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September 19, 2019

By FedEx and e-mail

The Honorable Andrew Wheeler
Administrator
United States Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Re: Petition for Rulemaking Pursuant to Section 6974(a) of the Resource Conservation and Recovery Act Concerning the Regulation of a Class of Wastes Containing Per-and Polyfluoroalkyl Substances.

Dear Administrator Wheeler:

Please accept the attached petition for issuance of a rule to list waste containing per-and polyfluoroalkyl substances (PFAS) as a hazardous waste under Subpart C of the Resource Conservation Recovery Act (RCRA). This petition is made pursuant to RCRA, 42 U.S.C. § 6974(a) and Section 260.20 of the Code of Federal Regulations (CFR), 40 CFR § 260.20.

Thank you for your consideration of this petition.

Sincerely,

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The Proposed Action
EPA Should Regulate Wastes Containing PFAS Under Subtitle C of RCRA

I. PEER Has the Right to Petition the Administrator for This Rulemaking

PEER meets the statutory definition of a person and has the right to petition United States Environmental Protection Agency (EPA) under the **Resource Conservation and Recovery Act (RCRA)**. Under 42 U.S.C. 6974(a) and 40 CFR § 260.20, "[a]ny person may petition the Administrator for the promulgation, amendment, or repeal of any regulation under this chapter. Within a reasonable time following receipt of such petition, the Administrator shall take action with respect to such petition and shall publish notice of such action in the Federal Register, together with the reasons therefor."

II. Overview: The United States Needs to Regulate Waste Contaminated with PFAS

This petition requests that EPA develop regulations under the **RCRA** Subtitle C for generators, transporters, and owners or operators of treatment, storage, and disposal facilities to ensure the safe management and disposal of wastes containing per-and polyfluoroalkyl substances (PFAS)[1].

EPA's failure to address the cradle-to-grave management of waste contaminated with PFAS means the problems associated with PFAS contamination will grow exponentially worse over time, imposing tremendous financial, health, and environmental costs on society, while allowing those who created the problem to avoid or minimize financial responsibility for the harm caused by this waste.

A. PFAS are Dangerous Chemicals

PFAS are often referred to as "forever chemicals" because they do not break down in the environment and bioaccumulate in the food chain. PFAS are manufactured and used because of their unique physical and chemical properties. Widely used in fire retardants, water repellent-fabrics, furniture, take out containers, non-stick cookware, and other applications, thousands of PFAS chemicals are produced and in use in the United States.

Human exposure to PFAS is associated with cancer, birth defects, developmental damage to infants, and impaired functioning of the liver, kidneys, and immune system. As many as 100 million Americans could be drinking water contaminated with PFAS.[2] PFAS has been found in grocery store meats, milk, seafood, and off-the-shelf chocolate cakes. It is also found in wildlife and game, such as deer and fish. A study by American Red Cross recently found that American

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[1] There are thousands of PFAS is use today. PFAS are referred to as "long-chain" and "short chain." Long chain PFAS include:

- perfluoroalkane sulfonic acids (PFSAs) with carbon chain lengths of 6 and higher, including perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS);
- perfluorocarboxylic acids (PFCAs) with carbon chain lengths of 8 and higher, including perfluorooctanoic acid (PFOA).

Short-chain PFAS include:

- PFSAs with carbon chain lengths of 5 and lower, including perfluorobutane sulfonic acid (PFBS);
- PFCAs with carbon chain lengths of 7 and lower, including perfluorohexanoic acid (PFHxA).

[2] *EWG PFAS Testimony for the Record to the House Committee on Oversight and Reform*, Environmental Working Group (July 24, 2019), https://www.ewg.org/testimony-official-correspondence/ewg-pfas-testimony-record-house-committee-oversight-and-reform.

adults have an average of 4,300 ppt of PFOS and 1,100 ppt of PFOA (two types of PFAS) in their bloodstreams.[3]

PFAS use continues to increase. EPA reports that in 2016, 205 facilities each produced or imported in excess of 25,000 lbs of PFAS in the United States,[4] which means the United States produced or imported at least 5.125 million lbs of PFAS chemicals that year. This is likely a significant underreporting of PFAS production as it does not account for both low-volume production and actual production figures of major producers of PFAS, who are only required to report if they produce or import in excess of 25,000 lbs.

All PFAS will eventually work their way into waste streams, where, because of improper management, they will reenter the environment and harm human health and the environment.

B. PFAS Contamination is Widespread

Communities throughout the United States are affected with PFAS contamination.[5] According to the Northeastern SSEHRI PFAS Contamination Site Tracker, as of August 26, 2019, there were 721 sites known to be contaminated with PFAS in the United States. The number of known PFAS contaminated sites is expected to grow significantly as more entities begin to investigate the presence of PFAS contamination.

The threats posed by the mismanagement of PFAS waste are well-documented. Reports of illegal dumping of PFAS waste are growing.[6] Yet, even PFAS waste disposed of in landfills poses a threat to human health and the environment. Toxic PFAS can leak from landfills and severely pollute groundwater[7]—the primary source of drinking water for half the nation. Improper incineration of PFAS chemicals expels them into our environment and threatens our clean air and public health.[8] Throughout the United States, communities are finding sewage sludge

[3] Olsen GW et al., *Per- and Polyfluoroalkyl Substances (PFAS) in American Red Cross Adult Blood Donors, 2000–2015*, 157 ENVTL RES. 87-95 (2017).

[4] *See* Kirsten Stade, *PFAS Use in U.S. Skyrockets*, PEER (Mar. 27, 2019), https://www.peer.org/news/press-releases/pfas-use-in-u.s.-skyrockets.html; and supporting document: 3_27_19 CDR_PFAS_Data, https://docs.google.com/spreadsheets/d/1HX5u3mSp2TvpA9TiYLDYSUNdlFZFfAciHyat1VQaL1c/edit#gid=195201775.

[5] *Mapping the PFAS Contamination Crisis: New Data Show 712 Sites in 49 States*, Environmental Working Group https://www.ewg.org/interactive-maps/2019_pfas_contamination/.

[6] *See* Mike Papantonio, *3M Corporation Admits to Illegally Dumping Toxic Chemicals Into Tennessee River*, Ring of Fire (June 28, 2019), https://trofire.com/2019/06/28/3m-corporation-admits-to-illegally-dumping-toxic-chemicals-into-tennessee-river/; *see also* Paula Gardner, *Businesses Discharging PFAS Into Michigan's Waterways*, Michigan Live (Nov. 29, 2018), https://www.mlive.com/news/2018/11/businesses_discharging_pfas_in.html.

[7] Elizabeth Gribkoff, *We Don't Want to be the Dumping ground for All of New England*, VTDigger (Sept. 11, 2018), https://vtdigger.org/2018/09/11/dont-want-dumping-ground-new-england/. Italy, North Carolina, etc.

[8] Concawe Soil and Groundwater Taskforce (STF/33), *Environmental Fate and Effects of Poly-and Perfluoroalkyl Substances (PFAS)*, Brussels: Concawe (June 2016), https://www.concawe.eu/wp-content/uploads/2016/06/Rpt_16-8.pdf.; Kerri Jansen, *'Forever Chemicals' No More? These Technologies Aim to Destroy PFAS in Water*, Chemical & Engineering News (Mar. 25, 2019), https://cen.acs.org/environment/persistent-pollutants/Forever-chemicals-technologies-aim-destroy/97/i12.

contaminated with PFAS. [9] This sludge is often used as a fertilizer and works its way back into the food chain, contaminating the food supply and destroying the livelihood of farmers.[10]

C. U.S. Lacks PFAS Waste Management Standards

Despite the prevalence of PFAS production and imports into the United States, and its use in consumer and industrial products, no federal standards exist for the tracking and management of waste containing PFAS. With a growing focus on the toxicity of PFAS and the difficulties and costs associated with identifying and cleaning up contaminated sites, now is the time for EPA to develop a program for the safe management of PFAS wastes from the moment the waste is generated.

III. RCRA is the Proper Statute to Regulate PFAS Waste

RCRA Subtitle C is the only federal statute that can provide a comprehensive framework to manage PFAS waste in a way that protects public health and the environment. RCRA § 1004(5) requires EPA to regulate PFAS contaminated wastes that (1) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Subtitle C establishes a federal program to manage hazardous wastes from cradle to grave. It contains regulations for the generation, transportation, and treatment, storage, or disposal of hazardous wastes, and sets technical standards for the design and safe operation of Treatment Storage and Disposal Facilities (TSDF). These standards are designed to minimize the release of hazardous waste into the environment. Furthermore, the regulations for TSDFs serve as the basis for developing and issuing the permits required by the Act for each facility.

Regulating PFAS as a hazardous waste will also prevent the United States from becoming a dumping ground for PFAS wastes from other part of the world, such as Europe, that regulate PFAS as a hazardous waste. Because PFAS waste is not regulated as hazardous in the United States, EPA has no mechanisms to review, approve, and track imports, or to ensure that the disposal of these wastes is done in a safe manner. We know, for example, that Chemours used the United States to dispose of PFAS waste from the Netherlands, resulting in a pollution crisis in North Carolina because the waste was disposed of as non-hazardous. There is credible evidence that Chemours sent waste to underground injection wells and incinerators in the United States. These imports were only discovered by accident when a state inspector was told the waste was imported during a site inspection.[11]

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[9] Steven Verburg, *Wisconsin Battles Waste Plants that Spread Hazardous PFAS*, StarTribune (June 29, 2019), http://www.startribune.com/wisconsin-battles-waste-plants-that-spread-hazardous-pfas/511991101/.

[10] Amy Linn, *Groundwater Contamination Devastates a New Mexico Dairy—and Threatens Public Health*, NM Political Report (Feb. 19, 2019), https://nmpoliticalreport.com/2019/02/19/groundwater-contamination-devastates-a-new-mexico-dairy-and-threatens-public-health/.

[11] Sharon Lerner, *Chemours is Using the U.S. as an Unregulated Dump for Europe's Toxic GenX Waste*, The Intercept (Feb. 1, 2019), https://theintercept.com/2019/02/01/chemours-genx-north-carolina-netherlands/.

IV. RCRA requires EPA to Regulate PFAS Waste

There is enough available evidence for EPA to identify when solid waste contains high enough levels of PFAS to regulate the waste as hazardous under RCRA, and to establish what industrial processes and sources produce PFAS waste streams that pose sufficient threats such that they should be listed as a hazardous waste.[12]

Pursuant to 40 CFR §261.11(a)(1)–(3), the Administrator of EPA shall list a solid waste as hazardous if it: 1) exhibits characteristics of a hazardous waste; 2) is acutely hazardous; or 3) contains toxic constituents and the Administrator "concludes that the waste is capable of posing a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed" given 11 listed factors to be considered.[13] All PFAS contain fluorine, which is listed in Appendix VIII of toxic constituents.[14] Some PFAS chemicals also contain other toxic constituents.

In addition, PFAS pose a substantial hazard to human health and the environment. Each of the 11 factors to be considered is discussed below.

(i) *Nature of the Toxicity Presented by the Constituent.* Mounting scientific evidence shows that PFAS have toxic properties. Epidemiological studies identify the immune system as a target of long-chain PFAS toxicity.[15] Studies have found decreased antibody response to vaccines, and associations between blood serum levels of PFAS and immune system hypersensitivity (asthma) and autoimmune disorders (ulcerative colitis).[16]

Long-chain PFAS are also toxic to humans in very small concentrations—in the parts per trillion.[17] Long-chain PFAS are suspected carcinogens and have been linked to growth, learning, and behavioral problems in infants and children; fertility and pregnancy problems, including pre-eclampsia; interference with natural human hormones; increased cholesterol; immune system problems; and interference with liver, thyroid, and pancreatic function.[18] Long-chain PFAS have been linked to increases in testicular and kidney cancer in human adults.[19] The developing fetus and newborn babies are particularly

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[12] 40 C.F.R. § 261.11(a)(1)–(3).

[13] 40 C.F.R. § 261.11(a)(1)–(3).

[14] 40 C.F.R. Appendix VIII to Part 261—Hazardous Constituents, https://www.law.cornell.edu/cfr/text/40/appendix-VIII_to_part_261.

[15] EPA, Drinking Water Health Advisory for Perflourooctanoic Acid (PFOA), (May 2016) https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf at 10.

[16] *Id.* at 39.

[17] Agency for Toxic Substances and Disease Registry, Toxicological Profile for Perfluoroalkyls, supra note 2, at 5-6.

[18] *Id.*

[19] *See* Agency for Toxic Substances and Disease Registry, Toxicological Profile for Perfluoroalkyls, *supra* note 2; *see also* Vaughn Barry et al., *Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers Among Adults Living Near a Chemical Plant*, 121 ENVTL. HEALTH PERSPECTIVES 11-12, 1313-18 (Nov.-Dec. 2013), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3855514/pdf/ehp.1306615.pdf, and Agency for Toxic Substances and Disease Registry, Toxicological Profile for Perfluoroalkyls, supra note 2, at 6.

sensitive to certain long-chain PFAS.[20] Even the long-chain PFAS's most well-known short-chain replacement, Gen X, has been shown to cause cancer in lab animals.[21]

For many short-chain PFAS, there is little or no information about toxicity to the environment or to humans.[22] However, the U.S. Department of Health and Human Service's National Toxicology Program concedes that long- *and* short-chain PFAS affect the liver and thyroid hormones, and that they both inhibit mitochondrial function.[23] Other peer-reviewed papers have concluded that "[s]hort chain perfluoroalkyl substances (PFAS), replacements for long-chain legacy PFAS such as perfluorooctanoic acid (PFOA), have similar toxicity, negative health effects, and exceptional persistence as long chain PFAS."[24]

As of 2018, 4,730 PFAS have been identified.[25] It is unfortunate that very little research has been performed on the toxicity of the vast majority of these PFAS, with most studies performed by industry itself.[26] Additionally, many countries have failed to consider "mixture toxicity." Regulatory paradigms should consider the dangers of exposure to large numbers of known and unknown PFAS simultaneously, not just concentrations of individual substances (i.e. PFOA) one at a time.[27]

[20] *Supra* note 15.

[21] Sharon Lerner, *New Teflon Toxin Found in North Carolina Drinking Water*, The Intercept (June 17, 2017), https://theintercept.com/2017/06/17/new-teflon-toxin-found-in-north-carolina-drinking-water/.

[22] Zhanyun Wang, Jamie C. DeWitt, Christopher P. Higgins & Ian T. Cousins, *A Never-Ending Story of Per-and Polyfluoroalkyl Substances (PFASs)?*, 51 ENVTL. SCI. TECH. 51, 2508–2518 (2017).

[23] *Per- and Polyfluoroalkyl Substances (PFAS)*, National Toxicology Program (Aug. 8, 2019), https://ntp.niehs.nih.gov/results/areas/pfas/index.html.

[24] Mary Jo Weiss-Errico & Kevin E. O'Shea, *Enhanced Host–Guest Complexation of Short Chain Perfluoroalkyl Substances with Positively Charged β-cyclodextrin Derivatives*, J. INCLUSION PHENOMENA & MACROCYCLIC CHEMISTRY 1–7 (2019).

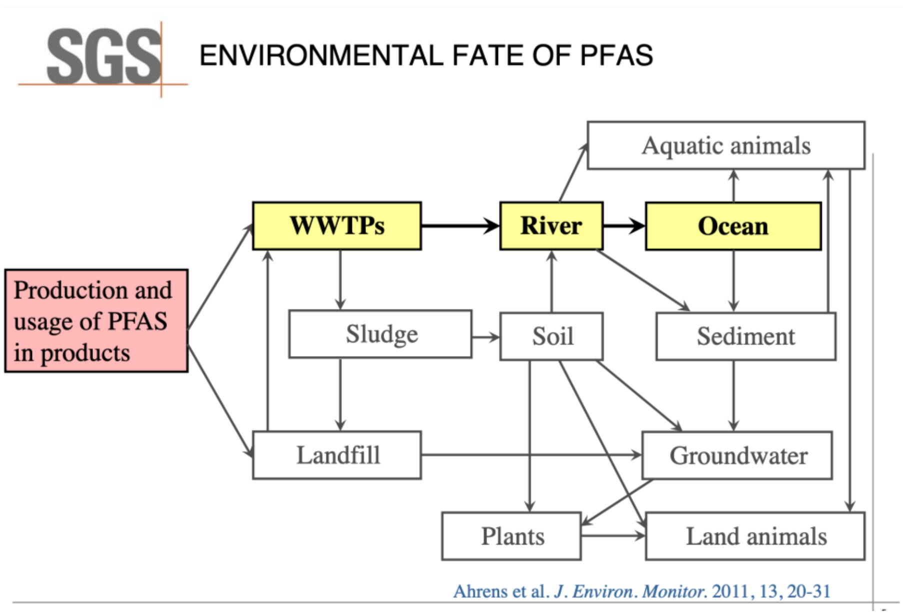
[25] Organisation for Economic Co-Operation and Development, *Environment Directorate—Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology*, (May 4, 2018) http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV-JM-MONO(2018)7&doclanguage=en.

[26] Supra note 22, at 2512.

[27] *Id*.

(ii) *Concentration of Toxicity in Discarded Waste Containing PFAS.* Discarded waste containing PFAS can contaminate both water supplies and the food chain. "[L]andfill leachate is highly concentrated with PFAS and acts as a point source of PFAS to the environment."[28] PFAS, especially short-chain, are commonly detected in landfill leachate. PFOA is still found in landfill leachate, despite the fact it is no longer used.[29] Ambient air above and downwind of landfills has elevated concentrations of PFAS, indicating that landfills can contribute to atmospheric PFAS.[30]

PFAS can enter water through direct discharge, accidental spills, landfill leachate, airborne deposition, leaching of biosolids to groundwater, or stormwater runoff.[31] PFAS then enters soil, plants, surface waters, wetlands, groundwater, oceans, and gets into the muscle of both fish and terrestrial animals (see figure, below).[32]



Landfills: Leachate from 27 landfills were examined for nine PFAS compounds, and five were found to be ubiquitous.[33] PFAS concentrations were higher in operating landfills and newer landfills, and landfills accepting construction and demolition waste had higher

[28] Brent McKay Allred, *Poly- and Perfluorinated Alkyl Substance Release From Landfills and Landfill Model Reactors*, Dissertation, Oregon State University (2015).

[29] Hamid, H., L.Y. Li & J.R. Grace, *Review of the Fate and Transformation of Per- and Polyfluoroalkyl Substances (PFASs) in Landfills*, 235 ENV. POLLUTION 74–84 (2018).

[30] *Id.*

[31] Harry Behzadi, *The Next Frontier on PFAS Contamination in Sediment, Surface Water And Fish Tissue, Emerging Contaminants in the Environment*, http://hdl.handle.net/2142/103963 (2019).

[32] *Id.*

[33] Gallen, C. et al., *Australia-Wide Assessment of Perfluoroalkyl Substances (PFASs) in Landfill Leachates*, 331 J. HAZARDOUS MATERIALS, 132–141 (2017).

concentrations of PFAS than municipal landfills.[34] PFAS has also been found to leach from carpets disposed in landfills.[35]

Biosolids: PFAS are also found in biosolids.[36] Because PFAS are not removed by conventional wastewater treatment, they accumulate in biosolids. When biosolids are then applied to gardens and crops, this may lead to transfer of PFAS into food.[37] Short-chain PFAS are more easily taken up to edible parts of plants than long-chain PFAS.[38]

Incineration: There is some evidence that PFAS can be destroyed by incineration with temperatures greater than 1,000 degrees C,[39] or even 1,200 degrees C.[40] If an incinerator only reaches temperatures below 1,000 degrees C, it is possible that PFAS will not be completely destroyed, and byproducts formed by incomplete destruction may themselves be harmful.[41] Although there is also some evidence that temperature needed to destroy PFAS increases with increasing chain length,[42] very little research has been done on short-chain and GenX PFAS to determine how incineration affects them. Finally, taking into account the cost associated with high temperature incineration, and the difficulty of maintaining high temperatures given some municipal waste facility abilities, it is possible that ash waste from incineration would still contain PFAS that could migrate into groundwater, drinking water, and the ecosystem.

It is clear that discarded waste containing PFAS is responsible for unacceptable levels of PFAS found in drinking water, groundwater, and the food chain.

The EPA's current non-binding Lifetime Health Advisory (LHA) cautions that the concentration of PFAS in drinking water should not exceed 70 ppt.[43] A number of states have cautioned much lower concentrations of PFAS in drinking water should be maintained, even in some cases limiting the combined concentrations of PFAS to as low as 12 ppt for PFOA.[44] A recent study from Harvard University researchers has suggested

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[34] *Id.*

[35] Kim, M. et al., *Compositional Effects on Leaching of Stain-Guarded (Perfluoroalkyl and Polyfluoroalkyl Substance-Treated) Carpet in Landfill Leachate*, 49(11) ENVTL. SCI. TECH. 6564–6573 (2015).

[36] Paz-ferreiro, J. et al., *Biochar from Biosolids Pyrolysis: A Review*, 15(5) INT'L J. ENVTL. RES. PUB. HEALTH 956 (2018).

[37] Rooney Kim Lazcano, *Perfluoroalkyl Acids and Other Trace Organics in Wastederived Organic Products: Occurrence, Leachability, And Plant Uptake*, Thesis, Purdue University (2019).

[38] *Id.*

[39] Michigan PFAS Science Advisory Panel, *Scientific Evidence and Recommendations for Managing PFAS Contamination in Michigan* (Dec. 7, 2018).

[40] Concawe, *supra* note 8.

[41] *Id.*

[42] Kucharzyk, K.K., et al., *Novel Treatment Technologies for PFAS Compounds: A Critical Review*, J. ENVTL. MGMT. 1–8 (2017).

[43] EPA, *Fact Sheet—PFOA & PFOS Drinking Water Health Advisories*, (Nov. 2016) https://www.epa.gov/sites/production/files/2016-06/documents/drinkingwaterhealthadvisories_pfoa_pfos_updated_5.31.16.pdf.

[44] Annie Ropeik, *N.H. Approves Unprecedented Limits for PFAS Chemicals in Drinking Water*, NHPR (Jul. 18, 2019), https://www.nhpr.org/post/nh-approves-unprecedented-limits-pfas-chemicals-drinking-water#stream/0.

that a safe limit for PFAS in drinking water is a mere 1 ppt.[45] Indeed, in June 2019, Linda Birnbaum, director of the National Institute for Environmental Health Sciences (NIEHS) and the National Toxicology Program (NTP), suggested that the safety threshold for PFOA in drinking water should be as low as 0.1 parts per trillion, which is 700 times lower than the safety level set by the EPA.[46] Every reported case of PFAS contamination is certainly higher than these lower suggested safety limits. Nearly two-thirds of military base contaminations are above concentrations of 1,100 ppt.[47]

(iii) *Migration Potential.* PFAS waste has great potential to migrate, although most studies have been conducted on two long-chain PFAS—PFOA and PFOS. One study found that levels of PFAS in subsurface soils "show a general increase with depth, suggesting a downward movement toward the groundwater table and a potential risk of aquifer contamination."[48] Airborne transport of PFAS occurs frequently, and precipitation can wash PFAS into soil and surface waters.[49] PFAS leaches out of landfills,[50] and can migrate from the air and land into surface and groundwater, drinking water, and into the food chain (see Figure 1, below).[51] As a result, PFAS can be found in groundwater, surface water, soil, air, food, breast milk, and human blood,[52] including umbilical cord blood.[53] A study by the Centers for Disease Control and Prevention (CDC) found four PFAS (PFOS, PFOA, perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA)) in the serum of nearly all of the people tested, indicating widespread exposure in the U.S. population.[54] PFOA and PFOS were found in up to 99 percent of the U.S. general population between 1999 and 2012.[55] There are no medical interventions

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[45] Philippe Grandjean & Esben Budtz-Jørgensen, *Immunotoxicity of Perfluorinated Alkylates: Calculation of Benchmark Doses Based on Serum Concentrations in Children*, 12 Envtl. Health (2013).

[46] *2019 Per- and Polyfluoroalkyl Substances: Second National Conference*, PFASProject (Feb. 5, 2019) https://pfasproject.com/2019/02/05/2019-pfas-conference/.

[47] *See* Bill Walker, *Update: Mapping the Expanding PFAS Crisis*, Environmental Working Group (Apr. 18, 2018), https://www.ewg.org/research/update-mapping-expanding-pfas-crisis; *see also* Wang, *supra* note 22.

[48] Xiao, F. et al., *Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoate (PFOA) in Soils and Groundwater of a U.S. Metropolitan Area: Migration and Implications for Human Exposure*, 72 WATER RES. 64–74 (2015).

[49] Interstate Technology Regulatory Council, *Environmental Fate and Transport for Per- and Polyfluoroalkyl Substances*, (Mar. 2018) https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_fate_and_transport__3_16_18.pdf.

[50] *Id*.

[51] Oliaei, F. et al., *PFOS and PFC Releases and Associated Pollution from a PFC Production Plant in Minnesota (USA)*, 20 ENVTL. SCI. POLLUTION RES. 1977–1992 (2013).

[52] Agency for Toxic Substances and Disease Registry, *Per-and Polyfluoroalkyl Substances (PFAS) and Your Health*, https://www.atsdr.cdc.gov/pfas/health-effects.html; Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Perfluoroalkyls*, https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf at 2.

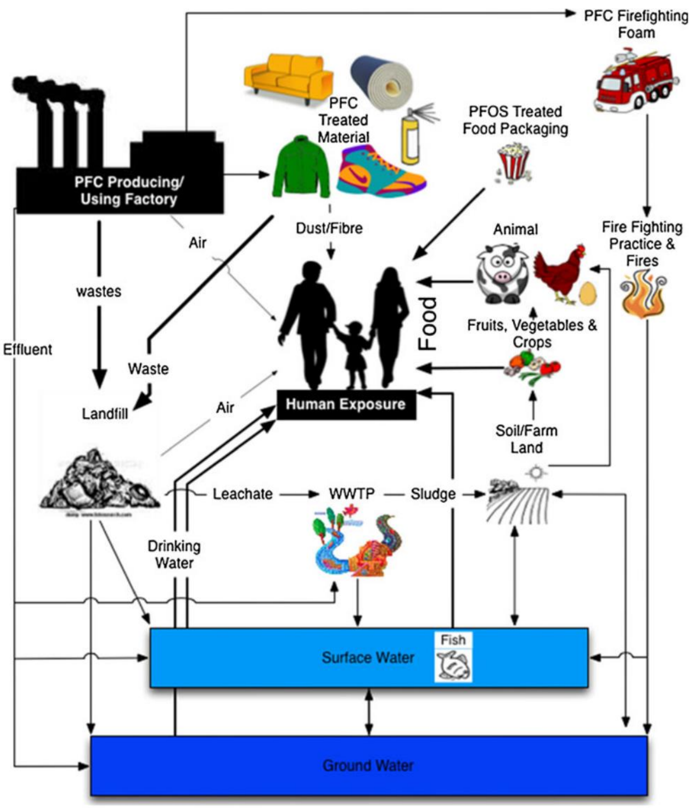
[53] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Perfluoroalkyls*, *supra* note 52, at 3.

[54] Ctr. for Disease Control and Prevention, *Per-and Polyfluorinated Substances (PFAS) Factsheet* (Apr. 7, 2017), https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html.

[55] EPA, *Drinking Water Health Advisory for Perflourooctanoic Acid (PFOA)*, (May 2016) https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf at 9.

that will remove PFAS from the body.[56] The prevalence of PFAS in human blood is indicative of the huge migration potential of these substances.

Fig. 1 PFC release from the technosphere and contamination pathways in the environment and exposure pathways to humans



Due to their ability to travel vast distances while remaining stable, PFAS produced in certain countries will lead to distribution of these PFAS and their end products across the world, "in the environment, wildlife, and humans."[57]

This migration potential is not limited to long-chain PFAS. Short-chain PFAS have been considered by scientists to be highly mobile, which is also confirmed by their widespread environmental distribution.[58] Such mobility means that short-chain PFAS are highly effective at reaching water bodies, which is of special concern regarding human exposure because drinking water resources are highly sensitive to contamination by short-chain PFAS.[59]A scientific paper currently in press concludes, "[s]hort-chain PFAS are more

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[56] Vermont Dep't of Health, *Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in Drinking Water*, (July 9, 2018) http://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS.pdf.

[57] *Id*. at 2511.

[58] Zhao P, Xia X, Dong J, Xia N, Jiang X, Li Y, Zhu Y, *Short-and Long-Chain Perfluoroalkyl Substances in the Water, Suspended Particulate Matter, and Surface Sediment of a Turbid River*, SCI. TOTAL ENV. 2016;568:57–65. doi: 10.1016/j.scitotenv.2016.05.221; *See also* Ahrens L. *Polyfluoroalkyl Compounds in the Aquatic Environment: A Review of Their Occurrence and Fate*, 079.J. ENVTL. MONITORING 2011;13:20–31. doi: 10.1039/C0EM00373E.

[59] Schwanz TG, Llorca M, Farré M, Barceló D., *Perfluoroalkyl Substances Assessment in Drinking Waters from Brazil, France and Spain*, SCI. TOTAL ENV'T..02 (201539:143–152. doi: 10.1016/j.scitotenv.2015.08.0346); *see also* Boiteux V, Dauchy X, Bach C, Colin A, Hemard J, Sagres

widely detected, ***more persistent and mobile*** in aquatic systems, and thus may pose more risks on the human and ecosystem health" (emphasis added).[60]

Another result of this high mobility is that short-chain PFAS have a higher potential for long-range transport compared to the long-chain homologues.[61] Monitoring data show that short-chain PFAS are present in remote areas and have a widespread distribution in biotic and abiotic compartments.[62] In a few cases, increasing concentrations of short-chain PFAS in the environment and biota are already observed; for example, with perfluorobutanesulfonic acid (PFBS) in dolphins from the South China Sea,[63] and perfluorohexanoic acid (PFHxA) in water samples near a fluoropolymer production plant in Japan.[64]

(iv) *Persistence*. All PFAS pose a substantial present and potential hazard to human health and the environment because PFAS are extremely persistent in the environment (hence their nickname, "forever chemicals").[65] PFAS persistence is so extreme due to the carbon-fluorine covalent bond (one of the strongest known chemical bonds).[66]

All PFAS "ultimately transform into highly stable end products, which are usually the highly persistent perfluoroalkyl or perfluoroalkyl(poly)ether acids."[67] Replacing one PFAS with another PFAS (such as PFOA with Gen X) "does not solve issues in relation to PFAS as a whole group—it will only increase the numbers of PFAS on the market and the difficulties in tracking them."[68]

V, Rosin C, Munoz J-F., *Concentrations and Patterns of Perfluoroalkyl and Polyfluoroalkyl Substances in a River and Three Drinking Water Treatment Plants Near and Far from a Major Production Source*. SCI. TOTAL ENV'T. 583:393–400. doi: 10.1016/j.scitotenv.2017.01.079 (2017).

[60] Li, F. et al., *Short-Chain Per- and Polyfluoroalkyl Substances in Aquatic Systems: Occurrence, Impacts and Treatment*, CHEMICAL ENGINEERING J. 380 (2020).

[61] Vierke L, Möller A, Klitzke S, *Transport of Perfluoroalkyl Acids in A Water-Saturated Sediment Column Investigated Under Near-Natural Conditions*. ENVT POLLUTION:7–13. doi: 10.1016/j.envpol.2013.11.011 (2014).

[62] Ahrens L. RJ, Axelson S., Kallenborn R., *Source Tracking and Impact of Per- and Polyfluoroalkyl Substances at Svalbard*, Svalbard Environmental Protection Fund, https://www.sysselmannen.no/link/036987d037924f23a96a0a05304596f3.aspx (e.g, the North Pole); Llorca M, Farré M, Tavano MS, Alonso B, Koremblit G, Barceló D, *Fate of a Broad Spectrum of Perfluorinated Compounds in Soils and Biota from Tierra del Fuego and Antarctica*, ENVTL. POLLUTION 163:158–166. Doi:10.1016/j.envpol.2011.10.027 (e.g. Antarctica)(2012); Kirchgeorg T, Dreyer A, Gabrielli P, Gabrieli J, Thompson L, Barbante C, Ebinghaus R. *Seasonal Accumulation of Persistent Organic Pollutants on a High-Altitude Glacier in the Eastern Alps*, ENVTL. POLLUTion 218:804–812. doi: 10.1016/j.envpol.2016.08.004. (e.g. Swiss Alps)(2016).

[63] Lam JC, Lyu J, Kwok KY, Lam PK. *Perfluoroalkyl Substances (PFASs) in Marine Mammals from the South China Sea and Their Temporal Changes 2002–2014: Concern for Alternatives of PFOS?*, ENVTL. SCI. TECH. 50:6728–6736. doi: 10.1021/acs.est.5b06076 (2016).

[64] Shiwaku Y, Lee P, Thepaksorn P, Zheng B, Koizumi A, Harada KH, *Spatial and Temporal Trends in Perfluorooctanoic and Perfluorohexanoic Acid in Well, Surface, and Tap Water Around a Fluoropolymer Plant in Osaka, Japan*, Chemosphere 164:603–610. doi: 10.1016/j.chemosphere.2016.09.006 (2016).

[65] *See* Parsons JR, Sáez M, Dolfing J, de Voogt P. *Biodegradation of Perfluorinated Compounds*. Rev Environ Contam Toxicol. 2008 ; 196 : 53–71; *See also* Vierke L, Staude C, Biegel-Engler A, Drost W, Schulte C. *Perfluorooctanoic acid (PFOA)—Main Concerns and Regulatory Developments in Europe from an Environmental Point of View*, Environ Sci Eur. 2012;24:16. doi: 10.1186/2190-4715-24-16.

[66] *Infra* note 76.

[67] *Supra* note 22.

[68] *Id*. at 2513.

This extreme persistence is regarded by scientists as a substantial hazard itself, as PFAS will stay in the environment for decades to centuries.[69] Each released PFAS molecule remains in the environment, meaning that it is then impossible to reverse human exposure. Thus, levels of these substances will most probably increase over time. Consequently, long-term effects on humans and wildlife may be possible in the future, when certain effect thresholds are reached.[70]

Due to their low adsorption potential, short-chain PFAS do not bind to particles and stay mainly dissolved in water. Thus, while long-chain PFAS can be removed from water with activated carbon filters, this removal method is not as effective for short-chain PFAS.[71] Alarmingly, the result is that large scale short-chain PFAS can only hardly, if at all, be removed from the environment with the main methods available today.[72] The absence of effective measures on a larger scale is particularly problematic with respect to contaminated drinking water reservoirs. Since short-chain PFAS are not expected to degrade chemically and biologically, and considering the lack of ability to remove them from the environment cheaply and at scale, the only way that the concentrations of short-chain PFAS contaminations will ever decline is with further spatial distribution. The logical and crucial corollary to this conclusion, however, is that no further releases must be allowed to occur.[73]

(v) *Degradation Potential and Rate of Degradation*. PFAS were "designed to be naturally resistant to degradation."[74] All PFAS are extremely persistent in the environment (hence their nickname, "forever chemicals").[75] As stated above, the carbon-fluorine covalent bond (one of the strongest known chemical bonds), renders PFAS highly resistant to degradation.[76] For example, PFOS has "no known natural mechanism of degradation."[77]

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[69] *Supra* note 49.

[70] *Supra* note 50.

[71] Zhang C, Yan H, Li F, Hu X, Zhou Q, Sorption of Short- and Long-Chain Perfluoroalkyl Surfactants on Sewage Sludges, J. HAZARDOUS MATERIALS 260:689–699. doi: 10.1016/j.jhazmat.2013.06.022 (2013).

[72] Boiteux V., et al., *supra* note 59; *See also* Rahman M, et al, supra note 1; *See also* Lundgren S., *Evaluation Of The Efficiency Of Treatment Techniques In Removing Perfluoroalkyl Substances From Water*, Dissertation, Uppsala University, http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-231195 (2014).

[73] Brendel S, Fetter É, Staude C, Vierke L, Biegel-Engler A, *Short-Chain Perfluoroalkyl Acids: Environmental Concerns and A Regulatory Strategy Under REACH*, ENVTL. SCI. EUR. 30(1):9. doi:10.1186/s12302-018-0134-4 (2018).

[74] O'Carroll, D.M., et al., *Impact of PFAS on In-Situ Microbial Communities at a Field Site,* American Geophysical Union, Fall Meeting 2018, abstract #H21D-05.

[75] Parsons JR, Sáez M, Dolfing J, de Voogt P. Biodegradation of perfluorinated compounds. Rev Environ Contam Toxicol. 2008 ; 196 : 53–71; See also Vierke L, Staude C, Biegel-Engler A, Drost W, Schulte C. Perfluorooctanoic acid (PFOA)—main concerns and regulatory developments in Europe from an environmental point of view. Environ Sci Eur. 2012;24:16. doi: 10.1186/2190-4715-24-16.

[76] Kirsch P. Modern fluoroorganic chemistry: synthesis, reactivity, applications. Hoboken: Wiley; 2013; Siegemund G, Schwertfeger W, Feiring A, Smart B, Behr F, Vogel H, McKusick B, Kirsch P. Fluorine compounds, organic. Ullmann's encyclopedia of industrial chemistry. Weinheim: Wiley-VCH Verlag GmbH & Co. KGaA; 2000.

[77] Lindstrom, A.B., M.J. Strynar, and E.L. Libelo, Polyfluorinated Compiunds: Past, Present, and Future, *Environ. Sci. Technol*, 45,19, pp. 7954-7961 (2011).

Finally, PFAS can degrade and actually turn into other PFAS;[78] all PFAS "ultimately transform into highly stable end products, which are usually the highly persistent perfluoroalkyl or perfluoroalkyl(poly)ether acids."[79]

(vi) *Bioaccumulation*. Long-chain PFAS readily bioaccumulate. They are found throughout the environment in groundwater, surface water, soil, and air, as well as in food, breast milk, and human blood serums.[80] A study by the CDC found four PFAS (PFOS, PFOA, perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA)) in the serum of nearly all of the people tested, indicating widespread exposure in the U.S. population.[81] PFOA and PFOS were found in up to 99 percent of the U.S. general population between 1999 and 2012.[82] PFAS are found in human breast milk and umbilical cord blood.[83] There are no medical interventions that will remove PFAS from the body.[84]

Additionally, in the few cases that have been studied, increasing concentrations of short-chain PFAS in the environment and biota are already observed; for example, with perfluorobutanesulfonic acid (PFBS) in dolphins from the South China Sea,[85] and perfluorohexanoic acid (PFHxA) in water samples near a fluoropolymer production plant in Japan.[86] Due to the phase-out of long-chain PFAS,[87] manufacturing and use of short-chain PFAS and related substances are likely to further increase in the near future.[88] Thus, emissions of short-chain PFAS will increase as well. Along with the expected increasing emissions, short-chain PFAS will further release into the environment leading to increased background concentration levels. This is especially true in the long-term for aquatic systems.[89]

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[78] Sharma, B.M., et al., Perfluoroalkyl substances (PFAS) in river and ground/drinking water of the Ganges River basin: Emissions and implications for human exposure, *Env. Pollution* (2015).

[79] *Supra* note 22.

[80] Supra note52.

[81] *Supra* note 54; Centers for Disease Control and Prevention, *Per- and Polyfluorinated Substances (PFAS) Factsheet* (Apr. 7, 2017), https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html.

[82] Supra note 55.

[83] *Supra* note 52; National Center for Environmental Health—Agency for Toxic Substances and Disease Registry, *An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns*, (May 7, 2018), https://www.atsdr.cdc.gov/pfas/docs/pfas_clinician_fact_sheet_508.pdf.

[84] *Supra* note 56.

[85] *Supra* note 61.

[86] *Supra* note 64.

[87] Renner R. *The long and the Short of Perfluorinated Replacements*, ENVTL SCI. TECH. 2006;40:12–13. doi: 10.1021/es062612a.

[88] Andrew Blok, *"Forever Chemical" Replacements on the Rise in the Great Lakes*, Environmental Health News (July 22, 2019), https://www.ehn.org/forever-chemical-replacements-on-the-rise-in-the-great-lakes-2639219145.html.

[89] Ahrens L, Bundschuh M. *Fate and Effects of Poly- and Perfluoroalkyl Substances in the Aquatic Environment: A Review*, Environ Toxicol Chem. 2014;33:1921–1929. doi: 10.1002/etc.2663.

Short-chain PFAS also have a higher potential to bioaccumulate in edible plants, thus making their way into the food chain.[90] Considering that the use of short-chain PFAS will continue to increase, it is therefore likely that both the environment and humans will be permanently exposed to short-chain PFAS, which is not easily reversible. Therefore, the amount of time that the human body takes to eliminate each class of PFAS becomes irrelevant. This becomes more evident when considering that the half-lives of short-chain PFAS in the environment far exceed their half-lives in the organisms, causing the contamination of drinking water resources with short-chain PFAS to lead to a poorly reversible exposure in humans when compared to a contamination with long-chain PFAS.[91]

(vii) *Improper Management*. Wastes generated during primary PFAS production, or through secondary manufacturing using PFAS, become, without a robust hazardous waste management system under RCRA, improperly managed wastes resulting in environmental contamination. PFAS manufacturing waste is sent to solid waste landfills where it becomes leachate—an additional source of release to the environment—with some leachate reportedly due to the disposal of consumer goods treated with PFAS in this manner.[92] Leachate treatment by wastewater treatment plants (WWTPs) is common prior to discharge to surface water, or distribution for agricultural or commercial use.[93] Standard WWTP technologies may do little to reduce or remove PFAS and such discharge represents a secondary source of release of PFAS to the environment.[94] Further, scientists have assigned a risk score of 100 for PFAS escaping landfills and draining into groundwater.[95] Other types of improper waste management include releases into the air[96] and the improper disposal of spent water utility treatment materials, e.g. activated carbon filters. Indeed, when the manager of a township in Pennsylvania was asked whether they were incinerating their PFAS-laden carbon filters properly, his response was, ″(The waste) has to go somewhere, so we need our state and federal people to be on top of that . . . [i]f it's not the right disposal method, then we need them to be telling us what is the right way to dispose of it."[97] At military facilities using aqueous film-forming foam,

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[90] Scher, D.P., *Occurrence of Perfluoroalkyl Substances (PFAS) In Garden Produce at Homes with A History of PFAS-Contaminated Drinking Water*, Chemosphere 196, 548-555 (2018).

[91] Cousins IT, et al., *The Precautionary Principle and Chemicals Management: The Example of Perfluoroalkyl Acids in Groundwater*, ENVTL. INT. 94:331-340. doi: 10.1016/j.envint.2016.04.044 (2016).

[92] Eggen T, Moeder M, Arukwe A, *Municipal Landfill Leachates: A Significant Source for New and Emerging Pollutants*, SCI. TOTAL ENVTL. 2010 Oct 1;408(21):5147-57. doi: 10.1016/j.scitotenv.2010.07.049.

[93] Lang JR, Allred BM, Peaslee GF, Field JA, Barlaz MA, *Release of Per- and Polyfluoroalkyl Substances (PFASs) from Carpet and Clothing in Model Anaerobic Landfill Reactors*, ENVTL SCI. TECH. 50(10):5024-32. doi: 10.1021/acs.est.5b06237 (May 17, 2016).

[94] Ahrens, *supra* note 58.

[95] Jennifer L. Guelfo, et al., *Evaluation and Management Strategies for Per- and Polyfluoroalkyl Substances (PFASs) in Drinking Water Aquifers: Perspectives from Impacted U.S. Northeast Communities*, 126(6) ENVTL. HEALTH PERSPECTIVES https://ehp.niehs.nih.gov/doi/pdf/10.1289/EHP2727 (2018).

[96] Vaughn Hagerty, Carolina Public Press, *Regukators Prepare Crackdown on Air and Water Emissions of GenX*, North Carolina Health News (Oct. 8, 2018), https://www.northcarolinahealthnews.org/2018/10/08/regulators-prepare-crackdown-dupont-chemours-genx/.

[97] Jenny Wagner & Kyle Bagenstose, *Waste Containing PFAS Chemicals Poses Conundrums*, The Intelligencer (Aug, 2, 2019) https://www.theintell.com/news/20190802/waste-containing-pfas-chemicals-poses-conundrums.

"fires [are] ignited and the foam [is] showered over the area as practice for the real thing. From there, it soak[s] into the soil and down into the groundwater." [98]

(viii) *Quantities of Waste Generated*. There are no readily available estimates of the quantities of waste containing PFAS. For example, documents that might give such quantifications for GenX are redacted as Confidential Business Information.[99] One study attempted to estimate the mass of PFAS from U.S. landfill leachate to wastewater treatment plants for the year 2013, but the focus was quite narrowly trained on landfill leachate estimated from concentrations of 70 PFAS in 95 samples of leachate from a survey of U.S. landfills. This estimate was between 563 and 638 kg. Notably, the authors draw particular attention to the importance of the concentrations of the PFAS in the leachate, rather than the mass.[100]

(ix) *Nature and Severity of the Human Health and Environmental Damage that Has Occurred*. According to the Environmental Working Group (EWG), as of the end of July 2019, there are 712 locations throughout 49 states in the U.S. known to be affected with PFAS contamination.[101] EWG estimates that as many as 100 million Americans could be drinking water contaminated with PFAS.[102] In short, these pollutants are everywhere and inside of everyone. Distressingly, nearly two years ago, an American Red Cross study found that the average American has 4,300 ppt of PFOS and 1,100 ppt of PFOA in their bloodstreams.[103] And this is only for the two most infamous and deeply studied long-chain PFAS that are under the closest scrutiny at present. Patrick Breysse, former director of the CDC's National Centre for Environmental Health, described the chemicals as "one of the most seminal public health challenges for the next decades . . . ."[104]

Michigan, which has conducted extensive testing for PFAS, has found PFAS contamination throughout the state.[105] The state's testing began with showing unexpectedly high levels in private drinking water wells.[106] When authorities soon realized that the extent of the contamination was larger than anything they had

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[98] Andrew Brown, *The Air Force Polluted 4 SC Bases With a Toxic Firefighting Foam, Didn't Tell Neighbors*, The Post and Courier (July 13, 2019), https://www.postandcourier.com/news/the-air-force-polluted-sc-bases-with-a-toxic-firefighting/article_edc3f77a-98d5-11e9-902d-db2e98d79884.html.

[99] https://assets.njspotlight.com/assets/19/0329/0942.

[100] Lang JR, Allred BM, Field JA, Levis JW, Barlaz MA, *National Estimate of Per- and Polyfluoroalkyl Substance (PFAS) Release to U.S. Municipal Landfill Leachate*, ENVTL. SCI. TECH. 51(4):2197-2205. doi: 10.1021/acs.est.6b05005 (Feb 21, 2017).

[101] *Supra* note 5.

[102] *Supra* note 2.

[103] Olsen G, Mair C, *Per- and Polyfluoroalkyl Substances (PFAS) In American Red Cross Adult Blood Donors, 2000–2015*, 157 ENVTL. RESEARCH 87–95 (2017).

[104] Christopher Knaus, *Toxic Firefighting Chemicals 'The Most Seminal Public Health Challenge'*, The Guardian (Oct. 18, 2017) https://www.theguardian.com/australia-news/2017/oct/18/toxic-firefighting-chemicals-the-most-seminal-public-health-challenge.

[105] Keith Matheny, *PFAS Contamination is Michigan's Biggest Environmnetal Crisis in 40 Years*, Detroit Free Press (Apr. 26, 2019), https://www.freep.com/in-depth/news/local/michigan/2019/04/25/pfas-contamination-michigan-crisis/3365301002/.

[106] Garret Ellison, *PFAS Found in Drinking Water Wells in Unexpected Places*, Michigan Live (Nov. 8, 2017), https://www.mlive.com/news/grand-rapids/2017/11/pfas_private_well_test_results.html.

anticipated,[107] they soon began the process of testing 1,300 public drinking water sources for PFOA and PFOS.[108] Of 1,114 public water systems eventually tested, 119 were found to contain some level of one or a combination of PFOA and PFOS.[109] Of 461 schools and 152 daycares with their own drinking water wells, 59 were found to contain some level of PFOA and PFOS.[110] This widespread contamination, when taking into consideration the average levels of these two toxic long-chain PFAS already in American bloodstreams and the fact that only these two PFAS were tested for, demonstrates the critical need for regulation of PFAS waste. In March 2018, Michigan had to issue "do not eat" advisories for fish caught in several rivers, and for deer killed within five miles of an air force base because of PFAS contamination of the meat.[111, 112] Based on these findings and further study, in July 2018 the Michigan Department of Environmental Quality (DEQ) dramatically increased their estimates saying that over 11,300 sites throughout the state had PFAS contamination.[113] Understandably, this left Michigan communities feeling anxious and sickened by the prospect of their children drinking toxic water.[114] Michiganders have been exposed to PFAS by paper mills,[115] horse farms,[116] auto suppliers,[117] land-applied sewage sludge,[118] the military,[119] construction sites of major infrastructure projects,[120] other businesses,[121] and most prominently a large shoemaking

[107] Garret Ellison, *Homes Above EPA Safety Level Double as PFAS Zones Expand*, Michigan Live (Dec. 20, 2017), https://www.mlive.com/news/grand-rapids/2017/12/algoma_township_pfas_results.html.

[108] Bryce Huffman, *DEQ to Begin Testing 1,300 Public Water Supplies for PFAS*, Michigan Radio (Mar. 5, 2018), https://www.michiganradio.org/post/deq-begin-testing-1300-public-water-supplies-pfas.

[109] Kaye LaFond & Jodi Westrick, *PFAS: Where Have They Been Found in Public Water Supplies?*, Michigan Radio (Feb. 25, 2019), https://www.michiganradio.org/post/pfas-where-have-they-been-found-public-water-supplies.

[110] *Id*.

[111] Ron Fonger, *State Issues New Guidelines on Flint River Fish Because of Elevated PFOS*, Michigan Live (Apr. 3, 2018), https://www.mlive.com/news/flint/2018/04/state_issues_new_advisories_on.html.

[112] Paul Egan, *Scientist: PFAS Has Been Contaminating Michigan Population for Years*, Detroit Free Press (Nov. 13, 2018), https://www.freep.com/story/news/local/michigan/2018/11/13/delaney-pfas-michigan/1986891002/.

[113] Keith Matheny, *DEQ: Harmful PFAS Might Contaminate More Than 11,000 Sites Statewide*, Detroit Free Press (July 30, 2018), https://www.freep.com/story/news/local/michigan/2018/07/30/deq-pfas-chemical-contamination-pollution-michigan/851152002/.

[114] Nadia Kounang, *'What Did We Do?' Families Anxious About Chemicals Found in Tap Water*, CNN (Aug. 16, 2018), https://www.cnn.com/2018/08/16/health/tap-water-crisis-toxic-michigan-pfoa-pfas/index.html.

[115] Malachi Barrett, *High Levels of PFAS Found at Parchment Paper Mill's Landfill*, Michigan Live (Sept. 6, 2018), https://www.mlive.com/news/kalamazoo/2018/09/extremely_high_levels_of_pfas.html.

[116] Justine Lofton, *High PFAS Levels Found at Grand Haven Horse Farm*, Michigan Live (Dec. 28, 2018), https://www.mlive.com/news/muskegon/2018/12/high-pfas-levels-found-at-grand-haven-horse-farm.html.

[117] Paula Gardner, *Metro Detroit Auto Supplier is a Source of PFAS Pollution in Huron River*, Michigan Live (Sept. 4, 2018), https://www.mlive.com/news/2018/09/pfas_michigan_wixom_contaminat.html.

[118] Paula Gardner, *The Hunt for PFAS Turns to Michigan Farms Using Human Waste as Fertilizer*, Michigan Live (June 19, 2019), https://www.mlive.com/news/2019/06/the-hunt-for-pfas-turns-to-michigan-farms-using-human-waste-as-fertilizer.html.

[119] *Former Wurtsmith Air Force Base, Iosco County*, Michigan.gov (Sept. 11, 2019), https://www.michigan.gov/pfasresponse/0,9038,7-365-86511_82704_83952---,00.html.

[120] Paula Gardner, *PFAS Found at Gordie Howe International Bridge Site in Detroit*, Michigan Live (Apr. 11, 2019), https://www.mlive.com/news/2019/04/pfas-found-at-gordie-howe-international-bridge-site-in-detroit.html.

[121] *Gardenr*, *supra* note 6.

corporation called Wolverine World Wide.[122] The state has become so inundated that they are even turning a blind eye to possible contamination of dairy farms for fear of suffocating yet another sector of their state economy.[123] In Ann Arbor, at least seven different types of PFAS were found in the drinking water.[124] Depressingly, though in line with the record presented in this petition, the town is only able to filter out some types of PFAS using activated carbon filtration, meaning the contamination there is presently irreversible, short of stopping environmental releases.[125]

Michigan is just the most visible tip of a country-wide iceberg. Communities in Alabama,[126] California,[127] Colorado,[128] Minnesota,[129] Maine,[130] Massachusetts,[131] New Hampshire,[132] New Jersey,[133] New Mexico,[134] New York,[135] Pennsylvania,[136] South

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[122] Garret Ellison, *Michigan Sues Wolverine as EPA Deepens PFAS Investigation*, Michigan Live (Jan. 10, 2018), https://www.mlive.com/news/grand-rapids/2018/01/wolverine_deq_pfas_lawsuit.html.

[123] Garret Ellison, *Michigan is Tiptoeing Around PFAS in Dairy Agriculture*, Michigan Live (Aug. 20, 2019), https://www.mlive.com/news/ann-arbor/2019/07/michigan-is-tiptoeing-around-pfas-in-dairy-agriculture.html.

[124] Ryan Stanton, *At Least 7 Types of PFAS in Ann Arbor's Drinking Water, Reports Show*, Michigan Live (Dec. 18, 2018), https://www.mlive.com/news/ann-arbor/2018/12/at-least-7-types-of-pfas-in-ann-arbors-drinking-water-reports-show.html.

[125] Ryan Stanton, *Ann Arbor's New Carbon Filters Only Removing Some PFAS From Drinking Water*, Michigan Live (Feb. 18, 2019), https://www.mlive.com/news/ann-arbor/2019/02/ann-arbors-new-carbon-filters-only-removing-some-pfas-from-drinking-water.html.

[126] Chelsea Brentzel, *State of Alabama Permitted 3M to Release Toxic Chemicals Into Tennessee River for Years, Records Show*, WHNT News (June 19, 2019), https://whnt.com/2019/06/19/state-of-alabama-permitted-3m-to-release-toxic-chemicals-into-tennessee-river-for-years-records-show/.

[127] Dan Ross, *Is a New Toxic Danger Threatening California?*, Capital & Main (Nov. 19, 2018), https://capitalandmain.com/is-a-new-toxic-danger-threatening-california-1119.

[128] Brett Walton, *As PFAS Lawsuits Proliferate, Legal Tactics Emerge*, Circle of Blue (Dec. 14, 2018), https://www.circleofblue.org/2018/world/as-pfas-lawsuits-proliferate-legal-tactics-emerge/.

[129] Kirsti Marohn, *Minnesota Tightens Rules on 'Forever' Chemical in Drinking Water*, MPRNews (Apr. 3, 2019), https://www.mprnews.org/story/2019/04/03/minnesota-tightens-rules-on-forever-chemical-in-drinking-water.

[130] Sharon Lerner, *Toxic PFAS Chemicals Found in Maine Farms Fertilized with Sewage Sludge*, The Intercept (June 7, 2019), https://theintercept.com/2019/06/07/pfas-chemicals-maine-sludge/.

[131] Jason Claffey, *Toxic PFAS Founf in 21 Places in Massachusetts*, Patch (May 8, 2019), https://patch.com/massachusetts/danvers/toxic-pfas-found-19-places-massachusetts.

[132] Jeff McMenemy, *Moms put Face on PFAS Contamination*, Fosters.com (June 23, 2018), https://www.fosters.com/news/20180623/moms-put-face-on-pfas-contamination.

[133] Sharon Lerner, *New Jersey is Making Companies Pay For Toxic Contamination—Shining a New Light on a Little-Known Offender*, The Intercept (Mar. 27, 2019), https://theintercept.com/2019/03/27/new-jersey-pfas-contamination/.

[134] *Supra* note 10.

[135] Jim Therrien, *Hoosick Falls Native Produces PFAS Documentary*, Bennington Banner (Dec. 12, 2018), https://www.benningtonbanner.com/stories/hoosick-falls-native-produces-pfas-documentary,558842.

[136] Justine McDaniel, *State to Start Testing Drinking Water Across PA Within Weeks; Nearly 500 Public Water Systems Are Near Potential Contamination Sources*, The Philadelphia Inquirer (May 3, 2019), https://www.inquirer.com/news/pfas-water-contamination-bucks-montgomery-county-pfoa-pfos-dep-20190503.html.

Carolina,[137] Vermont,[138] Washington,[139] Wisconsin,[140] also have PFAS contamination.[141] In Colorado Springs, 16 members of the same family developed cancer living near water sources with high contamination from PFAS; 10 of those relatives succumbed to their illnesses.[142] In the highly PFAS-contaminated region of Oakdale, Minnesota, high-schoolers had to watch their friends die from terminal cancers and were left to wonder when they might be next.[143] The contamination proliferates from some 500 industrial sites,[144] some 131 military bases,[145] and as PFOA and PFOS are phased out, new PFAS are phased-in to take their place; always with the expected build-up of their concentrations in the environment.[146] Hundreds of new PFAS are approved and hundreds more enter our society in secret through various regulatory evasions or by claiming that all information about a new PFAS and its manufacturer are secret and must be shielded from public scrutiny.[147] PFAS contaminates bottled water,[148] personal hygiene products,[149] the food we buy at the grocery store,[150] and every single bowl of Chipotle or Sweet Green that we consume.[151]

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137 *Supra* note 98.

138 Elizabeth Gribkoff, *Senate Passes Bill Requiring Testing and Treatment for PFAS Contaminants*, VTDigger (Mar. 13, 2019), https://vtdigger.org/2019/03/13/senate-passes-bill-requiring-testing-treatment-pfas-contaminants/.

139 Hal Bernton, *Washington State to Test Drinking Water for PFAS Contamination linked to Firefighting Foam*, The Seattle Times (May 21, 2018), https://www.seattletimes.com/seattle-news/environment/state-to-test-drinking-water-sites-for-pfas-contamination-linked-to-firefighting-foam/.

140 Phoebe Petrovic, *Wisconsin Takes on PFAS Groundwater Contamination*, Wisconsin Public Radio (Feb. 11, 2019), https://www.wpr.org/wisconsin-takes-pfas-groundwater-contamination.

141 *Supra* note 22.

142 Tara Copp, *16 Cancer Cases in One Family: Base Water Contamination Fight Moves to Congress*, Military Times (Mar. 4, 2019), https://www.militarytimes.com/news/your-military/2019/03/04/16-cancer-cases-in-one-family-base-water-contamination-fight-moves-to-congress/.

143 Carrie Fellner, *Toxic Secrets: The Town That 3M Built—Where Kids Are Dying of Cancer*, The Sydney Morning Herald (June 15, 2018), https://www.smh.com.au/world/north-america/toxic-secrets-the-town-that-3m-built-where-kids-are-dying-of-cancer-20180613-p4zl83.html.

144 Jared Hayes et.al., *PFAS Nation: Toxic Discharges Suspected From Almost 500 Industrial Facilities Across U.S.*, Environmental Working Group (June 11, 2019), https://www.ewg.org/news-and-analysis/2019/06/pfas-nation-toxic-discharges-suspected-almost-500-industrial-facilities.

145 *A Toxic Threat: Government Must Act Now on PFAS Contamination at Military Bases (2018)*, Union of Concerned Scientists, (https://www.ucsusa.org/center-science-and-democracy/preserving-science-based-safeguards/toxic-threat-pfas-contamination-military-bases.

146 *Supra* note 88.

147 Sharon Lerner, *EPA Continues to Approve Toxic PFAS Chemicals Despite Widespread Contamination*, The Intercept (Oct. 25, 2018), https://theintercept.com/2018/10/25/epa-pfoa-pfas-pfos-chemicals/.

148 Iris Lewis, *Massachusetts Bottled Water Company Shutters After PFAS Detected*, VTDigger (Aug. 5, 2019), https://vtdigger.org/2019/08/05/massachusetts-bottled-water-company-shutters-after-pfas-detected/.

149 Katherine E. Boronow et.al., *Serum Concentrations of PFASs and Exposure-Related Behaviors in African American and Non-Hispanic White Women*, Journal of Exposure Science & Environmental Epidemiology (2019), https://www.nature.com/articles/s41370-018-0109-y.

150 Ellen Knickmeyer et. al., *FDA: Sampling Find Toxic Nonstick Compounds in Some Food*, AP News (June 3, 2019), https://www.apnews.com/e9c5fa42a1244de48e3edea7a1bb14eb.

151 Joe Fassler, *The Bowls at Chipotle and Sweetgreen Are Supposed to be Compostable. They Contain Cancer-Linked "Forever Chemicals."*, The New Food Economy (Aug. 5, 2019), https://newfoodeconomy.org/pfas-forever-chemicals-sweetgreen-chipotle-compostable-biodegradable-bowls/.

This onslaught has overwhelmed states to the point that they cannot make their communities safe from the improper management of wastes containing PFAS. Litigation against the big PFAS manufacturers will be tied up in court, likely for years.[152] Pennsylvania is resorting to a taxing pool scheme that some lawmakers are not sure they can actually fund.[153] In the words of Laurel Schaider, Visiting Scientist, Harvard T.H. Chan School of Public Health at Harvard University, ". . . the emerging regulatory patchwork raises concerns that some Americans are not adequately protected. Some states have the resources and technical know-how to conduct their own risk assessments, but others may lack the funding and expertise."[154] The same must certainly be said for the management of PFAS hazardous waste.

(x) *Action Taken by Other Governmental Agencies Based on the Health or Environmental Hazard Posed by Discarded PFAS*. EPA released a PFAS Action Plan in February 2019.[155] There has been no regulatory action taken at the federal level to ensure the proper management of waste containing PFAS, though there are many regulatory actions that EPA could take to ensure safety from the real and substantial hazard that PFAS is to human health and the environment.

However, in the absence of federal action, states are attempting to protect their citizens by developing regulatory standards. Eighteen states are instituting partial bans of PFAS, regulatory limits in drinking water and/or groundwater, and taking other actions.[156] This is resulting in a patchwork of laws across the country which leaves hundreds of millions of Americans unprotected from the hazards of PFAS.

(xi) *Likelihood of Additional Harm if No Action is Taken*. Currently, because the toxicity and persistence of the longer chain PFAS are known and worrisome, short-chain PFAS are being substituted at an alarming rate. This "current common practice of replacing one PFAS with other structurally similar PFASs, is a major concern for society."[157] Despite the fact that short-chain PFAS are relatively new to the market, the ubiquitous release of these unregulated and less studied compounds are "in some cases . . . detected at much

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[152] Kyle Bagenstose & Jenny Wagner, *Military Challenging States on $2 Billion Chemical Liability*, The Intelligencer, (http://gatehousenews.com/unwellwater/battleground/site/theintell.com/.

[153] https://www.ehn.org/residents-experts-tell-pa-officials-that-pfas-chemical-cleanup-will-be-expensive-and-difficult-but-its-time-to-act-2622011117.html

[154] Katrina Marusic & Oliver Morrison, *Residents, Experts Tell Pennsylvania Officials That PFAS Chemical Cleanup Will Be Expensive and Difficult, But It's Time to Act*, Environmental Health News (Nov. 30, 2018), https://theconversation.com/epas-plan-to-regulate-chemical-contaminants-in-drinking-water-is-a-drop-in-the-bucket-111243.

[155] EPA, *EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan*, (Feb. 2019) https://www.epa.gov/sites/production/files/2019-02/documents/pfas_action_plan_021319_508compliant_1.pdf.

[156] *PFAS*, Safer States, http://www.saferstates.com/toxic-chemicals/pfas/.

[157] *See* Zhanyun, W., I.T Cousins, M. Scheringer, and K. Hungerbuehler, *Hazard Assessment of Fluorinated Alternatives to Long-Chain Perfluoroalkyl Acids (PFAS) and Their Precursors: Status Quo, Ongoing Challenges and Possible Solutions*. 75 ENVTL. INT'L. 172–179 (2015); *see also* Wang, *supra* note 22.

higher levels than the long chain compounds."[158] This may be due to the fact that the longer chain PFAS perform better than the short-chain replacements, thus requiring larger quantities to achieve similar results.[159] For many of these short-chain compounds, there is little or no information about their toxicity to the environment or to humans.[160]

Both wildlife and humans are currently exposed to numerous PFAS, most of which cannot be identified, let alone evaluated for toxicity, total burden, mechanisms of action, or mixture effects.[161] But that is just the beginning of the problem—"once a risk associated with PFASs is identified, it is challenging to mitigate such a risk: due to their high persistence, environmental exposure to existing PFASs is poorly reversible, and there is a lack of effective measures to remove them from the environment and human exposure media, both technically and financially."[162] Given these scientific and financial hurdles, the only prudent approach is to establish standards to regulate waste containing PFAS as hazardous, whether short- or long-chain.

V. Conclusion

EPA's failure to address the cradle-to-grave management of waste contaminated with PFAS under RCRA Subtitle C means the problems associated with PFAS contamination will grow exponentially worse over time, imposing tremendous financial, health, and environmental costs on society, while allowing those who created the problem to avoid or minimize financial responsibility for the harm caused by this waste.

Despite the prevalence of PFAS production and imports into the United States, and its use in consumer and industrial products, no federal standards exist for the tracking and management of waste containing PFAS. With a growing focus on the toxicity of PFAS and the difficulties and costs associated with identifying and cleaning up contaminated sites, now is the time for EPA to develop a program for the safe management of PFAS wastes from the moment the waste is generated.

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[158] Ateia, M. et al., The Overlooked Short- and Ultrashort-Chain Poly- and Perfluorinated Substances: A Review, 220 Chemosphere 866–882, 873 (2019).

[159] Lindstrom, A.B., Strynar, M.J., Libelo, E.L., *Polyfluorinated Compounds: Past, Present, and Future*. 45, 19 ENVTL. SCI. TECH. 7954–7961 (2011).

[160] *Supra* note 22.

[161] *Id.*

[162] *Id.*