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Twenty years of private well testing in New Jersey: A review of the United States's most comprehensive well water testing regulation

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ABSTRACT

Since the adoption of New Jersey (NJ) Private Well Testing Act (PWTA) over 20 years ago, approximately 134,000 wells have been tested, representing an estimated 34% of the private wells in NJ. The PWTA requires testing of raw water from residences with a private well at real estate transfer. Landlords are required to test private wells every five years and provide results to tenants. There are up to 43 required parameters including bacteria, volatile organic compounds (VOCs), synthetic organic compounds (SOCs), arsenic, iron, lead, mercury, nitrates, gross alpha radioactivity, uranium, three per- and polyfluoroalkyl substances (PFAS), alongside secondary contaminants iron, manganese, and pH. Among tested wells, 15.7% had at least one or more exceedance of a primary drinking water standard. The most common exceeding contaminants have historically been gross alpha radioactivity and arsenic, but since the inclusion of PFAS in 2022, over 12% of wells have exceeded for at least one PFAS. Jurisdictions interested in developing real estate private well testing policies can contemplate many of the findings, successes, and limitations of NJ's PWTA and should consider private well testing policies as a part of a larger private well program which brings together local, state, and federal resources.

Key words: Private wells, Water testing, Policy

HIGHLIGHTS

- Since 2002, the PWTA has resulted in approximately 134,000 tested wells.
- Among tested wells, 15.7% exceed for a primary drinking water standard.
- Naturally occurring arsenic and gross alpha are commonly detected contaminants.
- Since the addition of PFAS in 2022, 12% of wells have exceeded the standard.
- PWTA data are utilized in a variety of research and public health projects.

1. INTRODUCTION

The U.S. Safe Drinking Water Act (SDWA) was first established in 1974 to enforce health and safety standards in drinking water to help protect the public from exposure to hazardous contaminants. However, more than 42.5 million people (13%) in the United States receive their drinking water from private domestic wells (DeSimone *et al.*, 2009), and are not protected under the SDWA. It has been estimated that as many as 20% of private drinking water wells contain at least one contaminant at concentrations greater than its human-health benchmark

(DeSimone *et al*., 2009). Unlike individuals on public water supply, private well owners are solely responsible for the quality of their water including any costs associated with testing, water treatment, and treatment maintenance.

Among states, there is a 'patchwork of policies and practices' related to private wells (Bowen *et al*., 2019). An evaluation of state policies for private wells found 100% of states had a policy related to well construction, and far fewer had policies related to well water testing at real estate transfer (22%) and rentals (6%) (Bowen *et al*., 2019). New Jersey (NJ) (Figure 1) is the most densely populated state in the United States in which over 1 million people (11%) rely on an estimated 400,000 private wells as their source of drinking water (Dieter *et al*., 2018). The NJ Private Well Testing Act (PWTA, the Act, N.J.S.A. 58:12A-26 et seq) is a landmark legislation signed into law on March 2001 and went into effect September 2002. The Act is a consumer information law administered by the NJ Department of Environmental Protection (DEP, the Department), which requires the buyer or seller of a residence with a private well to test the raw/untreated water for a suite of parameters and to review results before the closing of title. Landlords are required to test private wells and provide a written copy of the results to tenants every five years.

Fig. 1 | The geographic location of New Jersey in North America.

The PWTA has now been in effect for over 20 years. We provide an overview of the Act and its rules, present results from over two decades of testing, evaluate the strengths and limitations of the Act, and finally, describe how these data are used for promoting public health. This review will provide a primer for other states considering well water testing policies, offer insight into private well data and its uses, and address public health challenges of protecting private well users from contaminated water.

2. OVERVIEW OF THE PWTA

2.1. Parameters

In total, there are up to 43 required parameters under the PWTA which includes: total coliform and *Escherichia coli*/fecal bacteria, 26 volatile organic compounds (VOCs), three synthetic organic compounds (SOCs), arsenic, lead, mercury, nitrates, gross alpha radioactivity, uranium, three per- and polyfluoroalkyl substances (PFOS, PFOA, PFNA), as well as the secondary contaminants iron, and manganese, and pH (Table 1). Several contaminants were originally required only in some counties, including gross alpha (12 counties in the southern region of the state), arsenic (nine counties in the northern region of the state), and mercury (nine counties in the southern region). The Department has expanded the list of required parameters and the county specific requirements two times (Figure 2), including the expansion of arsenic and gross alpha statewide in 2018, addition of uranium in 12 counties in the northern part of the state where contamination is assumed possible, addition of three SOCs (1,2,3-trichloropropane, ethylene dibromide, and 1,2-dibrome-3-choloropropane) in 2018, and three PFAS in 2020. The addition of 1,2,3-tricholorpropane, PFOS, PFOA, and PFNA followed shortly after the state adopted NJ

Table 1 | Required PWTA parameters and percent exceedance, 2002–2022.

Drinking water parameters[a]	MCL	Wells tested (percent exceedance)
Bacteriological: Total coliform/*E. coli* or fecal	Presence/Absence	133,973 (1.8%)
Volatile organic compounds (VOCs) – 26	MCLs vary	134,269 (0.9%)
Synthetic organic compounds (SOCs)[b] – 3	MCLs vary	31,852 (0.4%)
Per- and polyfluoroalkyl Substances (PFAS)[c] – 3	MCLs vary	9,145 (12.1%)
Inorganic compounds		
Arsenic[d]	5 μg/L	80,547 (5.9%)
Mercury[e]	2 μg/L	67,304 (0.9%)
Nitrates	10 mg/L	134,292 (2.8%)
Radiological		
Gross Alpha (48-h)[f]	15 pCi/L	92,390 (10.8%)
Uranium[g]	30 μg/L	14,559 (1.0%)
Secondary contaminants		
pH	6.5–8.5	134,271 (46.3%)
Iron	0.3 mg/L	134,283 (29.3%)
Manganese	0.05 mg/L	134,285 (19.9%)

[a]Lead is not included due to limitations with the data as discussed in the 'Limitations' section.
[b]Included into PWTA in 2018 and testing commenced from 2019.
[c]Included into PWTA in 2020 and testing commenced from December 2021, includes PFNA, PFOA, and PFOS.
[d]Prior to 2018, only required in northern counties.
[e]Currently only required in southern counties.
[f]Prior to 2018, only required in southern counties.
[g]Currently only required in northern counties.

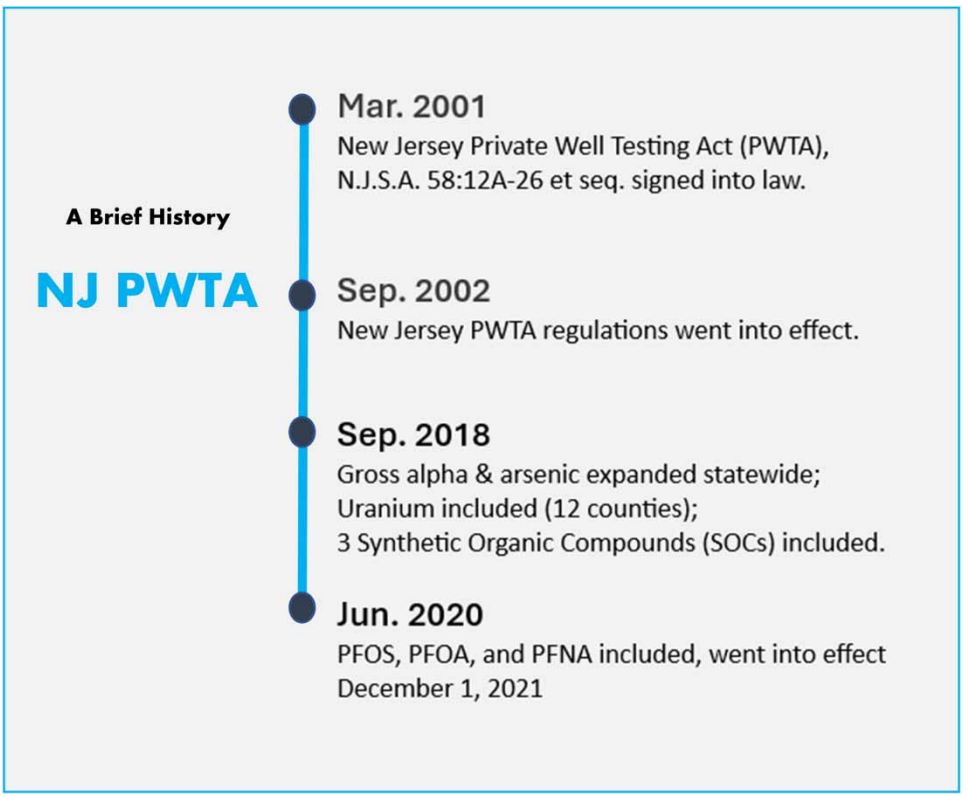

Fig. 2 | Timeline of legislative actions for the New Jersey PWTA.

Maximum Contaminant Levels (MCLs) for these chemicals. All samples are of raw water and can be accessed from a drinking water tap/faucet if there is no treatment in between the well and faucet, otherwise the sample must bypass the treatment system.

2.2. Commercial laboratories

Water sampling must be conducted by a certified laboratory, which is overseen by the Department's Office of Quality Assurance. Sample collection and analyses are performed by private commercial laboratories. These commercial laboratories must be certified by the Department for each parameter or rely on a third-party certified laboratory. For example, some private laboratories will utilize a third-party laboratory for gross alpha radioactivity. Analytical results are valid for up to one year, except for coliform which is only valid for six months. Laboratories send results directly to the client. The laboratory is also required to notify both the client and local health authority of a primary drinking water exceedance within 24 h of obtaining the results. These commercial laboratories report results into an electronic reporting system that feeds the database housed by the Department. The Department also notifies local health authorities within five business days after receiving notice through electronic laboratory reporting system when a well that is tested within their jurisdiction is found to exceed a drinking water standard.

2.3. Confidentiality and data sharing

An important component of the Act is its requirement that all data must remain confidential. Except for a data use agreement, almost exclusively granted by DEP to inter-Department program staff, the locations of the tested

wells are not shared beyond required notification to local health departments. Instead, the Act allows for DEP to make available a general compilation of water test results. Through 2018 geolocation data for wells were reviewed and corrected to ensure accuracy within 75 ft (22.86 m) of the property parcel, however locational submission has vastly improved since 2002. To reduce staff hours required for making corrections to locational data, geolocational accuracy is now reviewed to ensure the address and locational coordinates are in the correct municipality. The data dating from 2002 are shared with the public through online interactive maps (NJDEP, 2023). These maps provide data on the percent of wells exceeding the drinking water standard and the number of tested wells by county, municipality, and 2 × 2-mile (3.2 × 3.2-km) grids for each parameter/parameter grouping (e.g., VOCs). Any geographic unit with fewer than 10 tested wells is suppressed to maintain confidentiality.

2.4. Public notification

An additional component of the PWTA is the authorization for local health departments to issue a public notice to neighbors of the subject property found to be in exceedance of a drinking water standard. The Act further recommends identifying homes within 200 ft (60.96 m) of the subject property. This is not a requirement, but instead, provides local health departments the authority to use the data to promote awareness of local drinking water contaminants. It is not known how many local health departments perform public notification activities, but communication with local health departments across the state reveals it may be limited. Additional efforts should be made to evaluate communities' private well needs, assess the private well related activities undertaken by local health departments, and identify ways the Department can support them.

2.5. Local health ordinances

We are aware of at least three municipal or county private well ordinances regarding private wells. Two ordinances require the local health department to review the PWTA results before issuing a certificate of occupancy and one of those requires an additional turbidity test. Another local ordinance requires the installation of a two-tank arsenic treatment system if a failing arsenic test (>5 μg/L) is identified during PWTA testing. These local health ordinances supplement the PWTA to provide additional public health protection.

3. DATA AND FINDINGS

As of December 2022, 276,619 samples have been received through the PWTA. Once de-duplicated to remove repeat samples at the same property over the years, these represent 134,315 unique wells, which represents data for an estimated 34% of private wells in the state. Table 1 provides the list of required parameters, total number of wells tested for each parameter/group of parameters, and the percent exceedance. Although much of the impetus of the PWTA was a concern over manmade pollutants in private well drinking water (Flanagan, 2017), only 1,166 (0.9%) of well water samples detected at least one of the 26 VOCs since 2002. Of the naturally occurring parameters with primary drinking water standards, gross alpha (10.8%) and arsenic (5.9%) are the most common to exceed. Gross alpha and arsenic were only measured regionally until 2018 so these percent exceedances are not representative of the state. These naturally occurring contaminants are detected above the standard in a much larger number of wells than other manmade contaminants, apart from PFAS.

Since the inclusion of three PFAS, as required parameters in December 2021, a concerning 12.1% of wells have exceeded for at least one NJ MCL for PFNA (13 ng/L), PFOS (13 ng/L) or PFOA (14 ng/L). Public water systems in NJ were found to have more PFAS detections than water systems nationally (NJDWQI, 2017), which also indicates private well water may also be impacted at a greater frequency than other states. However, this should remain a concerning reality for other states and jurisdictions hoping to characterize the scope of PFAS contamination in their drinking water sources.

We estimated the number of wells with at least one contaminant in exceedance of a primary drinking water standard, the number of wells with two exceedances, and the number of wells with three or more (Figure 3). Out of a total 134,215 tested wells, 21,045 (15.7%) had at least one or more parameters exceed the MCL (42 MCLs, described in Table 1, excluding lead). This includes 18,163 (13.5%) wells with one exceedance, 2,740 (2.0%) wells with two exceedances, and 142 (0.1%) wells with exceedances for three or more primary standards. When parameters with secondary standards (iron, manganese, and pH) were included in this calculation, the number of wells with at least one or more contaminant that exceeds increases to a staggering 70.4%. Only a limited number of wells have been tested for PFAS ($n = 9{,}145$), given the recent addition of PFAS to the PWTA, we restricted the analysis to 2021 before the inclusion of PFAS for which only tested wells. Out of a total of 126,013 tested wells, 18,863 (15.0%) had at least one or more parameters exceed the MCL (38 MCLs, excluding lead) tested for in the PWTA. The occurrence of many of these contaminants varies significantly across the state. In some municipalities, the occurrence of gross alpha exceeding the MCL in drinking water is over 60% and as high as 68% exceeding for NJ's arsenic MCL (5 μg/L) (Figure 4).

The percent exceedances identified from PWTA is comparable to a previously published water quality survey, which found 13.2% of wells contained one or more contaminants at concentrations greater than the MCL and increases to 22.6% exceedances when contaminants with proposed MCLs and Health-based Screening Levels were included including testing for 52 contaminants including major ions, trace elements, nitrate, and organic compounds (DeSimone *et al.*, 2009).

4. UTILIZATION OF PWTA DATA

Although the Act is not a comprehensive source of all private well locations, PWTA data have been used by the Department's Site Remediation & Waste Management Program for identifying locations of private wells located within or near a contaminated site. Further, these data have been used for research to identify public health relevant recommendations and for private well outreach initiatives aimed to identify at-risk residents and promote the reduction of hazards in private well drinking water.

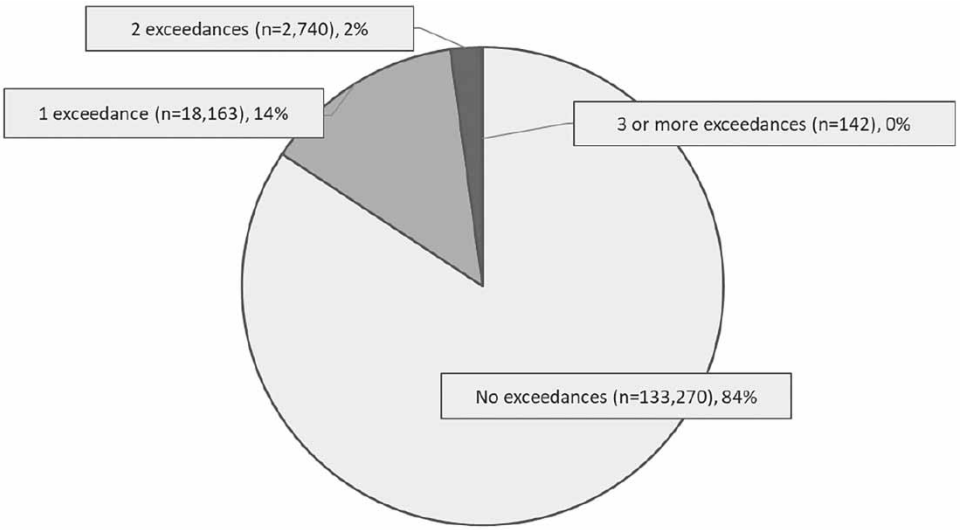

Fig. 3 | Percent of wells exceeding for one, two, and three or more primary drinking water standards.

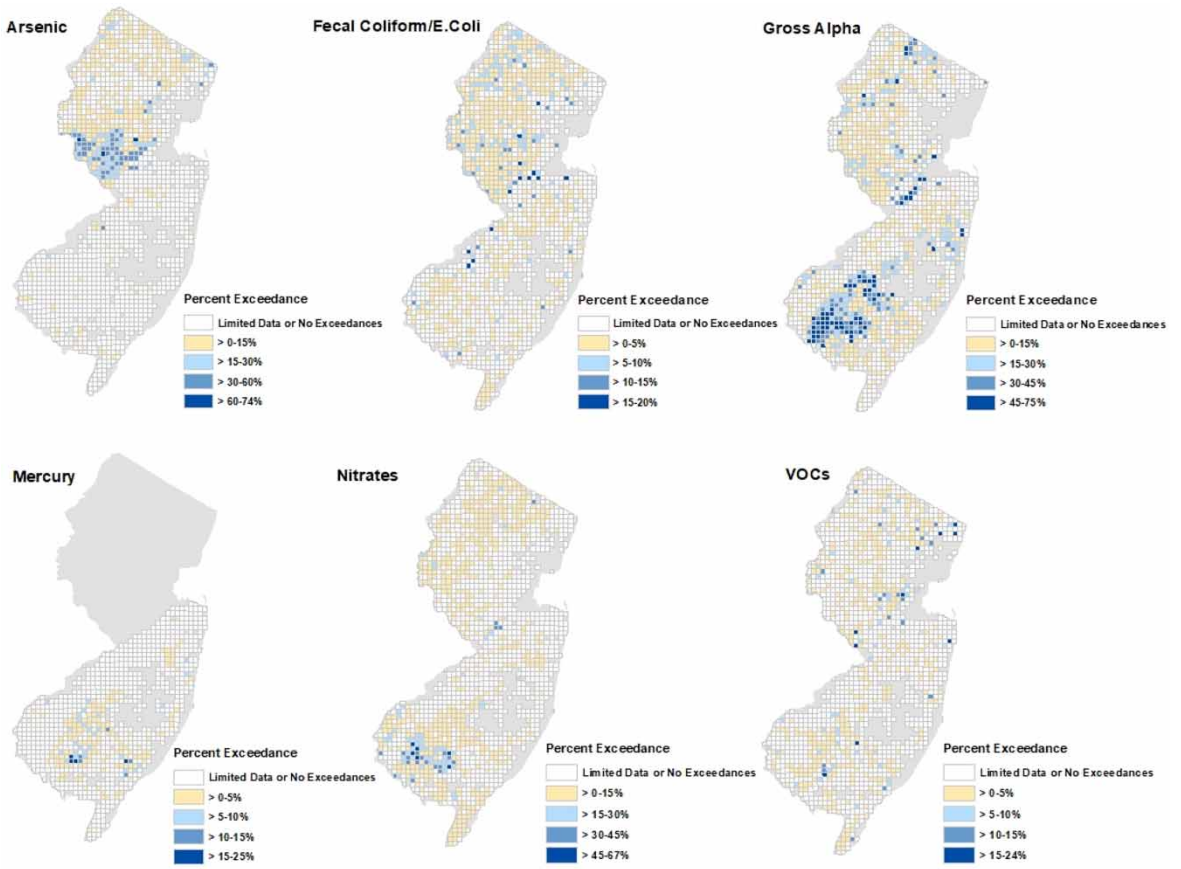

Fig. 4 | Series of 2 × 2 mile (3.2 × 3.2-km) grid maps with percent MCL exceedances identified from PWTA for arsenic (5 μg/L), presence of fecal coliform/*Escherichia coli*, gross alpha (15 pCi/L), mercury (2 μg/L), nitrates (10 mg/L), and VOCs (MCLs vary). Areas not covered by a grid are areas where no wells were tested as part of the PWTA.

4.1. Research

There is a significant benefit to identifying the wells that have been sampled multiple times through the PWTA to understand how certain parameters change or vary over time. Repeat samples of coliform occur in the database either because a property was sold more than once or the home sale did not occur within six months of the test result, in which case the well must be retested for coliform only. Atherholt *et al.* (2015) used a population of wells sampled multiple times to evaluate the effect of repeat sampling on bacteria detection rates and reported that the rate of coliform and fecal coliform/*E. coli* bacteria detections increased with the number of times wells were sampled. This was most pronounced in the northern bedrock region of the state where the authors estimated that if a well was sampled 10 times, one could expect TC bacteria to be detected in 90% of wells. Rate of bacteria detections were much lower in the sandy soils of the coastal plain in the southern part of the state. Additional studies of PWTA coliform detection data demonstrate vulnerability of domestic wells to coliform contamination due to geology (Atherholt *et al.*, 2013), seasonality (Atherholt *et al.*, 2017), precipitation (Procopio *et al.*, 2017), and occurrence and frequency of coliform detections were also dependent on the type of analytical method, the

reporting laboratory, and the pH of the well water (Atherholt *et al*., 2015). A summary of these findings are available (Atherholt & Procopio, 2017).

Access to repeat sample results of arsenic provided a resource to determine a defensible testing frequency recommendation for this geogenic compound (Mailloux *et al*., 2021). In addition to analyzing data from repeat well samples collected from the NJ PWTA, it also included national wells with multiple samples compiled by the United States Geological Survey (USGS) and repeated samples from wells in Bangladesh. Results from this study suggest that wells that are 1/2 an MCL and above (e.g., ≥2.5 μg/L) should be tested every year and wells below 1/2 an MCL should be tested every five years. This recommendation is universal whether referencing the World Health Organization (WHO) guideline and EPA standard or MCL of 10 μg/L or a lower MCL like 5 μg/L, the NJ MCL. These results reinforce the notion that a single test result or infrequent testing is inadequate to fully understand one's exposure potential given the variability of arsenic or coliform levels in groundwater. Results from these studies may have application to areas outside of NJ with similar geologies and ultimately support educational outreach opportunities.

4.2. Public health outreach

The State and their partners have utilized PWTA data to drive additional testing and outreach initiatives. Among these outreach initiatives, a targeted outreach campaign was conducted due to a change in the drinking water standard for arsenic (O'Neill *et al*., 2023). The NJ MCL for arsenic was lowered from the default federal drinking water standard of 50 to 5 μg/L in 2006. Homes that tested prior to the MCL change and had an arsenic result of less than 50 μg/L but greater than 5 μg/L, would have been notified under the PWTA that they had 'safe' levels of arsenic in their drinking water. However, following the change in standard, they would no longer pass the more health protective NJ standard. Homes that had not been retested for arsenic since the lowering of the arsenic drinking water standard could have been under the false impression that their water was still at 'safe' arsenic levels. In 2020, program staff identified 1,200 homes where a PWTA test was performed prior to 2006 and the results were less than 50 μg/L but greater than 5 μg/L. All eligible homeowners were offered free testing and 292 respondents returned water samples for analysis and completed a survey. Among respondents, 68% reported they had little or no knowledge the arsenic standard had been lowered. Among the analyzed samples, 63% of raw water samples and 12% of treated samples were above the NJ MCL of 5 μg/L.

PWTA data have been used to identify at-risk wells that have not yet been tested under the Act. Several outreach projects have identified neighbors within close vicinity (500 ft (152.4 m)) to a PWTA-tested well exceeding the primary drinking water standards for arsenic and gross alpha radioactivity (Flanagan *et al*., 2020b; Schwartz *et al*., 2023). These naturally occurring contaminants are the most prevalent parameters, prior to the addition of PFAS to the PWTA in 2021, to exceed their MCLs in NJ private well drinking water based on PWTA data. A 2020 study evaluated the efficacy of targeting neighbors of private wells within 1,000 ft (304.8 m) of a PWTA exceedance of the NJ arsenic MCL (5 μg/L) (Flanagan *et al*., 2020b). A total of 1,743 neighbors were invited to participate and 230 (13%) submitted water samples. Among participating neighbors, 56 (26%) exceeded the NJ arsenic MCL. The study also found that homes within closer proximity (500 ft (152.4 m)) to PWTA-tested wells with arsenic exceedance >25 μg/L were more likely to exceed the NJ arsenic MCL. A neighbors-based outreach initiative from 2019 to 2020 for gross alpha radioactivity selected the highest exceeding wells for gross alpha radioactivity (≥100 pCi/L) from the PWTA data. Neighbors within 500 ft (152.4 m) were identified. Among participating neighbors ($n = 70$), 47 (67%) exceeded the gross alpha MCL (15 pCi/L) in the raw water. Of the 62 participants with water treatment, 12 (19%) exceeded the gross alpha MCL post-treatment (Schwartz *et al*., 2023).

The public availability of the aggregated data (Figures 3 and 4) has also been the driving force behind community private well outreach initiatives (Rockafellow-Baldoni *et al.*, 2020; Seliga *et al.*, 2022). Public PWTA data maps can be used to identify municipalities that have a high percentage of wells exceeding for specific contaminants. In 2016, private well outreach for arsenic was conducted in two NJ municipalities (Rockafellow-Baldoni *et al.*, 2020). This outreach effort worked with the school communities to target homes with younger children due to their higher susceptibility to the effects of arsenic. A total of 376 homes were sampled in 1 week, and 94 (25%) exceeded the NJ arsenic MCL of 5 μg/L. In addition to this school-based outreach, two additional free and voluntary private well testing events were undertaken for naturally occurring contaminants in NJ (Seliga *et al.*, 2022). An evaluation of 571 participants from across the three testing events found 226 (40%) were identified as having one or more contaminants exceeding drinking water standards.

Furthermore, the clear identification of an arsenic-rich region in the state helped manifest a collaborative partnership with a primary medical system where free drinking water tests for arsenic and lead were offered to patients with private wells (Flanagan *et al.*, 2020a). This was a novel outreach strategy which included supplying test kits at doctors' offices, notifying nearly 10,000 patients of the free arsenic and lead testing offer through the online patient portal, and hosting a question-and-answer event on the healthcare system's Facebook page with a press release about the testing collaboration.

5. STRENGTHS AND LIMITATIONS

5.1. Limitations of a real estate testing Act

After 20 years, only one-third of the estimated wells in the state have been tested under the Act, leaving the remaining two-thirds still untested. It is likely that the PWTA will never test all the private drinking water wells in the state. Specifically, the PWTA will underrepresent wells in areas with lower housing turnover. This could differentially impact agricultural communities in which homes are passed down from one generation to the next. Because there is no direct enforcement of the PWTA by government entities; there may be types of real estate transfers in which PWTA is not initiated, such as foreclosures or short sales in which the buyer and seller are not represented by two independent real estate agents but instead managed through a financial agency. Additionally, although the PWTA is required every five years by landlords, it is not clear whether this testing is being completed or whether local health departments are universally enforcing this mandate. Also, to note, a real estate testing act will not reliably capture or protect private well owners from contaminants that are acute or seasonal in nature, such as coliform bacteria or nitrates.

The PWTA database does not include any additional non-regulatory testing. Without these data we are not able to assess how frequently private well owners are testing their well water, how frequently tests may exceed drinking water standards, or the reach or impact of local health department notification efforts or other private well education and outreach campaigns. As of December 2022, the cost of the test is estimated to be approximately $1,250; however, this varies based on laboratory. The buyer and the seller can negotiate who is responsible for paying this fee, but in most cases the seller pays the cost of the testing. It is not clear whether the expense of the PWTA limits some homebuyers from purchasing a home with a private well.

5.2. No treatment requirements

The Act does not include enforceable remedial actions if a parameter is found to exceed its drinking water standard, and many homeowners do not take any action to reduce exposure. Among a subset of surveyed NJ households with known or reported arsenic problems identified from PWTA ($n = 71$), 56% were using some kind of treatment for arsenic, 10% were drinking bottled water, and 34% were not taking any action (Flanagan

et al., 2016). A 2019 survey of NJ homes with a PWTA test which had an arsenic exceedance (>5 μg/L – the NJ MCL; $n = 486$) revealed 40% of respondents did not remember they had an arsenic exceedance, and despite having an arsenic exceedance in their drinking water over 25% of the respondents reported taking no action to reduce exposure (Flanagan *et al.*, 2018).

Although the installation of water treatment is not required if a parameter under the PWTA exceeds its standard, real estate transfer is a great negotiation opportunity for installing water treatment. Indeed, from a survey of NJ homeowners with a PWTA arsenic exceedance above the NJ MCL (>5 μg/L), 75% of the 486 respondents reported taking action to reduce exposure (Flanagan *et al.*, 2018). However, it has been suggested that if the seller purchases and installs water treatment, then the buyer may be less knowledgeable about the water treatment, how it works, and how and why it should be maintained.

5.3. Parameter-specific limitations

Primary drinking water standards including MCLs or action levels are developed for public water systems and may not be directly protective or appropriate for private well users. For example, public water systems must test for gross alpha radioactivity and although the MCL for gross alpha radioactivity is 15 pCi/L, a value greater than 5 pCi/L requires further testing from the water utility for combined radium 226 + 228. If the combined radium is greater than 5 pCi/L, the water utility is in exceedance of the standard and must mitigate. However, this additional radium testing is not required by the PWTA. Therefore, homeowners with gross alpha radioactivity measures greater than 5 pCi/L but less than 15 pCi/L are not found to exceed the drinking water standard, when, especially in the Kirkwood-Cohansey aquifer region in southern NJ, well water is likely to exceed the radium MCL (Szabo *et al.*, 1997; Szabo & Vincent, 1998). The Department recommends individuals in southern NJ take action when gross alpha is greater than 5 pCi/L, either with follow-up testing for combined radium-226 and radium-228, or alternatively, saving the expense of testing and instead, just install water treatment (NJDEP, 2002). However, this recommended guidance is not likely followed by most homeowners.

Lead is an important drinking water contaminant which can cause a variety of health effects, to which children are particularly vulnerable. Lead enters drinking water from plumbing materials containing lead or from well parts composed of lead (Triantafyllidou *et al.*, 2021). The PWTA requires that samples are representative of the raw groundwater and sample collection can take place at an exterior spigot, the well head, holding tank, or a drinking water faucet, like the kitchen sink, if there is no treatment in place between the well and the faucet. Sampling for lead requires the water to be flushed for at least 2 min. Flushing ensures the sample is representative of the raw groundwater. Instances of unexpectedly high lead results have been reported. High results are unexpected because lead is seldom found in groundwater. Therefore, when lead is detected in the sample, the source of the lead is almost always attributed to being from the well structure or plumbing materials inside the home – not the groundwater. Since the lead results are not likely representative of the raw groundwater, it is likely that elevated lead results get reported due to collection of water samples from unflushed water tanks or spigots. It is not clear how lead data collected from the PWTA should be interpreted since any detected lead may be coming from sample collection taps such as hose-bibs and holding tanks that people do not drink from. Conversely, detecting no lead may not reflect drinking water exposure if the home has leaded plumbing materials, but the water sample was collected prior to entry in the home. Inclusion of pre- and post-flushing may provide better insight.

6. CONCLUSION

The Act is the most comprehensive private well testing policy in the U.S. and has resulted in the identification of almost 19,000 wells exceeding a primary drinking water standard for naturally occurring and manmade contaminants. However, water testing is only the first step at reducing exposure to contaminated private well water, as

behavioral, situational, and financial barriers impact homeowners from managing their own well water safety (Zheng & Flanagan, 2017). Indeed, despite identification of contamination, many homeowners do not take further action (Flanagan *et al*., 2016, 2018). Appropriate treatment and system maintenance, in addition to frequent testing, are staples of successful and protective behaviors toward drinking water management. Although a real estate testing policy is effective at identifying drinking water contamination and creates a unique setting to negotiate installation of water treatment, the effectiveness of the Act, and others like it, are limited since installation of water treatment and subsequent maintenance is not required. Therefore, effective use of these data must be considered as part of a larger public health program which supports research and targeted outreach. Jurisdictions interested in developing private well testing policies can consider many of the findings, successes, and limitations of NJ's PWTA and should consider this policy as a part of a larger private well program which brings together local, state, and federal resources to support private well users.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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