BEFORE THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Petition for Revised Nitrate/Nitrite Maximum Contaminant Level and Goal Pursuant to Safe Drinking Water Act 42 U.S.C. § 300g to Protect Residents of the United States from Adverse Public Health Outcomes	EPA Docket No. _____, 2026

Submitted on Behalf of Petitioners

Alliance for the Great Lakes,
Center for Biological Diversity,
Center for Food Safety,
Clean Wisconsin,
Environmental Law & Policy Center,
Environmental Working Group,
Food & Water Watch,
Friends of Toppenish Creek,
Midwest Environmental Advocates,
Natural Resources Defense Council,
Oregon Rural Action,
Prairie Rivers Network,
Sentinels of Eastern Shore Health,
Sierra Club,
Sussex Health and Environmental Network, and
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I. Introduction

Nitrates in drinking water are causing a public health crisis across the country. The current crisis is not a surprise. Elected officials and regulators at the federal, state, and local levels have systematically ignored or failed to respond to the causes of this pollution for decades, leading to widespread drinking water contamination. The levels of nitrate[1] in our surface and groundwater resources have increased in many areas due to over application of inorganic fertilizer, excessive generation and over-application of concentrated animal feeding operation (CAFO) waste, inadequately treated sewage and industrial discharges, and failed septic systems. Industrial agriculture practices are widely understood as the primary contributor but are often the least regulated.

On top of this ongoing pollution problem, public health research now makes clear that the current Safe Drinking Water Act (SDWA) drinking water standard, or maximum contaminant level (MCL), of 10 milligrams per liter (mg/L) nitrate plus nitrite, set decades ago based on research from the 1950s, does not protect public health. Extensive scientific study now shows that drinking water with much lower levels is associated with increased cancer risks and has been linked to thyroid disease and fetal harms like low birth weight and preterm births. The result of the failure to protect water quality is that tens of millions of people across the United States are drinking water with unsafe levels of nitrate. According to our analysis, nearly 120 million people across the country, from California to Maryland are being served drinking water with dangerously high levels of nitrate.[2] These millions are on top of people relying on private wells for their household water needs in nitrate contaminated areas who also are exposed to unsafe levels.[3]

A 2019 study calculated that the annual one-in-one-million cancer risk level for nitrate in drinking water, the threshold typically used by agencies in the U.S., is approximately 0.14 mg/L based on colorectal cancer risk — 71 times lower than the current standard of 10 mg/L.[4] The researchers estimated that each year, between 2,300 and 12,594 new cancer cases in this country are attributable to nitrate exposure through drinking water with billions of dollars in costs from medical bills, lost productivity, and other indirect costs. They also concluded that a benchmark concentration of 0.1–0.45 mg/L nitrate would protect against nitrate-associated adverse birth outcomes.[5]

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[1] This Petition uses nitrate to be inclusive of nitrite. Nitrate and nitrite are closely related, with nitrate being converted into nitrite in the human body. Both nitrate and nitrite are also present in surface and groundwaters. This petition requests EPA change the drinking water standard to apply to total nitrate or nitrate plus nitrite, as the current standard does. Therefore, where the Petition references nitrate alone, we intend to also refer to a combined concentration of nitrate plus nitrite.

[2] *See* ONE WATER ECON, BENEFIT-COST ANALYSIS OF ALTERNATIVE NITRATE DRINKING WATER STANDARD LIMITS at 5 & Appx. B (Sept. 19, 2026) (hereinafter Benefit-Cost Analysis) (included as Exhibit 1).

[3] As EPA knows, communities across the country that rely on underground sources of drinking water and private wells face a parallel crisis to those that depend on Public Water Systems. *See infra* note 173. Revising the nitrate standard as this Petition requests would aid these communities as well by defining a safe standard and guiding pollution control and remediation efforts.

[4] Alexis Temkin et al., *Exposure-Based Assessment and Economic Valuation of Adverse Birth Outcomes and Cancer Risk Due to Nitrate in United States Drinking Water*, 176 ENV'T RESEARCH 108442 (2019), https://doi.org/10.1016/j.envres.2019.04.009 (included as Exhibit 2).

[5] *Id.*

For these reasons, the undersigned Petitioners request that EPA revise the Maximum Contaminant Level Goal for nitrate (MCLG) to zero and the MCL to 1 mg/L pursuant to its SDWA authority.[6] Petitioners further request, pending promulgation of a revised MCL, that EPA promulgate an interim MCL of 1 mg/L pursuant to 42 U.S.C. § 300g-1(b)(1)(D), because nitrate levels above this present "an urgent threat to health." This Petition presents extensive peer-reviewed public health research, legal analysis, and a detailed Benefit-Cost Analysis[7] that clearly establish the need and support for an MCLG of zero and an MCL of 1 mg/L. This change would reflect the best available, peer-reviewed science and would bring substantial health benefits to communities across the country.

Section II of this Petition briefly describes the interests of the Petitioners and then presents community testimonials underscoring the importance of protecting the public from nitrate in drinking water. Communities from coast to coast want safe, affordable drinking water and will no longer accept industrial agriculture getting a free pass while they pay with their health.

Section III outlines the dozens of peer-reviewed public health studies that have evaluated a wide range of human health endpoints and establish that there are serious risks to human health from nitrate levels well below the current standard.

Section IV lays out the legal background and shows that EPA has the authority and obligation to revise the nitrate MCL and MCLG as requested.

Section V summarizes why an MCLG of zero is appropriate in view of nitrate's likely carcinogenic effects. It then explains why an MCL of 1 mg/L is not only feasible but will provide huge benefits to human health and wellbeing that more than justify the costs of compliance.

Section VI requests that EPA take immediate action under 42 U.S.C. §§ 300g-1(b)(1)(D) to address the urgent threat to human health posed by nitrate in drinking water by establishing an MCLG of zero and an interim nitrate MCL of 1 mg/L immediately while it works to establish a new, revised final MCL.

Section VII requests that EPA prioritize protections for our water at the source, where Public Water Systems (PWSs) get our drinking water. It explains that this would lower the compliance costs for PWSs, as fewer systems would need treatment or would need less treatment. It also outlines strategies to achieve reductions and highlights the co-benefits of addressing this pollution at the source. Treatment alone will not solve the nitrate crisis caused by ongoing industrial agricultural pollution; this problem demands solutions at the source to protect our surface and groundwaters.

Finally, Section VIII calls on EPA to identify and direct federal funding for PWSs, especially small and rural systems, to comply with the new nitrate MCL. There are a variety of

[6] 42 U.S.C. § 300g-1(b)(1)(A), (b)(4) & (b)(9). Petitioners submit this Petition pursuant to the Administrative Procedure Act, 5 U.S.C. § 553.
[7] *See* Benefit-Cost Analysis, Exhibit 1.

federal grant and loan programs that EPA should leverage to assist PWSs that will need to invest in additional treatment to achieve the lowered nitrate MCL while other programs could assist in cleaning up those systems' source waters.

The best available, peer-reviewed science shows that nitrate is a likely carcinogen and increases the risk of a variety of other human health issues. Petitioners' detailed Benefit-Cost Analysis establishes that it is not only feasible to reduce the nitrate MCL to 1 mg/L, but doing so would bring massive benefits to public health and the lives of millions of people across the country that more than justify the costs. EPA must grant this Petition and act with the urgency this issue deserves by lowering the nitrate MCL and reining in industrial agriculture's pollution to start cleaning up our source waters.

II. INTEREST OF PETITIONERS

The undersigned Petitioner Organizations represent millions of people across the country demanding clean, safe water and effective regulation of industrial agriculture's nitrate pollution problem. The threat to public health from nitrate in drinking water is present and pervasive, and all signs indicate that dangerous contamination levels will continue or worsen absent EPA action. Questions or inquiries regarding this Petition should be directed to the lead Petitioners: Alliance for the Great Lakes, Environmental Law & Policy Center, Environmental Working Group, Food & Water Watch, Natural Resources Defense Council, Prairie Rivers Network, and Union of Concerned Scientists.

A. Petitioners

Alliance for the Great Lakes (AGL) is a nonpartisan nonprofit organization headquartered in Chicago, with offices in Indiana, Michigan, Minnesota, Ohio, and Washington, D.C. The Alliance is dedicated to protecting, conserving, and restoring the Great Lakes through science-based research, policy analysis, advocacy, and regional engagement. It works to ensure safe, clean, and affordable water for Great Lakes communities by advancing policies and research that protect water quality, including efforts to reduce agricultural pollution and other upstream threats to drinking water.

The **Center for Biological Diversity** is a nonprofit environmental organization dedicated to the protection of people, native species, and wild places through science, policy, and environmental law. The Center has over 1.8 million members and online activists and has worked for more than 30 years to protect endangered plants and wildlife, open space, air and water quality, and overall quality of life for all living things. The Center's Environmental Health Program aims to secure programmatic improvements in water quality protections under the Safe Drinking Water Act and Clean Water Act and to stop industrial agricultural operations from harming people, wildlife, and their habitats.

Center for Food Safety is a nonprofit environmental advocacy organization that aims to empower people and protect the environment from the harmful effects of industrial agriculture, including groundwater contamination from the concentration of industrial animal operations and

their waste. CFS represents over a million members and supporters across the country, including thousands of rural community members. CFS uses education, science-based advocacy, and litigation to protect farmers, farmworkers, rural communities, and consumers from the impacts of industrial agriculture and corporate consolidation in the food system.

Founded 55 years ago, **Clean Wisconsin** is a non-profit, non-partisan environmental advocacy organization working to secure a sustainable future for every Wisconsin community by combatting climate change and pollution in our air, water and land. With over 20,000 members and supporters around the state, we are scientists, policy experts, communications professionals and attorneys working to protect and improve Wisconsin's environment.

Environmental Law and Policy Center (ELPC) is a Midwest-based not-for-profit public interest environmental advocacy organization dedicated to improving environmental quality and public health, including protecting the Great Lakes and other Midwest natural resources. For nearly 30 years, ELPC has used litigation, policy advocacy, and strategic communications to improve environmental quality and protect the Midwest's natural resources. ELPC is headquartered in Chicago, Illinois and has additional offices in Ohio, Iowa, Wisconsin, Michigan, and Washington, D.C.

Environmental Working Group (EWG) is a nonprofit, nonpartisan organization that empowers people to live healthier lives in a healthier environment. EWG harnesses its signature blend of research, advocacy, and unique educational tools to drive consumer choice and inspire civic action. EWG is headquartered in Washington, D.C. and has teams in Minneapolis, Minn. and Sacramento, Calif. EWG has conducted research into agricultural pollution and farm policy programs for over three decades. Our expertise focuses on the environmental and climate impacts of agricultural practices, with a particular emphasis on water quality.

Food & Water Watch (FWW) is a national, nonprofit membership organization that mobilizes regular people to build political power to move bold and uncompromised solutions to the most pressing food, water, and climate problems of our time. FWW uses grassroots organizing, media outreach, public education, research, policy analysis, and litigation to protect people's health, communities, and democracy from the growing destructive power of the most powerful economic interests. FWW has long advocated for stronger regulation of nutrient and other pollution from factory farms to protect rural communities, public health, and the environment. FWW also has a long history of advocating for safe and equitable water systems and infrastructure.

Friends of Toppenish Creek is a non-profit group that formed in Washington's Yakima Valley in 2008 to prevent the construction of a concentrated animal feeding operation next to a wildlife refuge on the Yakama Indian Reservation. FOTC is dedicated to protecting the rights of rural communities and improving oversight of industrial agriculture. FOTC operates under the simple principle that all people deserve clean air, clean water and protection from abuse that results when profit is favored over people. FOTC works through public education, citizen investigations, research, legislation, special events, and direct action.

Midwest Environmental Advocates is a nonprofit law center that combines the power of law with the resolve of communities facing environmental injustice to secure and protect the rights of all people to healthy water, land, and air. Through legal advocacy, public education, and community partnerships, MEA empowers people across Wisconsin to participate in environmental decision-making and advance solutions that support healthy, thriving communities.

Natural Resources Defense Council (NRDC) is a 501(c)(3) nonprofit environmental and public health organization with several hundred thousand members. NRDC engages in research, advocacy, media, and litigation related to protecting public health and the environment. NRDC is based in New York, New York.

Oregon Rural Action is a grassroots 501(c)(3) nonprofit organization based in eastern Oregon. Our mission is to promote social and environmental justice, agricultural and economic sustainability and stewardship of the region's land, air, and water. We do this through community organizing that builds leadership and collective agency, research, and public policy to advance systemic change.

Prairie Rivers Network is an Illinois not-for-profit organization with more than 1000 members that champions clean, healthy rivers and lakes and safe drinking water to benefit the people and wildlife of Illinois.

Sentinels of Eastern Shore Health (SESH) works with residents on Maryland's Lower Eastern Shore to protect clean air and safe drinking water. The group supports communities affected by industrial poultry operations and advocates for stronger public health protections.

The **Sierra Club** is America's largest grassroots environmental organization, with more than two million members and supporters nationwide. In addition to creating opportunities for people of all ages, levels and locations to have meaningful outdoor experiences, Sierra Club works to safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and litigation. We amplify the power of our millions of members and supporters to defend the right to a healthy world. The role of the government in providing safe drinking water includes establishing drinking water quality standards and providing the means for utilities to keep water treatment plants in working order. This petition addresses drinking water standards. There is a correlation between different kinds of cancers, miscarriages, and spina bifida at nitrate concentration at or even below the current drinking water standard. When people drink water with high nitrates it can lead to increased healthcare costs and loss of productivity due to illness. There is an added cost to the public when to ensure their drinking water is safe they either buy bottled water or install systems in their home. The responsibility of the government is to require that drinking water protect its citizens.

Sussex Health and Environmental Network (SHEN) is a nonprofit that works with rural communities in Sussex County, Delaware, and on Maryland's Lower Eastern Shore. SHEN

uses community science, education, and advocacy to help residents document air and water pollution and push for solutions.

Union of Concerned Scientists (UCS) is a national nonprofit organization that puts rigorous, independent science into action to create a healthy, safe, and just future. UCS conducts research, develops science-based solutions, provides technical expertise to more than 1,500 local and national organizations, and mobilizes more than 600,000 supporters to advocate for healthier communities, a sustainable environment, and a safer world. Driven by the strong commitment of our supporters and partner organizations, UCS works to address nutrient pollution from agricultural operations in order to protect clean, safe drinking water and healthy waterways for communities across the United States.

B. Community Testimonials

Access to safe drinking water is not a luxury; it is a necessity. Every person in America should know that when they turn on their tap, what comes out is safe for them, their family, and their community. Many communities in certain regions have been struggling with nitrate contamination for years, sometimes decades, and their stories highlight the human toll at stake here.

- "I live in Iowa City, IA and grew up in rural Clare, IA in Northwest Iowa. I grew up on well water. Back then, we really weren't aware enough to check our water quality. However, I am quite certain that there was a good chance of contamination through agricultural runoff. Now that I live in Iowa City, we are on a municipal water source. This should allow us to feel safer. However, it doesn't. Allow me to explain.

  While running one day, I ran by the Iowa River. This happens to be the source of drinking water for Iowa City (or the water is drawn from an alluvial aquifer which is essentially the same water source from what I understand). As I ran by the Iowa River, there was a murky conglomerate of foamy, dirty water along the edges of the bank. This made me wish that I had my strips with me to test, but I did not. However, I thought that I should test my water once I got home. I did test my water and the city water was testing near 10 ppm. So, I decided to test the water coming from my reverse osmosis system. Low and behold it was around 5 ppm. In the end, after talking to several companies dealing with water filtration systems, it was determined that my particular system was not strong enough even though the filters were new. I did put in a new system and it appears to be reducing nitrate levels to zero or near zero. However, why should I have to pay for my own system? Why should I have consistent exposure to nitrate levels above 5 ppm? Why should I live with a great risk of experiencing cancer?

  I decided to tour the Iowa City Water Treatment Facility. They were very gracious and gave me an excellent tour with explanations. What I learned is that they don't even attempt to reduce nitrate levels until they get to around 8 ppm. Where I live, that is most days in the summertime. I also learned that they only reduce the levels to around 6

ppm. Many studies now indicate that nitrates may be carcinogenic at rates as low as 1–3 ppm. How should this make me feel safe? My kids are now raised but I have grandkids. It is unfair for my generation to pass this health risk (which is preventable) to my grandchildren.

Cancer rates in Iowa are rising. So are nitrate levels in our water supply. The recommended safe levels for nitrates is only enough to protect infants from Blue Baby Syndrome. It is not enough to protect Iowans from increased risks of cancer. The scientific literature demonstrating elevated risks of various forms of cancer at nitrate levels far below 10 ppm is extensive. It is time that our government and municipalities lower the safe limits of nitrate exposure in our waters." - **Mike Stein** of Iowa City, IA

- "In 1979, I first tested a beloved local spring for nitrates. The result was 4.7 parts per million. My instructor tut-tutted and said, 'That's kind of high.' I have been testing that spring ever since. Today, nitrate levels hover around 15 ppm, with periodic higher spikes. Despite my warnings, people continue to collect drinking water there, believing that clear, cold water must be safe water. But clear water is not necessarily safe water. And though 10 ppm of nitrates in drinking water is compliant with standards, it is still contaminated.

  During my long career as a teacher in a tiny rural school, I taught all my students to test their own water. I wanted them to understand that protecting water begins with knowing what's in it. My own well water fluctuates with the seasons, rainfall, and fertilizer application. I have spent decades watching nitrate pollution incessantly rise in our local water.

  I have also spent decades watching in despair as neighbors have body parts lopped off or slowly wither and die due to the elevated cancer rates we have here in Iowa. And now research increasingly implicates nitrate pollution as one of the environmental factors contributing to the cancer burden. This is personal for another reason. A friend nearly died as an infant from methemoglobinemia in the late 1960s. She survived and ultimately dedicated her life to educating her community about water policy. Her story reminds us that contaminated water can threaten the most vulnerable among us before they are old enough to protect themselves.

  We have known about nitrate pollution for decades. We have increasingly compelling evidence of its consequences. Yet we continue to rely on standards that fail to adequately protect public health. A legal limit is not necessarily a safe limit. Our water standards should protect human lives, not simply accommodate continued pollution. Our children and future generations deserve water that is genuinely safe to drink." - **Birgitta Meade** of Decorah, Iowa.

- "In January of 2022 I was diagnosed with bladder cancer. What's unusual is that bladder cancer was traditionally a 'smokers cancer.' And I have never been a smoker. Luckily, it was caught very early.

My treatment consisted of removing the tumor, then scraping the bladder wall, followed by 6 weeks of chemotherapy injected directly into my bladder. I have had quarterly checkups with my urologist which moved to biannually and now take place once per year.

My prognosis is very good, but why did a non-smoker develop bladder cancer? My urologist tells me that because of the high nitrates and other contaminants in Iowa's waters, we are seeing all kinds of people developing cancer that do not fit the traditional molds. And in my case, perhaps it's because I had donated a kidney in 2017 and my surgeon's only order for me was to drink more water, nearly a gallon/day. Water that is under the regulatory standard of 10mg/L, but is far too often in the 2–5mg/L range.

I am a lifelong Iowan and water has always been very important to me. My expectation is that Iowans should be able to enjoy water to drink and for recreation, without worrying that we are putting our health in jeopardy." - **Rich Gradoville** of Johnston, Iowa

- "In Sussex County, Delaware, and on Maryland's Lower Eastern Shore, many families living near industrial poultry operations rely on the water they drink, cook with, and use to mix infant formula. The science is clear and public health must reflect the science in our public systems. For families that rely on private wells, that step must go hand in hand with affordable testing and stronger protections to keep manure and fertilizer from contaminating groundwater. Families shouldn't have to pay out of pocket for expensive systems to have potable water." - **Maria Payan**, Executive Director of Sussex Health & Environmental Network (SHEN) and Sentinels of Eastern Shore Health (SESH)

- "I don't know what the acceptable number should be, but living with one kidney, watching one loved one suffer from thyroid disease, watching a would-be mother grieve over her unborn child. One? One is too many. For nearly forty years, nitrate contamination in our region's sole source of drinking water has upended life for thousands of people in northeast Oregon. Nitrate levels continue to rise as families dependent on nitrate-contaminated wells grapple with the reality of widespread illness and disease, and the loss of both unborn children and longtime neighbors. Increasingly, people in small towns and cities worry water from their tap may be making them sick. The MCL must be lowered to align with modern science and meet public health needs." - **Jim Doherty**, rancher and former Morrow County Commissioner, Boardman, Oregon

- "As a resident of the Pinelands Sands in Minnesota I have watched forests disappear in favor of row cropping and irrigation which flush ag chemicals into our groundwater. Sometimes conditions are right to force chemicals applied to crops into the groundwater residents drink by the end of the day. Nitrate is the easiest to test for and we find it all over where row crops and irrigation have been in use. The Minnesota Department of Agriculture's own data shows almost 20% of wells in townships in our area are contaminated with nitrate beyond the very old standard EPA still uses to say water is safe to drink. Nitrate found in ag settings invariably indicates multiple pesticides will be in the

water too. There is no better example of 'chemical trespass.'" - **Mike Tauber** of Minnesota.

- "When the results came back, we found out that the nitrate levels were 26.6 mg/L. Blue baby syndrome was definitely a concern. We had done some research of our own after discovering the contamination and wanted to protect our family from not only blue baby syndrome, but also the other health risks like cancer, thyroid problems, birth defects, chronic headaches, and more…. We do really like living here. We love the community and the church. We know a lot of our neighbors. I volunteer with the fire department. But there's the nitrate issue hanging over our heads." - **Tyler Frye** of Casco, WI

III. EXPOSURE TO NITRATE IN DRINKING WATER AT CONCENTRATIONS BELOW 10 MG/L INCREASES RISKS OF CANCER AND OTHER SERIOUS HEALTH EFFECTS

EPA established the current nitrate MCL of 10 mg/L in 1975 as an interim regulation and then as a National Primary Drinking Water Regulation in 1991 based solely on the risk of methemoglobinemia, or blue baby syndrome.[8] Blue baby syndrome is a very serious condition resulting from an infant's inability to carry oxygen in the blood.[9] In 1991, the available data did not convince EPA that nitrate in drinking water posed a potential risk of cancer or certain other adverse effects, but the agency said that the cancer concerns could not be "entirely dismissed" and promised to create an interagency working group to evaluate the issue.[10] EPA has not published an updated cancer assessment since then, and in 2026 EPA reportedly shelved its effort to reassess nitrates' carcinogenicity.[11]

Since EPA's 1991 review, the state of the science has dramatically changed. In the intervening 35 years, more than 30 epidemiologic studies have evaluated nitrate in drinking water and health outcomes other than blue baby syndrome, with several identifying potential risks at concentrations well below the current standard of 10 mg/L. These studies are outlined below. By 2010, the International Agency for Research on Cancer (IARC) concluded that ingested nitrate or nitrite is "probably carcinogenic" to humans because the acidic environment of the human stomach generates N-nitroso compounds.[12]

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[8] National Interim Primary Drinking Water Regulations, 40 Fed. Reg. 59,566, 59,570 (Dec. 24, 1975); National Primary Drinking Water Regulations—Synthetic Organic Chemicals and Inorganic Chemicals; Monitoring for Unregulated Contaminants; National Primary Drinking Water Regulations Implementation; National Secondary Drinking Water Regulations, 56 Fed. Reg. 3526, 3537–38 (Jan. 30, 1991).

[9] Mary H. Ward et al., *Drinking Water Nitrate and Human Health: An Updated Review*, 15(7) INT'L J. ENV'T RES. PUB. HEALTH 1557 (2018), https://doi.org/10.3390/ijerph15071557 (included as Exhibit 3).

[10] 56 Fed. Reg. at 3537–38.

[11] Brian Bienkowski, *EPA Stalls Long-Planned Nitrate Cancer Review as Pollution Crisis Grows*, NEW LEDE (Aug. 25, 2026), https://www.investigatemidwest.org/epa-stalls-long-planned-nitrate-cancer-review-as-pollution-crisis-grows/ (included as Exhibit 4).

[12] World Health Organization, IARC, Evaluation of Carcinogenic Risks to Humans: Volume 94, *Ingested Nitrate and Nitrite, and Cyanobacterial Peptide Toxins* at 325, https://www.ncbi.nlm.nih.gov/books/NBK326544/pdf/Bookshelf_NBK326544.pdf (included as Exhibit 5). *See also*

Research on nitrate in drinking water has examined a range of health outcomes, including several cancers, thyroid disease, and adverse birth outcomes. According to a review of the issue coauthored by leading government and academic experts including a key scientist at the National Institutes of Health (NIH) published in 2018, "the strongest evidence for a relationship between drinking water nitrate ingestion and adverse health outcomes (besides methemoglobinemia) is for colorectal cancer, thyroid disease, and neural tube defects."[13] Research funded by NIH found a relationship between levels of nitrate in drinking water below the 10mg/L and cancer mortality.[14] Further, studies have reported dose-response relationships between nitrate in drinking water and several adverse human health outcomes, including colorectal cancer, ovarian cancer, and very low birth weight.

There have also been a number of studies in other countries into the public health impacts of nitrates in drinking water. Those studies have shown a link between nitrate levels lower than the current European Union standard of 50 mg/L for the whole nitrate ion – approximately 11.3 mg/L as expressed in the United States[15] – and colorectal cancer. An epidemiological study from Denmark found statistically significant increased risks of colon and rectal cancer associated with drinking water levels above 0.87 mg/L.[16] A subsequent study found that reducing Denmark's current drinking water standard to 0.9 mg/L would have an annual positive net benefit of $302 million and reduce colorectal cancer cases by 127 annually in Denmark.[17]

The Danish Ministry of Environment and Gender Equality convened an international group of experts to evaluate the existing limit for nitrate in drinking water and, if warranted, to

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Centers for Disease Control and Prevention, Agency for Toxic Substances Disease Registry, *Tox FAQs for Nitrate and Nitrite* (2017), https://wwwn.cdc.gov/tsp/ToxFAQs/ToxFAQsDetails.aspx?faqid=1186&toxid=258 ("The International Agency for Research on Cancer (IARC) noted that the presence of nitrite and some types of amines or amides in the acid environment of the stomach may result in the production of some cancer-causing N-nitroso compounds; under these conditions, IARC determined that ingested nitrate and nitrite is probably carcinogenic to humans.") (included as Exhibit 6).

[13] Mary H. Ward et al., Exhibit 3.

[14] Angelico Mendy & Peter S Thorne, *Long-Term Cancer and Overall Mortality Associated with Drinking Water Nitrate in the United States*, 228 PUB. HEALTH 82 (Mar. 2024), https://pmc.ncbi.nlm.nih.gov/articles/PMC11626709/ (included as Exhibit 7).

[15] The United States and European Union report nitrate concentrations using different conventions. The U.S. MCL of 10 mg/L measures only the nitrogen portion of nitrate (NO_3-N), whereas the European Union measures the entire nitrate molecule (NO_3). The U.S. MCL of 10 mg/L is approximately equivalent to 44 mg/L NO_3. *See* Amalie Timmermann et al., *Evaluation of the Parametric Value for Nitrate in Drinking Water* at n.12, mim.dk/publikationer/2025/december/evaluation-of-the-parametric-value-for-nitrate-in-drinking-water, nitratereport-jan-7-2026-revised-clean.pdf ("In the United States, nitrate concentrations in drinking water are typically reported as mg/L NO_3-N, whereas in Europe they are more often reported as mg/L NO_3. In the latter case, values can be converted to mg/L NO_3-N using a factor of 0.226.") (included as Exhibit 8). This Petition defaults to the U.S. way of measuring unless otherwise stated.

[16] Jorg Schullehner et al., *Nitrate in Drinking Water and Colorectal Cancer Risk: A Nationwide Population-Based Cohort Study*, INT'L J. CANCER (Feb. 13, 2018), https://onlinelibrary.wiley.com/doi/10.1002/ijc.31306 (included as Exhibit 9).

[17] Brian H. Jacobsen et al., *Health-Economic Valuation of Lowering Nitrate Standards in Drinking Water Related to Colorectal Cancer in Denmark,* 906 SCI. OF THE TOTAL ENV'T 167368 (2024), https://www.sciencedirect.com/science/article/pii/S0048969723059958 (included as Exhibit 10).

propose a revised value based on the available evidence.[18] Based on these studies and other recent research, in December 2025 the international group of experts recommended that Denmark reduce its nitrate drinking water standard from 11.3 mg/L to 1.35 mg/L.[19]

Temkin et al. (2019) calculated that the annual one-in-one-million cancer risk level for nitrate in drinking water is approximately 0.14 mg/L NO_3-N based on colorectal cancer risk — 71 times lower than the current U.S. standard of 10 mg/L. The researchers estimated that each year, 2,300 – 12,594 new cancer cases in the U.S. are attributable to nitrate exposure through drinking water, with associated medical costs of up to $1.5B and an additional $1.3B-$6.5B in lost productivity and other indirect costs. They also concluded that a benchmark concentration of 0.1–0.45 mg/L NO_3-N would be protective against nitrate-associated adverse birth outcomes.[20] This research, from a widely cited and rigorous meta-analysis, suggests that both cancer and developmental endpoints independently support a substantially lower nitrate standard than currently exists.

Below are summaries of epidemiological evidence for health risks associated with nitrate exposure in drinking water, including colorectal and other cancers, thyroid disease, and adverse birth outcomes.[21] Many of these studies identify increased health risks from drinking water with nitrate concentrations below 10 mg/L.

For the studies referenced below that report nitrate as the full molecule following European Union norms (NO_3^-), we provide the appropriate nitrate-nitrogen (NO_3-N) equivalent value for ease of comparison to how the nitrate MCL is measured under the SDWA.

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[18] Timmermann et al., Exhibit 8.

[19] *Id.* As noted previously, in the United States, nitrate concentrations in drinking water are typically reported as mg/L NO_3-N, whereas in Europe they are more often reported as mg/L NO_3. The Timmermann et al. authors refer to their current drinking water limit as 50 mg/L and their recommended new limit as 6 mg/L, using the European style of reference—the latter would be translated to 1.35 mg/L mg/L NO_3-N in the U.S.

[20] Temkin et al., Exhibit 2.

[21] This petition focuses on nitrate exposure studies because the epidemiological literature examining nitrite in drinking water is relatively sparse. Nitrite is an unstable compound that is readily oxidized to nitrate in water, making nitrite more difficult to detect and quantify than nitrate in drinking-water samples. This may help explain the relatively limited number of epidemiological studies examining drinking-water nitrite exposure and health outcomes. *See* Robert Picetti et al., *Nitrate and Nitrite Contamination in Drinking Water and Cancer Risk: A Systemic Review with Meta-Analysis*, ENV'T RESOURCES (Feb. 2022), https://pubmed.ncbi.nlm.nih.gov/35217009/ (included as Exhibit 11); Jorg Schullehner, Leslie Stayner, & Birgitte Hansen, *Nitrate, Nitrite, and Ammonium Variability in Drinking Water Distribution Systems*, 14(3) INT'L J. ENV'T RES. AND PUB. HEALTH 276 (2017), https://doi.org/10.3390/ijerph14030276 (included as Exhibit 12).

A. Nitrate Exposure and Cancer Risks

Colorectal Cancer

Researchers have extensively studied colorectal cancer in relation to drinking water nitrate exposure. Several large, methodologically rigorous studies have identified significant positive associations between nitrate exposure and colorectal cancer risk, including at levels below current U.S. drinking water standards, for example:

- A case-control study of 5,399 adults in Spain and Italy investigated nitrate exposure from food and water and found increased risk of colorectal cancer with waterborne nitrate exposure. Nitrate intake above 10 mg/day NO_3^- (~2.26 mg/day NO_3-N) was associated with a 50% greater risk of colorectal cancer compared to intake of 5 mg/day or less (~1.13 mg/day NO_3-N or less) (Odds Ratio (OR) = 1.49; 95% CI: 1.24–1.78).[22]
- A large population-based cohort study of 1.7 million adults in Denmark found increased colorectal cancer risk at nitrate concentrations at or above 9.3 mg/L NO_3 (~2.1 mg/L NO_3-N) in public waterworks and private wells (HR = 1.16; CI: 1.08–1.25), with similar findings for colon cancer and rectum cancer separately (HR = 1.15, CI: 1.05–1.26; HR = 1.17, CI: 1.04–1.32; respectively). Statistically significant increased risk was also observed at concentrations as low as 3.87 mg/L NO_3 (~0.87 mg/L NO_3-N).[23]

Other studies examining colon and rectal cancers separately have reported positive associations that varied by cancer site and population characteristics. One Iowa cohort study found an increased risk of rectal cancer when studied separately; a second Iowa study found an increased risk of colon cancer among individuals with low vitamin C or high meat intake; and a Danish cohort study found an increased risk of colon cancer when studied separately.[24]

Secondary analyses can integrate evidence across studies to support robust and generalizable conclusions. Systematic reviews and meta-analyses account for factors such as statistical power, sample size, consistency across populations, and exposure assessment quality to synthesize the evidence and provide a reliable basis for informed conclusions. Several such studies have examined the cumulative evidence on drinking water nitrate exposure and concluded that nitrate exposure is associated with colorectal cancer risk:

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[22] Nadia Espejo-Herrera et al., *Colorectal Cancer Risk and Nitrate Exposure through Drinking Water and Diet*, 139(2) INT'L J. CANCER 334–346 (2016), https://doi.org/10.1002/ijc.30083 (included as Exhibit 13).

[23] Schullehner et al., Exhibit 9.

[24] Jones et al. reported HR = 1.12 (CI: 1.03–1.22) and HR = 1.03 (CI: 0.99–1.08) for rectal and colon cancers, respectively, in a cohort study of postmenopausal women in Iowa. Rena R. Jones et al., *Ingested Nitrate, Disinfection By-Products, and Risk of Colon and Rectal Cancers in the Iowa Women's Health Study Cohort*, 126 ENV'T INT'L 242 (2019) (included as Exhibit 14). De Roos et al. (2003) reported increased colon cancer risk among participants with low vitamin C intake (OR = 2.0; CI: 1.2–3.3) or high meat consumption (OR = 2.2; CI: 1.4–3.6) in an Iowa case-control study. Anneclaire J. De Roos et al., *Nitrate in Public Water Supplies and the Risk of Colon and Rectum Cancers*, 14 EPIDEMIOLOGY 640 (2003) (included as Exhibit 15). Erichsen et al. (2025) reported that tap water nitrate concentrations above 9.25 mg/L NO_3 (~2.09 mg/L NO_3-N) were associated with HR = 1.52 (CI: 1.11–2.07) and HR = 0.86 (CI: 0.49–1.50) for colon and rectal cancer, respectively, in a cohort of more than 54,000 adults in Denmark. Dorit W. Erichsen et al., *Source-Specific Nitrate and Nitrite Intake and Association with Colorectal Cancer in the Danish Diet, Cancer and Health Cohort*, ENV'T INT'L (2025) (included as Exhibit 16).

- A review of more than 30 published epidemiological studies on potential health impacts from nitrate exposure, including four that studied colorectal cancer specifically, noted that all four studies reported a positive association between nitrate exposure in water sources (public and/or well water) and colorectal cancer. The researchers concluded that there is strong evidence of an association between drinking water nitrate ingestion and colorectal cancer. The reviewed studies were from populations in the U.S. (Wisconsin) and abroad (Spain, Italy, Indonesia, Denmark) and included Schullehner et al. (2018) which found an increased risk at nitrate concentrations below U.S. standards.[25]
- A meta-analysis of eight studies on nitrate and colorectal cancer found that colorectal cancers account for more than half of the estimated 2,300–12,594 nitrate-attributable cancer cases in the United States each year and identified a statistically significant positive association between drinking water nitrate levels and colorectal cancer risk (RR = 1.04; 95% CI: 1.01–1.07 per mg/L increase in nitrate concentration). Using the colorectal cancer findings, the researchers estimated that a water nitrate concentration of just 0.14 mg/L NO_3-N (71 times lower than the current U.S. drinking water standard of 10 mg/L) corresponds to a one-in-one-million annual cancer risk level.[26]

Thyroid Cancer and Thyroid Disease

Epidemiological studies also report associations between nitrate exposure and thyroid cancer and related thyroid disorders, including at nitrate concentrations below the U.S. drinking water standard:

- A cohort study of 21,977 post-menopausal women in Iowa found that long-term consumption of drinking water nitrate exceeding 5 mg/L—approximately half of the current U.S. drinking water standard—was associated with a 2.6-fold increased risk of thyroid cancer (RR = 2.6; 95% CI: 1.1–6.2).[27]
- A literature review of five epidemiological studies examining select populations in the U.S. (older women in Iowa and Amish adults in Pennsylvania) and other countries (adult women in the Netherlands, adults in Bulgaria, and school-age children in Slovakia) found that four of the five studies reported associations between higher nitrate exposure and thyroid disorders including thyroid hypertrophy, subclinical hypothyroidism, and goiter.[28]

[25] Ward et al., Exhibit 3 (reviewing McElroy et al., 2008; Espejo-Herrera et al., 2016; Fathmawati et al., 2017; and Schullehner et al., 2018).
[26] Temkin et al., Exhibit 2 (reviewing Chiu et al., 2010; De Roos et al., 2003; Espejo-Herrera et al., 2016; Fathmawati et al., 2017; McElroy et al., 2008; Schullehner et al., 2018; Weyer et al., 2001; and Yang et al., 2007).
[27] Mary H. Ward et al., *Nitrate Intake and the Risk of Thyroid Cancer and Thyroid Disease*, 21(3) EPIDEMIOLOGY 389 (2010), https://www.ovid.com/jnls/epidem/abstract/10.1097/ede.0b013e3181d6201d~nitrate-intake-and-the-risk-of-thyroid-cancer-and-thyroid?redirectionsource=fulltextview (included as Exhibit 17).
[28] Ward et al., Exhibit 3 (reviewing thyroid disorder outcomes in Aschebrook-Kilfoy et al., 2012; Radikova et al., 2008; Tajtáková et al., 2006; van Maanen et al., 1996; and Ward et al., 2010).

Ovarian Cancer

Prospective cohort studies have identified increased risk of ovarian cancer associated with nitrate concentrations as low as 2.98 mg/L in drinking water:

- The Iowa Women's Health Study followed 28,555 post-menopausal women and identified 315 incident cases of epithelial ovarian cancer from 1986 to 2010. Using historical nitrate levels in public water utilities, researchers found that women with long-term average nitrate levels greater than or equal to 2.98 mg/L from public water supplies had over twice the risk of developing ovarian cancer compared with women whose public water supplies contained less than 0.47 mg/L (HR = 2.03; 95% CI = 1.22–3.38). While the researchers reported that risk may also be elevated among private well users, the study lacked nitrate measurements for private wells.[29]
- More recently, the Agricultural Health Study considered 33,689 pesticide applicators and their spouses and found that nitrate levels in public water supplies greater than 3.13 mg/L were associated with an elevated risk of ovarian cancer in women, though this result did not reach statistical significance (HR = 1.35, 95% CI: 0.85–2.17).[30]
- A second cohort study, the California Teachers Study, found that among 59,881 study participants, a two-fold increase in nitrate concentrations in public water systems corresponded to a 9% increased risk of high-grade serous ovarian cancer, the most aggressive ovarian cancer subtype (HR = 1.09, CI: 1.02–1.17).[31]

Bladder Cancer

Multiple epidemiological studies suggest a positive association between long-term nitrate exposure in drinking water and bladder cancer risk:

- A case-control study of 531 cases and 556 controls in Spain suggested an elevated bladder cancer risk with chronic exposure to nitrate in municipal drinking water. Among individuals exposed for more than 20 years to the highest concentrations evaluated (9.5 mg/L NO_3, or approximately 2.15 mg/L NO_3-N), the study reported a 40% higher risk of bladder cancer (OR = 1.40; 95% CI: 0.90–2.30).[32]
- The Iowa Women's Health Study found that, among 34,708 post-menopausal women in Iowa, women exposed to drinking water nitrate concentrations exceeding 5 mg/L for four

[29] Maki Inoue-Choi et al., *Nitrate and Nitrite Ingestion and Risk of Ovarian Cancer Among Postmenopausal Women in Iowa*, 137(1) INT'L J. CANCER 173 (2015) (included as Exhibit 18).
[30] Samantha Ammons et al., *Nitrate and Disinfection By-Products in Drinking Water and Risk of Ovarian Cancer*, 9(3) ENV'T EPIDEMIOLOGY 382 (June 2025), https://www.ovid.com/jnls/environepidem/fulltext/10.1097/ee9.0000000000000382~nitrate-and-disinfection-by-products-in-drinking-water-and (included as Exhibit 19).
[31] Maya Spaur et al., *Exposures to Drinking Water Contaminants in Community Water Systems and Risk of Ovarian Cancer in the California Teachers Study Cohort*, ENV'T HEALTH PERSP. (June 2025) (included as Exhibit 20).
[32] Nadia Espejo-Herrera et al., *Nitrate in Drinking Water and Bladder Cancer Risk in Spain*, 137 ENV'T RES. 299 (Feb. 2015) (included as Exhibit 21).

or more years experienced a 62% higher risk of bladder cancer compared with women with no exposure (HR = 1.62; 95% CI: 1.06–2.47).[33]

- A case control study conducted in New England (Maine, New Hampshire, and Vermont), which included 987 cases and 1,180 controls and incorporated historical municipal water data as well as measured and modeled nitrate concentrations in private wells, found a statistically significant trend between increasing drinking water nitrate exposure and bladder cancer risk (p-trend = 0.01). Participants in the highest exposure category (>2.07 mg/L) experienced a 50% higher risk of bladder cancer compared with those in the lowest exposure group (≤0.21 mg/L), although this estimate did not reach statistical significance.[34]

Other Cancers

Studies have also found associations between drinking water nitrate exposure and elevated risks of other cancer sites:

- *Kidney (renal pelvis) cancer*: The prospective cohort Iowa Women's Health Study found that, among 15,577 post-menopausal women using public water supplies for more than 10 years, women with average drinking water nitrate concentrations greater than 5 mg/L NO_3-N experienced more than twice the risk of kidney cancer compared with women in the lowest exposure group (HR = 2.3; CI: 1.2–4.3, compared to exposure <0.47 mg/L).[35]
- *Prostate cancer*: A case-control study in Spain considered 697 prostate cancer cases and 927 population-based controls and concluded that men ingesting more than 13.8 mg/day NO_3^- (approximately 3.12 mg/day NO_3-N) had 74% higher odds of prostate cancer overall compared with those ingesting less than 5.5 mg/day NO_3 (approximately 1.24 mg/day NO_3-N) (OR = 1.74; 95% CI: 1.19–2.54). For aggressive prostate tumors (Gleason score ≥8), the study reported a 178% increase in odds.[36]

Pediatric Cancers

Epidemiological studies, while limited in number, have found associations between nitrate exposure in drinking water and certain pediatric cancers:

- An ecological study in Nebraska found significantly higher incidence of pediatric brain/central nervous system cancers, leukemia, and lymphoma in counties with

[33] Rena R. Jones et al., *Nitrate from Drinking Water and Diet and Bladder Cancer Among Postmenopausal Women in Iowa*, 124:11 ENV'T HEALTH PERSP. 1751 (Nov. 2016) (included as Exhibit 22).
[34] Kathryn Hughes Barry et al., *Ingested Nitrate and Nitrite and Bladder Cancer in Northern New England*, 31(1) EPIDEMIOLOGY 136 (Jan. 2020) (included as Exhibit 23).
[35] Rena R. Jones et al., *Ingested Nitrate, Disinfection By-Products, and Kidney Cancer Risk in Older Women*, 28(5) EPIDEMIOLOGY 703 (Sept. 2017) (included as Exhibit 24).
[36] Carolina Donat-Vargas et al., Long-Term Exposure to Nitrate and Trihalomethanes in Drinking Water and Prostate Cancer: A Multicase–Control Study in Spain, 131(3) ENV'T HEALTH PERSP. 037004 (2023), https://pubs.acs.org/evhpaz/article/131/3/037004/5213194/Long-Term-Exposure-to-Nitrate-and-Trihalomethanes (included as Exhibit 25).

groundwater nitrate concentration between 2.1–5 mg/L compared to counties with groundwater nitrate concentrations of 2 mg/L or below, after adjusting for atrazine and socioeconomic status (IRR = 8.39, 95% CI: 8.24–8.54; IRR = 7.35, 95% CI: 7.22–7.48; IRR = 5.59; CI: 5.48–5.69; for pediatric brain and other CNS cancers, leukemia, and lymphoma, respectively). As an ecological study, the analysis was not designed to establish causal relationships.[37]

- A large and methodologically robust case-control study in Denmark considered 310 children with central nervous system cancers and approximately 100 controls matched per case and found that maternal exposure to nitrate in drinking water at concentrations greater than 25 mg/L NO_3 (approximately 5.65 mg/L NO_3-N) prior to conception was associated with a significantly increased risk of childhood central nervous system cancers (OR = 1.82, CI: 1.09–3.04). This study, however, did not identify associations between nitrate exposure and childhood leukemia or lymphoma.[38]

Summary of Cancer Risks, and Requirement that EPA Establish an MCLG of Zero

Thus, the "best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective scientific practices," 42 U.S.C. §300g-1(b)(3)(A)(i), demonstrates substantial evidence of carcinogenic risk associated with nitrate in drinking water, including increased risks observed at concentrations below the current drinking water standard. This evidence is supported by IARC's evaluation, the Ward et al. review paper whose lead author was NIH's key expert on nitrates, and numerous other peer-reviewed, published scientific papers discussed above. Therefore, as required by the SDWA's mandate that the MCLG be set at a level at which there are no known or anticipated adverse health effects with an adequate margin of safety, 42 U.S.C. §300g-1(b)(4)(A), and consistent with the legislative history of the Act and EPA's longstanding policy, the MCLG for nitrates/nitrites must be set at zero.

B. Nitrate Exposure and Non-Cancer Risks

Methemoglobinemia

The association between nitrate exposure and methemoglobinemia, a life-threatening condition commonly called "blue baby syndrome" due to bluish skin discoloration caused by low blood oxygen levels, was first reported in 1945 and is the basis for the current U.S. drinking water standard of 10 mg/L.[39] However, a retrospective cohort study of 150 private well users in Iowa found that drinking water with nitrate levels below 10 mg/L was positively associated with elevated blood methemoglobin levels, suggesting that nitrate can affect blood oxygen-carrying capacity even at exposures below the current standard.[40]

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[37] Balkissa S. Ouattara et al., *Geospatial Distribution of Age-Adjusted Incidence of the Three Major Types of Pediatric Cancers and Waterborne Agrichemicals in Nebraska*, GEOHEALTH (Feb. 10, 2022), https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GH000419 (included as Exhibit 26).

[38] Leslie T. Stayner et al., *Exposure to Nitrate from Drinking Water and the Risk of Childhood Cancer in Denmark*, 155 ENV'T INT'L 106613 (Oct. 2021), https://www.sciencedirect.com/science/article/pii/S0160412021002385?via%3Dihub (included as Exhibit 27).

[39] Ward et al., Exhibit 3.

[40] Catherine Zeman et al., *New Questions and Insights Into Nitrate/Nitrite and Human Health Effects: A Retrospective Cohort Study of Private Well Users' Immunological and Wellness Status*, 74(4) J. ENV'T HEALTH 8 (Nov. 2011) (included as Exhibit 28).

Adverse birth outcomes: Structural and developmental defects

Overall, epidemiological studies have reported associations between drinking water nitrate exposure and several categories of congenital structural and developmental defects, with the strongest and most consistent evidence for neural tube and central nervous system defects and more limited or mixed evidence for other outcomes:

- *Neural tube and other central nervous system defects*: A narrative review of six epidemiological studies assessed drinking water nitrate exposure during pregnancy and birth defects in the United States, Australia, Canada, and Sweden.[41] The review found that five of the six studies reported positive associations between higher drinking water nitrate exposure and neural tube or other central nervous system birth defect outcomes.[42] The one study that did not find a positive association did not report measures of association, limiting its comparability to the other studies.[43]

  One study reviewed by Ward et al. (2018) that used rigorous exposure assessment accounting for water consumption patterns, bottled water use, and private well nitrate levels found that higher maternal nitrate intake (≥ 5 mg daily from drinking water) was associated with approximately doubled odds of spina bifida birth outcomes (OR = 2.0; 95% CI: 1.3–3.2; with 3,300 cases and 1,121 controls in Iowa and Texas).[44]

  Temkin et al. (2019) undertook a disease burden analysis based on risk estimates from two epidemiological studies considered in Ward et al. (2018) and estimated that nitrate exposure through drinking water contributes to approximately 41 neural tube defect cases annually in the United States, representing about 1.4% of all cases in the United States each year.[45]

  A systematic review and meta-analysis of epidemiological studies from the United States, Denmark, France, Sweden, Canada, and Australia, concluded that evidence from case control studies showed a linear relationship between nitrate exposure and risk of neural tube defects (OR = 1.06, 95% CI: 1.02–1.10, based on two studies with 2,196 participants) and a significantly higher risk when comparing the highest to lowest exposure groups (OR = 1.51, 95% CI: 1.12–2.05, based on three studies of 1,501 participants).[46]

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[41] Ward et al., Exhibit 3.
[42] Including the following: Arbuckle et al., 1988; Brender et al., 2004, 2013; Croen et al., 2001; Dorsch et al., 1984.
[43] *See* Anders Ericson et al., *Environmental Factors in the Etiology of Neural Tube Defects: A Negative Study*, 45(1) ENV'T RSCH. 38 (Feb. 1988) (included as Exhibit 29).
[44] Jean D. Brender et al., *Prenatal Nitrate Intake from Drinking Water and Selected Birth Defects in Offspring of Participants in the National Birth Defects Prevention Study*, 121(9) ENV'T HEALTH PERSP. 1083 (June 14, 2013), https://pubs.acs.org/evhpaz/article/121/9/1083/5247126/Prenatal-Nitrate-Intake-from-Drinking-Water-and (included as Exhibit 30).
[45] Temkin et al., Exhibit 2 (reviewing Brender et al., 2013 and Stayner et al., 2017).
[46] Luling Lin et al., *Nitrate Contamination in Drinking Water and Adverse Reproductive and Birth Outcomes: A Systematic Review and Meta-Analysis*, 13(1) SCI. REP. 563 (Jan. 11, 2023), https://www.nature.com/articles/s41598-

Additionally, a cohort study of 348,250 births in Missouri found evidence suggesting an elevated risk of neural tube defects at nitrate concentrations generally below 10 mg/L (RR = 1.18, CI: 0.93–1.51).[47]

- *Limb and musculoskeletal defects*: Brender et al. (2013) found positive associations between higher nitrate ingestion from drinking water (≥ 5 mg/day) and limb deficiencies (OR = 1.8; 95% CI: 1.1–3.1) among mother-child pairs in Iowa and Texas. Similarly, a cohort study in Missouri reported that each 1 mg/L increase in county-level nitrate concentrations in public drinking water was associated with a significantly increased risk of limb deficiencies (RR = 1.26, CI: 1.05–1.51), including at nitrate concentrations generally below 10 mg/L.[48]

- *Craniofacial defects*: A case-control study in Iowa and Texas reported associations between higher maternal nitrate ingestion from drinking water (≥ 5 mg/day) and craniofacial birth defects including cleft palate (OR = 1.9; 95% CI: 1.2–3.1) and cleft lip (OR = 1.8; 95% CI: 1.1–3.1).[49]

Adverse birth outcomes: Fetal growth and gestational duration

While findings are not uniform across all outcome definitions, evidence from systematic reviews and large cohort studies suggests associations between drinking water nitrate exposure and adverse fetal growth and gestational duration outcomes, with some studies observing an association at nitrate levels well below 10 mg/L:

- In a narrative review of four epidemiological studies, Ward et al. (2018) reported evidence suggesting that more severe fetal growth and gestational age birth outcomes (very low birth weight <1.5 kg, very preterm birth <32 weeks, and small-for-gestational-age births) were associated with nitrate exposure in drinking water. However, the review did not identify consistent evidence of associations between nitrate exposure and more broadly defined birth outcomes, including preterm birth and low birth weight.[50]
- Using risk estimates from two epidemiological studies reviewed by Ward et al. (2018), Temkin et al. (2019) conducted a disease burden analysis and estimated that nitrate exposure through drinking water is attributable to approximately 2,939 cases of very low birth weight (5.3% of all annual U.S. cases) and 1,725 cases of very preterm birth (2.7% of annual cases).[51]

022-27345-x (reviewing Brender et al., 2004, 2013; Croen et al., 2001; Ericson et al., 1988; all of which were reviewed by Ward et al. (2018)) (included as Exhibit 31). Brender et al. 2013 was also included in Temkin et al. (2019).

[47] Julie Blaisdell et al., *Prenatal Exposure to Nitrate in Drinking Water and the Risk of Congenital Anomalies*, 176 ENV'T RES. 108553 (Sept. 2019), https://www.sciencedirect.com/science/article/pii/S0013935119303500?via%3Dihub (included as Exhibit 32).

[48] *Id.*

[49] Brender et al., Exhibit 30.

[50] Ward et al., Exhibit 3 (reviewing Albouy-Llaty et al., 2016; Joyce et al., 2008; Migeot et al., 2013; and Stayner et al., 2017).

[51] Temkin et al., Exhibit 2 (reviewing Brender et al., 2013; and Stayner et al., 2017).

- A systematic review and meta-analysis of epidemiological studies from the United States, Denmark, France, Sweden, Canada, and Australia found statistically significant associations between drinking water nitrate exposure and preterm birth but did not identify consistent evidence of associations with small-for-gestational-age births (Lin et al., 2023). Across three reviewed cohort studies of over 5 million participants total, each 1 mg/L increase in nitrate corresponded to a 1% increased risk of preterm birth (OR = 1.01; 95% CI: 1.00–1.01).[52]
- In contrast to Lin's conclusions on gestational age, a large cohort study of 1,078,892 births in Denmark linked household tap water nitrate estimates during pregnancy to birth registry data and identified an increased risk of small-for-gestational-age births at nitrate concentrations exceeding 2 mg/L NO_3^- (~0.45 mg/L NO_3-N, well below the U.S. drinking water standard). Each 10-fold increase in nitrate concentration was associated with a 2% greater likelihood of small-for-gestational-age birth (OR = 1.02, CI: 1.01–1.04).[53]
- Most recently, a retrospective cohort study in New Zealand linked drinking water nitrate exposure estimates to 735,831 live singleton births between 2008 and 2021 and found that higher prenatal nitrate exposure was associated with an increased risk of preterm birth (overall adjusted Odds Ratio (aOR) 1.01; 95% CI 1.01–1.02). Stronger associations were seen between nitrate exposure and more extreme outcomes, including very early preterm birth (28–31 weeks) and extremely early preterm birth (20–27 weeks). When exposure was considered categorically, pregnancies exposed to nitrate concentrations in the highest quartile (>0.66 mg/L) had significantly greater odds of preterm birth compared to those exposed in the lowest exposure quartile (<0.04 mg/L) (aOR = 1.08, 95% CI: 1.05–1.12 for all preterm birth; aOR 1.17; 95% CI 1.03–1.32 for extremely early preterm birth).[54]

Dementia

A prospective cohort study of 54,804 adults from Denmark examined associations between nitrate exposure and dementia. National drinking water quality monitoring data was linked to participant address to estimate individual water nitrate consumption over several decades. The researchers found higher concentrations of nitrate in drinking water were associated with increased risk of dementia (HR =1.14, 95% CI: 1.05–1.25, comparing the highest to the lowest exposure groups). People who were exposed to average water nitrate concentrations of 0.41–1.15 mg/L had a 12–16% higher rate of dementia compared to those whose water concentrations had an average of 0.18 mg/L.[55]

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[52] Lin et al., Exhibit 31 (reviewing Albouy-Llaty et al., 2016; Coffman et al., 2022; Sherris et al., 2021). Albouy-Llaty et al. was also reviewed by Ward et al. (2018).

[53] Anja Sondergaard Jensen et al., *Prenatal Exposure to Tap Water Containing Nitrate and the Risk of Small-for-Gestational-Age: A Nationwide Register-Based Study of Danish Births, 1991–2015*, 174 ENV'T INT'L 107883 (Apr. 2023), https://www.sciencedirect.com/science/article/pii/S0160412023001563?via%3Dihub (included as Exhibit 33).

[54] Tim Chambers et al., *Nitrate in Drinking Water and Preterm Birth: A National Retrospective Cohort Study in New Zealand*, 306(1) ENV'T RES. 125169 (Sept. 15, 2026), https://www.sciencedirect.com/science/article/pii/S0013935126015008 (included as Exhibit 34).

[55] Catherine P. Bondonno et al., *Source-Specific Nitrate Intake and Incident Dementia in the Danish Diet, Cancer and Health Study*, ALZHEIMER'S & DEMENTIA (Dec. 19, 2025), https://alz-journals.onlinelibrary.wiley.com/doi/10.1002/alz.70995 (included as Exhibit 35).

As the above studies make clear, the current MCLG and MCL of 10 mg/L is not protective of public health. EPA must grant this Petition to protect the tens of millions of people across the country being exposed to unsafe levels of nitrate through their tap water.

IV. THE SDWA REQUIRES EPA TO ADDRESS THE URGENT THREAT TO PUBLIC HEALTH POSED BY NITRATE IN DRINKING WATER

Congress enacted the SDWA as a powerful tool for protecting drinking water resources throughout the United States. Shortly after the establishment of EPA in 1970, Congress enacted the SDWA as a vital federal law for protecting much of the nation's public water from harmful contaminants. Signed into law by President Gerald Ford in 1974, the SDWA grants EPA the responsibility to set national health standards for drinking water "to protect against both naturally-occurring and man-made contaminants that may be found in drinking water."[56] The US Water Alliance has characterized the SDWA's success:

> It is difficult to overstate the dramatic effect that the provision of treated drinking water has had on public health and life expectancy. The enactment of national, enforceable drinking water standards in the federal Safe Drinking Water Act (SDWA) defeated the patchwork of state regulations and toothless public health advisories that existed before 1974, finally creating a national baseline for every water provider to meet or exceed. [While some challenges remain], advanced water treatment technologies have allowed people in the US to enjoy some of the best drinking water in the world.[57]

The importance of the SDWA and the protections EPA can provide through it are as critical today as they have been over the decades since it was enacted. But its continued effectiveness relies on EPA ensuring that SDWA standards keep pace with our understanding of human health outcomes and the risks posed by drinking water contaminants. To accomplish this, EPA must ensure that MCLGs and MCLs set in the National Primary Drinking Water Regulations (NPDWRs) reflect current science and protect the public from health risks.

A. Establishing and Revising MCLGs and MCLs

A central feature of the SDWA is EPA's promulgation of NPDWRs for specific contaminants found in PWSs. EPA must regulate a contaminant if the Administrator finds that 1) the contaminant may have an adverse human health effect, 2) it is known to occur in public water systems at a level that warrants public health concern, and 3) regulating the contaminant would give EPA a meaningful opportunity to reduce health risks for those served by the water systems.[58] For each regulated contaminant under the NPDWRs, EPA must publish a MCLG and a MCL. MCLGs are "the maximum level of a contaminant in drinking water at which no known

[56] EPA, *Understanding the Safe Drinking Water Act*, https://www.epa.gov/sites/production/files/2015-04/documents/epa816f04030.pdf.
[57] Scott Berry, *Celebrating 50 Years of the Safe Drinking Water Act*, US WATER ALLIANCE (Dec. 16, 2024), https://uswateralliance.org/celebrating-50-years-of-the-safe-drinking-water-act/ (included as Exhibit 36).
[58] *NRDC v. Regan*, 67 F.4th 397, 399 (D.C. Cir. 2023).

or anticipated adverse effects on the health of persons occur, and which allows an adequate margin of safety."[59]

In setting MCLGs and MCLs, the administrator is required to use the "best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective scientific practices."[60] For chemical contaminants that are carcinogenic and have no dose below which the chemical is considered safe, EPA's policy for decades has been to set the MCLG at zero, consistent with Congressional intent.[61] The agency is required to set MCLs at a level as close to the MCLG as is feasible for large or regional water systems, though small or disadvantaged water systems, for example, can apply for case-by-case variances and exemptions.[62] Under the 1996 Amendments to the SDWA, EPA is required to conduct a cost-benefit analysis in a so-called "health risk reduction and cost analysis" and to determine whether the health risk reduction benefits of the MCL justify the costs of compliance.[63] If EPA finds that the benefits of an MCL do not justify the costs of a standard, it may—but is not required to—establish a standard that is not as strict as is feasible. However, in such a case EPA must still set the MCL at a level "that maximizes health risk reduction benefits at a cost that is justified by the benefits."[64] EPA must analyze and seek public comment on the following factors when establishing or revising an MCL:

1. quantifiable and nonquantifiable health risk reduction benefits and benefits from reductions in co-occurring contaminants,
2. quantifiable and nonquantifiable costs occurring solely as a result of compliance (including monitoring and treatment),
3. the incremental costs and benefits associated with any alternative MCLs considered,
4. the effects of the contaminant on the general populations and groups within it (including children, pregnant women, the elderly, individuals with a history of serious illness, or other subpopulations likely to be at greater risk),
5. any increased health risk that may occur through compliance (such as an increase in health risks from other contaminants), and
6. other relevant factors like the quality and extent of information, uncertainties in the analysis of the factors, and factors with respect to the degree and nature of the risk.[65]

[59] 42 U.S.C. § 300g-1(b)(4)(A) & (B); 40 C.F.R. § 141.2.
[60] 42 U.S.C. § 300g-1(b)(3)(A)(i).
[61] National Primary Drinking Water Regulations—Synthetic Organic Chemicals and Inorganic Chemicals; Monitoring for Unregulated Contaminants; National Primary Drinking Water Regulations Implementation; National Secondary Drinking Water Regulations, 56 Fed. Reg. 3526, 3532–33 (Jan. 30, 1991); *see also* EPA, *Chemical Contaminant Rules*, https://www.epa.gov/dwreginfo/chemical-contaminant-rules.
[62] 42 U.S.C. §§ 300g-1(b)(4)(B) & (D) (MCLs to be as close to MCLGs as feasible), 300g-4 (variances), 300g-5 (exemptions).
[63] 42 U.S.C. § 300g-1(b)(3)(C) & (4)(C).
[64] 42 U.S.C. § 300g-1(b)(6)(A).
[65] 42 U.S.C. § 300g-1(b)(3)(C)(i).

As noted, in general EPA must establish MCLs as a level that is as close to the MCLG as feasible.[66] Feasibility under the SDWA is defined as the "use of the best technology [and] treatment techniques . . . available (taking cost into consideration)."[67] As EPA recently explained in developing the PFAS drinking water standards, EPA interprets "taking cost into consideration" to be limited to "reasonable cost based on large and metropolitan water systems."[68]

Feasible technologies for treating a contaminant must be listed in the NPDWR for that contaminant, including any technologies available for small systems that serve populations of 10,000 or fewer, 3,300 or fewer, and 500 or fewer.[69] The NPDWRs also lay out compliance requirements for PWSs to monitor and treat to achieve the MCL.[70] While MCLs are to be based on what is feasible for larger systems, EPA and state agencies implementing or enforcing the standards are authorized to consider unique compliance challenges smaller systems may face and may make specific accommodations for them in certain circumstances through variances or exemptions.[71]

EPA is authorized to revise existing MCLs and MCLGs according to the same standards above, but the revision must "maintain, or provide for greater, protection of the health of persons."[72] EPA has an obligation to review existing NPDWRs at least every six years and strengthen them as appropriate.[73] EPA considers a possible revision to be "appropriate" if, at a minimum, it presents a meaningful opportunity to improve the level of public health protection or achieve cost savings while maintaining or improving the level of public health protection.[74] In its second six-year review of drinking water standards in 2009, EPA identified studies that implicated nitrate as "probably carcinogenic" and recommended a human health reassessment.[75] Nitrate remained nominated for a new human health assessment in the third six-year review in

[66] 42 U.S.C. § 300g-1(b)(4)(B); 40 C.F.R. § 141.2.
[67] 42 U.S.C. § 300g-1(b)(4)(D).
[68] PFAS National Primary Drinking Water Regulation Rulemaking: Proposed Rule, 88 Fed. Reg. 18,638, 18,668 (Mar. 29, 2023).
[69] 42 U.S.C. § 300g-1(b)(4)(E)(i)–(ii).
[70] 40 C.F.R. § 141.2.
[71] A small water system is "a water system that serves 10,000 persons or fewer." 40 C.F.R. § 141.2. Accommodations for small system flexibility under the SDWA are provided, for example, under 42 U.S.C. §§ 300g-4 (variances) & 300g-5 (exemptions). In certain circumstances, point-of-use or point-of-entry filters in homes may be used as an alternative to centralized treatment. *See, e.g.*, 42 U.S.C. §§ 300g-1(b)(4)(E)(ii); 40 C.F.R. § 141.100 (use of point-of-entry devices for compliance).
[72] 42 U.S.C. § 300g-1(b)(9).
[73] *Id.*
[74] EPA, *Safe Drinking Water Act Requirements for Six-Year Reviews*, https://www.epa.gov/dwsixyearreview/safe-drinking-water-act-requirements-six-year-reviews.
[75] EPA, *Six-Year Review 2 Health Effects Assessment: Summary Report* (Oct. 2009), https://www.epa.gov/sites/default/files/2014-12/documents/822r09006.pdf.

2017.[76] In the fourth and most recent review in 2024, nitrate was categorized as a contaminant with "emerging information and/or data gaps."[77]

EPA's Integrated Risk Information System (IRIS) began the process of reassessing nitrate in September 2017. Under the first Trump administration, EPA suspended work on the assessment in 2019, citing changed priorities of the agency.[78] IRIS restarted the assessment in 2023 by proposing a protocol for proceeding with the reassessment.[79] But under the second Trump administration, EPA eliminated the long-standing, independent Office of Research and Development under which IRIS was housed,[80] and now has reportedly eliminated the IRIS program entirely.[81] EPA's website shows no action since the public comment period for the reassessment protocol in 2023.[82] Media outlets recently reported that EPA has now essentially shelved its effort to reassess the carcinogenicity of nitrates in drinking water.[83]

Thankfully, the SDWA does not require EPA to conduct an IRIS assessment in promulgating MCLGs and MCLs. EPA *shall* use the "best available, peer-reviewed science and supporting studies and data."[84] The current MCL does not reflect this standard because it does not rely on the best available science, but rather on extraordinarily out-of-date science that focused solely on methemoglobinemia.

B. The Chemical Contaminant Rules and Current Nitrate MCL

EPA has promulgated NPDWRs for contaminants in several categories such as microorganisms, disinfectants, disinfection byproducts, chemicals, and radionuclides.[85] EPA established the current nitrate MCLG and MCL of 10 mg/L as part of the multi-phase chemical

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[76] National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues, 82 Fed. Reg. 3518 (Jan. 11, 2017); EPA, *Six-Year Review 3 of Drinking Water Standards*, https://www.epa.gov/dwsixyearreview/six-year-review-3-drinking-water-standards.

[77] National Primary Drinking Water Regulations; Announcement of the Results of EPA's Fourth Review of Existing Drinking Water Standards, 89 Fed. Reg. 59,623, 59,629 (July 23, 2024).

[78] EPA, *IRIS Assessment Plan for Nitrate and Nitrite (Scoping and Problem Formulation Materials)* (2017), https://iris.epa.gov/document/&deid=337470 (included as Exhibit 37).

[79] EPA, *Protocol for the Nitrate and Nitrite IRIS Assessment (Oral) (Preliminary Assessment Materials)* (Nov. 2023), https://assessments.epa.gov/risk/document/&deid%3D338654 (included as Exhibit 38).

[80] EPA, *EPA Announces Reduction in Force, Reorganization Efforts to Save Taxpayers Nearly Three-Quarters of Billion Dollars* (July 17, 2025), https://www.epa.gov/newsreleases/epa-announces-reduction-force-reorganization-efforts-save-taxpayers-nearly-three (included as Exhibit 39).

[81] *See* Sharon Lerner, *"A Huge Setback": New EPA Directive Could Weaken Hundreds of Chemical Regulations*, PRO PUBLICA (May 1, 2026), https://www.propublica.org/article/trump-epa-directive-chemical-assessments (included as Exhibit 40); *Former EPA Officials Warn EPA Directive Will Leave Communities Less Protected from Toxic Chemicals*, ENV'T PROTECTION NETWORK (May 8, 2026), https://www.environmentalprotectionnetwork.org/20260508_iris_release/ (included as Exhibit 41).

[82] *See* Exhibit 38.

[83] Brian Bienkowski, *EPA Stalls Long-Planned Nitrate Cancer Review as Pollution Crisis Grows*, NEW LEDE (Aug. 25, 2026), https://www.investigatemidwest.org/epa-stalls-long-planned-nitrate-cancer-review-as-pollution-crisis-grows/ (included as Exhibit 42).

[84] 42 U.S.C. § 300g-1(b)(3) (emphasis added).

[85] EPA, *National Primary Drinking Water Regulations* (updated Dec. 1, 2025), https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Inorganics.

contaminant rules in 1991.[86] Under these 1991 rules, EPA regulates nitrate as one of the regulated inorganic contaminants but approached the nitrate NPDWR differently than other contaminants. For the other contaminants (*i.e.*, antimony, arsenic, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium, and thallium), EPA assessed them for, and established an MCL designed to protect against, a variety of chronic health risks including hypertension, cancer, and cardiovascular disease.[87] But EPA controlled nitrate at a level intended to address only the acute condition of methemoglobinemia, or blue baby syndrome.[88]

The 1991 rules set the current MCLG for nitrate at 10 mg/L based on a 1951 study showing infants can suffer from blue baby syndrome at levels above this.[89] EPA determined that literature surveys of the available studies at the time of the rule's promulgation provided insufficient evidence that any adverse health effects are seen at nitrate levels below 10 mg/L.[90] EPA's survey focused on infants because their ratio of water consumption per kilogram of body weight is larger, they have an increased percent conversion of nitrate to more toxic nitrite, and they have a greater sensitivity of hemoglobin, which reacts with nitrate after it reduces to nitrite and compromises oxygen transport.[91] In its final rule, EPA also stated that it found insufficient evidence of cancer linked to nitrates or other adverse health effects associated nitrate in drinking water.[92] The literature reviews cited by EPA dealt primarily with blue baby syndrome.[93] EPA found that evidence from human studies concerning the carcinogenicity of nitrate was inconclusive; however, the agency acknowledged that there was a possibility of a cancer risk, stating the agency "does not believe that data concerning the possible oncogenicity of nitrate and/or nitrite can be entirely dismissed," and promised to convene an interagency workgroup to assess the issue.[94] The agency still has not completed a reassessment of the carcinogenicity of nitrates/nitrites, despite repeated starts and stops and promises to conduct such an analysis.

Following from the 1991 MCLG, EPA set the MCL for nitrate at 10 mg/L because it found the best available treatment and associated costs were reasonable, already publicly available and installed in PWSs, and were compatible with other water treatment processes.[95]

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[86] EPA, *Chemical Contaminant Rules* (updated Mar. 16, 2026), https://www.epa.gov/dwreginfo/chemical-contaminant-rules.
[87] National Primary and Secondary Drinking Water Regulations Proposed Rule, 54 Fed. Reg. 22,062, 22,072–79 (May 22, 1989).
[88] *Id*. at 22,076–77.
[89] 56 Fed. Reg. at 3,537–38 (*citing,* Graham Walton, *Survey of Literature Relating to Infant Methemoglobinemia Due to Nitrate Contaminated Water*, 41 AM. J. PUB. HEALTH 986 (Aug. 1951)).
[90] 40 C.F.R. § 141.51(b); 54 Fed. Reg. at 22,077.
[91] 54 Fed. Reg. at 22,076.
[92] *Id*. at 22,078.
[93] *See* 54 Fed. Reg. at 22,077; Graham Walton, *Survey of Literature Relating to Infant Methemoglobinemia Due to Nitrate Contaminated Water*, 41 AM. J. PUB. HEALTH 986 (Aug. 1951); Anna M. Fan et al., *Evaluation of the Nitrate Drinking Water Standard with Reference to Infant Methemoglobinemia and Potential Reproductive Toxicity*, 7 REGUL. TOXICOLOGY AND PHARMACOLOGY 135 (June 1987).
[94] 56 Fed. Reg. at 3,538.
[95] 40 C.F.R. § 141.62(b); 54 Fed. Reg. at 22,113.

This MCL applies to community water systems, non-transient, non-community water systems, and transient non-community water systems.[96] Some non-community water systems can have an MCL of 20 mg/L if the water supplier can demonstrate that 1) the water will not be available to children under 6 months, 2) the non-community water system is meeting the public notification requirements (including continuous posting of the fact that nitrate levels exceed 10 mg/L and the potential health effects of exposure), 3) local and state public health authorities will be notified annually of nitrate levels that exceed 10 mg/L, and 4) no adverse health effects shall result.[97]

C. Monitoring Compliance with the Nitrate MCL

PWSs are required to monitor the water they deliver to their users to assess compliance with NPDWRs. Monitoring and compliance procedures can differ depending on the type of PWS and whether the NPDWR is designed to protect against acute and/or chronic health issues. As the only inorganic contaminant regulated under the 1991 rule based on acute effects, nitrate has distinct monitoring requirements. Community and non-transient non-community systems that draw from groundwater must monitor annually and systems that draw from surface water must monitor quarterly.[98] Surface water systems can reduce their sampling frequency to annually if they receive four consecutive quarters of samples where the result is less than 50% of the MCL.[99] If one sample taken from a groundwater system has a concentration that is equal to or greater than 50% of the MCL, the system will need to return to quarterly monitoring for at least one year.[100] If any nitrate sample is found to exceed the MCL, the system must take a confirmation sample within 24 hours of the first sample.[101] Compliance with the MCL will then be determined based on an average between the initial and confirmation samples.[102]

If a PWS exceeds the nitrate MCL, it must issue a Tier 1 Public Notice.[103] All public notices of violations must include a description of the violation, the potential adverse health effects, the population at risk, whether alternative water supplies should be used, what is being done to correct the situation, when the situation is expected to resolve, and other details.[104] EPA also requires that systems provide an informational statement in their reports if the system detects nitrate at levels above 5 mg/L but below 10 mg/L to inform parents with infants about the risk of blue baby syndrome even at these lower levels.[105]

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[96] 40 C.F.R. § 141.62(b).
[97] *Id.* § 141.11(d).
[98] *Id.* § 141.23(d)(1).
[99] *Id.* § 141.23(d)(3).
[100] *Id.* § 141.23(d)(2).
[101] *Id.* § 141.23(f)(2).
[102] *Id.* § 141.23(j)(3).
[103] *Id.* § 141.202(a)(2).
[104] *Id.* § 141.205.
[105] The sample informational statement is as follows: "Even though [NAME OF UTILITY] meets the EPA nitrate drinking water standard, also known as a Maximum Contaminant Level (MCL), if you are caring for an infant and using tap water to prepare formula, you may want to use alternate sources of water or ask for advice from your

Now that nitrate is known to be a likely carcinogen with other chronic health effects in addition to its acute health risks, EPA should establish a monitoring regime that protects the public from both chronic and acute human health impacts.

D. Variances and Exceptions from MCL Compliance

EPA cannot reasonably or lawfully reject a protective MCL only because some communities will have difficulty in meeting a protective standard. The SDWA requires EPA to set the standard at a level feasible for larger systems but allows EPA or states with primacy to grant variances or exemptions for PWSs with respect to most regulated contaminants, including nitrate, under limited circumstances. In addition to this general authority to issue variances, the statute authorizes a specific program for Small System Variances for systems that serve fewer than 3,300 users or, with the approval of EPA, systems that serve fewer than 10,000 users.[106] EPA or a delegated state may grant a variance only if a PWS meets certain conditions including: identification and deployment of an alternative treatment technology; inability to affordably comply with the MCL via treatment, alternative source water, or restructuring/consolidation; and ensuring adequate protection of human health under the circumstances.[107] Regulators "must find that the variance will not result in an unreasonable risk to health" before issuing a variance under the statute's general variance authority.[108] Regulators must review variances at least every 5 years to make sure systems remain eligible.

Regulators may also temporarily exempt PWSs from MCL compliance and treatment requirements under limited circumstances, with special extensions for smaller systems serving fewer than 3,300 people.[109] To grant an exemption, regulators must determine that a PWS meets several criteria including "compelling factors" that make it unable to comply.[110] Exemptions must also include a schedule for compliance that is as expeditious as practicable but cannot be more than 3 years from otherwise applicable compliance deadlines, though this deadline can be extended in certain circumstances to up to 6 years for systems serving fewer than 3,300 people.[111]

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health care provider. Nitrate levels above 10 ppm pose a particularly high health concern for infants under 6 months of age and can interfere with the capacity of the infant's blood to carry oxygen, resulting in a serious illness. Symptoms of serious illness include shortness of breath and blueness of the skin, known as "blue baby syndrome." Nitrate levels in drinking water can increase for short periods of time due to high levels of rainfall or agricultural activity, therefore we test for nitrate [INSERT APPLICABLE SAMPLING FREQUENCY]. The highest level for nitrate found during [YEAR] was [INSERT MAX NITRATE LEVEL per § 141.153(d)(4)(iv)] ppm." 40 C.F.R. § 141.154(c).

[106] 42 U.S.C. § 300g-4(e).
[107] *Id.* § 300g-4(e)(2).
[108] *Id.* § 300g-4(a)(1)(A).
[109] *Id.* § 300g-5.
[110] *Id.* § 300g-5(a).
[111] *Id.* § 300g-5(b).

E. EPA's Responsibility to Address Urgent Threats to Public Health

In addition to the duty to promulgate, review, and revise as appropriate MCLGs and MCLs outlined above, in 1996 Congress added mechanisms to the SDWA to allow EPA to regulate expeditiously contaminants that present "urgent threats to public health."[112] Pursuant to Section 1412(b)(1)(D), EPA may promulgate an interim NPDWR for a contaminant after consultation with the Secretary of Health and Human Services and responding in writing to any comments offered during that consultation, and determining an "urgent threat to public health" exists. This provision allows the Administrator to promulgate an interim regulation without going through the usual process of making a regulatory determination that the contaminant should be regulated to protect public health and without first completing the cost-benefit analysis normally undertaken to set an MCL.[113] Within three years of the interim regulation, EPA must publish the full cost-benefit analysis and standard determination. Within five years, the regulation must be repromulgated.[114]

Prior to 1996, the SDWA was driven by defined rulemaking schedules established in 1986, which required EPA to regulate 83 contaminants. The 1996 SDWA Amendments comprehensively restructured this process.[115] The 1996 history reveals that the urgent threats to health provision in § 1412(b)(1)(D) was added to counterbalance new, rigorous procedural requirements, including the mandatory cost-benefit analysis, that could otherwise delay protections in time-sensitive situations. Congress intended this provision to serve as a safety valve, prioritizing public health urgency over process requirements.

In addition to these rulemaking authorities under the SDWA, EPA has emergency powers under the SDWA, 42 U.S.C. § 300i, to address any contaminant "which is present in or is likely to enter a public water system or an underground source of drinking water" and that "may present an imminent and substantial endangerment" to health. These powers include filing suit or taking other action necessary to restrain pollution that presents an imminent and substantial endangerment to human health or welfare. Nitrate pollution resulting in widespread, devastating risks of cancer or other health threats clearly satisfies the threshold for imminent and substantial endangerment in these provisions. EPA should exercise its expansive authority to crack down on sources of nitrate pollution that threaten sources of drinking water to facilitate compliance with the revised MCL and bring myriad benefits to communities across the country.

V. EPA MUST REVISE THE NITRATE MCLG AND MCL TO PROTECT PUBLIC HEALTH

As explained above, tens of millions of Americans receive drinking water from PWSs containing nitrate at concentrations that current scientific evidence correlates with serious health risks. EPA has an obligation under the SDWA to review existing NPDWRs at least every six years and revise them "as appropriate," provided that any revision maintains or increases public

[112] *Id.* § 300g-1(b)(1)(D).
[113] *Id.* § 300g-1(b)(1)(D).
[114] *Id.* § 300g-1.
[115] Public Law 104-182.

health protection.[116] Revising the nitrate MCLG and MCL is not only appropriate; the current scientific and economic evidence demonstrates that it is necessary to provide the protection contemplated by the SDWA.

EPA, under § 1412(b)(3)(A)(i), is required to use the "best available, peer-reviewed science" in establishing and revising NPDWRs. As described in Section III, the existing nitrate MCLG and MCL of 10 mg/L was established to protect only against acute infant methemoglobinemia and does not reflect the substantial body of evidence developed since then regarding cancer, adverse birth outcomes, and other chronic health effects at substantially lower concentrations. The economic evidence now available further demonstrates that the benefits of treating drinking water to a much lower standard far exceeds the costs of compliance, more than justifying a revised nitrate MCLG and MCL.

A. EPA Should Establish an MCLG of Zero for Nitrate

As explained above, the science is clear that nitrate in drinking water poses a threat of cancer to users of PWSs across the country, including at very low levels. When a contaminant *may* present cancer risks and there is no dose below which the chemical is considered safe, EPA sets the MCLG for that contaminant at zero. Nitrate presents a clear cancer risk, and there is no established safe dosage over the long term that justifies an MCLG other than zero. Further, EPA must consider the effects of nitrate on vulnerable populations like "infants, children, pregnant women, the elderly" and other groups likely to be at greater risk when setting the MCLG.[117] As shown above, nitrate poses cancer and other risks for especially vulnerable populations, for example by increasing the risk of pediatric cancers and adverse birth outcomes. Adopting an MCLG of zero is consistent with the SDWA, its legislative history, the SDWA's particular consideration for vulnerable populations, and EPA's longstanding methodology for setting MCLGs for numerous other contaminants.

B. EPA Should Establish an MCL of 1 mg/L for Nitrate

EPA must establish MCLs "as close to the [MCLG] as is feasible."[118] Petitioners acknowledge that attainment of zero nitrate in drinking water is not feasible, and therefore EPA must determine what level of reduction is feasible and provides the public health protections demanded by the SDWA.[119]

To inform that decision, Petitioners commissioned One Water Econ, LLC to conduct a national Benefit-Cost Analysis of alternative nitrate drinking water standards of 1, 3, and 5 mg/L. The analysis used recent nitrate occurrence data, EPA drinking water treatment cost models, peer-reviewed dose-response studies, and EPA methods for valuing avoided illness and mortality. It evaluated costs and benefits over a 50-year period and tested its principal conclusions against alternative assumptions concerning treatment technology, health risk

[116] 42 U.S.C. § 300g-1(b)(9).
[117] *Id.* § 300g-1(b)(3)(C)(i)(V).
[118] *Id.* § 300g-1(b)(4)(B).
[119] Petitioners also acknowledge that the Practical Quantitation Limit for nitrate (*i.e.*, the lowest concentration that can be accurately measured) can be as low as .01 mg/L depending on method, which likely also is not a feasible MCL.

estimates, discount rates, and other variables. Petitioners provide this full Benefit-Cost Analysis as Exhibit A to this Petition.

The analysis demonstrates that an MCL of 1 mg/L is both technically achievable and economically justified. Of the standards evaluated, 1 mg/L produces the greatest quantified health benefits and net benefits, as well as having the highest benefit to cost ratio, and the economic case for tightening the standard becomes stronger as the MCL moves from 5 to 3 to 1 mg/L. The 1 mg/L result also remains cost beneficial under every individual sensitivity analysis conducted. These findings provide ample support for setting the nitrate MCL at 1 mg/L.

1. Available Treatment Technologies for PWSs Can Feasibly Achieve Drinking Water Nitrate Concentrations At or Below 1 mg/L.

The Benefit-Cost analysis looked at ion exchange, reverse osmosis, biological denitrification, and point-of-use (POU) filters as treatment technologies for nitrate removal. It based its analysis upon these treatment approaches—as well as treatment with bypass blending as appropriate—because these technologies are widely used and field-tested and because PWSs can achieve nitrate concentrations below 1 mg/L using one or a mix of these treatment technologies and techniques. The Benefit-Cost Analysis confirms that achieving substantially lower nitrate concentrations is feasible using technologies that are widely used by PWSs already and does not depend on a speculative or undeveloped treatment technology.

When evaluating feasibility in this context, EPA ensures that treatment is technically possible and also takes cost into consideration. Regarding technical feasibility, EPA looks to "whether a technology has been shown to be effective by water systems and is compatible with other water treatment processes."[120] A nitrate MCL of 1 mg/L satisfies this standard because EPA has already recognized technologies capable of achieving this level of nitrate removal from public water supplies.[121]

Petitioners' Benefit-Cost Analysis evaluated ion exchange, reverse osmosis, biological denitrification, and point-of-use treatment using EPA's Work Breakdown Structure cost models.[122] Ion exchange is a mature treatment technology for nitrate; reverse osmosis can produce water with very low nitrate concentrations and also removes many other contaminants; and biological denitrification can likewise substantially remove nitrate. For very small systems, the analysis also evaluated point-of-use treatment.

Importantly, the technologies evaluated can remove nitrate to concentrations near zero. Under the Benefit-Cost Analysis's central "partial treatment" scenario, a utility treats a portion of its flow to near-zero nitrate and blends that water with water untreated for nitrate. To provide an operating margin below the regulatory limit, the Analysis modeled utilities as delivering water at 80% of the applicable MCL, including approximately 0.8 mg/L under a 1 mg/L standard.

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[120] *See* National Primary Drinking Water Regulations for Lead and Copper: Improvements, 89 Fed. Reg. 86,418, 86,434 (Oct. 31, 2024) (cleaned up).
[121] 40 C.F.R. § 141.62 (table of best available technologies).
[122] *See* EPA, *Drinking Water Treatment Technology Unit Cost Models*, https://www.epa.gov/sdwa/drinking-water-treatment-technology-unit-cost-models.

Alternatively, systems may fully treat their water to near-zero concentrations. Thus, the analysis does not merely assume that systems can reach exactly 1 mg/L under ideal circumstances; it models utilities operating below the proposed standard to provide a compliance margin.

Regarding the cost aspect of feasibility, EPA considers compliance costs to ensure that treatment technologies are not only feasible but also affordable for large PWSs.[123] As EPA said in its final PFAS rules, "Based on legislative history, the EPA interprets 'taking cost into consideration' in section 1412(b)(4)(D) to be limited to 'what may reasonably be afforded by large metropolitan or regional public water systems."[124] Thus, EPA may not reject an MCL because it is arguably unaffordable for smaller PWSs. Instead, as discussed in Section IV, the SDWA provides for variances and exemptions to address small system compliance difficulties in appropriate circumstances.[125] The Benefit-Cost Analysis found that total annualized costs for customers of large systems is $53 per household per year, which clearly meets EPA's large system feasibility and affordability criteria.[126] Additionally, the treatment systems considered in the Benefit-Cost Analysis are each currently in use by many large PWSs, further indicating their feasibility and affordability.

The Analysis also demonstrates that systems have multiple treatment options at different costs. Ion exchange is generally the least-cost centralized treatment option. Under the 1 mg/L partial-treatment scenario, the nationwide least-cost under this approach would be about $3 billion per year. Biological denitrification and reverse osmosis are more expensive alternatives, but the availability of multiple technologies gives systems flexibility to select the treatment approach most appropriate to their circumstances.

Taken together, these findings demonstrate that a 1 mg/L standard is technically achievable using existing nitrate-removal technologies and does not require development of a new treatment method.

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[123] 42 U.S.C. § 300g-1(b)(4)(D); 89 Fed. Reg. at 86,433.

[124] PFAS National Primary Drinking Water Regulation, 89 Fed. Reg. 32,532, 32,573 n.4 (Apr. 26, 2024) (citing H.R. Rep. No. 93–1185 (1974), reprinted in 1974 U.S.C.C.A.N. 6454, 6470–71).

[125] 42 U.S.C. §§ 300g-4(e) & 300g-5.

[126] EPA uses an affordability threshold calculation of 2.5 percent of median household income minus the baseline water cost in its *small system* compliance technology evaluations. *See, e.g.*, EPA, EPA-815-R-24-001, Economic Analysis for the Final Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation at 9-34 to 9-37 (2024), https://www.regulations.gov/document/EPA-HQ-OW-2022-0114-3084. If the agency were to use this approach for large systems, the $53 cost per year for large system customers would clearly meet this affordability criterion. For example, 2.5% MHI or about $2,100 (2.5% of U.S. MHI in 2025 per the Census Bureau, *U.S. Real Median Household Income Reached Record High in 2025* (Sept. 15, 2026), https://www.census.gov/library/stories/2026/09/median-household-income.html (included as Exhibit 43)) minus baseline water cost of roughly $630 (the 2026 per household cost adjusted to 2026 dollars from the high-end large system per-connection cost in the 2006 EPA Community Water System Survey (Feb. 2009), EPA 815-R-09-001, https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009JJI.PDF?Dockey=P1009JJI.PDF (included as Exhibit 44)), leaving about $1,500 as the "expenditure margin," or amount available to pay for nitrate treatment. This supports that these costs are feasible for large systems and affordable. Of course, there is a need for water systems of all sizes to adopt water affordability programs including structured water rates to address affordability issues for low-income households, and for a national low-income household water assistance program, but this is beyond the scope of this petition. *See generally*, NRDC & National Consumer Law Center, *Water Affordability Advocacy Toolkit* (Sept. 16, 2022), https://www.nrdc.org/resources/water-affordability-advocacy-toolkit (included as Exhibit 45).

Finally, as discussed in Section VII below, stronger measures to protect source water from nitrate pollution caused by overapplication of chemical fertilizers and waste from CAFOs can further reduce compliance costs by achieving lower nitrate concentrations in the influent coming into PWSs.

2. The Human Health Benefits of an MCL of 1 mg/L Justify the Costs of Compliance

The SDWA requires EPA to consider both the quantifiable and nonquantifiable benefits of an MCL and the costs attributable to compliance when determining if the MCL is justifiable. The Benefit-Cost Analysis demonstrates that the benefits of a 1 mg/L nitrate standard substantially exceed its costs, more than justifying a revised MCL.

Under the Benefit-Cost Analysis's central partial-treatment scenario, an MCL of 1 mg/L would conservatively result in approximately $364.1 billion in present-value health benefits, compared with approximately $94.5 billion in compliance costs, yielding approximately $269.7 billion in net benefits over the 50-year analysis period. Put differently, the 1 mg/L standard would return approximately $3.90 in quantified health benefits for every dollar spent on compliance. Under a "full treatment" scenario without blending, the benefits would be event more substantial: $628.9 billion in benefits compared to $130.4 billion in costs, for net benefits of $498.5 billion—in other words, for every dollar spent, there would be a return of $4.80 in quantified health benefits.

Our analysis underestimates total benefits because it reflects only three health outcomes for which the Benefit-Cost Analysis identified sufficiently usable dose-response relationships for quantitative modeling: colorectal cancer, ovarian cancer, and very low birth weight. For those three adverse health outcomes, once the benefits are fully realized, a 1 mg/L standard under the partial treatment scenario is estimated to avoid approximately 1,900 colorectal cancer cases, 440 ovarian cancer cases, and 2,180 very-low-birth-weight births each year. Under the SDWA, EPA is required to consider the benefits of the standard,[127] which would be enormous.

The estimated $364.1 billion in benefits is not a valuation of every health benefit associated with reducing nitrate exposure. The analysis did not monetize potential effects including preterm birth, neural tube defects, thyroid disease, bladder and kidney cancer, and dementia because available evidence did not provide the information needed to develop national quantitative estimates for these outcomes. It also excludes avoided household expenditures for bottled water or home treatment and potential benefits associated with the removal of co-occurring contaminants by nitrate-treatment technologies, which could have very large benefits.[128] Accordingly, the quantified benefit estimate does not capture all potential benefits of a revised nitrate standard.

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[127] 42 U.S.C. §300g-1(b)(3)(C)(i).

[128] Tasha Stoiber et al., *Short Communication: Simultaneous Removal of Co-Occuring Contaminants Reduces Drinking Water-Attributed Cancer Risk: A United States Case Study*, 284 ENVT'L RES. 122125 (2025), https://pubmed.ncbi.nlm.nih.gov/40541903/ (included as Exhibit 46).

3. The Incremental Analysis Demonstrates That EPA Should Set the MCL at 1 mg/L, not 3 or 5 mg/L.

The Benefit-Cost analysis also directly addresses the SDWA requirement that EPA consider the incremental costs and benefits of alternative MCLs. The results strongly support 1 mg/L rather than a higher standard of 3 or 5 mg/L.

Under the central treatment scenario, a 5 mg/L standard would produce approximately $25 billion in benefits against $22.2 billion in costs, for a benefit-cost ratio of only 1.1. A 3 mg/L standard would produce approximately $96.7 billion in benefits against $42.4 billion in costs, for a ratio of 2.3. By contrast, the 1 mg/L standard produces approximately $364.1 billion in benefits against $94.5 billion in costs, for a ratio of 3.9.

More significantly, each additional tightening step becomes more economically favorable. Moving from the current standard to 5 mg/L returns approximately $1.10 in benefits for every incremental dollar of cost. Tightening further from 5 to 3 mg/L returns approximately $3.50 per incremental dollar, while tightening from 3 to 1 mg/L returns approximately $5.10 per incremental dollar. Even if ovarian cancer benefits are excluded entirely, the incremental return from moving from 3 to 1 mg/L remains approximately $4.40 per dollar spent.

There is therefore no economic basis in the range studied for stopping at 3 or 5 mg/L. As the analysis concluded, there is no "knee in the curve" between 5 and 1 mg/L at which the next increment of public-health protection ceases to justify its cost. Instead, the greatest incremental return occurs in moving from 3 to 1 mg/L.

4. A 1 mg/L MCL Remains Cost-Beneficial Across a Range of Assumptions.

The case for 1 mg/L does not depend on any single health endpoint, treatment-cost assumption, or discount rate. The analysis tested the 1 mg/L result against a range of alternative assumptions, and no individual sensitivity analysis caused the benefits to fall below costs.

For example, increasing the discount rate from 2% to 7% still produced a benefit-cost ratio of 2.8. Substituting the lower 95% confidence bounds for the colorectal cancer or very-low-birth-weight dose-response relationships produced ratios of approximately 2.5 and 2.8, respectively. Excluding ovarian cancer altogether produced a ratio of 3.4. Even assuming nationwide use of reverse osmosis, the most expensive centralized technology evaluated, produced a benefit-cost ratio of approximately 1.3.

The break-even analysis likewise found that no plausible change in any single modeled input would cause the costs of the 1 mg/L standard to exceed its quantified benefits. The value assigned to avoided mortality, for example, would have to fall to approximately $2.4 million, or 19% of EPA's value of a statistical life before the conclusion reversed. No cancer-latency assumption tested reverses the result because the quantified benefits associated with avoiding very low birth weight alone exceed modeled compliance costs by more than 70%. Total

compliance costs would have to rise to approximately $364 billion, well above even the reverse-osmosis cost scenario, before costs would exceed quantified benefits.

Only a combined scenario in which numerous unfavorable assumptions occur simultaneously caused the modeled quantified benefits to fall below costs for the 1 mg/L standard, producing a benefit-cost ratio of 0.7. The analysis characterized that combination as implausible because it requires multiple uncertain parameters simultaneously to take their least favorable values. In contrast, the 5 mg/L standard falls below break-even under several individual assumptions.

The Benefit-Cost Analysis therefore provides strong evidence that the benefits of an MCL of 1 mg/L justify its costs even when substantial uncertainty is taken into account.

5. EPA Should Address Affordability Concerns Through Assistance and Compliance Flexibility, Not a Less Protective National MCL.

The Benefit-Cost Analysis also identifies an important distributional concern. Small public water systems bear higher per-household compliance costs because they cannot spread fixed treatment costs across as many customers. Under the 1 mg/L scenario, systems serving 500 or fewer people face an estimated average annual cost of approximately $304 per household, compared with approximately $53 per household for systems serving more than 100,000 people.

Those affordability concerns warrant meaningful federal assistance, technical support, and use of appropriate compliance options, but they do not support setting a less protective national MCL. Even among systems serving 500 or fewer people, the modeled health benefits exceed costs by approximately 2.3 to 1. Every system size category analyzed produces positive net benefits under the 1 mg/L scenario.

As discussed in Section IV.D, Congress expressly provided mechanisms to address circumstances in which smaller systems face unusual compliance burdens. The existence of those mechanisms reinforces that the appropriate response to affordability challenges is to assist affected systems in achieving the health-protective standard, not to expose people served by smaller systems to a higher permissible level of nitrate solely because of the size or financial capacity of their water provider. The SDWA struck the balance in favor of protecting public health, and EPA may not reject a protective and feasible MCL based on small system cost challenges.

Some may have concerns that a stricter health-protective standard for nitrates could make water bills unaffordable, especially for low-income customers served by smaller water systems. Clearly, people served by water systems contaminated with nitrates should not be expected to resign themselves to drinking unsafe water. This approach would only perpetuate existing inequities in access to safe drinking water—inequities that the Safe Drinking Water Act is meant to remedy.

In its February 2023 Clean Water Act Financial Capability Assessment Guidance, EPA refused to accede to persistent utility demands for weak standards whenever utilities

raise concerns about affordability for low-income households.[129] Instead, EPA's guidance pushes utilities to pursue "strategies for lowering costs and reducing impacts on low-income households" using tools that "ensure that a financial strategy is in place to support needed infrastructure upgrades without overburdening their most vulnerable ratepayers."[130] The guidance identifies "strategies for communities to support affordable utility rates while planning investments in water infrastructure that are essential to protecting clean water…. Tools such as variable rate structures, consumer assistance programs, and grants or subsidies from the… State Revolving Fund are some of the tools outlined in the guidance."[131]

EPA should apply the same principles when adopting a Safe Drinking Water Act standard for nitrates: adopt a strong standard that is needed to protect human health *and* help water systems meet that standard without making bills unaffordable for low-income households. In developing and implementing a nitrate rule, EPA should highlight several key strategies[132]:

- Maximize the use of available federal funding, especially for disadvantaged communities.
- Hold nitrate polluters accountable for the costs of treatment where possible.
- Provide water systems strategies for communities to support affordable utility rates including variable rate structure and low-income household consumer assistance programs. See the "Water Affordability Advocacy Toolkit."[133]
- Adopt equitable rate structures and other programs to increase utility revenue without burdening low-income customers.

For all of these reasons, EPA should revise the nitrate NPDWR by establishing an MCLG of zero and an enforceable nitrate MCL of 1 mg/L. In revising the nitrate standard, EPA should

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[129] EPA, Clean Water Act Financial Capability Assessment Guidance (revised Mar. 2024), https://www.epa.gov/system/files/documents/2023-01/cwa-financial-capability-assessment-guidance.pdf (included as Exhibit 47).

[130] EPA, Financial Capability Assessment Guidance: Questions and Answers (Feb. 1, 2023), https://nepis.epa.gov/Exe/ZyNET.exe/P101B5YH.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2016+Thru+2020&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C16thru20%5CTxt%5C00000045%5CP101B5YH.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL (included as Exhibit 48); EPA, *EPA Announces Financial Capability Guidance to Support Communities and Ensure Clean, Affordable Water* (Jan. 31, 2023), https://www.epa.gov/newsreleases/epa-announces-financial-capability-guidance-support-communities-and-ensure-clean (included as Exhibit 49).

[131] EPA, Fact Sheet: Clean Water Act Financial Capability Assessment Guidance (Feb. 2023), https://www.epa.gov/system/files/documents/2023-02/cwa-fca-fact-sheet.pdf (included as Exhibit 50).

[132] For further discussion of how affordability considerations can be fully incorporated into EPA's actions, see the comments of dozens of consumer, environmental, and health groups regarding affordability and the PFAS standards. Comments of the Anthropocene Alliance et al. on Per- and Polyfluoroalkyl Substances (PFAS): Proposed National Primary Drinking Water Regulations (May 28, 2023) (Docket ID: EPA-HQ-OW-2022-0114-1723) (included as Exhibit 51).

[133] NRDC & National Consumer Law Center, Exhibit 45.

also ensure that monitoring and compliance requirements protect against both long-term exposure and shorter-term exposures. The best available health evidence demonstrates the need for substantially greater protection than the existing 10 mg/L standard provides, and Petitioners' Benefit-Cost Analysis demonstrates that 1 mg/L provides substantial health risk reduction at a cost that is strongly justified by its benefits.

VI. EPA SHOULD IMMEDIATELY ESTABLISH AN INTERIM NITRATE MCL TO ADDRESS URGENT THREATS TO PUBLIC HEALTH

The evidence also is clear that large numbers of people are currently drinking water that contains levels of nitrate associated with increased risks for cancer and other serious health impacts. As discussed in Sections III and V, pursuant to 42 U.S.C. § 300g-1(b)(1)(D), EPA should immediately establish an interim nitrate MCL of 1 mg/L to address urgent threats to public health as it works to revise the permanent MCL under its general authority at § 300g-1(b)(1)(A). As discussed in Section V and detailed our Benefit-Cost Analysis, the available economic analysis that considers potential standards of 1 mg/L, 3 mg/L, and 5 mg/L strongly supports 1 mg/L.

There are several reasons why EPA should invoke its interim MCL authority now:

1. There is a currently unaddressed chronic health risk to a substantial portion of the population served by public water systems. As discussed in Section III, a growing body of peer-reviewed evidence links sub-10 mg/L nitrate levels to colorectal cancer, thyroid disease, and other health outcomes. Our Benefit-Cost Analysis further identifies 13,205 community water systems serving approximately 119.7 million people that recorded at least one nitrate sample at or above 1 mg/L between 2021 and 2023. Because such chronic risks were not fully understood when the current standard was set, they constitute a newly identified "urgent threat" under 42 U.S.C. § 300g-1.

2. As discussed in Section III, there also is substantial evidence of adverse birth outcomes, including very low birth weight and possibly neural tube defects and other adverse impacts from acute exposure of a pregnant mother to nitrates during pregnancy.

3. The scale and persistence of the risk, combined with decades of regulatory delay, make immediate action warranted. As discussed in Section IV, EPA's repeated Six-Year Reviews have not resulted in revision of the nitrate standard despite the growing evidence of chronic health effects below 10 mg/L. State and federal efforts have likewise failed to adequately prevent nitrate contamination of drinking water sources. EPA's review process has therefore left millions of people exposed while the evidence of harm has continued to grow.

4. Finally, as recognized in *W.R. Grace v. U.S. EPA*, 261 F. 3d 330 (3d Cir. 2001), a threat need not be an immediate acute outbreak. Latent or chronic risks to large populations can satisfy the "urgent threat" standard. The health risks presented by

nitrate are chronic and cumulative, but that does not make them less urgent where exposure is widespread and ongoing.

As discussed in Section IV.E, the legislative history of EPA's § 1412(b)(1)(D) authority confirms that Congress created this provision so EPA could act expeditiously where the regulatory process might delay necessary public health protections. The epidemiological and other health effects data and documented widespread exposure of tens of millions of Americans to nitrates at dangerous levels prove the existence of an urgent, nationwide health crisis that necessitates an immediate interim standard. EPA should therefore establish an interim MCL of 1 mg/L while it undertakes the process of revising the permanent nitrate MCL as requested in Section V.

VII. SOURCE CONTROL PROGRAMS THAT CURB NITRATE POLLUTION FROM AGRICULTURE ARE ESSENTIAL AND CAN REDUCE COMPLIANCE COSTS

EPA and regulators across the country need to look beyond treatment and also work together to prevent and mitigate harmful levels of nitrate in source waters, many of which are being actively contaminated by industrial agriculture practices. EPA should focus on reining in this pollution at the source, which could significantly reduce compliance costs. This problem appears to only be getting worse as a result of EPA's decades-long failure to stop overapplication of chemical fertilizers and irresponsible management of CAFO waste.

A. Nitrate Is a Prevalent Contaminant in Our Source Waters

Both surface and groundwaters used for drinking, irrigation, livestock watering, and other uses across the country have high levels of nitrate. A study from 2015 predicted that nitrate contamination of drinking water is most likely where vulnerable surface or groundwaters meet intensive agricultural practices on the landscape.[134] Finding no more recent federal agency evaluation of nitrates in surface and groundwater, Petitioners undertook an analysis of data from the Water Quality Portal 3.0 API from January 2015 through August 2026.[135]

1. Surface Water

For surface water, there were 343,601 nitrate results from approximately 20,477 monitoring stations across the country from 2015 to August 2026 that had a mean of 1.11 mg/L and a median of 0.28 mg/L. Because sampling frequency varies considerably among monitoring locations, a second analysis was done of site-level means and medians, so that sites that were sampled more frequently were not given undue weight. The site-level mean was 0.94 mg/L and the median was 0.18. The difference reflects the unequal sampling frequency among sites. The overall trend was upward with the highest nitrate level in surface waters in 2025 and the second

[134] *Predicted Concentrations of Nitrate in U.S. Groundwater*, U.S. GEOLOGICAL SURVEY (2015), https://www.usgs.gov/media/images/predicted-concentrations-nitrate-us-groundwater (included as Exhibit 52).
[135] The Water Quality Portal (WQP) 3.0 API integrates water quality data from multiple national, state, and local monitoring systems, including USGS National Water Information System (NWIS) records and WQX records, submitted by EPA, state agencies, tribes, local governments, and other monitoring organizations. *Water Quality Portal*, NAT'L WATER QUALITY MONITORING COUNCIL, https://www.waterqualitydata.us/.

highest in 2024. The number of monitoring sites decreased with a high of 6,190 monitoring sites in 2017 and a low of 3,264 monitoring sites in 2025.

Year	Sites	Mean of Site Means (mg/L)	Median of Site Means (mg/L)
2015	5,289	1.07	0.24
2016	5,045	1.07	0.24
2017	6,190	0.90	0.18
2018	5,896	1.12	0.24
2019	5,787	1.13	0.23
2020	4,335	0.95	0.25
2021	5,060	0.92	0.24
2022	4,828	0.99	0.25
2023	5,759	1.11	0.25
2024	4,578	1.33	0.30
2025	3,264	1.46	0.35
2026*	1,141	1.35	0.45

**2026 represents a partial year*

The 10 states with the highest mean levels of nitrate in surface waters from January 2015 through August 2026 were as follows: IA, MN, DE, IL, IN, KS, CA, MD, PA, and UT.

State	Sites	Mean of Site Means (mg/L)	Median of Site Means (mg/L)
Iowa	274	4.22	2.44
Minnesota	806	3.60	0.55
Delaware	47	2.56	1.07
Illinois	149	2.03	1.34
Indiana	1,347	1.92	1.19
Kansas	345	1.30	0.04
California	1,999	1.29	0.16
Maryland	305	1.28	0.63
Pennsylvania	1,528	1.25	0.45
Utah	278	1.25	0.19

Our analysis shows that nationally surface water levels of nitrate are increasing and monitoring of them is decreasing. As nitrate levels in source waters increase, so do the costs in terms of avoidable cancer incidents and other adverse health effects. So too will compliance costs rise for PWSs.

2. Groundwater

Nitrate is the most common chemical contaminant across the world's groundwater aquifers.[136] In 2010, USGS estimated that nitrate exceeded background concentrations in 65% of shallow wells (<100 feet) in agricultural and urban areas. In 2010, USGS found up to 7% of 2,388 domestic wells sampled in agricultural and urban areas have nitrate levels above 10 mg/L.[137] Petitioners used the same Water Quality Portal data from 2015–2026 to analyze groundwater nitrate levels.[138] The dataset contained 27,687 nitrate results from approximately 12,451 monitoring wells across the country. The mean across groundwater monitoring observations was 3.21 mg/L and the median was 0.80 mg/L. As with surface water monitoring, the number of groundwater monitoring wells decreased over time with a high of 2,477 in 2017 and a low of 1,262 in 2025.

Year	Wells
2015	2,563
2016	2,689
2017	2,477
2018	1,840
2019	1,825
2020	1,652
2021	1,692
2022	1,673
2023	1,498
2024	1,533
2025	1,262
2026*	591

**2026 represents a partial year*

As with the surface water results, we analyzed the trends per monitoring site, but found no statistically significant overall trend with the groundwater results. The highest mean was in 2025, but the highest median was in 2021.

Year	Mean of Well Means (mg/L)	Median of Well Means (mg/L)
2015	3.06	0.38
2016	2.79	0.70
2017	3.30	0.95
2018	3.53	0.97
2019	2.60	0.79

[136] R.F. Spalding & M.E. Exner, *Occurrence of Nitrate in Groundwater – A Review*, J. ENV'T QUALITY (July 1, 1993), https://hero.epa.gov/reference/760520/ (included as Exhibit 53).
[137] *Groundwater Fact Sheet: Nitrate (N or NO_3-)* (rev. Nov. 2017), www.waterboards.ca.gov/gama/docs/coc_nitrate.pdf (included as Exhibit 54).
[138] *Water Quality Portal*, NAT'L WATER QUALITY MONITORING COUNCIL, https://www.waterqualitydata.us/.

2020	3.55	0.94
2021	3.35	1.04
2022	3.03	0.93
2023	3.31	0.95
2024	2.93	0.80
2025	3.60	1.01
2026*	3.80	0.77

**2026 represents a partial year*

The 10 states with the highest mean values of nitrate in groundwater were CO, MT, WA, AZ, DE, NE, WI, NM, IA, and CA.

State	Mean of Well Means (mg/L)	Median of Well Means (mg/L)
Colorado	7.89	3.65
Montana	6.60	1.12
Washington	6.35	2.48
Arizona	6.06	1.59
Delaware	5.89	4.29
Nebraska	5.74	1.34
Wisconsin	5.55	3.26
New Mexico	4.58	0.92
Iowa	4.44	0.84
California	3.96	1.06

Many of these top states for surface and groundwater nitrate pollution are also states where CAFOs and industrial agriculture dominate the landscape. These concerning data in states like California, Delaware, Illinois, Iowa, Minnesota, and others are being driven by the overapplication of fertilizers and overproduction and mishandling of CAFO waste. The list of states producing the most CAFO waste closely tracks those with growing nitrate contamination.[139]

And these are the same surface and groundwaters that supply drinking water for tens of millions of Americans every day, whether from private wells or PWSs. As these data show, the prevalence of nitrate in our source waters is widespread and appears to be getting worse. The costs associated with PWS compliance with a new nitrate MCL of 1 mg/L can be significantly reduced with stronger controls on the pollution going into our source waters.

[139] *New Map Paints Comprehensive Picture of Factory Farm Dominance in U.S.*, FOOD & WATER WATCH (Sept. 24, 2024), https://www.foodandwaterwatch.org/press/2024/09/24/new-map-paints-comprehensive-picture-of-factory-farm-dominance-in-u-s/ (listing California, Colorado, Iowa, Kansas, Minnesota, Nebraska, and Wisconsin among the top ten states with the most CAFO waste) (included as Exhibit 55).

B. Stronger Source Control Measures for Agricultural Nitrogen Pollution Are Feasible and Effective.

EPA can substantially reduce compliance costs for a nitrate MCL of 1 mg/L by controlling pollution at the source through stronger regulation and effective control measures. The largest contributors to nitrate contamination in the United States are industrial agricultural systems. Agricultural systems contribute the vast majority of nitrogen pollution that ends up as nitrate in ground and surface water,[140] largely through the runoff of nitrogen from synthetic fertilizers and waste from CAFOs.[141] Agriculture is the dominant source of nitrogen runoff to coastal estuaries on the East Coast and the eastern Gulf of Mexico.[142]

One of the primary drivers of agricultural nitrate pollution is overapplication of fertilizer and inadequate implementation of practices to reduce nitrate runoff. Synthetic nitrogen fertilizer is the largest nitrogen source in 41% of U.S. watersheds.[143] Approximately 40 to 60% of the nitrogen applied to U.S. croplands is not used by crops and instead runs off into the environment.[144] Regional studies have reached similar conclusions; for instance, a 2014 study of three midwestern states found that an estimated 37% of 134 farmers interviewed overapplied nitrogen by 5 pounds of nitrogen per acre or more.[145] The average farm size in the study was

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[140] THE CALIFORNIA NITROGEN ASSESSMENT at 106, section 4.1.9.1 (edited by Thomas P. Tomich, Sonja B. Brodt, Randy A. Dahlgren, Kate M. Scow , 1st ed. [2016]) (agricultural sources accounting for 88% or more of the state's groundwater nitrate contamination) (Petitioners can provide a copy to EPA upon request, can be purchased at https://www.ucpress.edu/books/the-california-nitrogen-assessment/paper); Iowa Dept. of Agric. and Land Stewardship et al., Iowa Nutrient Reduction Strategy (updated Feb. 2025), https://www.nutrientstrategy.iastate.edu/sites/default/files/documents/2025%20INRS%20Complete%20Feb%202025.pdf#page=35 (non-point sources, primarily agricultural, accounting for 93% of nitrogen input to the Mississippi River in Iowa) (included as Exhibit 56); MARK A. SUTTON & HANS VAN GRINSVEN, THE EUROPEAN NITROGEN ASSESSMENT: SOURCES, EFFECTS AND POLICY PERSPECTIVES – SUMMARY FOR POLICY MAKERS at paragraph 21 (2011), https://unece.org/fileadmin/DAM/env/documents/2011/eb/wg5/WGSR49/Informal%20docs/11_ENA_SPM.pdf (agricultural sources accounting for 60% of nitrate losses to ground and surface water) (included as Exhibit 57).

[141] Daniel J Sobota, Jana E Compton, & John A Harrison, *Reactive Nitrogen Inputs to US Lands and Waterways: How Certain Are We about Sources and Fluxes?*, 11(2) FRONTIERS IN ECOLOGY AND THE ENV'T 82 (Mar. 2013), https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/110216 (included as Exhibit 58).

[142] Naomi E Detenbeck, Mingde You, & Daniel Torre, *Recent Changes in Nitrogen Sources and Load Components to Estuaries of the Contiguous United States*, 42(8) ESTUARIES COAST. (Dec. 2019), https://pmc.ncbi.nlm.nih.gov/articles/PMC7751647/ (included as Exhibit 59); Todd S Rosenstock et al., *Agriculture's Contribution to Nitrate Contamination of California Groundwater (1945–2005)*, 43(3) J. ENV'T QUALITY 895 (May 2014), https://pubmed.ncbi.nlm.nih.gov/25602818/ (included as Exhibit 60). Bijay-Singh & Eric Craswell, *Fertilizers and Nitrate Pollution of Surface and Ground Water: An Increasingly Pervasive Global Problem*, 3 DISCOVER APPLIED SCI. 518 (Mar. 2021), https://link.springer.com/article/10.1007/s42452-021-04521-8 (included as Exhibit 61).

[143] Daniel J. Sobota et al., Exhibit 58.

[144] Kelsey L. Griesheim et al., *Nitrogen-15 Evaluation of Fall-Applied Anhydrous Ammonia*, 83(6) SOIL SCI. SOCIETY AM. J. 1809 (Nov.-Dec. 2019), https://acsess.onlinelibrary.wiley.com/doi/abs/10.2136/sssaj2019.04.0098 (included as Exhibit 62); Jennifer B. Gardner & Laurie E. Drinkwater, *The Fate of Nitrogen in Grain Cropping Systems: A Meta-Analysis of ^{15}N Field Experiments*, ECOLOGICAL APPLICATIONS 2167 (Dec. 2009), https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/08-1122.1 (included as Exhibit 63).

[145] Matthew Houser, *Farmer Motivations for Excess Nitrogen Use in the U.S. Corn Belt*, 6(1) CASE STUD. ENV'T (2022), https://online.ucpress.edu/cse/article-abstract/6/1/1688823/124569/Farmer-Motivations-for-Excess-Nitrogen-Use-in-the?redirectedFrom=fulltext (included as Exhibit 64).

1615 acres, meaning an estimated overapplication of at least 400,000 pounds of nitrogen was occurring per year for the study area. A 2020 study of Illinois corn acres showed that 67% of sampled acres were applying nitrogen above the maximum return to nitrogen value, with 33% of fields applying at least 20 pounds of nitrogen per acre over the recommended rate.[146] In addition, certain "hot spots" contribute disproportionately to nitrate pollution; a 2021 study found that approximately 2–8% of the land area within the contiguous U.S. accounted for 75% of the estimated nitrate pollution to rivers and lakes.[147] Another 2021 study found that many nitrate pollution hotspots were dominated by animal feed crops.[148]

Adding to this, CAFOs have come to dominate certain regions and produce far more nitrogen-laden waste than local watersheds can accommodate.[149] CAFOs produce an estimated 941 billion pounds of animal manure every year, many times the total human sewage produced by the U.S. population.[150] CAFOs also produce leachate from silage and decomposing animal carcasses that contain extremely high levels of nitrogen.[151] These massive quantities of waste contaminate both surface and groundwaters with nitrate by overwhelming landscapes and watersheds with excess nitrogen.[152]

Reducing overapplication of fertilizer and CAFO waste and implementing practices to minimize nitrogen runoff could dramatically reduce this nitrogen pollution.[153] Reducing overapplication while maintaining agricultural productivity is possible both because overapplication is occurring, and the majority of the nitrogen that plants use during the cropping season actually comes from soil organic matter.[154] In addition, a variety of practices can reduce

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[146] Conference Paper (Agric. and Applied Economics Assoc. 2020 Annual Meeting), Sarah C. Sellars, Gary D. Schnitkey, & Laura F. Gentry, *Do Illinois Farmers Follow University-Based Nitrogen Recommendations?*, https://doi.org/10.22004/ag.econ.304617 (included as Exhibit 65).

[147] Rebecca J. Frei et al., *Limited Progress in Nutrient Pollution in the U.S. Caused by Spatially Persistent Nutrient Sources*, PLOS ONE (Nov. 29, 2021), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0258952 (included as Exhibit 66).

[148] Eric D. Roy, Courtney R. Hammond Wagner, & Meredith T. Niles, *Hot Spots of Opportunity for Improved Cropland Nitrogen Management Across the United States*, 16(3) ENV'T RES. LETTERS (Feb. 16, 2021), https://doi.org/10.1088/1748-9326/abd662 (included as Exhibit 67).

[149] *E.g.*, Lorrayne Miralha et al., *The Spatial Organization of CAFOs and Its Relationship to Water Quality in the United States*, 613 J. HYDROLOGY 128301 (Oct. 2022), https://www.sciencedirect.com/science/article/abs/pii/S0022169422008733 (included as Exhibit 68).

[150] FOOD & WATER WATCH, FACTORY FARM NATION: 2024 EDITION, https://www.foodandwaterwatch.org/wp-content/uploads/2024/09/RPT_2409_FacFarmMapUpdate-WEB2.pdf (included as Exhibit 69).

[151] Natalie Rector, *Environmental Stewardship: Controlling Silage Leachage*, MICH. STATE U. (Apr. 2, 2012), https://www.canr.msu.edu/resources/environmental_stewardship_controlling_silage_leachage (included as Exhibit 70).

[152] For example, a dairy industry funded study of groundwater in California's San Joaquin Valley where most of the state's dairy CAFOs operate found levels of nitrate above the current MCL of 10 mg/L at each of the 42 monitored CAFOs. CENTRAL VALLEY DAIRY REPRESENTATIVE MONITORING PROGRAM, SUMMARY REPRESENTATIVE MONITORING REPORT at 6 (Apr. 2019), https://leadershipcounsel.org/wp-content/uploads/2019/10/Dairy-report.pdf (included as Exhibit 71).

[153] Bertrand Hirel et al., *Improving Nitrogen Use Efficiency in Crops for Sustainable Agriculture*, 3(9) SUSTAINABILITY 1452 (2011), https://www.mdpi.com/2071-1050/3/9/1452 (included as Exhibit 72).

[154] Helio Antonio Wood Joris et al., *Long-Term N Fertilization Reduces Uptake of N from Fertilizer and Increases the Uptake of N from Soil*, 10 SCI. REP. 18834 (2020), https://www.nature.com/articles/s41598-020-75971-0 (included as Exhibit 73); Bruno Basso et al., *Yield Stability Analysis Reveals Sources of Large-Scale Nitrogen Loss*

nitrate pollution when deployed responsibly and with oversight to ensure effectiveness such as cover cropping, wetlands protection and restoration, riparian buffers or field border strips, and crop diversification. Policies or programs that set limits on nitrogen application and discharge from fields can accelerate adoption of these practices.[155]

Very few U.S. jurisdictions have implemented caps on fertilizer overapplication or nitrate pollution from fertilizer.[156] Similarly, CAFOs have been left largely unregulated in most states across the country, allowing them to dispose of untold amounts of excess nitrogen into watersheds.[157] Instead, states have primarily relied on voluntary programs, which by themselves have not meaningfully reduced nitrate pollution. For instance, for a decade Minnesota has largely relied on its voluntary Minnesota Agricultural Water Quality Certification Program, a program that certifies farms that use certain conservation practices, to reduce farm nutrient loss. One in eight Minnesotans rely on groundwater-based PWSs that have exceeded the existing federal and state limit of 10 mg/L for nitrate in their drinking water source.[158] This statistic does not include the 1.1 million Minnesotans that rely on private drinking wells, who are more vulnerable to nitrate exposure through drinking water because they must treat and test their water themselves.[159] In some parts of Minnesota, drinking water exceedances reach staggering rates, with a sample in the Southeast part of the state detecting 25.2 mg/L and a sample in the Central Sands region detecting 81.2 mg/L.[160] A recent legislative audit in Minnesota concluded that more than a decade of voluntary participation in the Certification Program had produced no

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from the US Midwest, 9 SCI. REP. 5774 (2019), https://doi.org/10.1038/s41598-019-42271-1 (included as Exhibit 74); S. Sela et al., *Adapt-N Outperforms Grower-Selected Nitrogen Rates in Northeast and Midwestern United States Strip Trials*, 108(4) AGRONOMY J. 1726 (2016), https://doi.org/10.2134/agronj2015.0606 (included as Exhibit 75); Stefan Gailans, *Can We Reduce N Rates to Corn and Improve ROI?*, PRACTICAL FARMERS OF IOWA (June 16, 2024), https://practicalfarmers.org/research/can-we-reduce-n-rates-to-corn-and-improve-roi/ (included as Exhibit 76).

[155] Timothy M. Bowles et al., *Addressing Agricultural Nitrogen Losses in a Changing Climate*, 1 NATURE SUSTAINABILITY 399 (2018), https://www.nature.com/articles/s41893-018-0106-0 (included as Exhibit 77).

[156] S. Emily Grams & James Rehwaldt, *Mandatory Fertilizer Regulations: A Survey of State and Federal Laws*, 49(2) WILLIAM & MARY ENV'T L POLICY REV. (2025), https://scholarship.law.wm.edu/cgi/viewcontent.cgi?article=1889&context=wmelpr (included as Exhibit 78).

[157] *E.g.*, *Precautionary Moratorium on New and Expanding Concentrated Animal Feeding Operations*, AM. PUB. HEALTH ASS'N (Nov. 4, 2019), https://www.apha.org/policy-and-advocacy/public-health-policy-briefs/policy-database/2020/01/13/precautionary-moratorium-on-new-and-expanding-concentrated-animal-feeding-operations (included as Exhibit 79); Jon Devine, *CAFOs: What We Don't Know Is Hurting Us*, NRDC (Sept. 23, 2019), https://www.nrdc.org/resources/cafos-what-we-dont-know-hurting-us (included as Exhibit 80); ZOE ROBERTSON ET AL., CONFINED ANIMAL FACILITY PERMITTING AND REPORTING UNDER THE PORTER-COLOGNE WATER QUALITY CONTROL ACT: AN ANALYSIS OF REGIONAL BOARD ACTIVITIES (Feb. 2026), https://law.stanford.edu/wp-content/uploads/2026/02/Robertson-et-al_CAF-Reporting-and-Permitting-Under-the-PCA_final.pdf (included as Exhibit 81).

[158] Sarah Porter & Anne Schechinger, *Tap Water for 500,000 Minnesotans Contaminated with Elevated Levels of Nitrate*, ENV'T WORKING GROUP (Jan. 14, 2020), http://www.ewg.org/interactive-maps/2020_nitrate_in_minnesota_drinking_water_from_groundwater_sources/ (included as Exhibit 82).

[159] *Minnesotans with Private Wells Urged to Test Their Drinking Water for Five Common Contaminants*, MINN. DEP'T OF HEALTH (Mar. 11, 2024), https://www.health.state.mn.us/news/pressrel/2024/wellsprivate031124.html (included as Exhibit 83).

[160] *Southeast Minnesota Volunteer Nitrate Monitoring Network 2024 Results*, MINN. DEP'T OF AGRIC. (June 2025), https://wrl.mnpals.net/node/4369 (included as Exhibit 84); *Central Sands Private Well Network 2024 Results*, MINN. DEP'T OF AGRIC. (Mar. 2025), https://wrl.mnpals.net/node/4370 (included as Exhibit 85).

measurable evidence of water quality improvements.[161] Iowa is in a similar position, as its voluntary Nutrient Reduction Strategy has failed to reduce nitrate contamination in over a decade,[162] thousands of Iowans rely on private wells contaminated by nitrate,[163] and Iowans have endured rising cancer rates driven in part by nitrate-contaminated drinking water.[164]

In contrast, a notable exception to the voluntary approach of most U.S. jurisdictions is the California Water Resources Control Board's recent Dairy Order, which was adopted in September 2026 and will set numeric, enforceable limits on nitrogen application to protect drinking water quality.[165] Outside the U.S., regions that have implemented caps on nitrogen application have experienced reductions in nitrate leaching. For instance, the European Union (EU)'s 1991 Nitrate Directive established compulsory action programs for farmers in nitrogen vulnerable zones, including limiting fertilizer application and implementation of best management practices. Since 1991, there has been a 33% reduction in estimated nitrate leaching across the entire EU, and larger leaching reductions in intensively farmed regions: a 60% reduction in nitrate leaching in regions of the Netherlands and a 48% reduction in nitrogen surplus in Denmark.[166] New Zealand also placed limits on nitrogen application to grazed land in 2023.[167] While data from New Zealand is limited, one estimate of nitrogen leaching showed an average decrease in estimated nitrate leaching of 15% (-6 kg N/ha) in one region (Canterbury) and 32% (-22kg N/ha) in another (Southland).[168]

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[161] STATE OF MINN., OFFICE OF THE LEGISLATIVE AUDITOR, MINNESOTA AGRICULTURAL WATER QUALITY CERTIFICATION PROGRAM: 2026 EVALUATION REPORT (July 2026), https://www.auditor.leg.state.mn.us/ped/pedrep/2026-mawqcp.pdf (included as Exhibit 86). *See also* Maya Korb & Julia Kirkland, *Minnesota's Water Quality Wakeup Call*, NRDC (Aug. 9, 2026), https://www.nrdc.org/bio/maya-korb/minnesotas-water-quality-wake-call (included as Exhibit 87).

[162] Iowa introduced a Nutrient Reduction Strategy in 2012 but in 2024 Iowa had the highest flow-weight mean concentration of nitrate recorded in the past 25 years. *See* Iowa Nutrient Reduction Strategy – Water Quality Dashboard (updated May 2026), https://www.arcgis.com/apps/dashboards/2ce0b4558163447d8b0351c6865a59c2#.

[163] Iowa Dep't of Health and Human Serv., *Nitrate Testing in Private Water Wells – 2020 Dashboard*, https://data.idph.state.ia.us/t/IDPH-DataViz/views/PrivateWaterNitrate/NitrateTesting?iframeSizedToWindow=true&:embed=y.

[164] IOWA ENV'T COUNCIL & HARKIN INST. FOR PUB. POLICY & CITIZEN ENGAGEMENT, ENVIRONMENTAL RISK FACTORS AND IOWA'S CANCER CRISIS: A 2026 REPORT 40–41 (2026), https://www.iaenvironment.org/webres/File/Environmental%20Risk%20Factors%20and%20Iowa's%20Cancer%20Crisis%20-%20Report(1).pdf (included as Exhibit 88).

[165] State of Cal., State Water Resources Control Board Order WQ 2026-2028, *In the Matter of Review of Waste Discharge Requirements General Order No. R5-2013-0122 for Milk Cow Daires in the Central Valley Region Issued by the California Regional Water Quality Control Board, Central Valley*, https://waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2026/wqo2026-0028.pdf (included as Exhibit 89).

[166] Masooma Batool et al., *Long-Term Annual Soil Nitrogen Surplus across Europe (1850–2019)*, 9 SCI. DATA 612 (Oct. 22, 2022), https://doi.org/10.1038/s41597-022-01693-9 (included as Exhibit 90); Gerard L. Velthof et al., *The Impact of the Nitrates Directive on Nitrogen Emissions from Agriculture in the EU-27 during 2000–2008*, SCI. TOTAL ENV'T 468–469 (Jan. 15, 2014), https://doi.org/10.1016/j.scitotenv.2013.04.058 (included as Exhibit 91).

[167] *Understanding the Synthetic Nitrogen Fertiliser Cap*, NEW ZEALAND MINISTRY FOR THE ENV'T (2021) https://environment.govt.nz/assets/publications/N-Cap-guidance-for-dairy-farms-infosheet.pdf (included as Exhibit 92).

[168] Phil Journeaux et al., *On-Farm Nitrogen Management in the Face of Regulated Fertiliser Input*, AGRIMAGIC (Dec. 2023), https://ourlandandwater.nz/wp-content/uploads/2024/05/N-Management-Report.pdf (included as Exhibit 93).

C. EPA Has the Authority to Require Stronger Source Control Programs and to Bring Enforcement Actions.

EPA has significant authority pursuant to Section 1431 of the SDWA to remediate threats to public health, particularly when there is imminent and substantial endangerment to the health of people.[169] EPA may take remedial actions necessary to protect the health of persons notwithstanding existing licenses or permits, including investigating the nature and extent of contamination, monitoring of contaminants, and control of the source of contaminants.[170] For example, EPA has used its Section 1431 authority to bring enforcement actions against polluting dairy operations and to secure alternative sources of drinking water for impacted community members in Washington State's Lower Yakima Valley.[171]

EPA also has other tools to protect source water, including the Sole Source Aquifer program[172] and EPA's authority under 33 U.S.C. § 1364 of the Clean Water Act to bring enforcement actions or take other action to rein in sources of nitrate pollution. Petitioners call on EPA to use each of these and any other authorities it has to protect our source waters.

D. Effective Source Control Programs Would Bring Benefits to Private Well Users

While this Petition focuses on nitrate in PWSs, many rural communities rely on private wells and can be the most vulnerable to nitrate contamination in drinking water due to lack of information and lack of resources to install and maintain treatment on their own. Protecting source waters will benefit *everyone's* drinking water by addressing the systemic contamination of our waters by industrial agriculture. EPA knows this is a widespread problem as numerous SDWA emergency petitions remain pending at EPA to address the imminent and substantial endangerment posed by nitrate in groundwater used by rural communities and private well users.[173]

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[169] 42 U.S.C. § 300i; EPA, *Updated Guidance on Emergency Authority under Section 1431 of the Safe Drinking Water Act* (May 30, 2018), https://www.epa.gov/sites/default/files/2018-09/documents/updatedguidanceonemergencyauthorityundersection1431sdwa.pdf (included as Exhibit 94).

[170] *Id*.

[171] *EPA, Department of Justice Sue Lower Yakima Valley Dairies for Manure Practices Endangering Neighboring Well-Users*, EPA (July 1, 2024), https://www.epa.gov/newsreleases/epa-department-justice-sue-lower-yakima-valley-dairies-manure-practices-endangering (included as Exhibit 95).

[172] 42 U.S.C. § 300h-3; EPA, *Overview of the Drinking Water Sole Source Aquifer Program* (updated July 14, 2026), https://www.epa.gov/dwssa/overview-drinking-water-sole-source-aquifer-program.

[173] Advocacy organizations (including several of the Petitioners here) have sought relief from EPA for nitrate pollution pursuant to Section 1431 on behalf of rural communities not served by PWSs. *See* FOOD & WATER WATCH ET AL., PETITION FOR EMERGENCY ACTION PURSUANT TO THE SAFE DRINKING WATER ACT § 1431, 42 U.S.C. § 300I, TO PROTECT CITIZENS OF THE LOWER UMATILLA BASIN IN OREGON (2020), https://www.epa.gov/system/files/documents/2022-12/Lower-Umatilla-Groundwater-SWDA-Petition-2020.pdf; CENTER FOR FOOD SAFETY ET AL., PETITION FOR EMERGENCY ACTION UNDER SECTION 1431 OF THE SAFE DRINKING WATER ACT TO PROTECT RESIDENTS OF THE LOWER YAKIMA VALLEY, WASHINGTON (2021), https://www.centerforfoodsafety.org/files/20211026-petition-for-emergency-action-under-section-1431-of-the-sdwa_00006.pdf; MINNESOTA CENTER FOR ENVIRONMENTAL ADVOCACY ET AL., PETITION FOR EMERGENCY ACTION PURSUANT TO THE SAFE DRINKING WATER ACT, 42 U.S.C. § 300I, TO PROTECT THE CITIZENS OF THE KARST REGION OF MINNESOTA (2023), https://www.mncenter.org/sites/default/files/permalinks/42423-emergency-sdwa-petition-to-epa-with-exhibits.pdf; IOWA ENVIRONMENTAL COUNCIL ET AL., PETITION FOR EMERGENCY ACTION PURSUANT TO THE SAFE DRINKING WATER ACT, 42 U.S.C. § 300I, TO PROTECT THE CITIZENS OF THE KARST REGION OF IOWA (2024), https://www.iaenvironment.org/webres/File/IA_SDWA_Petition_Complete.pdf.

Protecting our shared source waters would therefore bring massive public health benefits in addition to those outlined and analyzed above. Rural communities deserve clean water too, and EPA can deliver it with aggressive action to stop nitrate pollution at the source.

E. Effective Source Control Programs Would Bring Additional Co-Benefits to Ecosystems and Communities.

In addition to reducing compliance costs for achieving the new MCL, source control programs would benefit ecosystems and fish and wildlife. Currently, inadequate source control programs result in unchecked agricultural nitrogen pollution, which fuels harmful algal blooms and sickens or kills fish and wildlife.[174] Excess and largely unregulated nitrogen runoff extends beyond state boundaries, flowing down the Mississippi River and contributing to the annual hypoxic zone in the Gulf of Mexico.[175] Within the United States, up to 78 species listed under the Endangered Species Act are at risk due in part to nitrogen pollution[176] and nitrogen pollution is linked to deadly tumors in iconic species like the green sea turtle.[177]

Source control programs would also reduce nitrous oxide emissions, a major driver of climate change and ozone layer depletion. Inadequate source control programs for fertilizer management and CAFOs have led to increased nitrous oxide emissions, which are 273 times more effective at warming the planet than carbon dioxide.[178] Nitrous oxide represents about 10% of all total human-caused greenhouse gas emissions and agricultural practices are the primary contributor.[179] Nitrous oxide depletes the ozone layer and increases ultraviolet radiation, which has the potential to result in 4 million premature deaths in the next 10 years, and 20 million by 2050.[180] Finally, source control programs limiting overapplication of fertilizer would also reduce emissions of nitrogen oxides, which are a leading cause of premature death in humans and loss of biodiversity.[181]

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[174] J.P. ROSE ET AL., THE NITROGEN POLLUTION CRISIS: HOW FERTILIZER OVERUSE IS POISONING AMERICA'S WATER, AIR AND ECOSYSTEMS (May 2026), https://www.nrdc.org/sites/default/files/2026-05/Nitrogen_Pollution_R_26-05-B_04.pdf (included as Exhibit 96); Meredith M. Brehob et al., *Estimates of Lake Nitrogen, Phosphorus, and Chlorophyll-a Concentrations to Characterize Harmful Algal Bloom Risk Across the United States*, 12(8) EARTH'S FUTURE (2024), https://doi.org/10.1029/2024EF004493 (included as Exhibit 97); Melissa Denchak & Melanie Sturm, *Freshwater Harmful Algal Blooms 101*, NRDC (Aug. 28, 2019), https://www.nrdc.org/stories/freshwater-harmful-algal-blooms-101 (included as Exhibit 98).

[175] *The Effects: Dead Zones and Harmful Algal Blooms*, EPA (updated Jan. 15, 2026), https://www.epa.gov/nutrientpollution/effects-dead-zones-andharmful-algal-blooms (included as Exhibit 99).

[176] Daniel L. Hernández et al., *Nitrogen Pollution Is Linked to U.S. Listed Species Declines*, 66(3) BIOSCIENCE 213 (2016), https://doi.org/10.1093/biosci/ biw003 (included as Exhibit 100).

[177] Kyle S. Van Houtan et al., *Eutrophication and the Dietary Promotion of Sea Turtle Tumors*, 2 PEERJ 602 (Sept. 2014), https://doi.org/10.7717/peerj.602 (included as Exhibit 101).

[178] *IPCC Global Warming Potential Values*, GREENHOUSE GAS PROTOCOL (Aug. 7, 2024), https://ghgprotocol.org/sites/default/files/2024-08/Global-WarmingPotential-Values%20%28August%202024%29.pdf (included as Exhibit 102).

[179] Yunhu Gao & André Cabrera Serrenho, *Greenhouse Gas Emissions from Nitrogen Fertilizers Could Be Reduced by up to One-Fifth of Current Levels by 2050 with Combined Interventions*, 4 NATURE FOOD 170 (Feb. 2023), https://doi.org/10.1038/s43016-023-00698-w (included as Exhibit 103).

[180] A. R. Ravishankara, John S. Daniel, & Robert W. Portmann, *Nitrous Oxide (N2O): The Dominant Ozone-Depleting Substance Emitted in the 21st Century*, 326(5949) SCI. 123 (Aug. 2009), https://doi.org/10.1126/science.1176985 (included as Exhibit 104).

[181] Maya Almaraz et al., *Agriculture Is a Major Source of NOx Emissions in California*, 4(1) SCI. ADVANCES 4 (2018), https://www.science.org/doi/10.1126/sciadv.aao3477 (included as Exhibit 105).

VIII. EPA SHOULD PROVIDE SUPPORT FOR NITRATE DRINKING WATER TREATMENT AND SOURCE PROTECTION THROUGH EXISTING FEDERAL GRANT AND LOAN PROGRAMS

Complying with the new nitrate MCL will result in costs for drinking water utilities and potentially for ratepayers as well. While new sources of federal support would be beneficial, there are a number of existing loan and grant programs at the federal level that could support efforts to protect water sources and treat drinking water. Many of these programs are administered by the EPA, and others are administered by the Department of Agriculture, Bureau of Reclamation, Department of Commerce, and the Department of Health and Human Services.

Because each of these programs has limited funds and capacity, as discussed above, EPA should utilize all of its authorities under the CWA and SDWA to bring enforcement actions against polluters to compel those that have caused this problem to directly clean it up and provide safe drinking water to impacted communities in the meantime. Critically, no federal funds should be used to support or perpetuate the very agricultural practices that are the problem, like overapplication of chemical fertilizers and out-of-control CAFO waste production and disposal. Funds must be focused on efforts that improve water quality in the real world and foster agricultural practices that produce the food we need without poisoning our communities.

With that said, EPA, USDA, and other federal agencies have several grant programs that provide funding for drinking water treatment and protection projects:

- **EPA Drinking Water State Revolving Fund (DWSRF)**: provides support for infrastructure improvements in drinking water systems including projects to install or upgrade facilities to improve drinking water quality to comply with SDWA regulations.[182] The DWSRF has provided over $48.5 billion to communities, with types of funding including low-interest loans, grants, principal forgiveness, and negative interest rate loans.[183]
- **EPA Small, Rural, and Tribal (SmaRT) Drinking Water Assistance Grant Program**: provides funding to public water systems in small, underserved, and disadvantaged communities, with funds available for upgrades to infrastructure to comply with the SDWA.[184]
- **USDA Rural Development Water & Environmental Programs (WEP) Water & Waste Disposal Loan & Grant Program**: provides loans, grants, and loan guarantees to rural areas, cities, and towns with populations of 10,000 or less for clean and reliable drinking water systems, with funds able to be used for activities including drinking water sourcing and treatment.[185]

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[182] *Drinking Water State Revolving Fund (DWSRF)*, EPA (Sept. 2, 2026), https://www.epa.gov/dwsrf; *DWSRF Eligibilities*, EPA (Nov. 12, 2025), https://www.epa.gov/dwsrf/dwsrf-eligibilities.

[183] ASS'N OF STATE DRINKING WATER ADMINISTRATORS, A NEW ERA FOR THE DRINKING WATER STATE REVOLVING FUNDS: IDENTIFYING WAYS TO BETTER ASSIST DISADVANTAGED COMMUNITIES 1 (Jan. 2023).

[184] *Small, Rural, and Tribal Drinking Water Assistance Grant Program*, EPA, https://www.epa.gov/dwcapacity/small-rural-and-tribal-drinking-water-assistance-grant-program.

[185] *Water & Waste Disposal Loan & Grant Program*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/water-waste-disposal-loan-grant-program.

- **USDA WEP Revolving Funds for Financing Water and Wastewater Projects**: provides grants to nonprofits to create revolving loan funds that can provide financing for water system improvements in rural areas. Funds can be used for pre-development costs for water projects and for short-term small capital improvement projects.[186]
- **USDA WEP Special Evaluation Assistance for Rural Communities and Households (SEARCH) Grant**: provides funding to financially-distressed rural communities for predevelopment planning costs and activities for water projects, including feasibility studies, preliminary design and engineering analysis, and technical assistance and environmental impact analysis.[187]

Other federal agencies provide support for local economic development that can be used for water projects:

- **Housing and Urban Development, Community Development Block Grant (CDBG) program**: support community development activities including infrastructure.[188]
- **Department of Commerce, Economic Development Administration, Economic Adjustment Assistance:** helps distressed communities revitalize, expand, and upgrade their physical infrastructure.[189]
- **Department of Commerce, Economic Development Administration, Public Works**: assists communities to become competitive by investing in public works including water system improvements.[190]

In addition to support for capital costs, EPA and USDA provide technical support to help primacy agencies and PWSs achieve compliance:

- **EPA Training and Technical Assistance to Improve Water Quality and Enable Small Public Water Systems to Provide Safe Drinking Water Grants**: provides funding to be used for technical, financial, and managerial needs at small public drinking water systems to achieve and maintain compliance with the SDWA.[191]
- **EPA Public Water System Supervision (PWSS) Grant Program**: provides funding for states, territories, and tribes to develop and implement PWSS programs adequate to enforce SDWA requirements, with activities under PWSS programs including providing

[186] *Revolving Funds for Financing Water and Wastewater Projects*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/revolving-funds-financing-water-and-wastewater-projects.
[187] *SEARCH - Special Evaluation Assistance for Rural Communities and Households Grant*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/search-special-evaluation-assistance-rural-communities-and-households-grant.
[188] *Community Development Block Grant Program*, DEP'T OF HOUSING AND URBAN DEV., https://www.hud.gov/hud-partners/community-cdbg.
[189] *Economic Adjustment Assistance*, DEP'T OF COMMERCE, https://www.eda.gov/economic-adjustment-assistance.
[190] *Public Works*, DEP'T OF COMMERCE, https://www.eda.gov/funding/programs/public-works.
[191] *Training and Technical Assistance for Small Systems Funding*, EPA (July 24, 2026), https://www.epa.gov/dwcapacity/training-and-technical-assistance-small-systems-funding.

technical support to managers and operators of public water systems and reviewing public water system plans and specifications.[192]

- **USDA Rural Utilities Service, Water and Waste Disposal Technical Assistance and Training Program**: helps qualified nonprofits provide technical assistance and training to improve water facilities.[193]
- **USDA Rural Utilities Service, Circuit Rider Program**: provides technical assistance to rural water systems.[194]

EPA, USDA, and the Bureau of Reclamation have programs that can be used to provide funding for source water protection projects:

- **EPA Clean Water State Revolving Fund**: provides support for water quality protection projects for centralized and decentralized wastewater treatment, nonpoint source pollution control, and watershed and estuary management. Eligible projects include developing and implementing watershed partnerships to address nonpoint sources of pollution, managing stormwater and subsurface drainage, and implementing agricultural best management practices.[195] Over $194 billion has been provided to communities through the CWSRF, with types of assistance include loans, purchase of debt, negative interest rate loans, and grants.[196]
- **EPA Nonpoint Source Grants Program (Section 319 of the Clean Water Act)**: provides funding for activities that prevent water pollution from nonpoint sources, including education, training, technical and financial assistance, technology transfer, demonstration projects, and monitoring nonpoint source implementation projects.[197]
- **EPA Water Pollution Control Grants Program (Section 106 of the Clean Water Act)**: provides funding to states, territories, the District of Columbia, tribes, and interstate agencies to establish and implement ongoing water pollution control programs.[198]
- **USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP)**: provides technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns, including improving water quality. Listed benefits of the program include reducing contamination from agricultural sources and reducing nonpoint source pollution.[199]

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[192] *Public Water System Supervision (PWSS) Grant Program,* EPA, https://www.epa.gov/dwreginfo/public-water-system-supervision-pwss-grant-program.

[193] *Water & Waste Disposal Technical Assistance & Training Grants*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/water-waste-disposal-technical-assistance-training-grants.

[194] *Circuit Rider Program*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/circuit-rider-program-technical-assistance-rural-water-systems.

[195] *Clean Water State Revolving Fund (CWSRF)*, EPA (Sept. 9, 2026), https://www.epa.gov/cwsrf.

[196] *About the CWSRF*, EPA (June 25, 2026), https://www.epa.gov/cwsrf/about-cwsrf.

[197] *319 Grant Program for States and Territories*, EPA, https://www.epa.gov/nps/319-grant-program-states-and-territories.

[198] *Water Pollution Control (Section 106) Grants*, EPA, https://www.epa.gov/water-pollution-control-section-106-grants.

[199] *Environmental Quality Incentives Program (EQIP)*, USDA NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/programs-initiatives/environmental-quality-incentives-program. EQIP is notorious for funding projects that exacerbate water pollution issues by, for example, enabling CAFO expansions. EQIP funds should not be used for any project that may cause or contribute to nitrate contamination of drinking water.

- **USDA NRCS Regional Conservation Partnership Program (RCPP)**: provides technical and financial assistance to address natural resource challenges on agricultural land. Objectives include furthering the conservation, protection, restoration, and sustainable use of drinking water and groundwater.[200]
- **USDA NRCS Watershed Protection and Flood Prevention Operations (WFPO) Program**: provides technical and financial support to states, local governments, and tribal organizations to assist with planning and implementation of watershed projects with purposes including agricultural water management, municipal water supply, and water quality management. Watershed plans can include measures to improve water quality impacted by pollutants.[201]
- **Bureau of Reclamation WaterSMART Enhancing Water Resources Projects**: provides funding to support collaboratively developed projects that benefit multiple water users, improve water supply reliability, and enhance watershed health, with eligible projects including those that improve water quality.[202]
- **USDA Agricultural Conservation Easement Program, Wetland Reserve Easements**: purchases easements to help restore, protect, and enhance wetland functions on farmed or converted wetlands that have been degraded due to agricultural use; applications prioritized based on the potential of the easement to improve water quality and enhance habitat.[203]
- **USDA NRCS Agricultural Management Assistance**: provides financial assistance to agricultural producers on private lands for activities including constructing or improving water management structures and planting trees to improve water quality.[204]
- **Bureau of Reclamation WaterSMART Cooperative Watershed Management Program (CWMP)**: provides funding for watershed group development, watershed restoration planning, and phase 1 watershed management project design.[205]
- **Bureau of Reclamation WaterSMART Aquatic Ecosystem Restoration Program**: provides funding for large-scale aquatic ecosystem restoration projects, with eligible restoration activities including implementation of nature-based solutions projects and the improvement of water quality.[206]

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[200] *Regional Conservation Partnership Program (RCPP)*, USDA NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/programs-initiatives/regional-conservation-partnership-program; *Regional Conservation Partnership Program*, U.S. GEN. SERV. ADMIN. (Feb. 3, 2026), https://sam.gov/workspace/assistance/fal/65b2cbfb62224cb389bc2f7be1e90ba9/view.

[201] *Watershed Protection and Flood Prevention Operations (WFPO) Program*, USDA NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/programs-initiatives/watershed-protection-and-flood-prevention-operations-program.

[202] *WaterSMART Enhancing Water Resources Projects*, BUREAU OF RECLAMATION, https://www.usbr.gov/watersmart/ewrp/index.html.

[203] *Agricultural Conservation Easement Program Fact Sheet*, USDA NAT. RES. CONSERVATION SERV. (June 23, 2026), https://www.usda.gov/guidance-documents/conservation/nrcs/agricultural-conservation-easement-program-fact-sheet.

[204] *Agricultural Management Assistance*, U.S. GEN. SERV. ADMIN. (Feb. 3, 2026), https://sam.gov/workspace/assistance/fal/c29ad801955048ef9d42fffd8096b02b/view.

[205] *WaterSMART Cooperative Watershed Management Program*, BUREAU OF RECLAMATION, https://www.usbr.gov/watersmart/cwmp/index.html.

[206] *WaterSMART Aquatic Ecosystem Restoration Program*, BUREAU OF RECLAMATION (Sept. 1, 2026), https://www.usbr.gov/watersmart/aquatic/index.html.

Some federal programs provide funds that could be used for both drinking water treatment and source water protection:

- **EPA Water Infrastructure Finance and Innovation Act (WIFIA) Program**: provides supplemental, flexible, low-cost loans for wastewater, drinking water, and stormwater programs, including treatment and nonpoint source projects.[207] Since 2018, the WIFIA program has provided $24 billion in credit assistance, helping to finance $53 billion for water infrastructure projects.[208]
- **EPA Midsize and Large Drinking Water System Infrastructure Resilience and Sustainability Program**: provides funding to assist medium and large public water systems with protecting drinking water sources from natural hazards, extreme weather events, and cybersecurity threats. Eligible projects include drinking water infrastructure projects and the enhancement of water supply through watershed management and source water protection.[209]
- **EPA Drinking Water System Infrastructure Resilience and Sustainability Program:** provides funding to assist underserved, small, and disadvantaged communities for the purpose of increasing drinking water facility resilience to natural hazards. Eligible projects include drinking water infrastructure projects and the enhancement of water supply through watershed management and source water protection.[210]
- **EPA Emergency Assistance under section 1442(b) of the SDWA**: provides funding to states and publicly owned water systems to prevent, limit, or mitigate danger to public health from an emergency situation affecting public water systems or their water sources.[211]
- **EPA Environmental Protection Consolidated Grants for the Insular Areas**: provides funding to U.S. territories for activities supporting EPA's funding priorities, including complying with and enforcing safe drinking water regulations, advancing watershed management, establishing and managing special management areas to prevent groundwater contamination, and mitigating or eliminating nonpoint discharges of pollution.[212]
- **USACE Environmental Infrastructure Assistance**: provides funding to non-Federal sponsors for a variety of environmental infrastructure projects within eligible locations, typically focusing on improving environmental conditions and supporting infrastructure such as water treatment facilities.[213]

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[207] *About the WIFIA Program*, EPA (Aug. 17, 2026), https://www.epa.gov/wifia/about-wifia-program.
[208] *WIFIA Projects*, EPA (Oct. 2, 2026), https://www.epa.gov/wifia/wifia-projects.
[209] *Midsize and Large Drinking Water System Infrastructure Resilience and Sustainability Program*, EPA (Aug. 31, 2026), https://www.epa.gov/dwcapacity/midsize-and-large-drinking-water-system-infrastructure-resilience-and-sustainability.
[210] *Drinking Water System Infrastructure Resilience and Sustainability*, EPA (July 21, 2026), https://www.epa.gov/dwcapacity/drinking-water-system-infrastructure-resilience-and-sustainability.
[211] Reference Guide for SDWA 1442(b) Drinking Water Emergency Assistance, EPA, https://www.epa.gov/system/files/documents/2026-08/1442b-resource-guide_2026.pdf.
[212] Environmental Protection Consolidated Grants for the Insular Areas - Program Support, U.S. GEN. SERV. ADMIN. (June 15, 2026), https://sam.gov/workspace/assistance/fal/eba0da57fa6b45b78fee912888d05350/view.
[213] *Environmental Infrastructure*, U.S. ARMY CORPS OF ENG'RS, https://www.usace.army.mil/Missions/Civil-Works/Environmental-Infrastructure/.

Several federal grant programs provide support specifically for tribal communities:

- **EPA Tribal Water Pollution Control Program Grants (Section 106 of the Clean Water Act)**: provides funding to tribes to establish and implement ongoing water pollution control programs.[214]
- **U.S. Department of Health and Human Services, Indian Health Service, Sanitation Facilities Construction Program**: provides technical and financial assistance to American Indian tribes and Alaska Native villages for cooperative development and construction of safe water, wastewater, and solid waste systems.[215]
- **USDA WEP Water and Waste Facility Loans and Grants to Alleviate Health Risks on Tribal Lands**: provides funding for the construction of drinking water and waste disposal systems in eligible areas where residents face significant health risks resulting from lack of access to adequate and affordable water or waste disposal services.[216]
- **Administration for Native Americans Environmental Regulatory Enhancement (ERE) Grants**: provide Tribes with resources to develop legal, technical, and organizational capacity to protect their natural environments, with eligible uses of funds including building the technical and program capability to perform essential environmental program functions to meet tribal and federal regulatory requirements.[217]
- **EPA Alaska Native Villages and Rural Communities Grant Program**: provides funding through the Alaska Department of Environmental Conservation to assist with the construction of new or improved wastewater and drinking water systems.[218]
- **USDA WEP Grants for Rural and Native Alaskan Villages**: provides funding to help remote Alaskan villages provide safe, reliable drinking water, specially to remedy dire sanitation conditions.[219]

As this petition shows, reducing nitrates in drinking water is necessary to protect public health. Americans should not suffer the adverse health outcomes resulting from drinking nitrate-contaminated water because funds are not available to ensure safe drinking water, nor should communities be burdened with the full costs of reducing nitrate contamination driven by under-regulated industrial agriculture. Coupled with mandatory nitrogen reduction practices that hold polluters accountable, federal grant and loan programs should be utilized to their fullest extent to ensure that all communities have the necessary resources to provide water users with drinking

[214] *Tribal Grants under Section 106 of the Clean Water Act*, EPA (Mar. 24, 2026), https://www.epa.gov/water-pollution-control-section-106-grants/tribal-grants-under-section-106-clean-water-act.
[215] *Division of Sanitation Facilities Construction,* INDIAN HEALTH SERV., https://www.ihs.gov/dsfc/index.cfm?module=mission.
[216] *Water and Waste Facility Loans and Grants to Alleviate Health Risks on Tribal Lands*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/water-and-waste-facility-loans-and-grants-alleviate-health-risks-tribal-lands.
[217] *Funding Opportunities*, ADMIN. FOR NATIVE AMERICANS (Sept. 15, 2026), https://acf.gov/ana/grants-funding/funding-opportunities.
[218] *Alaska Native Villages and Rural Communities Water Grant Program*, EPA (Sept. 10, 2026), http://epa.gov/small-and-rural-wastewater-systems/alaska-native-villages-and-rural-communities-water-grant-program.
[219] *Grants for Rural and Native Alaskan Villages*, USDA RURAL DEV., https://www.rd.usda.gov/programs-services/water-environmental-programs/grants-rural-and-native-alaskan-villages.

water that complies with the new nitrate MCL and to reduce the financial burden placed on communities, PWSs, and users.

IX. CONCLUSION

For the reasons explained above, the undersigned Petitioners request that EPA adopt an urgent threat to health interim standard and later a final revision of the standard for nitrate, bringing the MCLG to zero and the MCL to 1 mg/L. The current standard of 10 mg/L does not reflect the best available science and poses unjustifiable risks to the health of tens of millions of people across the country. It is long past time to initiate bold action to clean up our tap water and rein in industrial agriculture's ongoing and pervasive pollution so that we can have clean, safe, and affordable water for this generation and those to come.

Please contact the representatives for the lead petitioners listed below for any questions regarding this Petition.



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Exhibit 1



Benefit-Cost Analysis of Alternative Nitrate Drinking Water Standard Limits

September 19, 2026

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Executive Summary

The federal drinking water standard for nitrate, 10 milligrams per liter (mg/L) as nitrogen, rests on a 1962 recommendation aimed at preventing methemoglobinemia (blue baby syndrome) in infants. Research since then has linked nitrate at lower concentrations to colorectal cancer, adverse birth outcomes, and other chronic health effects. The Environmental Law and Policy Center (ELPC) and its partners commissioned One Water Econ to estimate the benefits and costs of lowering the standard to 1, 3, or 5 mg/L.

Approach

We identified the community water systems (CWSs) that recorded at least one nitrate sample at or above each candidate standard between 2021 and 2023, using the Environmental Working Group's Tap Water Database and EPA's Safe Drinking Water Information System. We estimated what each system would pay to comply using EPA's treatment cost models and quantified the health benefits of lower exposure using peer-reviewed dose-response studies and EPA methods for valuing avoided illness and death. Benefits and costs reflect present values over a 50-year analysis period (2027 to 2076) at a 2% discount rate.

For each standard, we analyzed two compliance paths. Under partial treatment, a system treats only enough water to meet the standard and blends the rest or installs point-of-use devices or full treatment where those options cost less (typical for very small systems). Under full treatment, a system treats all of its water and removes nearly all nitrate. Treatment with bypass blending is the central case because it is what a standard requires. EPA cannot require full treatment under a standard set above zero; we include it to show the upper end of potential costs and the additional benefits available if systems go further.

Who is affected

Because compliance with the nitrate standard rests on a single sample, we count a system as being affected if any sample from 2021 to 2023 reached the standard. A 1 mg/L standard would affect 13,205 CWSs serving 119.7 million people, close to one in four systems nationally. A 3 mg/L standard would reach 6,046 systems serving 61.3 million people, and a 5 mg/L standard would reach 3,163 systems serving 37.7 million. Four of five affected systems serve 3,300 people or fewer, mirroring the national mix of systems, but large systems serve most of the affected population. Nitrate occurrence is concentrated geographically: ten states hold 62% of the affected population at 1 mg/L and 86% at 5 mg/L; California alone holds 22% and 48%.

What compliance costs

Under the least-cost compliance path, a 1 mg/L standard would cost $94.5 billion in present value, or $3.0 billion a year, covering treatment plants, point-of-use devices, operations and maintenance, and equipment replacement over 50 years. A 3 mg/L standard would cost $42.4 billion ($1.35 billion a year), and a 5 mg/L standard would cost $22.2 billion ($0.7 billion a year). Ion exchange is the least-cost technology for nearly every system large enough for a central plant, and point-of-use is least expensive for the smallest systems. Requiring reverse osmosis everywhere would triple the national cost. Full treatment costs 38% to 89% more than partial treatment, depending on the standard.

Systems serving 500 or fewer people incur costs of $304 per household per year under a 1 mg/L standard, compared with $53 for systems serving more than 100,000 people. At the same time, the 100 most expensive

systems account for 37% of national cost, so large systems drive the total while small ones bear the heaviest per-household burden.

The value of reduced exposure

We quantified three health effects that have usable dose-response evidence: colorectal cancer, ovarian cancer, and very low birth weight (VLBW), which carries a high risk of infant death. Once treatment is in place and cancer latency has passed, a 1 mg/L standard under partial treatment would avoid approximately 1,900 colorectal cancer cases, 440 ovarian cancer cases, and 2,180 VLBW births each year. Based on EPA's value of a statistical life and the medical cost of illness, those benefits total $364 billion in present value, or $11.6 billion a year. VLBW accounts for $165 billion of that total, colorectal cancer for $159 billion, and ovarian cancer for $40 billion. Avoided deaths account for 92% of that value. Benefits under a 3 mg/L standard are $97 billion and under 5 mg/L $25 billion, because the less strict standards reach fewer systems and leave more nitrate in the water at affected systems. Health effects we could not quantify, including neural tube defects, thyroid disease, and other cancers, would add to these totals.

Comparing benefits and costs

Table ES-1 compares benefits and costs under each standard and compliance path. Quantified benefits exceed costs in every case. In annualized terms (2% over 50 years), partial treatment yields quantified benefits of $11.6 billion a year against costs of $3.0 billion at 1 mg/L, $3.1 billion against $1.35 billion at 3 mg/L, and $0.8 billion against $0.7 billion at 5 mg/L.

Table ES-1. Present value of quantified benefits and costs by standard and compliance path ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Standard and compliance path	Benefits	Costs (least cost)	Net benefits	Benefit-cost ratio
1 mg/L, treatment w/blending	364.1	94.5	269.7	3.9
1 mg/L, full treatment	628.9	130.4	498.5	4.8
3 mg/L, treatment w/blending	96.7	42.4	54.2	2.3
3 mg/L, full treatment	483.9	68.3	415.6	7.1
5 mg/L, treatment w/blending	25.0	22.2	2.8	1.1
5 mg/L, full treatment	361.9	41.9	319.9	8.6

Note: 2026 USD, 2% discount rate, 2027 to 2076. Costs are the least-cost case for each path; benefits credit each system with the exposure reduction of the option it installs. Report Tables 5, 13, and 15 provide additional detail.

Key findings

Quantified benefits exceed costs at every standard. Under partial treatment, net benefits are $270 billion at 1 mg/L, $54 billion at 3 mg/L, and $3 billion at 5 mg/L, with benefit-cost ratios of 3.9, 2.3, and 1.1. The 1 mg/L

result holds under every single assumption we tested, including a 7% discount rate (ratio 2.8), the lower confidence bound of each dose-response estimate (2.5 for colorectal cancer and 2.8 for VLBW), and reverse osmosis costs (1.3). Beyond quantified health benefits, reducing the MCL would also yield significant non-quantified benefits, including additional health-related benefits and reduced exposure to other contaminants that would also occur with adopting some treatment technologies.

Tighter standards return more per dollar, not less. Moving from the current standard to 5 mg/L returns $1.10 in benefits per dollar of cost. Tightening from 5 to 3 mg/L returns $3.50 per dollar, and tightening from 3 to 1 mg/L returns $5.10. Each step returns more than the one before it, so there is no point within the range studied at which the next step stops paying for itself.

How much nitrate is removed matters more than how many systems are covered. Full treatment costs 38% to 89% more than partial treatment but returns $7 to $17 in quantified benefits per added dollar. Full treatment at 5 mg/L produces more net benefits ($320 billion) than partial treatment at 1 mg/L ($270 billion) at less than half the cost. A standard alone does not secure full treatment, because utilities choose how far below a limit to operate, and EPA cannot require full treatment under a standard set above zero.

The benefits sit in the systems with high average concentrations. Systems whose long-run average nitrate exceeds 3 mg/L carry 24% of cost and 70% of benefits. At the other end, 2,927 systems serving 41 million people average 1 mg/L or less. Because at least one sample reached 1 mg/L, these systems would have to treat, but their average exposure is already at the partial treatment target, so they carry 26% of the cost ($24.9 billion) and gain almost no quantified benefit. This result reflects our exposure measure: we estimate all quantified health benefits from long-run average nitrate concentrations. Some effects depend on exposure during shorter windows. Studies have associated VLBW with nitrate in public water averaged over pregnancy at concentrations well below 10 mg/L (Stayner et al., 2017), and spina bifida with maternal nitrate intake from drinking water around conception (Brender et al., 2013). Where nitrate rises above a system's average during those windows, treatment would provide benefits that this analysis does not capture.

Customers of small systems gain less per dollar. Every size class shows net benefits, but systems serving 500 or fewer people return $2.30 per dollar against $3.50 to $4.50 for larger systems, pay the most per household, and in 44% of cases face costs above their benefits. Small system costs have affordability implications. Higher per-household costs in small systems are common to drinking water standards, because small systems spread treatment costs over fewer customers, and the comparison covers quantified benefits only.

The 5 mg/L standard is the weakest case. Treatment to 5 mg/L leaves most exposure in place at the systems it reaches. Its benefit-cost ratio of 1.1, which reflects quantified benefits only, falls below break-even under several assumptions, including a 7% discount rate and the lower confidence bound of either dose-response estimate.

What the results do not include

The analysis covers community water systems only; the nitrate standard also applies to non-community systems, and private wells fall outside any standard. Least-cost treatment is a lower bound on what utilities would actually spend. Costs also reflect treatment only; source water protection, such as reducing fertilizer and manure runoff upstream of wells and intakes, could lower compliance costs for some systems and provide added benefits for aquatic habitat, recreation, and downstream water quality. Benefits do not include an explicit

evaluation of non-quantified health effects, averting costs households already bear, and the removal of other contaminants that ion exchange and reverse osmosis may provide. These omissions mean that the quantified results likely understate the full benefits of a lower standard. The Safe Drinking Water Act directs EPA to weigh quantifiable and nonquantifiable health risk reduction benefits, including reductions in co-occurring contaminants, and to consider whether the benefits of a standard justify its costs (42 U.S.C. 300g-1(b)(3)(C)).

1. Introduction

The Maximum Contaminant Level (MCL) for nitrate in drinking water, 10 milligrams per liter (mg/L) as nitrogen, has remained unchanged since the U.S. Public Health Service first recommended it in 1962. The U.S. Environmental Protection Agency (EPA) adopted that limit in the 1975 National Interim Primary Drinking Water Regulations, under the authority of the Safe Drinking Water Act, and reaffirmed it in the 1991 Phase II rule. The 1962 recommendation was based almost entirely on a retrospective survey of infant methemoglobinemia cases, or blue baby syndrome, reported between 1945 and 1950 (Walton, 1951). Because the survey found no cases at nitrate concentrations below 10 mg/L, that became the federal drinking water standard.

Since 1962, a substantial body of research has linked nitrate exposure to chronic disease at concentrations below the current standard. Ward et al. (2018) reviewed more than 30 epidemiological studies published since 2005 and found the strongest evidence for colorectal cancer, thyroid disease, and neural tube defects, with many studies reporting increased risk at nitrate levels below regulatory limits. Temkin et al. (2019) estimated that nitrate in U.S. drinking water accounts for 2,300 to 12,600 cancer cases each year, with annual costs of $250 million to $1.5 billion in medical expenditures and $1.3 billion to $6.5 billion in lost productivity. Despite the growing evidence, in July 2024, EPA completed its fourth six-year review of existing drinking water standards and concluded that the nitrate and nitrite regulations were “not appropriate for revision at this time,” citing emerging information and data gaps.

The Environmental Law and Policy Center (ELPC) and a consortium of partners (the partners) continue to advocate for a nitrate standard that better protects public health. As part of that effort, the partners commissioned One Water Econ to assess the benefits and costs of lowering the nitrate MCL to 1, 3, and 5 mg/L. This report presents the economic assessment results. It is organized as follows:

- Section 2 provides an overview of the methodology One Water Econ used to conduct the analysis, including the overarching framework, data sources, and key assumptions.
- Section 3 characterizes the water systems that would likely be required to treat for nitrate under each regulatory scenario (1, 3, and 5 mg/L).
- Section 4 estimates the capital and operating costs these systems would incur to comply, by treatment technology and system size.
- Section 5 estimates the quantifiable avoided health outcomes associated with reduced nitrate exposure and assigns monetary value to those outcomes.
- Section 6 compares quantified benefits and costs under each regulatory scenario and tests how the results respond to the assumptions that drive them.
- Section 7 summarizes the key findings.
- Appendix A documents key assumptions and their effect on overall results; Appendix B reports the number of affected CWSs by state under each MCL regulatory scenario.

2. Overview of Methods

This section describes the economic framework, data sources, and key assumptions that One Water Econ used for this analysis. It covers methods and decisions that we applied at a high level across four analytical steps. Detailed methods and assumptions specific to a single analytical step appear in the relevant sections below.

2.1 Purpose and scope

This benefit-cost analysis (BCA) supports advocacy efforts and does not adhere to formal requirements for establishing a federal drinking water standard. Consistent with that purpose, the analysis covers community water systems (CWSs), which serve the same residential population year-round and account for most of the population exposed to nitrate through regulated supplies. The analysis draws on state and federal monitoring data, EPA engineering cost models, peer-reviewed dose-response relationships, and benefit transfer methods to value avoided health outcomes.

2.2 Analytical framework

The analysis proceeds in four steps. Each step is built at the system level and aggregated to the national level, allowing results to be reported by system size, source water type, and geography:

- **Identify and characterize affected systems.** The Environmental Working Group (EWG) drew on its Tap Water Database to identify CWSs that have documented exceedances for each candidate threshold. EWG compiles water testing results that utilities report to state drinking water agencies, supplemented with EPA data. We compiled additional data for each system, including population, design flow, source water type, treatment points, and location.
- **Estimate treatment and compliance costs.** We estimated the capital and operations and maintenance (O&M) costs that affected systems would incur to meet each threshold, using system-specific design flow and measured nitrate concentration, as applicable.
- **Estimate and monetize avoided health outcomes.** We converted the change in nitrate exposure into avoided adverse health outcomes using dose-response relationships from the epidemiological literature. We then assigned a monetary value to those outcomes, reflecting the value of avoided nitrate-exposure-related illnesses and deaths.
- **Compare benefits and costs.** We compared monetized benefits and costs under each scenario over a common analysis period and discount rate and performed sensitivity analysis on key assumptions. We also recognize and describe additional benefits that could not be quantified as part of this analysis.

2.3 Regulatory scenarios

The analysis covers three candidate MCL thresholds: 1, 3, and 5 mg/L as nitrogen. Natural background nitrate in groundwater is generally at or below about 1 mg/L (Nolan and Hitt, 2003), so a standard set below that level would be difficult to achieve in practice. These three scenarios allow the analysis to identify when the quantifiable benefits of a stricter standard exceed its costs, and to measure the incremental benefits and costs of moving from one threshold to the next. Each scenario is compared against a baseline of current conditions, in which affected systems do not implement nitrate treatment.

2.4 Data sources

EWG provided sampling data for CWSs with at least one nitrate sample at or above each MCL scenario, drawn from its Tap Water Database for 2021 through 2023. We joined those records to EPA's Safe Drinking Water Information System (SDWIS) summary file to characterize each system. SDWIS contains system-level information, including population, number of connections, ownership classification, primary source, city and county served, and treatment facility records. We used 2025 SDWIS data to remove inactive systems and non-

community water systems from the EWG database, and to identify wholesale systems with no direct retail customers, so that treatment costs are not counted twice for a wholesaler and the retail systems it supplies.

Treatment costs come from EPA's Work Breakdown Structure (WBS) cost models, a family of engineering models that price a treatment train component by component from a common cost database. We applied four WBS models: anion exchange, reverse osmosis and nanofiltration, biological treatment, and the point-of-use (POU) and point-of-entry (POE) tool. All four share the same cost architecture, so estimates are comparable across technologies. Section 4 describes how we configured and validated each model.

Health effect estimates come from the peer-reviewed epidemiological literature, screened for studies that report a dose-response relationship usable at the concentrations at issue. Baseline population health statistics come from the Centers for Disease Control and Prevention health and disease incidence data, and the demographic shares needed to apply each coefficient to the right population subgroup come from the U.S. Census American Community Survey. Section 5 describes the endpoint selection and the coefficient library.

2.5 Compliance assumptions

A utility meeting a new standard must choose how far below it to operate; that choice drives both compliance costs and the associated health-related benefits. EPA considers nitrate an acute contaminant, so compliance rests on a single sample rather than an annual average (pending a confirmation sample).[1] A system running at exactly the limit would violate the standard on any upward fluctuation, so utilities typically operate with a margin of safety. For this analysis, we analyze benefits and costs under the following treatment scenarios:

- **Treatment with bypass blending.** The system treats only the share of flow needed to deliver drinking water at 80% of the standard, then blends the treated water with the untreated remainder. This delivers 0.8, 2.4, and 4.0 mg/L under the 1, 3, and 5 mg/L scenarios.
- **Full treatment.** The system treats all flow, delivering nitrate at near zero.

Both apply under all three regulatory scenarios. Systems that rely on POU devices treat water at the tap and have no blending option, so they fall under full treatment in every scenario. Within the blending scenarios, a system installs full treatment or POU wherever it costs less than blending, and the benefit calculation credits that system with the full-treatment exposure reduction. Section 4 describes how bypass blending enters the cost models, and Section 5 describes how delivered concentrations enter the health calculation.

Full treatment is not a regulatory requirement under any of the scenarios. Under the Safe Drinking Water Act, EPA sets a maximum contaminant level, and each system chooses how to meet it. A standard set above zero cannot require a system to remove all nitrate, and a system that blends to meet the standard is fully in compliance. We include full treatment to show the upper end of the range of potential compliance costs for each standard, and the added health benefits that would follow if systems chose to go further.

[1] EPA regulates nitrate as an acute contaminant because of its effect on infants. A nitrate MCL violation requires Tier 1 public notice within 24 hours (40 CFR 141.202), and compliance is judged on a single sample, or on the average of the initial sample and a confirmation sample when the first exceeds the MCL (40 CFR 141.23(i)(3)).

2.6 Economic assumptions

Costs and benefits are reported in 2026 U.S. dollars (USD). To estimate present value, we applied a 2% discount rate, consistent with OMB Circular A-4 (2023) and EPA's benefit-cost analysis for PFAS standards in drinking water (EPA 2024). OMB rescinded its 2023 Circular A-4 in March 2025 and reinstated the 2003 Circular, which prescribes 3% and 7%. Section 6 applies those rates to test their effect on overall results.

We analyzed costs and benefits over a 50-year analysis period, accounting for treatment replacement needs at the end of each technology's useful life. The analysis period extends far enough for latent cancer benefits to accrue, and the same period applies to both sides of the comparison.

2.7 Sources of uncertainty

The analysis contains three key sources of uncertainty. First, occurrence data describe finished water, so they do not identify which source within a system is contaminated. Available records often cannot resolve how many locations a system would need to treat. Similarly, because SDWIS does not link wholesale suppliers to the systems they serve, we assigned treatment to retail systems, which likely overstates costs where one wholesale supplier could treat for several systems. Second, the epidemiological evidence has wide confidence intervals, and several health endpoints lack the dose-response relationship needed to distinguish one candidate threshold from another, so we describe them qualitatively. Third, treatment technology choice is a utility decision that no model can predict. We therefore report central estimates with ranges, clearly state the assumption behind each estimate, and describe the effect of uncertainty in Section 6.

2.8 What this analysis does not cover

This report estimates the treatment costs for CWSs to reduce nitrate in drinking water to below specific thresholds, assuming treatment occurs at the water systems' treatment plants or wellhead locations. It compares these estimates with quantifiable public health benefits from reduced nitrate exposure. This report does not cover alternative compliance approaches, including source water protection (SWP) strategies that can effectively reduce or prevent nitrate contamination upstream. SWP strategies are often less expensive than engineered treatment systems and, in some cases, can provide additional co-benefits, such as improved instream habitat and higher-quality recreational opportunities (Clements et al. forthcoming). This report also recognizes, but does not explicitly weigh, non-quantifiable benefits associated with nitrate reductions. These benefits are described in Section 6.

3. Potentially Affected Water Systems

This section characterizes the CWSs that would likely need to add treatment to comply with the MCL regulatory scenarios.

3.1 Affected CWS and population served

Between 2021 and 2023, 13,205 CWSs recorded at least one nitrate sample at or above 1 mg/L. Collectively, these systems serve 119.7 million people. At 3 mg/L the count falls to 6,046 systems serving 61.3 million people, and at 5 mg/L to 3,163 systems serving 37.7 million people. The U.S. has nearly 50,000 community water systems; under a 1 mg/L standard, one in four would be affected.

Table 1 shows affected systems by system size under each regulatory scenario. Systems serving 3,300 or fewer people account for close to 80% of affected systems across all three MCL thresholds. Note that affected systems include systems with a single exceedance, so they may capture some systems whose confirmation sample would fall below the applicable threshold.

Table 1. Community water systems with at least one nitrate exceedance, by system size

	Number of systems			Percentage of affected systems		
Population category	≥1 mg/L	≥3 mg/L	≥5 mg/L	≥1 mg/L	≥3 mg/L	≥5 mg/L
<100	3,256	1,447	709	24.7%	23.9%	22.4%
101 - 500	4,154	1,919	1,045	31.5%	31.7%	33.0%
501 - 1,000	1,226	580	311	9.3%	9.6%	9.8%
1,001 - 3,300	1,868	851	450	14.1%	14.1%	14.2%
3,301 - 10,000	1,180	503	262	8.9%	8.3%	8.3%
10,001 - 50,000	1,094	512	245	8.3%	8.5%	7.7%
50,001 - 100,000	221	115	62	1.7%	1.9%	2.0%
100,001 - 250,000	138	87	62	1.0%	1.4%	2.0%
250,001 - 500,000	38	19	8	0.3%	0.3%	0.3%
> 500,000	30	13	9	0.2%	0.2%	0.3%
Total	**13,205**	**6,046**	**3,163**	**100%**	**100%**	**100%**

Source: EWG Tap Water Database (2021 – 2023) and EPA SDWIS data (2025)

Note: An additional 16 wholesale systems exceeded 1 mg/L (seven at 3 mg/L and six at 5 mg/L) but are excluded because they have no directly served population. Their customers are counted through the retail systems they supply.

As shown in Table 2, large systems serve most of the affected population. Systems serving 3,300 or fewer people account for close to 80% of affected systems but serve less than 5% of the affected population. Systems serving more than 100,000 people are 1.6% of affected systems and serve 56.0% of the affected population under the 1 mg/L scenario. This increases to 65.5% under the 5 mg/L scenario. This distribution closely tracks the national distribution of water systems. Approximately 81% of all CWSs serve 3,300 or fewer people, so nitrate exceedances do not appear to be concentrated in small systems relative to the sector overall.

Table 2. Population served by affected community water systems, by system size (millions of people)

Population category	Population served (M)			Percentage of affected population		
	≥1 mg/L	≥3 mg/L	≥5 mg/L	≥1 mg/L	≥3 mg/L	≥5 mg/L
<100	0.20	0.09	0.05	0.2%	0.1%	0.1%
101 - 500	1.03	0.47	0.26	0.9%	0.8%	0.7%
501 - 1,000	0.90	0.43	0.23	0.8%	0.7%	0.6%
1,001 - 3,300	3.54	1.58	0.83	3.0%	2.6%	2.2%
3,301 - 10,000	7.02	3.01	1.60	5.9%	4.9%	4.3%
10,001 - 50,000	24.79	12.01	5.88	20.7%	19.6%	15.6%
50,001 - 100,000	15.13	8.03	4.16	12.6%	13.1%	11.0%
100,001 - 250,000	21.22	13.30	9.90	17.7%	21.7%	26.3%
250,001 - 500,000	13.01	6.44	2.57	10.9%	10.5%	6.8%
> 500,000	32.85	15.94	12.20	27.4%	26.0%	32.4%
Total	**119.69**	**61.32**	**37.69**	**100%**	**100%**	**100%**

Source: EWG Tap Water Database (2021 – 2023) and EPA SDWIS data (2025)

Of the 13,205 affected systems, 597 (4.5%) recorded at least one sample at or above the current MCL of 10 mg/L between 2021 and 2023. These systems serve 2.9 million people, or 2.4% of the affected population. Most are very small (62% serve 500 people or fewer), and a third (200) are in California. Some have likely responded since their first exceedance: 39 systems serving 208,000 people stayed below 5 mg/L in every later year sampled, which suggests new treatment, blending, or a change in source. Another 19 recorded a single high year between two years below 5 mg/L, which is more consistent with an isolated sample than an ongoing problem. We retain all 597 systems in the analysis. They account for 3.8% of national cost and 12.6% of national benefits under a 1 mg/L standard; the 58 systems that appear to have treated or had a single isolated exceedance account for about 1% of each.

3.2 Geographic distribution

Nitrate occurrence is geographically concentrated, and it becomes more concentrated as the standard tightens. Ten states account for 62% of the affected population under the 1 mg/L scenario and 86% under the 5 mg/L scenario. California alone accounts for 22% of the affected population at 1 mg/L and 48% at 5 mg/L (Table 3).

Figures 1 and 2 show the share of each state's population served by affected systems under the 1 and 5 mg/L scenarios, respectively. Under the 1 mg/L scenario, 15 states have at least half their population served by a system with a nitrate exceedance. Under the 5 mg/L scenario, only four states exceed 25%: Arizona, California, Delaware, and Nevada. Every state except New Hampshire has at least one affected system under the 1 mg/L scenario.

Table 3. States with the largest affected populations

State	Affected systems		Population served (M)		% of state population		Share retained from 1 to 5 mg/L[a]
	≥1 mg/L	≥5 mg/L	≥1 mg/L	≥5 mg/L	≥1 mg/L	≥5 mg/L	
California	1,411	616	26.6	18.0	67.4%	45.7%	68%
Texas	809	158	10.0	0.3	32.0%	0.8%	3%
Arizona	463	143	6.5	5.4	86.0%	71.5%	83%
Pennsylvania	853	232	6.4	2.1	49.2%	16.0%	33%
Ohio	224	22	6.1	1.5	50.9%	12.5%	25%
New Jersey	249	46	5.1	0.5	53.4%	5.6%	11%
Washington	967	176	4.4	0.4	54.7%	5.3%	10%
Maryland	154	51	4.3	0.2	67.9%	3.8%	6%
Indiana	161	30	2.9	0.5	41.3%	6.5%	16%
Missouri	121	11	2.5	0.0	40.3%	0.8%	2%
Nevada	85	22	2.3	2.1	68.9%	64.1%	93%
Iowa	279	78	1.5	0.8	45.5%	24.4%	54%

a. Share retained at 5 mg/L is the population served by affected systems under the 5 mg/L scenario divided by the population served under the 1 mg/L scenario. Nevada and Iowa are shown because of their exceedance severity rather than their total affected population.

3.3 Severity of exceedance

Counts of affected systems understate how differently the scenarios play out across states, because states differ in how far above each threshold their exceedances sit. Two patterns appear in the data.

- In some states, nitrate concentrations sit well above the thresholds. In Nevada, 93% of the population affected at 1 mg/L remains affected at 5 mg/L; the same is true for 83% of Arizona's affected population, 68% in California, 62% in Delaware, and 54% in Iowa.
- In others, exceedances cluster just above 1 mg/L. Texas serves 10.0 million people through affected systems under the 1 mg/L scenario but only 259,831 under the 5 mg/L scenario, so only 3% of the population affected at 1 mg/L remains affected at 5 mg/L. Missouri, Kentucky, and Louisiana show the same pattern.

This difference carries directly into the cost and benefit estimates. Where exceedances cluster just above the threshold, a system treats only a small share of its flow to comply, so compliance costs relatively little and the reduction in exposure is correspondingly small. Where concentrations sit well above the threshold, both the costs and the health benefits are large.

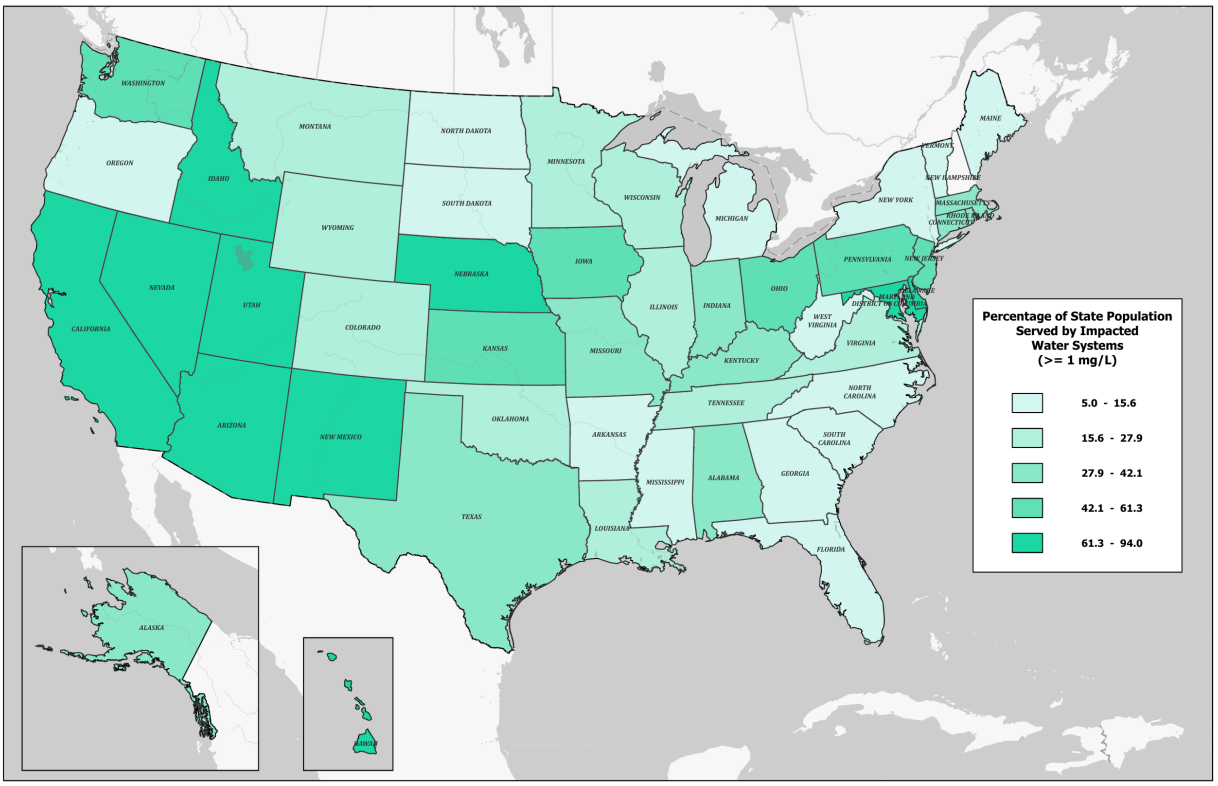


Figure 1. Percentage of state population served by affected water systems, 1 mg/L scenario

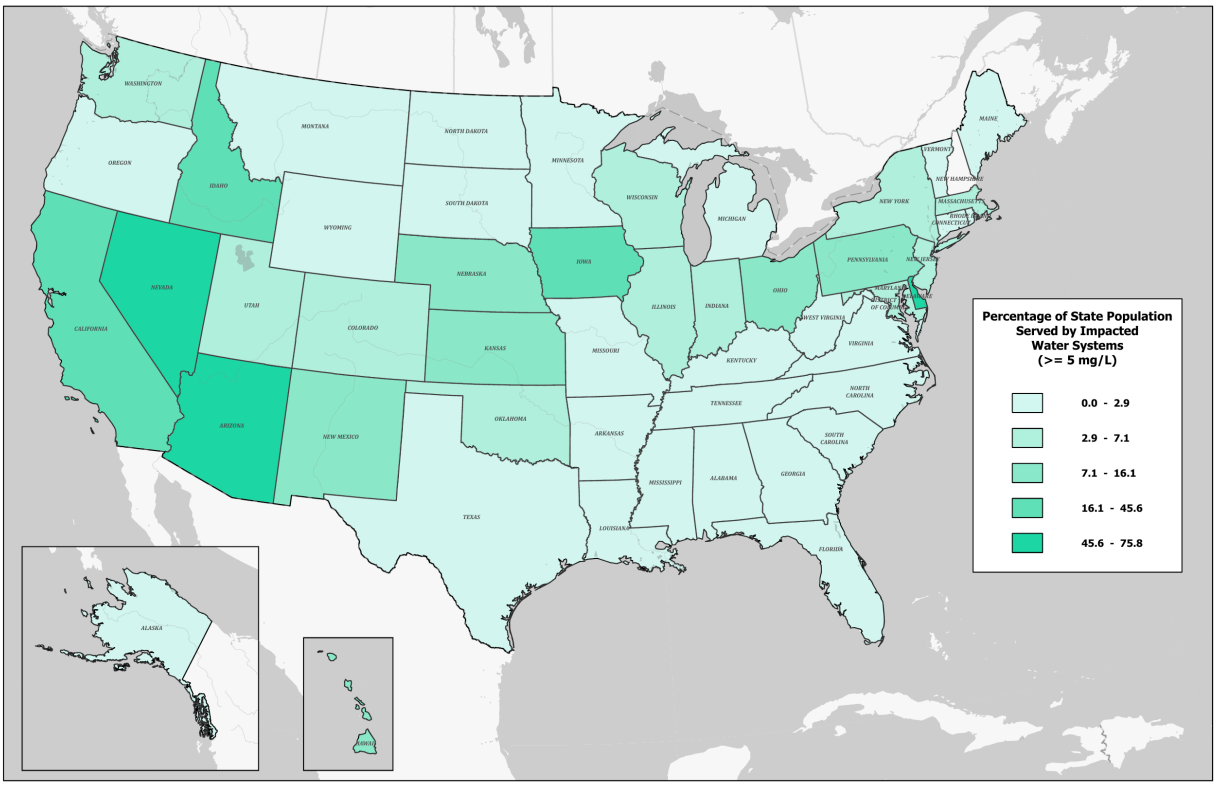


Figure 2. Percentage of state population served by affected water systems, 5 mg/L scenario

4. Treatment costs

This section describes the methods used to estimate compliance costs across different treatment technologies and presents results by system size. All costs are reported in 2026 USD.

4.1 Overview

The project team estimated compliance costs across four treatment technologies using EPA's WBS cost models. We estimated capital and O&M costs for each system, applying relevant models based on system design flow, population served, nitrate concentrations, and other factors, as applicable. Table 4 summarizes each treatment technology, including the system size range, useful life of the installed equipment, cost drivers, key advantages, and practical limitations.

Table 4. Treatment technologies evaluated

Technology	Best fit by size (per EPA cost models)	Useful life (per EPA cost models)	Cost drivers	Advantages	Limitations
Ion exchange (IX)	0.02 to 75 MGD design flow per treatment point (~200 people+)	16 years below 1 MGD; 31 years above	Treated flow; resin bed life, which sets salt use and brine volume	Mature technology; EPA best available technology for nitrate; often lowest cost.	Brine disposal; sulfate competes with nitrate for resin sites
Reverse osmosis (RO)	0.0224 MGD treated flow and up	23 years below 1 MGD; 32 years above	Treated flow; feed-water quality (dissolved solids, scaling potential)	Removes many contaminants; very low effluent nitrate	Highest cost of the central options; concentrate disposal; energy use
Biological denitrification (BD)	> 0.010 MGD treated flow	17 to 20 years below 1 MGD; 29 to 32 years above	Treated flow; carbon source dose	No concentrated brine; low chemical input	Few U.S. installations; requires skilled operators and post-treatment
Point of use (POU)	Any size; priced per household	10 years	Number of households; device maintenance and program administration	Cheapest for single homes; no central plant	Treats one tap per home; requires customer outreach; state acceptance varies

Note: MGD = million gallons per day. Each WBS model calculates useful life from its component lives; Section 4.3.6 provides additional detail.

For all systems, we evaluated full treatment and treatment with bypass blending. Bypass blending applies to all technologies except for POU. Treated water leaves an IX, RO, or BD plant with near-zero nitrate, so a system can treat only part of its flow and blend it with untreated water to reach a target concentration. Blending happens around the treatment train on a single source, so it does not require a second supply. It reduces both the treatment facility size and the annual volume treated, which lowers capital and O&M. POU devices treat water at the tap and have no blending option.

4.2 Cost Modeling Approach

The four WBS models share one cost database and price treatment-train components by component, so estimates are comparable across technologies. EPA designed the models as interactive spreadsheets that price one design at a time. We automated each model to run outside Excel, validated the automated version before use, and applied it either system by system or through a table of model runs and cost curves based on source water, water quality, design flow, or household counts. The following sections overview our cost modeling approach for each technology.

4.2.1 Ion exchange

We configured the anion exchange model for nitrate-selective resin and ran it once for every unique combination of design flow and bypass share in the affected-system data, a total of 20,117 runs. EPA's WBS model returns no valid design for systems with treatment facilities with less than 0.02 MGD of design flow. This flow level serves approximately 200 people.

Resin bed life drives IX O&M. It measures how much water the resin treats between regenerations, in bed volumes, meaning gallons treated per gallon of resin, and each regeneration consumes salt and produces brine for disposal. We apply 420 bed volumes, the value EPA specifies for its nitrate standard designs, based on Clifford and Liu (1993).

4.2.2 Reverse osmosis

The RO model does not require nitrate contamination level as an input. It sizes and prices the membrane system based on feed-water profiles that specify source, dissolved solids, temperature, pH, and scaling potential. We ran 394 cost estimates across various system design flows and under four profiles: high- and low-quality groundwater, and high- and low-quality surface water. The high-quality profiles represent a low-cost case with low-pressure membranes, higher flux, a basic antiscalant, and low-cost components, while the low-quality profiles represent a high-cost case. Groundwater systems use the groundwater profiles embedded in the model; surface water systems and groundwater systems "under the direct influence of surface water" use the surface water profiles.

The 394 model runs allowed us to develop treatment cost curves based on source water type, design flow, average flow, and bypass percentage. We used the curves to assign each system an RO treatment cost. The model returns no valid design below 0.0224 MGD. The RO model settings follow EPA's RO standard designs, with one change. High-quality surface water uses low-pressure RO rather than nanofiltration, which removes monovalent ions such as nitrate poorly. EPA made the same change in its PFAS analysis.

4.2.3 Biological denitrification

We configured the biological treatment model for nitrate with a fixed-bed bioreactor, acetic acid as the carbon source, a 10-minute empty bed contact time, phosphoric acid as a nutrient, and post-treatment by aeration and filtration. EPA's model offers pressure-vessel and gravity-basin fixed-bed designs but no rule for choosing between them, so we priced both and assigned each system the less expensive design. Pressure vessels are the least expensive for 93% of systems under full treatment, while gravity basins apply mainly at the small end, where they significantly reduce capital costs. The model produces valid designs down to 0.010 MGD of treated flow.

4.2.4 Point of use

We configured the POU/POE tool for under-sink RO without ultraviolet disinfection. We ran the model at 17 household counts, from one household to 1.5 million, and assigned each system a cost per household by log-log interpolation on its household count. Households equal SDWIS population divided by 2.53 persons, the model default. Cost per household falls about tenfold across that range, because larger programs spread monitoring, administration, and certification across more homes.

POU carries a regulatory caveat specific to nitrate. EPA's 1998 list of small-system compliance technologies classified POU for nitrate as an emerging technology, pending requirements for a public education program (U.S. EPA, 1998). EPA's later guidance permits POU for nitrate but warns that households must not use untreated taps for infant formula, and that outreach costs may offset the savings from POU (U.S. EPA, 2006).

4.3 Global Cost Assumptions

4.3.1 Treatment points

The number of treatment points at which a CWS must install treatment significantly affects overall costs. Affected systems range from having a single source to dozens of sources feeding several treatment facilities. A system that combines its sources into one line before treatment builds one plant. A system that treats at each wellhead or has multiple sources with elevated nitrates must build multiple treatment plants, and several small plants cost far more than one plant of the same total capacity.

The sampling data from EWG's Tap Water Database does not report contamination by source or treatment facility. To estimate the number of treatment points for each CWS, we relied on SDWIS facility data, which includes system-level information on wells, wellheads, intakes, treatment plants, and the common headers and manifolds that join sources into one line. Where a system reports treatment plant facilities or wellheads (indicating a treatment facility at a well), we counted those. Where it reports none, we counted its sources and then reduced that count wherever the records showed sources already joined. Common connections, manifolds, and similar intertie facilities carry several sources into one line, so we read those records together with the facility descriptor fields to estimate how many sources already share piping.

This analysis assumes that nitrate treatment would happen at systems that directly serve households, so we removed wholesale water suppliers impacted by nitrate contamination (where SDWIS population served equals zero). Systems that report no sources but receive water from another supplier therefore incur treatment costs. SDWIS facilities data do not provide information to match wholesale suppliers to retail water providers. Significant

cost savings could accrue if wholesale suppliers treated nitrate-contaminated water prior to distribution. However, data limitations required us to assume treatment at retail water suppliers rather than aggregating treatment at wholesale systems.

Each treatment point receives its own plant, sized to each system's design flow divided by the number of treatment points. This results in 32,747 treatment points across the 13,205 affected systems, with a mean of 2.5 per system and a median of one. Just over half of systems (55.6%) need a single plant, and 3.1% need 10 or more.

4.3.2 How nitrate concentration affects cost

The maximum nitrate sample sets the size of the treatment facility at each treatment point, which directly drives capital costs. As described previously, EPA considers nitrate an acute contaminant, with compliance based on a single sample (along with a confirmation sample), so a plant must handle the worst concentration observed from 2021 through 2023. The bypass share equals 0.8 × standard ÷ maximum concentration, which fixes the treated design flow and therefore capital cost.

Average flow, derived from the WBS cost model design flow, and average nitrate contamination across available samples determine O&M for each system. Nitrate levels can spike seasonally (e.g., in response to agricultural irrigation/fertilization patterns), but available data do not allow for more nuance in treatment timing. We do not reduce O&M to reflect treatment only during the share of the year a system exceeds the standard. EPA also does not adjust for seasonality in its own costing models; this likely overstates O&M costs to some degree where systems have the flexibility to adjust treatment.

4.3.3 Design and average flow

Design flow equals SDWIS population × 150 gallons per person per day × a peaking factor of 1.5. Average flow follows EPA's standard designs, in which average flow ranges from 25% of design flow for very small systems to 50% for large systems (U.S. EPA, 2022). We apply one equation fitted to EPA's eight standard designs, with an R^2 of 0.990, in all three central technology models, so the technologies compete on the same volume of water.

4.3.4 Technology cases and the cost range

No single technology suits every system, and utilities choose treatment on grounds a cost model does not necessarily capture, including residuals disposal, operator capability, co-occurring contaminants, and state policy. We therefore report four national estimates for each treatment scenario:

- **Least cost.** Each system receives its least-cost option, or for very small systems, POU is assumed. This case is the low end of the range and a lower bound on compliance cost.
- **Ion exchange.** Every system uses IX where the model produces a valid design, and POU below its size floor. IX is EPA's best available technology for nitrate and the most common choice in practice.
- **Biological denitrification.** Every system uses BD where valid, and POU below its floor, at low and high component cost.
- **Reverse osmosis.** Every system uses RO where valid, and POU below its floor, for high- and low-quality feed water. This case is the high end of the range on treatment costs.

In the least-cost case, full treatment competes with blending for each system, and a system takes full treatment whenever it costs less. At 1 mg/L, 6,354 systems take full treatment: 6,251 through POU and 103 through central ion exchange, where the cost curve is flat at small flows or a high maximum sample leaves almost nothing to bypass. Section 5 credits each system with the exposure reduction of the approach it installs.

4.3.5 Dollar year and index

The WBS models report costs in 2021 USD, except the POU tool, which reports 2020 USD. We updated both capital and O&M costs to 2026 USD using the U.S. Bureau of Labor Statistics producer price index for inputs to construction industries (series WPUIP2300001).

4.3.6 Useful life

Each WBS model calculates useful life as a weighted average of its component lives. Small plants rely more on short-lived equipment such as instrumentation, controls, and media, so their useful lives are shorter. We apply the life each model calculates for each system rather than a single figure per technology. Median lives run 16 years for IX and 17 to 20 years for BD below 1 MGD, rising to 31 and 29 to 32 years above 1 MGD; the BD range spans its low and high component cost estimates. RO takes the two lives EPA assigns by plant size, 23 years below 1 MGD and 32 years above. POU devices last 10 years.

4.3.7 Timing of costs

The analysis assumes a rule takes effect in 2027 with a five-year compliance period. Systems incur capital cost at the end of the compliance period and again at the end of each useful life that falls inside the analysis period. O&M begins at the end of the compliance period and continues each year thereafter. We discount at 2% over a 50-year analysis period and test 3% and 7% in Section 6. Assets rarely reach the end of the analysis period fully depreciated, so we credit the undepreciated share of the last asset installed at year 50.

4.3.8 Systems outside model range

Each central model has a minimum plant size: 0.02 MGD of design flow per treatment point for IX, 0.010 MGD of treated flow for BD, and 0.0224 MGD of treated flow for RO. Systems below the floor receive POU costs in that technology's total. Under full treatment, this group covers 3,433 systems serving 270,854 people for IX, 1,190 systems serving 60,636 people for BD, and 3,817 systems serving 317,112 people for RO. The floor applies to treated flow, so blending moves additional systems below it, and those systems also receive POU costs.

Thirteen systems exceed 75 MGD per treatment point, EPA's largest standard design. The models still produce designs for them, but outside EPA's published range.

4.4 Results

This section presents cost estimates across compliance scenarios, technologies, system size, and location.

4.4.1 National costs

Table 5 shows national compliance cost estimates by regulatory scenario, compliance method (i.e., full treatment or partial treatment with bypass flow), and technology. At 1 mg/L under partial treatment, the least-cost total is $94.5 billion in present value, including capital costs, O&M, and replacement costs over the 50-year analysis period. Ion exchange costs 1% more than the least-cost total, biological denitrification 83% more, and reverse osmosis close to three times more. For systems with smaller flows than are appropriate for EPA's cost models, the estimates assume POU treatment devices are installed. Across IX, BD, and RO scenarios, POU accounts for 0.6% (BD) to 1.6% (IX) of total present value costs.

Table 5. National compliance cost by regulatory scenario, compliance method, and technology case ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Scenario and compliance method	Least cost	Ion exchange	Biological denitrification	Reverse osmosis
1 mg/L, w/blending	94.5	95.4	172.6	285.8
1 mg/L, full	130.4	131.7	220.3	361.3
3 mg/L, w/blending	42.4	42.8	80.5	132.6
3 mg/L, full	68.3	68.9	118.0	192.4
5 mg/L, w/blending	22.2	22.3	43.1	71.4
5 mg/L, full	41.9	42.3	72.0	117.6

Note: Biological denitrification and reverse osmosis are reported at the midpoint of their low and high component cost estimates. Each case covers all affected systems, with point-of-use cost assigned wherever a technology has no valid design. POU has no blending option.

Tightening the standard does not increase costs linearly. A 5 mg/L standard costs $22.2 billion in present value under the least-cost scenario. Moving from 5 to 3 mg/L adds $20.3 billion, and moving from 3 to 1 mg/L adds an additional $52.0 billion. Two factors drive the difference. Each step pulls in newly affected systems: 2,883 from 5 to 3 mg/L and 7,159 from 3 to 1 mg/L, which accounts for 64% and 70% of the two increments. The rest comes from systems affected at less strict standards, which must treat a larger share of their flow as the standard ratchets down: for the 3,163 systems that exceed all three standards, the median share treated rises from 45% at 5 mg/L to 67% at 3 mg/L and 89% at 1 mg/L. Full treatment costs 38% more than partial treatment at 1 mg/L, 61% more at 3 mg/L, and 89% more at 5 mg/L (Table 5). The gap widens at the less strict standards because blending leaves more flow untreated. Partial treatment is the central case throughout.

4.4.2 Cost by system size

Table 6 shows average costs by system size for the least-cost compliance option under the 1 mg/L and 5 mg/L regulatory scenarios. As shown, average initial capital costs for the 1 mg/L MCL runs from $66,934 for systems serving 500 or fewer people to $28.0 million for systems serving more than 100,000. Average present value per system spans a wider range, from $626,124 to $212.9 million.

Table 6. Average cost per system by size, least-cost case, partial treatment, 1 and 5 mg/L (2026 USD)

Standard (mg/L)	Population served	Systems	Average initial capital	Average annual O&M	Average 50-year present value	Average annualized cost
1 mg/L	500 or fewer	7,410	$66,934	$17,368	$626,124	$19,925
	501 to 3,300	3,094	$416,871	$58,107	$2,384,093	$75,869
	3,301 to 10,000	1,180	$933,767	$163,942	$6,109,200	$194,414
	10,001 to 50,000	1,094	$2,772,067	$528,267	$18,466,059	$587,649
	50,001 to 100,000	221	$7,801,147	$1,491,305	$50,630,205	$1,611,216
	>100,000	206	$28,000,858	$6,671,410	$212,905,888	$6,775,349
5 mg/L	500 or fewer	1,754	$75,102	$17,485	$645,420	$20,539
	501 to 3,300	761	$431,050	$51,324	$2,239,547	$71,270
	3,301 to 10,000	262	$990,261	$144,490	$5,771,297	$183,661
	10,001 to 50,000	245	$2,486,375	$445,770	$16,444,539	$523,318
	50,001 to 100,000	62	$5,633,360	$1,135,658	$39,770,676	$1,265,631
	>100,000	79	$20,168,139	$4,270,360	$143,226,749	$4,557,935

Note: Initial capital and annual O&M are first-build figures, undiscounted. Present value covers capital replacement, the residual value credit, and all 45 years of O&M. System counts fall as the standard loosens because fewer systems exceed it.

Tightening the standard raises the average cost of a large system a great deal and the average cost of a small system hardly at all. Average present value for systems above 100,000 people rises 49%, from $143.2 million at 5 mg/L to $212.9 million at 1 mg/L. For systems serving 500 or fewer people the same tightening moves average cost from $645,420 to $626,124, which is a slight decline rather than an increase. This is because small systems are using POU or treating to the minimum flow for other technologies, so a tighter standard does not make their treatment facilities much bigger. What changes is the mix: at 5 mg/L only the worst-affected small systems are in scope, and at 1 mg/L the group grows to 7,410 systems that are on average slightly cheaper to serve. Large systems have significant flow to treat, so the standard directly affects their costs.

Table 7 shows the same results on a per-household basis and adds the single-technology cases. Economies of scale dominate. Least-cost expenditures fall from $304 per household a year in the smallest class to $53 in the largest.

Table 7. Average annualized cost per household by system size, standard, and technology case, partial treatment ($ per household per year, 2026 USD)

Standard (mg/L)	Population served	Systems	Least cost	Ion exchange	Biological denitrification	Reverse osmosis	Point of use
1 mg/L	500 or fewer	7,410	304	346	1,294	1,473	333
	501 to 3,300	3,094	134	136	351	576	291
	3,301 to 10,000	1,180	83	83	169	292	288
	10,001 to 50,000	1,094	66	66	116	204	287
	50,001 to 100,000	221	60	60	100	174	286
	>100,000	206	53	53	80	143	286
5 mg/L	500 or fewer	1,754	296	313	1,110	1,218	330
	501 to 3,300	761	129	131	375	562	292
	3,301 to 10,000	262	76	76	176	305	288
	10,001 to 50,000	245	55	55	112	193	287
	50,001 to 100,000	62	48	48	84	152	286
	>100,000	79	37	37	61	110	286

Note: Each central technology covers only the systems in that class for which its model produces a valid design, so the columns are not drawn from the same system set. Coverage is nearly complete above 3,300 people and thins sharply below it. In the smallest class at 1 mg/L, IX serves 3,690 of the 7,410 systems, BD serves 4,700, and RO serves 2,188. Least cost and POU cover every system.

POU behaves differently from every other technology. Its cost per household is nearly flat, between $286 and $333 across every size class and standard, because a POU program buys and maintains one device per home no matter how many homes there are or how strict the standard is. Central treatment costs fall steeply with scale.

Technology choice affects what households pay far more than the standard's stringency. Under least cost, the average annual cost per household in the smallest systems is $296 at 5 mg/L and $304 at 1 mg/L. In the largest systems, it is $37 and $53. By contrast, if the largest systems installed reverse osmosis instead of ion exchange at 1 mg/L, the average would rise from $53 to $143 per household.

4.4.3 Where the cost falls

National costs are driven by a small number of large systems (Table 8). At 1 mg/L, the 100 most expensive systems (0.76% of the affected universe) account for 36.7% of expenditures under the least-cost scenario. The 1,000 most expensive (7.6% of affected systems) account for 74.0%. Those same systems serve 42.5% and 82.2% of the affected population, so cost is in fact slightly less concentrated than people are. Expenditure per person is therefore higher in small systems, while large ones drive the national total.

Table 8. Concentration of national cost, least-cost case

Standard (mg/L)	Systems ranked by cost	Share of systems	Share of national cost	Share of affected population
1 mg/L	Top 10	0.1%	12.4%	14.4%
	Top 50	0.4%	27.5%	32.7%
	Top 100	0.8%	36.7%	42.5%
	Top 500	3.8%	62.3%	70.1%
	Top 1,000	7.6%	74.0%	82.2%
	Top 2,000	15.1%	84.3%	91.8%
5 mg/L	Top 10	0.3%	22.7%	33.6%
	Top 50	1.6%	44.2%	55.4%
	Top 100	3.2%	56.7%	68.2%
	Top 500	15.8%	84.7%	93.9%
	Top 1,000	31.6%	92.2%	98.0%
	Top 2,000	63.2%	97.7%	99.7%

Note: The affected universe is 13,205 systems at 1 mg/L and 3,163 at 5 mg/L, so the same rank covers a much larger share of systems at 5 mg/L.

Concentration rises as the standard becomes less strict. At 5 mg/L only 3,163 systems are affected, and the 100 most expensive carry 56.7% of the total. A 5 mg/L standard therefore targets large systems almost entirely, while a 1 mg/L standard reaches deep into the small-system population.

Cost also concentrates geographically, and it concentrates further as the standard becomes less strict (Table 9). At 1 mg/L, EPA Region 9 carries 34.6% of national compliance cost, more than three times any other region, and California alone accounts for 25.4%. At 5 mg/L, Region 9 carries 62.0%. Only the most severely affected systems remain in scope at 5 mg/L, and they are located overwhelmingly in the Southwest.

Table 9. Compliance cost by EPA region, least-cost case, partial treatment (2026 dollars)

Standard (mg/L)	EPA region	States with affected systems	Systems (#)	Population served	Present value ($ billion)	Share of national cost
1 mg/L	1	CT, MA, ME, RI, VT	605	4,172,296	3.43	3.6%
	2	NJ, NY	964	7,532,125	6.23	6.6%
	3	DC, DE, MD, PA, VA, WV	1,399	14,593,049	10.40	11.0%
	4	AL, FL, GA, KY, MS, NC, SC, TN	1,787	10,382,435	7.69	8.1%
	5	IL, IN, MI, MN, OH, WI	1,410	14,573,158	9.84	10.4%
	6	AR, LA, NM, OK, TX	1,381	14,031,149	9.45	10.0%
	7	IA, KS, MO, NE	1,166	7,211,930	5.34	5.7%
	8	CO, MT, ND, SD, UT, WY	755	4,021,228	3.27	3.5%
	9	AZ, CA, HI, NV	1,994	36,591,599	32.65	34.6%
	10	AK, ID, OR, WA	1,744	6,581,217	6.17	6.5%
5 mg/L	1	CT, MA, ME, RI, VT	66	382,605	0.28	1.3%
	2	NJ, NY	162	1,274,069	1.10	4.9%
	3	DE, MD, PA, VA, WV	386	2,970,570	1.59	7.2%
	4	AL, FL, GA, KY, MS, NC, SC, TN	197	553,330	0.54	2.4%
	5	IL, IN, MI, MN, OH, WI	308	3,267,434	1.79	8.1%
	6	AR, LA, NM, OK, TX	319	720,992	0.67	3.0%
	7	IA, KS, MO, NE	491	1,417,693	1.36	6.2%
	8	CO, MT, SD, UT, WY	136	378,433	0.34	1.5%
	9	AZ, CA, HI, NV	784	25,757,111	13.74	62.0%
	10	AK, ID, OR, WA	314	970,363	0.74	3.3%

Note: The states column lists only states with affected systems, so it is not the full regional roster. New Hampshire has no affected systems at any standard. The District of Columbia drops out of Region 3 and North Dakota out of Region 8 at 5 mg/L. State is assigned from the PWSID prefix.

Figure 3 brings the size and technology results together. Panel (a) plots every affected system by population served and annualized cost per household under least cost, colored by the technology that wins. Panel (b) traces

the median cost per household for each technology across the same range, drawn only where that technology's model produces a valid design.

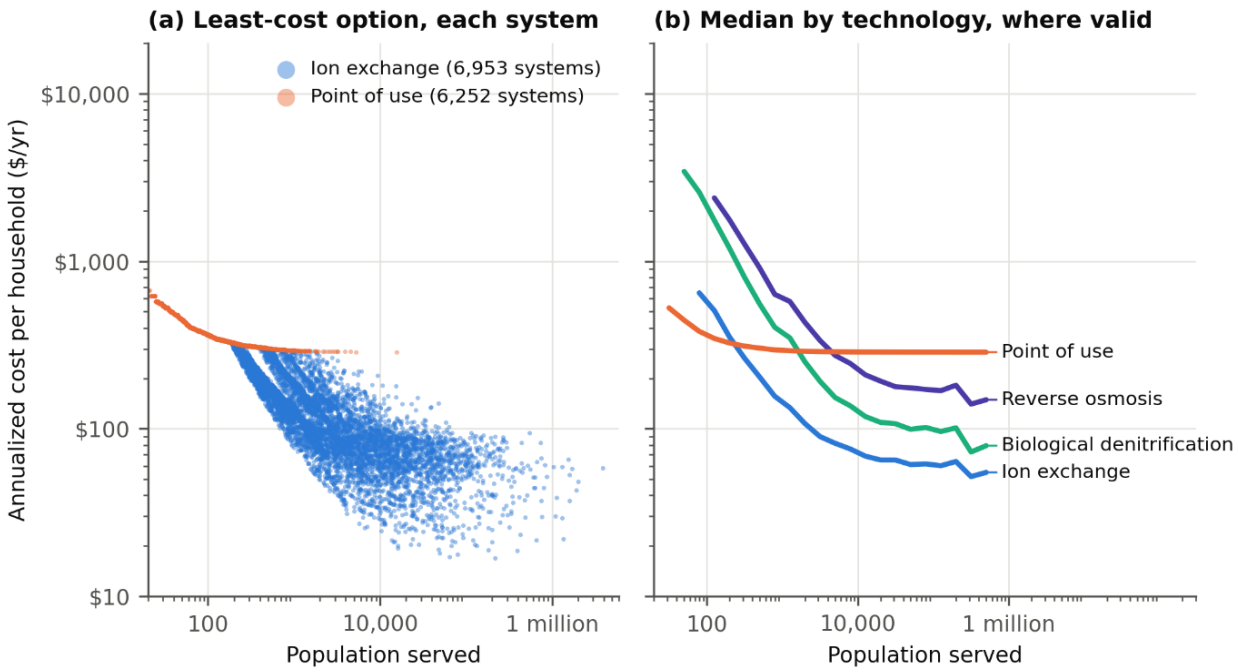


Figure 3. Annualized cost per household by population served, 1 mg/L partial treatment (2026 dollars)
Note: Both axes are logarithmic. Panel (b) plots the median within population bins of 0.2 log units, showing a bin only where it holds at least 15 systems. Biological denitrification and reverse osmosis are at the midpoint of low and high component cost.

Three features stand out. Every central technology falls steeply with scale, so cost per household drops by an order of magnitude between the smallest and largest systems. Each central line begins at a different population, which is where its model first produces a valid design; reverse osmosis starts latest. POU runs nearly flat nearly $290 per household, and it crosses below ion exchange at a few hundred people, which is exactly where panel (a) shows the winning technology switch from blue to orange.

4.5 Limitations

Key limitations for the cost analysis are as follows:

- **Least cost understates actual cost.** Utilities weigh residuals disposal, operator skill, co-occurring contaminants, and state policy, so they sometimes choose a more expensive option.
- **Point of use may not be a realistic path at scale.** POU wins for 6,251 systems in the least-cost case. Those systems are very small and account for 4.3% of national cost, but a POU program requires sustained customer outreach and state acceptance, and EPA's own guidance is cautious about nitrate.
- **No throughput adjustment.** Holding O&M at the model's full average flow may overstate cost for systems that exceed the standard only seasonally.

5. Avoided Health Outcomes

This section quantifies the avoided adverse health outcomes under each regulatory scenario and assigns monetary values to those cases using cost-of-illness and mortality-related valuation methods.

5.1 Overview

The project team quantified and monetized avoided cases for three health endpoints: colorectal cancer, ovarian cancer, and very low birth weight (VLBW, defined as birth weight under 1,500 grams). Each endpoint has a peer-reviewed dose-response relationship drawn from U.S. and European studies, which we apply using U.S. incidence and valuation data. Under the 1 mg/L least-cost scenario, we estimate approximately 4,520 avoided cases per year once benefits are fully realized, including about 2,180 avoided VLBW births, 1,900 colorectal cancer cases, and 440 ovarian cancer cases, with benefits totaling $364 billion in present value. Under the least-cost 5 mg/L scenario, benefits amount to $25 billion.

Nitrate has been linked to other health effects that we did not monetize. Some lack a dose-response relationship suitable for a national estimate, some overlap with a quantified endpoint, and some are described in too few studies. Table 10 summarizes how we treat each endpoint.

Table 10. Health endpoints and their evidence base

Health endpoint	Treatment	Basis
Colorectal cancer	Quantified and monetized	Pooled dose-response slope from eight studies (Temkin et al., 2019); strongest cancer evidence (Ward et al., 2018)
Ovarian cancer	Quantified and monetized	Cohort of postmenopausal women in Iowa (Inoue-Choi et al., 2015); California cohort study found association for high-grade serous ovarian cancer, the most common subtype (Spaur et al., 2025)
Very low birth weight	Quantified and monetized	Continuous rate ratio from births in four Midwestern states (Stayner et al., 2017)
Preterm birth	Described qualitatively	Pooled evidence supports an association between nitrate exposure and preterm birth (Lin et al., 2023).
Neural tube defects	Described qualitatively	Case-control evidence (Brender et al., 2013; Lin et al., 2023); about 41 cases a year nationally (Temkin et al., 2019)
Thyroid, bladder, and kidney cancer	Described qualitatively	Evidence from case-control studies and cohort studies indicates an association, most consistently for thyroid and bladder cancers (Ward et al., 2010; Jones et al., 2016; Barry et al., 2020; Jones et al., 2017).
Methemoglobinemia	Described qualitatively	Acute infant effect that the current standard addresses; cases concentrate above 10 mg/L
Dementia	Described qualitatively	One recent cohort (Bondonno et al., 2025); no U.S. burden estimate

5.2 Estimating Avoided Cases

5.2.1 Exposure

Chronic disease reflects long-term exposure; we therefore measure each system's baseline exposure as its long-run average nitrate concentration: the mean of its 2021 to 2023 annual averages, weighted by the number of samples in each year. This measure understates exposure for systems with seasonal peaks because the annual average smooths over months when concentrations run above it. Benefit estimates for those systems are therefore conservative. The monitoring data do not report sample dates, so we cannot quantify how much seasonality the averages conceal.

Post-treatment exposure equals the standard for systems that blend under partial treatment, and near zero for systems that install full treatment or POU. Section 4 prices partial treatment at 80% of the standard, the operating margin a utility needs to stay in compliance, but for systems that blend we credit only the reduction in long-run exposure down to the standard itself. The pairing is conservative: costs include the margin, and benefits do not. Where a system blends and its long-run average already sits at or below the standard, it receives no health benefit. Under the 1 mg/L scenario, 2,927 affected systems serving 41.0 million people have long-run averages at or below 1 mg/L even though at least one sample reached it. Of these, 1,813 blend and receive no benefit; the other 1,114 install POU or full treatment and receive a small one.

5.2.2 Avoided cases

For each system, endpoint, scenario, and compliance method, we estimate annual avoided cases as:

$$\textit{Avoided cases} = \textit{population at risk} \times \textit{baseline disease incidence} \times [\textit{RR(baseline exposure)} - \textit{RR(post-treatment exposure)}]$$

Relative risk (RR) is the ratio of disease incidence at a given nitrate concentration to incidence with no nitrate. The population at risk is the SDWIS population served for the two cancers and annual births for VLBW. Relative risk reflects an annual incidence rate; thus, the calculation applies to the full population served every year. Each year's avoided cases are new diagnoses.

Baseline incidence includes the cases nitrate causes today. To avoid overstating benefits, we divide observed rates by the national population-weighted average relative risk, which recovers the incidence expected with no nitrate exposure. This adjustment lowers baseline incidence by 2.5% for colorectal cancer, 6.0% for ovarian cancer, and 10.8% for VLBW.

5.2.3 Dose-response relationships

Table 11 lists the dose-response relationship for each health endpoint. All concentrations are nitrate as nitrogen, consistent with the occurrence data.

Table 11. Dose-response relationships used to quantify benefits

Health endpoint	Form	Estimate (95% CI)	Population	Source
Colorectal cancer	Continuous (log-linear)	0.040 per mg/L (0.009 to 0.072)	All residents	Temkin et al. (2019)
Ovarian cancer	Single relative risk above 2.98 mg/L	HR 2.03 (1.22 to 3.38) at 2.98 mg/L or more	Women aged 55 to 69	Inoue-Choi et al. (2015)
Very low birth weight	Continuous (log-linear)	RR 1.17 per mg/L (1.08 to 1.25)	Singleton births	Stayner et al. (2017)

Note: The colorectal estimate is the increase in log relative risk per mg/L. The very low birth weight estimate is a rate ratio per 1 mg/L, with exposure averaged over the nine months before birth. The ovarian estimate compares the highest quartile of exposure with the lowest (below 0.47 mg/L).

For colorectal cancer, we use the pooled slope from Temkin et al. (2019), 0.040 per mg/L, from a meta-analysis of eight case-control and cohort studies. The scope of work cited Schullehner et al. (2018), a national cohort in Denmark, which is one of the eight; its slope alone is 0.034. We use the pooled slope because it draws on more evidence. Results vary considerably across the eight studies, and Espejo-Herrera et al. (2016), the study with the steepest slope, accounts for most of that variation. Temkin reports that removing it lowers the pooled slope to 0.027. Section 6 tests both 0.034 and 0.027 as alternatives.

Evidence for ovarian cancer was taken from one cohort of 17,000 postmenopausal women in Iowa. Women in the highest quartile of public water nitrate (2.98 mg/L or more) had close to twice the risk of women in the lowest quartile (below 0.47 mg/L) (Inoue-Choi et al., 2015). The study reports risk by quartile of exposure. However, results for exposure below 2.98 mg/L were not statistically significant; we therefore applied relative risk as a single step to systems with long-run averages at or above 2.98 mg/L, and only to baseline ovarian cancer cases among women aged 55 to 69, the cohort's age range at enrollment. The age restriction reflects the study population, not evidence that other women are unaffected, so it likely understates benefits. Because our ovarian estimate rests on one cohort and a single cutoff, Sections 5 and 6 also report results without ovarian cancer.

For VLBW, we use the rate ratio from Stayner et al. (2017): a 17% increase in the VLBW rate for each 1 mg/L increase in nitrate. The study covered 134,258 singleton births in 46 counties in four Midwestern states, where mean nitrate was 0.95 mg/L. A log-linear slope compounds quickly beyond that range; at 5 mg/L it implies more than twice the baseline rate. We cap the exposure entering the rate ratio at 10 mg/L, the current MCL. Stayner et al. report that dropping observations above the MCL left their results unchanged. The authors caution that the study compares county averages rather than individual exposures, so factors that differ across counties, not nitrate, could explain part of the association. Because the study population was singleton births, we apply the rate ratio to singleton births only. Twins and other multiple births account for about 22% of VLBW births nationally and fall outside the evidence, so we exclude them from the baseline.

As noted by Temkin et al. (2019), the extent of overlap between preterm birth and very low birth weight births reported in the nitrate epidemiology literature is uncertain. To avoid potential double counting, we do not include preterm birth as a separate outcome and instead retain very low birth weight as described above.

5.2.4 Baseline incidence

CDC WONDER data reports cancer incidence by state, sex, and five-year age group (2022). We applied each state's age- and sex-specific cancer rates to each county's population in those groups from the American Community Survey (2024 five-year estimates) and summed to a county rate. This captures each county's age structure, which matters because colorectal and ovarian cancer rates rise steeply with age. Each system receives the rate for the county it serves, or its state rate where the county is unknown.

For VLBW, the population at risk is annual births, estimated from county birth rates (CDC WONDER Natality, 2024). Baseline VLBW rates equal singleton births under 1,500 grams divided by all births (CDC WONDER Natality, 2024), using county data where available, then state, then national.

5.3 Valuation and Timing Assumptions

5.3.1 Mortality

We value avoided deaths with EPA's value of a statistical life (VSL), which reflects the amount a population is willing to pay, in total, for risk reductions that add up to one fewer expected death. We updated the value to 2026 USD, resulting in a VSL of $12.6 million.

The fatal share of avoided cases equals expected deaths divided by expected new cases, computed from the same age- and sex-specific data: 0.35 for colorectal cancer and 0.59 for ovarian cancer. For VLBW, the fatal share is the infant death rate among VLBW births, 0.20 nationally and state-specific where data allow, from CDC's linked birth and infant death records (2023). We apply the VSL in the year of the avoided case.

5.3.2 Morbidity

We value cases based on avoided health care costs. This cost-of-illness measure excludes lost work time and pain and suffering, so it understates what people would pay to avoid illness.

- **Colorectal cancer.** Mariotto et al. (2020) estimate annual cancer-attributable Medicare costs of $63,900 in the first year after diagnosis, $6,100 in each continuing year, and $105,900 in the last year of life (2019 USD). A non-fatal case incurs the first year plus five continuing years. A fatal case incurs the first year, five continuing years, and the last year, in addition to the VSL.
- **Ovarian cancer.** Mariotto et al. (2020) estimate $76,000 in the first year after diagnosis, $13,600 in each continuing year, and $107,600 in the last year of life (2019 USD), applied the same way.
- **Very low birth weight.** Beam et al. (2020) report health care spending in the first six months of life for commercially insured infants by birth weight. Their data imply incremental spending of $302,329 (2016 USD) for infants under 1,500 grams relative to normal birth weight. The estimate covers only the first six months, so it understates lifetime medical costs. Fatal VLBW cases carry this cost in addition to the VSL.

5.3.3 Latency and timing

Treatment comes online at the end of the five-year compliance period, so exposure falls beginning in 2032, the first year of O&M in Section 4. Cancer develops over many years, so lower exposure reduces incidence only after

a delay. We apply a 10-year latency for colorectal cancer and a 20-year latency for ovarian cancer: colorectal benefits begin in 2042 and ovarian benefits in 2052, and both accrue each year through 2076. VLBW responds to exposure during pregnancy, so its benefits begin in 2032.

5.3.4 Discounting

Benefits follow the same timeline as costs: 2026 USD, discounted at 2% to the start of 2027 over the 2027 to 2076 analysis period. Cancer benefits begin 10 to 20 years after O&M starts, so discounting reduces them more than it reduces costs, and the analysis period captures 35 years of colorectal benefits and 25 years of ovarian benefits against 45 years of O&M.

5.4 Results

5.4.1 Avoided cases

Once benefits are fully realized, a 1 mg/L standard under partial treatment avoids an estimated 1,900 colorectal cancer cases, 440 ovarian cancer cases, and 2,180 VLBW births each year (Table 12). Colorectal cancer and VLBW risk rises with every mg/L of nitrate, so their avoided cases fall steadily as the standard becomes less strict: under a 5 mg/L standard with partial treatment, about 120 colorectal cancer cases and 190 VLBW births are avoided each year. Ovarian cancer does not decline steadily with exposure: its step at 2.98 mg/L means that under the 3 and 5 mg/L scenarios, only systems that install POU or full treatment cross the cutoff, together fewer than 10 cases a year.

Full treatment raises avoided cases by 90% for colorectal cancer and 74% for VLBW at 1 mg/L, because it lowers exposure below the partial treatment target in every system that blends. The gap widens at the less strict standards, where partial treatment leaves more nitrate in the delivered water: at 5 mg/L, full treatment avoids 17 times as many colorectal cases as partial treatment.

Table 12. Annual avoided cases once benefits are fully realized, by regulatory scenario / compliance method

Scenario and compliance method	Colorectal cancer	Ovarian cancer	Very low birth weight
1 mg/L, w/blending	1,900 (400 to 3,700)	440 (90 to 1,020)	2,180 (870 to 3,710)
1 mg/L, full	3,610 (780 to 6,820)	440 (90 to 1,020)	3,800 (1,640 to 6,070)
3 mg/L, w/blending	500 (100 to 1,030)	<10	710 (250 to 1,350)
3 mg/L, full	2,710 (580 to 5,180)	440 (90 to 1,020)	2,870 (1,200 to 4,700)
5 mg/L, w/blending	120 (20 to 250)	<10	190 (60 to 400)
5 mg/L, full	1,970 (420 to 3,790)	370 (80 to 870)	2,160 (890 to 3,610)

Note: Values are central estimates, with low and high values from the 95% confidence interval of each dose-response estimate. Colorectal cases apply from 2042, ovarian cases from 2052, and VLBW births from 2032. Under partial treatment, systems that blend receive credit for the reduction in long-run exposure down to the standard, and systems that install POU or full treatment for the reduction to zero. Full treatment credits the reduction to zero in every system. Values are rounded to the nearest 10; <10 indicates fewer than 10 cases a year.

5.4.2 Monetized benefits

At 1 mg/L under partial treatment, benefits total $364 billion in present value, or $324 billion without ovarian cancer (Table 13) because it is a stepwise estimate. Avoided deaths account for 92% of the total. VLBW contributes the largest share, $165 billion, because its benefits begin in 2032 rather than 2042 and one in five VLBW infants dies in the first year. Colorectal cancer contributes $159 billion and ovarian cancer $40 billion.

Benefits fall faster than costs as the standard loosens. Moving from 1 to 3 mg/L cuts benefits by 73%; moving from 3 to 5 mg/L cuts them by a further 74%, because the 3 and 5 mg/L scenarios reach fewer systems and leave more nitrate in the water at those they do reach.

Table 13. Present value of benefits by health endpoint ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Scenario and compliance method	Colorectal cancer	Ovarian cancer	Very low birth weight	Total	Total without ovarian cancer
1 mg/L, w/blending	158.9	40.4	164.8	364.1	323.7
1 mg/L, full	301.7	40.4	286.8	628.9	588.5
3 mg/L, w/blending	41.9	0.6	54.2	96.7	96.1
3 mg/L, full	226.8	40.4	216.8	483.9	443.5
5 mg/L, w/blending	9.7	0.4	15.0	25.0	24.6
5 mg/L, full	164.9	34.5	162.5	361.9	327.4

Note: Values are central estimates. Low and high values appear in Section 6. Annualized benefits equal present value × 0.0318; at 1 mg/L under partial treatment they are $11.6 billion per year.

5.4.3 Where benefits fall

Benefits follow population and the size of the exposure reduction, not the number of systems. Systems serving 3,300 or fewer people make up close to 80% of affected systems but serve less than 5% of the affected population, so they generate 11% of benefits at 1 mg/L, against 13% of cost. Systems serving more than 100,000 people generate 43% of benefits and carry 46% of cost. Geographically, benefits concentrate where nitrate levels are significantly above the thresholds: EPA Region 9 (which includes California) accounts for 47% of benefits and 35% of costs at 1 mg/L.

Figure 4 compares benefits and costs per household by system size. Benefits per household fall with system size, from $705 a year in the smallest class to $186 in the largest, because small systems carry higher average nitrate concentrations. Costs per household fall much faster, from $304 to $53, so benefits exceed costs in every size class, by a factor of 2.3 in the smallest and 3.5 to 4.5 in the others.

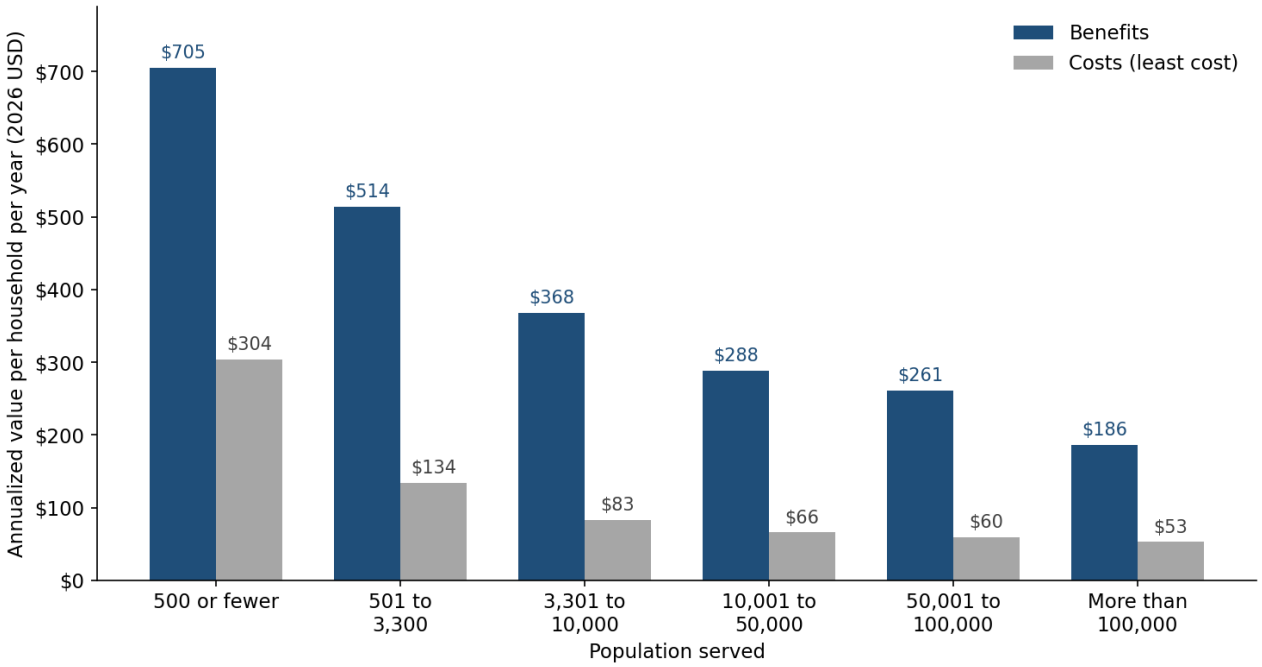


Figure 4. Annualized benefits and costs per household by system size, 1 mg/L partial treatment (2026 USD)

Note: Annualized present value divided by households served (population ÷ 2.53). Costs are the least-cost case from Section 4.

5.4.4 Health effects not monetized

The effects in Table 14 have some evidence of harm below the current standard but the information necessary to develop a national quantitative estimate is lacking or insufficient.

Table 14. Health effects not monetized

Health effect	Evidence	Why not monetized
Preterm birth	Pooled cohort studies show a 1% increase in odds per mg/L (Lin et al., 2023)	Extent of overlap with very low birth weight uncertain
Neural tube defects	Pooled case-control studies show 6% increase in odds per mg/L, but largest cohort found no association (Lin et al., 2023). Ward et al. (2018) list NTDs among better-supported nitrate outcomes.	Conflicting evidence; no transferable national dose-response
Thyroid cancer and thyroid disease	Iowa cohort of women aged 55 to 69 (Ward et al., 2010)	One subgroup study in the U.S.; no slope
Bladder and kidney cancer	Bladder: Iowa cohort (Jones et al., 2016) and a New England case-control study (Barry et al., 2020). Kidney: Iowa cohort (Jones et al., 2017) and high red meat consumers (Ward et al., 2007)	Mixed, inconsistent evidence; positive only at highest exposures in some cohorts, null in pooled analyses; no consistent slope for a national estimate.

Health effect	Evidence	Why not monetized
Methemoglobinemia	Basis of the current standard (Walton, 1951)	Cases concentrate above 10 mg/L
Dementia	One recent cohort (Bondonno et al., 2025)	No U.S. incidence/valuation basis

5.5 Limitations

Key limitations associated with the quantified health benefits analysis are as follows:

- **Observational evidence.** People with nitrate exposure via drinking water may also differ in other ways that affect health, such as income, diet, or where they live. Studies can adjust only for the differences they measure. Ward et al. (2018) call for future studies to measure what individuals actually drink and to account for diet and other factors that affect how the body converts nitrate into cancer-causing compounds. Even with these limitations, Ward et al. found associations, including for colorectal cancer, at nitrate levels below the current standard.

  Some studies, including the VLBW study used here (Stayner et al., 2017), are also ecological, meaning they compare county or regional averages rather than individual exposures.

- **Transferring study results.** The estimates come from specific populations, including postmenopausal Iowa women, Midwestern births, and European cohorts. We apply them to the national population served.

- **Low concentrations.** Full treatment credits risk reduction down to near zero, where the studies have little data.

- **Exposure snapshot.** Three years of monitoring stand in for decades of exposure, and we hold concentrations constant through 2076.

- **Omitted effects and narrow valuation.** Unmonetized endpoints and a cost-of-illness measure limited to medical costs both understate benefits.

6. Benefit-Cost Comparison and Sensitivity Analysis

This section compares benefits and costs under each regulatory scenario, identifies where the benefits of a stricter standard are concentrated, and tests how the results respond to key assumptions.

6.1 Overview

We compare the present value benefits from Section 5 with the present value costs from Section 4, discounted at 2% over the 50-year analysis period (2027 to 2076). Costs use the least-cost case, the lower bound on compliance cost; Section 6.7 substitutes the single-technology cases. Partial treatment is priced at 80% of the standard, but systems that blend receive credit only for the exposure reduction down to the standard (Section 5.2.1). Systems whose least-cost option is POU or full treatment receive credit for the full-treatment reduction.

Benefits exceed costs under every scenario and compliance method. Under partial treatment, the benefit-cost ratio is 3.9 at 1 mg/L, 2.3 at 3 mg/L, and 1.1 at 5 mg/L, and the 1 mg/L result holds under every single-assumption sensitivity we tested. Key findings that go beyond benefit-cost ratios:

- Returns rise as the standard tightens: each step from 5 to 3 to 1 mg/L returns more benefit value per dollar than the step before it, so there is no knee in the curve within the range studied.
- How much nitrate a system removes matters more than the number of affected systems: full treatment adds far more in benefits than it adds in cost at every standard, and full treatment at 5 mg/L produces more net benefits than partial treatment at 1 mg/L.
- Within any standard, benefits concentrate in the systems with high long-run average concentrations, while about a quarter of compliance cost falls on systems whose long-run averages already sit at or below 1 mg/L and that gain almost nothing.

6.2 National Results

At 1 mg/L under partial treatment, benefits of $364 billion compare with costs of $94.5 billion, for net benefits of $270 billion and a benefit-cost ratio of 3.9 (Table 15). Without ovarian cancer, the ratio is 3.4. The 3 mg/L scenario returns 2.3 per dollar, with net benefits of $54 billion. The 5 mg/L scenario under partial treatment returns the least, with benefits of $25 billion against costs of $22 billion, because treatment to 5 mg/L leaves most of the exposure in place at the 3,163 systems it reaches and crosses the ovarian cancer cutoff only where a system installs POU or full treatment. Under full treatment, every scenario returns more than four times its cost. Annualized at 2% over 50 years, quantified benefits at 1 mg/L under partial treatment are $11.6 billion a year against costs of $3.0 billion.

Table 15. Present value of quantified benefits and costs by regulatory scenario and compliance method ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Scenario and compliance method	Benefits	Costs (least cost)	Net benefits	Benefit-cost ratio	BCR without ovarian cancer
1 mg/L, w/blending	364.1	94.5	269.7	3.9	3.4
1 mg/L, full	628.9	130.4	498.5	4.8	4.5
3 mg/L, w/blending	96.7	42.4	54.2	2.3	2.3
3 mg/L, full	483.9	68.3	415.6	7.1	6.5
5 mg/L, w/blending	25.0	22.2	2.8	1.1	1.1
5 mg/L, full	361.9	41.9	319.9	8.6	7.8

Note: Costs are from Table 5 and benefits from Table 13. Annualized values equal present value × 0.0318, the capital recovery factor for 2% over 50 years.

6.3 Compliance Method: Partial Versus Full Treatment

Full treatment costs 38% more than treatment with bypass blending at 1 mg/L ($36.0 billion), 61% more at 3 mg/L ($25.9 billion), and 89% more at 5 mg/L ($19.8 billion). It raises benefits by far more: $265 billion, $387

billion, and $337 billion (Table 16). Every added dollar of treatment cost returns $7.40 in benefits at 1 mg/L, $15 at 3 mg/L, and $17 at 5 mg/L. Net benefits are highest under full treatment at every standard, and full treatment at 5 mg/L, which costs $42 billion, produces more net benefits ($320 billion) than partial treatment at 1 mg/L ($270 billion), which costs $94.5 billion.

Table 16. Added cost and added benefits of full treatment relative to partial treatment ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Standard	Added cost	Added benefits	Added net benefits	Ratio of added benefits to added cost
1 mg/L	36.0	264.8	228.8	7.4
3 mg/L	25.9	387.3	361.4	15.0
5 mg/L	19.8	336.9	317.1	17.0

The larger benefit under full treatment does not mean that partial treatment leaves water above the standard. Under partial treatment, a system treats part of its flow to near zero and blends it with untreated water so that delivered water stays below the standard, even at its highest observed concentration. The difference comes from what triggers treatment and what drives health benefits. A system must treat if any single sample reaches the standard, but the health effects we quantify depend on long-run average exposure, which at most systems sits well below the highest sample. For systems that blend, the benefit calculation credits only the reduction in the long-run average down to the standard (Section 5.2.1). Full treatment lowers the long-run average to near zero at every system.

Many affected systems fall in this gap. Systems whose long-run average is already at or below the standard serve 34% of the affected population at 1 mg/L, 66% at 3 mg/L, and 89% at 5 mg/L. For example, a system whose highest sample is 4 mg/L but whose average is 1.5 mg/L must comply with a 3 mg/L standard. Blending to stay under 3 mg/L at its peak earns no credit in the benefit calculation, because its average is already below 3 mg/L. Full treatment lowers that average from 1.5 mg/L to near zero. Because colorectal cancer and VLBW risk rise with every mg/L, removing this remaining exposure adds substantial benefits. The added cost is moderate, because the system builds a plant either way and full treatment only treats a larger share of its flow. This is also why the gap widens as the standard becomes less strict. The result carries a caution: EPA cannot require full treatment under a standard above zero, and utilities choose how far below a standard to operate. A rule that pairs a standard with an incentive to treat all flow, or a lower standard that makes partial treatment deliver near-zero water, captures the larger benefit.

6.4 Incremental Analysis: Tightening the Standard

Choosing among standards depends on whether each tightening step pays for itself, not only on whether the strictest standard does. Table 17 and Figure 5 show the added costs and benefits of each step under partial treatment. The first step, from the current standard to 5 mg/L, returns $1.10 per dollar. Tightening from 5 to 3 mg/L returns $3.50 per dollar, and tightening from 3 to 1 mg/L returns $5.10 per dollar.

Table 17. Incremental benefits and costs of each tightening step, partial treatment ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Step	Newly affected systems	Incremental cost	Incremental benefits	Incremental benefits without ovarian cancer	Incremental benefit-cost ratio (without ovarian cancer)
Current standard to 5 mg/L	3,163	22.2	25.0	24.6	1.1 (1.1)
5 to 3 mg/L	2,883	20.3	71.7	71.5	3.5 (3.5)
3 to 1 mg/L	7,159	52.0	267.5	227.6	5.1 (4.4)

Note: Incremental cost includes newly affected systems and deeper treatment at systems already affected at the less strict standard.

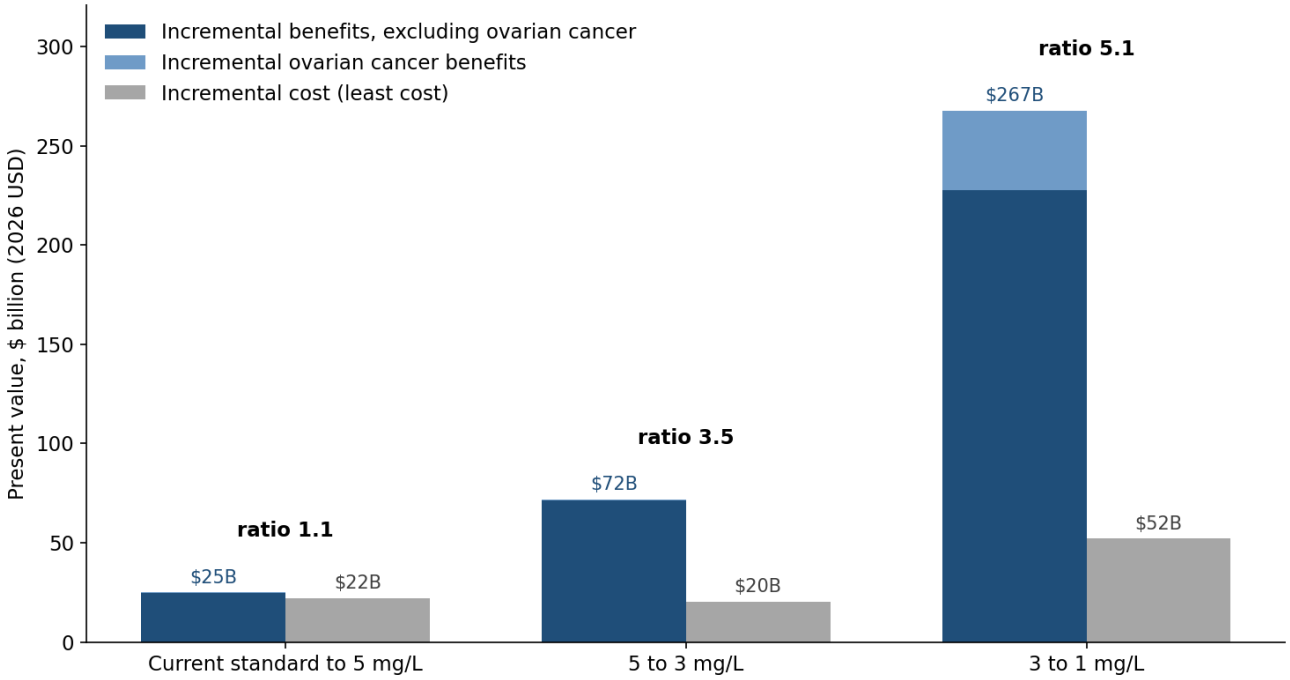


Figure 5. Incremental benefits and costs by tightening step, partial treatment (2026 USD)

6.5 Where the Benefits Are

Table 18 and Figure 6 group affected systems by their average nitrate concentration over 2021 to 2023 and show the cost and quantified benefit of a 1 mg/L standard in each group. Quantified benefits concentrate in the systems with high long-run average concentrations, and costs do not (Table 18 and Figure 6). At 1 mg/L under partial treatment, the 3,917 systems whose long-run averages exceed 3 mg/L account for 24% of cost and 70% of benefits, with benefit-cost ratios of 10 to 26. The 4,155 systems averaging between 1 and 2 mg/L carry 36% of cost and return $1.60 per dollar.

At the other end, 2,927 systems serving 41 million people have long-run averages at or below 1 mg/L. They are affected because at least one sample reached 1 mg/L, and under single-sample compliance they must treat. They carry 26% of national cost, $24.9 billion, and produce almost no quantified benefit ($0.4 billion, all from systems that install POU or full treatment), because their chronic exposure is already at the partial treatment target. In total, 5,825 systems (44% of the affected universe, serving 55 million people) have costs that exceed their benefits; their $36.2 billion in cost buys $6.2 billion in benefits.

This pattern reflects how the standard is enforced rather than the standard itself. Nitrate compliance rests on a single sample because the current standard protects against an acute effect, methemoglobinemia. The benefits quantified here are chronic, and they track long-run average exposure. A compliance metric based on a running annual average, as EPA uses for chronic contaminants, paired with the existing single-sample limit of 10 mg/L for the acute effect, would exempt the low-average systems and reduce the cost of a 1 mg/L standard by at least a quarter while giving up almost none of its quantified benefits. We do not model that alternative here, but the gap between the two compliance concepts is the largest single source of cost without benefit in the analysis. That conclusion rests on our exposure measure, a long-run average. Effects tied to exposure during pregnancy, such as VLBW and neural tube defects, may respond to short-term peaks that an annual average would not limit, and studies have associated both with nitrate below 10 mg/L. An averaging approach could therefore give up benefits this analysis does not capture.

Table 18. Benefits and costs by long-run mean nitrate concentration, 1 mg/L partial treatment ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Long-run mean (mg/L as N)	Systems	Population served (millions)	Costs (least cost)	Benefits	Share of cost	Share of benefits	Benefit-cost ratio
1 or less	2,927	41.0	24.9	0.4	26%	0%	0.0
1 to 2	4,155	44.5	34.5	55.3	36%	15%	1.6
2 to 3	2,206	13.3	12.9	54.5	14%	15%	4.2
3 to 5	2,302	16.6	16.8	167.1	18%	46%	9.9
5 to 10	1,505	4.2	5.3	83.0	6%	23%	15.7
More than 10	110	0.1	0.2	3.9	0%	1%	25.8
Total	**13,205**	**119.7**	**94.5**	**364.1**	**100%**	**100%**	**3.9**

Note: Long-run mean is the sample-weighted mean of 2021 to 2023 annual averages (Section 5.2.1). Systems averaging 1 mg/L or less receive no benefit under partial treatment unless they install POU or full treatment.

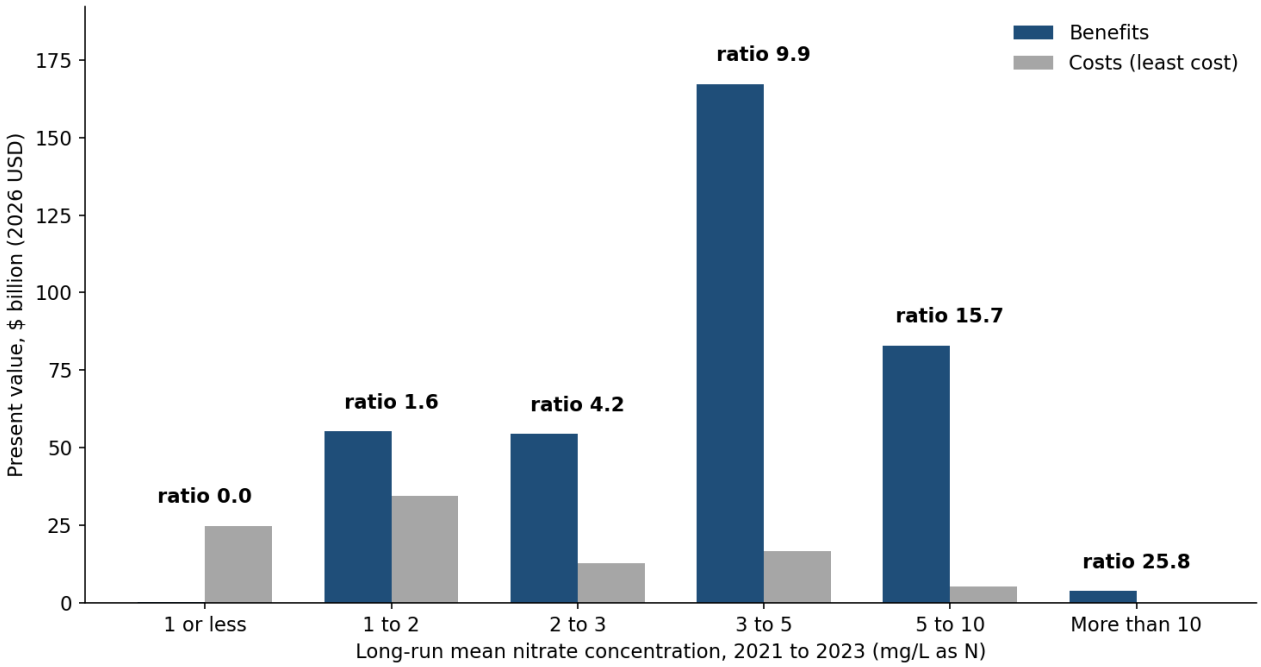


Figure 6. Benefits and costs by long-run mean nitrate concentration, 1 mg/L partial treatment (2026 USD)

The same concentration is visible in a ranking of systems by benefit-cost ratio. The 799 systems with the highest ratios deliver half of national benefits for 13% of cost, and 4,420 systems deliver 90% of benefits for 43% of cost. Geographically, EPA Region 9 accounts for 47% of benefits and 35% of cost, and California alone for 37% of benefits, because its exceedances sit well above the thresholds (Section 3.3). Region 1 has the lowest ratio, 1.3, and Region 3 the highest, 5.4.

6.6 Distribution Across System Sizes

Benefits exceed costs in every size class, but by the smallest margin in the smallest systems (Table 19). Systems serving 500 or fewer people return $2.30 per dollar, against $3.50 to $4.50 in every other class. Small systems pay the most per household, $304 a year, and carry 5% of cost for 3% of benefits; 3,292 of the 7,410 smallest systems have costs above benefits. The affordability concern from Section 4 therefore stands alongside a favorable national result: a standard can produce large net benefits nationally while the smallest systems, and the 5,825 systems with costs above benefits, bear costs their own customers will not recover in health terms.

Table 19. Benefits and costs by system size, 1 mg/L partial treatment ($ billion, 2026 USD, 2% discount rate, 2027 to 2076)

Population served	Systems	Costs (least cost)	Benefits	Net benefits	Benefit-cost ratio	Systems with costs above benefits
500 or fewer	7,410	4.6	10.8	6.1	2.3	3,292
501 to 3,300	3,094	7.4	28.4	21.0	3.8	1,315

Population served	Systems	Costs (least cost)	Benefits	Net benefits	Benefit-cost ratio	Systems with costs above benefits
3,301 to 10,000	1,180	7.2	32.1	24.9	4.5	504
10,001 to 50,000	1,093	20.2	88.7	68.5	4.4	512
50,001 to 100,000	221	11.2	49.1	37.9	4.4	103
>100,000	206	43.9	155.1	111.3	3.5	98
Total	**13,205**	**94.5**	**364.1**	**269.7**	**3.9**	**5,825**

Note: Costs are the least-cost present value for each system summed within the class, so they differ slightly from the class averages in Table 6 multiplied by system counts. One system has no population recorded and is excluded from the size classes.

6.7 Sensitivity Analysis

Table 20 shows how the benefit-cost ratio at 1 mg/L under partial treatment responds to each key assumption, changing one assumption at a time, and Figure 7 ranks the assumptions by their effect. No single assumption brings the ratio below 1.3. The choice of treatment technology, and the dose-response confidence intervals move the result most; no single endpoint carries the result, because VLBW and colorectal cancer each exceed costs on their own.

Table 20. Sensitivity of the quantified benefit-cost ratio, 1 mg/L partial treatment

Assumption	Central case	Alternative	Benefits ($ B)	Costs ($ B)	BCR
Central case			364.1	94.5	3.9
Discount rate	2%	3%	276.8	76.6	3.6
		7%	107.4	38.7	2.8
Colorectal cancer slope	0.040	0.009 (lower 95% CI)	238.4	94.5	2.5
		0.072 (upper 95% CI)	514.4	94.5	5.4
		0.027 (w/out Espejo-Herrera)	309.2	94.5	3.3
		0.034 (Schullehner alone)	338.4	94.5	3.6
VLBW rate ratio	1.17 per mg/L	1.08 (lower 95% CI)	265.3	94.5	2.8
		1.25 (upper 95% CI)	479.4	94.5	5.1
Ovarian cancer	RR 2.03	Excluded	323.7	94.5	3.4
		RR 1.22 (lower 95% CI)	332.4	94.5	3.5
		RR 3.38 (upper 95% CI)	417.1	94.5	4.4

Assumption	Central case	Alternative	Benefits ($ B)	Costs ($ B)	BCR
Cancer latency	10 years colorectal, 20 ovarian	5 and 10 years	419.9	94.5	4.4
		20 and 30 years	288.4	94.5	3.1
Exposure measure	Long-run mean	Highest annual average	455.5	94.5	4.8
Technology case	Least cost	Ion exchange	361.8	95.4	3.8
		Biological denitrification (midpoint)	361.5	172.6	2.1
		Reverse osmosis (midpoint)	362.6	285.8	1.3
All unfavorable together		Lower CI slopes, ovarian excluded, longer latencies, 7% discount rate	27.8	38.7	0.7

Note: The discount rate applies to both benefits and costs; costs at 3% and 7% come from re-running the cost model at each rate, so each system's least-cost technology and approach are re-selected at that rate. Throughput-adjusted O&M is not carried as a sensitivity because the adjusted runs exist only for ion exchange.

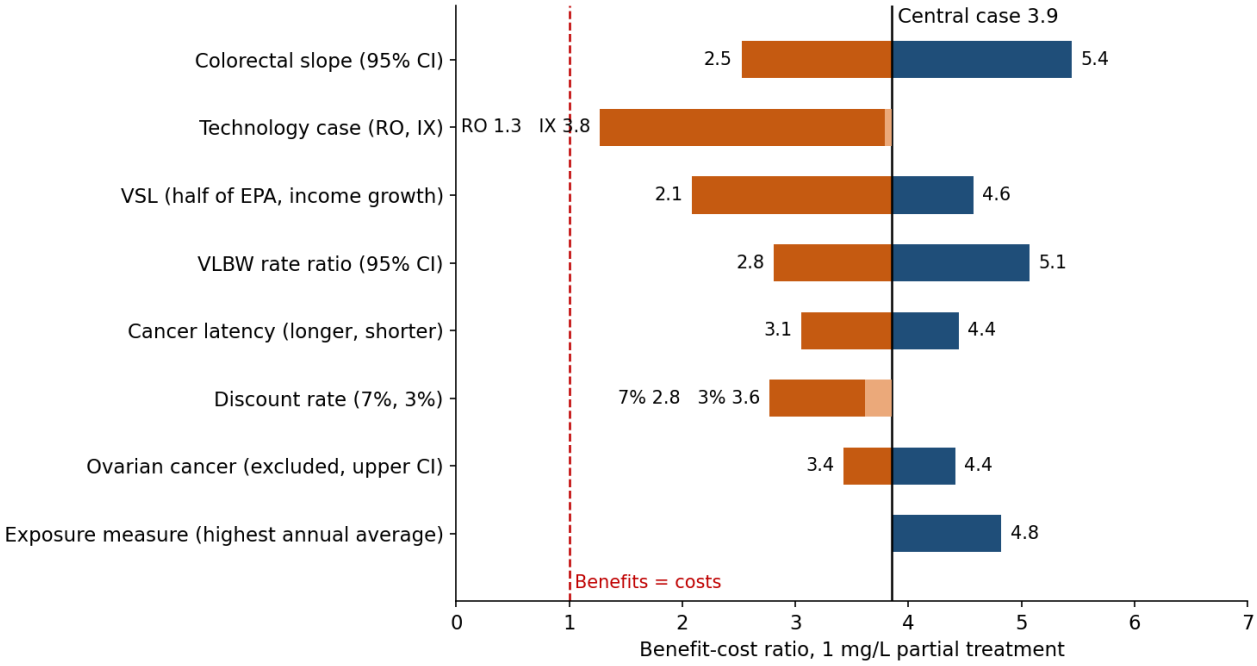


Figure 7. Effect of key assumptions on the benefit-cost ratio, 1 mg/L partial treatment

The 3 mg/L scenario responds the same way: at 7%, its ratio falls from 2.3 to 1.8, and it stays above 1 under every single assumption except the reverse osmosis cost case, where it falls to 0.7. The 5 mg/L partial treatment scenario is fragile. Its ratio falls to 1.08 at 3% and 0.91 at 7%, and the lower confidence bound of either dose-response estimate, the colorectal slope without Espejo-Herrera et al. (2016), the longer cancer latencies, half

the VSL, or the biological denitrification or reverse osmosis cost case each pushes it below 1. Combining every unfavorable assumption at once at 1 mg/L, including a 7% discount rate on both sides, gives benefits of $27.8 billion against costs of $38.7 billion, a ratio of 0.7. That case is not plausible, because it takes the lower confidence bound of every dose-response estimate together, but it marks the boundary: reversing the 1 mg/L result requires several assumptions to fail in the same direction, while the 5 mg/L partial treatment result reverses on several single assumptions. These comparisons cover quantified benefits only; the unquantified benefits in Section 6.9 would raise each ratio.

6.8 Break-Even Analysis

Break-even values show how far an input would have to move before costs exceed benefits at 1 mg/L under partial treatment. No plausible value of any single input does so. If colorectal cancer were the only quantified endpoint, its slope would have to fall to 0.025 per mg/L, just below Temkin's seven-study estimate of 0.027 and well above the lower confidence bound of 0.009; with all three endpoints, no positive slope reverses the result. The VSL would have to fall to $2.4 million, about 19% of EPA's value. No cancer latency reverses the result, because VLBW benefits alone, which carry no latency, exceed costs by more than 70%. Costs would have to rise to $364 billion, well above the reverse osmosis case.

6.9 Benefits and Costs Not Quantified

Several effects fall outside the monetized results. Most would raise net benefits.

- **Health effects not monetized.** The endpoints in Table 14, including neural tube defects and thyroid disease, would add benefits.
- **Averting behavior.** Households that buy bottled water or home filters because of nitrate would avoid those costs.
- **Co-removal.** Reverse osmosis and ion exchange also remove other contaminants, such as arsenic and perchlorate, depending on the process and configuration. Anion exchange can also remove uranium, and reverse osmosis removes most dissolved contaminants, including PFAS. The Safe Drinking Water Act directs EPA to consider benefits from reductions in co-occurring contaminants attributable to compliance (42 U.S.C. 300g-1(b)(3)(C)(i)(II)). This was not possible within the scope of this research.
- **Non-community systems.** The nitrate MCL also applies to non-transient and transient non-community water systems (40 CFR 141.62). Excluding them omits benefits and costs from both sides.
- **Residuals disposal.** Brine and concentrate disposal can cost more than the models assume, especially inland.
- **Private wells.** A new MCL would not reach private well users, whose exposure is often higher. The rule leaves that risk in place.

7. Summary and Key Findings

We estimated benefits and costs for three drinking water nitrate standards, 1 mg/L, 3 mg/L, and 5 mg/L, under two treatment scenarios, and tested results against alternative assumptions. The findings below cover the

benefit-cost comparison at each standard, what drives the returns, where benefits and costs concentrate across systems, and how robust the results are:

- **Quantified benefits exceed costs at every standard.** Under partial treatment, net benefits are $270 billion at 1 mg/L, $54 billion at 3 mg/L, and $3 billion at 5 mg/L, with benefit-cost ratios of 3.9, 2.3, and 1.1. The 1 mg/L result holds under every single-assumption sensitivity and without ovarian cancer, and the 3 mg/L result holds under all but the reverse osmosis cost case; the 5 mg/L partial treatment result falls below break-even under several single assumptions.
- **Returns rise as the standard tightens; there is no knee in the curve.** Moving to 5 mg/L returns $1.10 per dollar, tightening to 3 mg/L returns $3.50, and tightening to 1 mg/L returns $5.10 ($4.40 without ovarian cancer). The 5 mg/L standard returns least, because treatment to 5 mg/L leaves most exposure in place.
- **How much nitrate is removed matters more than how many systems are covered.** Full treatment returns $7 to $17 per added dollar and produces the highest net benefits at every standard. Full treatment at 5 mg/L produces more net benefits than partial treatment at 1 mg/L at less than half the cost. This finding credits exposure reductions down to zero, where the health evidence is thinnest.
- **Benefits sit in the high-concentration systems.** Systems averaging above 3 mg/L carry 24% of cost and 70% of quantified benefits. Systems averaging 1 mg/L or less carry 26% of cost and produce almost no quantified benefit. This result reflects our exposure measure: we estimate all quantified health benefits from long-run average nitrate concentrations. Some effects depend on exposure during shorter windows. Studies have associated VLBW with nitrate in public water averaged over pregnancy at concentrations well below 10 mg/L (Stayner et al., 2017), and spina bifida with maternal nitrate intake from drinking water around conception (Brender et al., 2013). Where nitrate rises above a system's average during those windows, treatment would provide benefits that this analysis does not capture.
- **Customers of small systems gain less per dollar.** Every size class shows net benefits, but the smallest systems return $2.30 per dollar and pay $304 per household a year, and 44% of them have costs above benefits, so affordability support belongs with any stricter standard.
- **The result is robust.** Reversing the 1 mg/L result would require the VSL to fall to about 19% of EPA's value or several assumptions to fail together; only the combined unfavorable case brings benefits below costs.

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Appendix A. Direction of Key Assumptions

Table B-1 lists the assumptions that result in more conservative (lower) net benefit estimates, either by lowering benefits or raising costs. Table B-2 lists those that may overstate net benefits.

Table A-1. Assumptions that make the estimates conservative

Assumption	Effect on estimates	Section
Systems that blend receive benefit credit only down to the standard, while costs include the 80% operating margin	Costs include improvements to water quality that benefits do not credit	2.5, 5.2.1
Exposure equals weighted average of sample results from 2021-2023	Smooths over seasonal and pregnancy-window peaks, which understates benefits for populations served by systems with seasonal spikes	5.2.1
Monetized benefits only include reduced cases of colorectal cancer, ovarian cancer, and VLBW	Omits quantified benefits of avoiding premature births, neural tube defects, thyroid disease, and other cancers	5.4.4
Ovarian benefits applied to women aged 55 to 69, matching study population	Undercounts benefits to women in other age groups that are likely also affected	5.2.3
VLBW benefits apply only to singleton births, omitting twins and other multiples (~22% of VLBW)	Undercounts benefits to children born in multiples that could be affected by nitrate contamination during pregnancy	5.2.3
Cost of illness covers medical costs only and over limited durations	Omits lost work time, pain and suffering, and medical costs accrued beyond the average duration	5.3.2
VSL is held constant over time	US EPA adjusts VSL by income growth (not inflation); future income growth compared to inflation is uncertain; we therefore did not increase VSL into the future in real terms.	5.3.1, 6.7
Cancer benefits begin 10 to 20 years after treatment, and the analysis period ends in 2076	Benefits of avoided cancer cases (35 years of colorectal and 25 years of ovarian) accrue over less time than O&M costs (45 years)	5.3.4
Co-removal of other contaminants and household averting costs are not valued	Undercounts benefit of treating for additional contaminants	6.9

Assumption	Effect on estimates	Section
Treatment costs are based on the highest nitrate concentration sample from 2021 to 2023	Could result in higher capital costs, particularly if confirmation sample (after exceedance) is lower.	4.3.2
O&M costs accrue based on full average flow all year	Overstates O&M costs for systems that only exceed the standard seasonally	4.3.2, 4.5
Treatment occurs at retail systems rather than wholesale suppliers	Overstates cost where one wholesale supplier could treat for several systems	2.7, 4.3.1
One sample at or above the standard indicates a system requires treatment	Adds cost at systems whose confirmation sample may fall below the standard and therefore not require treatment	3.1, 6.5
Source water protection is not considered	Omits a lower-cost compliance path for some systems	2.8

Table A-2. Assumptions that may inflate the estimates

Assumption	Effect on estimates	Section
Every system uses its least-cost technology	Lower bound on cost; requiring more expensive treatment (e.g., reverse osmosis) lowers the benefit cost ratio	4.3.4, 6.7
Full treatment eliminates nitrate from drinking water	Health impact studies often do not include low concentrations of nitrate in drinking water	5.5
The colorectal dose-response slope represents the pooled estimate (0.040)	Dropping the study with the steepest slope (equal to 0.027) from the pooled estimate decreases total avoided cases attributable to reductions in nitrate	5.2.3, 6.7
The VSL applies in the year of the avoided case	Cancer deaths occur years after diagnosis, so discounting to the year of death would lower benefits	5.3.1
Benefits and costs are discounted at 2%	Higher discount rates reduce benefits that accrue further in the future	2.6, 6.7

Other assumptions have no clear direction. Sampling data of nitrate contamination in drinking water includes the most recently available data from 2021-2023; there may be more or fewer affected systems today than are represented in this analysis. The dose-response studies are observational, so unmeasured differences between exposed and unexposed populations could bias them either way. Transferring results from Iowa women, Midwestern births, and European cohorts to the national population served could raise or lower benefits. Holding nitrate concentrations constant through 2076 ignores future trends in either direction. Excluding non-community systems omits benefits and costs from both sides of the comparison.

Appendix B: Nitrate-Affected Populations

Table B-1. Number of systems and total population served at the nitrate contamination thresholds

State	Concentrations >=1 mg/L		Concentrations >=3 mg/L		Concentrations >=5	
	# of Systems	Total Population Affected	# of Systems	Total Population Affected	# of Systems	Total Population Affected
AK	89	259,695	41	6,485	23	3,048
AL	79	1,543,359	25	709,349	5	76,368
AR	33	204,387	8	42,013	2	3,157
AZ	463	6,522,659	247	5,727,667	143	5,423,789
CA	1,411	26,594,637	911	23,104,367	616	18,022,543
CO	231	1,297,283	92	390,258	54	193,519
CT	219	1,445,710	79	814,428	24	42,108
DC	2	648,013	--	--	--	--
DE	96	854,124	83	847,595	58	531,727
FL	385	2,490,376	118	858,470	50	171,041
GA	280	1,463,509	67	268,725	27	100,270
HI	35	1,223,732	8	239,818	3	217,554
IA	279	1,476,415	142	1,185,024	78	791,085
ID	383	1,306,392	155	861,211	77	487,823
IL	273	2,278,003	123	1,158,011	74	652,942
IN	161	2,857,671	74	1,846,155	30	451,004
KS	388	1,801,273	305	443,366	215	314,097
KY	60	1,602,037	21	92,424	9	31,126
LA	64	1,290,322	6	23,029	2	4,680
MA	201	2,209,115	68	854,475	23	327,961
MD	154	4,255,601	96	331,436	51	237,292
ME	94	115,871	24	8,844	12	2,989
MI	191	645,477	72	121,555	34	90,161
MN	178	1,244,113	73	339,987	32	166,196
MO	121	2,515,387	24	186,894	11	48,099
MS	32	149,456	2	28,754	1	3,252
MT	258	247,432	75	120,394	35	15,517
NC	723	1,020,564	296	209,506	96	92,211
ND	11	76,113	2	770	--	--
NE	378	1,418,855	263	369,025	187	264,412
NJ	249	5,070,243	119	1,629,844	46	533,839
NM	199	1,430,609	78	638,204	26	211,975
NV	85	2,250,571	47	2,149,339	22	2,093,225
NY	715	2,461,882	269	1,477,447	116	740,230
OH	224	6,050,571	72	1,792,700	22	1,490,639
OK	276	1,104,316	183	318,233	131	241,349

State	Concentrations >=1 mg/L		Concentrations >=3 mg/L		Concentrations >=5	
	# of Systems	Total Population Affected	# of Systems	Total Population Affected	# of Systems	Total Population Affected
OR	305	660,580	106	152,340	38	56,571
PA	853	6,438,075	457	4,970,788	232	2,093,424
RI	33	366,262	14	315,574	4	4,963
SC	142	556,842	31	36,529	7	29,809
SD	8	76,526	7	4,517	5	3,217
TN	86	1,556,292	24	128,043	2	49,253
TX	809	10,001,515	258	1,479,106	158	259,831
UT	190	2,225,585	75	1,187,220	28	152,088
VA	238	2,140,575	87	211,733	31	61,730
VT	58	35,338	13	6,563	3	4,584
WA	967	4,354,550	433	2,459,109	176	422,921
WI	383	1,497,323	213	1,014,441	116	416,492
WV	56	256,661	30	133,442	14	46,397
WY	57	98,289	30	22,377	14	14,092
Total	**13,205**	**119,690,186**	**6,046**	**61,317,584**	**3,163**	**37,692,600**