BEFORE THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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 from Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Underground Sources of Drinking Water	EPA Docket No. _____, 2024

Submitted on Behalf of Petitioners
Iowa Environmental Council,
Allamakee County Protectors – Education Campaign,
Center for Food Safety,
Environmental Law & Policy Center,
Environmental Working Group,
Food & Water Watch,
Iowa Alliance for Responsible Agriculture,
Iowa Citizens for Community Improvement,
Izaak Walton League of America – Iowa Division,
Sierra Club Iowa Chapter,
Socially Responsible Agriculture Project,
Iowa Coldwater Conservancy,
and
Trout Unlimited – Iowa Driftless Chapter 717

To:

Administrator Michael S. Regan
U.S. Environmental Protection Agency
Mail Code 1101A
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
Regan.Michael@epa.gov

Regional Administrator Meg McCollister
U.S. Environmental Protection Agency, Region VII
11201 Renner Blvd
Lenexa, KS 66219
McCollister.Meg@epa.gov

Table of Contents

I. INTRODUCTION

Petitioners respectfully petition the U.S. Environmental Protection Agency (EPA) to exercise its emergency powers established in Section 1431 of the Safe Drinking Water Act (SDWA), 42 U.S.C. § 300i, to address groundwater contamination that presents an imminent and substantial endangerment to the health of residents in northeastern Iowa. Like many other parts of the Nation plagued by pollution from industrial agriculture, the residents in northeastern Iowa are suffering from drinking water contamination. As detailed in this Petition, this region has an extensive and well-documented history of nitrate contamination in its underground sources of drinking water, which continues to put the health of residents at risk. EPA acknowledged the urgency of this problem in responding to a similar petition filed in Minnesota;[1] that petition addressed the same geologic formation and many of the same underground sources of drinking water.[2] The EPA must act now to address this long-ignored health crisis in Iowa and ensure clean drinking water for Iowans.

Northeastern Iowa is particularly vulnerable to groundwater pollution due to its karst geography. This region is also called the "Driftless Area" due to the lack of recent glaciation. According to the Iowa Department of Natural Resources (DNR):

> Shallow aquifers are less protected than deeper aquifers. Karst bedrock aquifers are some of the most susceptible to contamination. Although Karst features can be found in a number of locations across Iowa, they are most abundant in the NE corner our state.[3]

The "karst region" of Northeast Iowa as identified by DNR is depicted in Figure 1 below.[4]

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[1] *See* Letter from Debra Shore, EPA Region 5 Administrator, to Brooke Cunningham, Thom Peterson, and Katrina Kessler (Nov. 3, 2023).

[2] 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 from Imminent and Substantial Endangerment to Public Health Caused By Nitrate Contamination of Underground Sources of Drinking Water," filed Apr. 24, 2023.

[3] *"Contamination in Karst*," IOWA DEPARTMENT OF NATURAL RESOURCES, https://www.iowadnr.gov/environmental-protection/water-quality/private-well-program/private-well-testing/contamination-in-karst (last visited Apr. 15, 2024).

[4] *Id.*

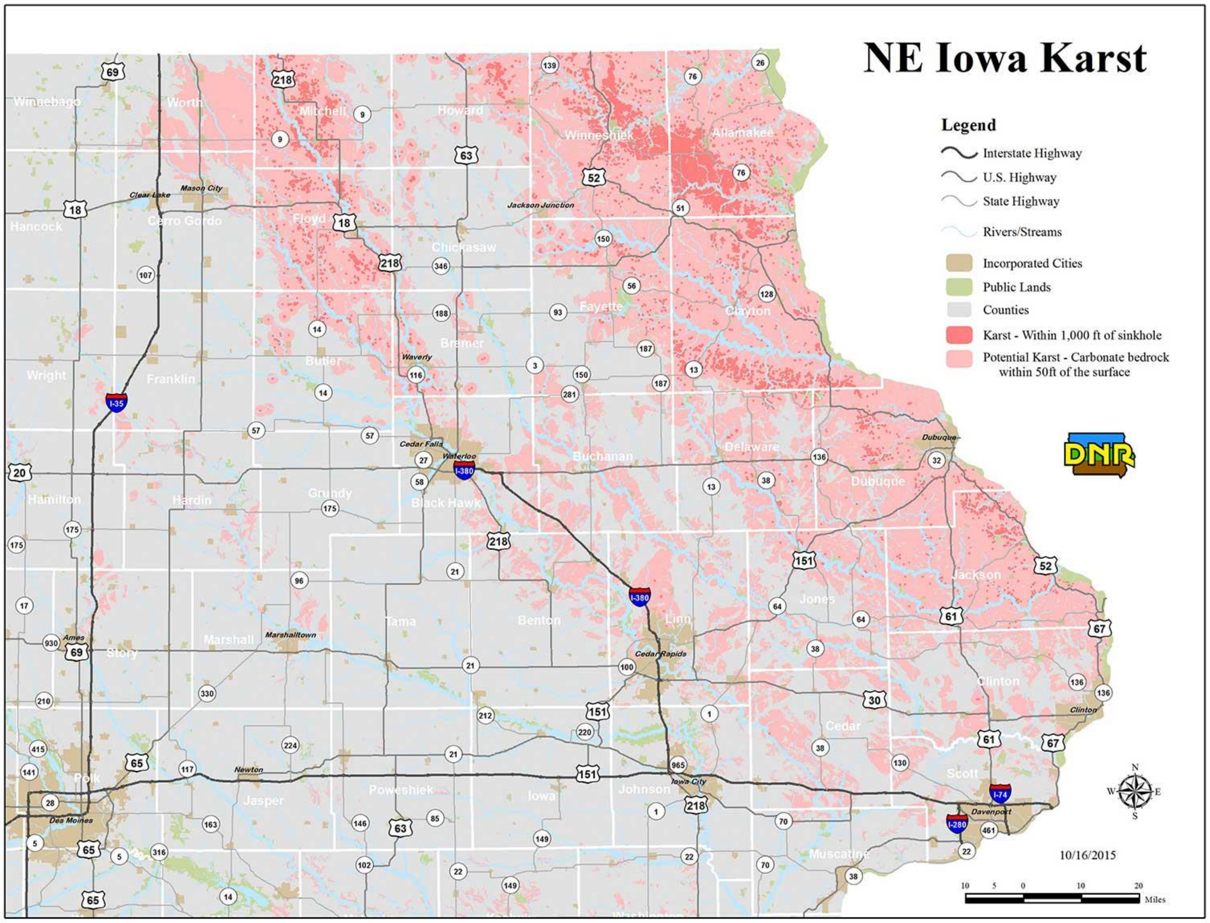

Figure 1. Iowa's Karst Region.

The karst region[5] is a predominantly rural area of the State where many people rely on private wells, rather than public water supplies, for their drinking water. All drinking water in this region—public and private—comes from groundwater aquifers. The population of the twelve counties comprising this region (Allamakee, Buchanan, Chickasaw, Clayton, Clinton, Delaware, Dubuque, Fayette, Howard, Jackson, Jones, Winneshiek Counties) is 316,074.[6] About 250,000 people in this area rely on community water systems while the remaining 63,000 use wells.[7] Nitrate contamination is more likely to impact rural populations who are dependent on community water systems and private wells and who are also more likely to be of lower income.[8] The Administrator

[5] The karst region does not follow county lines, but for purposes of data analysis, this Petition uses the twelve counties of Allamakee, Buchanan, Chickasaw, Clayton, Clinton, Delaware, Dubuque, Fayette, Howard, Jackson, Jones, and Winneshiek Counties.

[6] *See* Iowa Secretary of State, "2020 U.S. Census Iowa Counties Population," available at https://sos.iowa.gov/elections/pdf/2020census/counties.pdf (last visited Apr. 15, 2024).

[7] U.S. EPA tracks population served and the county for each public water supply. U.S. EPA ECHO Database, available at https://echo.epa.gov/facilities/facility-search/. The population not served by public water supplies was assumed to be served by a private well.

[8] "In Midwest farm states, nitrate pollution of tap water is more likely in lower-income communities," ENV'T WORKING GRP. (June 23, 2021), available at https://www.ewg.org/news-insights/news/2021/06/midwest-farm-states-nitrate-pollution-tap-water-more-likely-lower-income; *see also Interactive Maps: Poverty in Minnesota*

has called on EPA to strengthen the enforcement of cornerstone environmental statutes in these areas.[9]

This Petition is based on data that have been compiled by the Iowa Department of Health and Human Services (IHHS) and the Iowa Department of Natural Resources (DNR) and analyzed with support from Petitioners Environmental Working Group and the Izaak Walton League. The data demonstrate that nitrate concentrations in public water systems and underground sources of drinking water routinely exceed federal and state drinking water standards, putting the health of area residents at serious risk.

As explained in this Petition, the well-documented nitrate contamination of drinking water in the karst region necessitates prompt and decisive EPA emergency action under the SDWA. Elevated levels of nitrate in drinking water are known to increase the risk of a wide range of very serious health problems, including birth defects, blue-baby syndrome, cancer, thyroid disease, and other maladies. Nitrate contamination has long posed an imminent and substantial threat to human health, and the problem is not getting any better.

Despite Iowa applying for and being granted "primacy" under the SDWA, state and local officials have failed to do what is needed to correct the pervasive threat to human health. The data confirm that past measures employed by the State have been unsuccessful at reducing nitrate concentrations in crucial drinking water sources to below federal and state standards. EPA is fully empowered under the SDWA to take emergency action to protect human health in the karst region of Iowa and must do so, given present circumstances.

Because of its landscape features, groundwater quality in the karst region is largely driven by land use practices, and land use in this region is dominated by industrial row crop agriculture and livestock animal feedlots. Petitioners request that EPA act to protect human health and effectuate the goals of the SDWA in the karst region of Iowa through an investigation focused on the agricultural land uses that are driving the contamination of drinking water resources. Specifically, Petitioners request that EPA issue orders to protect the health of people who drink the contaminated water, including, at a minimum, orders:

- Requiring contaminators to provide a free and safe alternative source of drinking water for impacted communities;
- Prohibiting livestock operations from expanding or constructing new operations until nitrate concentrations fall below unsafe levels;
- Requiring public notice of potential contamination events, including manure land applications;
- Investigating the specific entities and land use practices causing the contamination;
- Initiating a survey to identify public water systems, private supply wells, or groundwater monitoring wells near potentially contaminated areas;
- Requiring the installation of a system of groundwater monitoring wells;

counties, MINN. DEP'T OF HEALTH, https://mndatamaps.web.health.state.mn.us/interactive/poverty.html (last visited Apr. 14, 2023).

[9] Memorandum from Lawrence E. Starfield, Acting Assistant Adm'r of U.S. EPA, on Strengthening Enf't in Communities with Env't Just. Concerns to Office of Enf't and Compliance Assurance (Apr. 30, 2021), https://www.epa.gov/sites/default/files/2021-04/documents/strengtheningenforcementincommunitieswithejconcerns.pdf.

- Controlling of the source of contaminants contributing to the endangerment;
- Requiring cleanup of contaminated soils that endanger underground sources of drinking water; and
- Commencing civil enforcement actions against entities causing threats to public health by contaminating drinking water supplies

Petitioners further request that EPA seek injunctions through civil actions, as needed, to return the area's underground aquifers to a safe and drinkable condition.

II. INTERESTS OF PETITIONERS

Iowa Environmental Council is an alliance of more than 100 organizations, over 500 individual members, and an at-large board of farmers, business owners, and conservationists. IEC works to build a just, healthy environment and sustainable future for all Iowans. Our members care about water quality across the state, and they fish, recreate, and drink water sourced from surface and groundwater sources.

Allamakee County Protectors Education Campaign is a group of concerned Iowa citizens that organized to keep frac sand mining from entering Allamakee County. The organization is concerned about conservation of natural resources and water quality in Allamakee County.

Center for Food Safety (CFS) 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 over 4,000 members in Iowa. CFS uses education, science-based advocacy, and litigation to address the negative environmental and public health effects of industrial agriculture.

Environmental Law and Policy Center 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, and Washington, D.C.

Environmental Working Group (EWG) is a nonprofit, nonpartisan organization that empowers people to live healthier lives in a healthier environment. For 30 years, EWG has harnessed its signature blend of research, advocacy, and unique educational tools to drive consumer choice and inspire civic action.

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 factory farm pollution and industrial agribusiness to protect farmers, rural communities, and the environment.

Since 1975, Iowa Citizens for Community Improvement has organized to build the power of everyday people in Iowa's rural towns and big cities. Iowa CCI members create change through grassroots organizing, educating, and mobilizing on issues that impact our communities the most. Together, we work to put people and planet first by stopping factory farms, ending racist policing and anti-immigrant legislation, and winning bold action on climate change, healthcare, and clean water for everyone.

The Iowa Alliance for Responsible Agriculture (IARA) is a diverse coalition of national, state, and local organizations and individuals who are concerned about the harmful impacts of factory farms and are each working to promote traditional and ethical agriculture in Iowa. The Iowa Alliance for Responsible Agriculture seeks to educate Iowans about the destructive impacts of industrial livestock production, advocate for a statewide factory farm moratorium, and promote traditional and humane livestock production.

Iowa's Coldwater Conservancy works as a facilitator and partner in collaborations with educators, businesses, other non-governmental organizations, public agencies, and landowners on projects to protect and improve the ecosystems that sustain our coldwater rivers and streams while expanding public access to these vital and unique natural resources. We envision Iowa's Coldwater rivers and streams being complete, healthy eco-systems that improve our natural environment and enhance the lives of everyone who has the opportunity to experience these examples of our natural heritage. This important effort to make the drinking water safe for everyone in the fragile karst region of northeast Iowa is also closely aligned with the work of ICC and our many partners to protect and conserve the ecosystems that are critical for the health of our unique coldwater rivers and streams. Humans and wildlife alike need clean water for healthy lives.

For over 100 years, the Izaak Walton League has fought for clean air and water, healthy fish and wildlife habitat, and conserving special places for future generations. It was the first conservation organization with a mass membership. Today, the League plays a unique role in supporting citizens locally and shaping conservation policy nationwide. The League is a grass roots member organization that has led efforts for clean water legislation achieving initial success with the passage of federal water pollution acts in 1948, 1956 and finally the Clean Water Act of 1972. The League continues to advocate for preserving wetlands, protecting wilderness, and promoting soil and water conservation. Its Save Our Streams (SOS) program involves activists in all fifty states in monitoring water quality. The Iowa Izaak Walton League was founded to conserve, restore, and promote the sustainable use and enjoyment of our natural resources, including soil, air woods, waters and wildlife. Furthermore, its special objective across the State is the preservation and restoration of the natural resources of the State of Iowa. It promotes, directly and through Chapters, true sportsmanship, and the principles of a broad, practical conservation program.

Sierra Club Iowa Chapter is the oldest and largest grassroots environmental organization in Iowa. We have approximately 7,000 members throughout the state. Sierra Club has been a leader in Iowa on addressing issues surrounding animal feeding operations and water quality. The Iowa Chapter takes action so all Iowans can enjoy clean air, clean water, clean and renewable energy, expansion and protection of natural areas and wildlife, and a government that represents people not polluters.

Socially Responsible Agriculture Project (SRAP) is a 501(c)(3) nonprofit organization incorporated in Delaware. For more than 20 years, SRAP has served as a mobilizing force to help communities protect themselves from the damages caused by industrial livestock operations, and to advocate for a food system built on regenerative practices, justice, democracy, and resilience. SRAP offers free support, providing communities with the knowledge and skills to protect their rights to clean air, water, and soil and to a healthy, just, and vibrant future. SRAP has worked on numerous matters in Iowa over the years, including helping communities protect their rights against industrial producers, and commenting to the Iowa DNR regarding Rule 65 revisions with other organizations working in Iowa.

Members of Trout Unlimited Iowa Driftless Chapter 717 work to protect and restore waters in the Driftless area of Northeast Iowa, including numerous trout streams threatened by water pollution. Trout Unlimited is a nationwide organization that brings together diverse interests to care for and recover rivers and streams so our children can experience the joy of wild and native trout and salmon.

III. LEGAL BACKGROUND

A. Safe Drinking Water Act

Congress enacted the SDWA as a powerful tool for protecting drinking water resources throughout the United States. Under the Act, EPA may delegate duties to state authorities to develop policies, regulations, and programs to ensure access to safe drinking water. On the federal level, the SDWA "requires EPA to protect the public from. . . drinking water contaminants."[10]

States may apply for, and EPA may delegate, "primacy" to states, which shifts significant authority and responsibility to state officials to implement the SDWA.[11] To assume primacy, the state is supposed to adopt regulations at least as stringent as EPA's national requirements, develop adequate procedures for enforcement and levying penalties, conduct inventories of water systems, maintain records and compliance data, and develop a plan for providing safe drinking water under emergency conditions.[12] While a state granted primacy has responsibility to implement the SDWA's provisions in that state, EPA retains emergency powers under Section 1431 of the SDWA to take actions necessary to abate imminent and substantial endangerment to the health of persons caused by drinking water contamination when state officials have failed to effectively do so on their own.

B. EPA's Emergency Powers

For EPA to exercise its Section 1431 authority, two conditions must be met. First, EPA must have received "information that a contaminant which is present in or likely to enter a public water system or an underground source of drinking water . . . may present an imminent and substantial endangerment to the health of persons."[13] Second, EPA must have received information that "appropriate State and local authorities have not acted to protect the health of such persons" in a timely and effective manner.[14] The emergency authority given to EPA broadens its authority by allowing EPA "to protect water supplies that do not meet the threshold of 25 persons served or

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[10] *City of Portland v. Env't Prot. Agency*, 507 F.3d 706, 709 (D.C. Cir. 2007).
[11] 42 U.S.C. § 300g-2; 40 C.F.R. §§ 142.10–142.19 (primacy enforcement responsibility).
[12] Elena H. Humphreys & Mary Tiemann, CONG. RES. SERV., RL31243, Safe Drinking Water Act (SDWA): A Summary of the Act & its Major Requirements 7 (2021), https://sgp.fas.org/crs/misc/RL31243.pdf.
[13] 42 U.S.C. § 300i; *see also* U.S. Env't Prot. Agency, Updated Guidance on Emergency Authority Under Section 1431 of the SDWA 8 (2018) [hereinafter Emergency Authority Guidance].
[14] 42 U.S.C. § 300i; *see also* Emergency Authority Guidance, *supra* note 13, at 12-13.

15 service connections in the definition of 'public water system' (for example, many private wells) that are at risk because of the contamination or threatened contamination of an [underground source of drinking water]."[15]

1. Contaminant

The SDWA defines a contaminant as "any physical, chemical, biological, or radiological substance or matter in water."[16] While this broad definition does not require a substance to be regulated under the Act in order to be classified as a "contaminant," nitrate is listed as a contaminant with an established maximum contaminant level (MCL) of 10 mg/L.[17] An MCL is the "maximum permissible level of a contaminant in water which is delivered to any user of a public water system."[18] MCLs are promulgated after a determination by EPA based on the best available, peer-reviewed science and data that the regulation of the contaminant will reduce a threat to public health.[19] Establishing nationwide, health-based MCLs is central to EPA's role in protecting drinking water under the SDWA.[20]

The MCL for nitrate was set at 10 mg/L to protect against blue-baby syndrome; however, recent studies have shown that even lower levels of nitrate can cause other health effects, including cancer and reproductive harm.[21] For example, recent studies have found statistically significant increased risks of colorectal cancer at drinking water levels far below the current MCL of 10 mg/L.[22]

2. Imminent & Substantial Endangerment

An endangerment from a contaminant is "imminent" if conditions that give rise to it are present, even if the actual harm may not be realized for years.[23] Courts have established that an "imminent hazard" may be declared at any point in a chain of events that may ultimately result in harm to the public.[24] Information presented to EPA need not demonstrate that residents are actually drinking contaminated water and becoming ill to warrant EPA exercising its Section 1431 emergency authority.[25] In other words, an actual injury need not have occurred for EPA to act, and to wait for such actual injury to befall the public would be counter to the precautionary intent

[15] 42 U.S.C. § 300i; *see also* Emergency Authority Guidance, *supra* note 13, at 8.
[16] 42 U.S.C. § 300f(6).
[17] 40 C.F.R. § 141.62(b).
[18] 42 U.S.C. § 300f(3).
[19] 42 U.S.C. §§ 300g-l(b)(1)(A), (b)(3)(A).
[20] 42 U.S.C. § 300g-1(b)(4)(B).
[21] *See, e.g.,* Mary. H. Ward et al., *Drinking Water Nitrate and Human Health: An Updated Review*, 15 Int'l J. Env't Rsch. & Pub. Health 1557 (2018); 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 Rsch. 108442 (2019).
[22] *See, e.g.,* Jorg Schullehner et al., *Nitrate in Drinking Water and Colorectal Cancer Risk: A Nationwide Population-Based Cohort Study*, 143 Int'l J. Cancer 73 (2018).
[23] Emergency Authority Guidance, *supra* note 12, at 8 (citing *United States v. Conservation Chem. Co.*, 619 F. Supp. 162, 193-94 (W.D. Mo. 1985)).
[24] *Id.* n.15 (citing cases).
[25] *See Trinity Am. Corp. v. Env't Prot. Agency*, 150 F.3d 389, 399 (4th Cir. 1998).
[24] Emergency Authority Guidance, *supra* note 13, at 8.

behind the SDWA. Thus, while the threat or risk of harm must be "imminent" for EPA to act, actual and documented harm itself need not be.[26] While endangerments are readily determined to be imminent where MCL violations expose sensitive populations to a contaminant, contaminants that lead to chronic health effects may also cause "imminent endangerment."[27] In such cases, it is appropriate to consider the length of time a population has been or could be exposed to a contaminant.[28]

An endangerment is "substantial" "if there is a reasonable cause for concern that someone may be exposed to a risk of harm."[29] For instance, Congress has deemed an endangerment sufficiently substantial where a substantial likelihood exists that contaminants capable of causing adverse health effects will be ingested by consumers if preventative action is not taken.[30] As with imminence, EPA has made clear that actual reports of human illness resulting from contaminated drinking water are not necessary to establish substantial endangerment.[31]

C. Iowa's Authority

Iowa adopted a Groundwater Protection Act (GWPA) in 1987 in response to the legislature's finding that "Groundwater is a precious and vulnerable natural resource."[32] The legislature acknowledged a range of human activities "have resulted in groundwater contamination throughout the state."[33] Because of the value of groundwater and the potential contamination, the legislature concluded that "preventing contamination of groundwater is of paramount importance"[34] and declared "[t]he intent of the state is to prevent contamination of groundwater from point and nonpoint sources of contamination to the maximum extent practical."[35]

To carry out its intent, the Iowa legislature declared that groundwater contamination "shall require appropriate actions to prevent further contamination."[36] The legislature also required DNR to adopt rules governing cleanup of groundwater contamination creating a risk to human health, and the cleanup must employ the best technology or practices available.[37]

However, agricultural producers are specifically exempt from any cleanup costs, including damages, so long as the producer applied fertilizer in compliance with soil tests and product labels.[38] None of the State's other programs fill in the gap in funding for cleaning up agriculture-caused groundwater contamination.

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[26] Emergency Authority Guidance, *supra* note 13, at 8.
[27] *Id.*
[28] *Id.*
[29] *Id.* at 11.
[30] *See* H.R. REP. NO. 93-1185, at 35-36 (1974).
[31] *See* Emergency Authority Guidance, *supra* note 13, at 11 (citing *United States v. North Adams*, 777 F. Supp. 61, 84 (D. Mass. 1991)).
[32] IOWA CODE § 455E.3.
[33] *Id.*
[34] *Id.*
[35] IOWA CODE § 455E.4.
[36] IOWA CODE § 455E.5.
[37] *Id.*
[38] IOWA CODE § 455E.6.

The GWPA established a groundwater protection fund with accounts for solid waste, agricultural management, household hazardous waste, and storage tank management.[39] Aside from a small designation for the Iowa Department of Public Health, the agricultural management account funds (1) the Iowa Nutrient Research Fund, (2) grants to counties for private well testing and closure, (3) a center for health effects of environmental contamination, and (4) financial incentives for agricultural drainage wells and sinkholes.[40] Notably, none of these uses fund cleanup of contamination caused by agricultural sources.

The authority to set regulations for DNR lies in the Environmental Protection Commission (EPC). In addition to authority under the Iowa GWPA, the EPC has broad statutory authority to "[d]evelop comprehensive plans and programs for the prevention, control and abatement of water pollution."[41] The EPC has adopted a range of rules addressing water quality, including regulations to set water quality standards and restrict pollution. No other department or commission has this duty in Iowa – only the EPC has authority to adopt rules for water quality protection.

The EPC has adopted regulations proposed by DNR governing groundwater in Chapter 41 of title 567 in the Iowa Administrative Code. This chapter includes the standards required for primacy under the SDWA, such as the maximum contaminant levels for drinking water.[42] It also addresses requirements for public water supplies that rely on groundwater.[43] Much like the Iowa GWPA, the chapter does not create a program to regulate groundwater pollution sources. The only regulations directly controlling the sources of groundwater pollution are in Chapter 113, which addresses systems to protect groundwater from contamination by sanitary landfills and corrective actions.[44]

Iowa has a Drinking Water State Revolving Fund, which funds public water systems to provide potable water.[45] Part of the scoring system includes mitigation of an imminent threat from groundwater contamination.[46] But again, this fund does nothing to clean up the contamination – it merely pays for water treatment at facilities for public water supplies.

To address agricultural sources of groundwater contamination, the EPC has adopted regulations governing animal feeding operations (AFOs) in karstic regions. By law, the EPC must ensure that "[m]anure from an animal feeding operation shall be disposed of in a manner which will not cause surface water or groundwater pollution."[47] After denying a petition to strengthen the rules in 2021, the EPC voted in April 2024 to adopt AFO rules that backtracked from DNR-drafted changes that would have strengthened AFO siting and manure storage protections for karst. Unlike EPC's final rules, DNR's draft was based on recommendations from a department-convened panel of groundwater experts. Rather than heeding the panel's advice, the EPC retained

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[39] IOWA CODE § 455E.11.
[40] *Id.* at (2)(b).
[41] IOWA CODE § 455B.173.
[42] IOWA ADMIN. CODE r. 567-41.3.
[43] IOWA ADMIN. CODE r. 567-41.7.
[44] IOWA ADMIN. CODE r. 567-113.
[45] IOWA ADMIN. CODE r. 567-44.
[46] IOWA ADMIN. CODE r. 567-44.7(7). *See also* IOWA ADMIN. CODE r. 567-91.8 (project ranking system for the water pollution control state revolving fund)
[47] IOWA CODE § 459.311(3).

the existing requirements for construction in karst terrain, even though the department's own experts deemed the existing requirements inadequate (see Appendix A).

The Iowa Department of Public Health, which has since been reorganized as an office of the Iowa Department of Health and Human Services,[48] used its authority under the Groundwater Protection Act to adopt regulations governing a program called Grants to Counties.[49] The program provides funding to counties, which in turn can be used to support private well testing, reconstruction, and plugging after abandonment.[50] It does not address prevention or mitigation of contamination in underground sources of drinking water.

D. EPA's Authority in Iowa

Despite Iowa's primacy under the SDWA, EPA retains emergency powers to abate present or likely contamination of public water systems (PWS) or underground sources of drinking water (USDW) when such contamination poses an imminent and substantial threat to human health and the state "ha[s] not acted to protect the health of [endangered] persons."[51]

EPA's Section 1431 authority extends to contaminated USDW and PWS that supply private wells.[52] EPA defines USDW as an aquifer or part of an aquifer "(1) [w]hich supplies any public water systems; or (2) which contains a sufficient quantity of ground water to supply a public water system; and (i) currently supplies drinking water for human consumption."[53] PWS are systems that provide water for human consumption and "ha[ve] at least fifteen service connections or regularly serve[] at least twenty-five individuals."[54] The drinking water for hundreds of thousands of residents of the karst region of Iowa comes from either private or community wells that rely on groundwater. The underground aquifers that supply these wells therefore qualify as USDW and PWS within the purview of the SDWA.

To abate endangerment to human health that arises despite a state's efforts to curtail it, Congress authorized EPA to, among other things, issue "such orders as may be necessary to protect the health of persons who are or may be users of" the affected drinking water supplies and to commence civil enforcement actions against entities causing threats to public health by contaminating drinking water supplies.[55] Petitioners ask EPA to use that authority here.

Most of the karst terrain in Iowa is in the northeast portion of the state, known as the Driftless Area that was not subject to glaciation (Figure 2).[56] Karst is an ideal aquifer, but because

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[48] Michaela Ramm, "Iowa introduces new Health and Human Services agency, but merger is still far from over," DES MOINES REGISTER, Aug. 30, 2022, available at https://www.desmoinesregister.com/story/news/2022/08/30/iowa-new-health-and-human-services-department/7942401001/.

[49] IOWA ADMIN. CODE r. 641-24.

[50] IOWA ADMIN. CODE r. 641-24.1.

[51] 42 U.S.C. § 300i(a).

[52] Emergency Authority Guidance, *supra* note 13, at 7-8.

[53] 40 C.F.R. § 144.3.

[54] 42 U.S.C. § 300f(4)(A).

[55] Emergency Authority Guidance, *supra* note 13, at Attach. 2.

[56] *See* "NE Iowa Watershed and Karst Map," Iowa DNR (Nov. 2010), available at https://www.iowadnr.gov/Portals/DNR/uploads/water/wells/IGWS%20Karst%20Map.pdf.

it is porous, water travels quickly through it while receiving little filtration.[57] Therefore, contaminants that enter a karst aquifer are rapidly transported and create water quality problems.[58] About 20% of the United States is underlain by karst landscapes and 40% of groundwater used for drinking comes from karst aquifers.[59]

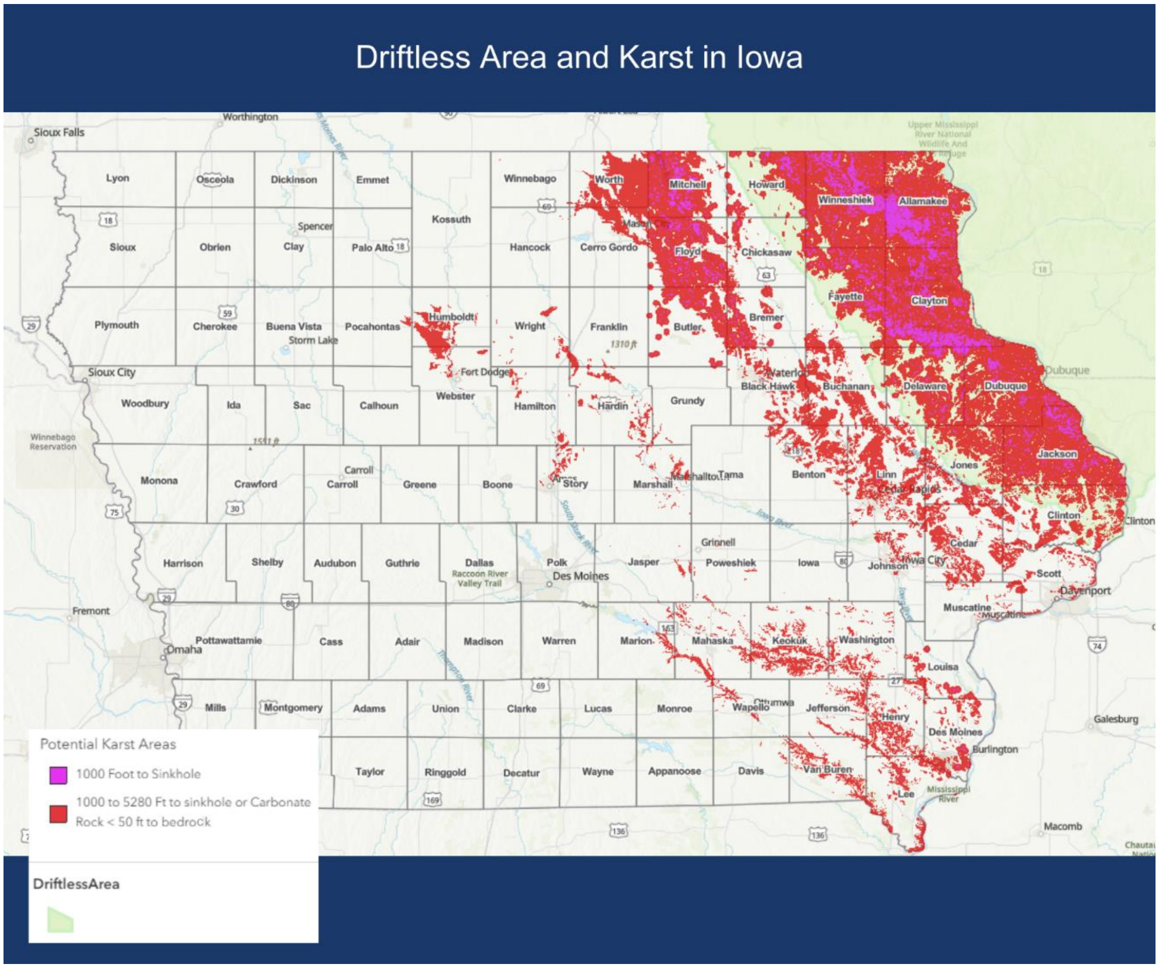

Figure 2. The Driftless area and karst terrain in Iowa.

Groundwater in the karst region is vulnerable to contamination because of the fluid interaction between groundwater and surface water. The rapid movement of water in and out of the ground in this region leaves less distinction between groundwater and surface water. "[N]ot only does karst aquifer groundwater flow rapidly (flows have been measured in miles per day versus the inches or feet per year common to sandstones), but contaminants in the groundwater are not readily filtered out. As a result, contaminants can reach domestic wells located miles from the

[57] *Id.*
[58] *Id.*
[59] *Id.*

source of contamination."[60] Many private wells in the karst region rely on the Silurian-Devonian aquifer, which regularly has nitrate concentrations greater than the drinking water standard, as shown in Figure 3.[61]

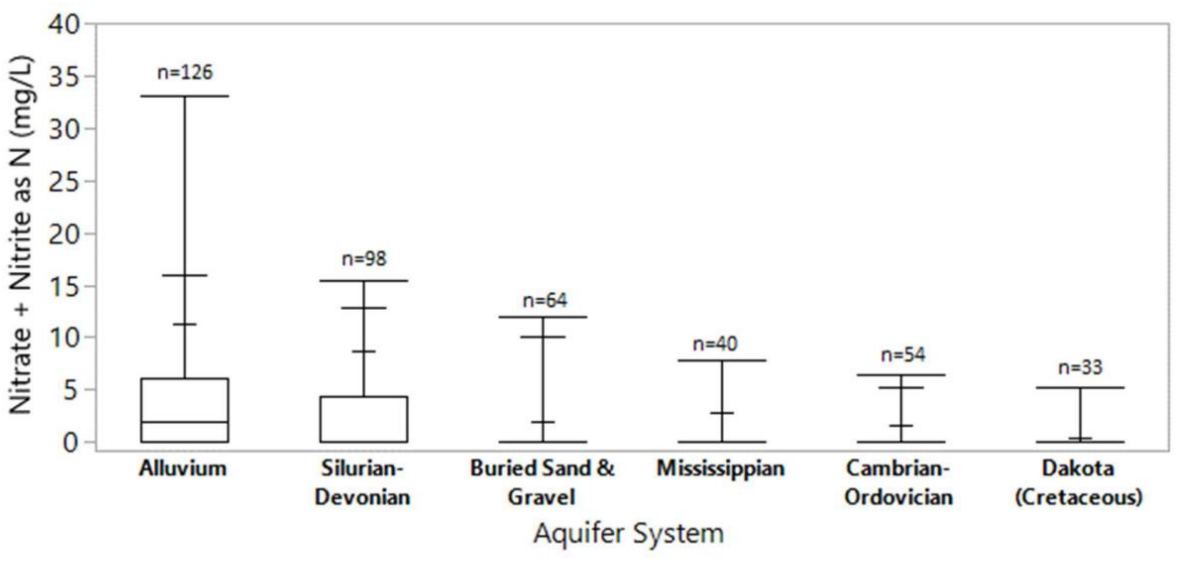

Figure 3. Aquifer nitrate concentrations.

Nitrate is highly mobile in groundwater.[62] Nitrate mobility in karst regions is largely determined by rainfall frequency and intensity. Recent research indicates that up to 80% of nitrate loading in karst regions can be traced to nitrogen fertilizers that are quickly flushed from soils into the karst and groundwater systems during rain events.[63] Water carries the excess nitrogen from fertilizers on the surface through the soil column and into the fractured karst bedrock, where oxygenated conditions facilitate conversion of nitrogen to nitrate.[64] Combining nitrogen-intensive

[60] Jeffrey St. Ores et al., Groundwater Pollution Prevention in Southeast Minnesota's Karst Region, 465 Univ. of Minn. Extension Bull. 6 (1982), https://conservancy.umn.edu/bitstream/handle/11299/169069/mn_2000_eb_ 465.pdf?sequence=1 [hereinafter Ores 1982].
[61] "Iowa DNR Ambient Groundwater Quality Monitoring Program Summary for FY19," Iowa DNR, available at https://publications.iowa.gov/34466/1/FY19%20Summary.pdf, at 7. The figure provides quartile boxplots showing distributions of nitrate + nitrite as N concentrations in ambient groundwater monitoring program wells (2002-FY2019) by aquifer system.
[62] Minn. Pollution Control Agency, Effects of Liquid Manure Storage System on Groundwater Quality 3 (2001), https://www.pca.state.mn.us/sites/default/files/rpt- liquidmanurestorage.pdf.; *see* Bijay-Singh, Craswell, E. Fertilizers and nitrate pollution of surface and ground water: an increasingly pervasive global problem. *SN Appl. Sci.* 3, 518 (2021). https://doi.org/10.1007/s42452-021-04521-8.
[63] Fu-Jun Yue et al., *Rainfall and Conduit Drainage Combine to Accelerate Nitrate Loss from a Karst Agroecosystem: Insights from a Stable Isotope Tracing and High-Frequency Nitrate Sensing*, 186 WATER RSCH. 116388 (2020), https://doi.org/10.1016/j.watres.2020.116388.
[64] Philip Monson, Minn. Pollution Control Agency, Aquatic Life Water Quality Standards Draft Technical Support Document for Nitrate 1 (2022), https://www.pca.state.mn.us/sites/default/files/wq-s6-13.pdf.

land uses (such as modern agriculture) with the karst region's heightened vulnerability to nitrate contamination is a major hazard.

Manure spills – which also contain nitrates – and other releases of pollutants on karst topography can quickly enter groundwater and pollute surface water. In July 2021, a leak from an underground chemical storage system managed to cause a fish kill in surface water before the stream "disappeared underground just upstream of the Turkey River."[65] A study of drinking water wells in karstic bedrock in Wisconsin found that livestock manure was the most likely source for contaminated drinking water that would result in gastrointestinal illness.[66] Similarly in Minnesota - just over the state line of Iowa's karst region - "[g]roundwater in uppermost bedrock units, especially on the karstic plateaus that dominate the landscape of southeastern Minnesota, is typically nitrate-enriched, with concentrations commonly between 5-15 ppm."[67] Rural communities are particularly at risk because private wells are more likely to draw from shallow aquifers than public water systems, which can pull water from deeper wells and multiple sources.[68]

A 1982 analysis of groundwater in Iowa identified counties with the most wells above 45 mg/L of nitrate – more than four times the drinking water standard – including Jackson, which is included in this petition.[69] Private well testing reported to the state has continued to show nitrate contamination. As EWG and IEC reported in 2019, the concentrations have shown an increase since 2002 (Figure 4).[70]

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[65] "DNR investigated fish kill in Winneshiek County over weekend," Iowa DNR News Release, July 12, 2021.

[66] Coburn Dukehart, "Cow Manure Predicted to Cause Most Sickness From Contaminated Wells on Kewaunee County," Wisconsin Public Radio (June 24, 2021) available at https://www.wpr.org/cow-manure-predicted-cause-most-sickness-contaminated-wells-kewaunee-county.

[67] Anthony C. Runkel et al., Geologic Controls on Groundwater and Surface Water Flow in Southeastern Minnesota and its Impact on Nitrate Concentrations in Streams, MINN. GEOLOGIC SURV., 4, 59 (2013).

[68] *Learn About Private Water Wells*, Env't Prot. Agency (Mar. 1, 2023), https://www.epa.gov/privatewells/learn-about-private-water-wells.

[69] G. Hallberg and B. Hoyer, *Sinkholes, Hydrogeology, and Ground-water quality in Northeast Iowa*, Iowa Geological Survey, 20 (May 31, 1982).

[70] "Iowa's Private Wells Overrun with Contaminants," Iowa Environmental Council (Apr. 24, 2019), available at https://www.iaenvironment.org/newsroom/water-and-land-news/iowas-private-wells-overrun-with-agricultural-contaminants.

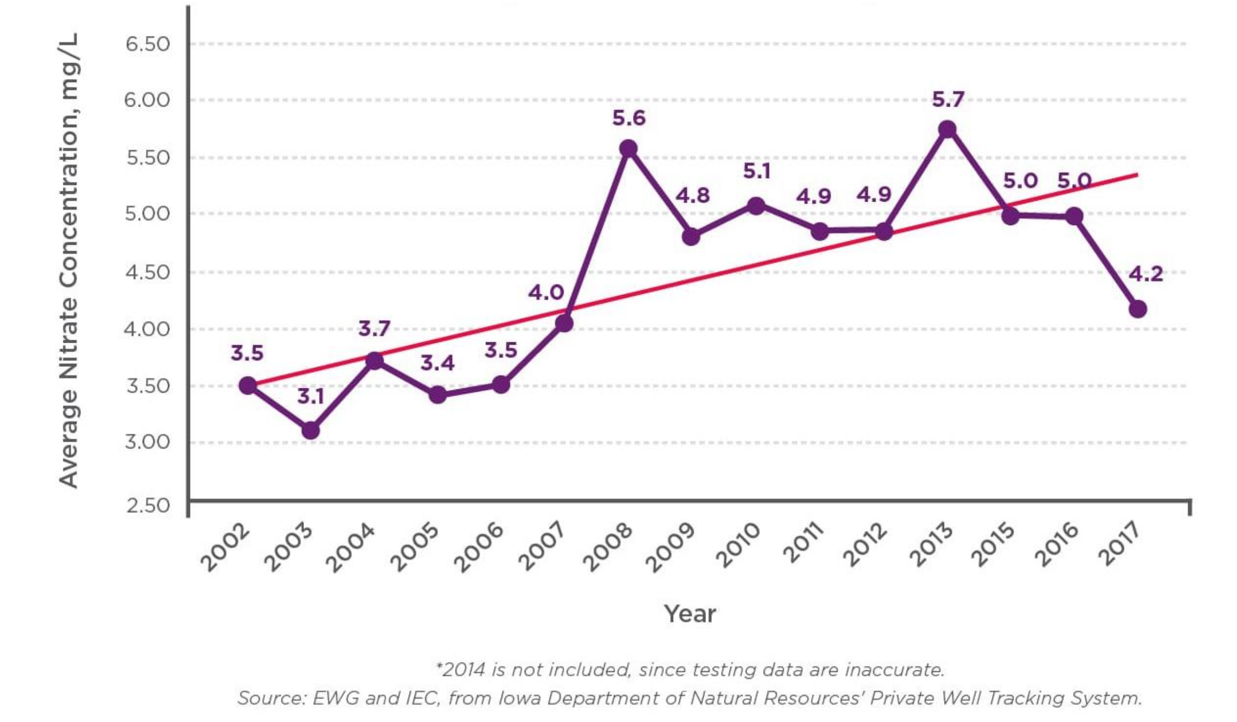

Figure 4. Average nitrate concentration in Iowa's private wells, 2002-2017.

E. The Karst Region Has a Documented History of Nitrate Contamination

The karst region has an extensive history with nitrate contamination in groundwater aquifers. Although nitrate is a naturally occurring substance, the presence of nitrate in groundwater at concentrations above 3 parts per million (3 milligrams per liter) is not natural and indicates an anthropogenic nitrate source.[71] Iowa Geological Survey noted in a 1982 report about nitrate in the karst region that high nitrate concentrations cause methemoglobinemia in infants, also known as "blue baby syndrome," and may be carcinogenic at lower concentrations.[72] Testing for nitrate in private wells began more broadly in 1989 and shows high concentrations in the region. Testing of public water supplies has also shown concentrations at or approaching the MCL.

1. Private Wells

In this petition, Petitioners present a compilation of data showing nitrate contamination in private wells in the karst region. The State of Iowa provides funding to counties to conduct private well testing for nitrate and *E. coli* through the Grants to Counties program. The private well testing samples are typically collected by county environmental health staff, analyzed by the Iowa State Hygienic Lab, and compiled by the Iowa DNR in the Private Well Tracking System. Iowa

[71] *Nitrate in Drinking Water*, MINN. DEP'T OF HEALTH (DEC. 8, 2022), https://www.health.state.mn.us/communities/environment/water/contaminants/nitrate.html.
[72] G. Hallberg and B. Hoyer, *Sinkholes, Hydrogeology, and Ground-water quality in Northeast Iowa*, Iowa Geological Survey, 14 (May 31, 1982).

Environmental Council staff analyzed the data from 1989 through 2023. During that time, 146,775 private well samples were tested for nitrate across Iowa.[73] Of those samples, 37,358 were in the Driftless region (Table 1), as identified through GIS analysis (Figure 5).

	Driftless Wells	All Iowa
Total samples	37,358	146,775
Samples greater than or equal to 5 mg/L	12,014	33,208
Samples greater than or equal to 10 mg/L	5,683	17,211

Table 1. Grants to Counties private well tests for nitrate, 1989 – 2023.

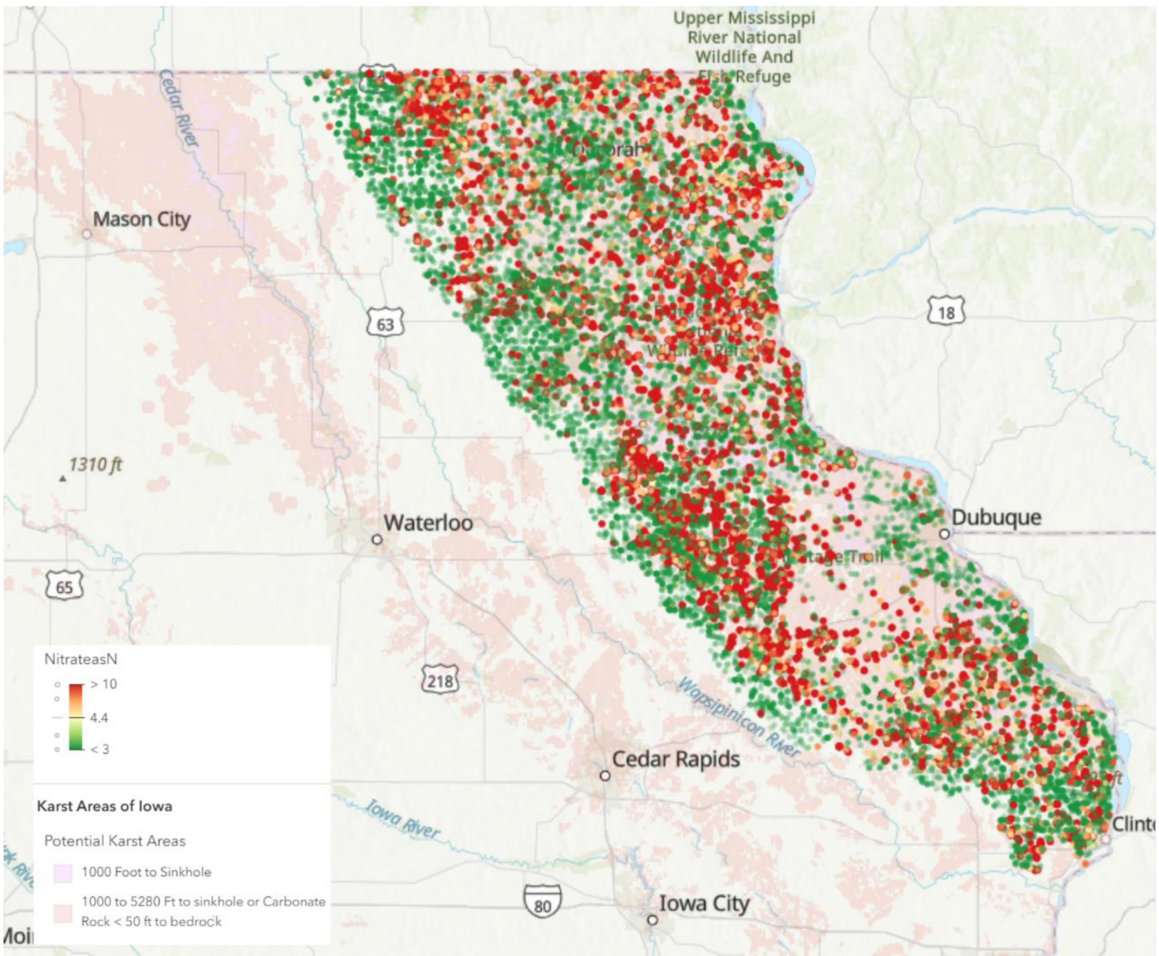

Figure 5. Private well nitrate test results in the Iowa Driftless area, 1989-2023.

Analysis of the private well data from the Iowa DNR show that 5,683 samples (15.2%) from Driftless area wells tested at or above the 10 mg/L drinking water standard for nitrate between

[73] Data from 2014 were inaccurate and are excluded from data analyses. *See* https://www.iaenvironment.org/webres/File/EWG_IowaWells-Report_C01.pdf.

1989 and 2023. For the entire state of Iowa, 11.7% of samples exceeded the 10 mg/L drinking water standard during the same timeframe (Figure 6).

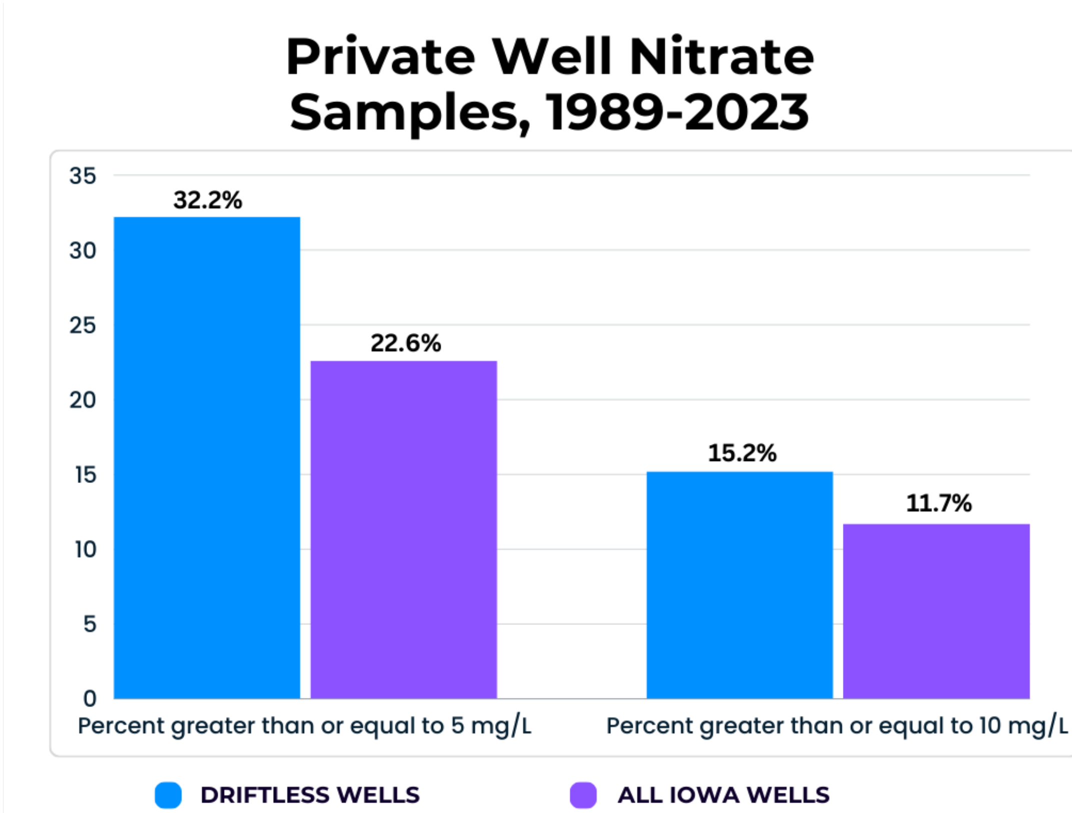

Figure 6. Private well samples testing high for nitrate in the Driftless region compared to statewide.

Wells in the Iowa Driftless region tested higher for nitrate than the rest of the state, demonstrating the susceptibility of these wells to nitrate contamination. In more recent years, analysis shows that more than 10% of private well tests in the Iowa Driftless were greater than the 10 mg/L MCL (Figure 7). Nearly 39% of samples tested above 3 mg/L, indicating anthropogenic sources of contamination.

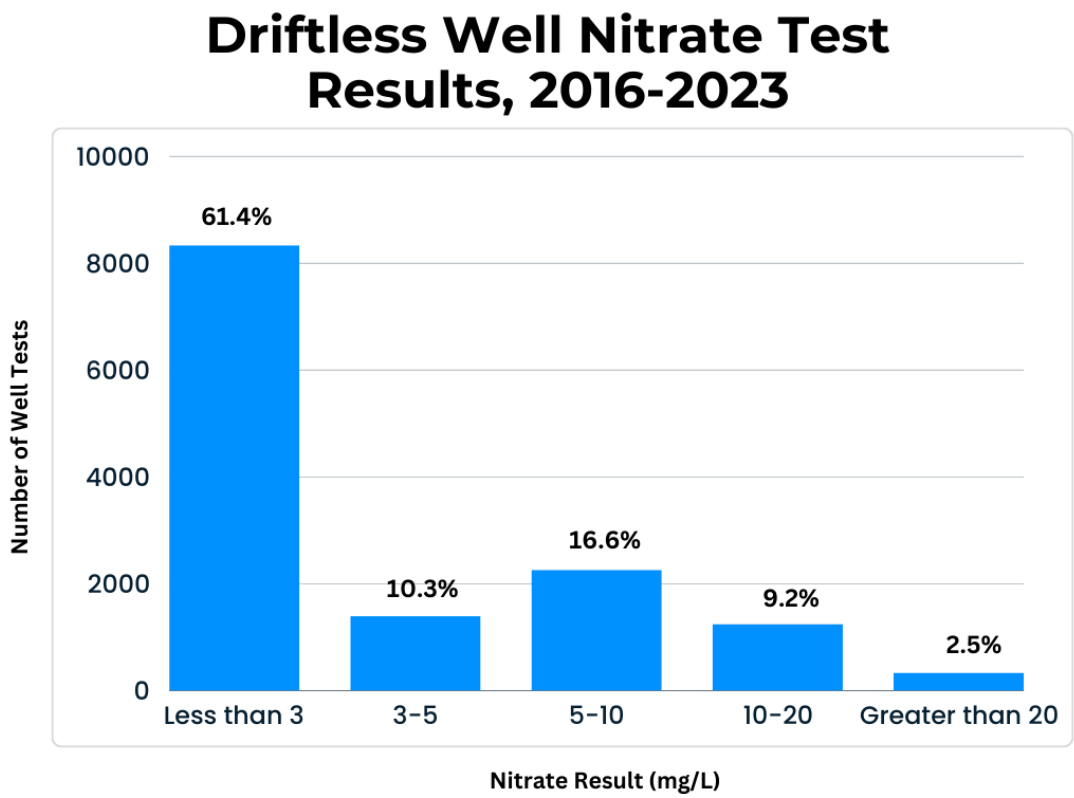

Figure 7. Nitrate test results for Driftless private wells, 2016-2023.

A small fraction of private wells are tested regularly for nitrate. For example, in 2020, only 6.5 percent of private wells were tested statewide.[74] Within the counties subject to this petition, just over seven percent were tested.[75] Even from that small fraction of tested wells, a substantial number of wells exceeded the MCL. From 2016 to 2023, 1,259 wells in the 12-county region subject to this petition tested above 10 mg/L for nitrate.[76] Figure 8 shows how many wells per county tested above the MCL. EPA needs to step in to protect private well owners from this damaging nitrate contamination.

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[74] "Workbook: Private Water Well Services," Iowa Department of Public Health, available at https://data.idph.state.ia.us/t/IDPH-DataViz/views/PrivateWaterWellServices/DatabyCounty?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3AshowVizHome=no&%3Arender=false (last visited Apr. 15, 2024).

[75] "Workbook: Private Water Well Services," Iowa Department of Public Health, available at https://data.idph.state.ia.us/t/IDPH-DataViz/views/PrivateWaterWellServices/DatabyCounty?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3AshowVizHome=no&%3Arender=false (last visited Apr. 15, 2024).

[76] Analysis of PWS violation data obtained from DNR's Drinking Water Portal at https://programs.iowadnr.gov/iowadrinkingwater (last visited March 26, 2024).

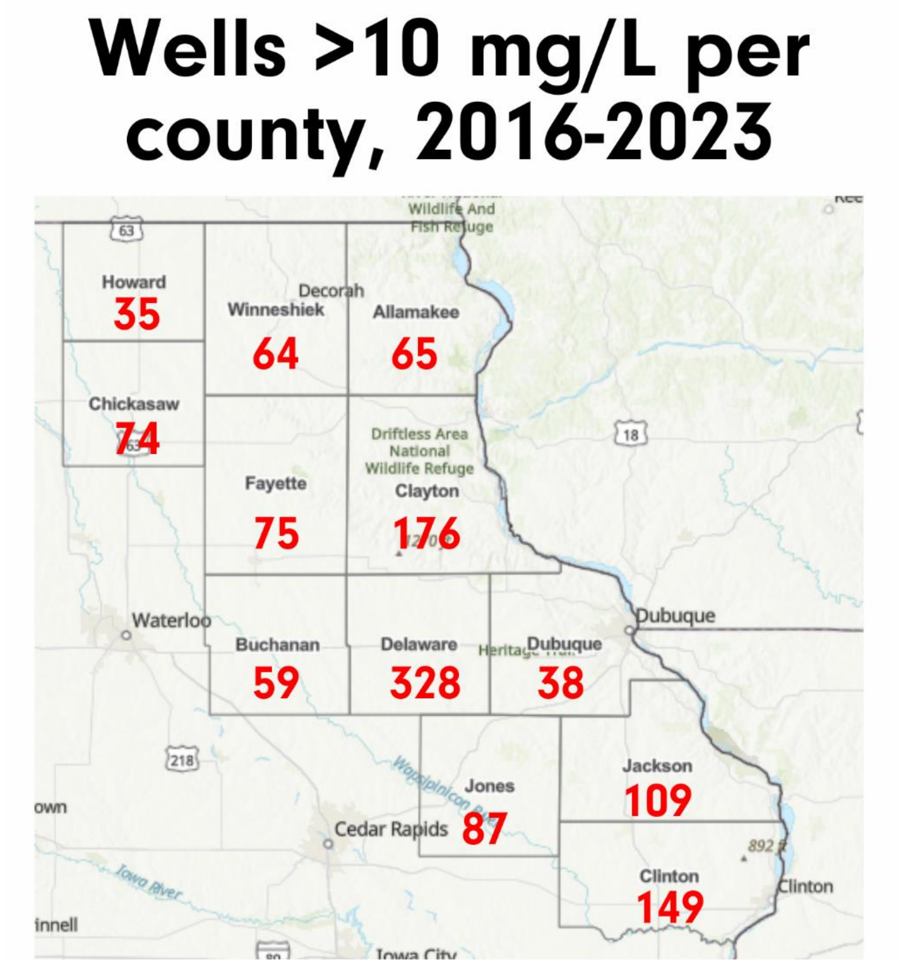

Figure 8. Wells per county that tested above 10 mg/L of nitrate between 2016-2023.

2. Public Water Supplies

According to DNR's Drinking Water Portal database, there are 407 public water systems in the 12-county area of focus. Despite the additional protection available to protect PWS, many community water supplies with 25 or more connections to a well and many transient community water supplies like churches, campgrounds, and businesses in the area, are also affected by nitrate contamination. Of the 83 health-based nitrate violations reported from the 407 PWS between 2016 and 2023, all but one were from a transient PWS.[77]

Non-transient community public water systems in the 12-county region also show impacts of anthropogenic sources of nitrate. Many communities struggle with controlling nitrate levels in their drinking water. Samples from Strawberry Point Water Supply averaged 5 mg/L from 2016 to 2023. Finished samples from the system's Well #4 averaged 8.2 mg/L during this time. The well was closed in 2019 and a new well was brought online (Figure 9).[78]

[77] Analysis of PWS violation data obtained from DNR's Drinking Water Portal at https://programs.iowadnr.gov/iowadrinkingwater (last visited March 26, 2024).
[78] Iowa DNR, Drinking Water Portal, https://programs.iowadnr.gov/iowadrinkingwater (last visited Mar. 26, 2024).

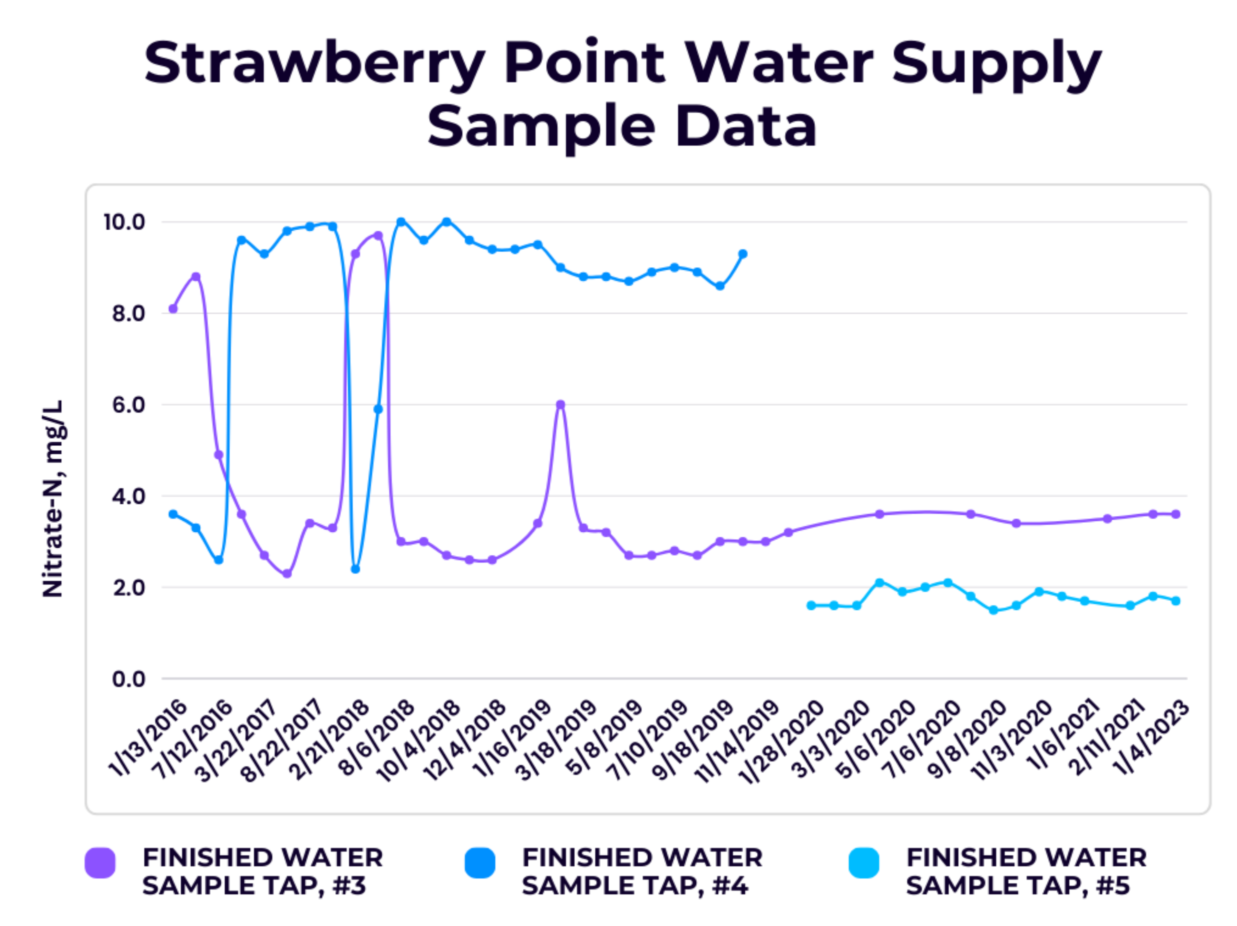

Figure 9. Nitrate sample data from Strawberry Point Water Supply finished drinking water, 2016-2023.

Other drinking water systems show similar issues. For Manchester Water Supply, the average nitrate level in its finished drinking water from 2016-2023 was 7.3 mg/L, well above the level indicating anthropogenic sources.[79] In fact, no samples during that period measured below 5 mg/L. Average nitrate in the finished drinking water from Independence Water Department measured 7 mg/L during the same period.[80] Detailed PWS information obtained from the Iowa DNR's Drinking Water Portal, including analysis data, can be found in Appendix B.

F. Under-Regulated Animal Feeding Operations and Industrial Row Crop Agriculture Are Dominant Land Use Activities and the Predominant Causes of Nitrate Contamination in the Karst Region

Most nitrate contamination in the karst region is caused by harmful agricultural practices on groundwater recharge areas that are not sufficiently addressed by Iowa agencies. Despite evidence of adverse impacts on groundwater and public health caused by manure storage, the

[79] *Id.*
[80] *Id.*

excessive or poorly timed application of manure, animal feeding operations, and industrial row-crop agriculture, Iowa has had inadequate state and local regulation for decades, resulting in a public health crisis that requires emergency action from EPA. The root cause of this pollution is public policy that makes polluting actions cheaper and easier than sustainable practices.

1. Industrial Animal Agriculture

The majority of the waters that DNR has designated as Outstanding Iowa Waters are in the area of karst terrain in Northeast Iowa.[81] The fact that these high-quality waters are located in karst terrain and are more vulnerable to pollution necessitates preventing further concentrated animal feeding operation (CAFO) siting in these areas. The DNR's recent approval of a large CAFO in the area led to widespread public outcry and poses a threat to multiple Outstanding Iowa Waters.[82]

Scholarship on karst shows that there is grave risk in building CAFOs on karst terrain,[83] but Iowa DNR's rules do not adequately address that risk. All construction above karst is dangerous for water quality due to the potential for sinkholes and groundwater contamination.[84] Because of this risk, experts have concluded it is safest to assess animal feeding operation construction – including the construction of the massive manure storage structures called lagoons – above karst on a site-by-site basis.[85] These experts also propose a more holistic process of handling construction above karst where scientists and farmers are more involved in the regulatory process to minimize risk to groundwater.[86]

Current DNR rules generally require a five-foot separation of a formed manure storage structure from karst geology, but do not require any separation if the structure is designed by a professional engineer or the Natural Resources Conservation Service.[87] This is not adequate to prevent contamination as required by statute.[88] IEC and the Environmental Law & Policy Center petitioned the EPC in 2021 to require a 25-foot vertical separation, which is already in effect for earthen basin AFO structures above karst.[89] EPC denied that petition in February 2022.[90] DNR subsequently began a process to revise the rules governing AFOs, and an internal technical committee addressing karst concluded that the state needed additional protections. The committee, made up of geologic experts and DNR technical staff, recommended increasing the separation

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[81] *See* "Iowa's Outstanding Iowa Waters Map," Iowa DNR, available at https://www.iowadnr.gov/Portals/DNR/uploads/water/standards/outstanding_iowa_waters.pdf.
[82] *See* "Summary of Comments Received by the Iowa Department of Natural Resources," Iowa DNR, April 2, 2021 (commenting on the Supreme Beef nutrient management plan); Clay Masters, "The Battle Over Bloody Run Creek," Iowa Public Radio (July 1, 2021), available at https://www.iowapublicradio.org/environment/2021-07-01/the-battle-over-bloody-run-creek.
[83] *See* Van Brahana et al., *CAFOs on Karst—Meaningful Data Collection to Adequately Define Environmental Risk, with a Specific Application from the Southern Ozarks of Northern Arkansas*, US GEOL. SURVEY SCI. INVEST. REP. 5035, 97.
[84] *See* Katarina Kosic et al., *Proposals for integrating karst aquifer evaluation methodologies into national environmental legislations*, 1 SUSTAIN. WATER RESOUR. MANAG. 373 (2015).
[85] *Id.*
[86] Katarina Kosic & Ira D. Sasowsky, *An interdisciplinary framework for the protection of karst aquifers*, 89 ENV. SCI. & POL'Y 41 (2018).
[87] IOWA ADMIN. CODE r. 567-65.2(10)(b).
[88] IOWA CODE § 459.311(3).
[89] IOWA ADMIN. CODE r. 567-65.15.
[90] Iowa Environmental Protection Commission, "Denial of Petition for Rulemaking" (Feb. 15, 2022).

distance to a minimum of 25 feet from karst geology as shown in Appendix A.[91] However, the rule adopted by the EPC on April 16, 2024 would make no change to the karst provisions, leaving the separation minimum at 5 feet.

Increasing the vertical separation distance would reduce the risk of leaking and failure of manure storage structures through sinkholes. A 1982 study of Iowa found that nearly all sinkholes formed when the overlay above karst was 25 feet or less, but some were as deep as 35 feet.[92] Minnesota has similarly concluded that karst greater than 50 feet below the ground surface will not typically lead to surface features:[93]

> In Minnesota surface karst features primarily occur where 50 feet or less of unconsolidated sediment overlies Paleozoic carbonate bedrock, the St. Peter Sandstone, or the Hinckley Sandstone. This coverage outlines areas where karst features can form on the land surface and where karst conditions are present in the subsurface… Subsurface karst conditions also occur in carbonate rock in areas where there is more than 50 feet of unconsolidated material over bedrock, but those conditions rarely lead to surficial karst feature development in Minnesota.

Karst in Minnesota is largely in the southeastern part of the state, adjacent to Iowa.[94] Because it is part of the same geologic formation, it behaves similarly to karst in Iowa. Numerous manure storage structures and wastewater storage structures have leaked or failed when constructed above karst terrain. In Iowa, the city of Garnavillo built a municipal wastewater pond over karst bedrock. During a test of the liner seal, the pond completely drained over one weekend through a sinkhole that formed in the bottom of the pond (Figure 10).[95]

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[91] "FINAL RULE PETITION RECOMMENDATION DOCUMENT" DNR Karst Team (Dec. 16, 2021), at 1.

[92] *See* G. Hallberg and B. Hoyer, *Sinkholes, Hydrogeology, and Ground-water quality in Northeast Iowa*, Iowa Geological Survey, 11 (May 31, 1982).

[93] Adams, R., et al. "Minnesota Regions Prone to Surface Karst Feature Development." Minnesota Department of Natural Resources (2016), at 4, available at http://files.dnr.state.mn.us/waters/groundwater_section/mapping/gw/gw01_report.pdf.

[94] *Id.* at 1.

[95] Libra, R.D. "Living in Karst." Iowa Geological Survey Guidebook Series No. 25 (Oct. 2005). Available at https://s-iihr34.iihr.uiowa.edu/publications/uploads/GB-25.pdf.

Figure 10. Sinkhole in Garnavillo Lagoon.

Sinkholes have formed under numerous earthen basins in other states.[96] Failures due to karst include a manure storage basin in Southeast Minnesota that leaked so quickly it never needed to be pumped.[97] Other municipal wastewater ponds lost millions of gallons of wastewater through sinkholes that formed after many years of use.[98] Wastewater storage sites in Missouri's karst region have resulted in sinkhole collapses that drained millions of gallons.[99] These include the collapse of the West Plains lagoon in 1978 that allowed 50 million gallons of sewage to enter groundwater, which led to hundreds of cases of flu-like illness attributed to the pollution.[100]

These millions of gallons of lost waste do not simply disappear; they discharge into groundwater aquifers. Despite these examples and scientific findings, the EPC has refused to adopt a 25-foot vertical separation distance requirement, which is the degree of protection allowed by Iowa Code.[101]

Within the Iowa karst region of the twelve counties subject to this petition, Iowa DNR has identified 989 medium and large animal feeding operations with a total of 1,059,404 animal units (Figure 11).[102] This includes 182,236 cattle animal units and 842,695 swine animal units.

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[96] "Recommendations of the Technical Workgroup Liquid Manure Storage in the Karst Region," Report to the Minnesota Senate and House Agriculture and Rural Development Committees (Dec. 20, 2000), at 7, available at https://www.pca.state.mn.us/sites/default/files/karst.pdf.
[97] *Id.*
[98] *Id.*
[99] Aley, T. "The Karst Setting." Journal of the Missouri Speleological Survey 65 (2022) at 119-120.
[100] *Id.* at 119.
[101] IOWA CODE § 459.308(3).
[102] *Animal Feeding Operations Download.* Iowa Department of Natural Resources NRGIS Geospatial Administrator, https://www.arcgis.com/home/item.html?id=abfbd972640d4e87b6c48dc669775767 (last visited Mar. 29, 2024).

According to an analysis of USDA's recently-released agricultural census data, Iowa's animal production industry produces far more animal waste than any other state — 109 billion pounds of manure annually, a 78% increase since 2002 and more than 25 times the state's human population.[103]

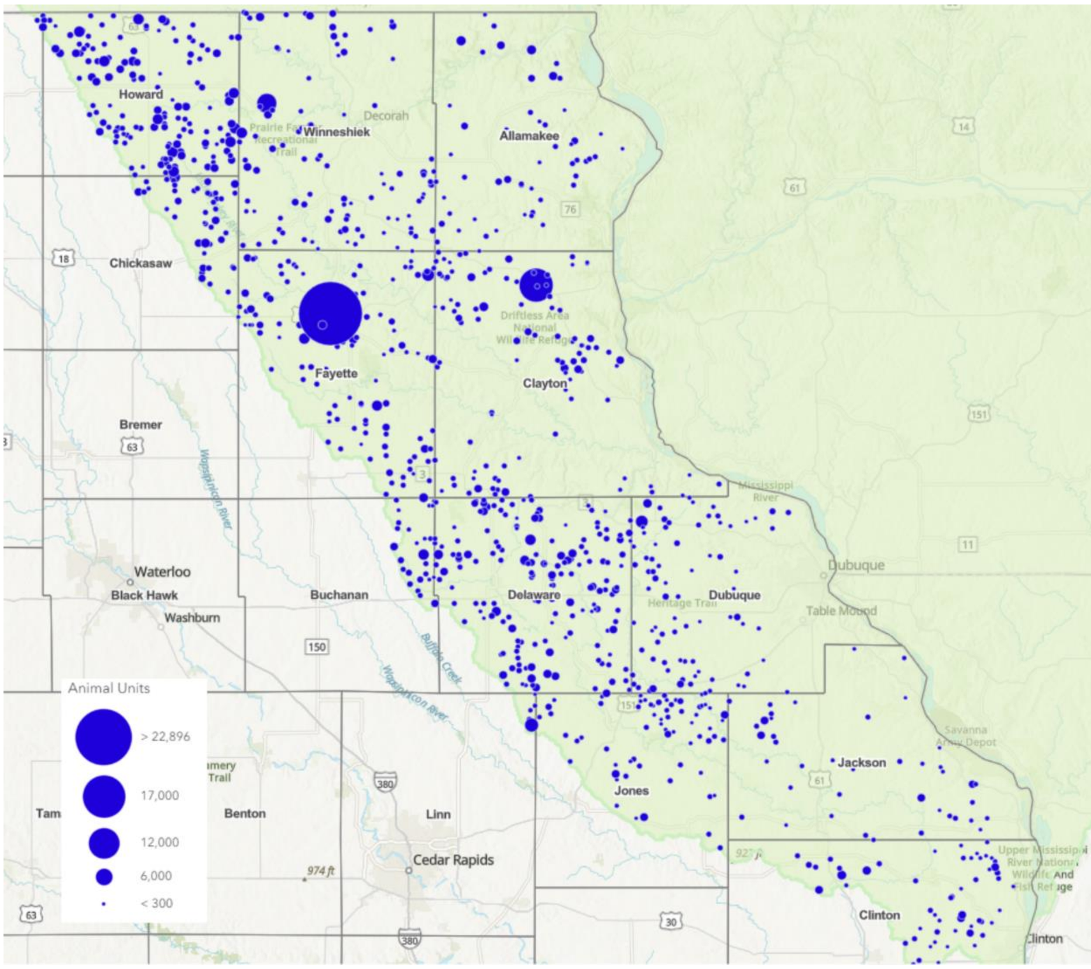

Figure 11. Medium and large animal feeding operations in the Driftless area as of 2022. Medium and large AFOs are defined as operations with 300 or more animal units. AFO data from Iowa DNR.[104]

The storage structures designed to contain millions of gallons of liquid manure, manure piles, and feedlot runoff, can also be significant sources of nitrogen to groundwater in this area.[105]

[103] "Iowa Produces More Factory Farm Waste Than Any Other State, Analysis of New USDA Data Finds," Food & Water Watch (Feb. 14, 2024), available at https://www.foodandwaterwatch.org/2024/02/14/iowa-produces-more-factory-farm-waste-than-any-other-state-analysis-of-new-usda-data-finds/.

[104] *Animal Feeding Operations Download.* Iowa Department of Natural Resources NRGIS Geospatial Administrator, https://www.arcgis.com/home/item.html?id=abfbd972640d4e87b6c48dc669775767 (last visited Mar. 29, 2024).

[105] Minn. Pollution Control Agency, Effects of Liquid Manure Storage Systems on Ground Water Quality–Summary Report (2001), https://www.pca.state.mn.us/sites/default/files/rpt-liquidmanurestorage-summary.pdf.

Manure storage structures that are constructed in compliance with National Resource Conservation Service (NRCS) standards are actually designed to leak. According to the NRCS handbook, "properly" constructed lagoons can leak up to 5,000 gallons of manure wastewater per acre per day.[106] In one study conducted by the Minnesota Pollution Control Agency, "[t]here was evidence of shallow ground water contamination down-gradient of manure storage areas at each [feedlot operation]."[107]

In addition to the manure storage structures themselves, manure from livestock operations in the karst region is commonly used as fertilizer for row crops in the area. When liquefied manure storage systems reach capacity, operators must empty them, generally by disposing of the liquefied manure and process wastewater onto nearby agricultural fields. These land applications of manure are one of the largest sources of nitrogen from animal feeding operations.[108]

2. Industrial Crop Production

Another major contributor to the nitrate contamination is widespread industrial agriculture in the region. In the 12-county area, much of the land cover is devoted to agriculture. Over the last few decades, more acreage has been converted to row crop production, with most of the conversion from pasture/grassland (Figure 12). There is a high concentration of agriculture in a sensitive karst landscape with a high sensitivity to groundwater contamination. A significant portion of this land is related to the animal agriculture in the region: it is used to grow feed crops for animals[109] and/or receives the application of manure and other waste from the nearby CAFOs as fertilizer.

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[106] U.S. Dep't of Agric. Nat. Res. Conservation Serv., Agricultural Waste Management Field Handbook, Chapter 10: Agricultural Waste Management System Component Design App. 10D-16 (2009), https://directives.sc.egov.usda.gov/31529.wba ("NRCS guidance considers an acceptable initial seepage rate to be 5,000 gallons per acre per day.").

[107] Minn. Pollution Control Agency, Effects Of Liquid Manure Storage Systems On Ground Water Quality– Summary Report 2 (2001), https://www.pca.state.mn.us/sites/default/files/rpt-liquidmanurestorage-summary.pdf.

[108] *Estimated Animal Agriculture Nitrogen and Phosphorus from Manure*, Env't Prot. Agency (Jan. 11, 2023), https://www.epa.gov/nutrient-policy-data/estimated-animal- agriculture-nitrogen-and-phosphorus-manure.

[109] Up to 40% of domestic corn use is allocated to livestock feed. *See Feed Grains Sector at a Glance*, U.S. Dep't of Agric., https://www.ers.usda.gov/topics/crops/corn-and-other- feed-grains/feed-grains-sector-at-a-glance/ (last visited Apr. 15, 2024).

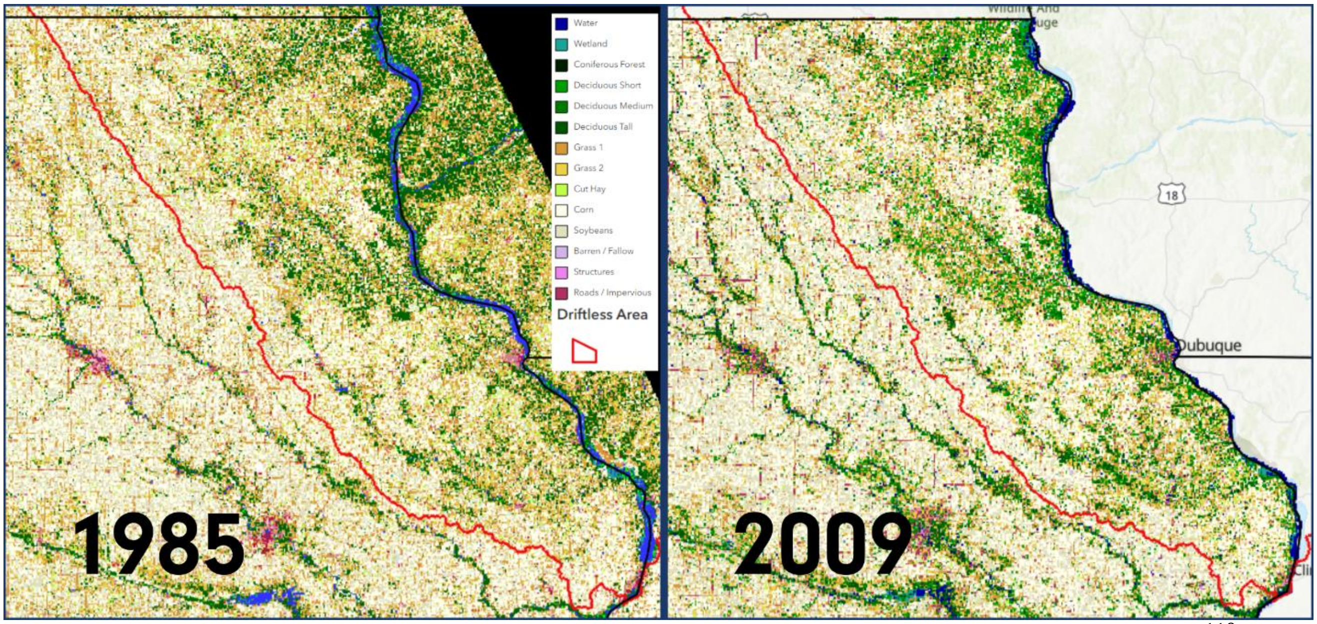

Figure 12. Comparison of land use in 1985 and 2009. Land cover data from Iowa DNR.[110]

The image below shows the coverage of corn and soybeans near a stream in the karst region, along with average nitrate concentrations consistently exceeding 10 mg/L for the second half of 2023.[111]

[110] Land cover data layer from Iowa DNR. Available at https://programs.iowadnr.gov/geospatial/rest/services/LandCover/Land_Cover/MapServer (last visited April 14, 2024).

[111] "IWQIS | Iowa Water Quality Information System," University of Iowa IIHR, available at https://iwqis.iowawis.org/app/?iwqis=/nitrate-con.

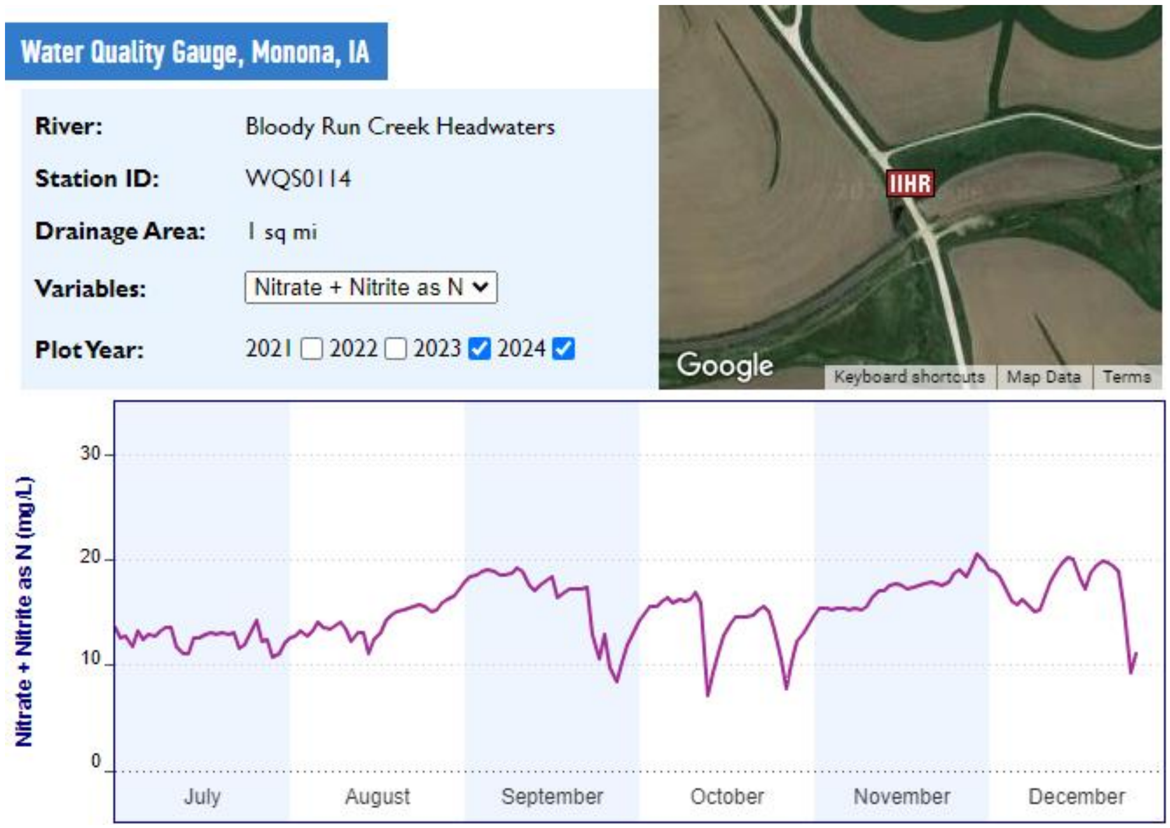

Figure 13. Industrial agriculture and nitrate contamination in Bloody Run Creek in 2023.

Elevated nitrate concentrations are also present in groundwater in karst, which surfaces in springs throughout the region. Figure 14 shows concentrations near 10 mg/L nitrate, with spikes likely driven by weather events that move crop fertilizer into the groundwater. This groundwater has high concentrations of nitrate even when it is not adjacent to cropland, as Figure 14 shows. Contamination that does not surface at a spring can reach deeper into aquifers.

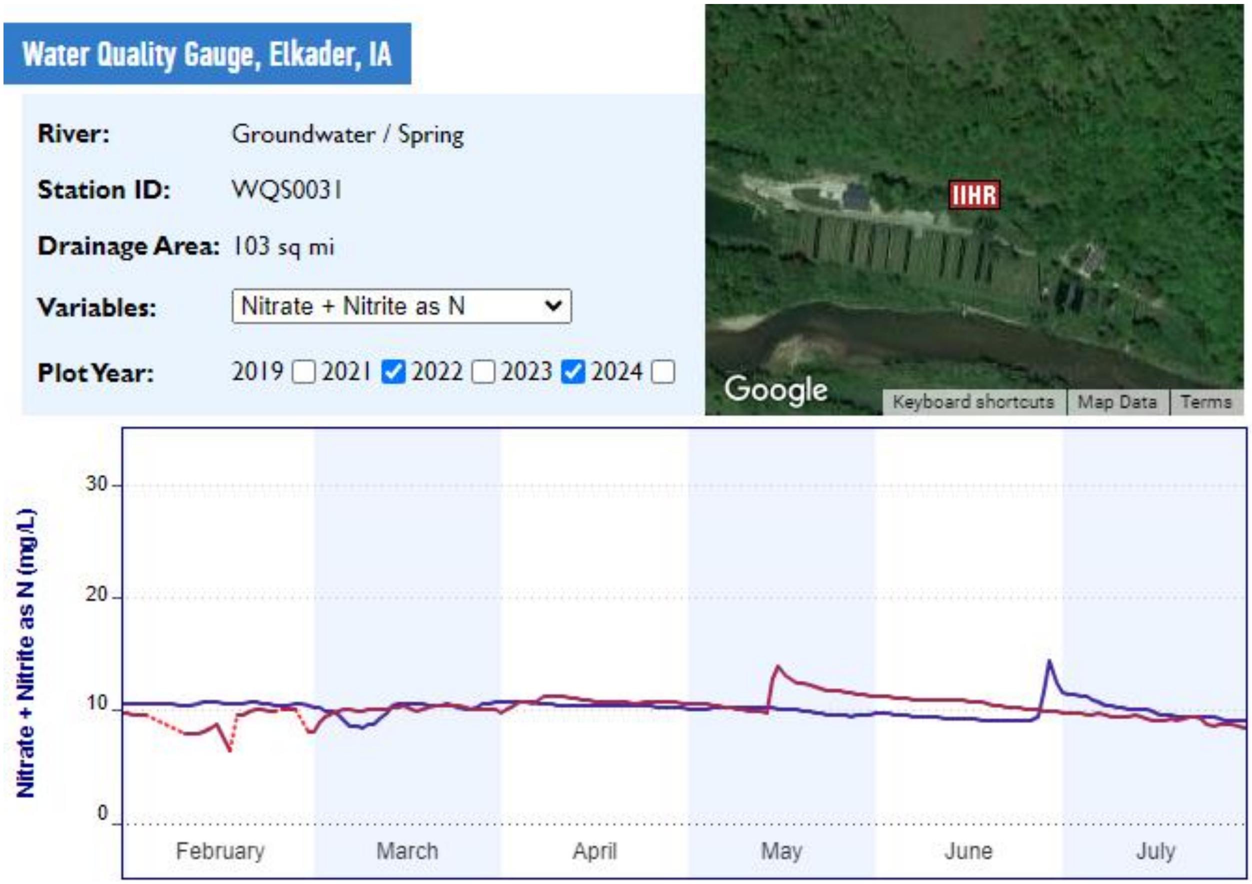

Figure 14. Nitrate Contamination in Shallow Groundwater near Elkader, Iowa. Data is displayed for 2021 and 2023.

The correlation between nitrate pollution and land used to grow exclusively corn and soybeans is well documented. A study of the relationship between CAFOs, row crops, and surface water nitrate concluded that achieving 10 mg/L nitrate concentrations would require fewer CAFOs and fewer row-cropped acres.[112] In a 2020 report, researchers at Minnesota Department of Agriculture found that the mean nitrate concentration of lysimeters placed on cropland that was in a constant corn or corn-soybean rotation was 22.3 mg/L.[113] The figure below compares this to other land uses.

[112] Weldon, Mark B., and Keri C. Hornbuckle. "Concentrated animal feeding operations, row crops, and their relationship to nitrate in eastern Iowa Rivers." *Environmental Science & Technology* 40.10 (2006): 3168-3173.
[113] Kevin Kuehner et al., Minn. Dep't of Agric., Examination of Soil Water Nitrate- N Concentrations From Common Land Covers and Cropping Systems in Southeast Minnesota Karst 14 (2020), https://wrl.mnpals.net/islandora/object/WRLrepository%3A3654/datastream/PDF/view.

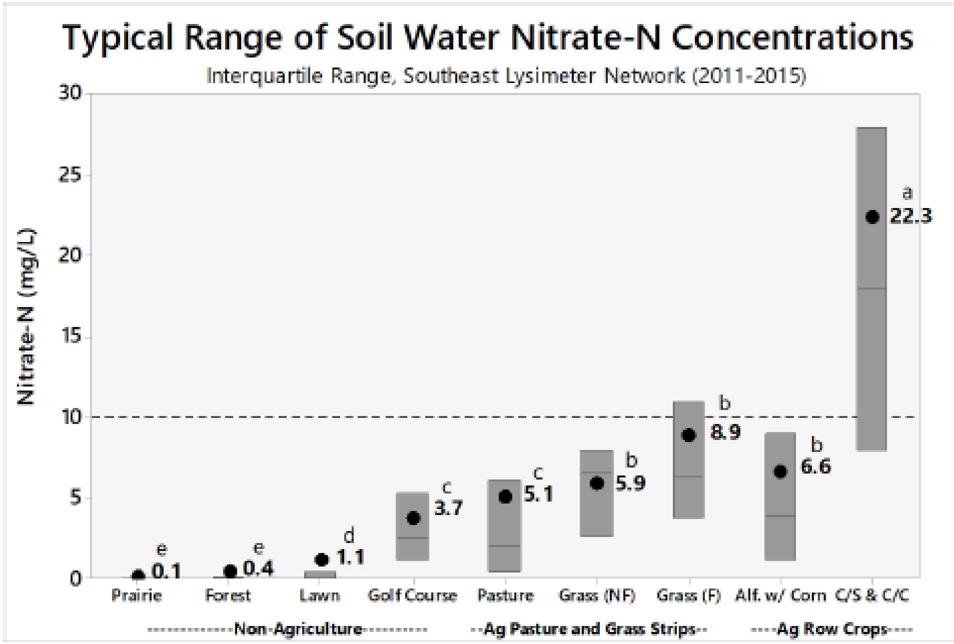

Figure 15. Land cover and nitrate contamination. C/S indicates a corn/soy cropping rotation and C/C indicates continuous corn.

As Figure 15 demonstrates, industrial agricultural land suffers from significantly more contamination than other types of land uses generating a risk to both surface and groundwater.

G. Conditions in the Karst Region Constitute an Imminent and Substantial Endangerment to Human Health Under the SDWA.

The current levels of nitrate in drinking water in the karst region present an imminent and substantial endangerment to human health because consumption of drinking water that is contaminated with nitrate is known to cause serious health risks. Given the thousands of individuals who rely on either contaminated private wells or contaminated PWS for drinking water in this region, there is reasonable cause for concern that individuals are, and will be, exposed to this risk at unhealthy concentrations.

Nitrate is plainly an endangerment to public health under the SDWA because EPA not only categorizes it as a "contaminant,"[114] but as an "acute contaminant" known to pose significant health risks. According to EPA, "[n]itrate is an acute contaminant, meaning that one exposure can affect a person's health. Too much nitrate in your body makes it harder for red blood cells to carry

[114] 40 C.F.R. § 141.62(b).

oxygen."[115] EPA previously found that nitrate levels above the MCL of 10 mg/L present an imminent and substantial endangerment to human health.[116]

Nitrate is a particularly insidious contaminant because it is colorless, odorless, and tasteless, meaning that people do not have a way of identifying its presence in their drinking water without testing.[117]

Additionally, boiling nitrate-laden drinking water, as is often done in preparation of baby formula, increases the nitrate concentration of the water because nitrates do not evaporate and become more concentrated in the formula.[118] Shallower aquifers are both more likely to be used for private wells and are more contaminated.

Drinking water contaminated with nitrate has well-documented acute and chronic adverse health risks including "blue-baby syndrome," a variety of cancers, and reproductive problems.[119] In terms of acute problems, the drinking water standard of 10 milligrams per liter (mg/L) of nitrate-nitrogen (nitrate-N) established in 1962 was calculated to prevent methemoglobinemia (blue-baby syndrome). Minnesota Department of Health also reports other potential health effects such as "increased heart rate, nausea, headaches, and abdominal cramps."[120]

Iowa currently has the second-highest rate of cancer incidence in the United States and the fastest-growing cancer rate nationwide.[121] As IEC reported in 2016, bladder cancer and thyroid disease have been linked to exposure to nitrate in drinking water.[122] Childhood brain cancer has been linked to high nitrate levels in drinking water.[123] Many of the studies identifying links

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[115] *Frequently Asked Questions About Nitrates & Drinking Water*, Env't Prot. Agency (Sept. 2012), https://nepis.epa.gov/Exe/ZyPDF.cgi/P10150PM.PDF?Dockey=P10150PM.PDF.

[116] *See, e.g.*, Administrative Order on Consent, *In the Matter of Yakima Valley Dairies*, SDWA- 10-2013-0080, at 7 (Mar. 19, 2013) (finding that "above the concentration of 10 mg/L in drinking water, nitrate may present an imminent and substantial endangerment to the health of persons"), https://www.epa.gov/sites/default/files/2017-12/documents/lower-yakima-valley-groundwater-consent-order-2013.pdf.

[117] *Nitrate in Drinking Water*, Minn. Dep't of Health (Dec. 8, 2022), https://www.health.state.mn.us/communities/environment/water/contaminants/nitrate.html.

[118] *Frequently Asked Questions About Nitrates and Drinking Water*, Env't Prot. Agency (Sept. 2012), https://nepis.epa.gov/Exe/ZyPDF.cgi/P10150PM.PDF?Dockey=P10150PM.PDF.

[119] *Nitrate in Drinking Water*, Minn. Dep't of Health (DEC. 8, 2022), https://www.health.state.mn.us/communities/environment/water/contaminants/nitrate.html;
N. Beaudet et al., Nitrates, Blue Baby Syndrome, and Drinking Water: a Factsheet for Families, Pediatric Env't Health Specialty Units (2014), https://ldh.la.gov/assets/oph/Center-EH/envepi/PWI/Documents/PEHSU_Nitrates_Consumer_1.20.15 FINAL.pdf; Roberto Picetti et al., *Nitrate and Nitrate Contamination in Drinking Water and Cancer Risk: A Systematic Review with Meta-Analysis*, 210 ENV'T RSCH. 112988 (2022), https://www.sciencedirect.com/science/article/pii/S0013935122003152#bib109.

[120] *Nitrate in Drinking Water*, Minn. Dep't of Health (DEC. 8, 2022), https://www.health.state.mn.us/communities/environment/water/contaminants/nitrate.html.

[121] "2024 Cancer in Iowa," Iowa Cancer Registry (Feb. 2024), at 7, available at https://shri.public-health.uiowa.edu/wp-content/uploads/2024/02/cancer-in-iowa-2024.pdf.

[122] "Nitrate in Drinking Water: A Public Health Concern for All Iowans," Iowa Environmental Council (2016), available at https://www.iaenvironment.org/webres/File/News%20%26%20Resources/Publications/Nitrate_in_Drinking_Water_Report_ES_Web.pdf (summarizing peer-reviewed research on nitrate health effects).

[123] A. Zumel-Marne et al., *Environmental Factors and the Risk of Brain Tumours in Young People: A Systematic Review*, 53 NEUROEPIDEMIOLOGY 121 (2019), https://www.karger.com/Article/Fulltext/500601?utm_source=external&utm_medium=referral&utm_campaig n=getFTR; *see also*, Yanqi Xu, *Nebraska's Dirty Water,* THE READER (Oct. 28, 2022), https://thereader.com/2022/10/28/nebraskas-dirty-water/

between cancer and nitrate use long-term health data from Iowans who have been exposed to nitrate, often at concentrations below 10 mg/L.[124]

Scientists know that nitrate byproducts in the body (n-nitroso compounds) can cause mutations and cancerous tumors in developed cells and organs.[125] Similar processes are also thought to affect developing cells and organ systems. Nitrate in water supplies has been linked to spontaneous miscarriages (preterm birth) and birth defects such as neural tube defects of the brain and spinal cord, including spina bifida, oral cleft defects, and limb deficiencies. [126]

The numerous studies demonstrating that a contaminant known to cause disease and illness is present at unsafe levels in wells used by tens of thousands of residents proves an unambiguous SDWA "endangerment."

Because the present contamination of the region's drinking water and risk of significant adverse health effects from drinking contaminated water are both thoroughly documented, endangerment is clearly imminent. As explained above, endangerment is "imminent" if conditions that give rise to it are present, even if actual harm has not already been documented in the contaminated area. Unsafe levels of nitrate contamination in the karst region drinking water supply were first identified over 30 years ago,[127] and recent data trends indicate that nitrate contamination is continuing at a persistent—and harmful—level.

The public health risks associated with nitrate contamination in the karst region constitute a "substantial" endangerment under the SDWA. According to EPA's updated guidance on SDWA emergency authority, an example of substantial endangerment is "a substantial likelihood that contaminants capable of causing adverse health effects will be ingested by consumers if preventative action is not taken."[128] Well sampling has consistently shown elevated nitrate levels in residential drinking water wells across the karst region. Thus, residents of the karst region have been, and continue to be, ingesting this contaminant. This alone demonstrates that the endangerment is substantial.

("Areas of the state that have higher pediatric cancer rates and birth defect rates also have higher nitrate levels, researchers say.").

[124] "Nitrate in Drinking Water: A Public Health Concern for All Iowans," Iowa Environmental Council (2016), available at https://www.iaenvironment.org/webres/File/News%20%26%20Resources/Publications/Nitrate_in_Drinking_Water_Report_ES_Web.pdf.

[125] Brambilla, Giovanni and Antonietta Martelli. 2005. Keynote comment: nitrosatable drugs, cancer, and guidelines for genotoxicity. *The Lancet Oncology*, Vol. 6(8):538-9. https://doi.org/10.1016/S1470-2045(05)70257-6. See Brender, Jean D., et al. 2013. Prenatal Nitrate Intake from Drinking Water and Selected Birth Defects in Offspring of Participants in the National Birth Defects Prevention Study. *Environmental Health Perspectives*, Vol. 121(9):1083-1089. https://ehp.niehs.nih.gov/doi/10.1289/ehp.1206249.

[126] Allison R. Sherris et al., *Nitrate in Drinking Water during Pregnancy and Spontaneous Preterm Birth: A Retrospective Within-Mother Analysis in California*, 129 ENV'T HEALTH PERSPECTIVES (2021), https://ehp.niehs.nih.gov/doi/full/10.1289/EHP8205.

[127] Ores 1982, *supra* note 60.

[128] Emergency Authority Guidance, *supra* note 13, at 11 (explaining that an endangerment is substantial "if there is a reasonable cause of concern that someone may be exposed to a risk of harm").

IV. IOWA OFFICIALS HAVE FAILED TO ACHIEVE SAFE DRINKING WATER QUALITY DESPITE DECADES OF ATTEMPTS TO MITIGATE POLLUTION

EPA should exercise its emergency authority under Section 1431 of the SDWA because, for decades, the state of Iowa and its officials have failed to mitigate the ongoing, imminent and substantial endangerment to the health of residents in the karst region. The chronology below describes state agencies' recognition of, and inadequate attempts to address, nitrate pollution. The ongoing, persistent contamination of the karst region's water supplies, despite these efforts, demonstrates their ineffectiveness. If EPA fails to step up, the ongoing contamination will continue.

Hydrologists prepared the Iowa Groundwater Protection Strategy in January 1987 with recommendations for the Iowa Legislature to implement over the next decade.[129] The study noted that "[c]oncentrations of nitrate in Iowa's groundwater have increased steadily over the last twenty years in response to the increased use of commercial nitrogen fertilizers."[130]

Iowa enacted a Groundwater Protection Act in 1987. It was based on a growing recognition of the vulnerability of Iowa's groundwater resources.[131] As noted above, the act stated the importance of protecting groundwater from degradation. The legislation created the funding mechanism for the Grants to Counties program, which funds water quality testing for private wells.

Congress amended the Safe Drinking Water Act in 1996 to address source water protection requirements.[132] In response, the DNR developed a source water program to address potential drinking water contamination.[133] Under the program, DNR conducts an assessment of source water susceptibility to contamination, the water supplier develops a protection plan, and steps in the plan are implemented.[134] DNR's source water program is voluntary for public water supplies.[135] The program does not apply to private wells.

In response to the rapid expansion of the livestock industry in Iowa, the state legislature required the DNR to adopt a "master matrix" to guide siting of new CAFOs. The matrix consists of questions for proposed CAFOs to answer, values for each answer, and a total score. If the applicant satisfies a minimum total score, the project can proceed. County governments can provide input but have no power to stop the project from proceeding.

The vast majority of CAFOs in Iowa do not have Clean Water Act (or NPDES) discharge permits, which regulate discharges of pollution to surface waters. DNR has records of more than 9,247 animal feeding operations in the state.[136] Of those, 4,082 facilities have at least 1,000 animal units.[137] Only 184 facilities - fewer than 5 percent of these large operations - have an NPDES

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[129] Bernard Hoyer, et al., *Iowa Groundwater Protection Strategy 1987* (January 1987), available at https://www.iowadnr.gov/Portals/DNR/uploads/water/wse/ground1987.pdf.
[130] *Id.* at 11.
[131] IOWA CODE § 455E.3.
[132] *See* Public Law No. 104-182 (1996) at sec. 401.
[133]
[134] *Id.*
[135] *Id.*
[136] Iowa DNR AFO Database, retrieved Feb. 19, 2024, available at https://programs.iowadnr.gov/animalfeedingoperations/Reports.aspx.
[137] *Id.*

permit.[138] Despite that small number, DNR has tracked more than 400 manure discharges in the last 13 years.[139]

In 2007, the Sierra Club Iowa Chapter, Iowa Citizens for Community Improvement, and the Environmental Integrity Project filed a petition with U.S. EPA to revoke the delegated authority of the Iowa DNR to operate the NPDES discharge permit program under the Clean Water Act.[140] The petition alleged that the DNR's oversight of CAFOs was inadequate, and specifically noted that CAFO waste was polluting surface water and groundwater with nitrates.[141] The petition sought additional Clean Water Act permit coverage and requirements for CAFOs to prevent pollution. EPA and DNR agreed upon a work plan to address the concerns raised in the petition.[142] As part of the work plan, DNR was to undertake a "comprehensive survey to identify AFOs that are CAFOs that discharge to waters of the U.S. and have failed to apply for NPDES permits."[143] DNR undertook the survey by reviewing satellite imagery to identify potential CAFOs.[144] The review resulted in the discovery of an additional 5,063 facilities, of which 1,300 were subject to regulation by the DNR, and half of those would require on-site inspections.[145] The petition work plan did not directly address groundwater contamination. EPA ultimately determined in 2019 that the petition's allegations did not merit withdrawal and denied the petition.[146]

In 2008, a team of Nutrient Science Advisors under the direction of the Iowa DNR developed and formally recommended numeric nutrient criteria to protect Iowa lakes designated for recreational use.[147] These recommendations were taken up by DNR, in part, in a 2011 Notice

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138 *Id.*

139 DNR-HSI Report of Manure Releases, Iowa DNR, available at https://programs.iowadnr.gov/hazardousspills/Reports/EPCManureRelease.aspx.

140 Iowa Citizens for Community Improvement, et al., *Petition for Withdrawal of the National Pollutant Discharge Elimination System Program Delegation from the State of Iowa* ("2007 Petition"), filed Sept. 20, 2007, available at https://ordspub.epa.gov/ords/wps/apex_util.get_blob?s=10845112150979&a=144&c=28168719431127025&p=5&k1=110&k2=&ck=eIDrh-oxd5kxJqoooX4LjmTInkXc5PcJ_YPSbmQ8ox44S_dvgpv-ISAi8ffPY5wFXUqGkHZc_K5GYGrMcTYGHQ&rt=CR.

141 *See* 2007 Petition at 22-23.

142 "Work Plan Agreement Between the Iowa Department of Natural Resources and the Environmental Protection Agency Region 7," U.S. EPA & Iowa DNR (Sept. 11, 2013), available at https://ordspub.epa.gov/ords/wps/apex_util.get_blob?s=10845112150979&a=144&c=28168719431127025&p=5&k1=702&k2=&ck=l-ft9dFcgGx5CLbO3rasDXZJBMqzCDFwThO0KdeBHT9gYOgaoE_AqagtH-YggRT2GHL11JqUPmDg9KmFwYc_GA&rt=CR.

143 *Id.* at 3.

144 Donnelle Eller, "Iowa uses satellites to uncover 5,000 previously undetected animal confinements," *Des Moines Register* (Sept. 15, 2017).

145 *Id.*

146 U.S. EPA, *Response to Petition to Withdraw Iowa's National Pollutant Discharge Elimination System Permit Program* (Apr. 3, 2019), available at https://ordspub.epa.gov/ords/wps/apex_util.get_blob?s=10845112150979&a=144&c=28168719431127025&p=5&k1=861&k2=&ck=Y80O7R58FOUrYlWSLaqizu8Gf3ybZ4GJ0QED2rpCn4oiLF68zFw_EFdhctgPDWHs3Id4LGDvDsdBJg4gvkNn_A&rt=CR.

147 *See* Michael Burkart, Michael Birmingham, Edward Bottei, Edward Brown, John Downing, Christopher Jones, Joe Larscheid, John Olson, Michael Quist, Peter Weyer, Tom Wilton, *Nutrient Criteria for Iowa Lakes: Recommended Criteria for Class A Recreational Lakes, Report of the Nutrient Science Advisors* (February 14, 2008) available at https://www.researchgate.net/profile/Joseph_Larscheid/publication/237509482_Nutrient_Criteria_for_Iowa_Lakes_Recommended_Criteria_for_Class_A_Recreational_Uses_Report_of_the_Nutrient_Science_Advisors/links/5579ebf

of Intended Action which contained a specified list of 159 lakes that would be protected.[148] These standards would limit nutrient inputs into Iowa waterbodies and better protect them from contamination. Although this rulemaking effort went through public meetings and a formal comment period, it expired due to inaction in September 2011.[149] IEC and the Environmental Law & Policy Center petitioned for the EPC to complete the rules, which it denied in 2013.[150] The EPC denied a renewed petition to adopt numeric nutrient criteria in 2019.[151]

After passage by the legislature and a public vote with 62 percent support, Iowa adopted a constitutional amendment in 2010 to create a Natural Resources and Outdoor Recreation Trust Fund.[152] Funding from the Trust Fund was intended to support water quality projects and natural resources conservation. The amendment stated that 3/8 of one cent from the next sales tax increase adopted by the Iowa legislature would go into the fund.[153] Since its adoption, the legislature has not increased the sales tax and the fund has sat empty.[154]

In 2011, Iowa began developing a Nutrient Reduction Strategy (NRS) in response to an EPA memorandum.[155] DNR, the Iowa Department of Land Stewardship, and Iowa State University completed the NRS in 2013 to address nitrate and phosphorus pollution, primarily in surface water.[156] The NRS did not directly address groundwater contamination, but its goal of significantly reducing nutrient losses would presumably benefit drinking water sources. The NRS has been adopted as official policy of the state by the Iowa legislature.[157]

Funding to implement the NRS has been characterized as the Water Quality Initiative, which began in 2013 and saw increased funding after the 2018 legislative session.[158] Despite that funding, implementation can charitably be characterized as slow. IEC has regularly assessed the reported rates of conservation practice adoption under the first scenario of the NRS and found that, at current rates, the adoption and subsequent nutrient load reduction would take thousands of years,

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108ae752158717b7d/Nutrient-Criteria-for-Iowa-Lakes-Recommended-Criteria-for-Class-A-Recreational-Uses-Report-of-the-Nutrient-Science-Advisors.pdf?origin=publication_detail.

[148] *See* Department of Natural Resources, Notice of Intended Action (Feb. 23, 2011) on file with the Department of Natural Resources.

[149] *See* Environmental Protection Commission, *Denial of Petition for Rulemaking by Iowa Environmental Council and Environmental Law and Policy Center* at 2 (Oct. 14, 2013).

[150] Denial of Petition for Rulemaking, Iowa Environmental Protection Commission (Oct. 14, 2013).

[151] Environmental Protection Commission, *Denial of Petition for Rulemaking* (Feb. 19, 2019).

[152] "Natural Resources and Outdoor Recreation 2023 Trust Fund Report," Iowa DNR (Jan. 15, 2024), available at https://www.legis.iowa.gov/docs/publications/DF/1444378.pdf.

[153] *Id.*

[154] *Id.*

[155] Nancy Stoner, "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions," U.S. EPA, Mar. 16, 2011, available at https://www.epa.gov/sites/default/files/documents/memo_nitrogen_framework.pdf.

[156] "Iowa Nutrient Reduction Strategy – A science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico" (hereinafter "NRS"). Updated December 2017.

[157] IOWA CODE § 455B.177(3).

[158] Alicia Vasto, "Water Quality Monitoring and the Water Quality Initiative," IEC (July 2022), available at https://www.iaenvironment.org/webres/File/Water%20Quality%20Monitoring%20and%20the%20Water%20Quality%20Initiative_June%202022(1).pdf.

as shown in Figure 16 below.[159] The state efforts under the NRS have no chance of remediating high nitrate concentrations in groundwater.

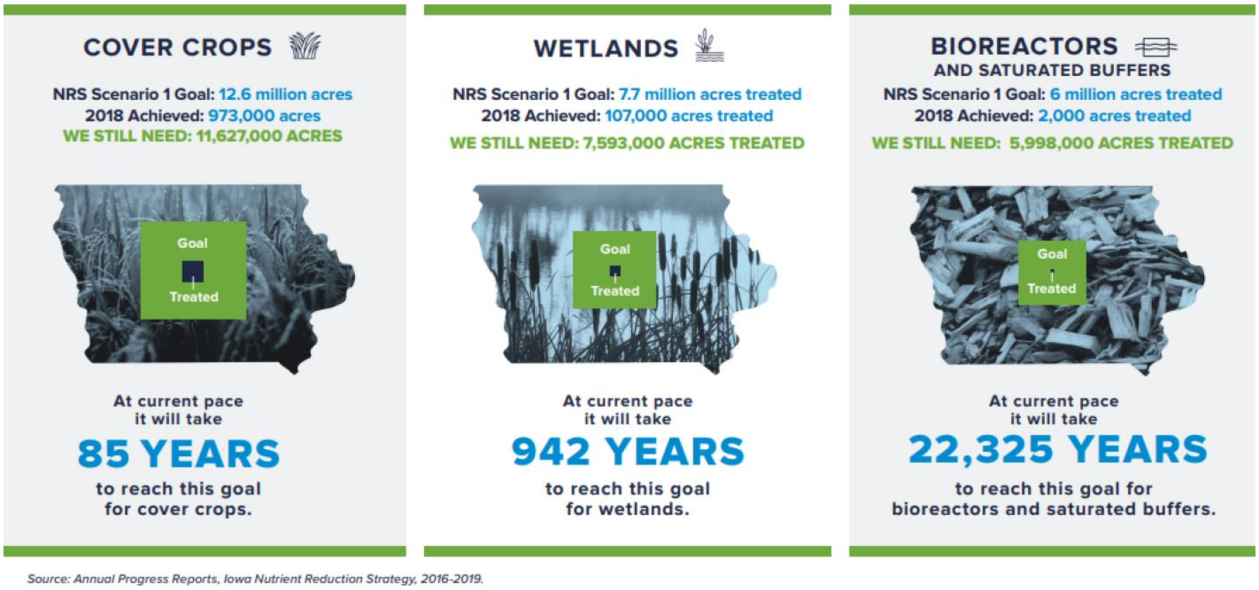

Figure 16. Nutrient Reduction Strategy progress rates by conservation practice.

The EPA issued final recommendations for microcystin and numeric nutrient water quality standards in 2019 and 2021, respectively, that would protect recreational users from harmful algae blooms.[160] In fact, the EPA's numeric nutrient criteria recommendations relied heavily on Iowa's water quality data. When the DNR released the 2020 and 2022 impaired waters lists, IEC called on the state to adopt microcystin and numeric nutrient criteria. DNR has not indicated that it will adopt those standards, and no timeline or formal process has been set to begin the process of adopting criteria. DNR left numeric nutrient criteria out of the 2021-2023 Triennial Review.

As described above, IEC and Environmental Law and Policy Center petitioned in 2021 to strengthen rules regulating animal feeding operations in karst terrain following the approval of a large beef operation.[161] The petition sought greater vertical separation between karst and manure

[159] Iowa Environmental Council, "The Iowa Nutrient Reduction Strategy: Ten Years and No Progress" (Aug. 2022), at 2, available at https://www.iaenvironment.org/webres/File/NRS%20Report%20and%20Recommendations%202022.pdf.

[160] "Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin," U.S. EPA (2019), available at https://www.epa.gov/sites/default/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf (last visited Apr. 13, 2024); "Ambient Water Quality Criteria to Address Nutrient Pollution in Lakes and Reservoirs," U.S. EPA, available at https://www.epa.gov/nutrientpollution/ambient-water-quality-criteria-address-nutrient-pollution-lakes-and-reservoirs (last visited April 13, 2024).

[161] Several petitioning groups sought to prevent the development and operation of a large CAFO in karst terrain that sits near several sinkholes and uphill from an Outstanding Iowa Water. A coalition of groups requested the DNR director and Environmental Protection Commission impose restrictions on the facility, which they declined to do. Sierra Club Iowa Chapter and Trout

storage structures and increased groundwater monitoring requirements for AFOs. The Environmental Protection Commission denied the petition in February 2022, noting that DNR would begin a more comprehensive rulemaking process. After several rounds of informal comments and a formal process under Iowa's Administrative Procedure Act, the EPC ultimately adopted rules on April 16, 2024, that reorganized karst provisions without making the long overdue and necessary changes sought in the petition.

V. REQUESTED EMERGENCY ACTION TO ABATE ONGOING AND EVER-INCREASING ENDANGERMENT TO HUMAN HEALTH FROM NITRATE CONTAMINATION

As discussed in detail above, the statutory prerequisites for emergency action under 42 U.S.C. § 300i are satisfied here. First, nitrate, which is a "contaminant" under the SDWA, is present in and continues to leach into USDW in the karst region. Second, the presence of nitrate contamination in groundwater is causing an imminent and substantial endangerment to public health; an alarming number of karst region residents rely on USDW that have been identified as carrying substantial nitrate risks for users. Finally, the State of Iowa has not taken timely or effective action to abate the public health endangerment.

EPA has broad authority to investigate and remediate threats to public health under the SDWA. "Once EPA determines that action under Section 1431 is needed, a very broad range of options is available" as necessary to protect users of USDW.[162] The tools available to EPA include conducting studies, halting the disposal of contaminants that may be contributing to the endangerment, and issuing orders such as mandatory changes to manure generation, handling, and land application practices. In fact, "EPA may take such actions notwithstanding any exemption, variance, permit, license, regulation, order, or other requirement that would otherwise apply."[163]

EPA should prioritize investigating and abating nitrate contamination in the karst region. EPA has already begun such action on a similar petition in Minnesota filed in April 2023.[164] Groundwater does not follow political boundaries, and as shown above, Iowans are suffering from the same drinking water contamination as Minnesotans. At a minimum, EPA Region 7 must provide the same level of relief to Iowans as to Minnesotans in the Karst Region. Accordingly, EPA must require the state of Iowa to do the following:[165]

1. Create a communication plan to specify how information and responsibilities will be shared among state agencies, local governments, and any other entities acting on the response to the petition.
2. Identify each residence obtaining drinking water from a private well in the region.

Unlimited successfully challenged the facility's nutrient management plan in district court, only to have a subsequent plan approved by DNR.

[162] Emergency Authority Guidance, *supra* note 13, at 14.
[163] *Id.* at 9.
[164] *See* Letter from Debra Shore, EPA Region 5 Administrator, to Brooke Cunningham, Thom Peterson, and Katrina Kessler (Nov. 3, 2023).
[165] *Id.* at 2-4.

3. Provide *immediate* notice and instruction to residents and continue providing such communication as long as contamination persists at or above the MCL, particularly for vulnerable populations.
4. Create and implement a plan for drinking water sample analysis for all residents that request it.
5. Offer alternate drinking water at no cost to residents for each residence where water tests show an exceedance of the MCL for nitrate in the private well. The state must provide a detailed plan for distribution and timeline and minimize the burden on impacted residents.
6. Maintain and regularly publish records that allow the public to understand the scope and severity of nitrate contamination in the karst region and measure progress in implementing the response plan.
7. Provide quarterly progress reports to EPA describing (a) actions taken to address immediate health impacts of nitrate contamination; (b) major accomplishments and issues; (c) actions and timelines for the upcoming quarter; and (d) any problems or delays and the solutions implemented to address them.
8. Develop and implement a long-term solution to achieve reductions in nitrate concentrations in drinking water supplies.

Furthermore, Petitioners respectfully request EPA undertake the following measures under its SDWA Section 1431 emergency powers, either by administrative order or through civil action:

Investigation and Risk Assessment:

- Investigate DNR's CAFO permit requirements and Iowa Department of Agriculture and Land Stewardship (IDALS)'s and DNR's best management practices for nutrient management to determine why they have been unsuccessful at protecting groundwater in the karst region;
- Investigate other potential sources of nitrate pollution, such as failing septic systems;

Planning:

- Determine what enforcement measures should be implemented to effectively reduce nitrogen pollution from CAFO and industrial agriculture sources;
- Provide a timetable for implementing a remedy to abate nitrate contamination from identified contaminators;

Assistance:

- Order the parties responsible for the nitrate contamination to supply free water testing and ensure a free source of clean drinking water to residents of the karst region whose private wells or PWSs exceed safe limits for nitrate to prevent blue-baby syndrome, cancer, and other adverse health effects;
- Provide assistance to private well owners to engage in effective private well management practices;

Regulation:

- Prohibit CAFOs from opening, expanding, or modifying operations in the karst region unless and until nitrate concentrations in wells with historically high levels of nitrate consistently fall below the MCL of 10 mg/L;
- Impose or require DNR to impose monitoring and discharge requirements in the karst region related to (1) subsurface discharges from manure, litter, and process wastewater storage, as well as (2) discharges from land application, in compliance with *Food & Water Watch v. EPA*, 20 F.4th 506 (9th Cir. 2021).
- Commence civil enforcement actions using authority in section 1431 against entities causing threats to public health by contaminating drinking water supplies

The threat to public health in the karst region from nitrate pollution of groundwater is present and pervasive, and all signs indicate that dangerous contamination levels will continue or worsen, absent EPA action. Therefore, the undersigned Petitioners respectfully request that EPA use its emergency powers under the SDWA to take the actions necessary to abate the sources of contamination that increasingly place the public at substantial risk and provide other forms of relief within its authority as long as the endangerment persists.

VI. CONCLUSION

In conclusion, for the reasons stated above, the undersigned Petitioners respectfully request that EPA invoke its emergency authority under Section 1431 of the Safe Drinking Water Act to urgently address the imminent and substantial endangerment to public health within the karst region of Iowa caused by ongoing and increasing nitrate contamination. Please contact the undersigned for more information regarding this Petition.

/s/ Michael R. Schmidt

Michael R. Schmidt
Staff Attorney
Iowa Environmental Council

/s/ Alicia Vasto

Alicia Vasto
Water Program Director
Iowa Environmental Council

APPENDIX A. IOWA DNR KARST TEAM'S RECOMMENDATION DOCUMENT

FINAL RULE PETITION RECOMMENDATION DOCUMENT
December 16

Please Indicate Agreement and Include Date

	Agreement (Y or N)	Date
Ryan Clark - Iowa Geological Survey	Y	12/17/21
Chad Fields - DNR Water Allocation	Y	12/17/21
Claire Hruby - DNR - GIS Section	Y	12/21/21
Jeremy Klatt - DNR Field Services	N	12/20/21
Paul Petitti - DNR Field Services	Y	12/17/21
Stephanie Tassier-Surine - Iowa Geological Survey	Y	12/20/21

The DNR Karst Team is in agreement that groundwater in karst areas is vulnerable to seepage from manure storage structures (along with many other sources). The group also confirms that cracks in the cement or new sinkhole formation could occur in the years following construction, and that it is difficult to assess whether a belowground formed structure is leaking. The group has proposed a reorganization of the proposed rule changes regarding increased protections for formed structures with less than 25 ft of material above soluble rock in areas identified as karst terrain as follows:

Text of the Proposed Rule

This petition proposes rule changes to Iowa Administrative Code, title 567, chapter 65.

A. Proposed karst rule changes

i. Allow for approval of structures less than 25 feet above limestone, dolomite, or other soluble rock within karst terrain only if designed by a PE or NRCS qualified staff.

Amend section 65.15, paragraph (14) as follows:

(2) If the vertical separation distance between the bottom of the proposed formed manure storage structure and limestone, dolomite, or other soluble rock is less than 25 feet, the structure shall be designed and sealed by a PE or NRCS qualified staff person who certifies the structural integrity of the structure. However, it is recommended that any formed manure storage structure be constructed above ground if the vertical separation distance between the bottom of the structure and the limestone, dolomite, or other soluble rock is less than 25 feet.

(3) If the vertical separation distance between the bottom of the proposed formed manure storage structure and limestone, dolomite, or other soluble rock is less than 25 feet, a minimum 5-foot-thick continuous layer of low permeability soil (1×10^{-6} cm/sec) or rock between the bottom of a formed manure storage structure and limestone, dolomite, or other soluble rock is required.

(4) If the vertical separation distance between the bottom of the proposed formed manure storage structure and limestone, dolomite, or other soluble rock is less than 25 feet AND if there is not a 5-foot-thick continuous layer of low permeability soil or rock between the bottom of the proposed formed manure storage structure and limestone, dolomite, or other soluble rock, a 2-foot-thick layer of compacted clay liner material shall be constructed directly underneath the floor of the formed manure storage structure.

ii. Prohibit CAFO structures within karst terrain that are less than 5 feet above limestone, dolomite, or other soluble rock.

Amend section 65.15, paragraph (14), by adding the following:

(6) Construction of belowground formed and unformed manure storage structures within karst terrain that are less than 5 feet above limestone, dolomite, or other soluble rock is prohibited.

The following list includes information provided by team members that support the proposed rule change:

1. Depth to bedrock is highly variable (often greater than 5 feet) within the footprint of a typical manure storage structure and, therefore, is not well represented by a small number of borings in the corners of the proposed structure. Additionally, it is difficult to determine the exact location of the bedrock surface. The boundary between soil and

competent rock in karst regions is often a gradual transition that includes weathered bedrock. In some cases, the rock is thinly bedded and could easily be excavated. In addition, a single boring may penetrate a fracture or even a filled sinkhole, and thus give the perception that the bedrock surface is deeper than it really is. The bedrock surface is often difficult to assess as there can be up to 10 feet (or more) of weathered bedrock above the unweathered surface, which would commonly be indicated by auger refusal. The first indication of weathered bedrock should be considered the top of the bedrock surface when evaluating CAFO designs.

2. Naturally occurring impermeable materials in Iowa are rarely homogenous (uniform) across a site and often have secondary permeability (cracks, fractures, worm burrows, etc.), which allow potential contamination to pass through unfiltered. Therefore, even soil testing cannot guarantee protection of vulnerable aquifers. A properly installed 2-ft clay layer increases protection.
3. Currently available data for most of Iowa is too coarse for differentiating areas where the depth to bedrock is less than 5 feet. This data limitation necessitates site-specific evaluation with enough borings to adequately delineate the depth to bedrock within the footprint of a CAFO.
4. Sinkholes in Iowa can occur even in areas where there is more than 25 feet of materials overlying the carbonate rock. However, sinkholes are much less likely to occur in areas where rock is greater than 25 feet below the surface. Minnesota defines karst as areas with <50 feet to rock. Well depth and distance to sinkholes were the most important factors for predicting nitrate concentrations in private wells in the Wheeler study.
5. A recent study by the Iowa Geological Survey found that, with the assistance of high-resolution geologic mapping, karst susceptibility is highly dependent on the depth to bedrock and bedrock lithology. The data showed approximately 80% of mapped sinkholes within the study area occurred where carbonate bedrock was less than 25 feet below the land surface. Whereas only about 16% of mapped sinkholes occurred where carbonate bedrock was less than 5 feet below the surface. Using a 25-foot separation distance ensures that the vast majority of proposed CAFO sites within this category will be able to identify potential risks due to karst.
6. The Source Water Protection Program defines “highly susceptible” aquifers as those water-bearing units that have less than 25 feet of confining material above them. Studies of public water supply wells also indicate that wells with less than 100 feet of confining materials are vulnerable to contamination from surface activities.http://s-iihr34.iihr.uiowa.edu/publications/uploads/2015-06-23_11-06-38_tis-57.pdf
7. Studies of groundwater around earthen manure storage structures designed by a PE and required to have a 2-ft compacted clay liner, show that groundwater contamination rarely moves more than 50 feet downgradient in areas dominated by glacial till. This data also clearly shows that even with a compacted clay liner, contamination from storage of liquid manure has the potential to travel 25 feet (horizontally or vertically).

8. Monitoring of perimeter tiles around newly constructed concrete manure storage structures showed ammonia-nitrogen levels exceeding 2 mg/L (max of 88 mg/L), which suggests that leakage may have been occurring; however, much more extensive

monitoring would have been necessary to distinguish ammonia from manure storage from other potential sources. (Hruby-IGWA presentation)

9. Private wells (<150 ft deep) in karst areas have higher nitrate concentrations than most other parts of Iowa. (Wheeler) While it is difficult to differentiate between nitrate contamination from manure vs. commercial fertilizer, this study indicates that distance to sinkhole and distance to nearest AFO are important predictive factors.
10. Support from other states for increased separation. Minnesota requires 5 feet to karst susceptible bedrock for facilities with less than 300 animal units, 10 ft for farms with 300-1000 animal units, and 15 feet for facilities with 1000 or more animal units. (Locating Feedlots and Manure Storage Areas in MN's Karst Region.)
11. Private wells in karst regions, especially those less than 50 feet deep, have been shown to be impacted by both human and livestock waste, causing increased risks to human health. Studies of private wells in Iowa (Luther College) and southwest Wisconsin (SWIGG) indicate that large microorganisms, like Cryptosporidia, along with other smaller pathogens can be transported to wells in karst.

Fiscal analysis? My assumptions for the fiscal analysis were:

- 30 additional sites affected/year
- 25 sites would not meet the 5' continuous layer and need the 2' clay liner
- 70% of the sites would use a PE over the NRCS
- 2' liner would cost $9,000 to construct
- PE design of 2' liner would be $3000
- PE design of pit would be $3000
- Total additional cost for the 30 sites to build = $336,000
- Average additional cost per site = $11,200

About 3 sites per year install a 2' liner (because it was within 5' of limestone). I would assume only 1 site could move and comply. The other 2 sites would simply not build or build an "open lot" barn instead.

APPENDIX B. PUBLIC WATER SYSTEM INFORMATION

Table 1. Health-based nitrate violations in 12-county Driftless area, 2016-2023. NC: Transient Non-Community; C: Community. Data from Iowa Department of Natural Resources Drinking Water Portal: https://programs.iowadnr.gov/iowadrinkingwater. Last visited March 20, 2024.

PWS ID	PWS Name	PWS Type	Compliance Begin Date	City	County	Population Served
IA2322202	BS GENERAL STORE LLC	NC	1/1/2016	CAMANCHE	CLINTON	27
IA2322202	BS GENERAL STORE LLC	NC	2/1/2016	CAMANCHE	CLINTON	27
IA2322202	BS GENERAL STORE LLC	NC	3/1/2016	CAMANCHE	CLINTON	27
IA2322202	BS GENERAL STORE LLC	NC	4/1/2016	CAMANCHE	CLINTON	27
IA2322202	BS GENERAL STORE LLC	NC	6/1/2016	CAMANCHE	CLINTON	27
IA3130883	DYERSVILLE GOLF AND COUNTRY CLUB	NC	6/1/2016	DYERSVILLE	DUBUQUE	40
IA2817860	HARTWICK POINT WELL	NC	7/1/2016	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	8/1/2016	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	9/1/2016	DELHI	DELAWARE	120
IA5377727	THE GROVE	NC	3/1/2017	SCOTCH GROVE	JONES	31
IA2817860	HARTWICK POINT WELL	NC	3/1/2017	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	4/1/2017	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	5/1/2017	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	6/1/2017	DELHI	DELAWARE	120
IA2817860	HARTWICK POINT WELL	NC	7/1/2017	DELHI	DELAWARE	120
IA3353746	HICKORY GROVE (GOLF COURSE)	NC	8/1/2017	OELWEIN	FAYETTE	28
IA2817860	HARTWICK POINT WELL	NC	8/1/2017	DELHI	DELAWARE	120
IA9609874	BURR OAK LUTHERAN CHURCH	NC	9/1/2017	BURR OAK	WINNESHIE K	50
IA2817860	HARTWICK POINT WELL	NC	9/1/2017	DELHI	DELAWARE	120

IA5343408	CAMP COURAGEOUS OF IOWA	NC	9/1/2017	MONTICELLO	JONES	155
IA3353746	HICKORY GROVE (GOLF COURSE)	NC	9/1/2017	OELWEIN	FAYETTE	28
IA9609874	BURR OAK LUTHERAN CHURCH	NC	12/1/2017	BURR OAK	WINNESHIE K	50
IA9609874	BURR OAK LUTHERAN CHURCH	NC	1/1/2018	BURR OAK	WINNESHIE K	50
IA9609874	BURR OAK LUTHERAN CHURCH	NC	2/1/2018	BURR OAK	WINNESHIE K	50
IA9609874	BURR OAK LUTHERAN CHURCH	NC	3/1/2018	BURR OAK	WINNESHIE K	50
IA1957201	THE BALK TANK	NC	2/1/2019	LAWLER	CHICKASAW	25
IA1957201	THE BALK TANK	NC	3/1/2019	LAWLER	CHICKASAW	25
IA2268601	LAZY SUSAN CAMPGROUND	NC	4/1/2019	NORTH BUENA VISTA	CLAYTON	70
IA1957201	THE BALK TANK	NC	4/1/2019	LAWLER	CHICKASAW	25
IA1957201	THE BALK TANK	NC	5/1/2019	LAWLER	CHICKASAW	25
IA2839401	LAZY T CAMPGROUND	NC	7/1/2019	MANCHESTER	DELAWARE	25
IA5300688	MONTIPARK LLC	C	7/1/2019	MONTICELLO	JONES	60
IA5377727	THE GROVE	NC	8/1/2019	SCOTCH GROVE	JONES	31
IA2234101	PATTISON SHOP	NC	8/1/2019	GARNAVILLO	CLAYTON	34
IA2234101	PATTISON SHOP	NC	9/1/2019	GARNAVILLO	CLAYTON	34
IA2234101	PATTISON SHOP	NC	10/1/2019	GARNAVILLO	CLAYTON	34
IA5343401	RIVERVIEW RIDGE CAMPGROUND S	NC	5/1/2020	CASCADE	JONES	80
IA3130883	DYERSVILLE GOLF AND COUNTRY CLUB	NC	5/1/2020	DYERSVILLE	DUBUQUE	40
IA2839401	LAZY T CAMPGROUND	NC	5/1/2020	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	6/1/2020	MANCHESTER	DELAWARE	25
IA5343401	RIVERVIEW RIDGE	NC	6/1/2020	CASCADE	JONES	80

	CAMPGROUNDS					
IA2839401	LAZY T CAMPGROUND	NC	7/1/2020	MANCHESTER	DELAWARE	25
IA5343401	RIVERVIEW RIDGE CAMPGROUNDS	NC	7/1/2020	CASCADE	JONES	80
IA5343401	RIVERVIEW RIDGE CAMPGROUNDS	NC	8/1/2020	CASCADE	JONES	80
IA2839401	LAZY T CAMPGROUND	NC	8/1/2020	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	9/1/2020	MANCHESTER	DELAWARE	25
IA5377727	THE GROVE	NC	2/1/2021	SCOTCH GROVE	JONES	31
IA2839401	LAZY T CAMPGROUND	NC	4/1/2021	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	5/1/2021	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	8/1/2021	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	10/1/2021	MANCHESTER	DELAWARE	25
IA5377727	THE GROVE	NC	12/1/2021	SCOTCH GROVE	JONES	31
IA0315707	WINGS	NC	4/1/2022	DORCHESTER	ALLAMAKEE	46
IA2839401	LAZY T CAMPGROUND	NC	4/1/2022	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	5/1/2022	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	6/1/2022	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	7/1/2022	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	8/1/2022	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	9/1/2022	MANCHESTER	DELAWARE	25
IA3122201	TOWN CLOCK	NC	10/1/2022	CENTRALIA	DUBUQUE	158
IA2839401	LAZY T CAMPGROUND	NC	10/1/2022	MANCHESTER	DELAWARE	25
IA3122201	TOWN CLOCK	NC	1/1/2023	CENTRALIA	DUBUQUE	158
IA3122201	TOWN CLOCK	NC	2/1/2023	CENTRALIA	DUBUQUE	158
IA3122201	TOWN CLOCK	NC	3/1/2023	CENTRALIA	DUBUQUE	158
IA3122201	TOWN CLOCK	NC	4/1/2023	CENTRALIA	DUBUQUE	158
IA1957201	THE BALK TANK	NC	4/1/2023	LAWLER	CHICKASAW	25
IA2839401	LAZY T CAMPGROUND	NC	4/1/2023	MANCHESTER	DELAWARE	25
IA2839401	LAZY T CAMPGROUND	NC	5/1/2023	MANCHESTER	DELAWARE	25

IA3122201	TOWN CLOCK	NC	5/1/2023	CENTRALIA	DUBUQUE	158
IA2839401	LAZY T CAMPGROUND	NC	6/1/2023	MANCHESTER	DELAWARE	25
IA3122201	TOWN CLOCK	NC	7/1/2023	CENTRALIA	DUBUQUE	158
IA2839401	LAZY T CAMPGROUND	NC	7/1/2023	MANCHESTER	DELAWARE	25
IA1957201	THE BALK TANK	NC	8/1/2023	LAWLER	CHICKASAW	25
IA2839401	LAZY T CAMPGROUND	NC	8/1/2023	MANCHESTER	DELAWARE	25
IA3122201	TOWN CLOCK	NC	8/1/2023	CENTRALIA	DUBUQUE	158
IA2839401	LAZY T CAMPGROUND	NC	9/1/2023	MANCHESTER	DELAWARE	25
IA1957201	THE BALK TANK	NC	9/1/2023	LAWLER	CHICKASAW	25
IA1957201	THE BALK TANK	NC	10/1/2023	LAWLER	CHICKASAW	25
IA3122201	TOWN CLOCK	NC	10/1/2023	CENTRALIA	DUBUQUE	158
IA2839401	LAZY T CAMPGROUND	NC	10/1/2023	MANCHESTER	DELAWARE	25
IA1957201	THE BALK TANK	NC	11/1/2023	LAWLER	CHICKASAW	25
IA3122201	TOWN CLOCK	NC	11/1/2023	CENTRALIA	DUBUQUE	158
IA3122201	TOWN CLOCK	NC	12/1/2023	CENTRALIA	DUBUQUE	158

Table 2. Strawberry Point Water Supply nitrate sample data, 2016-2023. PWS ID: IA2279003. Data from Iowa Department of Natural Resources Drinking Water Portal: https://programs.iowadnr.gov/iowadrinkingwater. Last visited March 26, 2024.

Sample Number	**Sample Collection Date**	**Nitrate as N (mg/L)**	**Facility Name**
OE335362	1/13/2016	8.1	FINISHED WATER SAMPLE TAP, #3
OE335363	1/13/2016	3.6	FINISHED WATER SAMPLE TAP, #4
OE366020	4/13/2016	8.8	FINISHED WATER SAMPLE TAP, #3
OE366021	4/13/2016	3.3	FINISHED WATER SAMPLE TAP, #4
OE400646	7/12/2016	4.9	FINISHED WATER SAMPLE TAP, #3
OE400645	7/12/2016	2.6	FINISHED WATER SAMPLE TAP, #4
OE443109	10/18/2016	3.6	FINISHED WATER SAMPLE TAP, #3
OE443110	10/18/2016	9.6	FINISHED WATER SAMPLE TAP, #4
OE493592	3/22/2017	2.7	FINISHED WATER SAMPLE TAP, #3
OE493591	3/22/2017	9.3	FINISHED WATER SAMPLE TAP, #4
OE512475	5/11/2017	2.3	FINISHED WATER SAMPLE TAP, #3
OE512476	5/11/2017	9.8	FINISHED WATER SAMPLE TAP, #4
OE555632	8/22/2017	3.4	FINISHED WATER SAMPLE TAP, #3
OE555633	8/22/2017	9.9	FINISHED WATER SAMPLE TAP, #4
OE598983	12/7/2017	3.3	FINISHED WATER SAMPLE TAP, #3
OE598982	12/7/2017	9.9	FINISHED WATER SAMPLE TAP, #4
OE625812	2/21/2018	9.3	FINISHED WATER SAMPLE TAP, #3
OE625811	2/21/2018	2.4	FINISHED WATER SAMPLE TAP, #4
OE660855	5/21/2018	9.7	FINISHED WATER SAMPLE TAP, #3

OE660856	5/21/2018	5.9	FINISHED WATER SAMPLE TAP, #4
OE694620	8/6/2018	3	FINISHED WATER SAMPLE TAP, #3
OE694621	8/6/2018	10	FINISHED WATER SAMPLE TAP, #4
OE711905	9/11/2018	3	FINISHED WATER SAMPLE TAP, #3
OE711904	9/11/2018	9.6	FINISHED WATER SAMPLE TAP, #4
OE723289	10/4/2018	2.7	FINISHED WATER SAMPLE TAP, #3
OE723290	10/4/2018	10	FINISHED WATER SAMPLE TAP, #4
OE739777	11/13/2018	2.6	FINISHED WATER SAMPLE TAP, #3
OE739776	11/13/2018	9.6	FINISHED WATER SAMPLE TAP, #4
OE746923	12/4/2018	2.6	FINISHED WATER SAMPLE TAP, #3
OE746922	12/4/2018	9.4	FINISHED WATER SAMPLE TAP, #4
OE749478	12/11/2018	9.4	FINISHED WATER SAMPLE TAP, #4
OE761503	1/16/2019	3.4	FINISHED WATER SAMPLE TAP, #3
OE761504	1/16/2019	9.5	FINISHED WATER SAMPLE TAP, #4
OE774831	2/25/2019	6	FINISHED WATER SAMPLE TAP, #3
OE774832	2/25/2019	9	FINISHED WATER SAMPLE TAP, #4
OE782949	3/18/2019	3.3	FINISHED WATER SAMPLE TAP, #3
OE782950	3/18/2019	8.8	FINISHED WATER SAMPLE TAP, #4
OE789786	4/3/2019	3.2	FINISHED WATER SAMPLE TAP, #3
OE789785	4/3/2019	8.8	FINISHED WATER SAMPLE TAP, #4
OE805686	5/8/2019	2.7	FINISHED WATER SAMPLE TAP, #3
OE805685	5/8/2019	8.7	FINISHED WATER SAMPLE TAP, #4
OE823292	6/18/2019	2.7	FINISHED WATER SAMPLE TAP, #3
OE823293	6/18/2019	8.9	FINISHED WATER SAMPLE TAP, #4
OE833160	7/10/2019	2.8	FINISHED WATER SAMPLE TAP, #3
OE833161	7/10/2019	9	FINISHED WATER SAMPLE TAP, #4
OE846017	8/6/2019	2.7	FINISHED WATER SAMPLE TAP, #3
OE846018	8/6/2019	8.9	FINISHED WATER SAMPLE TAP, #4
OE867963	9/18/2019	3	FINISHED WATER SAMPLE TAP, #3
OE867962	9/18/2019	8.6	FINISHED WATER SAMPLE TAP, #4
OE877617	10/9/2019	3	FINISHED WATER SAMPLE TAP, #3
OE877618	10/9/2019	9.3	FINISHED WATER SAMPLE TAP, #4
OE894172	11/14/2019	3	FINISHED WATER SAMPLE TAP, #3
OE913142	1/6/2020	3.2	FINISHED WATER SAMPLE TAP, #3
OE921876	1/28/2020	1.6	FINISHED WATER SAMPLE TAP, #5
OE931199	2/19/2020	1.6	FINISHED WATER SAMPLE TAP, #5
OE936341	3/3/2020	1.6	FINISHED WATER SAMPLE TAP, #5
OE954015	4/6/2020	3.6	FINISHED WATER SAMPLE TAP, #3
OE954014	4/6/2020	2.1	FINISHED WATER SAMPLE TAP, #5
OE996428	5/6/2020	1.9	FINISHED WATER SAMPLE TAP, #5
OE1055851	6/17/2020	2	FINISHED WATER SAMPLE TAP, #5
OE1095154	7/6/2020	2.1	FINISHED WATER SAMPLE TAP, #5
OE1159204	8/4/2020	3.6	FINISHED WATER SAMPLE TAP, #3
OE1159217	8/4/2020	1.8	FINISHED WATER SAMPLE TAP, #5
OE1235269	9/8/2020	1.5	FINISHED WATER SAMPLE TAP, #5
OE1315112	10/5/2020	3.4	FINISHED WATER SAMPLE TAP, #3
OE1315111	10/5/2020	1.6	FINISHED WATER SAMPLE TAP, #5
OE1388827	11/3/2020	1.9	FINISHED WATER SAMPLE TAP, #5

OE1470426	12/2/2020	1.8	FINISHED WATER SAMPLE TAP, #5
OE1533789	1/6/2021	1.7	FINISHED WATER SAMPLE TAP, #5
OE1544667	1/13/2021	3.5	FINISHED WATER SAMPLE TAP, #3
OE1587060	2/11/2021	1.6	FINISHED WATER SAMPLE TAP, #5
OE1995967	1/4/2022	3.6	FINISHED WATER SAMPLE TAP, #3
OE1995966	1/4/2022	1.8	FINISHED WATER SAMPLE TAP, #5
OE2225670	1/4/2023	3.6	FINISHED WATER SAMPLE TAP, #3
OE2225669	1/4/2023	1.7	FINISHED WATER SAMPLE TAP, #5

Table 3. Manchester Water Supply nitrate sample data, 2016-2023. PWS ID: IA2839021. Data from Iowa Department of Natural Resources Drinking Water Portal: https://programs.iowadnr.gov/iowadrinkingwater. Last visited March 26, 2024.

Sample Number	**Sample Collection Date**	**Nitrate as N (mg/L)**	**Facility Name**
OE334355	1/11/2016	7	FINISHED WATER SAMPLE TAP, #6
OE334356	1/11/2016	6.8	FINISHED WATER SAMPLE TAP, #7
OE334354	1/11/2016	6.7	FINISHED WATER SAMPLE TAP, #5
OE334358	1/11/2016	8.6	FINISHED WATER SAMPLE TAP, #4
OE334357	1/11/2016	6.9	FINISHED WATER SAMPLE TAP, #8
OE342916	2/8/2016	8.1	FINISHED WATER SAMPLE TAP, #6
OE342915	2/8/2016	7.7	FINISHED WATER SAMPLE TAP, #5
OE342914	2/8/2016	6.6	FINISHED WATER SAMPLE TAP, #7
OE355017	3/14/2016	6.8	FINISHED WATER SAMPLE TAP, #6
OE355018	3/14/2016	6.5	FINISHED WATER SAMPLE TAP, #7
OE355019	3/14/2016	7.4	FINISHED WATER SAMPLE TAP, #5
OE361629	4/4/2016	8.4	FINISHED WATER SAMPLE TAP, #5
OE361632	4/4/2016	6.8	FINISHED WATER SAMPLE TAP, #8
OE361630	4/4/2016	7.1	FINISHED WATER SAMPLE TAP, #6
OE361628	4/4/2016	6.6	FINISHED WATER SAMPLE TAP, #7
OE361631	4/4/2016	8.6	FINISHED WATER SAMPLE TAP, #4
OE373010	5/2/2016	6.4	FINISHED WATER SAMPLE TAP, #5
OE373008	5/2/2016	6.4	FINISHED WATER SAMPLE TAP, #7
OE373009	5/2/2016	7	FINISHED WATER SAMPLE TAP, #6
OE389860	6/15/2016	6.3	FINISHED WATER SAMPLE TAP, #7
OE389859	6/15/2016	7	FINISHED WATER SAMPLE TAP, #5
OE389861	6/15/2016	7.5	FINISHED WATER SAMPLE TAP, #6
OE399528	7/11/2016	8.8	FINISHED WATER SAMPLE TAP, #4
OE399525	7/11/2016	7.3	FINISHED WATER SAMPLE TAP, #6
OE399526	7/11/2016	7.1	FINISHED WATER SAMPLE TAP, #8
OE399527	7/11/2016	6.7	FINISHED WATER SAMPLE TAP, #5
OE399524	7/11/2016	7.7	FINISHED WATER SAMPLE TAP, #7
OE412950	8/9/2016	6.4	FINISHED WATER SAMPLE TAP, #7
OE412951	8/9/2016	7.3	FINISHED WATER SAMPLE TAP, #6
OE412952	8/9/2016	7	FINISHED WATER SAMPLE TAP, #5
OE424954	9/6/2016	6.9	FINISHED WATER SAMPLE TAP, #7
OE424952	9/6/2016	8.2	FINISHED WATER SAMPLE TAP, #5
OE424953	9/6/2016	7.5	FINISHED WATER SAMPLE TAP, #6

OE438830	10/10/2016	8.2	FINISHED WATER SAMPLE TAP, #4
OE438828	10/10/2016	6.4	FINISHED WATER SAMPLE TAP, #7
OE438829	10/10/2016	6.4	FINISHED WATER SAMPLE TAP, #8
OE438831	10/10/2016	6.9	FINISHED WATER SAMPLE TAP, #5
OE438827	10/10/2016	7.5	FINISHED WATER SAMPLE TAP, #6
OE449643	11/7/2016	7.2	FINISHED WATER SAMPLE TAP, #5
OE449642	11/7/2016	6.5	FINISHED WATER SAMPLE TAP, #7
OE449641	11/7/2016	7.5	FINISHED WATER SAMPLE TAP, #6
OE461073	12/12/2016	6.4	FINISHED WATER SAMPLE TAP, #5
OE461072	12/12/2016	6.3	FINISHED WATER SAMPLE TAP, #7
OE461074	12/12/2016	7.5	FINISHED WATER SAMPLE TAP, #6
OE469403	1/10/2017	6.8	FINISHED WATER SAMPLE TAP, #8
OE469402	1/10/2017	8.9	FINISHED WATER SAMPLE TAP, #4
OE469404	1/10/2017	6.6	FINISHED WATER SAMPLE TAP, #7
OE469401	1/10/2017	6.9	FINISHED WATER SAMPLE TAP, #5
OE469405	1/10/2017	8	FINISHED WATER SAMPLE TAP, #6
OE477968	2/6/2017	6.8	FINISHED WATER SAMPLE TAP, #5
OE477966	2/6/2017	8.4	FINISHED WATER SAMPLE TAP, #7
OE477967	2/6/2017	7.7	FINISHED WATER SAMPLE TAP, #6
OE487781	3/6/2017	6.7	FINISHED WATER SAMPLE TAP, #5
OE487779	3/6/2017	7.7	FINISHED WATER SAMPLE TAP, #6
OE487780	3/6/2017	6.3	FINISHED WATER SAMPLE TAP, #7
OE500788	4/11/2017	8.5	FINISHED WATER SAMPLE TAP, #4
OE500787	4/11/2017	6.7	FINISHED WATER SAMPLE TAP, #5
OE500789	4/11/2017	6.4	FINISHED WATER SAMPLE TAP, #7
OE500791	4/11/2017	6.8	FINISHED WATER SAMPLE TAP, #8
OE500790	4/11/2017	7.7	FINISHED WATER SAMPLE TAP, #6
OE510739	5/8/2017	7.5	FINISHED WATER SAMPLE TAP, #6
OE510738	5/8/2017	6.1	FINISHED WATER SAMPLE TAP, #7
OE510740	5/8/2017	6.3	FINISHED WATER SAMPLE TAP, #5
OE524105	6/13/2017	6.6	FINISHED WATER SAMPLE TAP, #7
OE524104	6/13/2017	7	FINISHED WATER SAMPLE TAP, #6
OE524103	6/13/2017	7.1	FINISHED WATER SAMPLE TAP, #5
OE539997	7/19/2017	7	FINISHED WATER SAMPLE TAP, #5
OE539996	7/19/2017	8.5	FINISHED WATER SAMPLE TAP, #4
OE539999	7/19/2017	7.5	FINISHED WATER SAMPLE TAP, #6
OE539998	7/19/2017	6.6	FINISHED WATER SAMPLE TAP, #7
OE539995	7/19/2017	6.8	FINISHED WATER SAMPLE TAP, #8
OE552231	8/15/2017	7.6	FINISHED WATER SAMPLE TAP, #5
OE552230	8/15/2017	8.4	FINISHED WATER SAMPLE TAP, #6
OE552232	8/15/2017	6.5	FINISHED WATER SAMPLE TAP, #7
OE564370	9/12/2017	8	FINISHED WATER SAMPLE TAP, #6
OE564371	9/12/2017	6.4	FINISHED WATER SAMPLE TAP, #5
OE564369	9/12/2017	6.5	FINISHED WATER SAMPLE TAP, #7
OE575857	10/9/2017	6.9	FINISHED WATER SAMPLE TAP, #5
OE575855	10/9/2017	6.7	FINISHED WATER SAMPLE TAP, #8
OE575856	10/9/2017	8.3	FINISHED WATER SAMPLE TAP, #4
OE575854	10/9/2017	8.7	FINISHED WATER SAMPLE TAP, #7

OE575853	10/9/2017	7.1	FINISHED WATER SAMPLE TAP, #6
OE586872	11/6/2017	7.2	FINISHED WATER SAMPLE TAP, #5
OE586871	11/6/2017	8	FINISHED WATER SAMPLE TAP, #6
OE586870	11/6/2017	7	FINISHED WATER SAMPLE TAP, #7
OE602517	12/18/2017	6.4	FINISHED WATER SAMPLE TAP, #5
OE602516	12/18/2017	6.6	FINISHED WATER SAMPLE TAP, #7
OE602515	12/18/2017	8.4	FINISHED WATER SAMPLE TAP, #6
OE609192	1/9/2018	6.9	FINISHED WATER SAMPLE TAP, #5
OE609191	1/9/2018	6.6	FINISHED WATER SAMPLE TAP, #7
OE609193	1/9/2018	8.6	FINISHED WATER SAMPLE TAP, #4
OE609189	1/9/2018	7.6	FINISHED WATER SAMPLE TAP, #6
OE609190	1/9/2018	7	FINISHED WATER SAMPLE TAP, #8
OE618846	2/5/2018	7.7	FINISHED WATER SAMPLE TAP, #6
OE618847	2/5/2018	7.1	FINISHED WATER SAMPLE TAP, #5
OE618845	2/5/2018	6.3	FINISHED WATER SAMPLE TAP, #7
OE636249	3/21/2018	7.4	FINISHED WATER SAMPLE TAP, #6
OE636248	3/21/2018	7.7	FINISHED WATER SAMPLE TAP, #5
OE636250	3/21/2018	6.7	FINISHED WATER SAMPLE TAP, #7
OE644356	4/11/2018	8.4	FINISHED WATER SAMPLE TAP, #4
OE644360	4/11/2018	6.9	FINISHED WATER SAMPLE TAP, #8
OE644359	4/11/2018	6.9	FINISHED WATER SAMPLE TAP, #6
OE644358	4/11/2018	6.2	FINISHED WATER SAMPLE TAP, #7
OE644357	4/11/2018	6.3	FINISHED WATER SAMPLE TAP, #5
OE658239	5/15/2018	6.5	FINISHED WATER SAMPLE TAP, #5
OE658241	5/15/2018	7.6	FINISHED WATER SAMPLE TAP, #6
OE658240	5/15/2018	7.2	FINISHED WATER SAMPLE TAP, #7
OE672650	6/19/2018	6.8	FINISHED WATER SAMPLE TAP, #5
OE672649	6/19/2018	7	FINISHED WATER SAMPLE TAP, #6
OE672648	6/19/2018	7.2	FINISHED WATER SAMPLE TAP, #7
OE680472	7/9/2018	7.6	FINISHED WATER SAMPLE TAP, #7
OE680473	7/9/2018	7.4	FINISHED WATER SAMPLE TAP, #8
OE680461	7/9/2018	7.6	FINISHED WATER SAMPLE TAP, #5
OE680471	7/9/2018	8.3	FINISHED WATER SAMPLE TAP, #6
OE680460	7/9/2018	9.1	FINISHED WATER SAMPLE TAP, #4
OE702562	8/21/2018	6.9	FINISHED WATER SAMPLE TAP, #7
OE702561	8/21/2018	7.5	FINISHED WATER SAMPLE TAP, #6
OE702560	8/21/2018	7	FINISHED WATER SAMPLE TAP, #5
OE715223	9/18/2018	6.6	FINISHED WATER SAMPLE TAP, #7
OE715221	9/18/2018	8	FINISHED WATER SAMPLE TAP, #6
OE715222	9/18/2018	8.1	FINISHED WATER SAMPLE TAP, #5
OE724883	10/9/2018	6.3	FINISHED WATER SAMPLE TAP, #4
OE724887	10/9/2018	6	FINISHED WATER SAMPLE TAP, #7
OE730385	10/22/2018	7	FINISHED WATER SAMPLE TAP, #8
OE730384	10/22/2018	7.8	FINISHED WATER SAMPLE TAP, #5
OE730386	10/22/2018	7.6	FINISHED WATER SAMPLE TAP, #6
OE741990	11/19/2018	7.7	FINISHED WATER SAMPLE TAP, #6
OE741991	11/19/2018	8	FINISHED WATER SAMPLE TAP, #5
OE741992	11/19/2018	8.6	FINISHED WATER SAMPLE TAP, #7

OE749347	12/11/2018	7.4	FINISHED WATER SAMPLE TAP, #5
OE749348	12/11/2018	6.8	FINISHED WATER SAMPLE TAP, #7
OE749346	12/11/2018	8	FINISHED WATER SAMPLE TAP, #6
OE760368	1/14/2019	7	FINISHED WATER SAMPLE TAP, #8
OE760367	1/14/2019	7.4	FINISHED WATER SAMPLE TAP, #7
OE760371	1/14/2019	7.4	FINISHED WATER SAMPLE TAP, #5
OE760372	1/14/2019	8	FINISHED WATER SAMPLE TAP, #4
OE760366	1/14/2019	8.2	FINISHED WATER SAMPLE TAP, #6
OE767617	2/5/2019	7.6	FINISHED WATER SAMPLE TAP, #5
OE767616	2/5/2019	7	FINISHED WATER SAMPLE TAP, #7
OE767615	2/5/2019	8.8	FINISHED WATER SAMPLE TAP, #6
OE780506	3/12/2019	7	FINISHED WATER SAMPLE TAP, #7
OE780507	3/12/2019	7	FINISHED WATER SAMPLE TAP, #5
OE780505	3/12/2019	8.1	FINISHED WATER SAMPLE TAP, #6
OE788993	4/2/2019	8.2	FINISHED WATER SAMPLE TAP, #4
OE788994	4/2/2019	9	FINISHED WATER SAMPLE TAP, #6
OE788996	4/2/2019	7.2	FINISHED WATER SAMPLE TAP, #5
OE788995	4/2/2019	6.8	FINISHED WATER SAMPLE TAP, #7
OE788992	4/2/2019	7.2	FINISHED WATER SAMPLE TAP, #8
OE807364	5/13/2019	7.4	FINISHED WATER SAMPLE TAP, #5
OE807362	5/13/2019	8	FINISHED WATER SAMPLE TAP, #6
OE807363	5/13/2019	7.1	FINISHED WATER SAMPLE TAP, #7
OE819133	6/10/2019	7.4	FINISHED WATER SAMPLE TAP, #5
OE819131	6/10/2019	8.4	FINISHED WATER SAMPLE TAP, #6
OE819132	6/10/2019	6.8	FINISHED WATER SAMPLE TAP, #7
OE835722	7/16/2019	7.3	FINISHED WATER SAMPLE TAP, #5
OE835723	7/16/2019	7.3	FINISHED WATER SAMPLE TAP, #7
OE835724	7/16/2019	7	FINISHED WATER SAMPLE TAP, #8
OE835725	7/16/2019	8.2	FINISHED WATER SAMPLE TAP, #6
OE835721	7/16/2019	8.1	FINISHED WATER SAMPLE TAP, #4
OE853432	8/20/2019	8.4	FINISHED WATER SAMPLE TAP, #5
OE853433	8/20/2019	7.4	FINISHED WATER SAMPLE TAP, #6
OE853434	8/20/2019	6.9	FINISHED WATER SAMPLE TAP, #7
OE864273	9/11/2019	7.4	FINISHED WATER SAMPLE TAP, #6
OE864272	9/11/2019	6.9	FINISHED WATER SAMPLE TAP, #5
OE864274	9/11/2019	6.6	FINISHED WATER SAMPLE TAP, #7
OE883628	10/22/2019	7.9	FINISHED WATER SAMPLE TAP, #4
OE883631	10/22/2019	8.5	FINISHED WATER SAMPLE TAP, #6
OE883632	10/22/2019	7.2	FINISHED WATER SAMPLE TAP, #8
OE883627	10/22/2019	7.1	FINISHED WATER SAMPLE TAP, #5
OE883626	10/22/2019	7.2	FINISHED WATER SAMPLE TAP, #7
OE896701	11/20/2019	9.1	FINISHED WATER SAMPLE TAP, #5
OE896703	11/20/2019	8.5	FINISHED WATER SAMPLE TAP, #6
OE896702	11/20/2019	7.7	FINISHED WATER SAMPLE TAP, #7
OE903475	12/9/2019	8.6	FINISHED WATER SAMPLE TAP, #6
OE903476	12/9/2019	7	FINISHED WATER SAMPLE TAP, #5
OE903474	12/9/2019	7.1	FINISHED WATER SAMPLE TAP, #7
OE917413	1/15/2020	7.8	FINISHED WATER SAMPLE TAP, #5

OE917415	1/15/2020	6.8	FINISHED WATER SAMPLE TAP, #7
OE917414	1/15/2020	8.1	FINISHED WATER SAMPLE TAP, #4
OE917412	1/15/2020	9	FINISHED WATER SAMPLE TAP, #6
OE917411	1/15/2020	7.3	FINISHED WATER SAMPLE TAP, #8
OE927717	2/11/2020	7.8	FINISHED WATER SAMPLE TAP, #6
OE927715	2/11/2020	6.8	FINISHED WATER SAMPLE TAP, #5
OE927716	2/11/2020	6.9	FINISHED WATER SAMPLE TAP, #7
OE939466	3/10/2020	6.7	FINISHED WATER SAMPLE TAP, #7
OE939468	3/10/2020	7.7	FINISHED WATER SAMPLE TAP, #5
OE939467	3/10/2020	8.4	FINISHED WATER SAMPLE TAP, #6
OE954796	4/7/2020	7.3	FINISHED WATER SAMPLE TAP, #5
OE954792	4/7/2020	8	FINISHED WATER SAMPLE TAP, #6
OE954791	4/7/2020	7.2	FINISHED WATER SAMPLE TAP, #7
OE954795	4/7/2020	8.1	FINISHED WATER SAMPLE TAP, #4
OE954793	4/7/2020	7.2	FINISHED WATER SAMPLE TAP, #8
OE1006479	5/12/2020	7.3	FINISHED WATER SAMPLE TAP, #6
OE1006480	5/12/2020	7.1	FINISHED WATER SAMPLE TAP, #5
OE1006478	5/12/2020	6.9	FINISHED WATER SAMPLE TAP, #7
OE1053441	6/16/2020	7.3	FINISHED WATER SAMPLE TAP, #5
OE1053439	6/16/2020	7.1	FINISHED WATER SAMPLE TAP, #7
OE1053440	6/16/2020	7.3	FINISHED WATER SAMPLE TAP, #6
OE1129476	7/20/2020	7.2	FINISHED WATER SAMPLE TAP, #8
OE1129478	7/20/2020	7	FINISHED WATER SAMPLE TAP, #5
OE1129477	7/20/2020	7.1	FINISHED WATER SAMPLE TAP, #6
OE1129475	7/20/2020	7.9	FINISHED WATER SAMPLE TAP, #4
OE1146305	7/28/2020	7.4	FINISHED WATER SAMPLE TAP, #7
OE1185232	8/18/2020	6.8	FINISHED WATER SAMPLE TAP, #7
OE1185233	8/18/2020	7.7	FINISHED WATER SAMPLE TAP, #5
OE1185231	8/18/2020	8.4	FINISHED WATER SAMPLE TAP, #6
OE1266175	9/16/2020	7.1	FINISHED WATER SAMPLE TAP, #7
OE1266173	9/16/2020	6.5	FINISHED WATER SAMPLE TAP, #5
OE1266174	9/16/2020	7.2	FINISHED WATER SAMPLE TAP, #6
OE1319883	10/6/2020	8	FINISHED WATER SAMPLE TAP, #4
OE1319880	10/6/2020	7.3	FINISHED WATER SAMPLE TAP, #8
OE1319881	10/6/2020	7	FINISHED WATER SAMPLE TAP, #6
OE1319884	10/6/2020	9	FINISHED WATER SAMPLE TAP, #7
OE1319882	10/6/2020	7.2	FINISHED WATER SAMPLE TAP, #5
OE1410951	11/10/2020	8.4	FINISHED WATER SAMPLE TAP, #6
OE1410950	11/10/2020	7.7	FINISHED WATER SAMPLE TAP, #7
OE1410949	11/10/2020	6.8	FINISHED WATER SAMPLE TAP, #5
OE1482842	12/8/2020	7.3	FINISHED WATER SAMPLE TAP, #5
OE1482840	12/8/2020	8.1	FINISHED WATER SAMPLE TAP, #7
OE1482841	12/8/2020	7.8	FINISHED WATER SAMPLE TAP, #6
OE1544538	1/13/2021	7.2	FINISHED WATER SAMPLE TAP, #8
OE1544540	1/13/2021	7.5	FINISHED WATER SAMPLE TAP, #6
OE1544539	1/13/2021	7.3	FINISHED WATER SAMPLE TAP, #7
OE1544514	1/13/2021	7.9	FINISHED WATER SAMPLE TAP, #4
OE1544515	1/13/2021	8.4	FINISHED WATER SAMPLE TAP, #5

OE1576381	2/3/2021	7.8	FINISHED WATER SAMPLE TAP, #5
OE1576382	2/3/2021	7.3	FINISHED WATER SAMPLE TAP, #7
OE1576383	2/3/2021	7.1	FINISHED WATER SAMPLE TAP, #6
OE1619387	3/9/2021	7.3	FINISHED WATER SAMPLE TAP, #6
OE1619386	3/9/2021	7	FINISHED WATER SAMPLE TAP, #7
OE1619385	3/9/2021	8.6	FINISHED WATER SAMPLE TAP, #5
OE1660274	4/13/2021	7.9	FINISHED WATER SAMPLE TAP, #4
OE1660275	4/13/2021	6.8	FINISHED WATER SAMPLE TAP, #5
OE1660271	4/13/2021	7	FINISHED WATER SAMPLE TAP, #7
OE1660273	4/13/2021	7.3	FINISHED WATER SAMPLE TAP, #8
OE1660272	4/13/2021	8.2	FINISHED WATER SAMPLE TAP, #6
OE1694959	5/12/2021	8.6	FINISHED WATER SAMPLE TAP, #5
OE1694960	5/12/2021	9.3	FINISHED WATER SAMPLE TAP, #6
OE1694961	5/12/2021	6.7	FINISHED WATER SAMPLE TAP, #7
OE1724136	6/9/2021	6.6	FINISHED WATER SAMPLE TAP, #5
OE1724135	6/9/2021	7.2	FINISHED WATER SAMPLE TAP, #6
OE1724134	6/9/2021	7	FINISHED WATER SAMPLE TAP, #7
OE1754614	7/12/2021	7.6	FINISHED WATER SAMPLE TAP, #4
OE1754612	7/12/2021	8.2	FINISHED WATER SAMPLE TAP, #7
OE1754613	7/12/2021	6.5	FINISHED WATER SAMPLE TAP, #6
OE1754610	7/12/2021	8	FINISHED WATER SAMPLE TAP, #5
OE1754615	7/12/2021	7.2	FINISHED WATER SAMPLE TAP, #8
OE1793456	8/11/2021	6.6	FINISHED WATER SAMPLE TAP, #7
OE1793457	8/11/2021	7.9	FINISHED WATER SAMPLE TAP, #5
OE1793433	8/11/2021	6.8	FINISHED WATER SAMPLE TAP, #6
OE1848631	9/15/2021	6.8	FINISHED WATER SAMPLE TAP, #7
OE1848630	9/15/2021	6.6	FINISHED WATER SAMPLE TAP, #6
OE1848629	9/15/2021	7.2	FINISHED WATER SAMPLE TAP, #5
OE1886590	10/11/2021	7.7	FINISHED WATER SAMPLE TAP, #4
OE1886589	10/11/2021	7.2	FINISHED WATER SAMPLE TAP, #8
OE1886587	10/11/2021	6.7	FINISHED WATER SAMPLE TAP, #6
OE1886588	10/11/2021	7.1	FINISHED WATER SAMPLE TAP, #7
OE1886586	10/11/2021	6.6	FINISHED WATER SAMPLE TAP, #5
OE1925303	11/8/2021	7.1	FINISHED WATER SAMPLE TAP, #5
OE1925304	11/8/2021	6.5	FINISHED WATER SAMPLE TAP, #7
OE1925305	11/8/2021	7	FINISHED WATER SAMPLE TAP, #6
OE1973312	12/15/2021	7.8	FINISHED WATER SAMPLE TAP, #5
OE1973314	12/15/2021	6.7	FINISHED WATER SAMPLE TAP, #7
OE1973313	12/15/2021	8.2	FINISHED WATER SAMPLE TAP, #6
OE2017615	1/19/2022	8	FINISHED WATER SAMPLE TAP, #7
OE2017614	1/19/2022	7.6	FINISHED WATER SAMPLE TAP, #6
OE2017613	1/19/2022	7.2	FINISHED WATER SAMPLE TAP, #8
OE2017611	1/19/2022	7.8	FINISHED WATER SAMPLE TAP, #4
OE2017612	1/19/2022	8.2	FINISHED WATER SAMPLE TAP, #5
OE2047436	2/16/2022	7.8	FINISHED WATER SAMPLE TAP, #6
OE2047437	2/16/2022	7	FINISHED WATER SAMPLE TAP, #7
OE2047438	2/16/2022	7	FINISHED WATER SAMPLE TAP, #5
OE2070419	3/23/2022	9.1	FINISHED WATER SAMPLE TAP, #6

OE2070420	3/23/2022	6.9	FINISHED WATER SAMPLE TAP, #7
OE2070418	3/23/2022	6	FINISHED WATER SAMPLE TAP, #5
OE2081089	4/12/2022	7.5	FINISHED WATER SAMPLE TAP, #4
OE2081088	4/12/2022	6.3	FINISHED WATER SAMPLE TAP, #7
OE2081087	4/12/2022	6.2	FINISHED WATER SAMPLE TAP, #5
OE2081091	4/12/2022	6.9	FINISHED WATER SAMPLE TAP, #8
OE2081090	4/12/2022	6.7	FINISHED WATER SAMPLE TAP, #6
OE2097096	5/10/2022	9.2	FINISHED WATER SAMPLE TAP, #6
OE2097097	5/10/2022	6.7	FINISHED WATER SAMPLE TAP, #7
OE2097095	5/10/2022	7	FINISHED WATER SAMPLE TAP, #5
OE2121494	6/21/2022	6.6	FINISHED WATER SAMPLE TAP, #6
OE2121495	6/21/2022	6.6	FINISHED WATER SAMPLE TAP, #7
OE2121493	6/21/2022	6.3	FINISHED WATER SAMPLE TAP, #5
OE2133432	7/12/2022	6.6	FINISHED WATER SAMPLE TAP, #7
OE2133431	7/12/2022	6.8	FINISHED WATER SAMPLE TAP, #6
OE2133430	7/12/2022	7.2	FINISHED WATER SAMPLE TAP, #8
OE2138359	7/19/2022	6.5	FINISHED WATER SAMPLE TAP, #5
OE2138360	7/19/2022	8	FINISHED WATER SAMPLE TAP, #4
OE2151763	8/9/2022	6.8	FINISHED WATER SAMPLE TAP, #5
OE2151762	8/9/2022	8.4	FINISHED WATER SAMPLE TAP, #6
OE2151761	8/9/2022	6.3	FINISHED WATER SAMPLE TAP, #7
OE2177038	9/20/2022	7.1	FINISHED WATER SAMPLE TAP, #6
OE2177037	9/20/2022	6.6	FINISHED WATER SAMPLE TAP, #7
OE2177036	9/20/2022	7	FINISHED WATER SAMPLE TAP, #5
OE2193198	10/19/2022	7.4	FINISHED WATER SAMPLE TAP, #5
OE2193197	10/19/2022	7.8	FINISHED WATER SAMPLE TAP, #4
OE2193199	10/19/2022	7.9	FINISHED WATER SAMPLE TAP, #6
OE2193201	10/19/2022	7.1	FINISHED WATER SAMPLE TAP, #8
OE2193200	10/19/2022	6.9	FINISHED WATER SAMPLE TAP, #7
OE2203035	11/8/2022	7.5	FINISHED WATER SAMPLE TAP, #5
OE2203034	11/8/2022	7.1	FINISHED WATER SAMPLE TAP, #6
OE2203036	11/8/2022	6.9	FINISHED WATER SAMPLE TAP, #7
OE2221629	12/20/2022	6.3	FINISHED WATER SAMPLE TAP, #6
OE2221630	12/20/2022	6.9	FINISHED WATER SAMPLE TAP, #7
OE2221628	12/20/2022	7.6	FINISHED WATER SAMPLE TAP, #5
OE2231558	1/18/2023	7.2	FINISHED WATER SAMPLE TAP, #6
OE2231559	1/18/2023	6.6	FINISHED WATER SAMPLE TAP, #7
OE2231537	1/18/2023	7	FINISHED WATER SAMPLE TAP, #8
OE2231557	1/18/2023	5.7	FINISHED WATER SAMPLE TAP, #5
OE2231538	1/18/2023	7.4	FINISHED WATER SAMPLE TAP, #4
OE2245432	2/22/2023	7.3	FINISHED WATER SAMPLE TAP, #5
OE2245434	2/22/2023	8.2	FINISHED WATER SAMPLE TAP, #7
OE2245433	2/22/2023	6.5	FINISHED WATER SAMPLE TAP, #6
OE2254417	3/15/2023	6.6	FINISHED WATER SAMPLE TAP, #6
OE2254416	3/15/2023	6.3	FINISHED WATER SAMPLE TAP, #5
OE2254415	3/15/2023	6.8	FINISHED WATER SAMPLE TAP, #7
OE2269610	4/19/2023	7.5	FINISHED WATER SAMPLE TAP, #4
OE2269612	4/19/2023	6.3	FINISHED WATER SAMPLE TAP, #7

OE2269609	4/19/2023	6.8	FINISHED WATER SAMPLE TAP, #5
OE2269613	4/19/2023	6.2	FINISHED WATER SAMPLE TAP, #6
OE2269611	4/19/2023	6.8	FINISHED WATER SAMPLE TAP, #8
OE2284263	5/23/2023	7	FINISHED WATER SAMPLE TAP, #6
OE2284261	5/23/2023	8.2	FINISHED WATER SAMPLE TAP, #5
OE2284262	5/23/2023	6.5	FINISHED WATER SAMPLE TAP, #7
OE2290537	6/7/2023	7.2	FINISHED WATER SAMPLE TAP, #6
OE2290535	6/7/2023	7.4	FINISHED WATER SAMPLE TAP, #5
OE2290536	6/7/2023	6.4	FINISHED WATER SAMPLE TAP, #7
OE2306259	7/12/2023	7.1	FINISHED WATER SAMPLE TAP, #8
OE2306256	7/12/2023	6.8	FINISHED WATER SAMPLE TAP, #6
OE2306260	7/12/2023	8	FINISHED WATER SAMPLE TAP, #4
OE2306257	7/12/2023	7.8	FINISHED WATER SAMPLE TAP, #5
OE2306258	7/12/2023	8.8	FINISHED WATER SAMPLE TAP, #7
2GH0539-01	8/16/2023	7.5	FINISHED WATER SAMPLE TAP, #5
2GH0539-03	8/16/2023	6.9	FINISHED WATER SAMPLE TAP, #6
2GH0539-02	8/16/2023	7.6	FINISHED WATER SAMPLE TAP, #7
2GI0350-01	9/13/2023	8.1	FINISHED WATER SAMPLE TAP, #5
2GI0350-02	9/13/2023	6.2	FINISHED WATER SAMPLE TAP, #7
2GI0350-03	9/13/2023	7.2	FINISHED WATER SAMPLE TAP, #6
2GJ0166-04	10/4/2023	7	FINISHED WATER SAMPLE TAP, #8
2GJ0166-03	10/4/2023	6.1	FINISHED WATER SAMPLE TAP, #7
2GJ0166-02	10/4/2023	6.7	FINISHED WATER SAMPLE TAP, #5
2GJ0166-05	10/4/2023	6.6	FINISHED WATER SAMPLE TAP, #6
2GJ0166-01	10/4/2023	7.7	FINISHED WATER SAMPLE TAP, #4
2GK0044-02	11/1/2023	7.7	FINISHED WATER SAMPLE TAP, #7
2GK0044-03	11/1/2023	7.5	FINISHED WATER SAMPLE TAP, #6
2GK0044-01	11/1/2023	8.2	FINISHED WATER SAMPLE TAP, #5
2GL0158-03	12/6/2023	9.2	FINISHED WATER SAMPLE TAP, #6
2GL0158-01	12/6/2023	7.5	FINISHED WATER SAMPLE TAP, #5
2GL0158-02	12/6/2023	8.9	FINISHED WATER SAMPLE TAP, #7

Table 4. Independence Water Department nitrate sample data, 2016-2023. PWS ID: IA1037070. Data from Iowa Department of Natural Resources Drinking Water Portal: https://programs.iowadnr.gov/iowadrinkingwater. Last visited March 26, 2024.

Sample Number	**Sample Collection Date**	**Nitrate as N (mg/L)**	**Facility Name**
2A60269-09	1/12/2016	9.1	FINISHED WATER TAP AT WELL #4
2B60370-09	2/16/2016	8.3	FINISHED WATER TAP AT WELL #4
2C60335-09	3/15/2016	9.4	FINISHED WATER TAP AT WELL #4
2D60355-09	4/12/2016	8.5	FINISHED WATER TAP AT WELL #4
2E60625-01	5/23/2016	<1.00	FINISHED WATER TAP AT WELL #4
2E60625-02	5/23/2016	<1.00	FINISHED WATER TAP AT WELL #6
2E60625-03	5/23/2016	<1.00	FINISHED WATER TAP AT WELL #3
2E60625-04	5/23/2016	<1.00	FINISHED WATER TAP AT WELL #7
2G60003-01	6/30/2016	9.1	FINISHED WATER TAP AT WELL #4
2H60627-09	8/23/2016	7.8	FINISHED WATER TAP AT WELL #4

2I60559-09	9/20/2016	7.3	FINISHED WATER TAP AT WELL #4
2J60644-09	10/19/2016	7.3	FINISHED WATER TAP AT WELL #4
2K60576-09	11/21/2016	7	FINISHED WATER TAP AT WELL #4
2L60300-09	12/13/2016	7.3	FINISHED WATER TAP AT WELL #4
2A70481-09	1/24/2017	7.3	FINISHED WATER TAP AT WELL #4
2B70394-01	2/16/2017	8	FINISHED WATER TAP AT WELL #4
2C70304-09	3/14/2017	8.9	FINISHED WATER TAP AT WELL #4
2D70730-01	4/25/2017	8.3	FINISHED WATER TAP AT WELL #4
2E70531-11	5/17/2017	<1.00	FINISHED WATER TAP AT WELL #3
2E70531-12	5/17/2017	<1.00	FINISHED WATER TAP AT WELL #7
2E70531-10	5/17/2017	<1.00	FINISHED WATER TAP AT WELL #6
2E70531-09	5/17/2017	8.3	FINISHED WATER TAP AT WELL #4
2F70356-09	6/13/2017	7.7	FINISHED WATER TAP AT WELL #4
2G70416-09	7/18/2017	8.7	FINISHED WATER TAP AT WELL #4
2H70577-09	8/22/2017	8.2	FINISHED WATER TAP AT WELL #4
2J70734-01	10/24/2017	6	FINISHED WATER TAP AT WELL #4
2K70391-09	11/14/2017	6	FINISHED WATER TAP AT WELL #4
2L70385-09	12/18/2017	6.2	FINISHED WATER TAP AT WELL #4
2A80498-05	1/23/2018	6.2	FINISHED WATER TAP AT WELL #4
2B80235-05	2/13/2018	5.9	FINISHED WATER TAP AT WELL #4
2C80437-01	3/22/2018	7	FINISHED WATER TAP AT WELL #4
2D80175-05	4/4/2018	7	FINISHED WATER TAP AT WELL #4
2E80310-08	5/9/2018	<1.00	FINISHED WATER TAP AT WELL #6
2E80310-09	5/9/2018	<1.00	FINISHED WATER TAP AT WELL #7
2E80310-06	5/9/2018	<1.00	FINISHED WATER TAP AT WELL #3
2E80310-07	5/9/2018	7.5	FINISHED WATER TAP AT WELL #4
2F80612-04	6/25/2018	8	FINISHED WATER TAP AT WELL #4
2G80189-05	7/10/2018	7.8	FINISHED WATER TAP AT WELL #4
2J80746-01	10/23/2018	6.5	FINISHED WATER TAP AT WELL #4
1B91242-01	2/19/2019	7.8	FINISHED WATER TAP AT WELL #4
2E90294-01	5/13/2019	5.9	FINISHED WATER TAP AT WELL #4
2E90625-03	5/29/2019	<1.00	FINISHED WATER TAP AT WELL #7
2E90625-02	5/29/2019	<1.00	FINISHED WATER TAP AT WELL #6
2E90625-01	5/29/2019	<1.00	FINISHED WATER TAP AT WELL #3
2I90450-04	9/17/2019	4.7	FINISHED WATER TAP AT WELL #4
2K90293-05	11/13/2019	5.3	FINISHED WATER TAP AT WELL #4
2A00403-05	1/21/2020	5.8	FINISHED WATER TAP AT WELL #4
2D00565-06	4/21/2020	<1.00	FINISHED WATER TAP AT WELL #6
2D00565-05	4/21/2020	6	FINISHED WATER TAP AT WELL #4
2D00565-07	4/21/2020	<1.00	FINISHED WATER TAP AT WELL #7
2D00565-04	4/21/2020	<1.00	FINISHED WATER TAP AT WELL #3
2I00438-04	9/15/2020	6.8	FINISHED WATER TAP AT WELL #4
2K00123-05	11/3/2020	5.6	FINISHED WATER TAP AT WELL #4
2EA0238-04	1/12/2021	6.1	FINISHED WATER TAP AT WELL #4
2ED0756-04	4/21/2021	<1.00	FINISHED WATER TAP AT WELL #7
2ED0756-02	4/21/2021	6.3	FINISHED WATER TAP AT WELL #4
2ED0756-01	4/21/2021	<1.00	FINISHED WATER TAP AT WELL #3
2ED0756-03	4/21/2021	<1.00	FINISHED WATER TAP AT WELL #6

2EH0476-01	8/18/2021	4.8	FINISHED WATER TAP AT WELL #4
2EJ0353-01	10/12/2021	5.6	FINISHED WATER TAP AT WELL #4
2FA0417-01	1/18/2022	6.2	FINISHED WATER TAP AT WELL #4
2FD0617-04	4/19/2022	<1.00	FINISHED WATER TAP AT WELL #7
2FD0617-02	4/19/2022	7.9	FINISHED WATER TAP AT WELL #4
2FD0617-03	4/19/2022	<1.00	FINISHED WATER TAP AT WELL #6
2FD0617-01	4/19/2022	<1.00	FINISHED WATER TAP AT WELL #3
2FH0533-01	8/17/2022	7.1	FINISHED WATER TAP AT WELL #4
2FL0348-01	12/14/2022	5.8	FINISHED WATER TAP AT WELL #4
2GC0503-01	3/22/2023	6.9	FINISHED WATER TAP AT WELL #4
2GF0731-03	6/28/2023	<0.60	FINISHED WATER TAP AT WELL #6
2GF0731-02	6/28/2023	6.2	FINISHED WATER TAP AT WELL #4
2GF0731-04	6/28/2023	<0.60	FINISHED WATER TAP AT WELL #7
2GF0731-01	6/28/2023	<0.60	FINISHED WATER TAP AT WELL #3
2GI0685-01	9/27/2023	4.8	FINISHED WATER TAP AT WELL #4
2GL0466-01	12/26/2023	5.7	FINISHED WATER TAP AT WELL #4