# Tainted Tap:

## Nitrate Pollution, Factory Farms, and Drinking Water in Maryland and Beyond

by Darya Minovi and Katlyn Schmitt

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CPR
Center for Progressive Reform

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# Table of Contents

# Tainted Tap:

## Nitrate Pollution, Factory Farms, and Drinking Water in Maryland and Beyond

## Executive Summary

Nitrates are a toxic compound found in groundwater and surface waters, sometimes at unsafe levels. One of the major sources of nitrates is animal waste from industrial agriculture operations. On Maryland's Lower Eastern Shore, the number of concentrated animal feeding operations (CAFOs) has proliferated in recent years. Over-application or mismanagement of nitrogen-rich manure can cause nitrates to leach into the groundwater that Lower Eastern Shore residents rely on for drinking water, with serious implications for public health. Nitrate pollution has been linked to cancer, thyroid disease, and neonatal health issues, including a condition fatal to infants.

CPR researchers acquired sample well water testing data in two out of three Lower Eastern Shore counties and reviewed annual reports on water quality at public water utilities in the three counties. Based on our analysis of the available data, here are some of the ways that nitrate pollution may be harming Marylanders on the Lower Eastern Shore:

- Wicomico and Worcester counties have detected nitrates at levels exceeding the U.S. Environmental Protection Agency's (EPA) safe drinking water threshold in roughly one out of every 25 private drinking water wells. An additional one out of 14 wells had nitrate concentrations just below EPA's threshold, which public health research suggests may be hazardous to people's health.

- While the majority of residents on the Lower Eastern Shore appear to rely on private wells, between 2018 and 2020, one public water utility reported nitrate levels above EPA's threshold, and more than half of the public water utilities that reported nitrate concentrations had levels just below the threshold. Several water utilities did not report nitrate levels or reported nitrate levels from samples collected in previous years, painting a troubling and incomplete picture of nitrate contamination in public water supplies in the region.

- Based on our sample of well testing data and annual water quality reports for public utilities, CPR estimates that at least 61,000 people in Wicomico and Worcester counties (more than a third of the counties' estimated population) may have been or are being exposed to nitrate

levels that may be hazardous to health. Somerset County's well sampling and testing data was incomplete and in some cases unreadable. Additional investigation is necessary to determine the extent of nitrate pollution in the county.

- Public health data reveal that disease incidence rates associated with nitrate consumption are higher in Lower Eastern Shore counties than in other regions in the state.

These findings are troubling on their own, but they raise larger questions. What *don't* we know about nitrate contamination in private wells and public water sources on the Lower Eastern Shore? Are health hazards lurking just beneath the surface, unknown and unaddressed because of a lack of testing and transparency?

In reviewing protective policies and programs states have adopted to protect the drinking water of private well owners, Maryland ranked among the five worst states. Public information regarding the safety of Maryland well water is very limited, and county records are often outdated, incomplete, or do not contain basic information, such as the year the well was drilled and tested. Private wells in Maryland are only required to be tested and recorded at the time they are drilled — regardless of how long the well has been used for drinking water or whether there may be new sources of potential contamination threatening the health and safety of those drinking well water. The state does not (a) provide online access to well data information, (b) notify private well owners of known groundwater contamination nearby, (c) offer financial assistance for well remediation or well water testing, and (d) require landlords and property owners to disclose recent well water quality results to tenants or potential home buyers. The state also does not require laboratories that regularly analyze well water samples to share test results with local county health departments. Like all other states, Maryland does not require periodic testing of private well water.

Furthermore, the Safe Drinking Water Act, the primary federal law governing the health of the nation's drinking water, does not extend its protections to private drinking water wells and smaller community-based systems. As a result, approximately 42 million people in the United States rely on unregulated drinking water, primarily from private wells, while an estimated 19.5 million Americans fall ill each year from drinking contaminated water. While the Safe Drinking Water Act allows states to adopt stronger protections for local drinking water, state requirements concerning drinking water wells vary dramatically and often do not provide necessary protections for residents who rely on well water.

For instance, 46 of the 50 states do not have basic rules in place to protect tenants who drink well water in apartments or rented commercial properties. Forty-five states do not provide notice to private well owners who may be impacted by known groundwater contamination. Thirty-eight states do not require homeowners to disclose recent well water quality test results to potential homebuyers. Half of states require initial water quality testing at the time a well is drilled and constructed. Only 17 states offer free or low-cost water test kits to residents who drink well water, and only a handful have well remediation programs. Maryland's Lower Eastern Shore is a case study in these problems. Despite issues with nitrate contamination and heavy reliance on private wells, Maryland has not implemented any programs to mitigate the public health hazards of nitrate consumption in drinking water on the Eastern Shore.

*While lawsuits and federal enforcement of laws like the Resource Conservation and Recovery Act and the Clean Water Act might supplement a regulatory system specifically designed to protect drinking water, they are no substitute for that system. States—particularly states with nitrate problems—should develop those protections now.*

**To better protect the health of the nearly 182,000 residents of the Lower Eastern Shore, the Maryland state legislature should enact legislation that would:**

- Establish safe drinking water standards for private wells and smaller community systems that are not covered by the Safe Drinking Water Act;
- Require the Maryland Department of Health or Maryland Department of the Environment to implement a well compensation program that helps cover the costs of well water testing, sampling and analysis, along with any needed remediation or replacement due to contaminated drinking water, prioritizing funding for low-income residents;
- Require property owners wishing to sell their homes to test well water quality within six months of sale and disclose well water test results to potential buyers;
- Require landlords to test well water quality on leased property every three to five years and inform tenants of the results;
- Publish all water quality testing results for private wells on a public online portal operated by state and local health departments, and require regular information-sharing between relevant state and local agencies and state-approved laboratories;

- Work with relevant state agencies and local county health departments to engage in outreach and public education, encouraging residents to test their water annually and educating them about the availability of financial assistance;

- Create a well surveillance and sampling program requiring relevant agencies to sample well water and collect well water quality testing data from local health departments, notify private well owners of suspected groundwater contamination nearby, and publish updated information about areas of known or suspected groundwater contamination;

- Ensure all public water utilities test for and report nitrate levels annually in Consumer Confidence Reports, and ensure most recent reports are publicly available;

- Require farms in areas with known or suspected groundwater contamination to implement best management practices to minimize the leaching of nitrate to groundwater; and

- Establish a statewide moratorium on new and expanding CAFOs.

**The U.S. Environmental Protection Agency should:**

- Complete an updated review on the relationship between nitrate consumption and adverse health outcomes, either through an Integrated Risk Information System health assessment, or by other means, and then update the safe drinking water thresholds, or "Maximum Contaminant Level," for nitrates accordingly; and

- Work with states to establish stronger, more protective safe drinking water thresholds for nitrates based on the latest research regarding adverse health effects.

**In addition, policy and public health advocates can:**

- Develop model legislation for states and litigation theory under state and federal law to hold CAFOs accountable for spreading animal waste on fields in amounts that pollute drinking water sources, whether private or public.

# Tainted Tap:

## Nitrate Pollution, Factory Farms, and Drinking Water in Maryland and Beyond

## Introduction

Nitrates are a colorless, odorless, and tasteless compound[1] that, if ingested in excessive quantities, can pose a serious threat to public health. They are formed by soil microorganisms breaking down nitrogen from fertilizer, manure, or decaying plants.[2] While they occur naturally in the environment, nitrates are also produced by agricultural activity, specifically, the massive quantities of manure generated by factory farms.

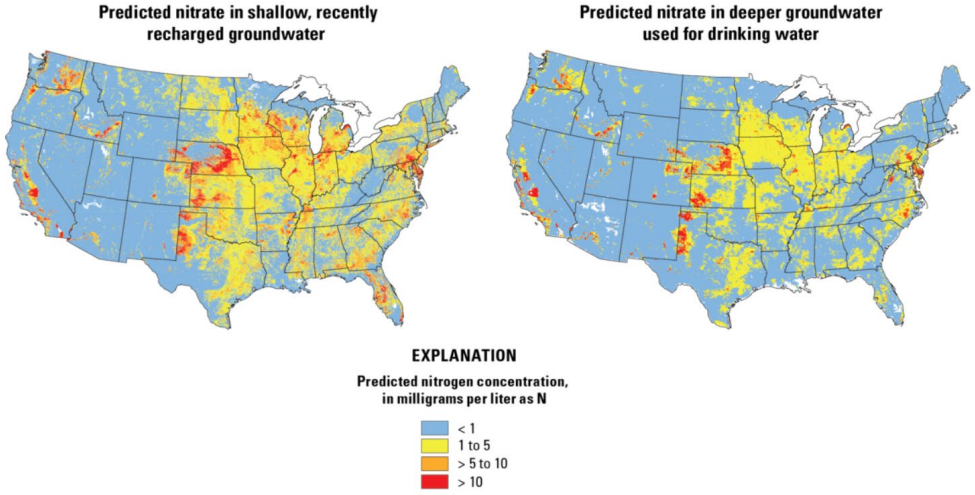
Concentrated animal feeding operations (CAFOs) are a leading source of nitrates. These operations produce industrial-sized amounts of manure; a single CAFO raising 82,000 laying hens, for instance, can produce 2,800 tons of manure a year, more than three times the amount produced by the Maryland Zoo in Baltimore each year.[3,4] Most manure from CAFOs never undergoes sewage treatment; instead it is typically applied to fields in solid, slurry, or liquid form.[5,6] The most common form of disposal is directly on top of soil.[7] While some of this manure serves as fertilizer, it is often applied in concentrations far greater than is needed to grow crops—that is, more than crops can absorb.[8] CAFOs have other vectors for nitrate pollution, as well, including improper management and storage of manure or leaks in storage or containment units. Since nitrates are highly mobile in soil, all of these disposal methods cause nitrates to enter groundwater, where rainfall or irrigation water percolates through the subsurface.[9]

*CAFOs are a leading source of nitrates. These operations produce industrial-sized amounts of manure, more than three times the amount produced by the Maryland Zoo in Baltimore each year. Most manure from CAFOs never undergoes sewage treatment; instead it is typically applied to fields in solid, slurry, or liquid form.*

Groundwater contamination can pollute drinking water for many Americans. The National Groundwater Association estimates that 38 percent of the U.S. population relies on groundwater for its drinking water supply,[10] and an estimated 42 million people in the country rely primarily on drinking water from private wells.[11] The U.S. Geological Survey's (USGS) National Water Quality Assessment sampled groundwater aquifers used as public and private drinking water supplies from 1988 to 2015. USGS found that nitrate levels in groundwater under agricultural land were three times greater than the national background level of 1 milligram per liter (mg/L).[12] They also found that nitrate concentrations in 3 percent of public supply wells and 7 percent of private wells exceeded 10 mg/L.[13] Private wells in agricultural areas exceeded that level at a rate of more than three times the national

level, with 21 percent of private wells reporting nitrate levels higher than 10 mg/L.[14] Furthermore, in 2009, USGS sampled 2,167 private wells across the country and found that 23 percent had at least one contaminant at concentrations greater than health-based standards.[15] Nitrate was one of the more common contaminants identified, particularly in agricultural areas. In 2019, in light of the various public health concerns associated with CAFOs—including nitrates in drinking water—the American Public Health Association published a policy statement in support of moratoriums on new and expanding CAFOs.[16]

**Figure 1: Predicted Concentrations of Nitrate in U.S. Groundwater**




(Public domain.)

*Predicted nitrate concentrations in U.S. groundwater show that nitrate concentrations greater than 5 mg/L are prevalent in Maryland. Source: U.S. Geological Survey.*

# Nitrates in Drinking Water Harm Public Health

Nitrates can pose a significant risk to public health when people drink contaminated water. Nitrate consumption has been linked to blue baby syndrome, cancer, pregnancy complications, thyroid disease, and more.

Because of these dangers, nitrates are regulated under the Safe Drinking Water Act. Congress enacted the Safe Drinking Water Act in 1974 as the primary federal law to ensure the safety of public drinking water at a time when nationwide studies revealed widespread health risks due to poor water quality.[17] While the Safe Drinking Water Act's requirements and protections extend to both groundwater and surface water sources of drinking water, the law only applies to drinking water systems with at least 15 service connections or that provide service for at least 25 individuals.[18] Smaller drinking water systems, private wells, and systems without collection and treatment facilities are not protected by the law.[19]

In 1962, the federal government established a drinking water limit for nitrates, known as the Maximum Contaminant Level ("safe drinking water threshold"), of 10 mg/L (or parts per million, ppm).[20] This was based on an earlier study of drinking water sources for 278 reported cases of methemoglobinemia, or blue baby syndrome.[21] Though the Safe Drinking Water Act requires the U.S. Environmental Protection Agency (EPA) to set enforceable drinking water standards and reassess them every six years,[22] the agency has never updated the safe drinking water threshold for nitrates.

*A 2019 study from the Environmental Working Group found that up to 12,594 cases of cancer per year may be linked to nitrate pollution in U.S. drinking water. Approximately 80 percent of the estimated cases were colorectal cancer, and the others were ovarian, thyroid, kidney, and bladder cancer.*

Blue baby syndrome was long considered the primary risk from nitrate consumption. This condition can affect infants under six months of age because ingested nitrate is more readily converted to nitrite in an infant's gastrointestinal tract, which can form methemoglobin that disrupts the blood's oxygen carrying capacity, resulting in potentially fatal oxygen deprivation.[23] In the nearly 60 years since EPA's safe drinking water threshold for nitrate was established, cases of blue baby syndrome have been reported at concentrations below 10 mg/L.[24] Furthermore, a 2010 study of 357 pregnant women in rural Minnesota observed that methemoglobin levels at 36 weeks gestation were higher among women with 3 to 10 mg/L tap water nitrate levels compared to women with less than 3 mg/L of nitrate in their tap water.[25]

Recent studies show a range of adverse health impacts from long-term nitrate consumption at levels below EPA's safe drinking water threshold, including links to cancer, neonatal health issues (such as neural tube

defects), thyroid disease, and other conditions.[26] In some cases, these effects were observed at levels less than one-tenth of the current safe drinking water threshold. One study of postmenopausal women in Iowa found that ovarian cancer risk was 2.03 times greater for women consuming drinking water with nitrate levels greater than 2.98 mg/L, compared to those consuming concentrations below 0.47 mg/L.[27]

A 2019 study from the Environmental Working Group (EWG) found that up to 12,594 cases of cancer per year may be linked to nitrate pollution in U.S. drinking water.[28] Approximately 80 percent of the estimated cases were colorectal cancer, and the others were ovarian, thyroid, kidney, and bladder cancer.[29] The cost of treating these cases was estimated to be up to $1.5 billion a year.[30] The study also identified a link between nitrate pollution and neonatal health issues, primarily "very low birth weight" and "very preterm birth."[31] Based on an analysis of eight studies related to nitrates in drinking water and colorectal cancer, EWG scientists found a one-in-a-million cancer risk (the typical benchmark for "acceptable" risk[32]) at 0.14 mg/L—a level much lower than EPA's threshold. This level would also protect against adverse pregnancy and birth outcomes. Currently, more than 9,000 water utilities nationwide have average nitrate concentrations 10 times greater than EWG's calculated cancer risk level, and therefore likely pose a significant nitrate-related cancer risk.[33] It must also be noted that EWG's cancer risk estimate is lower than background levels for nitrates (1 mg/L), suggesting that all groundwater conveys some degree of cancer risk.

Boiling or chemically disinfecting water does not remove nitrates; removing them requires costlier technologies such as ion exchange, distillation, or reverse osmosis, which may be out of reach for many homeowners and even some public water utilities.[34] At least 1,155 public water systems in the United States have average nitrate levels at or above 5 mg/L, and they have no treatment system in place to reduce or remove the contaminants.[35]

Nitrates also increase drinking water treatment costs. For example, an economic analysis of nitrate treatment in the Mississippi Basin found that annual operation and maintenance costs at water treatment plants were positively correlated with nitrate contamination.[36] Expenses for several plants in the region peaked during the same year as the highest recorded nitrate levels. On average, water utilities in Decatur, Illinois and Des Moines, Iowa spent 1.3 percent and 3.4 percent of their annual operating budget on nitrate treatment, respectively.[37] Those values increased during the years when nitrate concentrations were greatest. For example, over a six-year period, the Des Moines utility spent more than $500,000 on average per year on operations and maintenance.[38] However, in 2015, the region had the highest recorded annual average nitrate concentrations and highest number of days when water at intake locations exceeded EPA's safe drinking water threshold for nitrates. That year, operations and maintenance costs were in excess of $1.4 million.

Since nitrate treatment is expensive, many utilities choose to first blend water from multiple sources to dilute the nitrate or simply eliminate contaminated water sources.[39] For small public water systems, the most cost-effective option is sometimes to drill a new well, but this may not be a feasible solution if nitrate contamination is widespread. Where water quality issues persist, the utility may connect to another system or consolidate multiple small systems into a larger utility that can afford adequate treatment technology.[40] One assessment of nitrate contamination in Nebraska found that reverse osmosis at point-of-use—that is, at the user's location—is the most cost-effective treatment method for three- to four-person households.[41] Overall, however, these solutions place much of the burden of treating nitrates not on the industries that create it, but rather on local water utilities and homeowners, which can be costlier and more resource-intensive than upstream interventions to address agricultural sources of pollution.[42] This downstream approach can also result in disparate impacts on low-income families who cannot afford household treatment.

*Overall, these solutions place much of the burden of treating nitrates not on the industries that create it, but rather on local water utilities and homeowners, which can be costlier and more resource-intensive than upstream interventions to address agricultural sources of pollution. This downstream approach can also result in disparate impacts on low-income families who cannot afford household treatment.*

While EWG's cancer risk level for drinking water nitrates may be impractical for all public utilities to achieve with existing resources, state agencies and public health experts agree that the current safe drinking water threshold of 10 mg/L is not adequately protective.[43] The Maryland Geological Survey, Minnesota Department of Health, and Oregon Department of Environmental Quality posit that nitrate levels greater than 3 mg/L indicate that water is contaminated by human-made sources and may worsen over time.[44,45,46] Furthermore, as discussed above, research shows that risks of blue baby syndrome and cancer are distinctly elevated at drinking water nitrate concentrations above 3 mg/L. A more stringent standard would benefit families who rely on public water systems, but without legislative changes, private well owners remain responsible for monitoring and addressing well water quality on their own.

Finally, nitrate contamination contributes to other environmental and public health harms. Runoff and groundwater discharges convey nitrogen-laden water directly into surface waterways, promoting algae blooms, which can create oxygen-depleted conditions that harm or kill fish, dolphins, and other aquatic life.[47] For example, in recent years, a growing proportion of the Chesapeake Bay has been deemed a "dead zone" (8 percent in 2019, compared to 6 percent in 2014).[48] Algae blooms can also be toxic to humans.[49] While toxic algae blooms are not the focus of this report, it is important to note that efforts to address the sources of nitrate

contamination can pay other dividends for public health and the environment.

## The Safe Drinking Water Act Lacks Private Well Water Protections

While the EPA has broad authority to set specific standards for contaminants in public drinking water under the Safe Drinking Water Act, a majority of drinking water oversight happens at the state level.[50] Every state other than Wyoming and Washington, D.C. (treated as a state for this purpose), has been delegated primary enforcement and oversight authority for public water systems under the law.[51] EPA may withdraw that delegation at any time if a state fails to comply with Safe Drinking Water Act requirements.[52] The Safe Drinking Water Act also requires that states adopt a Source Water Assessment Program to identify potential sources of contamination for drinking water.[53] States must ensure the public water suppliers issue annual Consumer Confidence Reports to educate the public about local drinking water quality, including contaminants that exceed EPA's safe drinking water thresholds and any other violations of the law. This transparency requirement is key, as many states do not devote the needed funding for adequate enforcement and compliance with the Safe Drinking Water Act.[54] The federal government offers funding to improve water treatment and compliance through the Drinking Water State Revolving Fund, which has provided more than $26 billion in grants and loans since 1997. But the EPA estimates that a total of $384 billion is needed through 2030 to upgrade outdated infrastructure for public water suppliers.[55]

*The Safe Drinking Water Act does not protect smaller drinking water systems, private wells, and systems without collection and treatment facilities. As a result, approximately 42 million people in the United States rely on unregulated drinking water, primarily from private wells, while an estimated 19.5 million Americans fall ill each year from drinking contaminated water.*

As noted earlier, the Safe Drinking Water Act does not protect smaller drinking water systems, private wells, and systems without collection and treatment facilities.[56] As a result, approximately 42 million people in the United States rely on unregulated drinking water, primarily from private wells,[57] while an estimated 19.5 million Americans fall ill each year from drinking contaminated water.[58] Since many private wells are supplied by groundwater, and water quality testing is not federally mandated for groundwater-sourced private wells, nitrate pollution is of greatest concern for families with self-supplied well water. Some states and counties have chosen to regulate private wells, but in many areas, individual well owners are on their own.

Maryland's Maximum Contaminant Level for contaminants in public drinking water, including nitrates, match EPA's safe drinking water thresholds. However, state regulations admit that the Maximum Contaminant Level for nitrates may not be based on potential adverse health effects due to long-term exposure, like all the other contaminants are.

The regulations note that "[w]ith the exception of nitrate, nitrite, and total nitrate plus nitrite, all inorganic chemical contaminant levels are based on potential adverse health effects resulting from long-term exposure to the contaminant in drinking water..."[59] Maryland does require that private well water quality meet federal safe drinking water thresholds after initial drilling, but no subsequent testing is required, no matter how long the well is in use, and no matter what potential pollutants might have entered local groundwater since the initial drilling. No other Safe Drinking Water Act protections are extended to private wells in Maryland.

**Table 1. Maryland's Maximum Contaminant Levels for 15 Drinking Water Contaminants Align with EPA's Limits**

| Contaminant | Maximum Contaminant Level (mg/l) |
|---|---|
| Antimony | 0.006 |
| Arsenic | 0.010 |
| Asbestos | 7 million fibers per liter (longer than 10 µm) |
| Barium | 2 |
| Beryllium | 0.004 |
| Cadmium | 0.005 |
| Chromium | 0.1 |
| Cyanide (as free cyanide) | 0.2 |
| Flouride | 4.0 |
| Mercury | 0.002 |
| Nitrate as nitrogen | 10 |
| Nitrite as nitrogen | 1 |
| Total nitrate plus nitrite | 10 |
| Selenium | 0.05 |
| Thallium | 0.002 |

*Source: Maryland Division of State Documents.*

It is important to note that Maryland regulations also allow motels, hotels, medical facilities, restaurants, schools, industrial plants, and other similar facilities that are not connected to a community water system to supply water with nitrate levels that exceed 10 mg/L, but below 20 mg/L, at the discretion of the Maryland Department of Environment or another approving authority.[60] In such instances, the facility must demonstrate that the water is not available to children under six months of age, must post a warning sign listing nitrate levels and noting the potential health effects of exposure, demonstrate that "[a]dverse health effects do not result," and

notify the relevant county health department annually of the nitrate levels in its drinking water.[61]

In 2017, EPA published a plan to review the health effects of nitrate in drinking water[62] and came close to updating its regulations that allow states to apply less stringent nitrate drinking water standards for non-community water systems. EPA's plan identified two activities: 1) considering an updated health assessment of nitrate in the next Six-Year Review cycle for National Primary Drinking Water regulations under the Safe Drinking Water Act, and 2) evaluating the National Primary Drinking Water regulations that allow, at the discretion of the state, a non-community water system to have nitrate levels exceeding 10 mg/L if the supplier demonstrates that the water will not be available for children under six months and the public and appropriate authorities are notified.[63] Unfortunately, in April 2019, the agency suspended plans to complete the review, citing a priority on assessments of greatest need and those "actively under development."[64]

# Nitrate Pollution in Maryland

Over the last decade, the number of CAFOs in Maryland has skyrocketed, with most located on the Lower Eastern Shore. In 2009, there were seven registered poultry operations in the state,[65] though there were likely more that were not registered or accounted for by state agencies through other means. Between 2014 and 2017, there was a dramatic increase in the number of CAFOs, with hundreds of additional operations brought online. As of October 1, 2020, the number of registered CAFOs had grown to 526, with the highest concentration in Wicomico (113), Worcester (96), and Somerset (87) counties.[66] Alongside Caroline County (located in the Upper Eastern Shore), these adjacent counties have the greatest number of CAFOs in the state, and each registered operation may be associated with multiple chicken houses. While groundwater nitrate can take decades to reach surface waters, nitrogen pollution from broiler chickens alone increased by almost 30 percent between 2009 and 2018 in Maryland's waterways.[67] This was due, in part, to the poultry boom and the excessive amounts of manure that came along with it.

**Figure 2: Concentration of Poultry Houses in Pocomoke City and Surrounding Area**


*Source: Google Earth (click for larger image).*

Maryland's political leaders have been reluctant to adopt the strong requirements needed to reduce agricultural pollution, instead relying largely on grant funding and measures designed to encourage, but not require, pollution-mitigating practices. For instance, in 1982, the state Department of

Agriculture established the Maryland Agricultural Water Quality Cost-Share (MACS) Program to offer farmers grants to install best management practices (BMPs) to "prevent soil erosion, manage nutrients, and safeguard water quality in streams, rivers, and the Chesapeake Bay."[68] This includes systems such as manure transport, waste treatment lagoons, and wastewater treatment strips. The MACS Program, adopted long before the poultry boom of the last decade, remains the cornerstone of the state's efforts to mitigate pollution from agriculture. While funding for the program has increased over time, it has unfortunately failed to prevent nitrogen pollution at levels needed to protect public health.

In order to comply with Maryland's Phosphorus Management Tool—another program seeking to mitigate the impacts of agriculture on Maryland's waters—data suggest that a significant amount of manure generated by farms on the Lower Eastern Shore is transported to other farms and "alternative use facilities." The 2019 MACS report shows that the tons of manure transported through the program has increased more than three-fold since 2010.[69] Clean Water Act regulations generally restrict the amount of manure applied within the boundaries of a CAFO, but they do not extend to land application of manure transported off-site.[70] A 2014 analysis by the Environmental Integrity Project found that CAFOs on the Eastern Shore ship up to 85 percent of their manure off-site.[71] It also found that poultry operations in the region spread three times more manure on agricultural land than crops need.[72] In 2019, Maryland enacted Senate Bill 546, which requires farms to include manure tracking information—such as how much is generated and where it is transported—in reports that farmers must submit each year to the state.[73] This will increase transparency around manure generation on the Eastern Shore and give the public the ability to more accurately map out where manure may end up.

*As a result of the state's lackluster efforts to reduce nitrate pollution, Maryland is second only to neighboring Delaware, also burdened by CAFOs, in the percentage of the state's area with groundwater nitrate levels in excess of 5 mg/L. Twenty-eight percent of Maryland's square mileage has groundwater nitrate concentrations above that level.*

As a result of the state's lackluster efforts to reduce nitrate pollution, Maryland is second only to neighboring Delaware, also burdened by CAFOs, in the percentage of the state's area with groundwater nitrate levels in excess of 5 mg/L.[74] Twenty-eight percent of Maryland's square mileage has groundwater nitrate concentrations above that level.[75] Some of the highest nitrate levels in groundwater in the Chesapeake Bay watershed occur in the agricultural areas of the Eastern Shore.[76] In addition, nitrate concentrations in the Eastern Shore's unconfined shallow aquifer are far greater than what would be expected to occur naturally, often at levels "high enough to affect the suitability of the water for human consumption."[77] USGS studies estimate that 53 percent of nitrogen inputs to the Eastern Shore are applied in inorganic fertilizers or fixed directly from the atmosphere in crops, and an

additional 37 percent is from manure, demonstrating that agriculture is the most significant contributor of nitrogen to the region.[78] While nitrate concentrations tend to be lower in deeper groundwater, USGS experts predict that these concentrations will likely increase as shallow groundwater moves downward.[79] They also note that potential contamination of deep aquifers warrants attention because these water sources are typically used for public water supply and restoration would be difficult and expensive.

Decades of nitrate contamination have also affected the region's surface waters, which are fed by groundwater discharges and surface runoff. Nitrate concentrations in the Choptank and Nanticoke rivers have steadily increased since the mid-1960s.[80] Modeling from the Chesapeake Bay Program estimates that 45 percent of the nitrogen loads to the Chesapeake Bay in 2019 were from agriculture; up from 41 percent in 2009.[81] The program also estimates that poultry litter alone accounts for at least 12 percent of nitrogen in waterways on Maryland's Eastern Shore and that nitrate levels are three times greater than the average for streams outside this area.[82] Since groundwater is slow-moving, experts predict that it would require at least a 40 percent reduction in nitrogen loads to groundwater on the Eastern Shore (from 2010 levels) to achieve the Total Maximum Daily Load (TMDL) target for the region by 2045 (20 years after the 2025 deadline established by the EPA and agreed to by Maryland and other Chesapeake Bay states).[83]

## Analysis of Eastern Shore Drinking Water Data and Public Health Implications

Between 13 and 19 percent of Maryland residents rely on private wells for household water consumption, and most of them are located in the rural, agricultural parts of the state, including the Lower Eastern Shore.[84,85,86] We were unable to find any recent studies of drinking water nitrate contamination in the region, but a 2018 study by University of Maryland researchers assessed private well water quality from 118 households in Montgomery, Cecil, Kent, and Queen Anne's counties (the latter three are on the Eastern Shore and all have CAFOs). The researchers found that 3.4 percent of samples exceeded 10 mg/L.[87]

To understand the extent of nitrate contamination on the Lower Eastern Shore, CPR researchers assessed water quality in private wells and public water utilities in Wicomico, Worcester, and Somerset counties. While the state does not require or conduct periodic testing of private wells, counties test water quality when issuing permits for new wells or when a well's use is converted, such as from agricultural to household use.

CPR researchers submitted Maryland Public Information Act (PIA) requests to county agencies for private well water data and received varying degrees of information based on how the data is stored and limited staff capacity in the midst of the COVID-19 pandemic. We obtained comprehensive well data

from Worcester County and a sample of data from Wicomico and Somerset counties. Wicomico and Somerset counties shared well data from up to two properties per tax map in the county. Tax maps, also known as parcel maps, are a geographic representation of individual property boundaries, and each map contains various parcels of property.[88] CPR requested that the two properties be randomly selected, but we were unable to oversee or participate in the selection process due to COVID-19 restrictions. In addition, CPR researchers acquired the most current information on public water systems from annual Consumer Confidence Reports (CCRs), which are publicly available. According to EPA's CCR database, all of the public water systems in the three counties draw from groundwater.[89]CCRs for smaller community systems, like cooperatives and privately owned mobile home parks, were not included in the county-by-county analysis but notable findings for mobile home parks are summarized below.

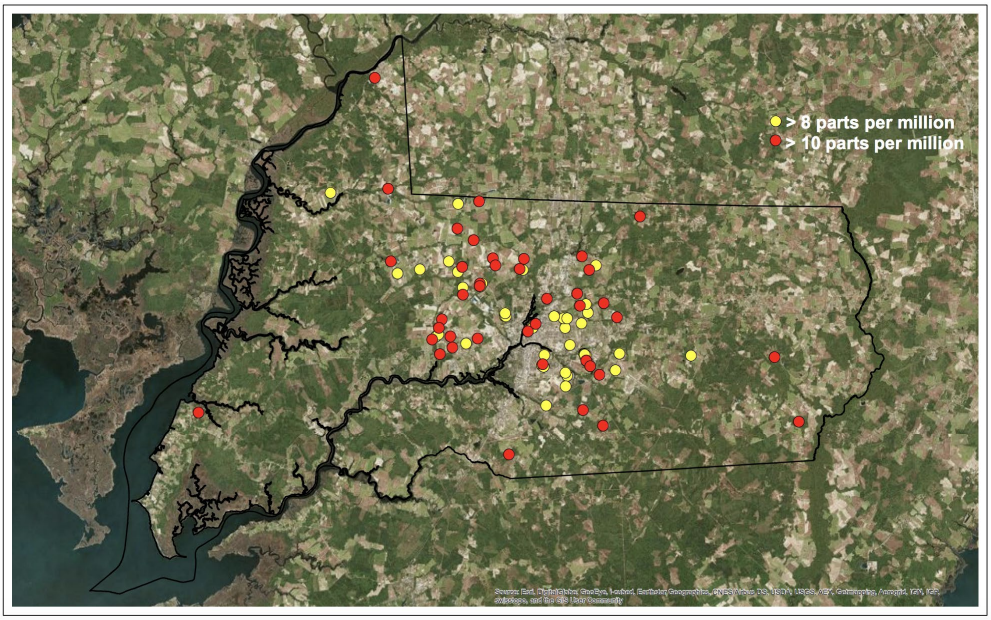
Given the latest scientific evidence and statements by various state agencies, we considered two categories of risk: nitrate concentrations between 3 and 10 mg/L, which evidence indicates "may be or become hazardous to health," and concentrations above 10 mg/L, which are "very likely hazardous to health."

### *Wicomico County*

The Wicomico County Health Department provided CPR with well permit and water quality testing data from up to two properties per tax map in the county. From 129 well samples collected between December 1981 and July 2020, 5 percent had nitrate concentrations between 3 and 10 mg/L, and 2 percent were above 10 mg/L. The highest recorded nitrate concentration was 44.7 mg/L, sampled in 2015.

Wicomico County was the only county to also have publicly available information about nitrate contamination in private wells, in the form of a static map that is posted on the health department's website (Figure 3).[90] There is no accompanying narrative explaining how many wells were tested total, why they were tested, and what, if anything, was done to address contamination. Figure 3 shows that at least 39 wells tested between 2008 and 2014 had nitrate concentrations above 8 mg/L (shown as ppm).[91] An additional 42 wells had nitrate concentrations above 10 mg/L.[92] Since we only received a sample of well data as a result of our request to the county health department, this map provides additional, albeit incomplete, data demonstrating that at least 81 wells tested within the last decade contain hazardous levels of nitrates.

**Figure 3: Wicomico County Wells Tested Between 2008 and 2014 with Nitrate Concentrations Greater than 8 mg/L (shown as ppm)**




*Source: Wicomico County Health Department.*

Water and sewerage in Wicomico County are managed independently by eight municipalities through the county's Comprehensive Water and Sewerage Plan.[93] Seven of these municipalities have a public water system and together serve 44,837 residents (approximately 43 percent of the county's estimated population).[94,95] Table 2 presents the highest nitrate concentrations detected in each of the water utilities in 2018 (2019 reports were not yet available for analysis).[96] Of the seven water utilities, five reported nitrate levels in their CCRs. Of those that reported nitrate concentrations, four (Delmar, Fruitland, Salisbury, and Sharptown) had levels exceeding 3 mg/L.

**Table 2. Nitrate Concentrations in Wicomico County Public Water Utilities (2018)***

| Service Area | Estimated Population Served | Level Detected (mg/L)** | Range Detected (mg/L) |
|---|---|---|---|
| Delmar | 4,500 | 3.1 | Not reported |
| Fruitland | 5,907 | 4.0 | 3.2-4.5 |
| Hebron | 1,022 | Not reported | Not reported |
| Pittsville | 1,500 | Not reported | Not reported |
| Salisbury | 30,343 | 6.0 | 4.6-6.0 |
| Sharptown | 625 | 9.0 | 8.0-10.3 |
| Willards | 940 | 1.3 | Not reported |

**Nitrate levels that exceed EPA's Maximum Contaminant Level (10 mg/L) are "very likely hazardous to health"; levels between 3 and 10 mg/L "may be or become hazardous to health." ** Utilities either presented the average or the highest level detected. Source: EPA Consumer Confidence Reports database, Wicomico County Consumer Confidence Reports, via the Maryland Department of the Environment.*

As shown in Table 2, Sharptown reported 9 mg/L as the detected nitrate level, but the data range shows that the highest detected concentration exceeds EPA's safe drinking water threshold. Notably, every public water utility that reported nitrate levels had concentrations that exceed background levels for nitrates (1 mg/L). Furthermore, using EWG's cancer risk level, nitrate concentrations of 3 mg/L correspond to approximately 2 cases per 100,000. This is the minimum estimated cancer risk facing residents in the four service areas that had nitrate levels above 3 mg/L.

### *Worcester County*

The Worcester County Department of Environmental Programs provided CPR researchers with a complete database of well permit and water quality testing data from private wells in the county. A small number of wells in the database (less than 50) were tested more than once; therefore, we refer to the results as "well samples."

Our analysis of 9,243 well samples collected between November 1965 and May 2020 found that 9 percent had nitrate concentrations between 3 to 10 mg/L, and 5 percent were above 10 mg/L. The highest recorded nitrate concentration was 136 mg/L, nearly 14 times greater than EPA's safe drinking water threshold. Using EWG's cancer risk estimate, this exposure level corresponds to nearly one case per 1,000, which is an order of magnitude greater than EPA Office of Water's Drinking Water Specific Risk Level Concentration for cancer of one per 10,000.[97] In other words, this level far exceeds what EPA considers an acceptable cancer risk from a drinking water contaminant.

The county also provided CPR with data on well depth, which showed that shallower wells had higher nitrate concentrations, on average. The average depth of wells with nitrate concentrations of 10 mg/L or greater was 71.2 feet, compared to 136.3 feet for wells with nitrate levels between 0 and 10 mg/L. These findings align with previous research that shows an inverse relationship between well depth and nitrate concentrations.[98]

**Table 3. Nitrate Concentrations in Worcester County Public Water Utilities (2019 and 2020)***

| Service Area | Estimated Population Served | Year | Highest Level Detected (mg/L) | Range Detected (mg/L) |
|---|---|---|---|---|
| Berlin | 4,500 | 2020 | Not available | Not available |
| | | 2019 | 5.6 | 3.9-5.6 |
| Briddletown | 150 | 2020 | 5.6 | 3.9-5.6 |
| | | 2019 | 6.0 | 3.6-5.5 |
| Edgewater Acres/ Nantucket Point | 500 | 2020 | Not reported | Not reported |
| | | 2019 | Not reported | Not reported |
| Mystic Harbour/Landings/ Assateague Point | 3,600 | 2020 | Not reported | Not reported |
| | | 2019 | <1.0 | <1.0 |
| Newark | 250 | 2020 | Not reported | Not reported |
| | | 2019 | <1.0 | <1.0 |
| Ocean City | 7,000 | 2020 | Not available | Not available |
| | | 2019 | Not reported | Not reported |
| Ocean Pines | 11,890 | 2020 | 6.0 | 1.8-6.4 |
| | | 2019 | 6.0 | 1.8-6.4 |
| Pocomoke City | 4,100 | 2020 | Not available | Not available |
| | | 2019 | Not available | Not available |
| Riddle Farm | 600 | 2020 | 6.0 | 1.8-6.4 |
| | | 2019 | <1.0 | <1.0 |
| Snow Hill | 2,409 | 2020 | Not available | Not available |
| | | 2019 | Not available | Not available |

**Nitrate levels that exceed EPA's Maximum Contaminant Level (10 mg/L) are "very likely hazardous to health"; levels between 3 and 10 mg/L "may be or become hazardous to health." ** Utilities either presented the average or the highest level detected. Source: EPA Consumer Confidence Reports database, Worcester County Drinking Water Quality Reports.*

Water utilities in the county are managed by the Worcester County Department of Public Works' Water and Wastewater Division. The county manages six service areas and an additional four municipalities (Berlin, Ocean City, Pocomoke City, and Snow Hill) independently operate their utilities. Together these ten utilities serve a total of 34,999 residents (approximately 67 percent of the county's estimated population).[99,100] Table

3 shows the nitrate levels in each public water utility in 2019 and 2020.[101] The highest nitrate concentrations detected in Berlin, Briddletown, Ocean Pines, and Riddle Farm in 2019 and/or 2020 were all greater than 3 mg/L. Nitrates were not reported, not detected, or reports were not available in the remaining six service areas.

### *Somerset County*

The Somerset County Health Department provided CPR with well permit and water quality testing data from up to two properties per tax map in the county. We received files for 127 wells, but several did not have an associated water analysis, or the files were so old that the text was unreadable. From 99 files that included the water analysis (samples collected between June 1979 and July 2020), all reported nitrate levels below 0.8 mg/L.

The county's public water utilities are managed by the Somerset County Sanitary District, which oversees three service areas.[102] The three public water utilities in the county together serve 7,026 people (approximately 27 percent of the county's estimated population).[103,104] Nitrate levels for 2018 and 2019 are shown in Table 4. In Fairmount and Princess Anne, nitrates were not detected, and Crisfield did not report nitrate concentrations.

**Table 4. Nitrate Concentrations in Somerset County Public Water Utilities (2018 and 2019)**

| Service Area | Estimated Population Served | Year | Level Detected (mg/L) |
|---|---|---|---|
| Crisfield | 2,976 | 2019 | Not reported |
| | | 2018 | Not reported |
| Fairmount | 750 | 2019 | Not detected |
| | | 2018 | Not detected |
| Princess Anne | 3,300 | 2019 | Not detected |
| | | 2018 | Not detected |

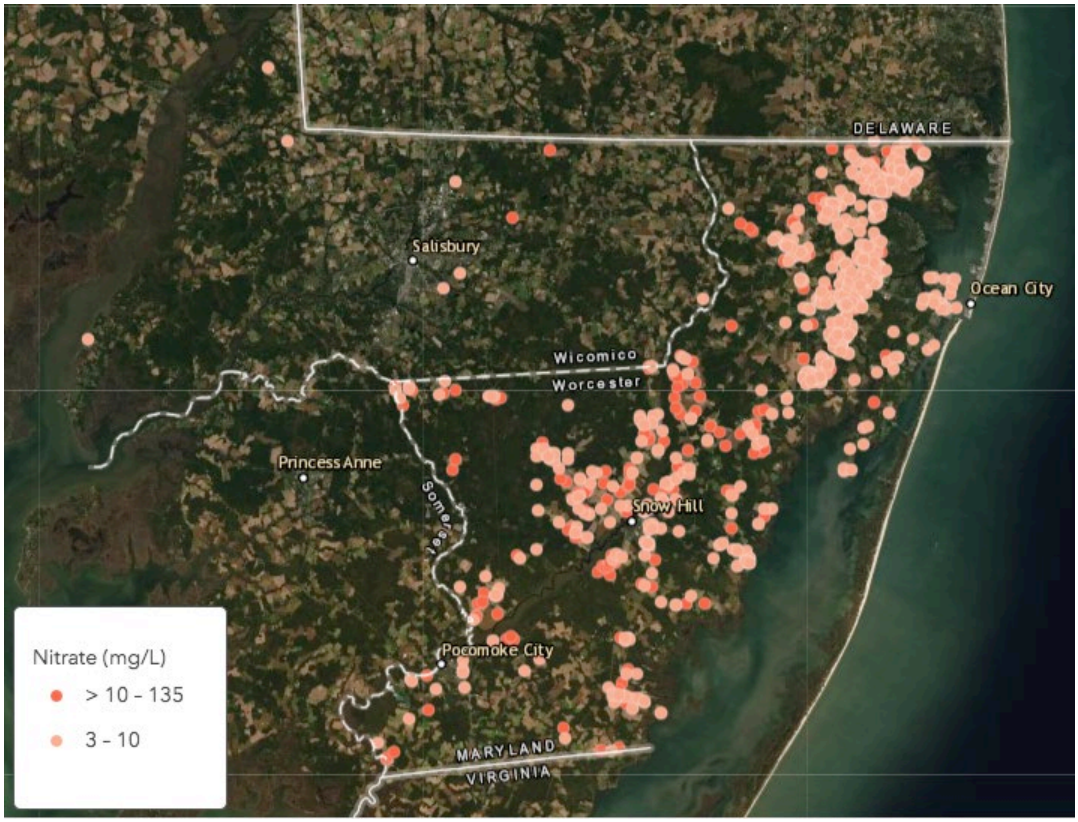
*Source: EPA Consumer Confidence Reports database, Somerset County Sanitary District.*

## Nitrate Contamination in Private Wells and Public Utilities on the Lower Eastern Shore

According to our analysis of the well data acquired from CPR's information requests, 7 percent of private wells sampled between November 1965 and July 2020 in Wicomico and Worcester counties had nitrate levels between 3 and 10 mg/L, and 3.5 percent were above 10 mg/L, on average. In other words, roughly one out of ten private wells sampled in the two counties had nitrate concentrations of 3 mg/L or above, a level that may be or already is hazardous to health. Figure 4 provides a visual representation of where wells

with nitrate levels between 3 and 10 mg/L and above 10 mg/L in Wicomico and Worcester counties are or were located, as some wells may no longer be in use. As CPR researchers acquire additional data, the map will be updated and available on our website at www.progressivereform.org.

**Figure 4: Map of Worcester and Wicomico County Private Well Samples**




*Source: Data for map acquired from the Wicomico County Health Department and the Worcester County Department of Environmental Programs.*

As noted, records provided by the Somerset County Health Department showed that all wells had nitrate levels below 0.8 mg/L. However, the sample of data provided by the county was incomplete and given the extent of contamination in the adjacent counties, additional investigation is necessary regarding nitrate pollution in Somerset County.

While in recent years counties have implemented short-term strategies, such as drilling deeper wells, to access less contaminated groundwater, 7 percent of wells sampled between 2015 and 2019 in Wicomico and Worcester counties still had nitrate levels of 3 mg/L or above. Our researchers were unable to obtain information on the number of people served by each well, but based on our sample of data and assuming two people per household, approximately 1,616 people had wells with nitrate levels between 3 and 10 mg/L and 834 had wells with nitrate levels above 10 mg/L. Data on public water usage in Lower Eastern Shore counties suggest that the majority of

residents in the region rely on private drinking water wells for household use.

Of the 20 public water utilities assessed on Maryland's Lower Eastern Shore, seven did not report nitrate levels in their most recently available CCR. It is unclear why this information was omitted, whether because nitrate was undetected, a sample was not collected, or another reason. Among the 13 utilities that did report nitrate levels at least once between 2018 and 2020, eight had concentrations exceeding 3 mg/L (all were in Wicomico and Worcester counties). These eight utilities serve approximately 58,515 people, representing nearly a third of the Lower Eastern Shore population. The Sharptown public utility in Wicomico County also reported a range of nitrate levels that exceeded 10 mg/L. Notably, some public utilities reported samples collected in the same year of the CCR, some in the year prior, and some reported nitrate levels from samples collected two years prior. Furthermore, we were unable to find CCRs from 2019 or 2020 for all public utilities in Wicomico County, as well as Pocomoke City and Snow Hill in Worcester County. Finally, while we did not include mobile home parks in the county-by-county analysis, it is of note that of 18 private mobile home parks in the three counties (together serve approximately 2,443 people), 12 failed to report nitrate levels and five reported nitrate levels between 3 and 10 mg/L in their latest CCRs.

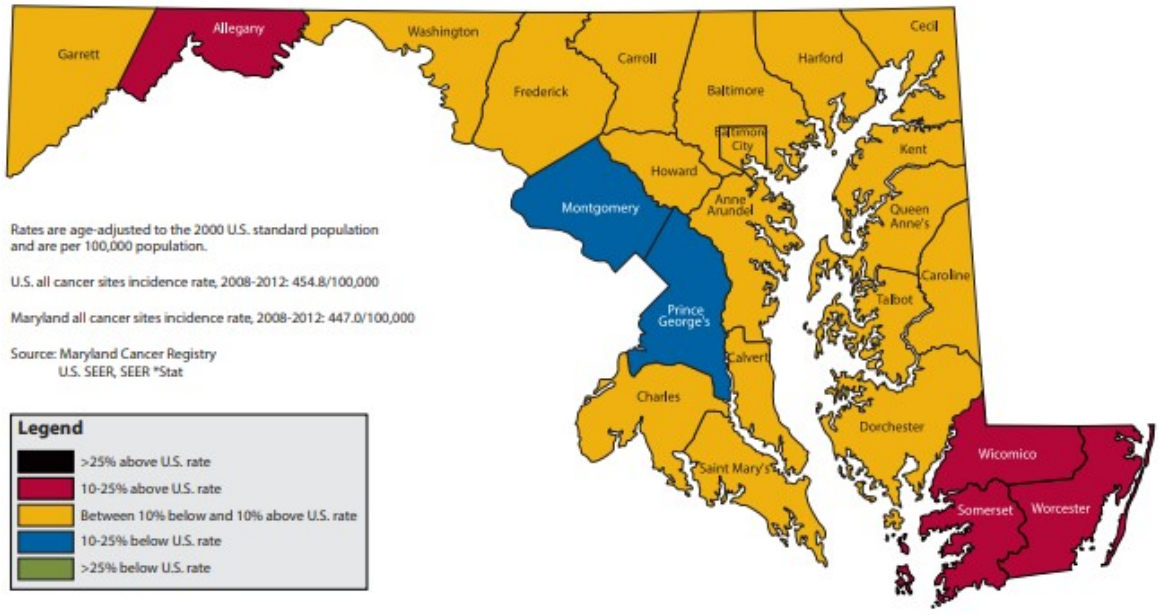
While CPR researchers were only able to obtain a sample of well data from Wicomico and Somerset counties, these findings suggest that Lower Eastern Shore residents, especially private well owners and those who do not have reverse osmosis or other treatment technologies in place, may be exposed to harmful levels of nitrates. Moreover, the findings raise larger questions. What *don't* we know about nitrate contamination in private wells and public water sources on the Lower Eastern Shore? Are health hazards lurking just beneath the surface, unknown and unaddressed because of a lack of testing and transparency? More research is necessary to understand the full scope of contamination, especially in residential wells currently in use.

## Public Health Implications for the Lower Eastern Shore

The elevated levels of nitrates found in drinking water in Lower Eastern Shore counties should raise concerns about public health hazards. As noted earlier, nitrate consumption has been linked to various illnesses, some of them fatal. According to the Environmental Working Group's 2019 study, the maximum number of cancer cases attributable to nitrate contamination in public water systems in Maryland is estimated at 8.1 per 100,000 people.[105] Neighboring Delaware had the highest attributable cases of any state in the country, at 17 per 100,000 people. While cancer incidence is related to a variety of social, economic, and environmental factors, Wicomico County had the highest age-adjusted cancer incidence rate in the state at 537.5 cases per 100,000 between 2013 and 2017.[106] This significantly exceeds the

statewide cancer incidence rate of 453.8 cases per 100,000 (Somerset and Worcester counties ranked fifth and sixth, also exceeding the statewide rate). Colorectal cancer, which is associated with nitrate consumption, also appears to be more prevalent in Eastern Shore counties where there is significant agricultural activity. Colorectal cancer rates among adults over 50 years of age in Somerset and Wicomico counties are greater than the statewide incidence rate of 111.1 cases per 100,000 between 2013 and 2017.[107]

**Figure 5: Maryland All Cancer Sites Incidence Rate by Geographical Area: Comparison to U.S. Rate, 2008-2012**




*Maryland's Comprehensive Cancer Control Plan 2016-2020 shows that cancer incidence rates between 2008 to 2012 were 10 to 25 percent greater in Lower Eastern Shore counties compared to the United States as a whole. Source: Maryland Department of Health.*

Neonatal health issues are also of concern in Lower Eastern Shore counties. In 2017, the infant mortality rate was highest in Somerset, Worcester, and Wicomico counties, at 41.2, 12.6, and 10.9 per 1,000 live births, respectively, compared to the statewide infant mortality rate of 6.5 per 1,000 live births.[108] According to the Maryland Department of Health, the two identified leading causes of infant death in 2017 were low birth weight and congenital abnormalities, which are also associated with nitrate consumption.[109]

Infant mortality does, to some degree, appear to be related to poverty, however mortality rates are still greater in Lower Eastern Shore counties compared to areas of the state with similar poverty rates and no poultry CAFOs. For example, between 2013 to 2017, average infant mortality rates

were greater in Somerset County (18.1 per 1,000 births, 22.5 percent poverty in 2017) compared to Baltimore City (9.3 per 1,000 live births, 22.4 percent poverty in 2017).[110,111] Similarly, in Worcester County (11.3 per 1,000 live births, 10.3 percent poverty in 2017), average infant mortality rates were greater than in Garrett County (9.6 per 1,000 live births, 11.4 percent poverty in 2017), a rural county on the western side of the state. Caroline County, which also has a large number of CAFOs, has a lower infant mortality rate during this time period; however, this may be because the state has specifically directed efforts to address the issue in the county.[112] Unfortunately, there is no requirement to report cases of blue baby syndrome, so it is unclear how prevalent this condition is.

*Of the nine counties on Maryland's Eastern Shore, Somerset and Wicomico (in addition to Dorchester) have the highest proportion of Black residents, suggesting that the adverse impacts of nitrate pollution could widen existing health disparities borne of systemic racism.*

Nitrate pollution may also disproportionately harm lower-income families that may not be able to afford costly water treatment systems. The proportion of people living in poverty is greater in Somerset, Wicomico, and Worcester counties compared to the state as a whole.[113] Furthermore, of the nine counties on Maryland's Eastern Shore, Somerset and Wicomico (in addition to Dorchester) have the highest proportion of Black residents,[114] suggesting that the adverse impacts of nitrate pollution could widen existing health disparities borne of systemic racism. These findings align with previous studies that found that communities with a higher percentage of Black and poor residents also have a greater proportion of CAFOs.[115,116] Further research and analysis is required to determine the degree to which nitrates contribute to adverse health outcomes and who is most impacted.

# State Action

## The Landscape of State Laws and Rules Governing Private Wells

The Safe Drinking Water Act allows states to adopt stronger laws, standards, and regulations to protect local drinking water. While every state has adopted regulations or laws governing the drilling and construction of new water wells, state requirements concerning private drinking water wells vary dramatically.

- Almost all states have policies governing the design and potential abandonment of residential wells.[117]
- Every state — except for Alaska, Georgia, and Rhode Island — requires notice, registration or permitting of newly constructed private wells.
- Forty-one states provide free, online access to private well data records and information.
- Thirty-seven states have adopted some form of groundwater protection program or have extended safe drinking water thresholds to groundwater — either directly or indirectly benefiting private well owners.
- Twenty-five states require initial water quality testing at the time a well is drilled and constructed; twenty-four states require basic well maintenance, which does not include any type of mandated well water quality testing.[118]
- Seventeen states offer free or low-cost water quality tests for private well owners.
- Thirteen states have water quality disclosure rules governing the transfer or sale of a property that contains a private drinking well.
- Nine states offer private well owners financial or one-on-one technical assistance with well remediation for contaminated wells.
- Five states require relevant agencies to notify private well owners who may be impacted by known groundwater contamination.
- No state requires regular water quality testing for private wells, nor has any state adopted a more stringent standard for nitrates in municipal or private well drinking water.

That said, some counties have adopted stronger rules for well construction and maintenance or provide greater financial assistance for well water

testing. For instance, Worcester County in New York requires well testing and disclosure before the sale of any property that contains a residential well.[119] Suffolk County, New York, offers a comprehensive well water testing program and provides low-cost test kits for residents.[120] Johnson County, Iowa, has stricter setback requirements for wells from sources of pollution.[121]

Residential wells in Maryland are largely governed by the Maryland Department of the Environment (MDE) and local county health departments. Requirements include basic parameters on construction, abandonment, and maintenance of wells in the state, and licensed well contractors must obtain a permit from MDE (or a local county health department) prior to the construction of a proposed well.[122] Well owners must obtain a Certificate of Potability for every new well that is intended to be used for drinking water. To obtain the certificate, a well must be sampled and tested in accordance with some of the SDWA requirements for public drinking water, including (1) test negative for the presence of coliform bacteria (two consecutive tests 24 hours apart required), (2) meet the MCL for nitrate-nitrogen, and (3) meet the turbidity standards also required for public drinking water.[123] Any "special conditions" written into the Certificate of Potability must be disclosed before the property is sold or leased out. New wells sourced by confined aquifers must be located 50 feet from identifiable sources of contamination or designated subsurface sewage disposal areas, and MDE may not approve a permit for a proposed well that is less than 100 feet from an unconfined aquifer.[124]

At one point, MDE actively implemented a Groundwater Protection Program where it managed, monitored and annually reported on the state's groundwater resources,[125] but the state has not reported on the program since 2013. The 2013 report cited funding concerns, but it also stated that "[d]ue to agricultural land use practices, nitrate concentrations in shallow waters of unconfined Coastal Plain aquifers on Maryland's Eastern Shore commonly exceed the Federal Drinking Water Standard of 10 mg/L." The report further stated "[p]rivate residential wells are not monitored regularly and many homeowners are not aware of potential contamination. In addition, over time, contaminated groundwater can move deeper into the unconfined aquifer or may affect water in confined aquifers if there is a hydrologic connection between geologic layers."[126] While Maryland's Source Water Protection Program assesses sources of public drinking water, this program explicitly does not extend to groundwater that sources private drinking wells.[127] Other than issuing permits to potential polluters of groundwater, it's not clear that MDE is actively protecting groundwater, nor is it clear whether the state is monitoring and reporting on groundwater quality, identifying sources of contamination and regions of concern as it once did.

When it comes to Maryland's well water policies, as the following pages reveal, the state's protections for well owners are lagging behind relative to other states. In fact, the state ranked among the five states that had the least protective policies for private well owners. Unlike other states, for instance, Maryland does not provide low-cost or free test kits, does not provide any financial assistance for the remediation of wells, does not require notification to private well owners in areas of suspected groundwater contamination, does not provide online access to private well records, does not engage in regular well water sampling in areas of known contamination, does not require property sellers to disclose well water quality test results to potential buyers, does not provide any protections for tenants reliant on well drinking water, and does not require regular information-sharing between state-approved laboratories and county or state health departments. MDE's website also lacks comprehensive information and resources for private well owners compared to other states.[128]

*Maryland's protections for well owners are lagging behind relative to other states. In fact, the state ranked among the five states that had the least protective policies for private well owners.*

Across the country, well owners are currently expected to take the safety of their drinking water into their own hands but may lack the financial and technical means to do so, may not understand the need to regularly test their water, or may assume it's safe to drink. For example, a well owner may incorrectly be under the impression that their well water is safe because it met certain water quality requirements at the time the well was drilled—despite the fact that well water quality changes over time. People with less education or lower income are less likely to take measures to protect their well water quality, such as testing or installing treatment equipment.[129] There are many ways states and local governments can prioritize the health of private well owners by providing resources to ensure the safety of their drinking water. Table 5 below provides a comprehensive review of policies and programs utilized by states to protect private well drinking water. It should be noted that the table does not cover basic protections that most states have, such as well construction standards (i.e. depth, dimensions and materials used for construction) and well driller licensing.

The ten key policies and programs reviewed include:

1. **Low- or No-Cost Test Kits**: The state offers free or low-cost (<$100) test kits to private well owners for a single contaminant or more.

2. **Initial Water Test**: The state requires newly constructed private wells to be tested to ensure that water quality meets certain safe drinking water standards.

3. **Property Transfer Disclosure**: The state requires property owners to disclose recent well water quality test results to potential buyers.

4. **Landlord Disclosure**: The state requires landlords to test well water quality and leased property periodically and disclose results to tenants.

5. **Groundwater Protection Program**: Either (1) the state has a well surveillance program where samples are taken from private wells and analyzed, (2) the state has an active groundwater protection program that assesses the quality of groundwater, identifies sources of contamination in groundwater, identifies areas of known groundwater contamination, and samples or includes assessments relevant for private drinking water wells, or (3) the state has adopted Safe Drinking Water Act thresholds for groundwater that may be used as a private drinking water source.

6. **Notice of Contamination**: The state explicitly requires notice to private well owners that may be affected by known groundwater contamination.

7. **Well Remediation Program**: The state offers financial or one-on-one technical assistance to replace, reconstruct or treat contaminated private drinking wells and associated groundwater.

8. **Well Registration or Notic**e: The state requires some form of registration or notice of newly constructed private wells.

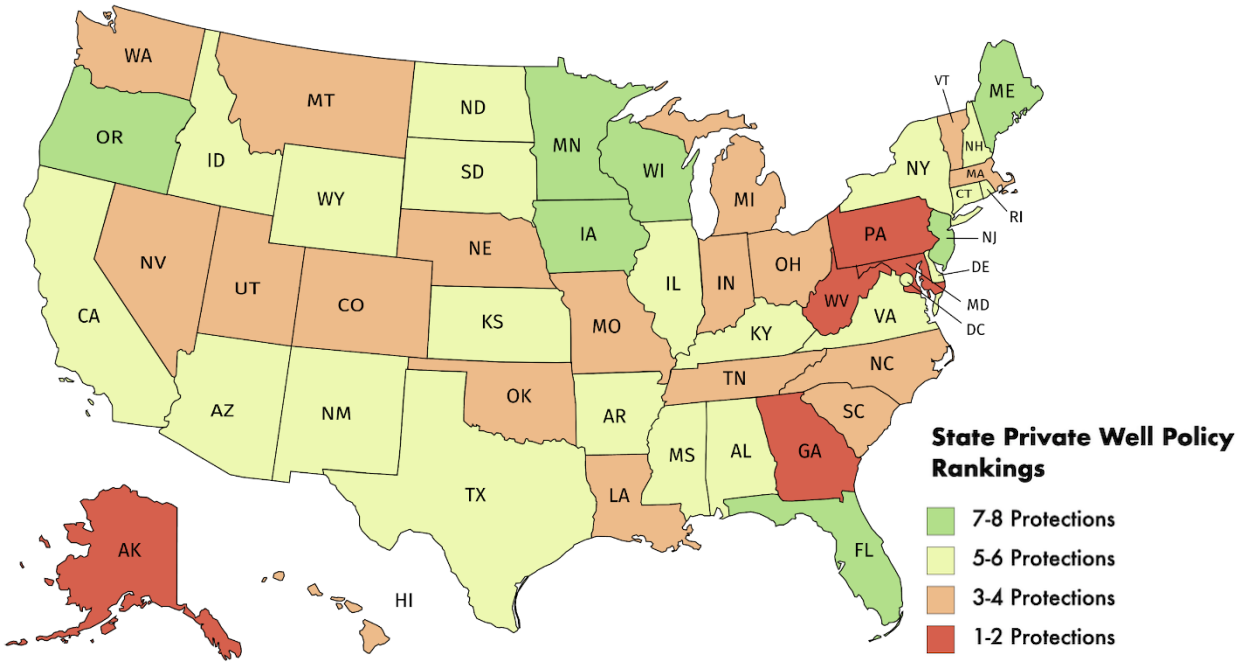
9. **Education on Private Wells**: The state posts comprehensive information on its website, in an accessible manner (i.e. a single web page with resources for private well owners and private well contractors linked throughout), that conveys the importance of regular private well testing and offers information regarding laws and regulations governing private wells.

10. **Online Well Data Access**: The state offers free, online access to basic well water data, such as location, well depth, and other relevant information.

## Table 5. Review of Protective State Policies Governing Private Wells

| State Well Water Policies | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low- or No-Cost Test Kits | Initial Water Test | Property Transfer Disclosure | Landlord Disclosure | Groundwater Protection Program | Notice of Contamination | Well Remediation Program | Well Registration or Notice | Education on Private Wells | Online Well Data Access |
| Alabama | √ | | | | √ | | | √ | √ | √ |
| Alaska | | | | | √ | | | | √ | |
| Arizona | | √ | √ | | √ | | | √ | √ | √ |
| Arkansas | | √ | | | √ | | | √ | √ | √ |
| California | | √ | | | √ | | | √ | √ | √ |
| Colorado | | | | | √ | | | √ | | √ |
| Conn. | | √ | √ | √ | | | √ | √ | √ | |
| Delaware | √ | | √ | | √ | | | √ | √ | √ |
| Florida | | √ | | √ | √ | √ | √ | √ | √ | √ |
| Georgia | | | | | | | | | √ | |
| Hawaii | | | | | | | | √ | √ | √ |
| Idaho | | √ | | | √ | | | √ | √ | √ |
| Illinois | | | √ | | | √ | | √ | √ | √ |
| Indiana | | | | | √ | | | √ | √ | √ |
| Iowa | √ | √ | | | √ | | √ | √ | √ | √ |
| Kansas | | | | | √ | | √ | √ | √ | √ |
| Kentucky | | √ | | | √ | | | √ | √ | √ |
| Louisiana | | | | | | | | √ | √ | √ |
| Maine | √ | √ | | √ | √ | | √ | √ | √ | √ |
| Maryland | | √ | | | | | √ | | | |
| Mass. | | √ | | | | | | √ | | √ |
| Michigan | | | | | | | | √ | √ | √ |
| Minnesota | √ | √ | √ | | √ | | √ | √ | √ | √ |
| Mississippi | √ | | | | √ | | | √ | √ | √ |
| Missouri | √ | √ | | | | | | √ | | √ |
| Montana | √ | | | | | | | √ | √ | √ |
| Nebraska | | | √ | | √ | | | √ | | √ |
| Nevada | | | | | √ | | | √ | √ | √ |
| New Hamp. | | | | | √ | √ | | √ | √ | √ |
| New Jersey | | √ | √ | √ | √ | | √ | √ | √ | √ |
| New Mex. | √ | | √ | | √ | | | √ | √ | √ |
| New York | √ | √ | | | | | | √ | √ | √ |
| North Car. | | √ | | | √ | | | √ | | |
| North Dak. | √ | √ | | | √ | √ | | √ | | √ |
| Ohio | | √ | | | | | | √ | | √ |
| Oklahoma | | | | | √ | | | √ | √ | √ |
| Oregon | √ | √ | √ | | √ | | | √ | √ | √ |
| Penn. | | | | | | | | √ | √ | |
| Rhode Isl. | √ | √ | √ | | √ | | | | √ | |
| South Car. | √ | | | | √ | | √ | √ | | |
| South Dak. | √ | √ | √ | | | | | √ | | √ |
| Tennessee | | | | | √ | | | √ | √ | √ |
| Texas | | | | | √ | √ | | √ | √ | √ |
| Utah | | | | | √ | | | √ | √ | √ |
| Vermont | | √ | | | √ | | | √ | | √ |
| Virginia | √ | √ | | | √ | | | √ | √ | |
| Washington | | | | | √ | | | √ | √ | √ |
| West Vir. | | | | | √ | | | √ | | |
| Wisconsin | | √ | √ | | √ | | √ | √ | √ | √ |
| Wyoming | | √ | | | √ | | | √ | √ | √ |
| D.C. | √ | | | | √ | | | √ | | √ |

## Figure 6. Private Well Protection Rankings By State




The map in Figure 6 ranks states based on the policies outlined in Table 5. Seven states—Florida, Iowa, Maine, Minnesota, New Jersey, Oregon, and Wisconsin—ranked highest because they had a significant majority of the protective policies in place for private well owners. Five states—Alaska, Georgia, Maryland, Pennsylvania, and West Virginia—ranked lowest because they only had one or two protective policies in place. The rest of the states had somewhere between three and six of the protective policies in place.

At a bare minimum, all states should require water quality testing for new wells at the time they are drilled to ensure that well drinking water is safe at the outset. Only half of the states in the country currently require initial water quality testing. For example, North Carolina and Ohio laws require local health officials to collect initial water samples for any new well and ensure the water meets safety standards. While Maryland is among the states that offer the least amount of protective policies for private wells, the state does require initial testing at the time a well is drilled to ensure that water quality meets federal safe drinking water thresholds.

Offering free or low-cost test kits to private well owners is another beneficial incentive that ensures the safety of well drinking water and the health of families that rely on it. At least 17 states offer free or low cost water test kits for certain contaminants. Maine, for instance, established a maximum cost of $10 for test kits. Other states, like New York, provide free test kits for known contaminants like lead. Providing free or low-cost test kits is important not only to encourage residents to test their unprotected well water, but for low-income residents who may not have the financial means to purchase a full-cost test kit that may be hundreds of dollars. This incentive ensures that well water is safe on an ongoing basis, which is essential given the nature of pollution migration over time. Incentivizing well water testing can also build a public record of groundwater quality and better inform well owners of areas of groundwater contamination, especially in states that collect and publish private well water test results.

Nine states offer some sort of well remediation program that provides financial or one-on-one technical assistance to replace, reconstruct, or treat contaminated private drinking wells and associated groundwater. In Iowa, the Iowa Groundwater Protection Act imposes a small tax on pesticide sales to create a continuous, state-controlled funding stream that county governments can apply to tap. The funding can be used for free or low-cost test kits, to rehabilitate wells that have been contaminated, or for outreach and education. [130]This program provides county governments with enough leeway and funding to set up individual well protection programs that meet the needs of local residents. Iowa's program was adopted after 8 percent of the wells in a certain region had reported high arsenic levels.[131] Wisconsin's Well Compensation Grant Program, administered by the state's Department of Natural Resources, also serves as an instructive model because it provides financial assistance to low-income residents or landlords for well water quality test kits and for the replacement, reconstruction, or treatment of contaminated drinking water wells.

Tenants who lease property with well water are commonly unprotected, except in Connecticut, Florida, New Jersey, and Maine. New Jersey's law may serve as a model for other states by requiring landlords to test wells and disclose those results to tenants at least every five years. Likewise, potential buyers of homes with well water should be adequately informed about the quality of the water, as is required in 12 states. Wisconsin law addresses this by requiring property owners to test water for certain known contaminants and disclose those results to potential buyers within a reasonable time frame.

States should also set up source-tracking and groundwater monitoring programs in areas where private wells are more prevalent. Thirty-seven states have set up some sort of well surveillance program or groundwater protection program where samples are taken from private wells or groundwater sources and analyzed. Some states have chosen to adopt Safe

Drinking Water Act thresholds for groundwater, requiring sampling and remediation of contaminated groundwater that sources private wells. These types of programs also typically identify sources of contamination in groundwater and areas of known groundwater contamination. Florida's well surveillance program provides an example for states that wish to assist residents who own wells in areas of known or suspected contamination. This serves as a good option for states that may lack funding to implement a comprehensive well compensation grant program but would like to protect residents who are reliant on well water.

Only a handful of states require notice to private well owners who may be affected by known groundwater contamination. Illinois regulations, for instance, require notification to nearby private well owners if the state Department of Public Health learns of groundwater contamination. State regulations in Texas require the state's Commission on Environmental Quality to notify residential owners of private drinking water wells that may be affected by groundwater contamination within 30 days of receiving notice of the contamination.[132] Just as residents who rely on public drinking water sources receive notification when their drinking water is contaminated at unsafe levels, residents who rely on private drinking water are entitled to the same. It is arguably even more important to provide notice of contamination to private well owners, because unlike those who drink from public water sources, private well owners bear the responsibility of initiating measures to clean up their drinking water.

Lastly, a majority of states provide online access to private well data and related information. If the data published provides enough information, such as ongoing water quality testing, it can be used as a powerful tool to inform residents about areas of concern for private wells and state officials about overall trends with private wells, so that the state can better protect private drinking water quality. The public should be informed about trends in well water quality data, especially in cases where contamination is prevalent, but where residents may not have access to assistance or resources for well water testing and remediation. In a similar vein, states should strive for better collaboration between state-certified laboratories that test well water quality and state or local health departments. For instance, Maine's law requires laboratories to report residential well water quality test results to the state Department of Health. Maine also requires county departments to routinely collect those results. This enables the government to access data relevant for informed decision-making, allowing agencies to better protect residents' health and safety.

For a more in-depth look at the state laws discussed, Table 6 in the Appendix outlines various state laws and regulations that provide protections for residential wells beyond federal law. The Appendix also contains principles for model legislation that advocates and policy makers can use to improve their state's protections for private well owners.

# Recommendations

**To better protect the health of the nearly 182,000 residents of the Lower Eastern Shore, the Maryland state legislature should enact legislation that would:**

- Establish safe drinking water standards for private wells and smaller community systems that are not covered by the Safe Drinking Water Act;
- Require the Maryland Department of Health or Maryland Department of the Environment to implement a well compensation program that helps cover the costs of well water testing, sampling and analysis, along with any needed remediation or replacement due to contaminated drinking water, prioritizing funding for low-income residents;
- Require property owners wishing to sell their homes to test well water quality within six months of sale and disclose well water test results to potential buyers;
- Require landlords to test well water quality on leased property every three to five years and inform tenants of the results;
- Publish all water quality testing results for private wells on a public online portal operated by state and local health departments, and require regular information-sharing between relevant state and local agencies and state-approved laboratories;
- Work with relevant state agencies and local county health departments to engage in outreach and public education, encouraging residents to test their water annually and educating them about the availability of financial assistance;
- Create a well surveillance and sampling program requiring relevant agencies to sample well water and collect well water quality testing data from local health departments, notify private well owners of suspected groundwater contamination nearby, and publish updated information about areas of known or suspected groundwater contamination;
- Ensure all public water utilities test for and report nitrate levels annually in Consumer Confidence Reports, and ensure most recent reports are publicly available;
- Require farms in areas with known or suspected groundwater contamination to implement best management practices to minimize the leaching of nitrate to groundwater; and
- Establish a statewide moratorium on new and expanding CAFOs.

**The U.S. Environmental Protection Agency should:**

- Complete an updated review on the relationship between nitrate consumption and adverse health outcomes, either through an Integrated Risk Information System health assessment, or by other

means, and then update the safe drinking water thresholds, or "Maximum Contaminant Level," for nitrates accordingly; and

- Work with states to establish stronger, more protective safe drinking water thresholds for nitrates based on the latest research regarding adverse health effects.

**In addition, policy and public health advocates can:**

- Develop model legislation for states and litigation theory under state and federal law to hold CAFOs accountable for spreading animal waste on fields in amounts that pollute drinking water sources, whether private or public.

# Appendix

**Principles for Model Legislation.** At a bare minimum, all states should (a) require a permit for any individual wishing to drill a well, (b) have policies governing the design of the residential well, such as the depth, dimensions and materials used for construction, (c) grant authority to county officials to inspect private wells, upon drilling and regularly as needed, (d) require water quality testing when a new well is drilled, and (e) have abandonment procedures in place for the proper decommissioning of a well, including filling and sealing it. Beyond these basic requirements, states should incorporate the following policies, programs and tools to ensure families with well water remain safe from unknown contaminants:

1. Low-cost or no-cost subsidized well water test kits and analysis;
2. Financial and technical assistance for residents to remediate contaminated well water;
3. Mandated well water quality test around time of well construction (either required by well owner, well driller, or county health department) that proves well water is safe for consumption based on federal safe drinking water thresholds;
4. Disclosure of known well water quality problems upon property transfer;
5. Regular landlord well water testing for leased properties, with disclosure to tenants;
6. Well water quality surveillance, sampling, and groundwater monitoring programs, with efforts to identify and track sources of contamination, administered by the state and county health departments;
7. Publicize areas of known groundwater contamination, assessments of groundwater quality, and sources of contamination;
8. Public access to well data, information, and water quality tests on a online portal operated by state and local health departments;
9. Regular information-sharing between relevant state and local agencies and state-approved laboratories regarding groundwater contamination and private well water;
10. Notification to private well owners of nearby groundwater contamination after relevant state agencies are made aware;
11. Outreach and education programs highlighting the importance of regular testing and the availability of assistance;

12. Extended federal Safe Drinking Water Act standards to protect groundwater that sources private wells; and

13. Greater authority for local water boards or other relevant agencies to order remedial action in cases of contaminated wells.

### Table 6. State Regulations and Laws Beyond the Safe Drinking Water Act[133]

| State | Policy |
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| Alaska | The state has a program where it tracks contaminated real estate, based on a number of sources of pollution, and encourages property owners to review contaminated areas before drilling new wells.[134] |
| Arizona | State law requires property owners to disclose "problems" that they are aware of with the private water supply prior to sale.[135] |
| California | State law grants authority to the State Water Resources Control Board "to order consolidation with, or extension of service from, a receiving water system… if a disadvantaged community is reliant on a domestic well that consistently fails to provide an adequate supply of safe drinking water."[136] |
| Connecticut | State law requires water quality testing of newly constructed wells for certain contaminants and requires laboratories to report the results to the state Department of Public Health.[137] The law allows local health departments to require testing for other groundwater contaminants. The legislature also convened a working group to study and make recommendations to ensure the quality of private wells.[138] |
| Delaware | The state's Department of Health & Social Services provides test kits to private well owners for $4 to test for nitrate, nitrite, iron, fluoride, alkalinity, pH, chloride, sulfate, sodium, hardness and other bacteria.[139] |
| Florida | The state has a well surveillance program under which county health department personnel conduct field sampling and surveys in drinking water wells around areas of known or suspected contamination.[140] The state's Department of Environmental Protection also notifies private well owners that may be impacted by known groundwater contamination.[141] |
| Illinois | Regulations require notification to private well owners if the state Department of Public Health learns of nearby groundwater contamination.[142] State law requires property sellers to disclose "material defects" of residential wells, including "unsafe drinking water."[143] |

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| Iowa | The Iowa Groundwater Protection Act provides counties with funding to test and rehabilitate private water wells for free or at a discounted cost.[144] To provide a continuous source of funding for this work, the state imposed a fee on pesticide sales. The Iowa Department of Public Health also has a Private Well Water Tracking Portal. [145] |
| Kansas | The Kansas Department of Health & Environment offers individuals wishing to drill new private wells a mapping tool to identify potential sources of groundwater contamination.[146] |
| Kentucky | State regulations require drillers of new or modified wells to test for E. coli and provide the results to the well owner. [147] State regulations require individuals who land-apply pollutants or fertilizers for commercial purposes to obtain a Groundwater Protection Permit that requires certain best management practices to mitigate pollution impacts to groundwater.[148] The state also has a Groundwater Assistance Program where state officials offer residents technical support by evaluating private well water quality, on request, and monitoring groundwater sources.[149] |
| Maine | State law requires laboratories to report residential well water quality test results to the state Department of Health; test results must also be collected by local county departments.[150] State laboratories charge no more than $10 for each water quality test. The Maine Private Well Safe Drinking Water Fund provides funding for these subsidized test kits, as well as outreach and education on the importance of regular well water testing. State law also requires landlords to test well water every three to five years and disclose the results to tenants.[151] |
| Minnesota | The state's Department of Health utilizes its Clean Water Fund to provide grants (of up to $100,000) to residents in counties with known contamination for testing and well remediation. The department also utilizes the fund to promote well water testing. |
| Maryland | State regulations require well owners to disclose any special conditions with residential well before entering into a contract of sale or lease.[152] Regulations also require each new well owner to obtain a Certificate of Potability to ensure that initial water quality meets certain basic standards. |
| Montana | The state laboratory offers a wide range of private well testing kits, with basic screening tests starting at $50.[153] |
| Michigan | State law requires all new, repaired, and reconditioned wells to be tested for coliform bacteria.[154] |

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| Minnesota | State regulations require any person who constructs a new residential well to test the water for coliform bacteria, nitrate, and arsenic by a certified laboratory and disclose those results to the well owner.[155] The Minnesota Department of Agriculture also created a Groundwater Protection Rule, which restricts the use of nitrogen fertilizer in the fall on frozen soils in areas of the state with vulnerable groundwater. |
| Mississippi | The Mississippi State Department of Health will test private wells for bacteriological contamination for free.[156] The department samples and monitors water quality in private wells.[157] The state adopted the federal Safe Drinking Water Act thresholds for all groundwater that meets EPA's definition of underground sources of drinking water.[158] The department oversees compliance with the thresholds by periodically surveying groundwater wells that source community-based systems.[159] |
| Missouri | The Missouri Department of Health & Senior Services provides low-cost test kits and analysis to private well owners for $10.[160] State law also requires private well water sampling during well installation.[161] |
| New Jersey | The state's Private Well Testing Act requires well water testing to take place when a property is expected to be sold or leased;[162] the test results must meet federal safe drinking water thresholds.[163] The results must be disclosed to the potential buyer or tenant. Landlords are also required to test well water once every five years and provide the results to each tenant.[164]The state has also extended the Safe Drinking Water Act thresholds to groundwater that can be used as a potable water supply.[165] |
| New Mexico | The New Mexico Department of the Environment provides free testing of private domestic wells for nitrate, iron and fluoride.[166] The state also requires identification tags for all new wells.[167] |
| New York | New York offers free water quality testing for lead in private wells. New York also retains the authority to require wells serving five or more people to be tested for certain contaminants.[168] |
| North Carolina | State regulations require the relevant local health department to collect water samples for any newly constructed well and have the samples tested for certain contaminants by a state lab.[169] |
| North Dakota | The state Department of Health provides well water testing for $10 for E.coli.[170] |

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| Ohio | State regulations require the relevant local health districts to collect water samples for any newly constructed well and have the samples tested for E. coli, total coliform, and nitrates. The state also established microbiological standards for private drinking wells.[171] |
| Oklahoma | Through an executive order, the Oklahoma Department of Environmental Quality offered one-time free testing for private wells that were submerged due to a flooding incident. |
| Oregon | State law requires that the seller of a property with a private well have it tested for arsenic, nitrates and total coliform bacteria prior to the sale of a property; the results must be disclosed to the buyer.[172] |
| Rhode Island | State regulations require new private wells to be tested for certain contaminants. The State Department of Health offers low-cost test kits. |
| South Carolina | The Department of Health and Environment provides testing and analysis for $25-$95 for total or fecal coliform, metals and minerals, and other inorganic parameters.[173] |
| South Dakota | The Department of Health provides low-cost testing for bacteria, nitrate and lead. A more comprehensive test is offered for new wells. |
| Texas | State regulations require the Texas Commission on Environmental Quality to notify residential owners of private drinking water wells that may be affected by groundwater contamination within 30 days of the date the department receives notice (or becomes aware) of the contamination.[174] |
| Vermont | State law requires testing of groundwater sources for single-family residences.[175] New wells must be tested for a range of known contaminants and test kits are provided for $161. |
| Virginia | The Virginia Household Water Quality Program offers low cost annual water well testing, with drinking water clinics at various locations throughout Virginia. State regulations also require testing of newly constructed wells for coliform organisms.[176] |
| Washington | Small community-based drinking water systems serving two to 14 connections must follow water quality and operation requirements, including mandated testing for nitrate contamination every 36 months.[177] This does not apply to private wells that serve a single residence. |
| Washington D.C. | The Drinking Water Division provides free test kits to homeowners and tenants.[178] |

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| Wisconsin | The state's Department of Natural Resources has a well compensation grant program that provides funding for well owners and landlords to test their water quality and to "replace, reconstruct or treat contaminated private water supplies."[179] In order to be eligible for financial assistance, family income may not exceed $65,000. State rules also require new wells to be tested for nitrate and coliform bacteria.[180] The state requires testing and disclosure upon property transfer for arsenic, bacteria, and nitrate. |

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