clf
conservation law foundation

For a thriving New England

CLF Rhode Island 235 Promenade Street
Suite 560, Mailbox 28
Providence, RI 02908
P: 401.351.1102
F: 401.351.1130
www.clf.org

By email

February 7, 2019

Director Nicole Alexander-Scott, MD, MPH
Rhode Island Department of Health
3 Capitol Hill
Providence, RI 02908

Re: Petition for Rulemaking to Establish a Drinking Water Standard for Per- and Polyfluoroalkyl Substances

Dear Director Dr. Alexander-Scott:

Conservation Law Foundation (CLF) and Toxics Action Center (TAC) (collectively, Petitioners) hereby petition[1] the Rhode Island Department of Health (RIDOH)[2] to establish a drinking water standard for Per- and Polyfluoroalkyl Substances (PFAS) that is protective of public health. Specifically, Petitioners request that RIDOH immediately adopt the Vermont Department of Health's (Vermont Health's) Drinking Water Advisory for PFAS (Vermont PFAS Health Advisory) of 20 parts per trillion (ppt) for the sum of PFOA (perfluorooctanoic acid), PFOS (perfluoro-octane sulfonic acid), PFHxS (perfluorohexane sulfonic acid), PFHpA (perfluoroheptanoic acid), and PFNA (perfluorononanoic acid) as a maximum contaminant level (MCL)[3] to protect public health.[4]

Petitioners view adoption of the Vermont PFAS Health Advisory as an important first step to protect public health, but it is only the first step. Vermont has recently agreed to initiate

[1] Under the Rhode Island Administrative Procedures Act, "[a]ny person may petition an agency to promulgate a rule." R.I. Gen. Laws § 42-35-6; *see also* 216 R.I. Code R. § 10-05-4.17 (RIDOH regulation on petitioning for a rule). The "agency shall prescribe, by rule, the form of the petition and the procedure for its submission, consideration, and disposition." *Id.* The agency has thirty days to either initiate rulemaking or deny the petition with reasons for the denial. *Id.*

[2] The Director of RIDOH is "authorized to adopt regulations consistent with the provisions of this chapter, the federal Safe Drinking Water Act, 42 U.S.C. § 300f et seq., and the federal regulations adopted under that act." R.I. Gen. Laws § 46-13-18.

[3] Although this petition has prioritized a drinking water standard for PFAS, there is also an urgent need to develop comprehensive standards for PFAS compounds, including but not limited to, surface water quality standards, pre-treatment standards for industrial users, and limits for land application of sludges.

[4] *See* Memorandum, Vt. Agency of Human Res., Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) (Jul. 10, 2018), *available at* http://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf.

rulemaking to adopt its Health Advisory as an MCL for these five compounds.[5] Massachusetts has similarly agreed to set an MCL for a group of PFAS.[6]

A more comprehensive approach to protecting public health would be adoption of a treatment technique drinking water standard for the entire PFAS class of chemicals or adoption of an MCL for the entire PFAS class of chemicals. These options represent comprehensive approaches that will be more protective of public health, so we encourage you to initiate a process for evaluating drinking water standards for the PFAS class.

PFAS have been found in drinking water sources in Rhode Island[7] and numerous studies have linked PFAS to significant health risks, including cancer. Although Rhode Island has taken preliminary steps[8] to limit exposure to this dangerous class of chemicals, such as establishing the capacity to test for PFAS in 2017,[9] RIDOH must take additional affirmative steps to protect people in the Ocean State from PFAS in drinking water. In addition to regulating drinking water, RIDOH should conduct comprehensive statewide testing for PFAS.

We commend you for working with Brown University and encourage you to tap into the expertise at the University of Rhode Island's STEEP (Sources, Transport, Exposure & Effects of PFASs) partnership. We also urge you to collaborate with other states, the federal government, scientists, and stakeholders.

CLF protects New England's environment for the benefit of all people. Founded in 1966, CLF is a non-profit, member-supported organization with offices located in Massachusetts, Vermont, Rhode Island, Maine, and New Hampshire. CLF uses the law, science, and the market to create solutions that protect public health, preserve natural resources, build healthy communities, and sustain a vibrant economy. CLF has been a leading advocate for clean water and safe drinking water throughout New England and is engaged in numerous efforts to address the threat of emerging contaminants like PFAS throughout New England.

TAC is a Northeast public health and environmental non-profit. TAC believes that everyone has the right to breathe clean air, drink clean water, and live in healthy communities with government that operates responsively and democratically. Its mission is to make these

---

[5] Letter from Julia S. Moore, Sec'y, Vt. Natural Res. Council, to Zachary Griefen & Elena Mihaly, Conservation Law Found. (Jan. 24, 2019), *available at* https://www.clf.org/wp-content/uploads/2019/01/20190125-ANR-response-to-petition-for-PFAS-MCL.pdf.

[6] Letter from Martin Suuberg, Comm'r, Mass. Dep't of Envtl. Prot., to Heather Govern, Conservation Law Found., & Sylvia Broude, Toxics Action Ctr. (Jan. 28, 2019), *available at* https://www.clf.org/wp-content/uploads/2019/01/MassDEP-Action-on-PFAS-Petition-01-28-2019.pdf.

[7] Ctr. for Drinking Water Quality, R.I. Dep't of Health, 2017 Annual Report, *available at* http://www.health.ri.gov/publications/annualreports/2017DrinkingWaterQuality.pdf ("Two of the 17 large water systems in Rhode Island had PFAS detections in one of their wells. Although one of these wells was initially above EPA's health advisory, follow-up testing confirmed these wells were below the health advisory.").

[8] *Id.* (noting RIDOH partnership with Brown University and RI Department of Environmental Management on a PFAS sampling study of small water systems located near facilities that may have used PFAS).

[9] *Drinking Water Quality Testing*, R.I. Dep't of Health, http://www.health.ri.gov/programs/detail.php?pgm_id=1089 (last visited Jan. 9, 2019).

rights a reality by organizing with communities to build strong groups to tackle local environmental threats, while developing long-term, non-traditional leaders to strengthen the environmental movement. Since 1987, TAC has assisted nearly 1,000 communities, representing approximately 20,000 individuals, in the development of campaigns to clean up hazardous waste sites, reduce industrial pollution, curb pesticide use, prevent dangerous waste, energy, and industrial facilities, and promote clean energy and zero waste.

I. INTRODUCTION

RIDOH must immediately adopt a drinking water standard that protects the residents of Rhode Island from exposure to PFAS. PFAS are persistent in the environment; bioaccumulative; highly mobile in water; found in hundreds of different products; and are toxic in very small concentrations. PFAS have been found at unsafe levels in drinking water in Rhode Island,[10] as well as in groundwaters.[11] Drinking water contaminated with PFAS is a major source of exposure.[12] Without a drinking water standard, public water systems in Rhode Island are not required to regularly monitor for PFAS compounds or to treat water with unsafe levels of PFAS.

DuPont, 3M, and other chemical manufacturers recklessly produced these dangerous chemicals for decades despite being aware of the significant health risks associated with PFAS. Furthermore, in 1981, 3M and DuPont were aware that ingestion of PFOA caused birth defects in rats.[13] After receiving this information, DuPont tested seven children of pregnant workers: two had birth defects.[14] DuPont was also aware that at least one facility had contaminated local drinking water supplies with unsafe levels of PFOA by 1991 but failed to warn anyone.[15]

DuPont hid this vital health information from the public and the U.S. Environmental Protection Agency (EPA) while making billions of dollars in profits from continued production of PFOA.[16] Ultimately, DuPont was fined $16.5 million in 2005 for failing to disclose information about toxicity and health risks caused by PFOA.[17]

---

[10] Ctr. for Drinking Water Quality, *supra* note 7.

[11] *See* U.S. Envtl. Prot. Agency, PFAS Community Engagement Event (2018), *available at* https://www.epa.gov/sites/production/files/2018-06/documents/master_combined_exeterpresentationsjun26v.pdf.

[12] *PFAS Contamination of Water*, R.I. Dep't of Health, http://www.health.ri.gov/water/about/pfas/ (last visited Jan. 9, 2019).

[13] Nathaniel Rich, *The Lawyer Who Became DuPont's Worst Nightmare*, N.Y. Times, Jan. 6, 2016, *available at* https://www.nytimes.com/2016/01/10/magazine/the-lawyer-who-became-duponts-worst-nightmare.html.

[14] *Id.*

[15] *Id.*

[16] *Id.*

[17] *See* Memorandum from Granta Y. Nakayama, Assistant Administrator, U.S. Envtl. Prot. Agency, to Environmental Appeals Board Re Consent Agreement and Final Order to Resolve DuPont's Alleged Failure to Submit Substantial Risk Information Under the Toxic Substances Control Act (TSCA) and Failure to Submit Data Requested Under the Resource Conservation and Recovery Act (RCRA) 3 (Dec. 14, 2005), *available at* https://www.epa.gov/sites/production/files/2013-08/documents/eabmemodupontpfoasettlement121405.pdf.

Although PFOA and PFOS have now been phased out of production in the United States,[18] these compounds will remain in our drinking water, ground- and surface waters, as well as our bodies, for decades. In addition, manufacturers have rushed to produce thousands of alternative PFAS that are likely to pose similar health risks given the similarities in chemical structure.[19] **There are now over 3,000 different kinds of PFAS.**

To make matters worse, EPA has failed to take meaningful action to protect the public from exposure to PFAS in drinking water. After becoming aware of contamination of drinking water supplies and the significant health risks posed by these dangerous chemicals, EPA gave manufacturers almost a decade to phase out production and use of PFOA and PFOS through a voluntary program.[20] Despite learning in 2015 that millions of Americans were, and continue to be, exposed to PFAS contaminated drinking water, EPA has not taken steps toward requiring public water systems to regularly monitor for PFAS and to treat unsafe water.[21] EPA even suppressed a scientific study suggesting that EPA's current health advisory for PFOA and PFOS does not protect public health.[22] After widespread public outcry, EPA announced the possibility of setting drinking water standards for just two out of more than 3,000 PFAS, but no enforceable regulatory standard has been proposed to date and even this limited action will take years.[23]

In addition, the federal government's capacity to set a standard protective of health has been compromised by the staggering liabilities of the United States for releases

---

[18] *Assessing and Managing Chemicals Under TSCA, Fact Sheet: 2010/2015 PFOA Stewardship Program*, U.S. Envtl. Prot. Agency, https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program (last visited Jan. 9, 2019).

[19] *See, e.g.*, Stephen Brendel et al., *Short-Chain Perfluoroalkyl Acids: Environmental Concerns and a Regulatory Strategy under REACH*, 30 Envtl. Sci. Eur. 9 (2018), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5834591/pdf/12302_2018_Article_134.pdf.

[20] *See, e.g.*, In the matter of DuPont Company, Premanufacture Notice Numbers P-08-508 and P-08-509(U.S. Envtl. Prot. Agency April 9, 2009) (consent order), *available at* https://assets.documentcloud.org/documents/2746607/Sanitized-Consent-Order-P08-0508-and-P08-0509.pdf; Premanufacture Notification Exemption for Polymers; Amendment of Polymer Exemption Rule to Exclude Certain Perfluorinated Polymers, 75 Fed. Reg. 4295, 4296 (Jan. 27, 2010).

[21] David Andrews, *Report: Up to 110 Million Americans Could Have PFAS-Contaminated Drinking Water*, Envtl. Working Grp. (May 22, 2018), https://www.ewg.org/research/report-110-million-americans-could-have-pfas-contaminated-drinking-water.

[22] Abraham Lustgarten et al., *Suppressed Study: The EPA Underestimated Dangers of Widespread Chemicals*, ProPublica (June 20, 2018), https://www.propublica.org/article/suppressed-study-the-epa-underestimated-dangers-of-widespread-chemicals.

[23] *The Federal Role in the Toxic PFAS Chemical Crisis: Hearing Before the Subcomm. on Fed. Spending Oversight and Emergency Mgmt. of the S. Comm. on Homeland Sec. & Gov't Affairs*, 115th Cong. (2018) (statements of S. Rand Paul, Chairman, Subcomm. on Fed. Spending Oversight and Emergency Mgmt. and S. Gary C. Peters, Ranking Member, Subcomm. on Fed. Spending Oversight and Emergency Mgmt.), *available at* https://www.hsgac.senate.gov/hearings/the-federal-role-in-the-toxic-pfas-chemical-crisis.

of PFAS at federal facilities nationwide, including releases from federal facilities in Rhode Island.[24]

Rhode Island can—and must—take the lead in the absence of federal safeguards. We will never be able to reverse the damage caused by chemical manufacturers and EPA's inaction, but RIDOH has authority to promulgate rules that limit additional exposure to unsafe levels of PFAS in drinking water.[25] In the absence of such rules, the public will remain at risk, and the most vulnerable among us—nursing infants and children generally, who consume higher volumes of water for their body weight and have greater developmental susceptibility—will be at the greatest risk.

Moreover, in the absence of such rules, homeowners on well water and municipalities and other drinking water system operators will be stymied in their efforts to recover the costs of adopting filtration and other safeguards from responsible polluters.

For all these reasons, RIDOH should stop putting public health at risk and adopt Vermont's PFAS Health Advisory of 20 ppt for a sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA as a drinking water standard for Rhode Island's public water systems. In addition, RIDOH should begin the process for promulgating a PFAS treatment technique drinking water standard that will do even more to protect Ocean State residents from the entire class of PFAS. Petitioners encourage RIDOH to coordinate and collaborate with other states on such an initiative.

II. BACKGROUND

A. PFAS are harmful to human health

PFAS are a public health crisis "perfect storm" because PFAS compounds are extremely persistent in the environment, highly mobile in water, bioaccumulative, toxic in very small quantities, and found in hundreds of products. PFAS compounds are man-made substances that do not occur naturally. They have been used in non-stick cookware, water-repellent clothing, stain resistant fabrics and carpets, cosmetics, firefighting foams, and other products that resist

[24] *See* Envtl. Bus. Council New England, Contaminants of Emerging Concern: Update on PFAS (2018) (PFAS detected in groundwater at Naval Station Newport), *available at* http://ebcne.org/wp-content/uploads/2018/10/Presentations-EBC-Rhode-Island-Program-Contaminants-of-Emerging-Concern-Update-on-PFAS.pdf.

[25] The Director of RIDOH is "authorized to adopt regulations consistent with the provisions of this chapter, the federal Safe Drinking Water Act, 42 U.S.C. § 300f et seq., and the federal regulations adopted under that act." R.I. Gen. Laws § 46-13-18. In addition, "Any person maintaining a [public water system] who is aware of an unsafe condition, that the water is not safe or is subject to contamination, shall notify the Director [of RIDOH] immediately." 216 R.I. Code R. § 50-05-1.10. RIDOH has already established treatment technique requirements for several contaminants. *See* 216 R.I. Code R. § 50-05-1.6

grease, water, and oil.[26] These chemicals are extremely strong and highly resistant to degradation.[27]

PFAS are toxic to humans in very small concentrations—in the *parts per trillion*.[28] 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; asthma;[29] immune system problems; and interference with liver, thyroid, and pancreatic function.[30] PFAS have been linked to increases in testicular and kidney cancer in human adults.[31] The developing fetus and newborn babies are particularly sensitive to some PFAS.[32]

Alarmingly, epidemiological studies identify the immune system as a target of PFAS toxicity. Some studies have found decreased antibody response to vaccines, and associations between blood serum PFAS levels and immune system hypersensitivity and autoimmune disorders (ulcerative colitis).[33] There are no medical interventions that will remove PFAS from the body.[34]

PFAS are very resistant to breakdown, bioaccumulate, and easily migrate. PFAS "have been detected in all environmental media including air, surface water, groundwater (including drinking water), soil, and food."[35] A study by the Centers for Disease Control and Prevention (CDC) found four PFAS (PFOS, PFOA, PFHxS, and PFNA) in the serum of nearly all of the people tested, indicating widespread exposure in the U.S. population.[36] PFOA and PFOS were

---

[26] Seth Kerschner & Zachary Griefen, *Next Round of Water Contamination Suits May Involve CWA*, Law360 (October 5, 2017), https://www.law360.com/articles/970995/next-round-of-water-contamination-suits-may-involve-cwa.

[27] Div. of Sci., Research, and Envtl. Health, N. J. Dep't of Envtl Prot. *Investigation of Levels of Perfluorinated Compounds in New Jersey Fish, Surface Water, and Sediment*, (2018), *available at* https://www.nj.gov/dep/dsr/publications/Investigation%20of%20Levels%20of%20Perfluorinated%20Compounds%20in%20New%20Jersey%20Fish,%20Surface%20Water,%20and%20Sediment.pdf.

[28] Agency for Toxic Substances and Disease Registry, U.S. Dep't of Health & Human Services, *Toxicological Profile for Perfluoroalkyls 5-6 (2018), available at* https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf.

[29] Maria Averina et al., *Serum Perfluoroalkyl Substances (PFAS) and Risk of Asthma and Various Allergies in Adolescents*, 169 Envtl. Res. 114, *available at* https://www.ncbi.nlm.nih.gov/pubmed/30447498.

[30] Agency for Toxic Substances and Disease Registry, *supra* note 28, at 5-6.

[31] *Id.* at 6; Vaughn Barry et al., Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers among Adults Living Near a Chemical Plant, 121 Envtl. Health Perspectives no. 11-12, 2013, at 1313-18, *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3855514/pdf/ehp.1306615.pdf.

[32] U.S. Envtl. Prot. Agency, Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS) 10 (2016), *available at* https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf.

[33] *Id.* at 39.

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

[35] Agency for Toxic Substances and Disease Registry, *supra* note 28, at 2.

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

found in up to 99 percent of the U.S. general population between 1999 and 2012.[37] PFAS are found in human breast milk and umbilical cord blood.[38]

While a great deal of public attention has recently been paid to PFOA and PFOS, EPA and other scientists have raised concerns that other chemicals in the PFAS class of compounds are similar in chemical structure and are likely to pose similar health risks:[39]

> [T]hey contain perfluorinated chains that only degrade very slowly, if at all, under environmental conditions. . . . Although some of the long-chain PFASs are being regulated or phased out, the most common replacements are short-chain PFASs with similar structures, or compounds with fluorinated segments joined by ether linkages. While some shorter-chain fluorinated alternatives seem to be less bioaccumulative, they are still as environmentally persistent as long-chain substances or have persistent degradation products. In addition, because some of the shorter-chain PFASs are less effective, larger quantities may be needed to provide the same performance.[40]

Thus, drinking water rules must protect the public health from unsafe exposure to all compounds in the PFAS class.

B. PFAS in Rhode Island

Not only are PFAS toxic in very small amounts (in the nanograms per liter or parts per trillion), they are highly mobile in groundwater and surface water, and have been found in waters in Rhode Island.

Between 2013 and 2015, as part of the EPA's Unregulated Contaminant Monitoring Rule, all large water systems were tested in Rhode Island. Two of the 17 large water systems returned results showing the presence of PFAS in their wells.[41] The public water system in

---

[37] U.S. Envtl. Prot. Agency, Drinking Water Health Advisory for Perflourooctanoic Acid (PFOA) 9 (2016), *available at* https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf.

[38] Agency for Toxic Substances and Disease Registry, *supra* note 28, at 3.

[39] *See, e.g.*, U.S. Envtl. Prot. Agency, *supra* note 20, at vii (stating that, with respect to "GenX" compounds (chemical substances intended to replace long-chain (C8) PFAS used in Teflon), "EPA has concerns that these PMN substances will persist in the environment, could bioaccumulate, and be toxic ("PBT") to people, wild mammals, and birds.").

[40] Arlene Blum et al., *The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs),* 123 Envtl. Health Perspectives, no. 5, 2015, *available at* https://ehp.niehs.nih.gov/doi/pdf/10.1289/ehp.1509934; *see also* Swed. Chems. Agency, Occurrence and Use of Highly Fluorinated Substances and Alternatives (2009), *available at* https://www.kemi.se/en/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf.

[41] R.I. Dep't of Health, *supra* note 7.

Westerly showed the presence of PFOA between 0 ppt and 20 ppt and the public water system of Cumberland showed the presence of PFOA between 0 ppt and 81 ppt.[42]

The RIDOH, the Rhode Island Department of Environmental Management (RIDEM), and Brown University also conducted tests of a limited number of small water systems in Rhode Island and found the presence of PFAS.[43] The water system of the Oakland Association in Burrillville, Rhode Island returned test results higher than the EPA standard of 70 ppt.[44] Between September 14 and September 29, 2017, three separate tests of the Oakland Association water system returned PFAS/PFOS levels of 88 ppt, 69 ppt, and 114 ppt.[45] In addition, another water system tested between 35 and 70 ppt and seven others tested at less than 35 ppt.[46]

In addition to drinking water systems, tests of ground water at the Naval Station Newport detected PFAS in the majority of sites tested.[47] The source of the PFAS is suspected to be AFFF Fire Suppression Infrastructure and levels exceeded 20 ppb (parts per billion) in some locations.[48]

Because Rhode Island has not yet engaged in extensive testing in terms of either locations tested or types of PFAS tested, we do not yet know the extent of the PFAS problem in our drinking water.

III. RIDOH SHOULD IMMEDIATELY ADOPT VERMONT'S PFAS HEALTH ADVISORY AS A MAXIMUM CONTAMINANT LEVEL

As an immediate first step in addressing the public health risks associated with PFAS in drinking water, RIDOH should adopt Vermont's PFAS Health Advisory of 20 ppt for the sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA as an MCL. Enclosed is a copy of a proposed rule that would put this standard into RIDOH regulations.

A. The current EPA Advisory recognized by RIDOH does not protect Rhode Islanders

Currently, RIDOH requires that providers of water follow the EPA's Health Advisory for PFOA and PFOS in drinking water, requiring these chemicals to be below 70 ppt.[49] "When both

---

[42] *Interactive Map: Tracking Nonstick Chemical Pollution Across the U.S.*, Envtl. Working Grp., https://www.ewg.org/interactive-maps/2017_pfa/ (last visited Jan. 9, 2019).

[43] R.I. Dep't of Health, *supra* note 7.

[44] *Id.*

[45] Press Release, RI Dep't Of Heath, Residents in the Oakland Section of Burrillville Provided Health Guidance for Drinking Water (Oct. 2, 2017), *available at* https://www.ri.gov/press/view/31565.

[46] R.I. Dep't of Health, *supra* note 7.

[47] *SSEHRI PFAS Contamination Site Tracker*, Envtl. Working Grp., https://docs.google.com/spreadsheets/d/1HxLAzOmFdMh7V-mey4ExTPsnNKarEcGG6klBWZH8auA/edit#gid=676990244 (last visited Jan. 9, 2019).

[48] U.S. Envtl Prot. Agency, *supra* note 11, at 139.

[49] R.I. Dep't Of Health, *supra* note 12.

PFOA and PFOS are found in drinking water, the combined concentrations of PFOA and PFOS should be compared with the 70 parts per trillion health advisory level."[50]

A 20 ppt MCL provides Rhode Islanders with greater protection from a class of chemicals that is both toxic in very small concentrations and bioaccumulative. PFAS have been linked to a number of serious health effects, including growth, learning, and behavioral problems in infants and children; fertility and pregnancy problems; hormone, cholesterol, and immune system problems; interference with liver, thyroid, and pancreatic function; and several cancers.[51] Once an individual is exposed to PFAS, there are no medical interventions that can remove it from the body.[52] The irreversible nature of and severe health effects associated with PFAS exposure counsel in favor of a cautious approach.

RIDEM has also promulgated a rule to establish EPA's 70 ppt Health Advisory for PFAS as a groundwater quality enforcement standard. This standard is not only too high, it also fails to protect drinking water. Because RIDOH has yet to adopt an MCL or to establish an alternative drinking water standard for PFAS, public water systems in Rhode Island are not required to monitor for or treat unsafe concentrations of PFAS.

Even if the Vermont PFAS Health Advisory were adopted as an MCL, it would not be sufficiently protective of public health because it does not address the thousands of PFAS chemicals in the PFAS class. While this would be a good first step, as discussed in Section I, there are now over 3,000 different kinds of PFAS compounds. Testing for only a few of thousands of dangerous PFAS compounds is inadequate, especially because PFOA and PFOS are in the process of being phased out and replaced in products by other compounds.[53]

B. Drinking Water Health Advisory for Five PFAS

In July of 2018, Vermont updated its PFAS Health Advisory from 20 ppt for a sum of PFOA and PFOS (adopted in 2016) to 20 ppt for a sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA.[54] Announcing this expansion from two to five PFAS, Vermont's Agency of Natural Resources explained that "[s]ome studies show that these PFAS may affect growth, learning and behavior in babies and older children, lower a woman's chance of getting pregnant, interfere

[50] U.S. Envtl. Prot. Agency, Fact Sheet: PFOA & PFOS Drinking Water Health Advisories (2016), *available at* https://www.epa.gov/sites/production/files/2016-06/documents/drinkingwaterhealthadvisories_pfoa_pfos_updated_5.31.16.pdf.

[51] Agency for Toxic Substances and Disease Registry, *supra* note 28, at 5-6.

[52] Vt. Dep't of Health, *supra* note 34.

[53] See U.S. Envtl. Prot. Agency, *supra* note 18; *Teflon Chemical Harmful at Smallest Doses: Phased Out, but Still a Threat*, Envtl. Working Grp. (Aug. 20, 2015), https://www.ewg.org/research/teflon-chemical-harmful-at-smallest-doses/phased-out-still-threat.

[54] *Health Department Updates Health Advisory for PFAS, State Expands Testing Plan to include 10 Schools in Pilot Project*, Vt. Agency of Natural Res. (Jul. 10, 2018), https://anr.vermont.gov/node/1223.

with the body's natural hormones, increase cholesterol levels, affect the immune system, and increase the risk of cancer."[55]

Vermont Health's web page on its five PFAS health advisory levels explains that if tests of your water have a total sum of (i) PFOA, (ii) PFOS, (iii) PFHxS; (iv) PFHpA; and (v) PFNA of over 20 ppt, then "we recommend not using your water for drinking, food preparation, cooking, brushing teeth, preparing baby formula, or any other manner of ingestion."[56] Vermont Health also warns against using this water in a garden because "[t]he PFAS could be taken up by the vegetables."[57]

The Vermont PFAS Health Advisory of 20 ppt is "based on a non-cancer endpoint and derived using the oral reference dose of 0.00002 mg/kgBW-d provided in US EPA's 2016 Health Effects Support Documents for PFOA and PFOS."[58] Vermont Health "applied the oral reference dose for PFOA and PFOS to the sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA."[59] The Agency "also calculated a candidate drinking water advisory for consideration based on the cancer endpoint using the information provided in EPA's 2016 Health Effects Support Documents for PFOA and PFOS and determined that derivation of the Health Advisory based on the noncancer endpoint is more protective."[60]

In its memorandum on the Vermont PFAS Health Advisory, Vermont Health provides detailed information on each of the five PFAS contained in the Advisory:

> **PFOA** and **PFOS** are the most well-studied of the PFAS. The US EPA Office of Water has provided toxicity values for PFOA and PFOS, and advice to apply a single guidance value to the sum of them. PFOA and PFOS target many organ systems, including but not limited to the liver, endocrine and the immune system. The National Toxicology Program, a Division of the National Institute of Environmental Health Sciences, concludes that PFOA and PFOS are presumed to be immune hazards to humans, based on a high level of evidence in animals that PFOA and PFOS suppress the antibody response. Exposure to PFOA and PFOS is also associated with developmental toxicity. The offspring of mice exposed to PFOA showed neurodevelopmental effects, skeletal alterations, and reduced ossification and accelerated puberty in males. The offspring of rats exposed to PFOS showed delayed eye opening and decreased pup weight. Toxicity information for PFHxS, PFHpA and PFNA is summarized below.

---

[55] *Id.*

[56] *Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in Drinking Water*, Vt. Dep't of Health (July 13, 2018), http://www.healthvermont.gov/environment/drinking-water/perfluoroalkyl-and-polyfluoroalkyl-substances-pfas-drinking-water.

[57] *Id.*

[58] Vt. Agency of Human Res., *supra* note 4, at 3 (internal citations omitted).

[59] *Id.*

[60] *Id.* (internal citations omitted).

PFHxS - A single dose of PFHxS in mice at postnatal day resulted in altered spontaneous behavior and habituation at two and four months. Increased thyroid follicular cell damage was observed in male rats given PFHxS for 42 days. In vitro studies show PFHxS has the potential to bind thyroid transporter protein.

PFHpA - Data from two in vitro studies suggest PFHpA has the potential to exhibit developmental toxicity and bind PPARa. Colorado Department of Public Health and Environment issued a Health Advisory applicable to the sum of PFOA, PFOS and PFHpA, as they concluded PFHpA may have similar effects as PFOA and PFOS.

PFNA - Toxicity studies indicate that exposure to PFNA may have similar impacts as exposure to PFOA and PFOS including but not limited to; immunotoxicity, developmental toxicity, and liver toxicity. Decreased thymus and/or spleen weight, and changes in immune cell ratios were observed in rats and mice after PFNA exposure. Decreased pup weight and delayed development was observed in mice exposed gestationally to PFNA. The New Jersey Drinking Water Quality Institute developed an MCL for PFNA of 13 ppt, based on increased liver weight in mice.[61]

RIDOH should look to the Vermont PFAS Health Advisory and the materials referenced therein to adopt the 20 ppt sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA as a PFAS drinking water regulation in Rhode Island.

IV. RIDOH SHOULD BEGIN WORKING ON ADOPTION OF A TREATMENT TECHNIQUE DRINKING WATER STANDARD FOR THE ENTIRE PFAS CLASS OF CHEMICALS OR AN MCL FOR THE ENTIRE PFAS CLASS OF CHEMICALS

While petitioners request the immediate adoption of the Vermont PFAS Health Advisory because it is an important first step to improve public health, setting MCLs on a chemical-by-chemical basis is not the preferred way to protect the public from PFAS health impacts. Instead, either adopting a treatment technique drinking water standard for the class of PFAS or adopting an MCL for the entire PFAS as a class would be more protective of public health. These regulatory approaches are authorized by law and technically feasible. In addition to immediately adopting the Vermont PFAS Health Advisory, we encourage RIDOH to begin working on a treatment technique drinking water standard or an MCL for the entire PFAS class because these are better long-term ways to regulate PFAS. Petitioners encourage RIDOH to coordinate and collaborate with others in the region.

A. The chemical-by-chemical, MCL approach to regulating toxic chemicals is not the best way to protect public health and the environment

The current chemical-by-chemical regulatory framework for toxic chemicals is deeply inefficient and puts public health at risk. For example, even after the 2016

[61] *Id.* (emphasis added, internal citations omitted).

amendment to the Toxic Substances Control Act, "it could take decades to evaluate the 80,000 chemicals already in commerce that have yet to be tested, let alone the 2,000 new chemicals introduced each year."[62] The EPA "still treats each chemical individually, continuing the saga in which similar, but slightly different, chemicals can be regrettably substituted."[63]

This "whack-a-mole" approach is especially troublesome when it comes to setting drinking water standards for emerging contaminants like PFAS because it is time-consuming and assessment is expensive. It is "technically and financially challenging to identify and reverse environmental and human exposure to PFASs[,]" and both of these issues are exacerbated by the continual introduction of new PFAS compounds.[64] There are at least 3,000 PFAS compounds in use currently[65] and regulators don't know the names of all PFAS compounds, much less where they are located in their state. Recently developed PFAS are regarded as trade secrets and closely guarded confidential business information, so manufacturers often do not apply for patents or supply regulators with information about molecular structure or usage.[66]

In light of the thousands of PFAS that have been introduced into commerce, with more introduced each year, establishing MCLs for each PFAS compound is simply not feasible. The regulators fall farther behind every year, putting our citizens in harm's way. Thus, Rhode Island should work towards regulating the entire PFAS class or adopting a treatment technique drinking water standard that protects us from exposure to unsafe levels of all chemicals in the PFAS class.

B. A treatment technique drinking water standard is appropriate for PFAS

RIDOH has authority to regulate, monitor, and correct any unsafe conditions in the state's drinking water.[67] The unique nature of PFAS demands an alternative approach to chemical-by-chemical regulation through MCLs. Regulation of PFAS as a class and through a treatment technique standard is necessary.[68] There are well-established drinking water treatment technologies that public water systems can install to remove unsafe levels of PFAS from drinking water. RIDOH should not delay the promulgation of a treatment technique drinking water standard for the PFAS class to address this public health crisis "perfect storm."

---

[62] Joseph Allen, *Stop Playing Whack-a-Mole with Hazardous Chemicals*, Wash. Post, December 15, 2016, *available at* https://www.washingtonpost.com/opinions/stop-playing-whack-a-mole-with-hazardous-chemicals/2016/12/15/9a357090-bb36-11e6-91ee-1adddfe36cbe_story.html.

[63] *Id.*

[64] Zhanyun Wang et al., *A Never-Ending Story of Per- and Polyfluoroalkyl Substances (PFASs)*?, 51 Envtl Sci. & Tech. 2508, 2511 (2017), *available at* https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b04806.

[65] Swed. Chems. Agency, *supra* note 40, at 6.

[66] Zhanyun Wang et al., *supra* note 64.

[67] R.I. Gen. Laws § 46-13-1 et seq.

[68] RIDOH has previously established treatment technique requirements in lieu of MCLs for a number of contaminants. *See* 216 R.I. Code R. § 50-05-1.6.1(A).

1. RIDOH has the authority to adopt a treatment technique drinking water standard

RIDOH has authority to adopt a treatment technique drinking water standard for PFAS. Pursuant to R.I. Gen. Laws § 46-13-18(a), the director of RIDOH is authorized "to adopt regulations consistent with the provisions of this chapter"—the purpose of which is "to aid in assuring the public is provided with safe and potable drinking water"[69]—as well as "the federal Safe Drinking Water Act, 42 U.S.C. § 300f et seq., and the federal regulations adopted under that act."

"A treatment technique is an enforceable procedure or level of technological performance which public water systems must follow to ensure control of a contaminant."[70] Where a treatment technique is selected in lieu of an MCL, the treatment technique must "prevent known or anticipated adverse effects on the health of persons to the extent feasible."[71] EPA has adopted several treatment technique drinking water standards in lieu of an MCL where EPA has determined that it is "not economically or technologically feasible to ascertain the level of [a] contaminant."[72] For example, the Lead and Copper Rule requires the use of a treatment technique.[73] This rule requires public water systems to test drinking water in the homes of consumers and undertake additional treatment measures to control lead if 10% of the samples exceed 15 ppb.[74] The Surface Water Treatment Rule also requires the use of a treatment technique. Under this rule, most public water systems that obtain water from surface water or groundwater under the direct influence of surface water must use filters and disinfectants to reduce pathogens.[75] In both cases, EPA had to establish a unique procedure to address the risks posed by a specific contaminant because an MCL would not have been practical or protective of public health due to the unique characteristics of the contaminants.

Similarly, the unique characteristics of the PFAS class pose a public health threat that cannot be adequately addressed with the establishment of an MCL for one or a few PFAS chemicals. RIDOH has the authority to develop a procedure that would require installation of specific drinking water treatment technologies. For example, RIDOH employs a treatment technique for Giardia lamblia, viruses, heterotrophic plate count bacteria, Legionella, Cryptosporidium, and turbidity.[76]

---

[69] R.I. Gen. Laws § 46-13-1.

[70] *How EPA Regulates Drinking Water Contaminants*, U.S. Envtl. Prot. Agency, https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants (last visited Jan. 9, 2019).

[71] 42 U.S.C. § 300g-1(b)(7)(A).

[72] *Id.*

[73] U.S. Envtl. Prot. Agency, *supra* note 70.

[74] *Lead and Copper Rule*, U.S. Envtl. Prot. Agency, https://www.epa.gov/dwreginfo/lead-and-copper-rule (last visited Jan. 9, 2019).

[75] *Surface Water Treatment Rules*, U.S. Envtl. Prot. Agency, https://www.epa.gov/dwreginfo/surface-water-treatment-rules (last visited Jan. 9, 2019).

[76] *See* 216 R.I. Code R. § 50-05-1.6.1(A).

RIDOH has multiple options to protect Rhode Islanders from exposure to the PFAS class. For example, RIDOH could promulgate a rule that requires public water systems to install appropriate treatment technologies where (1) the sum of all measurable PFAS exceeds a conservative threshold level that is protective of public health and takes into account the cumulative impacts of all PFAS chemicals, or (2) the presence of PFAS compounds is detected using "non-targeted" laboratory analysis.[77] Non-targeted analysis allows "researchers [to] rapidly characterize thousands of never studied chemical compounds in a wide variety of environmental, residential, and biological media."[78] An alternative option would be to require a robust source water assessment for PFAS and treatment where PFAS may be present in the source water. RIDOH should determine a specific procedure for the drinking water standard through a robust stakeholder process as part of the rulemaking process.

2. Due to the unique characteristics of the PFAS class of compounds, a treatment technique is necessary to protect public health

i. Regulation of PFAS chemicals as a class is necessary

Even if RIDOH were to adopt the Vermont Health Advisory for PFAS as an MCL, a combined limit for five PFAS would not protect Rhode Island residents from the 3,000 or more other PFAS.[79]

First, in addition to PFOA, PFOS, PFHxS, PFHpA, and PFNA, there are thousands of other PFAS compounds likely to pose similar health risks given the similarities in chemical structure.[80] There are likely many other PFAS in Rhode Island that RIDOH is simply not aware of yet given the speed and secrecy with which chemical manufacturers have introduced these dangerous chemicals into commerce.[81]

Second, as discussed above, PFAS are similar in chemical structure and some PFAS break down into each other. While long-chain PFAS compounds may be decreasing in the environment due to voluntary phase-outs by manufacturers, "the most common replacements are short-chain PFAS with similar structures."[82] Third, these PFAS chemicals are often found together, and fourth, they are likely to have similar health effects as discussed in Section II A.

---

[77] *EPA Researchers Use Innovative Approach to Find PFAS in the Environment*, U.S. Envtl. Prot. Agency (Aug. 13, 2018), https://www.epa.gov/sciencematters/epa-researchers-use-innovative-approach-find-pfas-environment; Karl Leif Bates, *Duke Expert Helps Spearhead State's New Water-Testing Program*, Duke Today, Aug. 8, 2018, *available at* https://today.duke.edu/2018/08/duke-expert-helps-spearhead-states-new-water-testing-program.

[78] U.S. Envtl. Prot. Agency, *supra* note 77.

[79] Swed. Chems. Agency, *supra* note 40, at 6.

[80] Stephen Brendel et al., *supra* note 19.

[81] Envtl. Working Grp., Comments on the Agency for Toxic Substances and Disease Registry (ATSDR) Draft Toxicological Profile for Perfluoroalkyls, (2018), *available at* https://cdn.ewg.org/sites/default/files/testimony/EWG%20Comments%20for%20ATSDR_Aug20..pdf.

[82] Arlene Blum et al., *supra* note 40.

EPA has applied similar concepts to establish an MCL for a group of chemicals.[83] For example, EPA established an MCL for five haloacetic acid disinfection byproducts (HAA5) because it did not have sufficient information regarding (1) the occurrence of individual haloacetic acids; (2) how water quality parameters affect the formation of haloacetic acids; (3) how "treatment technologies control the formation of individual . . . [haloacetic acids]"; and (4) toxicity information for some of the individual haloacetic acids.[84] In light of the unique challenges associated with regulation of these chemicals, EPA promulgated a group MCL even in the absence of complete information about each individual haloacetic acid in order to better protect public health.[85] For all these reasons, it is appropriate to regulate PFAS chemicals as a class.

ii. A treatment technique in lieu of an MCL is necessary

A treatment technique in lieu of an MCL for specific PFAS chemicals or small groups of PFAS chemicals is necessary. As discussed previously, scientists suspect that other PFAS chemicals in the class may have adverse health effects similar to the handful of PFAS compounds that have been studied more extensively.[86] EPA has only developed targeted test methods for 18 PFAS chemicals out of more than 3,000 compounds.[87] Thus, it is simply not economically or technically feasible to ascertain the level of each specific PFAS chemicals in the PFAS class that poses a risk to Rhode Island residents.

As RIDOH is well aware, establishing an MCL for one compound is resource intensive and time-consuming. Adopting a treatment technique drinking water standard for the PFAS class in lieu of establishing MCLs for thousands of PFAS chemicals will require far fewer resources and will provide protection from exposure to unsafe levels of PFAS on a much shorter timeline. For these reasons, a treatment technique drinking water standard is necessary to protect Rhode Islanders.

3. Treatment technologies are available to remove long- and short-chain PFAS

There are both established and novel methods to remove and destroy PFAS. While long- and short-chain PFAS may be difficult to treat with any one traditional technology—some new technologies are in development—a "treatment train" of several technologies combining

---

[83] Vt. Dep't of Health, Drinking Water Guidance, Grouping Process for Drinking Water Health Advisories (2018), *available at* http://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_ECP_GeneralScreeningValues_Water.pdf.

[84] National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts, 63 Fed. Reg. 69390, 69409 (Dec. 16, 1998).

[85] *Id.*

[86] Swed. Chems. Agency, *supra* note 40.

[87] Press Release, U.S. Envtl. Prot. Agency, EPA Releases New Tools to Test and Treat Additional PFAS, Including GenX, in Drinking Water (Nov. 21, 2018), *available at* https://www.epa.gov/newsreleases/epa-releases-new-tools-test-and-treat-additional-pfas-including-genx-drinking-water.

adsorption, separation, and destruction in sequence, for example, would be effective in treating drinking water and protecting public health.

Adsorption technologies such as granular activated carbon (GAC) and ion exchange "are currently the most commonly encountered interim response measures to achieve immediate compliance with drinking water standards and serve as the benchmark of practicality and effectiveness for other treatment technologies."[88]

While new adsorption technologies like organically modified silica adsorbents show promise,[89] GAC has long been used for adsorption of chemical pollutants, consistently removes PFOS with an efficiency of more than 90 percent, and is the treatment technique specified in Safe Drinking Water Act for the control of synthetic organic chemicals:

> [G]ranular 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.[90]

Separation technologies, including reverse osmosis, microfiltration, ultrafiltration and nanofiltration, are highly effective for PFAS removal and can remove PFAS at more than 99% effectiveness.[91] "Membrane filtration has several benefits including: achieving continuous separation, low energy consumption, ease of combination with other existing techniques, easy up-scaling, and low chemical costs."[92] Ozofractionation (a patented process by the company EVOCRA and available commercially as Ozofractionative Catalyzed Reagent Addition (OCRA) (Dickson 2013, 2014)) is a novel separation technology that shows high (>99.99 percent reduction) effectiveness for PFAS.[93]

---

[88] John Horst et al., *Water Treatment Technologies for PFAS: The Next Generation, 38* Groundwater Monitoring & Remediation, no. 5, Spring 2018, at 15, *available at* https://doi.org/10.1111/gwmr.12281.

[89] *Id*. at 15–16.

[90] 42 U.S.C. § 300g-1(b)(4)(D).

[91] K.H. Kucharzyk et al., *Novel Treatment Technologies for PFAS Compounds: A Critical Review*, 204 J. Envtl. Mgmt. 204, 759; John Horst et al., *supra* note 88.

[92] V.A. Arias Espana et al., *Treatment Technologies for Aqueous Perfluorooctanesulfonate (PFOS) and Perfluorooctanoate (PFOA): A Critical Review with an Emphasis on Field Testing*, 4 Envtl. Tech. & Innovation 168, 177 (2015).

[93] John Horst et al., *supra* note 88, at 17.

Finally, novel destructive treatment technologies for PFAS are becoming available. Destructive technologies include sonochemical decomposition,[94] chemical/advanced photochemical oxidation,[95] and AECOM's DE-FLUORO™ technology.[96]

This treatment train solution will also confer significant co-benefits for public health, because the same technologies that are effective in PFAS treatment are effective in removing a host of other dangerous chemicals. Granular activated carbon (GAC) adsorption filters alone, for example, are effective in removing dozens of harmful contaminants in addition to PFAS (including, but not limited to: RDX, arsenic, benzene, cryptosporidium, MTBE, mercury, perchlorate, tetrachloroethylene (Perc), and trichloroethylene (TCE)).[97] Other technologies that should be considered as components of the treatment train confer similar co-benefits; for example, membrane separation technologies like reverse osmosis not only treat PFAS but, without limitation, also treat 1,4-dioxane, alachlor, chromium, malathion, and nitrates.[98]

For all these reasons, Petitioners urge RIDOH to initiate a rulemaking for a treatment technique drinking water standard for the PFAS class.

C. In the alternative, the Agency should adopt an MCL for the PFAS class

RIDOH must take action to establish drinking water standards for PFAS in the absence of federal safeguards even if RIDOH does not establish a treatment technique standard. As discussed in Section IV B 1, the Agency has the authority to regulate PFAS as a class. PFAS are present in Rhode Island waters and are known to cause adverse health effects. Thus, at a bare minimum, after adopting Vermont's PFAS Health Advisory of 20 ppt for the sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA as an MCL, RIDOH should move towards the adoption of an MCL for the PFAS class.

V. CONCLUSION

For all the forgoing reasons, Petitioners request that RIDOH establish a drinking water standard for PFAS that is protective of public health. Specifically, RIDOH should immediately adopt Vermont's PFAS Health Advisory of 20 ppt for the sum of PFOA, PFOS, PFHxS, PFHpA, and PFNA as an MCL. In addition, RIDOH should begin the process of promulgating a treatment technique drinking water standard for the entire PFAS class.

---

[94] V.A. Arias Espana et al., *supra* note 92, at 174.

[95] *Id.* at 178.

[96] AECOM, AECOM's Promising New PFAS Treatment Technology DE-FLUORO Shows Complete Destruction of PFAS (2018), *available at* https://www.aecom.com/content/wp-content/uploads/2018/04/PFAS-Treatment-Technology-DE-FLUORO_INFO-SHEET.pdf.

[97] U.S. Envtl. Prot. Agency, *Welcome to the Drinking Water Treatability Database, Granular Activated Carbon,* https://oaspub.epa.gov/tdb/pages/treatment/treatmentContaminant.do.

[98] *Id.*

The significant threats posed to human health and the environment by the PFAS class of compounds are clear. These compounds have been found in waters in Rhode Island. The dangers this class of chemicals pose to Rhode Islanders demand immediate action to limit further exposure. Thank you for your consideration.

Sincerely,

Amy E. Moses,
Vice President & RI Director
Conservation Law Foundation

James Crowley
Staff Attorney
Conservation Law Foundation

Sofia E. Owen
Attorney & Community Organizer
Toxics Action Center

Enclosure: Draft PFAS Drinking Water Regulation

CC (by email):

Lisa Vura-Weis
Acting Secretary, Rhode Island Executive Office of Health and Human Services

Kenny Alston
Chief Legal Counsel, Rhode Island Department of Health

Janet Coit
Director, Rhode Island Department of Environmental Management

Terrence Gray
Associate Director, Rhode Island Department of Environmental Management