) \times \text{RSC}$$

Where (values provided by ATSDR on website):

DWI for adults = 3.092 L/day

and

bw for adults = 80 kg

thus,

DWI/bw for adults = 0.0387 L/kg/day

DWI for children = 1.113 L/day

and

bw for children = 7.8 kg

thus,

DWI/bw for children = 0.142 L/kg/day

So, for adults:

MCLG = (MRL / (0.039 L/kg/day)) x RSC*

And for children:

MCLG = (MRL / (0.142 L/kg/day)) x RSC*

*RSC not provided by ATSDR, however, drinking water values provided by ATSDR can be used with these equations to solve for the RSC used by ATSDR. For example, for PFOA:

Adults:

RSC = (MCLG x DWI/bw) / MRL

RSC = (78 ng/L x 0.0387 L/kg/day) / 3 ng/kg/day

RSC = 1

Children:

RSC = (MCLG x DWI/bw) / MRL

RSC = (21 ng/L x 0.142 L/kg/day) / 3 ng/kg/day

RSC = 1

APPENDIX F – RFD AND MCLG CALCULATIONS FOR GENX

From EPA's Draft Toxicity Assessment of GenX chemicals:

https://www.epa.gov/sites/production/files/2018-11/documents/genx_public_comment_draft_toxicity_assessment_nov2018-508.pdf

"…POD human equivalent dose is 0.023 mg/kg/day. UF applied include a 10 for intraspecies variability, 3 for interspecies differences, and 3 for database deficiencies, including immune effects and additional developmental studies, to yield a subchronic RfD of 0.0002 mg/kg/day. In addition to those above, a UF of 3 was also applied for extrapolation from a subchronic to a chronic duration in the derivation of the chronic RfD of 0.00008 mg/kg/day."

If uncertainty factors that properly reflected the deficiencies in toxicity data (database, sub-chronic/chronic, children's vulnerability, inter/intra species) were used, the combined uncertainty factor could be as high as 100,000 (see Part IV, section GenX).

From pg. 58 of EPA's Draft Toxicity Assessment of GenX chemicals:

RfD = POD/total UF

With NRDC recommended UFs:

RfD = (0.023 mg/kg/day)/100,000 = 2.3 x 10^{-7} mg/kd/day

Where:

POD = Point of departure human equivalent dose

Total UF = 10 for intraspecies variability, 10 for interspecies differences, 10 for database limitations, 10 for extrapolation from subchronic to chronic duration, and 10 to protect fetuses, infants and children.

From Appendix C:

MCLG = (RfD / (DWI/bw)) x RSC

Using drinking water exposure parameters for lactating mothers, DWI/bw = 0.054 L/kg-day, the MCLG based on liver toxicity would be (rounded):

MCLG = (2 x 10^{-7} mg/kd/day / 0.054 L/kg-day) x (0.2 RSC) = 7.41 x 10^{-7} mg/L = **0.7 ppt**

Using drinking water exposure parameters for an infant under 1 year, DWI/bw = 0.175 L/kg-day, the MCLG based on liver toxicity would be (rounded):

MCLG = (2 x 10^{-7} mg/kd/day / 0.175 L/kg-day) x (0.2 RSC) = 2.29 x 10^{-7} mg/L = **0.2 ppt**

*NOTE: A MCLG based on EPA's proposed RfD for GenX based on liver toxicity would be (rounded):

Using drinking water exposure parameters for lactating mothers

MCLG = (8 x 10^{-5} mg/kd/day / 0.054 L/kg-day) x (0.2 RSC) = 2.96 x 10^{-4} mg/L = 296 ppt

Using drinking water exposure parameters for an infant under 1 year

MCLG = (8 x 10^{-5} mg/kd/day / 0.175 L/kg-day) x (0.2 RSC) = 9.14 x 10^{-5} mg/L = 91 ppt

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Exhibit B

ENVIRONMENTAL ADVOCATES OF NEW YORK
FOOD & WATER WATCH
NYPIRG
NEW YORK PUBLIC INTEREST RESEARCH GROUP

September 23, 2019

Howard Zucker, M.D., J.D., Commissioner
New York State Department of Health
Corning Tower
Empire State Plaza
Albany, NY 12237

Re: Proposed Maximum Contaminant Levels for perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and 1,4-dioxane

cc: Governor Andrew Cuomo
Basil Seggos, Commissioner, Department of Environmental Conservation
Paul Francis, Deputy Secretary for Health
Dale Bryk, Deputy Secretary for Energy & Environment
Roger Sokol, Department of Health
Lloyd Wilson, Department of Health
Katherine Ceroalo, Department of Health

Dear Commissioner Zucker:

On behalf of Environmental Advocates of New York, Food & Water Watch, and the New York Public Interest Research Group (NYPIRG) with the support of the undersigned organizations and elected officials, we thank you for the opportunity to submit comments on the New York State Department of Health's proposed Amendments to Subpart 5-1 of Title 10 NYCRR to establish Maximum Contaminant Levels (MCLs) for perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and 1,4-dioxane.

In December 2018, the New York State Drinking Water Quality Council issued MCL recommendations of 10 parts per trillion (ppt) for PFOA, 10 ppt for PFOS, and 1 part per billion (ppb) for 1,4-dioxane. On July 24, 2019, the NYS Department of Health published Amendments to Subpart 5-1 of Title 10 NYCRR, marking the start of a 60-day public comment period and proposing these NYS Water Quality Council recommendations as MCLs.

I. Overview of Recommendations

As noted on the NYS Department of Health website, your mission is to "protect, improve and promote the health, productivity and well being of all New Yorkers." We write to urge the Department of Health to adopt final drinking water standards for PFOA, PFOS, and 1,4-dioxane that will be most protective of the health, productivity and well-being of New Yorkers by utilizing all available scientific research and knowledge at your disposal, including new data that has emerged in 2019 after the last Drinking Water Quality Council meeting in December 2018. Our organizations believe that the purpose of establishing Maximum Contaminant Levels is to protect human health from contaminants in drinking water. The Department of Health must do everything in its power to ensure that all New Yorkers, including the most vulnerable residents of the state, can rely on and trust the safety of their public water supplies. There is, therefore, the greatest urgency to establish the strongest possible MCLs for PFOA, PFOS, and 1,4-dioxane, which are all dangerous chemicals that have already contaminated known drinking water supplies across the state and have potentially contaminated many more.

Specifically, our organizations are calling for the following, which we detail in subsequent sections:

- **Establish a combined MCL of 2 ppt for PFOA and PFOS.** A recent study published by the Natural Resources Defense Council (NRDC) found that there is likely no safe level of exposure to PFAS chemicals.[1] Additionally, the nation's top toxicologist has stated that the safety threshold for PFOA in water should be as low as 0.1 ppt, which is 700 times lower than the US Environmental Protection Agency's (EPA) current advisory level.[2] Treatment technology is currently capable of treating PFOA and PFOS as low as 2 ppt. *As technology becomes more advanced, the Department of Health should respond with lower MCLs to minimize New Yorkers' exposure to these toxic chemicals.*

- **Establish an MCL of 0.3 ppb for 1,4-dioxane.** The EPA conducted a cancer risk assessment for 1,4-dioxane, which indicated a concentration of 0.35 ppb in drinking water elevates the risk for cancer.[3] Based on this assessment and their own analysis, Massachusetts has a similar drinking water guidance level of 0.3 ppb. *Massachusetts' level was set at stringent levels to "err on the side of protecting public health."[4] New York should do the same.*

- **Establish MCL(s) for additional PFAS chemicals.** It is widely suspected that all per- and polyfluoroalkyl (PFAS) substances are likely to have similar negative health impacts as PFOA and PFOS. According to the Natural Resources Defense Council (NRDC), "our review suggests a combined MCL of 2 ppt is feasible for PFOA, PFOS, PFNA, and PFHxS, with a

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[1] Anna Reade, Ph.D., "Scientific and Policy Assessment for Addressing Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water," April 2019, https://www.nrdc.org/resources/michigan-pfas-2019-scientific-and-policy-assessment-addressing-pfas-chemicals-drinking

[2] Sharon Lerner, "TEFLON TOXIN SAFETY LEVEL SHOULD BE 700 TIMES LOWER THAN CURRENT EPA GUIDELINE," The Intercept, June 18, 2019, https://theintercept.com/2019/06/18/pfoa-pfas-teflon-epa-limit/

[3] EPA, "Technical Fact Sheet – 1,4-Dioxane," November 2017, https://www.epa.gov/sites/production/files/2014-03/documents/ffrro_factsheet_contaminant_14-dioxane_january2014_final.pdf

[4] Massachusetts Department of Environmental Protection, "FAQ's: 1,4-Dioxane," Accessed August 2, 2019, https://www.mass.gov/service-details/faqs-14-dioxane

separate MCL of 5 ppt for GenX. Laboratory methods support a reporting limit of 2 ppt with EPA Method 537.1 (5 ppt for GenX), and therefore all water testing should be required to achieve this limit for the PFAS chemicals detectable with this method."[5] We agree with NRDC's recommendation and *urge the Department of Health to establish a combined MCL of 2 ppt for not only PFOA and PFOS, but also PFNA and PFHxS, and a separate MCL of 5 ppt for GenX, until technology allows for these levels to be lowered even further.*

- **Reject the phased-in testing schedule outlined in the Notice of Proposed Rulemaking.** Testing for PFOA, PFOS, and 1,4-dioxane is not new. Water systems in New York serving 10,000 or more residents tested for these three contaminants under the EPA's Third Unregulated Contaminant Monitoring Rule (UCMR-3) in the period from 2013 to 2015. To ensure that the public is not exposed to unsafe levels of these contaminants further, it is critical to begin testing as soon as possible. However, the Department of Health has proposed that small systems do not have to begin testing until six months after adoption. *All systems, regardless of size, should begin testing within 60 days of adoption of the final MCLs.*

- **Previous tests for PFOA, PFOS, and 1,4-dioxane should not satisfy initial testing requirements.** While these contaminants may not have been detected in a community previously, there is always the possibility of pollution migration. *It is important for all water systems to test following the adoption of MCLs in order to establish a baseline of data across the state.*

- **Require 24-hour public notification of MCL violations and exceedances for any health advisory levels, Maximum Contaminant Level Goals (MCLG), and any other regulatory guidance.** Under the Department of Health's current drinking water program public notification requirements, there are three tiers for public notification. Tier 1 notification requires notification to the Department of Health and the public no later than 24 hours after the system learns of a public health hazard.[6] Tier 1 requirements should be applied to all water supply operators, county governments, and any contractors and consultants, across the board for regulated contaminants, and should also be applied to any contaminants with state or federal health advisory levels, MCLGs, or other guidance levels. *The public deserves prompt notification regarding contaminants in their drinking water so they can make informed decisions to protect their health and safety.*

II. Scope of PFOA, PFOS, and 1,4-Dioxane Contamination across the United States and in New York State

PFOA and PFOS and the 3,300-5,000 other chemicals in the PFAS class are known as "forever chemicals" because of specific properties such as not breaking down easily and persisting in the human body and the environment for long periods of time. Added to that is their widespread use by

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[5] Anna Reade, Ph.D., "Scientific and Policy Assessment for Addressing Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water," April 2019, https://www.nrdc.org/resources/michigan-pfas-2019-scientific-and-policy-assessment-addressing-pfas-chemicals-drinking

[6] "Public Notification Requirements," NYS Department of Health, https://www.health.ny.gov/environmental/water/drinking/pnr.htm

industry and in many common consumer, household and food products. It is estimated that most people in the United States have one or more PFAS chemicals in their blood, most commonly PFOA or PFOS.[7] PFAS chemicals can also be found in human urine[8] and breastmilk[9] as well as in dairy products.[10] These chemicals persist in the human body for two to four years for PFOA and five to six years for PFOS.[11]

Drinking water is only one source of PFAS contamination in our environment and potential source for human exposure. These chemicals can also be found in soil, rivers, lakes and other waterways as well as in air and dust, carpeting, food, and food packaging. A few predictors of the presence of these chemicals in public water supplies include the number of industrial sites that manufacture or use these chemicals, the number of military fire training areas, and the number of wastewater treatment plants.[12] In fact, each additional military site within a HUC-8 watershed is linked to a 10 percent increase in PFOA and a 35 percent increase in PFOS.[13]

As of July 2019, the Environmental Working Group reports that there are at least 712 sites in 49 states that are known to be contaminated, with 38 sites in New York State. This includes military sites, drinking water supplies, and other sites with known contamination.[14] The following map depicts these sites, and shows the extent of known contamination in the United States, with new sites being added over time:

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[7] PFAS Blood Testing, Agency for Toxic Substances and Disease Registry, January 2018, https://www.atsdr.cdc.gov/pfas/pfas-blood-testing.html.

[8] Hartmann et al, Perfluoroalkylated substances in human urine:
results of a biomonitoring pilot study, Biomonitoring 2017; 4: 1–10, https://www.degruyter.com/downloadpdf/j/bimo.2017.4.issue-1/bimo-2017-0001/bimo-2017-0001.pdf.

[9] Goeden et al, A transgenerational toxicokinetic model and its use in derivation of Minnesota PFOA water guidance, Journal of Exposure Science & Environmental Epidemiologyvolume 29, pp 183–195 (2019), https://www.nature.com/articles/s41370-018-0110-5.

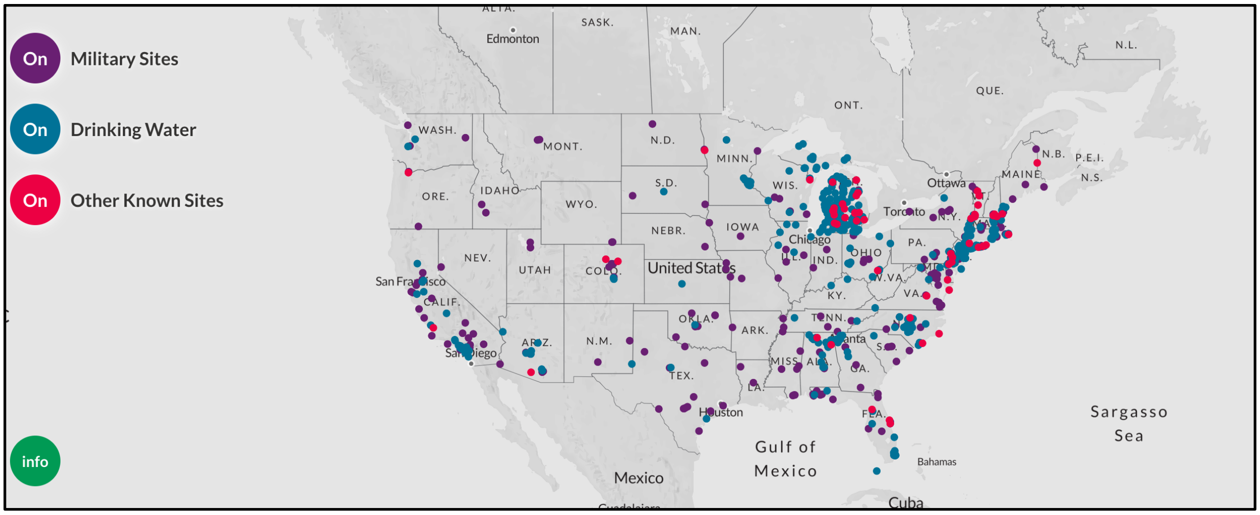
[10] FDA Issues Statement, Posts New Data on PFAS, Confirming Safety of Dairy Products, June 2019, International Dairy Foods Association, https://www.idfa.org/news-views/headline-news/article/2019/06/12/fda-issues-statement-posts-new-data-on-pfas-confirming-safety-of-dairy-products

[11] An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns, Agency for Toxic Substances and Disease Registry, June 2017, https://www.atsdr.cdc.gov/pfc/docs/pfas_clinician_fact_sheet_508.pdf.

[12] Xindi C. Hu et al., Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants, Environmental Science and Technology Letters 344-350 (2016), https://pubs.acs.org/doi/10.1021/acs.estlett.6b00260.

[13] Ibid, p. 344.

[14] PFAS Map Update: New Data Show Scope of Known Contamination Still Growing, https://www.ewg.org/release/pfas-map-update-new-data-show-712-contamination-sites-49-states



Source: Environmental Working Group and Northeastern University SSEHR, PFAS Contamination in the US, August 2019, https://www.ewg.org/interactive-maps/2019_pfas_contamination/map/

Under the EPA's Third Unregulated Contaminant Monitoring Rule (UCMR-3), the EPA collected data from public water systems serving over 10,000 people for chemicals that are suspected contaminants in drinking water, including in particular, 1,4-dioxane and six PFAS chemicals: perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), perfluorobutanesulfonic acid (PFBS).[15] The results showed that 1,077 of 4,915 public water systems with results, or 22 percent, tested above the minimum reporting level of 0.07 parts per billion for 1,4-dioxane and 341 public water systems, or seven percent, tested above the reference concentration of 0.35 parts per billion. The results showed that 375 public water systems of 4,920 public water systems with results, or eight percent, tested above the minimum reporting level for at least one of the six PFAS chemicals (minimum reporting levels: PFOS - 40 ppt, PFOA - 20 ppt, PFNA - 20 ppt, PFHxS - 30 ppt, PFHpA - 10 ppt, PFBS - 90 ppt) in addition to 46 public water systems above the reference concentration of 70 ppt for PFOS and 13 above the reference concentration of 70 ppt for PFOA.[16] In New York, the UCMR-3 testing showed 11 percent of the water systems tested in New York had 1,4-dioxane levels above one part per billion and 18 percent over 0.35 parts per billion.[17]

According to the Environmental Working Group, drinking water systems serving an estimated 19 million people are known to be contaminated with PFAS chemicals.[18] The extent of this drinking water contamination is depicted in the following map:

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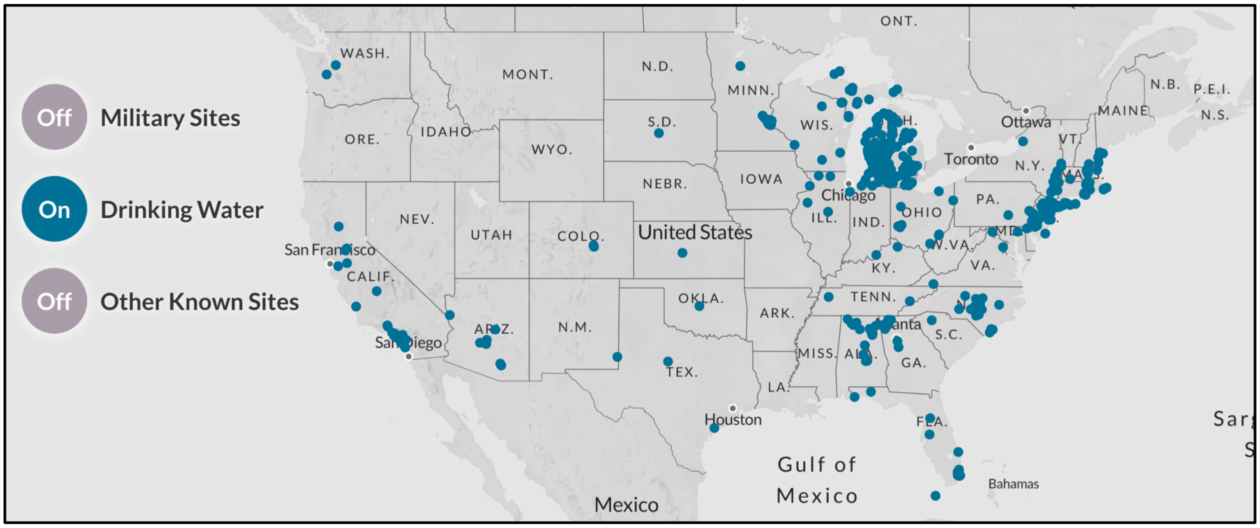
[15] Third Unregulated Contaminant Rule, US EPA, https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule.

[16] The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data Summary, January 2017, US EPA, https://www.epa.gov/sites/production/files/2017-02/documents/ucmr3-data-summary-january-2017.pdf.

[17] Amendment of Subpart 5-1 of Title 10 NYCRR (Maximum Contaminant Levels (MCLs)),

[18] PFAS Chemicals Must Be Regulated as a Class, Not One by One, Environmental Working Group, May 6, 2019, https://www.ewg.org/release/mapping-pfas-contamination-crisis-new-data-show-610-sites-43-states



Source: Environmental Working Group and Northeastern University SSEHR, PFAS Contamination in the US, August 2019, https://www.ewg.org/interactive-maps/2019_pfas_contamination/map/

In New York State, we do not know the full extent of PFAS and 1,4-dioxane contamination of drinking water, since testing under the UCMR-3 was only for public water systems serving over 10,000 people. Only 196 water systems in New York conducted testing under UCMR-3. Of the systems that conducted testing, an analysis conducted by NYPIRG found that drinking water for over 2.8 million New Yorkers have levels of 1,4-dioxane in their drinking water supplies above 0.3 parts per billion (the health guidance level in Massachusetts) , and drinking water for more than 1.4 million New Yorkers contained levels of PFOA/PFOS above the most stringent levels recommended in 2018.[19] Under the Department of Health's proposed MCLs, millions of New Yorkers would still be exposed to levels exceeding the most health protective levels.

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[19] During 2018, advocates recommended a combined MCL of 4 ppt. With additional science, discussed further in our comments, advocates now recommend a lower level of 2 ppt.

The following represents the populations impacted by PFOA, PFOS, and 1,4-dioxane in New York State:

	1,4 dioxane health risk limit (ppb)	Population affected by 1,4-dioxane	PFOA/PFOS health risk limit	Population affected by PFOA/PFOS
Environmental groups' recommended limit[27]	.3 parts per billion	2,840,646	4-10 parts per trillion	1,450,000
U.S. EPA findings	.35 parts per billion[28]	2,793,492	.07 parts per billion[29]	1,170,500

Source: *What's In My Water? Emerging Contaminants in New York's Drinking Water Systems,* New York Public Interest Research Group, May 2019.

We note that in the NYS Department of Health's regulatory impact statement for the MCL rulemaking process, of the 278 medium (serving 3,300 to 10,000 persons) and small (serving fewer than 3,300 persons) community water systems and non-transient noncommunity systems sampled between 2015 and 2018, 93 systems, a third of the sample, detected levels of PFOA between 2 ppt and 10 ppt, and 76 systems, over a quarter of the sample, detected levels of PFOS between 2 ppt and 10 ppt.[20] Under the Department of Health's proposed MCLs, these public systems would not be required to remove these harmful chemicals from their drinking water because their levels fall under the proposed MCL of 10 ppt. *Further, it is not known at this time whether these systems or the public they serve have been notified of these results, nor do we have further information about which systems these represent. If they have not already done so, we urge the Department of Health to notify these 278 public water systems of these results, who should then notify the public, in the interest of transparency and public safety.*

1,4-dioxane is especially prevalent on Long Island, with dozens of drinking water sources detecting the chemical at levels that far exceed EPA's lifetime cancer risk guideline of 0.35 ppb. Nassau and Suffolk water suppliers have reported the highest levels of 1,4-dioxane contamination in the nation, according to the Citizens Campaign for the Environment.[21] There are an estimated 185 drinking water wells on Long Island contaminated with 1,4-dioxane, which will cost an estimated $840 million to clean up.[22]

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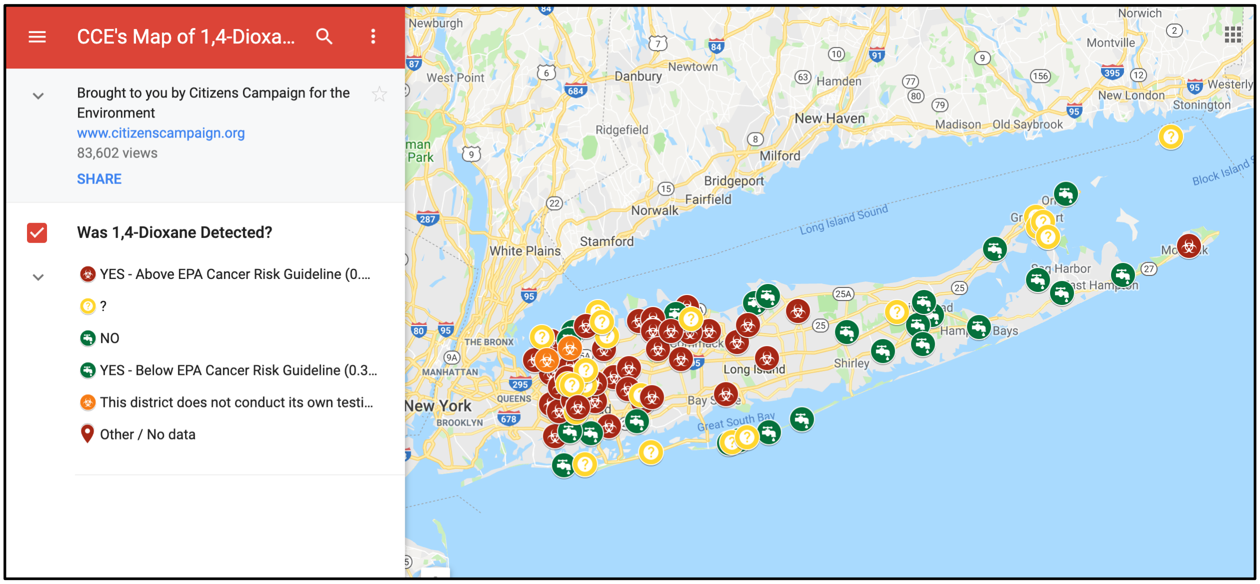
[20] New York State Department of Health, Amendment of Subpart 5-1 of Title 10 NYCRR (Maximum Contaminant Levels (MCLs), https://regs.health.ny.gov/sites/default/files/proposed-regulations/Maximum%20Contaminant%20Levels%20%28MCLs%29.pdf

[21] Protect Drinking Water from 1,4-dioxane, 2019, Citizens Campaign for the Environment, https://www.citizenscampaign.org/14dioxane

[22] Water providers put cost for 1,4-dioxane treatment systems at $840M, February 14, 2019, Newsday, https://www.newsday.com/long-island/1-4-dioxane-cleanup-costs-1.27268149

Citizens Campaign for the Environment has mapped the sites with 1,4-dioxane on Long Island, which is depicted here:



CCE's Map of 1,4-Dioxa...

Brought to you by Citizens Campaign for the Environment
www.citizenscampaign.org
83,602 views

☑ Was 1,4-Dioxane Detected?

- YES - Above EPA Cancer Risk Guideline (0....
- ?
- NO
- YES - Below EPA Cancer Risk Guideline (0.3...
- This district does not conduct its own testi...
- Other / No data

Source: Citizens Campaign for the Environment, https://www.citizenscampaign.org/14dioxane (accessed in September 2019).

Without MCLs and without comprehensive testing of these emerging contaminants in New York State, any public water systems serving fewer than 10,000 people, in addition to people served by private wells, do not know whether or not their drinking water has been contaminated with PFOA, PFOS, or 1,4-dioxane. There were 2,075 water systems that did not have any UCMR-3 testing, leaving 2,373,089 New Yorkers, plus approximately 4 million residents relying on private wells, unclear whether their drinking water contains 1,4-dioxane, PFOA, PFOS, and other contaminants.

The Village of Hoosick Falls, NY is a case in point: With a population of 3,399, the village was not required under UCMR-3 to test for PFOA in its water due to its small size, and did not find out about the contamination of its water supply until a local resident had the water tested. In the time since PFAS chemicals were found in Hoosick Falls, other municipalities and regions in the state have discovered contamination of drinking water supplies: Petersburgh, Newburgh, New Windsor, and several sites on Long Island. Most recently, drinking water in Watkins Glen, Montour Falls and Seneca County has been found to contain elevated levels PFAS chemicals when a grassroots group had the water tested independently, after failed attempts to request the data from the state.[23]

The bottom line is that New Yorkers deserve to know what's in their water, but the public will not know the extent of drinking water contamination until health-based MCLs are set and comprehensive testing is carried out throughout the state.

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[23] Water questions arise after group's test. September 10, 2019. Observer-Review.com, http://www.observer-review.com/water-questions-arise-after-groups-test-cms-6546.

III. Review of MCLs Under Consideration by Other States

In 2009, the US Environmental Protection Agency (EPA) established provisional health advisories for PFOA at 400 parts per trillion (ppt) and for PFOS at 200 ppt based on science that was available on these chemicals at this time. In May 2016, the EPA released revised health advisories for PFOA and PFOS at 70 ppt because of new science that had emerged.[24] There are currently no federal health advisories for PFNA (perfluoroonanoic acid), PFHxS (perfluorohexanesulfonic acid), PFHpA (perfluoroheptanoic acid), PFBS (perfluorobutanesulfonic acid), GenX or any other PFAS chemicals. As science has continually emerged since 2016 on PFOA and PFOS, in addition to many other PFAS compounds in this class of 3,300-5,000 chemicals, the EPA has failed to keep up. As of now, there are no federal enforceable standards, or Maximum Contaminant Levels or MCLs, for any PFAS chemical.

In light of the toxicity of these chemicals and without strong leadership at the federal level, several states have begun to take action to regulate these chemicals in drinking water. The following represent some of the many actions that states have begun to take to set drinking water standards for PFAS chemicals:

> **California:** In 2018, California established notification levels at concentrations of 13 parts per trillion for PFOS and 14 parts per trillion for PFOA, while maintaining a response level of 70 ppt combined for PFOA and PFOS.[25]
>
> **Connecticut:** The state set a drinking water action for private wells in 2016 for PFOA and PFOS that is the same as the EPA health advisory of 70 ppt, but has since added three additional chemicals - PFNA, PFHxS and PFHpA - to the group. The sum of this group of five PFAS chemicals must be below the target concentration of 70 ppt.[26]
>
> **Massachusetts:** In January 2019, Massachusetts announced its intent to begin to establish MCLs for the sum of PFOA, PFOS, PFNA, PFHxS, PFHpA, PFDA at 20 ppt. The state has proposed groundwater cleanup standards for six PFAS compounds.[27]
>
> **Michigan:** In June 2019, a state scientific advisory panel recommended the following MCLs: PFNA at 6 ppt, PFOA at 8 ppt, PFOS at 16 ppt, PFHxS at 51 ppt, GenX at 370 ppt, PFBS at 420 ppt, and PFHxA at 400,000 ppt. Final MCLs are expected later in 2019.[28] If approved, the MCL for PFOA at 8 ppt would be the lowest to date in the nation.

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[24] Drinking Water Health Advisories for PFOA and PFOS, US EPA, June 2016, www.epa.gov/sites/production/files/2016-06/documents/drinkingwaterhealthadvisories_pfoa_pfos_updated_5.31.16.pdf.

[25] Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS), California State Water Resources Control Council, July 2019, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/PFOA_PFOS.html.

[26] Perfluoroalkyl Substances (PFAS) in Drinking Water: Health Concerns, October 2017, Connecticut Department of Public Health, https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/eoha/Toxicology_Risk_Assessment/2018-uploads/Perfluoroalkyl-Substances-PFASs-in-DWHealth-Concerns.pdf?la=en

[27] Massachusetts Proposes Cleanup Standards for PFAS, April 2019, National Law Review, https://www.natlawreview.com/article/massachusetts-proposes-cleanup-standards-pfas

[28] Michigan eyes toughest limits for some PFAS in drinking water, Updated July 2019, Michigan Live, https://www.mlive.com/news/2019/06/michigan-eyes-toughest-limits-for-some-pfas-in-drinking-water.html.

Minnesota: In April 2019, the state issued new health-based values for two chemicals associated with groundwater contamination after reviewing the latest scientific data on the two chemicals. The new PFOS value of 15 parts per trillion (ppt) replaces the previous value of 27 ppt. The new health-based value for PFHxS is 47 ppt. Until now, the state had used the 27 ppt PFOS health-based value as a "surrogate" for PFHxS due to a lack of available data specific to PFHxS.[29]

New Hampshire: In June 2019, New Hampshire filed a final rulemaking proposal to establish Maximum Contaminant Levels (MCLs) and Ambient Groundwater Quality Standards (AGQS) for four PFAS chemicals: 12 ppt for PFOA, 15 ppt for PFOS, 18 ppt for PFHxS, and 11 ppt for PFNA.[30]

New Jersey: In 2018, New Jersey adopted an MCL and amended the Ground Water Quality Standard for PFNA to 13 parts per trillion. In 2017, the New Jersey Department of Environmental Protection (NJDEP) accepted a recommended MCL for PFOA of 14 ppt. In June 2018, the NJDEP accepted a recommended MCL for PFOS of 13 ppt.[31] The proposed rulemaking for PFOA and PFOS to establish these MCLs began on April 1, 2019 with a public hearing in May and public comments through May 31, 2019.[32]

North Carolina: In 2018, the state set a non-regulatory, non-enforceable health goal of 140 parts per trillion for GenX in drinking water, following extensive contamination by GenX in the Cape Fear River.[33]

Vermont: Vermont's health advisory level for the sum of five PFAS is set at 20 ppt in drinking water. The five PFAS chemicals are: PFOA, PFOS, PFHxS (perfluorohexane sulfonic acid), PFHpA (perfluoroheptanoic acid), PFNA (perfluorononanoic acid).[34] In May 2019, the Governor signed a law requiring all public water systems to test for these chemicals to ensure they do not exceed these levels and treat systems that do, in addition to requiring the state's Secretary for Natural Resources to issue a final proposed rule establishing an MCL for the five chemicals.[35]

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[29] Perfluoroalkyl Substances (PFAS), Minnesota Department of Health, https://www.health.state.mn.us/communities/environment/hazardous/topics/pfcs.html#guidancerelease

[30] Press Release: NHDES Proposes New PFAS Drinking Water Standards, Final Rulemaking Proposal for PFOA, PFOS, PFHxS and PFNA, June 2019, New Hampshire Department of Environmental Services, https://www.des.nh.gov/media/pr/2019/20190628-pfas-standards.htm.

[31] Contaminants of Emerging Concern, New Jersey Department of Environmental Protection, https://www.nj.gov/dep/srp/emerging-contaminants/.

[32] NJDEP Proposed Rulemaking: MCLs, GWQS, and Related Rules for PFOA and PFOS, April 1, 2019, New Jersey Department of Environmental Protection, https://www.nj.gov/dep/srp/srra/listserv_archives/2019/20190401_srra.html

[33] GenX Health Information, 2017, North Carolina Department of Environmental Quality, https://files.nc.gov/ncdeq/GenX/GenX%20factsheet%20FINAL%2013Sep2017.pdf

[34] Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in Drinking Water, Vermont Department of Health, https://www.healthvermont.gov/environment/drinking-water/perfluoroalkyl-and-polyfluoroalkyl-substances-pfas-drinking-water

[35] Vermont Governor Signs Law Setting Strict PFAS Limits, May 2019, National Law Review, https://www.natlawreview.com/article/vermont-governor-signs-law-setting-strict-pfas-limits.

From the above efforts by states to establish drinking water standards, there are some obvious conclusions to draw: First, scientific data has changed over time, increasingly demonstrating a need for stricter drinking water standards for these chemicals and oftentimes causing agencies to rethink their established levels to be more protective of human health. A better approach is a precautionary one, starting at the most protective levels based on all available science. Second, there is a growing list of PFAS chemicals, which can be substituted for PFAS chemicals that are phased out by industry, so any future regulations need to encompass a combined MCL that includes as many PFAS chemicals as possible. Third, with a lack of federal leadership, individual states are taking varying piecemeal approaches to try to regulate these dangerous chemicals in drinking water, resulting in inequitable protections across the United States. While there is a need for New York to take a strong leadership position and serve as a model in regulating the PFAS class of chemicals, this does not eliminate the need for even stronger leadership by the federal government to control a growing, nationwide drinking water crisis.

IV. Our Recommendations

Based on the above information, we have the following recommendations:

- **We urge the Department of Health to establish a combined MCL of 2 ppt for PFOA and PFOS.**

In December 2018, the New York State Drinking Water Quality Council recommended an MCL of 10 ppt for PFOA and an MCL of 10 ppt for PFOS. However, since that time, newly-released scientific evidence and modeling has expanded our understanding of the human health risks of extremely low levels of PFOA and PFOS exposure. The science is clearer than ever that there is likely no safe level of PFOA or PFOS in drinking water. The Department of Health must therefore revise and lower the Drinking Water Quality Council's recommendations in its final rulemaking decision.

A combined MCL must be in line with the most recent science and be set at the lowest level that is detectable and treatable. Developing an MCL is a complex process. First, a 'most sensitive endpoint,' the health effect that occurs at the lowest level of exposure, is identified. Second, 'uncertainty factors' are applied to account for database gaps and potential differences between animal and human exposure results. Third, exposure assumptions are made, such as drinking water intake rate, body weight and relative source contribution from drinking water (versus from food, consumer products, etc.). Finally, adjustments are made to take into consideration whether existing technology can detect and treat the contaminant at the desired level.

With each step in the MCL development process, critical assumptions are made that determine how health-protective the resulting standard is. In this section, we detail how recent science supports parameters that produce an MCL at the lowest level detectable and treatable for PFOA and PFOS.

In March 2019, the Natural Resources Defense Council (NRDC) produced a landmark report examining the latest science on PFAS chemicals. This report included detailed assessments of the human health impacts of PFOA and PFOS and extrapolated the necessary drinking water standards to protect the most vulnerable populations.[36] This report has been provided to regulators in Michigan and New Jersey along with localized data for each state.[37] We strongly support many of the scientific conclusions in NRDC's report:

- *We urge the Department of Health to use delayed mammary gland development as the most sensitive endpoint for PFOA.* Delayed mammary gland development can result in difficulty in breastfeeding and an increase in susceptibility to breast cancer.[38] Both animal and human studies have linked PFOA exposure to delayed mammary gland development.[39] [40] New Jersey's Drinking Water Quality Institute has acknowledged that delayed mammary gland development is an adverse health effect associated with PFOA.[41] Though the Institute developed a PFOA reference dose using delayed mammary gland development as the most sensitive endpoint, they did not use it to calculate their MCL for PFOA. According to NRDC, "if New Jersey's reference dose for mammary gland development had been used, New Jersey's MCLG for PFOA would be less than one ppt."[42] PFOA's effects on mammary gland development confirms that there is likely no safe level of PFOA in drinking water.

  We are concerned that the Department of Health's Notice of Proposed Rulemaking did not mention delayed mammary gland development as an adverse health effect of PFOA. We urge the Department of Health to rectify this in the final rulemaking decision. A lack of precedent for using delayed mammary gland development as a most sensitive endpoint in the MCL development process should not deter the Department of Health from following the large body of scientific evidence confirming the deleterious health effects of extremely low levels of PFOA exposure.

- *We urge the Department of Health to use immune system toxicity as the most sensitive endpoint for PFOS.* The National Toxicology Program conducted a systematic review to evaluate immunotoxicity data on PFOA and PFOS in 2016, associating exposure with decreased antibody response to vaccines in humans, decreased host resistance to viruses,

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[36] Anna Reade, et al. Scientific and Policy Assessment for Addressing Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water. Natural Resources Defense Council, March 15, 2019.

[37] Kimberly Ong. Re: Proposed Maximum Contaminant Level for Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS), DEP Dkt. No. 02-19-03. Natural Resources Defense Council, May 31, 2019.

[38] Ruthann Rudel, et al., Environmental Exposures and Mammary Gland Development: State of the Science, Public Health Implications, and Research Recommendations, 119 ENVIRON. HEALTH PERSPECT. 1053 (2011).

[39] Macon MB, et al., 2011. Prenatal perfluoroocyanoic acid exposure in CD-1 mice: low dose developmental effects and internal dosimetry. Toxicol Sci 122(1):131-145; White SS, et al., 2011. Gestational and chronic low-dose PFOA exposures and mammary gland growth and differentiation in three generations of CD-1 mice. Environ Health Perspect 119(8):1070-1076; Tucker DK, et al., 2015. The mammary gland is a sensitive pubertal target in CD-1 and C57Bl/6 mice following perinatal perfluorooctanoic acid (PFOA) exposure. Reprod Toxicol 54:26-36;

[40] Chunyuan Fei, et al., Maternal Concentrations of Perfluorooctanesulfonate (PFOS) and Perfluorooctanoate (PFOA) and Duration of Breastfeeding, 36 SCAND. J. WORK ENVIRON. HEALTH 413 (2010); M. E. Romano, et al., Maternal Serum Perfluoroalkyl Substances During Pregnancy and Duration of Breastfeeding, 149 ENVIRON. RES. 239 (2016); C. A. Timmermann, et al., Shorter Duration of Breastfeeding at Elevated Exposures to Perfluoroalkyl Substances, 68 REPROD. TOXICOL.164 (2017).

[41] New Jersey Drinking Water Quality Institute, "Maximum Contaminant Level Recommendation for Perfluorooctanoic Acid in Drinking Water: Basis and Background," March 15, 2017.

[42] Kimberly Ong. Re: Proposed Maximum Contaminant Level for Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS), DEP Dkt. No. 02-19-03. Natural Resources Defense Council, May 31, 2019.

and suppressed immune response to antigens in animals.[43] New Jersey and Michigan both used immunotoxicity as the most sensitive endpoint for PFOS when developing their MCL proposals.

- *We urge the Department of Health to use a relative source contribution (RSC) no greater than 20 percent for PFOA and PFOS.* The RSC is the percentage of a person's total exposure to PFOA or PFOS through drinking water. A low RSC is needed due to the wide variety of products containing PFOA and PFOS and the multiple sources of exposure present in our environment. PFOA and PFOS have been found in food packaging,[44] carpets,[45] dental floss,[46] and eels off the coast of Long Island.[47] The FDA has detected PFAS chemicals in fish, dairy, meat, produce, and chocolate cake.[48]

- *We urge the Department of Health to use infant-specific exposure parameters for both PFOA and PFOS.* Minnesota has developed a toxicokinetic model for infant exposure to PFOA and PFOS, peer-reviewed and published in the *Journal of Exposure Science & Environmental Epidemiology* on January 10, 2019.[49] Infants are one of the most sensitive population to chemical exposure due to their developing organs. Children exposed to PFOA or PFOS in utero have a greater blood serum concentrations than the general population upon birth due to prior placental transfer from the mother.[50] [51] [52] This risk compounds for breast-fed infants, since PFOA and PFOS becomes concentrated in the breast milk at higher levels than in drinking water.[53] [54] [55] Crucially, the study found that, "peak breastfed infant serum levels

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[43] U.S. Department of Health and Human Services, National Toxicology Program, Monograph on Immunotoxicity Associated with Exposure to Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) (2016), https://ntp.niehs.nih.gov/ntp/ohat/pfoa_pfos/pfoa_pfosmonograph_508.pdf.

[44] Laurel Schraider, et al. Fluorinated Compounds in U.S. Fast Food Packaging. Environ Sci Technol Lett. 2017; 4(3): 105–111.

[45] Courtney Columbus, PFAS detected in carpets from several U.S. manufacturers. E&E News. https://www.eenews.net/stories/1060109571. Accessed September 2, 2019.

[46] Boronow, K.E., J.G. Brody, L.A. Schaider, G.F. Peaslee, L. Havas, B.A. Cohn. 2019. "Serum concentrations of PFASs and exposure-related behaviors in African American and non-Hispanic white women." Journal of Exposure Science & Environmental Epidemiology. DOI: 10.1038/s41370-018-0109-y

[47] Joan Gralla. Warning on eating eels caught in Suffolk from health department. Newsday. https://www.newsday.com/news/health/eels-suffolk-contaminated-carcinogen-1.33679849. Accessed September 2, 2019.

[48] Food and Drug Administration. Analytical Results of Testing for PFAS in Foods. https://www.fda.gov/food/chemicals/and-polyfluoroalkyl-substances-pfas. Accessed September 2, 2019.

[49] Helen M. Goeden, et al., A Transgenerational Toxicokinetic Model and its Use in Derivation of Minnesota PFOA Water Guidance, 29 JOURNAL OF EXPOSURE SCIENCE & ENVIRONMENTAL EPIDEMIOLOGY 183 (2019), https://www.nature.com/articles/s41370-018-0110-5.

[50] Midasch O, Drexler H, Hart N, Beckmann MW, Angerer J. Transplacental exposure of neonates to perfluorooctanesulfonate and perfluorooctanoate: a pilot study. Int Arch Occup Environ Health. 2007;80:643–8.

[51] Beesoon S, Webster GM, Shoeib M, Harner T, Benskin JP, Martin JW. Isomer profiles of perfluorochemicals in matched maternal, cord, and house dust samples: manufacturing sources and transplacental transfer. Environ Health Perspect. 2011;119:1659–64.

[52] Lee Y, Kim M-K, Bae J, Yang J-H. Concentrations of perfluoroalkyl compounds in maternal and umbilical cord sera and birth outcomes in Korea. Chemosphere. 2013;90:1603–9.

[53] Cariou R, Veyrand B, Yamada A, Berrebi A, Zalko D, Durand S, et al. Perfluoroalkyl acid (PFAA) levels and profiles in breast milk, maternal and chord serum of French women and their newborns. Environ Int. 2015;84:71–81.

[54] Fromme H, Mosch C, Morovitz M, Alba-Alejandre I, Boehmer S, Kiranoglu M, et al. Pre- and postnatal exposure to perfluorinated compounds (PFCs). Environ Sci Technol. 2010;44:7123–9.

[55] Liu J, Li J, Liu Y, Chan HM, Zhao Y, Cai Z, et al. Comparison on gestation and lactation exposure of perfluorinated compounds for newborns. Environ Int. 2011;37:1206–12.

> were 4.4-fold higher than in formula-fed infants, with both of these scenarios producing serum levels in excess of the adult steady-state level."[56]
>
> Now that new data has come to light on the high risk to infants from these chemicals, several states have responded by adjusting their regulatory thresholds for PFOA and PFOS. The New Hampshire Department of Environmental Services specifically cited the Minnesota study in its rationale for lowering its MCL recommendations to 12 ppt for PFOA and 15 ppt for PFOS in June 2019.[57] One month later, a joint legislative committee approved NH DES's revised MCLs.
>
> In addition, the Minnesota study was used by the Michigan Science Advisory Workgroup to generate its MCL recommendations of 8 ppt for PFOA and 16 ppt for PFOS.[58] The PFOA MCL would be the lowest in the nation if adopted. The workgroup stated, "The traditional risk assessment approach using simple equations based on body weight, water intake rate and RSC [relative source contribution] to calculate drinking water HBVs [health-based values] is not adequate to address the bioaccumulative nature and known or presumed developmental toxicity of PFAS. These traditional equations do not consider the PFAS body-burden at birth or any transfer of maternal PFAS through breastmilk."[59]
>
> However, Michigan's proposed and New Hampshire's adopted MCL regulations still do not go far enough to fully protect public health. Both states refused to use delayed mammary gland development as the most sensitive endpoint for PFOA, and utilized a high relative source contribution of 50 percent for both PFOA and PFOS.[60] [61] *NRDC states that if MCLs for PFOA and PFOS were based on the most sensitive endpoints, with infant specific exposure rates and an uncertainty factor to protect fetuses, infants and children, the MCL for PFOA would be 0.01 ppt and the MCL for PFOS would be 0.2 ppt.*[62] The most recent scientific evidence therefore again confirms that the Department of Health must set its own MCLs for PFOA and PFOS at the lowest levels detectable and treatable, at 2 ppt.

We further urge the Department of Health to consider recent data that links PFOA in drinking water to pancreatic cancer in rats. The data was presented in June 2019 by Dr. Linda Birnbaum, of the National Toxicology Program, at the 2019 National PFAS Conference at Northeastern University. According to Dr. Birnbaum, "If you use the pancreatic tumors in the rats in the NTP study to calculate what would really be a virtually safe dose, you're getting down at about .1 ppt. Well, that's

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[56] Helen M. Goeden, et al., A Transgenerational Toxicokinetic Model and its Use in Derivation of Minnesota PFOA Water Guidance, 29 JOURNAL OF EXPOSURE SCIENCE & ENVIRONMENTAL EPIDEMIOLOGY 183 (2019), https://www.nature.com/articles/s41370-018-0110-5.

[57] Annie Ropeik. N.H. Sharply Lowers Proposed PFAS Water Limits, Now Among Nation's Strictest. New Hampshire Public Radio, June 28, 2019.

[58] Jamie Dewitt, et al. Health-Based Drinking Water Value Recommendations for PFAS in Michigan. Michigan Science Advisory Workgroup, June 27, 2019.

[59] Ibid.

[60] Ibid.

[61] New Hampshire Department of Environmental Services. Summary of the Technical Background Report for the Proposed Maximum Contaminant Levels and Ambient Groundwater Quality Standards for PFOA, PFOS, PFNA and PFHxS. June 9, 2019.

[62] Kimberly Ong. Re: Proposed Maximum Contaminant Level for Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS), DEP Dkt. No. 02-19-03. Natural Resources Defense Council, May 31, 2019.

really low. And that's only for one PFAS."[63] Furthermore, the study provides more evidence that PFAS exposure affected breast development, including impacts on the growth of the mammary gland and problems with lactation. This lends additional weight to the use of delayed mammary gland development as the most sensitive endpoint for PFOA, in addition to further confirmation that there is likely no safe level of PFAS in drinking water.

Dr. Birnbaum's study reinforces a key point when attempting to regulate emerging contaminants. The science on PFOA, PFOS, and many of the other 3,300-5,000 PFAS chemicals is constantly emerging. The more that we learn about the health effects of these chemicals, the more dangerous we realize they are, as the recent link to pancreatic cancer demonstrates. It is therefore imperative that the Department of Health take a precautionary approach when setting MCLs for PFOA and PFOS.

Finally, we urge the Department of Health to take the full costs to human health of PFOA and PFOS exposure into the rulemaking calculus. While water systems will indeed face costs to install and maintain complex treatment systems, the economic and social costs that come with setting MCLs too high, including increased number of hospital visits, increased number of early deaths, and increased number of stigmatized contaminated communities, which often lose businesses, home values and residents, are both of greater importance and greater in magnitude. And as climate change affects the availability of freshwater resources worldwide, cleaning up our water supplies and protecting them from harmful chemicals is an important economic investment New York needs to make. The Department of Health's stated mission is the health of all New Yorkers, and that should be the highest priority in setting MCLs.

A 2018 study examined the economic costs of low birth weight (LBW) caused by PFOA exposure across the nation. The study found that the total cost of PFOA-attributable LBW for 2003 through 2014 was estimated at $13.7 billion.[64] It is important to keep in mind that this staggering figure represents merely one of the negative health outcomes of PFOA exposure. Untallied are the costs of testicular and kidney cancer, immunotoxicity, thyroid disease, and so many other illnesses.

The Nordic Council of Ministers recently expanded the scope of costs of PFAS exposure, looking at three distinct exposure scenarios and the value of life lost in each. The total annual health-related costs, for three different levels of exposure, was found to be at least EUR 2.8 to EUR 4.6 billion in the Nordic countries and EUR 52 to EUR 84 billion in the European Economic Area countries.[65]

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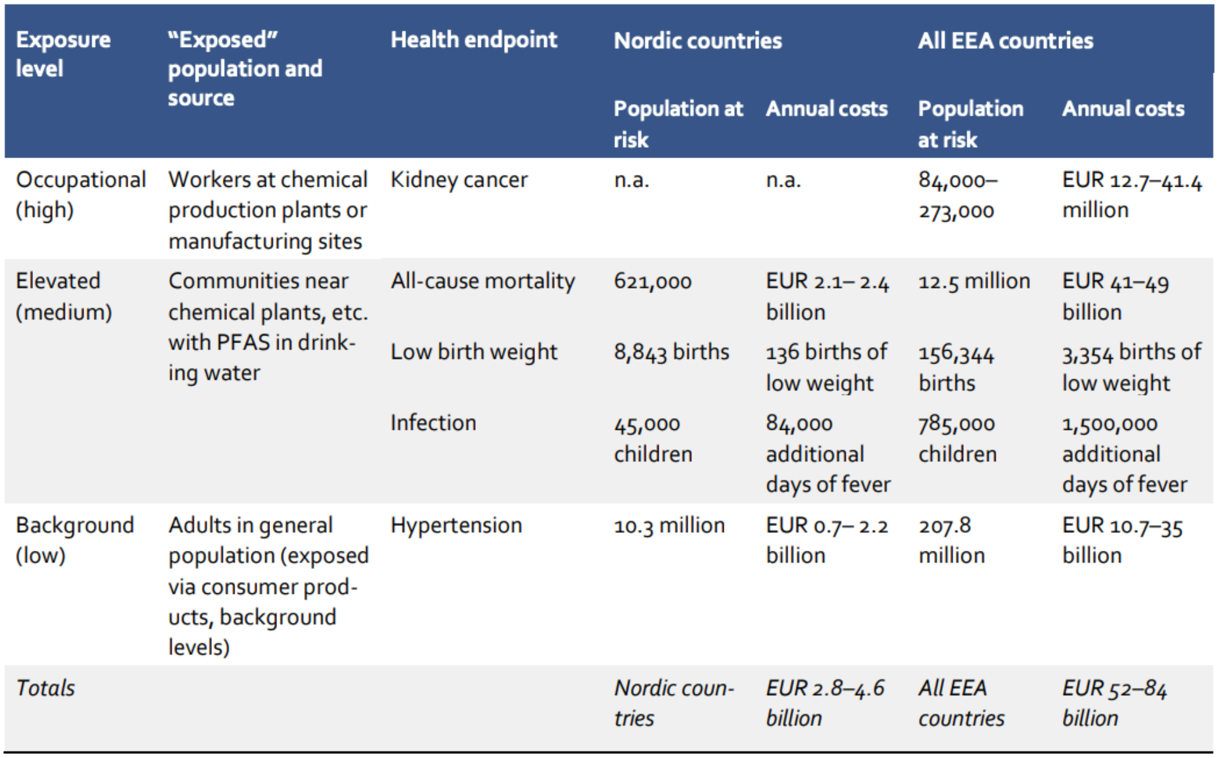
[63] Sharon Lerner, Teflon Toxin Safety Level Should Be 700 Times Lower Than Current EPA Guideline. The Intercept. June 18, 2019. https://theintercept.com/2019/06/18/pfoa-pfas-teflon-epa-limit/. Accessed September 2, 2019.

[64] Julia Malits. Perfluorooctanoic acid and low birth weight: Estimates of US attributable burden and economic costs from 2003 through 2014. International Journal of Hygiene and Environmental Health
Volume 221, Issue 2, March 2018, Pages 269-275.

[65] Gretta Goldenman, et al. The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS. Nordic Council of Ministers. 2019. http://norden.diva-portal.org/smash/get/diva2:1295959/FULLTEXT01.pdf. Accessed September 2, 2019.

A table detailing the Council's methodology, estimating annual health impact-related costs of exposure to PFAS, is found below:



Exposure level	"Exposed" population and source	Health endpoint	Nordic countries		All EEA countries	
			Population at risk	Annual costs	Population at risk	Annual costs
Occupational (high)	Workers at chemical production plants or manufacturing sites	Kidney cancer	n.a.	n.a.	84,000–273,000	EUR 12.7–41.4 million
Elevated (medium)	Communities near chemical plants, etc. with PFAS in drinking water	All-cause mortality	621,000	EUR 2.1– 2.4 billion	12.5 million	EUR 41–49 billion
		Low birth weight	8,843 births	136 births of low weight	156,344 births	3,354 births of low weight
		Infection	45,000 children	84,000 additional days of fever	785,000 children	1,500,000 additional days of fever
Background (low)	Adults in general population (exposed via consumer products, background levels)	Hypertension	10.3 million	EUR 0.7– 2.2 billion	207.8 million	EUR 10.7–35 billion
Totals			*Nordic countries*	*EUR 2.8–4.6 billion*	*All EEA countries*	*EUR 52–84 billion*

Source: Gretta Goldenman, et al. The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS. Nordic Council of Ministers. 2019. http://norden.diva-portal.org/smash/get/diva2:1295959/FULLTEXT01.pdf. Accessed September 2, 2019.

- **We urge the Department of Health to establish an MCL of 0.3 ppb for 1,4-dioxane.**

The EPA has classified 1,4-dioxane as "likely to be carcinogenic to humans" by all routes of exposure.[66] Studies have shown increased incidences of nasal cavity, liver and gall bladder tumors after exposure to 1,4-dioxane.[67] [68] [69] Recent science has linked high levels of 1,4-dioxane exposure to kidney damage in mice.[70] Massachusetts has a health advisory level for 1,4-dioxane of 0.3 ppb, and the Department of Health should adopt this level as an MCL to fully protect human health. Given the emerging science on this chemical, a precautionary approach must be taken when regulating 1,4-dioxane.

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[66] Technical Factsheet - 1,4-dioxane. U.S. EPA. November 2017. https://www.epa.gov/sites/production/files/2014-03/documents/ffrro_factsheet_contaminant_14-dioxane_january2014_final.pdf. Accessed September 2, 2019.

[67] EPA. Integrated Risk Information System (IRIS). 2013. "1,4-Dioxane (CASRN 123-91-1)." cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?su bstance_nmbr=326

[68] Agency for Toxic Substances and Disease Registry (ATSDR). 2012. "Toxicological Profile for 1,4-Dioxane." www.atsdr.cdc.gov/toxprofiles/TP.asp?id=955&tid=199

[69] U.S. Department of Health and Human Services (DHHS). 2014. "Report on Carcinogens, Twelfth Edition." Public Health Service, National Toxicology Program. 13th Edition. ntp.niehs.nih.gov/ntp/roc/content/profiles/dioxane. pdf

[70] Jingfan Qiu, et al. 1,4-Dioxane exposure induces kidney damage in mice by perturbing specific renal metabolic pathways: An integrated omics insight into the underlying mechanisms. Chemosphere
Volume 228, August 2019, Pages 149-158.

- **We urge the Department of Health to establish MCL(s) for additional PFAS chemicals.**

While establishing strong MCLs for PFOA, PFOS, and 1,4-dioxane is an important step, there are thousands of chemicals in the PFAS class that need to be better understood, monitored, and regulated in order to fully protect our drinking water and human health. In existence since the mid-20th century, some PFAS chemicals such as PFOS and PFOA were phased out in the United States beginning in the early 2000s, but have been replaced by shorter chain PFAS chemicals.[71] PFOA and PFOS are, in fact, no longer manufactured in or imported into the United States.[72] Shorter chain PFAS chemicals pose similar health risks, however, with the chemicals most studied being PFOA, PFOS, PFNA, and PFHxS.[73]

The Agency for Toxic Substances and Disease Registry (ATSDR) published a draft *Toxicological Profile for Perfluoroalkyls* in June 2018, which included fourteen perfluoroalkyl compounds that appeared in previous serum samples and monitoring studies. These fourteen chemicals include: perfluorobutyric acid (PFBA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA),perfluorodecanoic acid (PFDeA), perfluoroundecanoic acid (PFUA), perfluorobutane sulfonic acid (PFBuS), perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorododecanoic acid (PFDoA), perfluorooctane sulfonamide (PFOSA), 2-(N-Methyl-perfluorooctane sulfonamide) acetic acid (Me-PFOSA-AcOH), and 2-(N-Ethyl-perfluorooctane sulfonamide) acetic acid (Et-PFOSA-AcOH). This assessment concluded that there is an association with certain health effects and exposure to these fourteen PFAS chemicals, and that the data supports establishing minimum risk levels for PFOA, PFOS, PFNA, and PFHxS.[74]

The EPA's UCMR-3 monitored for six PFAS chemicals in public drinking water systems: perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), perfluorobutanesulfonic acid (PFBS). Individual states are also beginning to regulate these six chemicals, in addition to others such as GenX (North Carolina, Michigan) and PFDA (Massachusetts). States, in some cases, have addressed multiple PFAS chemicals with their drinking water standards: four (New Hampshire), five (Vermont, Connecticut), six (Massachusetts), and seven (Michigan).

As mentioned previously, the 2019 NRDC report suggests that a combined MCL of 2 ppt is feasible for PFOA, PFOS, PFNA, and PFHxS.[75] Based on all available science, we do not believe regulating just

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[71] History and Use of Per- and Polyfluoroalkyl Substances (PFAS), 2017, Interstate Technology Regulatory Council, https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf

[72] *Toxicological Profile for Perfluoroalkyls: Draft for Public Comment*, June 2018, ATSDR, https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

[73] NRDC Michigan report

[74] *Toxicological Profile for Perfluoroalkyls: Draft for Public Comment*, June 2018, ATSDR, https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

[75] Anna Reade, Ph.D., "Scientific and Policy Assessment for Addressing Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water," April 2019, https://www.nrdc.org/resources/michigan-pfas-2019-scientific-and-policy-assessment-addressing-pfas-chemicals-drinking

two PFAS chemicals in New York goes far enough, when the dangers of the larger class of these chemicals is quite clear.

- **We urge the Department of Health to reject the phased-in testing schedule outlined in the Notice of Proposed Rulemaking.**

In the Notice of Proposed Rulemaking, "the start of initial sampling is proposed to be staggered, requiring large systems to test first (within 60 days of adoption) and providing more time for smaller systems such that water systems serving between 3,300 to 10,000 persons should sample within 90 days of adoption and water systems serving less than 3,300 persons must begin sampling within 6 months of adoption."[76] There is simply no reason to delay testing for PFOA, PFOS, or 1,4-dioxane any longer. Large systems in New York have already conducted this testing under UCMR-3, so the testing is not new. Additionally, it has now been more than three years since the water crisis in Hoosick Falls came to light, and yet New Yorkers served by small water systems still do not know if elevated levels of these chemicals are impacting their drinking water.

Testing is especially urgent given the Department of Health's own sampling data showing 127 water systems exceeding 2 ppt of PFOA in its source water, 100 systems exceeding 2 ppt of PFOS, and 31 systems exceeding 0.35 ppb for 1,4-dioxane.[77] We know that contamination is present across the state. We do not believe New Yorkers should be exposed to contaminated water for another six months, especially in light of the extreme health risks of low levels of exposure detailed in this letter.

Furthermore, water systems have known for years that they would eventually be required to test for PFOA and PFOS. The Emerging Contaminant Monitoring Act passed by the New York State Legislature and signed into law by Governor Cuomo in 2017 specifically listed PFOA, PFOS, and 1,4-dioxane as contaminants that must be tested for by water systems of all sizes across the state. With several years to prepare, all water systems should be ready to conduct this testing within 60 days.

- **We urge the Department of Health not to use previous tests for PFOA, PFOS, and 1,4-dioxane for initial baseline testing requirements.**

It will be important for all water systems to test following the adoption of MCLs in order to establish a baseline of data across the state. Additionally, while these contaminants may not have been detected in a community previously, there is always the possibility of pollution migration. PFOA, PFOS, and 1,4-dioxane are particularly dangerous because they are persistent in the environment and do not readily biodegrade. Additionally, previous results for PFOA, PFOS, and 1,4-dioxane may have been established up to seven years ago, as early as 2012, when UCMR-3 testing began. Old results may no longer be relevant.

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[76] New York State Department of Health, Amendment of Subpart 5-1 of Title 10 NYCRR (Maximum Contaminant Levels (MCLs), https://regs.health.ny.gov/sites/default/files/proposed-regulations/Maximum%20Contaminant%20Levels%20%28MCLs%29.pdf

[77] Ibid.

Given the widespread use of these contaminants, their ease in migrating in water, and the need for statewide data, all systems should begin testing to establish a baseline result, and repeat testing once MCLs are established.

V. Conclusion

The EPA has not established a drinking water standard for any contaminant in decades and does not appear likely to do so with PFAS chemicals or 1,4-dioxane, despite evidence showing a growing water crisis across the country. In the meantime, the piecemeal approach being taken up at the state level is the best defense we have against these toxic chemicals in our drinking water. This is a moment when New York State clearly needs to step up to protect public health, ensure clean drinking water for all of its residents, and lead the way decisively for other states to follow.

In closing, we wish to underscore the importance of New York State establishing stringent MCLs for PFOA, PFOS, other PFAS chemicals, and 1,4-dioxane. Millions of New Yorkers have already been exposed to these contaminants, and other New Yorkers are still exposed and may not even know it. In the interest of public health and safety and to establish a foundation of trust in our public water supplies, we urge the state to adopt a precautionary approach in finalizing the rulemaking for these MCLs. New York State must err on the side of caution and adopt standards that reflect the most recent science, which indicates that there is likely no safe level of exposure to these chemicals in drinking water.

We thank you for your consideration of our comments, and for your time and attention to ensuring clean drinking water for all New Yorkers.

Sincerely,

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Environmental Advocates of New York

Nisha Swinton
Food & Water Watch

Elizabeth Moran
New York Public Interest Research Group (NYPIRG)

Michele Baker
NYWaterProject

Kathy Curtis
Clean & Healthy NY

Susan Van Dolsen
Westchester for Change

Judith Enck
Former EPA Regional Administrator

Anthony Grice
Councilperson, City of Newburgh

Anna Kelles, Tompkins County Legislator & Marion Porterfield, Schenectady City Council, Co-chairs
Local Progress NY

Karen Joy Miller
Huntington Breast Cancer Action Coalition, Inc.

Yvonne Taylor
Seneca Lake Guardian

KT Tobin, PhD
Deputy Mayor, Village of New Paltz

Elie Ward, MSW
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Exhibit C

SUEZ Water New York, Inc. - Rockland County
PFAS Sample Test Results - August 2020 - March 2021

Sample ID	Method	Analyte	Sample Date	Final	Units	MRL	MCL
LDF WTP EFF	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
LDF POE	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.2	ppt	2	NA
LDF POE	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluoroheptanoic acid	10/2/2020	3	ppt	2	NA
LDF POE	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorohexanoic acid	10/2/2020	3.8	ppt	2	NA
LDF POE	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10
LDF POE	EPA 537	Perfluorooctanoic acid	10/2/2020	5.8	ppt	2	10
LDF POE	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
LDF POE	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.2	ppt	2	NA
LDF POE	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluoroheptanoic acid	1/13/2021	2.8	ppt	2	NA
LDF POE	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorohexanoic acid	1/13/2021	4.1	ppt	2	NA
LDF POE	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
LDF POE	EPA 537	Perfluorooctanoic acid	1/13/2021	5.7	ppt	2	10
LDF POE	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
LDF POE	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
Letchworth WTP POE	EPA 537	Perfluorooctanoic acid	10/1/2020	ND	ppt	2	10
Letchworth WTP POE	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
Letchworth WTP POE	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 522	1,4-Dioxane	1/27/2021	ND	ppb	0.07	1
SW 100	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 100	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.5	ppt	2	NA
SW 100	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorohexanoic acid	10/1/2020	2.9	ppt	2	NA
SW 100	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.7	ppt	2	10
SW 100	EPA 537	Perfluorooctanoic acid	10/1/2020	4.8	ppt	2	10
SW 100	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 100	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.7	ppt	2	NA
SW 100	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluorohexanoic acid	1/13/2021	2.7	ppt	2	NA
SW 100	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA

SW 100	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4.1	ppt	2	10
SW 100	EPA 537	Perfluorooctanoic acid	1/13/2021	5.9	ppt	2	10
SW 100	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 100	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 106	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 106	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.4	ppt	2	NA
SW 106	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.1	ppt	2	NA
SW 106	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluorohexanoic acid	10/1/2020	2.6	ppt	2	NA
SW 106	EPA 537	Perfluorononanoic acid	10/1/2020	2.4	ppt	2	NA
SW 106	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.7	ppt	2	10
SW 106	EPA 537	Perfluorooctanoic acid	10/1/2020	8.9	ppt	2	10
SW 106	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 106	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.1	ppt	2	NA
SW 106	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluoroheptanoic acid	1/13/2021	2	ppt	2	NA
SW 106	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluorohexanoic acid	1/13/2021	2.6	ppt	2	NA
SW 106	EPA 537	Perfluorononanoic acid	1/13/2021	2.1	ppt	2	NA
SW 106	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.7	ppt	2	10
SW 106	EPA 537	Perfluorooctanoic acid	1/13/2021	8.6	ppt	2	10
SW 106	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 106	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 11	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 11	EPA 522	1,4-Dioxane	1/12/2021	0.07	ppb	0.07	1
SW 11	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanoic acid	10/1/2020	2.2	ppt	2	NA
SW 11	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 11	EPA 537	Perfluorooctanoic acid	10/1/2020	2.1	ppt	2	10
SW 11	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 11	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorobutanesulfonic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorodecanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorododecanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroheptanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanesulfonic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanoic acid	10/15/2020	2.1	ppt	2	NA
SW 11	EPA 537	Perfluorononanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorooctanesulfonic acid	10/15/2020	ND	ppt	2	10
SW 11	EPA 537	Perfluorooctanoic acid	10/15/2020	2.1	ppt	2	10
SW 11	EPA 537	Perfluorotetradecanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluorotridecanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroundecanoic acid	10/15/2020	ND	ppt	2	NA
SW 11	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA

SW 11	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	ND	ppt	2	10
SW 11	EPA 537	Perfluorooctanoic acid	1/12/2021	ND	ppt	2	10
SW 11	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 11	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 13	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 13	EPA 522	1,4-Dioxane	1/27/2021	ND	ppb	0.07	1
SW 13	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.4	ppt	2	10
SW 13	EPA 537	Perfluorooctanoic acid	10/2/2020	5.4	ppt	2	10
SW 13	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 13	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.1	ppt	2	10
SW 13	EPA 537	Perfluorooctanoic acid	1/13/2021	4.9	ppt	2	10
SW 13	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 13	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 522	1,4-Dioxane	1/13/2021	0.14	ppb	0.07	1
SW 14	EPA 522	1,4-Dioxane	10/2/2020	0.14	ppb	0.07	1
SW 14	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorohexanoic acid	10/2/2020	2	ppt	2	NA
SW 14	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10
SW 14	EPA 537	Perfluorooctanoic acid	10/2/2020	6.2	ppt	2	10
SW 14	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 14	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 14	EPA 537	Perfluorooctanoic acid	1/13/2021	5.5	ppt	2	10
SW 14	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 14	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA

SW 14	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 522	1,4-Dioxane	1/13/2021	0.093	ppb	0.07	1
SW 15	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 15	EPA 522	1,4-Dioxane	10/2/2020	0.11	ppb	0.07	1
SW 15	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	5.9	ppt	2	NA
SW 15	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroheptanoic acid	10/2/2020	4.2	ppt	2	NA
SW 15	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluorohexanoic acid	10/2/2020	7.5	ppt	2	NA
SW 15	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10
SW 15	EPA 537	Perfluorooctanoic acid	10/2/2020	9.1	ppt	2	10
SW 15	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 15	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	6.7	ppt	2	NA
SW 15	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroheptanoic acid	1/13/2021	4.7	ppt	2	NA
SW 15	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	2.4	ppt	2	NA
SW 15	EPA 537	Perfluorohexanoic acid	1/13/2021	6.9	ppt	2	NA
SW 15	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2	ppt	2	10
SW 15	EPA 537	Perfluorooctanoic acid	1/13/2021	12	ppt	2	10
SW 15	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 15	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorobutanesulfonic acid	2/5/2021	5.5	ppt	2	NA
SW 15	EPA 537	Perfluorodecanoic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorododecanoic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroheptanoic acid	2/5/2021	4.2	ppt	2	NA
SW 15	EPA 537	Perfluorohexanesulfonic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorohexanoic acid	2/5/2021	7.1	ppt	2	NA
SW 15	EPA 537	Perfluorononanoic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorooctanesulfonic acid	2/5/2021	ND	ppt	2	10
SW 15	EPA 537	Perfluorooctanoic acid	2/5/2021	8.1	ppt	2	10
SW 15	EPA 537	Perfluorotetradecanoic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluorotridecanoic acid	2/5/2021	ND	ppt	2	NA
SW 15	EPA 537	Perfluoroundecanoic acid	2/5/2021	ND	ppt	2	NA
SW 16	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 16	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	4.4	ppt	2	NA
SW 16	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroheptanoic acid	10/1/2020	7.3	ppt	2	NA
SW 16	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	8.8	ppt	2	NA
SW 16	EPA 537	Perfluorohexanoic acid	10/1/2020	11	ppt	2	NA
SW 16	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	8.6	ppt	2	10
SW 16	EPA 537	Perfluorooctanoic acid	10/1/2020	16	ppt	2	10
SW 16	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 16	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorobutanesulfonic acid	10/14/2020	4.7	ppt	2	NA
SW 16	EPA 537	Perfluorodecanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorododecanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroheptanoic acid	10/14/2020	7.4	ppt	2	NA
SW 16	EPA 537	Perfluorohexanesulfonic acid	10/14/2020	10	ppt	2	NA
SW 16	EPA 537	Perfluorohexanoic acid	10/14/2020	11	ppt	2	NA

SW 16	EPA 537	Perfluorononanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorooctanesulfonic acid	10/14/2020	11	ppt	2	10
SW 16	EPA 537	Perfluorooctanoic acid	10/14/2020	16	ppt	2	10
SW 16	EPA 537	Perfluorotetradecanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluorotridecanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroundecanoic acid	10/14/2020	ND	ppt	2	NA
SW 16	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	4.1	ppt	2	NA
SW 16	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroheptanoic acid	1/12/2021	8.6	ppt	2	NA
SW 16	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	10	ppt	2	NA
SW 16	EPA 537	Perfluorohexanoic acid	1/12/2021	13	ppt	2	NA
SW 16	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	7.3	ppt	2	10
SW 16	EPA 537	Perfluorooctanoic acid	1/12/2021	17	ppt	2	10
SW 16	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 16	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 17	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 17	EPA 522	1,4-Dioxane	10/2/2020	0.088	ppb	0.07	1
SW 17	EPA 522	1,4-Dioxane	10/7/2020	0.076	ppb	0.07	1
SW 17	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 17	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	6.1	ppt	2	NA
SW 17	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroheptanoic acid	10/2/2020	4.3	ppt	2	NA
SW 17	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	3.2	ppt	2	NA
SW 17	EPA 537	Perfluorohexanoic acid	10/2/2020	6.4	ppt	2	NA
SW 17	EPA 537	Perfluorononanoic acid	10/2/2020	4.3	ppt	2	NA
SW 17	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	9	ppt	2	10
SW 17	EPA 537	Perfluorooctanoic acid	10/2/2020	14	ppt	2	10
SW 17	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 17	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	5.9	ppt	2	NA
SW 17	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroheptanoic acid	10/7/2020	4.4	ppt	2	NA
SW 17	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	3.2	ppt	2	NA
SW 17	EPA 537	Perfluorohexanoic acid	10/7/2020	6.1	ppt	2	NA
SW 17	EPA 537	Perfluorononanoic acid	10/7/2020	4.2	ppt	2	NA
SW 17	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	9	ppt	2	10
SW 17	EPA 537	Perfluorooctanoic acid	10/7/2020	15	ppt	2	10
SW 17	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 17	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	6.7	ppt	2	NA
SW 17	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroheptanoic acid	1/13/2021	3.8	ppt	2	NA
SW 17	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	3.2	ppt	2	NA
SW 17	EPA 537	Perfluorohexanoic acid	1/13/2021	5.6	ppt	2	NA
SW 17	EPA 537	Perfluorononanoic acid	1/13/2021	3.8	ppt	2	NA
SW 17	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	9.5	ppt	2	10
SW 17	EPA 537	Perfluorooctanoic acid	1/13/2021	13	ppt	2	10
SW 17	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 17	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 18	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA

SW 18	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorohexanoic acid	10/2/2020	2	ppt	2	NA
SW 18	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.9	ppt	2	10
SW 18	EPA 537	Perfluorooctanoic acid	10/2/2020	7.1	ppt	2	10
SW 18	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 18	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.2	ppt	2	10
SW 18	EPA 537	Perfluorooctanoic acid	1/13/2021	7.2	ppt	2	10
SW 18	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 18	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 19	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 19	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 19	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluoroheptanoic acid	10/2/2020	2	ppt	2	NA
SW 19	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	3.2	ppt	2	NA
SW 19	EPA 537	Perfluorohexanoic acid	10/2/2020	2	ppt	2	NA
SW 19	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	4.8	ppt	2	10
SW 19	EPA 537	Perfluorooctanoic acid	10/2/2020	13	ppt	2	10
SW 19	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 19	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorobutanesulfonic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorodecanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorododecanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluoroheptanoic acid	10/15/2020	2.3	ppt	2	NA
SW 19	EPA 537	Perfluorohexanesulfonic acid	10/15/2020	3.3	ppt	2	NA
SW 19	EPA 537	Perfluorohexanoic acid	10/15/2020	2	ppt	2	NA
SW 19	EPA 537	Perfluorononanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorooctanesulfonic acid	10/15/2020	4.8	ppt	2	10
SW 19	EPA 537	Perfluorooctanoic acid	10/15/2020	13	ppt	2	10
SW 19	EPA 537	Perfluorotetradecanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluorotridecanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	Perfluoroundecanoic acid	10/15/2020	ND	ppt	2	NA
SW 19	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.3	ppt	2	NA
SW 19	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	3.3	ppt	2	NA
SW 19	EPA 537	Perfluorohexanoic acid	1/12/2021	2	ppt	2	NA
SW 19	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	5.1	ppt	2	10
SW 19	EPA 537	Perfluorooctanoic acid	1/12/2021	13	ppt	2	10
SW 19	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 19	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA

SW 19	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 1A	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 1A	EPA 522	1,4-Dioxane	10/2/2020	0.093	ppb	0.07	1
SW 1A	EPA 522	1,4-Dioxane	10/7/2020	0.074	ppb	0.07	1
SW 1A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	4.6	ppt	2	NA
SW 1A	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroheptanoic acid	10/2/2020	3.8	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	2.6	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanoic acid	10/2/2020	5.1	ppt	2	NA
SW 1A	EPA 537	Perfluorononanoic acid	10/2/2020	2	ppt	2	NA
SW 1A	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	7.2	ppt	2	10
SW 1A	EPA 537	Perfluorooctanoic acid	10/2/2020	14	ppt	2	10
SW 1A	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 1A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	4.6	ppt	2	NA
SW 1A	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroheptanoic acid	10/7/2020	3.8	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	2.8	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanoic acid	10/7/2020	5.1	ppt	2	NA
SW 1A	EPA 537	Perfluorononanoic acid	10/7/2020	2	ppt	2	NA
SW 1A	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	7.4	ppt	2	10
SW 1A	EPA 537	Perfluorooctanoic acid	10/7/2020	14	ppt	2	10
SW 1A	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 1A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	4.3	ppt	2	NA
SW 1A	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroheptanoic acid	1/13/2021	3.4	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	2.7	ppt	2	NA
SW 1A	EPA 537	Perfluorohexanoic acid	1/13/2021	4.7	ppt	2	NA
SW 1A	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	7.4	ppt	2	10
SW 1A	EPA 537	Perfluorooctanoic acid	1/13/2021	13	ppt	2	10
SW 1A	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 1A	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 20	EPA 522	1,4-Dioxane	1/13/2021	0.08	ppb	0.07	1
SW 20	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 20	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	5	ppt	2	NA
SW 20	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluoroheptanoic acid	10/1/2020	7.8	ppt	2	NA
SW 20	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	28	ppt	2	NA
SW 20	EPA 537	Perfluorohexanoic acid	10/1/2020	14	ppt	2	NA
SW 20	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	47	ppt	2	10
SW 20	EPA 537	Perfluorooctanoic acid	10/1/2020	11	ppt	2	10
SW 20	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 20	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	3.8	ppt	2	NA
SW 20	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluoroheptanoic acid	1/12/2021	5.4	ppt	2	NA
SW 20	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	20	ppt	2	NA

SW 20	EPA 537	Perfluorohexanoic acid	1/12/2021	9.7	ppt	2	NA
SW 20	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	32	ppt	2	10
SW 20	EPA 537	Perfluorooctanoic acid	1/12/2021	8.9	ppt	2	10
SW 20	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 20	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 21	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 21	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 21	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 21	EPA 537	Perfluorooctanoic acid	10/1/2020	3.6	ppt	2	10
SW 21	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 21	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 21	EPA 537	Perfluorooctanoic acid	1/13/2021	2.7	ppt	2	10
SW 21	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 21	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 22	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 22	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 22	EPA 537	Perfluorooctanoic acid	10/1/2020	6.4	ppt	2	10
SW 22	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 22	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 22	EPA 537	Perfluorooctanoic acid	1/13/2021	5	ppt	2	10
SW 22	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 22	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 23	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 23	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1

SW 23	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	3.5	ppt	2	NA
SW 23	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.7	ppt	2	NA
SW 23	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	2.6	ppt	2	NA
SW 23	EPA 537	Perfluorohexanoic acid	10/1/2020	2.6	ppt	2	NA
SW 23	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	6.4	ppt	2	10
SW 23	EPA 537	Perfluorooctanoic acid	10/1/2020	13	ppt	2	10
SW 23	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 23	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorobutanesulfonic acid	10/15/2020	4.2	ppt	2	NA
SW 23	EPA 537	Perfluorodecanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorododecanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroheptanoic acid	10/15/2020	2.6	ppt	2	NA
SW 23	EPA 537	Perfluorohexanesulfonic acid	10/15/2020	2.6	ppt	2	NA
SW 23	EPA 537	Perfluorohexanoic acid	10/15/2020	2.6	ppt	2	NA
SW 23	EPA 537	Perfluorononanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorooctanesulfonic acid	10/15/2020	6.7	ppt	2	10
SW 23	EPA 537	Perfluorooctanoic acid	10/15/2020	12	ppt	2	10
SW 23	EPA 537	Perfluorotetradecanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluorotridecanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroundecanoic acid	10/15/2020	ND	ppt	2	NA
SW 23	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	4.1	ppt	2	NA
SW 23	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.1	ppt	2	NA
SW 23	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	2.5	ppt	2	NA
SW 23	EPA 537	Perfluorohexanoic acid	1/12/2021	2.1	ppt	2	NA
SW 23	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	6.4	ppt	2	10
SW 23	EPA 537	Perfluorooctanoic acid	1/12/2021	11	ppt	2	10
SW 23	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 23	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 24	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 24	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 24	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.5	ppt	2	10
SW 24	EPA 537	Perfluorooctanoic acid	10/2/2020	6.8	ppt	2	10
SW 24	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 24	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.3	ppt	2	NA
SW 24	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.9	ppt	2	10
SW 24	EPA 537	Perfluorooctanoic acid	1/13/2021	8	ppt	2	10

SW 24	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 24	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 26	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 26	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 26	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2	ppt	2	NA
SW 26	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.5	ppt	2	NA
SW 26	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluorohexanoic acid	10/1/2020	3.5	ppt	2	NA
SW 26	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.4	ppt	2	10
SW 26	EPA 537	Perfluorooctanoic acid	10/1/2020	9.3	ppt	2	10
SW 26	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 26	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.4	ppt	2	NA
SW 26	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorohexanoic acid	1/12/2021	3.6	ppt	2	NA
SW 26	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.3	ppt	2	10
SW 26	EPA 537	Perfluorooctanoic acid	1/12/2021	9.1	ppt	2	10
SW 26	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 26	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 27	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 27	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 27	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.6	ppt	2	NA
SW 27	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorohexanoic acid	10/2/2020	2.4	ppt	2	NA
SW 27	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	4.5	ppt	2	10
SW 27	EPA 537	Perfluorooctanoic acid	10/2/2020	7.2	ppt	2	10
SW 27	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 27	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2	ppt	2	NA
SW 27	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.5	ppt	2	10
SW 27	EPA 537	Perfluorooctanoic acid	1/13/2021	4.5	ppt	2	10
SW 27	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 27	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 28	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 28	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.6	ppt	2	NA
SW 28	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA

SW 28	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.1	ppt	2	NA
SW 28	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluorohexanoic acid	10/1/2020	3.2	ppt	2	NA
SW 28	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.6	ppt	2	10
SW 28	EPA 537	Perfluorooctanoic acid	10/1/2020	9.6	ppt	2	10
SW 28	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 28	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.7	ppt	2	NA
SW 28	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluoroheptanoic acid	1/13/2021	3	ppt	2	NA
SW 28	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluorohexanoic acid	1/13/2021	4.9	ppt	2	NA
SW 28	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4	ppt	2	10
SW 28	EPA 537	Perfluorooctanoic acid	1/13/2021	9.5	ppt	2	10
SW 28	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 28	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 29	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 29	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.9	ppt	2	NA
SW 29	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	5.3	ppt	2	10
SW 29	EPA 537	Perfluorooctanoic acid	10/2/2020	5.5	ppt	2	10
SW 29	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 29	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.4	ppt	2	NA
SW 29	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4.2	ppt	2	10
SW 29	EPA 537	Perfluorooctanoic acid	1/13/2021	2.6	ppt	2	10
SW 29	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 29	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 3	EPA 522	1,4-Dioxane	10/2/2020	0.091	ppb	0.07	1
SW 3	EPA 522	1,4-Dioxane	10/7/2020	0.088	ppb	0.07	1
SW 3	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	5.4	ppt	2	NA
SW 3	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroheptanoic acid	10/2/2020	3.2	ppt	2	NA
SW 3	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	2.3	ppt	2	NA
SW 3	EPA 537	Perfluorohexanoic acid	10/2/2020	4.8	ppt	2	NA
SW 3	EPA 537	Perfluorononanoic acid	10/2/2020	2.9	ppt	2	NA
SW 3	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	6.4	ppt	2	10
SW 3	EPA 537	Perfluorooctanoic acid	10/2/2020	12	ppt	2	10
SW 3	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA

SW 3	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 3	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	4.1	ppt	2	NA
SW 3	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroheptanoic acid	10/7/2020	2.9	ppt	2	NA
SW 3	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	2.2	ppt	2	NA
SW 3	EPA 537	Perfluorohexanoic acid	10/7/2020	4.1	ppt	2	NA
SW 3	EPA 537	Perfluorononanoic acid	10/7/2020	2	ppt	2	NA
SW 3	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	5.5	ppt	2	10
SW 3	EPA 537	Perfluorooctanoic acid	10/7/2020	10	ppt	2	10
SW 3	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 3	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	4.6	ppt	2	NA
SW 3	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroheptanoic acid	1/13/2021	2.5	ppt	2	NA
SW 3	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	2.2	ppt	2	NA
SW 3	EPA 537	Perfluorohexanoic acid	1/13/2021	3.9	ppt	2	NA
SW 3	EPA 537	Perfluorononanoic acid	1/13/2021	2	ppt	2	NA
SW 3	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	6.1	ppt	2	10
SW 3	EPA 537	Perfluorooctanoic acid	1/13/2021	10	ppt	2	10
SW 3	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 3	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 30	EPA 522	1,4-Dioxane	1/13/2021	0.071	ppb	0.07	1
SW 30	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 30	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorohexanoic acid	10/1/2020	3.2	ppt	2	NA
SW 30	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.3	ppt	2	10
SW 30	EPA 537	Perfluorooctanoic acid	10/1/2020	7.2	ppt	2	10
SW 30	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 30	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	2.3	ppt	2	NA
SW 30	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.6	ppt	2	NA
SW 30	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorohexanoic acid	1/12/2021	3	ppt	2	NA
SW 30	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.2	ppt	2	10
SW 30	EPA 537	Perfluorooctanoic acid	1/12/2021	11	ppt	2	10
SW 30	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 30	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorobutanesulfonic acid	2/5/2021	2.3	ppt	2	NA
SW 30	EPA 537	Perfluorodecanoic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorododecanoic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroheptanoic acid	2/5/2021	2.6	ppt	2	NA
SW 30	EPA 537	Perfluorohexanesulfonic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorohexanoic acid	2/5/2021	3.1	ppt	2	NA
SW 30	EPA 537	Perfluorononanoic acid	2/5/2021	ND	ppt	2	NA

SW 30	EPA 537	Perfluorooctanesulfonic acid	2/5/2021	3.1	ppt	2	10
SW 30	EPA 537	Perfluorooctanoic acid	2/5/2021	11	ppt	2	10
SW 30	EPA 537	Perfluorotetradecanoic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluorotridecanoic acid	2/5/2021	ND	ppt	2	NA
SW 30	EPA 537	Perfluoroundecanoic acid	2/5/2021	ND	ppt	2	NA
SW 31A	EPA 522	1,4-Dioxane	10/1/2020	0.076	ppb	0.07	1
SW 31A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	10	ppt	2	NA
SW 31A	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluoroheptanoic acid	10/1/2020	8.6	ppt	2	NA
SW 31A	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	4.2	ppt	2	NA
SW 31A	EPA 537	Perfluorohexanoic acid	10/1/2020	14	ppt	2	NA
SW 31A	EPA 537	Perfluorononanoic acid	10/1/2020	4.7	ppt	2	NA
SW 31A	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.6	ppt	2	10
SW 31A	EPA 537	Perfluorooctanoic acid	10/1/2020	19	ppt	2	10
SW 31A	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 31A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorobutanesulfonic acid	10/15/2020	11	ppt	2	NA
SW 31A	EPA 537	Perfluorodecanoic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorododecanoic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluoroheptanoic acid	10/15/2020	8.3	ppt	2	NA
SW 31A	EPA 537	Perfluorohexanesulfonic acid	10/15/2020	4.4	ppt	2	NA
SW 31A	EPA 537	Perfluorohexanoic acid	10/15/2020	15	ppt	2	NA
SW 31A	EPA 537	Perfluorononanoic acid	10/15/2020	4.8	ppt	2	NA
SW 31A	EPA 537	Perfluorooctanesulfonic acid	10/15/2020	3.8	ppt	2	10
SW 31A	EPA 537	Perfluorooctanoic acid	10/15/2020	19	ppt	2	10
SW 31A	EPA 537	Perfluorotetradecanoic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluorotridecanoic acid	10/15/2020	ND	ppt	2	NA
SW 31A	EPA 537	Perfluoroundecanoic acid	10/15/2020	ND	ppt	2	NA
SW 32	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 32	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 32	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.2	ppt	2	NA
SW 32	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluoroheptanoic acid	10/2/2020	2	ppt	2	NA
SW 32	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluorohexanoic acid	10/2/2020	2.5	ppt	2	NA
SW 32	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.7	ppt	2	10
SW 32	EPA 537	Perfluorooctanoic acid	10/2/2020	6.2	ppt	2	10
SW 32	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 32	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.8	ppt	2	10
SW 32	EPA 537	Perfluorooctanoic acid	1/12/2021	5.8	ppt	2	10
SW 32	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 32	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 37	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 37	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 37	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA

SW 37	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3	ppt	2	10
SW 37	EPA 537	Perfluorooctanoic acid	10/2/2020	5.6	ppt	2	10
SW 37	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 37	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4.6	ppt	2	10
SW 37	EPA 537	Perfluorooctanoic acid	1/13/2021	6.2	ppt	2	10
SW 37	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 37	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 38	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 38	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroheptanoic acid	10/2/2020	2.4	ppt	2	NA
SW 38	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorohexanoic acid	10/2/2020	2.5	ppt	2	NA
SW 38	EPA 537	Perfluorononanoic acid	10/2/2020	3.7	ppt	2	NA
SW 38	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	5.2	ppt	2	10
SW 38	EPA 537	Perfluorooctanoic acid	10/2/2020	11	ppt	2	10
SW 38	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 38	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorobutanesulfonic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorodecanoic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorododecanoic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroheptanoic acid	10/15/2020	2.1	ppt	2	NA
SW 38	EPA 537	Perfluorohexanesulfonic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorohexanoic acid	10/15/2020	2.3	ppt	2	NA
SW 38	EPA 537	Perfluorononanoic acid	10/15/2020	3.3	ppt	2	NA
SW 38	EPA 537	Perfluorooctanesulfonic acid	10/15/2020	5.4	ppt	2	10
SW 38	EPA 537	Perfluorooctanoic acid	10/15/2020	11	ppt	2	10
SW 38	EPA 537	Perfluorotetradecanoic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluorotridecanoic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroundecanoic acid	10/15/2020	ND	ppt	2	NA
SW 38	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.6	ppt	2	10
SW 38	EPA 537	Perfluorooctanoic acid	1/13/2021	5.9	ppt	2	10
SW 38	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 38	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA

SW 4	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 4	EPA 522	1,4-Dioxane	10/2/2020	0.1	ppb	0.07	1
SW 4	EPA 522	1,4-Dioxane	10/7/2020	0.092	ppb	0.07	1
SW 4	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.7	ppt	2	NA
SW 4	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroheptanoic acid	10/2/2020	2	ppt	2	NA
SW 4	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorohexanoic acid	10/2/2020	2.9	ppt	2	NA
SW 4	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.9	ppt	2	10
SW 4	EPA 537	Perfluorooctanoic acid	10/2/2020	8	ppt	2	10
SW 4	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 4	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	2.2	ppt	2	NA
SW 4	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroheptanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorohexanoic acid	10/7/2020	2.3	ppt	2	NA
SW 4	EPA 537	Perfluorononanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	3.1	ppt	2	10
SW 4	EPA 537	Perfluorooctanoic acid	10/7/2020	7	ppt	2	10
SW 4	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 4	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.5	ppt	2	NA
SW 4	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorohexanoic acid	1/13/2021	2.4	ppt	2	NA
SW 4	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.7	ppt	2	10
SW 4	EPA 537	Perfluorooctanoic acid	1/13/2021	7.2	ppt	2	10
SW 4	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 4	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 522	1,4-Dioxane	1/13/2021	0.076	ppb	0.07	1
SW 42A	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 42A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10
SW 42A	EPA 537	Perfluorooctanoic acid	10/2/2020	ND	ppt	2	10
SW 42A	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 42A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA

SW 42A	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 42A	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 42A	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 42A	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 46	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 46	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 46	EPA 537	Perfluorooctanoic acid	10/1/2020	2.7	ppt	2	10
SW 46	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 46	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 46	EPA 537	Perfluorooctanoic acid	1/13/2021	2.5	ppt	2	10
SW 46	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 46	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 50	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 50	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.4	ppt	2	NA
SW 50	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorohexanoic acid	10/1/2020	2.8	ppt	2	NA
SW 50	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 50	EPA 537	Perfluorooctanoic acid	10/1/2020	5	ppt	2	10
SW 50	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 50	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluoroheptanoic acid	1/13/2021	2	ppt	2	NA
SW 50	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorohexanoic acid	1/13/2021	2.5	ppt	2	NA
SW 50	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 50	EPA 537	Perfluorooctanoic acid	1/13/2021	4.8	ppt	2	10
SW 50	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 50	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 51	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 51	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA

SW 51	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 51	EPA 537	Perfluorooctanoic acid	10/1/2020	ND	ppt	2	10
SW 51	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 51	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 51	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 51	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 51	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 53	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 53	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 53	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorohexanoic acid	10/1/2020	2.4	ppt	2	NA
SW 53	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	2.4	ppt	2	10
SW 53	EPA 537	Perfluorooctanoic acid	10/1/2020	6.4	ppt	2	10
SW 53	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 53	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorohexanoic acid	1/12/2021	2.2	ppt	2	NA
SW 53	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	2.5	ppt	2	10
SW 53	EPA 537	Perfluorooctanoic acid	1/12/2021	6	ppt	2	10
SW 53	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 53	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 54A	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 54A	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 54A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10

SW 54A	EPA 537	Perfluorooctanoic acid	10/2/2020	ND	ppt	2	10
SW 54A	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 54A	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 54A	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 54A	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 54A	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 55	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 55	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluoroheptanoic acid	10/2/2020	2.7	ppt	2	NA
SW 55	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorohexanoic acid	10/2/2020	5.3	ppt	2	NA
SW 55	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.6	ppt	2	10
SW 55	EPA 537	Perfluorooctanoic acid	10/2/2020	8.6	ppt	2	10
SW 55	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 55	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluoroheptanoic acid	1/13/2021	2	ppt	2	NA
SW 55	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorohexanoic acid	1/13/2021	4.1	ppt	2	NA
SW 55	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.9	ppt	2	10
SW 55	EPA 537	Perfluorooctanoic acid	1/13/2021	7.4	ppt	2	10
SW 55	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 55	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 56	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 56	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	3.3	ppt	2	NA
SW 56	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluoroheptanoic acid	10/2/2020	3.2	ppt	2	NA
SW 56	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorohexanoic acid	10/2/2020	4.5	ppt	2	NA
SW 56	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	4.2	ppt	2	10
SW 56	EPA 537	Perfluorooctanoic acid	10/2/2020	11	ppt	2	10
SW 56	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 56	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorobutanesulfonic acid	10/14/2020	3.5	ppt	2	NA
SW 56	EPA 537	Perfluorodecanoic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorododecanoic acid	10/14/2020	ND	ppt	2	NA

SW 56	EPA 537	Perfluoroheptanoic acid	10/14/2020	3	ppt	2	NA
SW 56	EPA 537	Perfluorohexanesulfonic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorohexanoic acid	10/14/2020	4.3	ppt	2	NA
SW 56	EPA 537	Perfluorononanoic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorooctanesulfonic acid	10/14/2020	4.2	ppt	2	10
SW 56	EPA 537	Perfluorooctanoic acid	10/14/2020	10	ppt	2	10
SW 56	EPA 537	Perfluorotetradecanoic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluorotridecanoic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	Perfluoroundecanoic acid	10/14/2020	ND	ppt	2	NA
SW 56	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	3.1	ppt	2	NA
SW 56	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluoroheptanoic acid	1/13/2021	3.2	ppt	2	NA
SW 56	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluorohexanoic acid	1/13/2021	3.9	ppt	2	NA
SW 56	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4.6	ppt	2	10
SW 56	EPA 537	Perfluorooctanoic acid	1/13/2021	11	ppt	2	10
SW 56	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 56	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 6	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 6	EPA 522	1,4-Dioxane	10/7/2020	ND	ppb	0.07	1
SW 6	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 6	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	3.6	ppt	2	NA
SW 6	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroheptanoic acid	10/2/2020	2.2	ppt	2	NA
SW 6	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorohexanoic acid	10/2/2020	3.2	ppt	2	NA
SW 6	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.6	ppt	2	10
SW 6	EPA 537	Perfluorooctanoic acid	10/2/2020	7.8	ppt	2	10
SW 6	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 6	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	3	ppt	2	NA
SW 6	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroheptanoic acid	10/7/2020	2.1	ppt	2	NA
SW 6	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorohexanoic acid	10/7/2020	3.1	ppt	2	NA
SW 6	EPA 537	Perfluorononanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	3.4	ppt	2	10
SW 6	EPA 537	Perfluorooctanoic acid	10/7/2020	7.9	ppt	2	10
SW 6	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 6	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	3.3	ppt	2	NA
SW 6	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorohexanoic acid	1/13/2021	3	ppt	2	NA
SW 6	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	4	ppt	2	10
SW 6	EPA 537	Perfluorooctanoic acid	1/13/2021	7.5	ppt	2	10
SW 6	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 6	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA

SW 64	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 64	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.2	ppt	2	10
SW 64	EPA 537	Perfluorooctanoic acid	10/2/2020	3	ppt	2	10
SW 64	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 64	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	2.1	ppt	2	10
SW 64	EPA 537	Perfluorooctanoic acid	1/12/2021	3	ppt	2	10
SW 64	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 64	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 65	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 65	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	3.1	ppt	2	NA
SW 65	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluoroheptanoic acid	10/2/2020	2.1	ppt	2	NA
SW 65	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluorohexanoic acid	10/2/2020	3.1	ppt	2	NA
SW 65	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.5	ppt	2	10
SW 65	EPA 537	Perfluorooctanoic acid	10/2/2020	7.5	ppt	2	10
SW 65	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 65	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	3.4	ppt	2	NA
SW 65	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorohexanoic acid	1/12/2021	2.9	ppt	2	NA
SW 65	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	4	ppt	2	10
SW 65	EPA 537	Perfluorooctanoic acid	1/12/2021	6.8	ppt	2	10
SW 65	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 65	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 66	EPA 522	1,4-Dioxane	1/12/2021	0.073	ppb	0.07	1
SW 66	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.2	ppt	2	NA
SW 66	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	2.2	ppt	2	NA
SW 66	EPA 537	Perfluorohexanoic acid	10/1/2020	2.9	ppt	2	NA

SW 66	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	2.3	ppt	2	10
SW 66	EPA 537	Perfluorooctanoic acid	10/1/2020	6.8	ppt	2	10
SW 66	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 66	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.2	ppt	2	NA
SW 66	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	2.2	ppt	2	NA
SW 66	EPA 537	Perfluorohexanoic acid	1/12/2021	2.6	ppt	2	NA
SW 66	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.1	ppt	2	10
SW 66	EPA 537	Perfluorooctanoic acid	1/12/2021	7	ppt	2	10
SW 66	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 66	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 67	EPA 522	1,4-Dioxane	10/1/2020	0.088	ppb	0.07	1
SW 67	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 67	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorohexanoic acid	10/2/2020	3.5	ppt	2	NA
SW 67	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3	ppt	2	10
SW 67	EPA 537	Perfluorooctanoic acid	10/2/2020	7.3	ppt	2	10
SW 67	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 67	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.1	ppt	2	NA
SW 67	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluoroheptanoic acid	1/13/2021	2.4	ppt	2	NA
SW 67	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluorohexanoic acid	1/13/2021	6.1	ppt	2	NA
SW 67	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.6	ppt	2	10
SW 67	EPA 537	Perfluorooctanoic acid	1/13/2021	8	ppt	2	10
SW 67	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 67	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 68	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 68	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 68	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 68	EPA 537	Perfluorooctanoic acid	10/1/2020	4.1	ppt	2	10
SW 68	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 68	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA

SW 68	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	ND	ppt	2	10
SW 68	EPA 537	Perfluorooctanoic acid	1/12/2021	3.8	ppt	2	10
SW 68	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 68	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 69	EPA 522	1,4-Dioxane	1/12/2021	0.37	ppb	0.07	1
SW 69	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorononanoic acid	10/1/2020	5.5	ppt	2	NA
SW 69	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 69	EPA 537	Perfluorooctanoic acid	10/1/2020	5.9	ppt	2	10
SW 69	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 69	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorononanoic acid	1/12/2021	7.5	ppt	2	NA
SW 69	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	2.6	ppt	2	10
SW 69	EPA 537	Perfluorooctanoic acid	1/12/2021	6.6	ppt	2	10
SW 69	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 69	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 70	EPA 522	1,4-Dioxane	10/1/2020	0.44	ppb	0.07	1
SW 70	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 70	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.6	ppt	2	NA
SW 70	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroheptanoic acid	10/2/2020	2.2	ppt	2	NA
SW 70	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorohexanoic acid	10/2/2020	2.3	ppt	2	NA
SW 70	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	4.7	ppt	2	10
SW 70	EPA 537	Perfluorooctanoic acid	10/2/2020	11	ppt	2	10
SW 70	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 70	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorobutanesulfonic acid	10/14/2020	3	ppt	2	NA
SW 70	EPA 537	Perfluorodecanoic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorododecanoic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroheptanoic acid	10/14/2020	2.3	ppt	2	NA
SW 70	EPA 537	Perfluorohexanesulfonic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorohexanoic acid	10/14/2020	2.4	ppt	2	NA
SW 70	EPA 537	Perfluorononanoic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluorooctanesulfonic acid	10/14/2020	5.4	ppt	2	10
SW 70	EPA 537	Perfluorooctanoic acid	10/14/2020	11	ppt	2	10
SW 70	EPA 537	Perfluorotetradecanoic acid	10/14/2020	ND	ppt	2	NA

SW 70	EPA 537	Perfluorotridecanoic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroundecanoic acid	10/14/2020	ND	ppt	2	NA
SW 70	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	ND	ppt	2	10
SW 70	EPA 537	Perfluorooctanoic acid	1/13/2021	3.6	ppt	2	10
SW 70	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 70	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 71	EPA 522	1,4-Dioxane	1/13/2021	0.096	ppb	0.07	1
SW 71	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 71	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2.8	ppt	2	NA
SW 71	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluoroheptanoic acid	10/2/2020	2	ppt	2	NA
SW 71	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluorohexanoic acid	10/2/2020	2.5	ppt	2	NA
SW 71	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.6	ppt	2	10
SW 71	EPA 537	Perfluorooctanoic acid	10/2/2020	9.1	ppt	2	10
SW 71	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 71	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	2.6	ppt	2	NA
SW 71	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorohexanoic acid	1/12/2021	2.1	ppt	2	NA
SW 71	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.8	ppt	2	10
SW 71	EPA 537	Perfluorooctanoic acid	1/12/2021	7.7	ppt	2	10
SW 71	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 71	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 72	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 72	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	2.7	ppt	2	10
SW 72	EPA 537	Perfluorooctanoic acid	10/1/2020	7.3	ppt	2	10
SW 72	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 72	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA

SW 72	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	2.7	ppt	2	10
SW 72	EPA 537	Perfluorooctanoic acid	1/12/2021	6.7	ppt	2	10
SW 72	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 72	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 73	EPA 522	1,4-Dioxane	10/2/2020	0.079	ppb	0.07	1
SW 73	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorohexanoic acid	10/2/2020	2	ppt	2	NA
SW 73	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	2.6	ppt	2	10
SW 73	EPA 537	Perfluorooctanoic acid	10/2/2020	6.4	ppt	2	10
SW 73	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 73	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	2	ppt	2	NA
SW 73	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	3.6	ppt	2	10
SW 73	EPA 537	Perfluorooctanoic acid	1/12/2021	6	ppt	2	10
SW 73	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 73	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 78	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 78	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 78	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	2	ppt	2	NA
SW 78	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluoroheptanoic acid	10/2/2020	3.6	ppt	2	NA
SW 78	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluorohexanoic acid	10/2/2020	12	ppt	2	NA
SW 78	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	3.2	ppt	2	10
SW 78	EPA 537	Perfluorooctanoic acid	10/2/2020	8.3	ppt	2	10
SW 78	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 78	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	2.2	ppt	2	NA
SW 78	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluoroheptanoic acid	1/13/2021	4.1	ppt	2	NA
SW 78	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluorohexanoic acid	1/13/2021	12	ppt	2	NA
SW 78	EPA 537	Perfluorononanoic acid	1/13/2021	2.1	ppt	2	NA
SW 78	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.4	ppt	2	10
SW 78	EPA 537	Perfluorooctanoic acid	1/13/2021	8.8	ppt	2	10
SW 78	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 78	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 79	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 79	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1

SW 79	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorohexanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 79	EPA 537	Perfluorooctanoic acid	10/1/2020	2.3	ppt	2	10
SW 79	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 79	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	ND	ppt	2	10
SW 79	EPA 537	Perfluorooctanoic acid	1/12/2021	2.1	ppt	2	10
SW 79	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 79	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 8	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 8	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorohexanoic acid	10/1/2020	3.2	ppt	2	NA
SW 8	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	ND	ppt	2	10
SW 8	EPA 537	Perfluorooctanoic acid	10/1/2020	2.8	ppt	2	10
SW 8	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 8	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorohexanoic acid	1/12/2021	2.6	ppt	2	NA
SW 8	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	ND	ppt	2	10
SW 8	EPA 537	Perfluorooctanoic acid	1/12/2021	2.6	ppt	2	10
SW 8	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 8	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 82	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 82	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	3.7	ppt	2	NA
SW 82	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.7	ppt	2	NA
SW 82	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	2.8	ppt	2	NA
SW 82	EPA 537	Perfluorohexanoic acid	10/1/2020	3.7	ppt	2	NA
SW 82	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA

SW 82	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	5.3	ppt	2	10
SW 82	EPA 537	Perfluorooctanoic acid	10/1/2020	12	ppt	2	10
SW 82	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 82	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	4.2	ppt	2	NA
SW 82	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluoroheptanoic acid	1/12/2021	2.8	ppt	2	NA
SW 82	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	2.9	ppt	2	NA
SW 82	EPA 537	Perfluorohexanoic acid	1/12/2021	3.7	ppt	2	NA
SW 82	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	5.2	ppt	2	10
SW 82	EPA 537	Perfluorooctanoic acid	1/12/2021	12	ppt	2	10
SW 82	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 82	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 83	EPA 522	1,4-Dioxane	10/2/2020	ND	ppb	0.07	1
SW 83	EPA 522	1,4-Dioxane	10/7/2020	ND	ppb	0.07	1
SW 83	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorobutanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorodecanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorododecanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroheptanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanesulfonic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorononanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorooctanesulfonic acid	10/2/2020	ND	ppt	2	10
SW 83	EPA 537	Perfluorooctanoic acid	10/2/2020	5.8	ppt	2	10
SW 83	EPA 537	Perfluorotetradecanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorotridecanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroundecanoic acid	10/2/2020	ND	ppt	2	NA
SW 83	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorobutanesulfonic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorodecanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorododecanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroheptanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanesulfonic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorononanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorooctanesulfonic acid	10/7/2020	ND	ppt	2	10
SW 83	EPA 537	Perfluorooctanoic acid	10/7/2020	5.8	ppt	2	10
SW 83	EPA 537	Perfluorotetradecanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluorotridecanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroundecanoic acid	10/7/2020	ND	ppt	2	NA
SW 83	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorobutanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorodecanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorododecanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroheptanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanesulfonic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorohexanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorononanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorooctanesulfonic acid	1/12/2021	ND	ppt	2	10
SW 83	EPA 537	Perfluorooctanoic acid	1/12/2021	5	ppt	2	10
SW 83	EPA 537	Perfluorotetradecanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluorotridecanoic acid	1/12/2021	ND	ppt	2	NA
SW 83	EPA 537	Perfluoroundecanoic acid	1/12/2021	ND	ppt	2	NA
SW 84	EPA 522	1,4-Dioxane	1/12/2021	ND	ppb	0.07	1
SW 84	EPA 522	1,4-Dioxane	10/1/2020	0.073	ppb	0.07	1
SW 84	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.8	ppt	2	NA

SW 84	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorohexanoic acid	10/1/2020	3.3	ppt	2	NA
SW 84	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.3	ppt	2	10
SW 84	EPA 537	Perfluorooctanoic acid	10/1/2020	5.8	ppt	2	10
SW 84	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 84	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.4	ppt	2	10
SW 84	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 84	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 84	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 85	EPA 522	1,4-Dioxane	10/1/2020	0.074	ppb	0.07	1
SW 85	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.2	ppt	2	NA
SW 85	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.4	ppt	2	NA
SW 85	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluorohexanoic acid	10/1/2020	7.2	ppt	2	NA
SW 85	EPA 537	Perfluorononanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.2	ppt	2	10
SW 85	EPA 537	Perfluorooctanoic acid	10/1/2020	5.9	ppt	2	10
SW 85	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 85	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2	ppt	2	10
SW 85	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 85	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 85	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 93	EPA 522	1,4-Dioxane	10/1/2020	0.074	ppb	0.07	1
SW 93	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.5	ppt	2	NA
SW 93	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	Perfluoroheptanoic acid	10/1/2020	3.8	ppt	2	NA
SW 93	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	Perfluorohexanoic acid	10/1/2020	9.4	ppt	2	NA
SW 93	EPA 537	Perfluorononanoic acid	10/1/2020	2	ppt	2	NA
SW 93	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.7	ppt	2	10
SW 93	EPA 537	Perfluorooctanoic acid	10/1/2020	9	ppt	2	10
SW 93	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA

SW 93	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 93	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorohexanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.4	ppt	2	10
SW 93	EPA 537	Perfluorooctanoic acid	1/13/2021	ND	ppt	2	10
SW 93	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 93	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 522	1,4-Dioxane	1/13/2021	ND	ppb	0.07	1
SW 94	EPA 522	1,4-Dioxane	1/13/2021	0.12	ppb	0.07	1
SW 94	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.1	ppt	2	NA
SW 94	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluorohexanoic acid	10/1/2020	5.6	ppt	2	NA
SW 94	EPA 537	Perfluorononanoic acid	10/1/2020	2.7	ppt	2	NA
SW 94	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.8	ppt	2	10
SW 94	EPA 537	Perfluorooctanoic acid	10/1/2020	5	ppt	2	10
SW 94	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 94	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorohexanoic acid	1/13/2021	2.1	ppt	2	NA
SW 94	EPA 537	Perfluorononanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.6	ppt	2	10
SW 94	EPA 537	Perfluorooctanoic acid	1/13/2021	2.6	ppt	2	10
SW 94	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 94	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 522	1,4-Dioxane	10/1/2020	0.17	ppb	0.07	1
SW 95	EPA 522	1,4-Dioxane	1/13/2021	0.35	ppb	0.07	1
SW 95	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.6	ppt	2	NA
SW 95	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.1	ppt	2	NA
SW 95	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluorohexanoic acid	10/1/2020	4.9	ppt	2	NA
SW 95	EPA 537	Perfluorononanoic acid	10/1/2020	11	ppt	2	NA
SW 95	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.1	ppt	2	10
SW 95	EPA 537	Perfluorooctanoic acid	10/1/2020	6.5	ppt	2	10
SW 95	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 95	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA

SW 95	EPA 537	Perfluorohexanoic acid	1/13/2021	3	ppt	2	NA
SW 95	EPA 537	Perfluorononanoic acid	1/13/2021	7	ppt	2	NA
SW 95	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.6	ppt	2	10
SW 95	EPA 537	Perfluorooctanoic acid	1/13/2021	4	ppt	2	10
SW 95	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 95	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 522	1,4-Dioxane	10/1/2020	0.47	ppb	0.07	1
SW 96	EPA 522	1,4-Dioxane	1/13/2021	0.16	ppb	0.07	1
SW 96	EPA 522	1,4-Dioxane	10/1/2020	ND	ppb	0.07	1
SW 96	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.1	ppt	2	NA
SW 96	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluorohexanoic acid	10/1/2020	5.1	ppt	2	NA
SW 96	EPA 537	Perfluorononanoic acid	10/1/2020	3.8	ppt	2	NA
SW 96	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	3.4	ppt	2	10
SW 96	EPA 537	Perfluorooctanoic acid	10/1/2020	4.2	ppt	2	10
SW 96	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 96	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorohexanoic acid	1/13/2021	2.3	ppt	2	NA
SW 96	EPA 537	Perfluorononanoic acid	1/13/2021	2.8	ppt	2	NA
SW 96	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.8	ppt	2	10
SW 96	EPA 537	Perfluorooctanoic acid	1/13/2021	2.7	ppt	2	10
SW 96	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 96	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 522	1,4-Dioxane	10/1/2020	0.15	ppb	0.07	1
SW 97	EPA 522	1,4-Dioxane	1/13/2021	0.23	ppb	0.07	1
SW 97	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.3	ppt	2	NA
SW 97	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluoroheptanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluorohexanoic acid	10/1/2020	3.4	ppt	2	NA
SW 97	EPA 537	Perfluorononanoic acid	10/1/2020	13	ppt	2	NA
SW 97	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	6	ppt	2	10
SW 97	EPA 537	Perfluorooctanoic acid	10/1/2020	5	ppt	2	10
SW 97	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 97	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorohexanoic acid	1/13/2021	2.6	ppt	2	NA
SW 97	EPA 537	Perfluorononanoic acid	1/13/2021	10	ppt	2	NA
SW 97	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	3.8	ppt	2	10
SW 97	EPA 537	Perfluorooctanoic acid	1/13/2021	4.2	ppt	2	10
SW 97	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 97	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 522	1,4-Dioxane	10/1/2020	0.22	ppb	0.07	1

SW 98	EPA 522	1,4-Dioxane	10/1/2020	0.13	ppb	0.07	1
SW 98	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2	ppt	2	NA
SW 98	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluoroheptanoic acid	10/1/2020	2.3	ppt	2	NA
SW 98	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluorohexanoic acid	10/1/2020	5.4	ppt	2	NA
SW 98	EPA 537	Perfluorononanoic acid	10/1/2020	3.9	ppt	2	NA
SW 98	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.4	ppt	2	10
SW 98	EPA 537	Perfluorooctanoic acid	10/1/2020	5.4	ppt	2	10
SW 98	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 98	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorobutanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorodecanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorododecanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluoroheptanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorohexanesulfonic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorohexanoic acid	1/13/2021	2.3	ppt	2	NA
SW 98	EPA 537	Perfluorononanoic acid	1/13/2021	2.8	ppt	2	NA
SW 98	EPA 537	Perfluorooctanesulfonic acid	1/13/2021	2.9	ppt	2	10
SW 98	EPA 537	Perfluorooctanoic acid	1/13/2021	3.4	ppt	2	10
SW 98	EPA 537	Perfluorotetradecanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluorotridecanoic acid	1/13/2021	ND	ppt	2	NA
SW 98	EPA 537	Perfluoroundecanoic acid	1/13/2021	ND	ppt	2	NA
SW 99	EPA 522	1,4-Dioxane	1/13/2021	0.1	ppb	0.07	1
SW 99	EPA 522	1,4-Dioxane	2/5/2021	ND	ppb	0.07	1
SW 99	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluorobutanesulfonic acid	10/1/2020	2.6	ppt	2	NA
SW 99	EPA 537	Perfluorodecanoic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluorododecanoic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluoroheptanoic acid	10/1/2020	3.1	ppt	2	NA
SW 99	EPA 537	Perfluorohexanesulfonic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluorohexanoic acid	10/1/2020	6.7	ppt	2	NA
SW 99	EPA 537	Perfluorononanoic acid	10/1/2020	2	ppt	2	NA
SW 99	EPA 537	Perfluorooctanesulfonic acid	10/1/2020	4.4	ppt	2	10
SW 99	EPA 537	Perfluorooctanoic acid	10/1/2020	9.4	ppt	2	10
SW 99	EPA 537	Perfluorotetradecanoic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluorotridecanoic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	Perfluoroundecanoic acid	10/1/2020	ND	ppt	2	NA
SW 99	EPA 537	N-ethyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	N-methyl Perfluorooctanesulfonamidoacetic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorobutanesulfonic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorodecanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorododecanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluoroheptanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorohexanesulfonic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorohexanoic acid	2/5/2021	3.8	ppt	2	NA
SW 99	EPA 537	Perfluorononanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorooctanesulfonic acid	2/5/2021	3.3	ppt	2	10
SW 99	EPA 537	Perfluorooctanoic acid	2/5/2021	5.2	ppt	2	10
SW 99	EPA 537	Perfluorotetradecanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluorotridecanoic acid	2/5/2021	ND	ppt	2	NA
SW 99	EPA 537	Perfluoroundecanoic acid	2/5/2021	ND	ppt	2	NA

Exhibit D

IMPORTANT INFORMATION ABOUT YOUR DRINKING WATER

The Livingston Township Division of Water Has Levels of Perfluorooctanoic Acid (PFOA) Above A Drinking Water Standard

Our water system violated a New Jersey drinking water MCL and requirement, and as our customers, you have a right to know what happened, what you should do, and what we did/are doing to correct this situation.

You were previously notified of the PFOA maximum contaminant level (MCL) violation in public notices issued on 9/16/2021, 12/21/2021, 3/21/2022 and 6/17/2022. Per the federal Safe Drinking Water Act, we will continue to provide you with an updated public notice every 3 months until we complete all approved remedial measures and return to compliance with the MCL.

We routinely monitor for the presence of federal and state regulated drinking water contaminants. New Jersey adopted a standard, or maximum contaminant level (MCL), for PFOA in 2020 and monitoring began in 2021. The MCL for PFOA is 0.014 parts per billion (ppb) (or micrograms per liter (µg/L)) and is based on a running annual average (RAA), in which the four most recent quarters of monitoring data are averaged. On 8/10/2022 we received notice that the samples collected in the third quarter 2022 on the dates below showed that our system exceeds the PFOA MCL at 5 of our 11 treatment plants. The RAAs above the MCL for PFOA based on samples collected over the last year and the current status of each treatment plant are provided in the table below. It should be noted for Well 10 TP, the RAA for PFOA is based on samples collected previously as there are no current results since the source is no longer being used. See the table and "What is being done" below for more information.

Treatment Plant (TP)	Third Quarter 2022 Running Annual Average (RAA)	Most Recent Sample Collection Date	Current Status of TP
Well 2 TP – TP002004	0.015 ppb	7/28/2022	This TP is still in use and is undergoing treatment design.
Well 4 TP – TP004010	0.022 ppb	7/28/2022	This TP is still in use and is undergoing treatment design.
Well 8 TP – TP008018	0.018 ppb	7/28/2022	This TP is still in use and is undergoing treatment design.
Well 10 TP – TP010023	N/A	7/22/2021	This TP is not in use as of 9/2/2021 and is undergoing treatment design.
Well 11 TP – TP011026	0.021 ppb	7/28/2022	This TP is still in use and is undergoing treatment design.

Note: We are required to keep you informed of the status of any treatment plant with a PFOA MCL violation even if it has been shut off and is no longer delivering water as the violation still persists.

What is PFOA?

Perfluorooctanoic acid (PFOA) is a member of the group of chemicals called per- and polyfluoroalkyl substances (PFAS), used as a processing aid in the manufacture of fluoropolymers used in non-stick cookware and other products, as well as other commercial and industrial uses, based on its resistance to harsh chemicals and high temperatures. PFOA has also been used in aqueous film-forming foams for firefighting and training, and it is found in consumer products such as stain-resistant coatings for upholstery and carpets, water-resistant outdoor clothing, and greaseproof food packaging. Major sources of PFOA in drinking water include discharge from industrial facilities where it was made or used and the release of aqueous film-forming foam. Although the use of PFOA has decreased substantially, contamination is expected to continue indefinitely because it is extremely persistent in the environment and is soluble and mobile in water.

What does this mean?

**People who drink water containing PFOA in excess of the MCL over time could experience problems with their blood serum cholesterol levels, liver, kidney, immune system, or, in males, the reproductive system. Drinking water containing PFOA in excess of the MCL over time may also increase the risk of testicular and kidney cancer. For females, drinking water containing PFOA in excess of the MCL over time may cause developmental delays in a fetus and/or an infant. Some of these developmental effects may persist through childhood.*

** For specific health information, see* https://www.nj.gov/health/ceohs/documents/pfas_drinking%20water.pdf and https://www.nj.gov/dep/pfas/index.html.

What should I do?

- Anyone concerned about their health should consult with their personal healthcare provider.
- The New Jersey Department of Health advises that infant formula and other beverages for infants, such as plain water or juice, should be prepared with bottled water when PFOA is elevated in drinking water.
- Pregnant, nursing, and women considering having children may choose to use bottled water or a home filter designed to remove PFOA for drinking and cooking to reduce exposure to PFOA.
- Other people may also choose to use bottled water for drinking and cooking to reduce exposure to PFOA or a home water filter that is certified to reduce levels of PFOA.
- Home water treatment devices are available that can reduce levels of PFOA. If a water treatment device is used, it is important to follow the manufacturer's guidelines for maintenance and operation. For more specific information regarding the effectiveness of home water filters for reducing PFOA, visit the National Sanitation Foundation (NSF) International website, http:/www.nsf.org/. [NSF does not certify reduction of PFOA to the NJ MCL for PFOA.]
- Boiling your water will not remove PFOA.

For more information, see https://www.nj.gov/dep/watersupply/pfas/

What is being done?

The design for all affected treatment plants is well under way and is estimated to be completed by the end of 2022. These designs include the construction of new buildings and are specific to the constraints of each affected treatment plant. They also require extensive permitting from the NJDEP, which can be a lengthy process. Construction is estimated to begin by February of 2023 with completion of construction by August 2024. We anticipate resolving the problem within 3 years. This timing is subject to the availability of specialized labor and materials, supplies of which are in high demand given the large number of water systems in New Jersey that need to build similar treatment systems in response to the new regulation. Once the construction is complete, all affected treatment plants should then be in compliance.

To view all the drinking water quality data collected by Livingston Township Division of Water visit https://www9.state.nj.us/DEP_WaterWatch_public/index.jsp and enter NJ0710001 for the PWSID.

For more information, please contact Livingston Township Division of Water at 973-535-7951 or 357 S Livingston Ave, Livingston, NJ 07039 or water@livingstonnj.org. The most recent public notice and updates regarding this matter are available at http://www.livingstonnj.org/PFOA.

> **Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.**

This notice is being sent to you by Livingston Township Division of Water, State Water System ID#: NJ0710001

Date distributed: 9/22/2022