

**Reducing Human Health Risks from Groundwater: Estimating Private
Well Testing Behaviors and Barriers among Private Well Owners in
Wisconsin
2015**

Acknowledgements

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Private Well Testing Behaviors and Barriers among Wisconsin Adults

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Executive Summary

Private well testing is an evidence-based strategy to reduce risks from exposure to harmful contaminants. It is a primary way contaminants can be detected, potential for health risks can be estimated, and actions taken. This report examines the role that private well testing and treatment behaviors and information gaps regarding these behaviors contribute to gaps in our ability to assess the vulnerability and uncertainty of human health risks posed by groundwater contaminants in the state of Wisconsin. Vulnerability is defined as the potential for increased exposure to groundwater contaminants to lead to adverse health effects. Uncertainty refers to our inability to measure health risks due to data gaps or due to limited private well testing. Previous testing by multiple state agencies suggest there is potential for widespread exposure to contaminants including bacteria, nitrates, arsenic and pesticide metabolites in private wells throughout the state of Wisconsin. Without testing, there is no incentive for treatment or potential for current treatment (use of water softener only) to be modified. Since water quality can change overtime, state agencies including the Department of Natural Resources (DNR) make recommendations for private well testing that suggest regular testing every 1-10 years depending on the contaminant of concern. The goals of this project were to look for patterns in private well testing and treatment behavior and the barriers and facilitators of testing in the state using data from the Survey of the Health of Wisconsin cohort.

In 2014, the Groundwater Coordinating Council awarded the Survey of the Health of Wisconsin, within the Department of Population Health Sciences at University of Wisconsin funds to study differences in health risks, and potential for health risks among private well owners in the state of Wisconsin with a focus on the prevalence of testing and treatment. In addition, we aimed to examine facilitators and barriers to testing and treatment such as perceived risks, knowledge and costs. The focus of this study was not high-risk individuals living in areas with known contamination, which has been the focus of many previous analyses, rather to examine these associations in a well-characterized general population based sample. Outcomes are intended to support evaluation of current policies and programs aimed at protecting private well owners and to identify future actionable evidence-based methods to mitigate future public health risks.

Methods included a follow-up study of 719 Survey of the Health of Wisconsin (SHOW) program households identified between 2008 and 2013 as having a private well during baseline interviews. The target sample represented approximately one-third of total participants, an estimate that is consistent with both the Department of Health Services (DHS) and Department of Natural Resources (DNR) estimates of private well-ownership in the state. All target sample households were sent up to three mailings and one email or phone call requesting participation in the follow-up survey. Information was gathered through the mail or on the web.

An advisory committee was formed to guide the research and included representation from stakeholders from academics, and three primary agencies responsible for statewide groundwater and public health protection among private well-owners. An initial meeting was held in July 2014 to assist in identifying concerns and agency priorities prior to data collection. A mail-based survey was developed and reviewed by agency representatives. Post data collection, preliminary data were shared with stakeholders at a second meeting in July 2015.

Below is a summary of key findings. These findings represent data from one randomly selected participant per household. Findings include the most relevant portion of all survey data collected summarized in response to information needs and gaps identified by state agencies prior to data collection and feedback received during a final stakeholder meeting.

Key findings:

Use of Private Well as Drinking Water Source

- Among household respondents 94% indicated they used their water for drinking and 75% said they always did.

- Private well owners on average tend to live in rural communities, are majority white, and have slightly higher incomes on average.
- Health indicators indicate a slightly higher percentage of private well owners are overweight, and have hypertension compared to those served by municipal wells. No differences in rates of diabetes or cancer were reported in the study sample

Private Well Testing Who, How Often, Why and Where

- Testing rates among respondent households was low – data suggests that only 50% of households have tested in the last 10 years; Of those, only 22% have tested in the last 1-5 years, suggesting state agency estimates for “regular” testing are consistent with prevalence of testing.
- The primary reasons for testing were based on health concerns, or as part of a real-estate transaction. Thirty-one percent of the total reasons for testing were to find out if well water is safe to drink and 19% was due to a real-estate transaction.
- The majority of testing is performed by a private laboratory or company; however, almost one-third of household respondents who indicated having tested their wells in the last ten years did not know who conducted their well water test.

Contaminants Tested for, Water Quality Issues Identified, and Actions Taken

- Bacteria (54%) and Nitrates (48%) were the most common contaminants tested for. Over one-quarter of responses also indicated testing for iron (28%), hardness (27%) and lead (25%), and another one-fifth identified testing for Arsenic (21%) or Pesticides (19%). Copper (14%) and Fluoride (11%) were also mentioned as contaminants tested for in greater than 10% of the sample.
- Almost 10% of respondents did not know what was tested for (9.3%).
- Very few water quality problems were identified due to testing. The majority of respondents (63%) did not have a problem identified through testing.
- Among the most common problems identified iron (11%), hardness (9.8%), don't know (9.8%) and nitrates (6%) were most commonly indicated.
- Many individuals test only for one or two contaminants, therefore, prevalence of chemical contaminant problems may be under-estimated
- Water quality testing did lead to action if a problem was identified, but not for everyone. Seventy-four percent reported taking action, however, roughly one quarter took no action even after a problem was identified (26%).
- The most commonly reported actions taken post-testing included treatment, filtration or softening of water, which was identified by 23.2% of respondents.

Barriers to Testing

- Perceptions that well water is safe to drink, lack of previous problems identified in a community, feelings of security after drinking water for years or having no at-risk individuals in the household were the primary reasons household respondents did not test their wells.

Future Testing

- Aesthetics (a change in taste, smell or appearance) was the most likely factor that would prompt respondents to test in the future (49%).
- Reducing costs associated with testing was another factor- 16% of respondents said they would test in the future if the testing price were reduced or free.

Convenience of Testing as a Potential Barrier

- Having a local and convenient option for receiving and returning water test kits was important to most respondents.
- Approximately 45% of respondents prefer to pick up a test kit at a local location and return the sample to the same location a couple of days later compared to only 5% of respondents indicating they wanted to go to the laboratory for pick up and drop off. About 28% of respondents wanted to order a test kit online and return by mail.

Knowledge as a Potential Barrier

- Information predicts testing and treatment behaviors among private well owners.
- Only about one-half of all respondents felt they had the information they needed for testing their wells (50.3%), whereas 43% did not have the information they needed and wanted more
- Over 75% of those who felt they had the information they needed did test their wells compared to only 41% of people who were lacking information.

Treatment Prevalence and Type of Treatment

- The majority (62%) of respondents did use some form of water treatment
- The most common treatment type was a water softener (42%). Only 43% of respondents indicated using some sort of treatment other than water softener
- Of those that used a filtration system designed for reducing chemical contamination most reported a refrigeration system, carbon filter (14%), and/or a pitcher type filter (8%)
- Use of absorbent media (7%), or reverse osmosis (7%) was rare.
- Health region and income were the most significant predictors of well-water treatment, regardless of treatment type.

Motivation and Barriers to Treatment

- Hardness or iron were the primary reasons respondents indicated for treating their well water (73%).
- Health based concerns were the second most commonly cited reasons for treating wells. Over 1/3 of the respondents indicated they treated their water because they felt it is safer and healthier (36%).
- The most common reason respondents reported for not wanting to treat their wells were that the water did not taste bad (78%) and the owners had been drinking the water for years without any problem (77%).
- Similarly, low perceived risk and appearance of clean water were the next most commonly cited reasons for not treating (69% and 68% respectively).
- Approximately 15% indicated costs were a barrier to treatment.
- Males and household participants ages 41-60 appear to have less information about testing and were more likely to list *I don't know what to test for, I don't know how to have my well water tested, I did not know it was my responsibility to test the water, and/or I did not know testing is available* as a main reason for not testing.

Perceptions of Well-Water Quality

- The majority (70-80%) of respondents were happy with the taste, smell, and appearance of their untreated well water and 80% believe their *untreated water is safe to drink*.
- The majority (88%) also believed that well water quality can change over time.
- Only 40% of household respondents are *happy with the hardness of their untreated water*

Predictors of Testing and Treatment

- Awareness and knowledge are important determinants of testing behavior.
- Having an actual health problem or suffering from a chronic condition did not influence testing behaviors or treatment in the study sample.
- Odds of testing in the last ten years were almost six times higher among respondents who agreed with the statement - *Yes, I have the information I need to make decisions about testing my well water*
- Those who know one or more households where the owners have tested their well in the last 5 years had a 4.08 odds of testing in the last ten years.
- Knowledge that well water is safe and that testing is homeowners responsibility are also driving factors in predicting testing behavior.
- Odds of treatment were reduced when participants were happy with the taste and smell of their well water.

Conclusions and Future Recommendations

The potential for wide-spread contamination combined with low-prevalence of consistent and regular testing among the general population of private well-owners in the state suggests that health risks are present; however, there is still uncertainty regarding the magnitude of these risks. Private well owners in Wisconsin are very likely to use their private well as a primary source of drinking water, suggesting that without testing they may be vulnerable to unknown exposures to hazards at levels that exceed health based standards. Findings are consistent with previous estimates that testing rates among Wisconsin private well-owners is low despite information provided by state agencies. While few contaminant issues were reported in this study, approximately ½ of the individuals in this study did not test. Of those that did test, very few (only 19%) tested regularly (within the last 12 months per recommendations). Furthermore, less than half of respondents tested for chemical contaminants beyond bacteria and nitrates. Therefore, a lack of significant water quality issues may be a function of limited testing and irregularity of testing in the population, not necessarily a lack of contaminants.

In the future, programs aimed at increasing public awareness, supporting public education regarding testing on a local level, and increasing convenience are needed. Education, information and knowledge sharing regarding what and how to test for chemical contaminants appear to be critically important predictors of testing behaviors. Motivations for testing are largely driven by personal perceptions of safety and risk and/or being informed that a neighbor had a health issue. Also, providing test kits in convenient locations and assisting consumers in understanding what to test for and when may help improve testing rates. Reducing costs was also identified as something that would motivate future testing and treatment by private well owners and should be considered in designing future interventions. Many individuals who do not test their wells feel they do not have the information they need regarding what to test for, how to test, and where to test. This information barrier seemed to be the most significant barrier to testing.

Further education and outreach regarding value of and appropriateness of treatment, and potential support for low income populations are also needed. Treatment among private well owners is largely driven by issues of water hardness and do not address issues of chemical contamination; this may also be driven by low and improper testing rates in the general population. Given that income was the greatest predictor of treatment, some resources may be needed for private well owners to subsidize drinking water treatment systems.

Future studies should focus on testing and intervention based studies to improve water testing over time. Education should include opportunities to improve knowledge on what and how to test for contaminants. It also appears that risk perceptions regarding safety of water irrespective of measurement/testing are reasons for not testing. Therefore, risk communication should try to improve the public's understanding of vulnerabilities. One way to increase motivation may also be to have community organizations and citizens involved in the dissemination of well water testing programs as many individuals stated they would test if their neighbor tested. Beyond health concerns, costs were also barriers, if testing programs were able to eliminate or mitigate costs

in any way, the public may move forward with testing. This report is a first summary of results from this study. Data gathered as part of this project is available to others for more in-depth analyses and use by stakeholders to ask more specific questions and as the basis for future research.

Introduction

Groundwater contamination of private wells is wide-spread across the state of Wisconsin and at times levels of contaminants can exceed health-based standards. Approximately one-third of private wells tested have detectable levels of pesticides, or their metabolites. Some private well-owners in the state are particularly vulnerable to having naturally occurring arsenic in their wells based on geology and location. Further, in 2007 the Department of Agriculture Trade and Consumer Protection found nitrate levels in close to ten percent of private wells exceeded health based standards¹.

Regular testing of private well water is a known and effective method for detecting contaminants and identifying strategies for reducing exposures and thereby protecting human health. However, since there are no mandated private well testing requirements, Wisconsin Department of Natural Resources (DNR) and the Wisconsin Department of Health Services (DHS) are concerned that many private well owners do not regularly test their wells. Regular testing of wells is recommended as being tested annually for some contaminants and a minimum of every five to ten years for other contaminants². Although basic advice on private well testing is provided by state and local agencies involved in public health, there is a knowledge gap in understanding private well testing practices across the state, barriers to testing, and uncertainty regarding how private well water data informs household decisions for drinking water consumption and other water uses such as bathing.

Approximately 1/4 to 1/3 of Wisconsin's residents rely on water drawn from over 900,000 private wells^{1,2,3}. Despite the fact that DNR has proposed health-based recommendations for private well testing, DNR estimates only 10% of private well owners test their wells on a regular basis³. Limited private well testing and treatment suggests that there exist potentially preventable human health risks from exposure to groundwater contaminants at unsafe levels among Wisconsin residents. Wisconsin DHS found 47% of the 4,000 rural drinking water supplies tested from 2007-2010 exceeded one or more health-based water-quality tests⁴. Arsenic has been detected in every county in Wisconsin, and previous studies by the DNR have seen detection levels over 10 parts per billion, the current drinking water standard, in more than 50 of the 72 counties⁵. Chronic exposure to arsenic via drinking water at levels greater than 10 ppb has been associated with increased risk of skin and lung cancers, skin lesions, peripheral neuropathy, and anemia^{6,7}. In 2011, the Wisconsin Department of Agriculture and Consumer Protection (DATCP) follow-up monitoring study investigated 36 private wells that have exceeded groundwater enforcement standards for pesticide and nitrate-nitrogen levels in high risk atrazine prohibition areas and found decreases in atrazine concentrations for most of the wells. DATCP's targeted sampling program also found that 77 out of 92 well water samples analyzed (87%) contained nitrate-N above the detection limit⁸. Additionally, 36% of the wells sampled had nitrate-nitrogen levels above the Wis. Admin. Code NR 140 Enforcement Standard (NR140 ES) of 10 milligrams per liter (mg/l)⁸. Microbial risks, including exposure to bacteria and viruses such as hepatitis A, rotavirus, and Norwalk-like viruses have also been detected in private wells in Wisconsin^{9,10}.

This report assesses gaps identified by the Wisconsin Department of Human Services and the Wisconsin Department of Natural Resources regarding the uncertainty of human health risks posed by groundwater contaminants due to lack of private well water testing in the state. More specifically this report identifies 1) the prevalence of private well testing, contaminants tested for, where testing occurs, and facilitators and barriers to private well testing in the state 2) the perceptions and awareness of groundwater quality and safety among the private well owners in Wisconsin and how this may or may not affect private well testing 3) the prevalence and perceptions around private well water treatment, filtration, and consumption.

This is the first study to assess private well water testing barriers in Wisconsin using a random statewide general population based sample of Wisconsin state adult residents. By examining a random sample of private

well owners rather than targeted towards a specific high risk population, it provides state agencies an improved understanding of facilitators and barriers to testing for, and to identify actionable evidence-based methods to address why people do not sample their wells.

Methods

Source Population

The Survey of the Health of Wisconsin (SHOW) was used as the source population for this study. SHOW is an ongoing household based health examination study. It includes a probabilistic statewide sample of Wisconsin state residents ages 21-74 (n = 3,384) from the years 2008-2013. A two-stage cluster sampling approach is used to select households and recruit approximately 800-1,000 adult participants every year. Details on study methods and design have been previously published (Nieto, 2010). In summary, after letters are sent to randomly selected addresses in the state, trained field-staff visit households in communities to recruit all age-eligible adults for participation in the survey. Between 2008 and 2013, the initial in-person interview was conducted in the home after consent. Two additional stages of data collection, including self-administered interviews, audio-computer assisted interviews and physical exams, were conducted at permanent or mobile examination centers at a later date. Individual survey data include physical, mental, and oral health history, health literacy, demographics, behavioral, lifestyle, occupation, household characteristics, health care access and utilization. The physical exam includes blood pressure, anthropometry, bioimpedance, spirometry, urine collection and blood draws. The household characteristics section of the SHOW survey asks the following questions pertaining to private well water:

- 1) Is your home connected to a private well or to a community water supply?
- 2) How deep is your well?
- 3) Do you use a home water filter/treatment system in the home for drinking?

Information on private well water testing behaviors, contamination issues, perceptions of risks and barriers to testing are not captured in the main SHOW questionnaire.

In 2014 and 2015, the Groundwater Coordinating Council provided funding to SHOW to conduct a follow-up survey targeted at private well owners in an effort to gather information on testing and treatment patterns and behaviors. Information gathered also included:

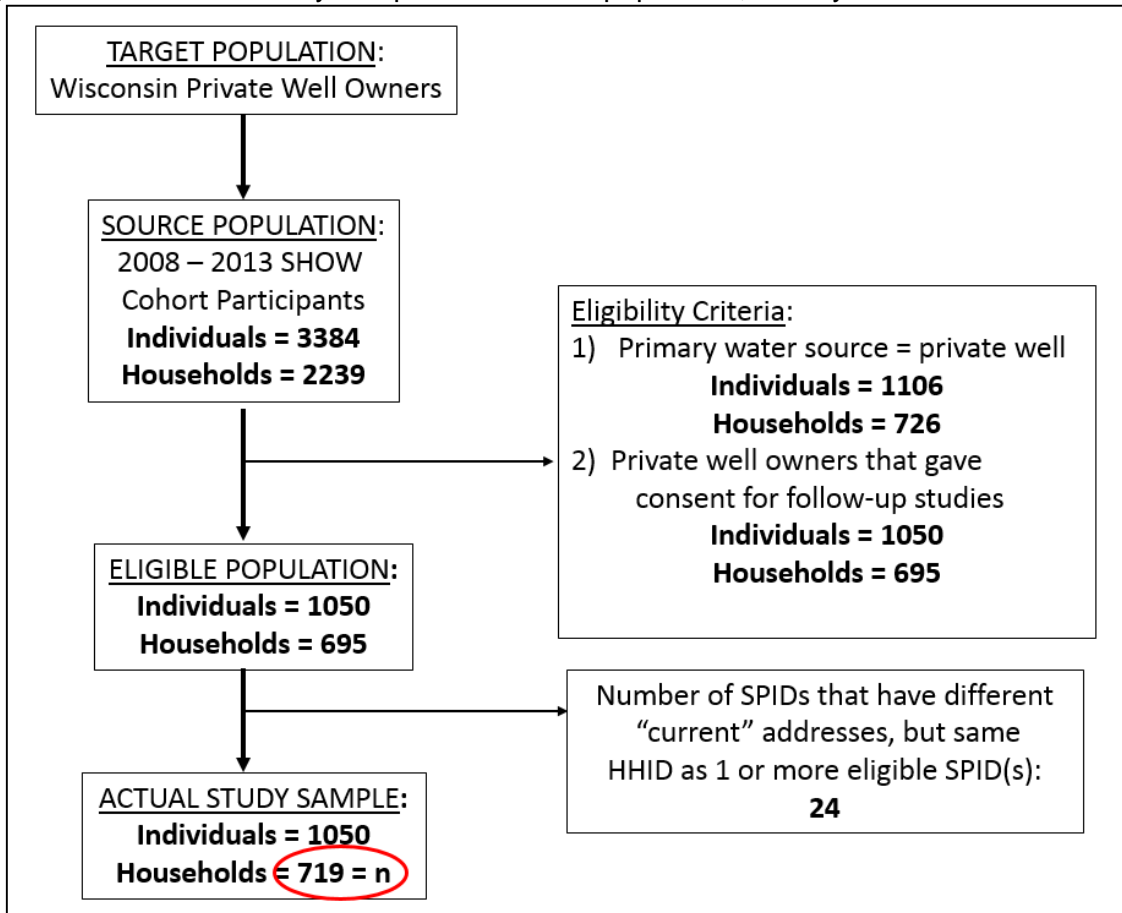
- 1) Prevalence of private well testing and treatment
- 2) Predictors of testing private well water for contaminants, frequency of testing, type and location of testing lab, and lab results
- 3) Predictors of testing private well water for contaminants, frequency of testing, type and location of testing lab, and lab results
- 4) Perceived as well as reported health and contamination issues in private wells
- 5) Perception of quality, taste, and safety of private well water
- 6) Perception and behavior around water treatment and filtration
- 7) Awareness of potential groundwater contaminants and their associated health risks
- 8) Basic demographic information

The overall goals of this project were to gather data to better understand testing and treatment patterns among state residents and improve understanding of barriers to testing and treatment in the general population of private well owners. Data were meant to provide evidence to evaluate existing programs and support future targeted evidence based efforts to protect private well owners from public health risks due to potential ground water contaminants. The protocol and informed consent for SHOW and for this ancillary private well water study were approved by the UW-Madison Health Sciences Institutional Review Board.

Eligible Population

Previous SHOW participants identified as private well-owners at baseline were recruited to participate in the follow-up study if they met the following inclusion criteria: 1) they consented to participate in future follow-up studies; 2) they reported private well water as the individual's main source of household water during initial interview. Exclusion criteria included those individuals who reported having a household water source other than private well and/or those who did not give consent to participate in future studies. The 2008-2013 SHOW cohort consists of a total of 3384 participants, with 1106 participants having reported private well water as the household's main water source. Figure 1 displays the process for deriving the sample population from the target and source populations. Of the private well water participants, 68 individuals did not give consent to be contacted for future SHOW studies, leaving 1050 individuals from 695 households that met the eligibility criteria. Twenty-four eligible individuals had previously lived in the same household with another eligible individual but have since split into different households, increasing the number of eligible households at which to target recruitment to 719.

Figure 1. Derivation of study sample from source population, Survey of the Health of Wisconsin.



Participant Recruitment

Recruitment of participants consisted of 4 attempts:

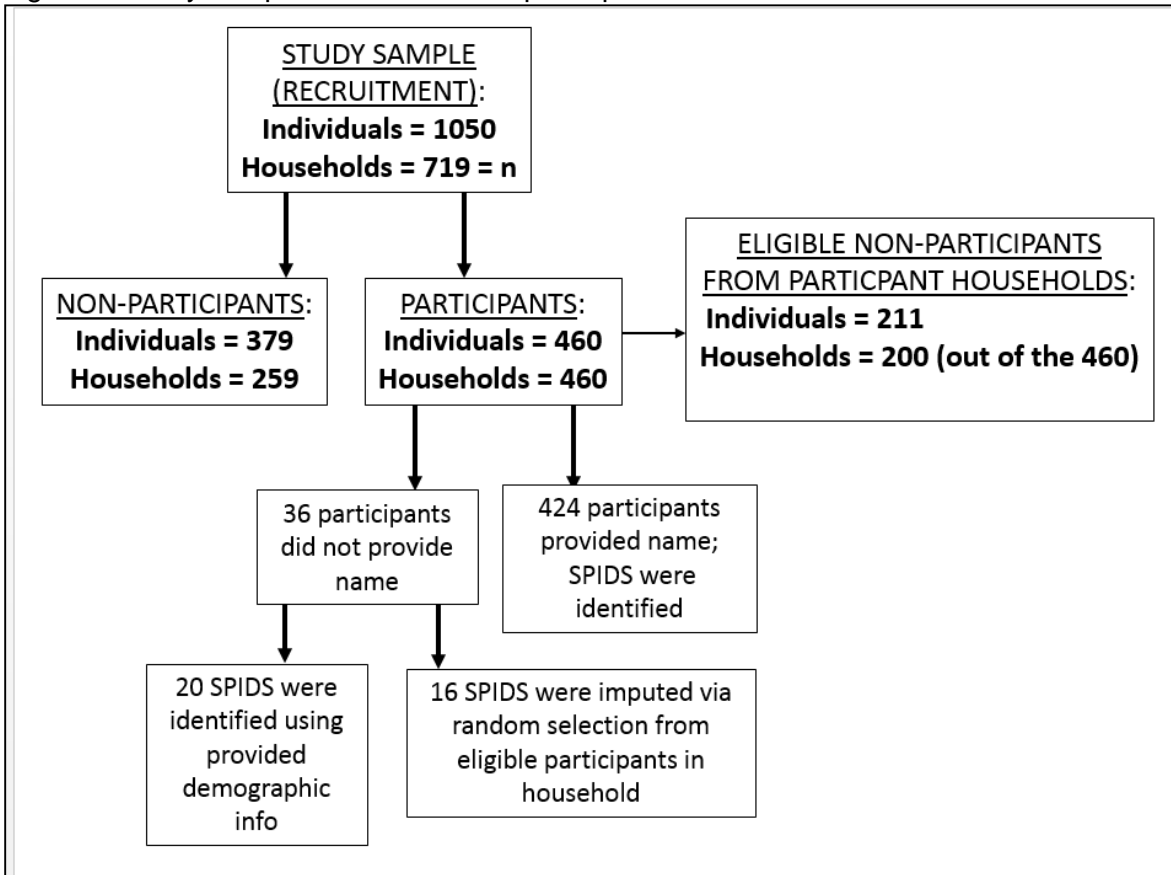
- 1) A letter describing the study and providing a web address to an online survey version, a 50 question paper questionnaire, a stamped return envelope, and a \$2 bill were mailed to eligible households. If more than one eligible participant lived in the same home, only one participant per household was asked to fill out the survey and participate in the study. This individual self-selected themselves.

- 2) Two weeks after the initial mailing, non-responders were mailed a follow-up reminder post-card
- 3) Five weeks after the initial mailing, non-responders were mailed another letter, paper survey, and stamped return envelope
- 4) Seven weeks after the initial mailing, non-responders were contacted via email and/or phone

The overall participation rate was 64% (460 participants out of the 719 total eligible households).

Figure 2 displays the study sample recruitment and participation by household respondents. Of the 460 household respondents, 424 provided their name on their survey and their private well water data were linked to all of their SHOW health data. Because we aimed to use data collected during the baseline survey to support demographic and health risk analyses, we had hoped that all respondents would have provided name and gender in the demographic section of the survey. The majority did, however, thirty-six household respondents did not provide a name on their returned survey and lived at a home containing more than one eligible household respondent. Twenty of the 36 without names were identified via other demographic information (age and gender) provided. For the remaining 16 individual survey respondents who did not provide demographic information on the private well water survey, a household member from the baseline survey among all eligible household respondents was randomly selected and their individual's health and demographic data were linked to the follow-up survey data on well testing and behaviors.

Figure 2. Study sample recruitment and participation.



Sociodemographic information

Baseline data from the initial SHOW survey on health and health determinants were linked to the follow-up survey to explore demographic determinants of testing and treatment. Personal information such as gender, age, race, marital status, household income, level of education, number of children, current hypertension medication use, and current diabetes were self-reported and collected during the baseline in-home interview (phase 1 of data collection). Self-reported smoking status, history of cancer diagnosis, body mass index, and blood pressure were collected during the baseline examination visit (phase 3 of data collection).

Data Analyses

For this report, data on testing and treatment behaviors were summarized according to demographic characteristics. Age was categorized as 21-40, 40-60 and > 60 years of age. Race was assessed as a dichotomous variable (white vs. non-white) due to Wisconsin being a relatively homogeneous population with few non-whites, and still fewer non-whites connected to a private well water source. Household income was categorized into four categories based on the categories used by the SHOW study⁹ (< \$25k, \$25k-\$49,999, \$50k-\$99,999, >\$99,999). Education was categorized into three categories (high school degree or GED, some college or associates degree, Bachelor's degree or higher). Smoking status was self-reported and categorized as current, former, or never. BMI, calculated from measured height and weight, was categorized as less than 25, 25-29.9, and 30 or above.

Residential addresses were verified during the time of the in-home interview. Participants were geocoded using ArcGIS 10.1 in order to determine the urbanicity of participants home, as well as what census block group, county, and health region a participant resides in. Urbanicity was defined as a dichotomous variable derived from the 2010 Census Urban and Rural Classification. Urbanized Areas (50,000 or more people) and Urban Clusters (2,500 to 50,000 people) were classified as "urban." All population, housing, and territory not included within an Urban area or Urban cluster = were classified as "rural." Due to small sample size of private well users living in non-urban areas, Urbanized Areas and Urban Clusters were combined in analysis and classified as Urban (2,500 or more people). Health region are defined by boundaries set by the Wisconsin's Department of Human Services. County-level and census block group level analyses used Census 2010 data. Measure of hypertension is defined as a participant having systolic blood pressure equal to or greater than 140 mm Hg and/or diastolic blood pressure equal to or greater than 90 mm Hg and/or self-report of currently taking anti-hypertensive medication.

Statistical Analysis

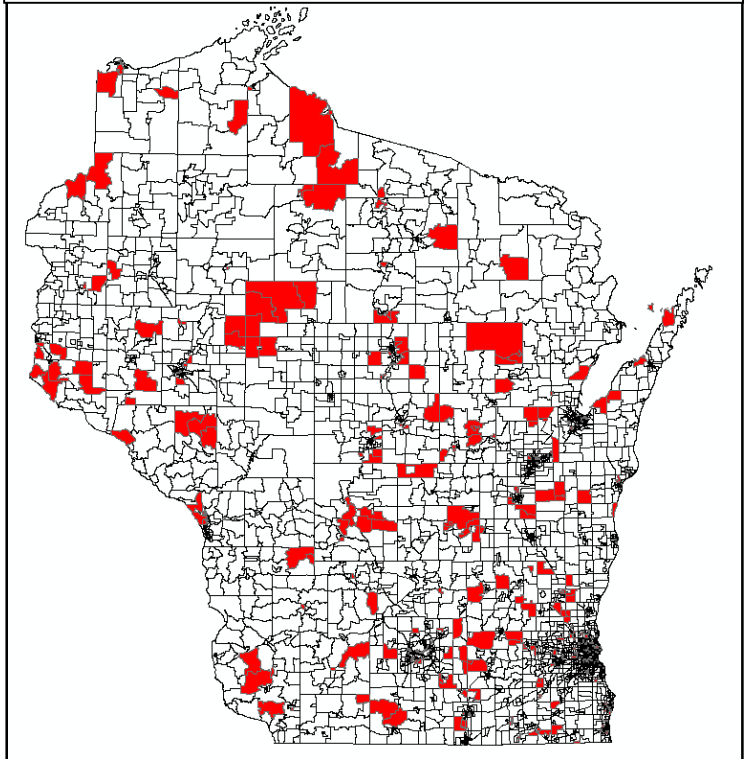
All analyses, which includes frequencies, cross-tabulations, and logistic regression, were conducted in ESRI ArcGIS 10.1 and SAS version 9.3. Unadjusted and adjusted odds were performed to determine the odds of testing or treatment of well water by demographic information as well as by health behaviors and beliefs. Unless specified as an adjusted odds ratio, it is presumed to be unadjusted. If testing and treatment behavior was statistically different by demographic stratum among household respondents when compared to household non-respondents at the $p < 0.05$ level, the demographic variable was controlled for in additional logistic regression models.

Results

Private Well Owners in Wisconsin

The SHOW's sampling frame provides a randomly selected, representative sample of Wisconsin residents who are spatially distributed throughout the state. Figure 3 depicts the 2008-2013 SHOW participants (n = 3,384) by census block groups. Results from the SHOW baseline survey indicated 1/3 of the SHOW participants (n = 1,106) reported a private well as their primary drinking water source compared with 2/3 who indicated they were connected to a community water supply (n = 2,069). Details regarding baseline SHOW participation and proportion of individuals on private well vs. municipal water supplies by demographics are presented in the Appendix - Table A1II. Urbanicity is the greatest predictor of having a private well. 55.9% of the entire SHOW population lives in an urban setting. Among private well owners only 11.7% were classified as living in an urban environment compared to 88% being rural.. Figure 4 displays the spatial differences between individuals on private well water versus community water. The majority of individuals on private well water live in larger block groups in the North and Northwest health regions of the state. As was expected, no residents in the city of Milwaukee indicated being on a private well. Milwaukee reported Overall, those on private well water consist of more Caucasians and married individuals when compared with those on municipal water. The SHOW population on private well water also tend to be older, have less education, and have a higher family income when compared with those on municipal water.

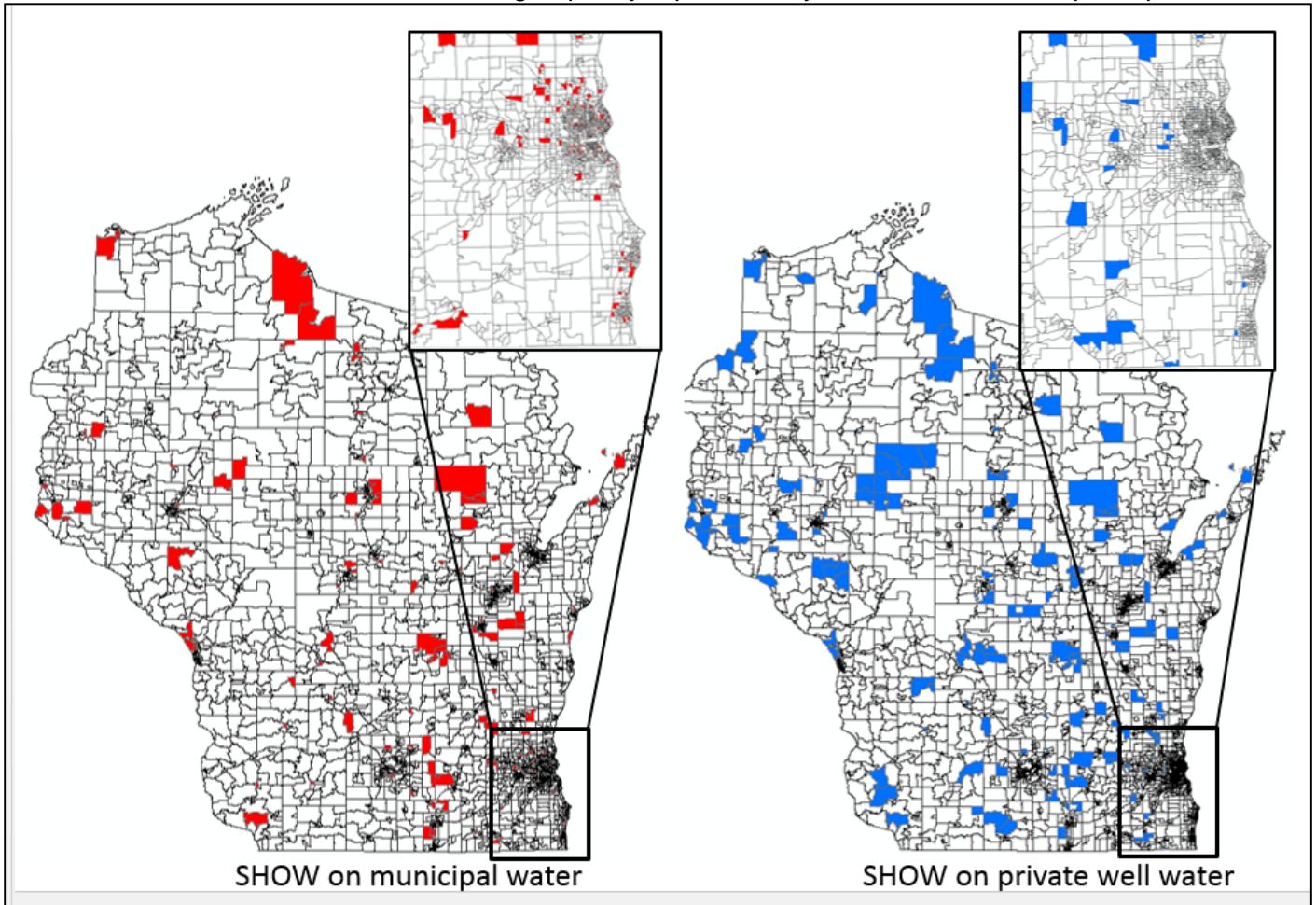
Figure 3. Distribution of all SHOW 2008-2013 participants by census block groups. Each census block group may represent anywhere between 1-29 participants.



Household respondents

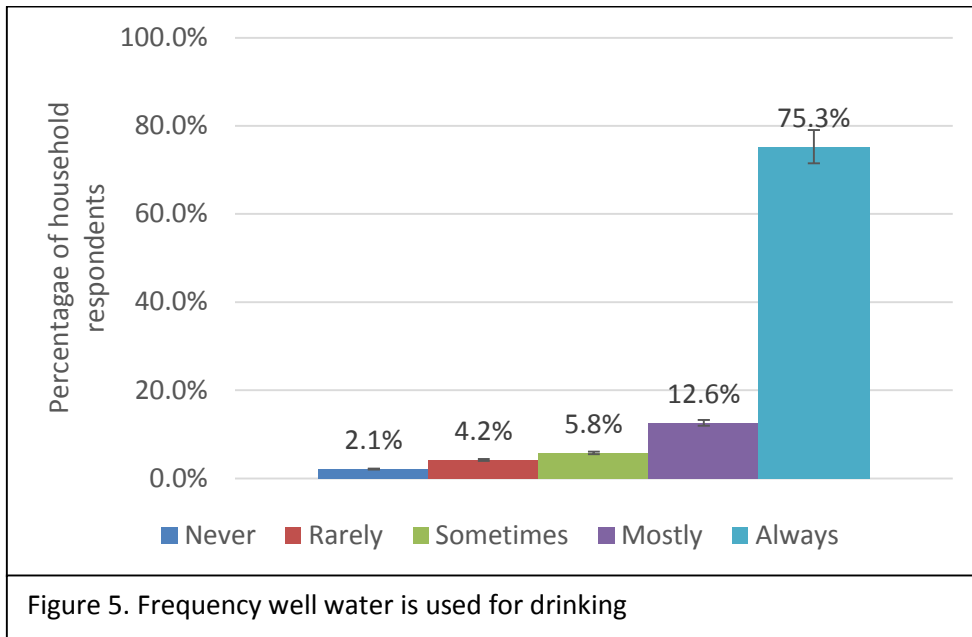
Among those identified as private well owners at baseline, follow-up household response varied according to age, education, income, and health statuses. Household respondents were more likely to be over 60 years of age, having a higher education status, higher family income, and higher BMI. Household respondents were also more likely to be non-smokers. There was no significant geographic difference between household respondents and non-respondents (see Appendix figure A2II). For more details regarding participation see Appendix Table A1III summarizing household participation in the Private Well Water ancillary study by demographic strata.

Figure 4. Distribution of SHOW 2008-2013 participants by census block groups according to what type their home is connected to. Each census block group may represent anywhere between 1-29 participants.



Use of Private Well for Drinking Water

A total of 434 of the 460 household respondents (94.4%) reported currently having a private well that supplies water to the home. The twenty-four household respondents who previously reported being connected to a private well, may have moved or connected to a community water supply since completing the SHOW questionnaire. Among the household respondents on private well water, 75.3% reported always using their well water for drinking.



Testing - Who, How Often, Why and Where

Private vs. Municipal Well-Owners

Table 1 in the appendix shows the distribution of private well owners vs. those served by municipal water supplies comparing total SHOW participants with each sub-group. Private well owners on average tend to live in rural communities, are majority white, and have slightly higher incomes on average. We also looked at differences in prevalence of chronic health conditions and found differences are small. Health indicators indicate a slightly higher percentage of private well owners were overweight, and had hypertension compared to those served by municipal wells. No differences in rates of diabetes or cancer were reported in the study sample

Prevalence and Frequency of Testing

A total of 222 household respondents (51.3%) have tested their well water in the last 10 years. Of those household respondents who reported testing their well in the last 10 years. Less than one-fifth (only 18.8%) have tested their well water within the past 12 months, compared with 40.9 percent between 1 to 5 years ago, and 37.1 percent between 6 to 10 years ago. These findings are consistent with previous estimates from the DNR and DHS that among all private well households in the general population, only about 9-10% of respondents indicate they “regularly” test their wells annually.

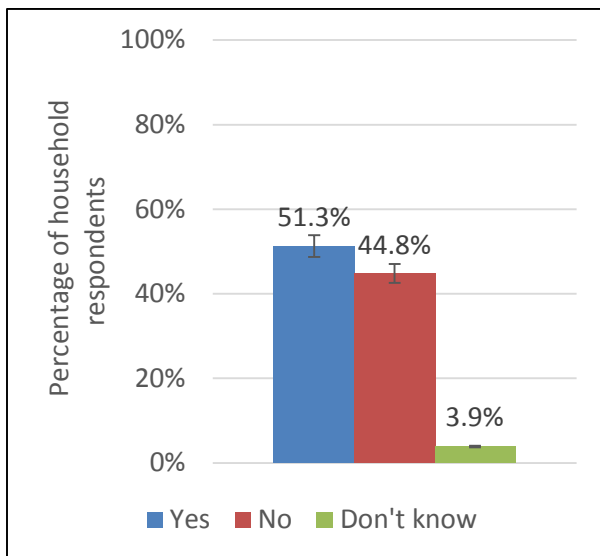


Figure 6. Prevalence of well water testing within the last 10 years.

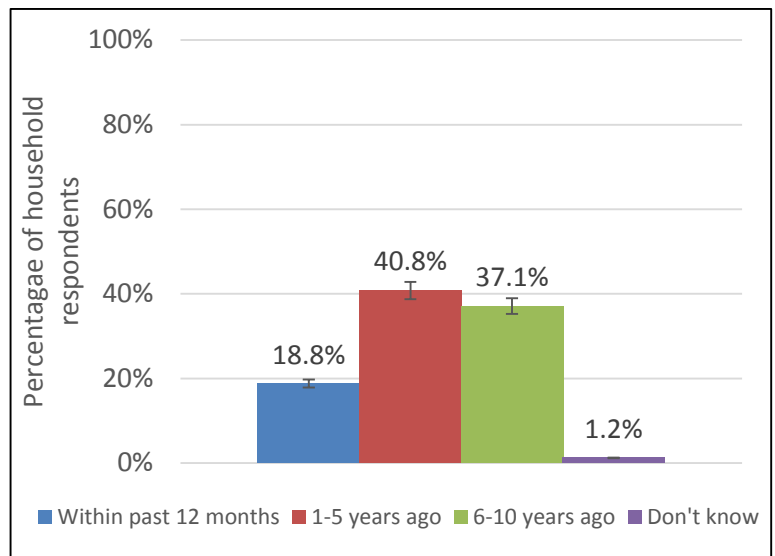


Figure 7. Frequency of time since last test.

Reasons for Testing

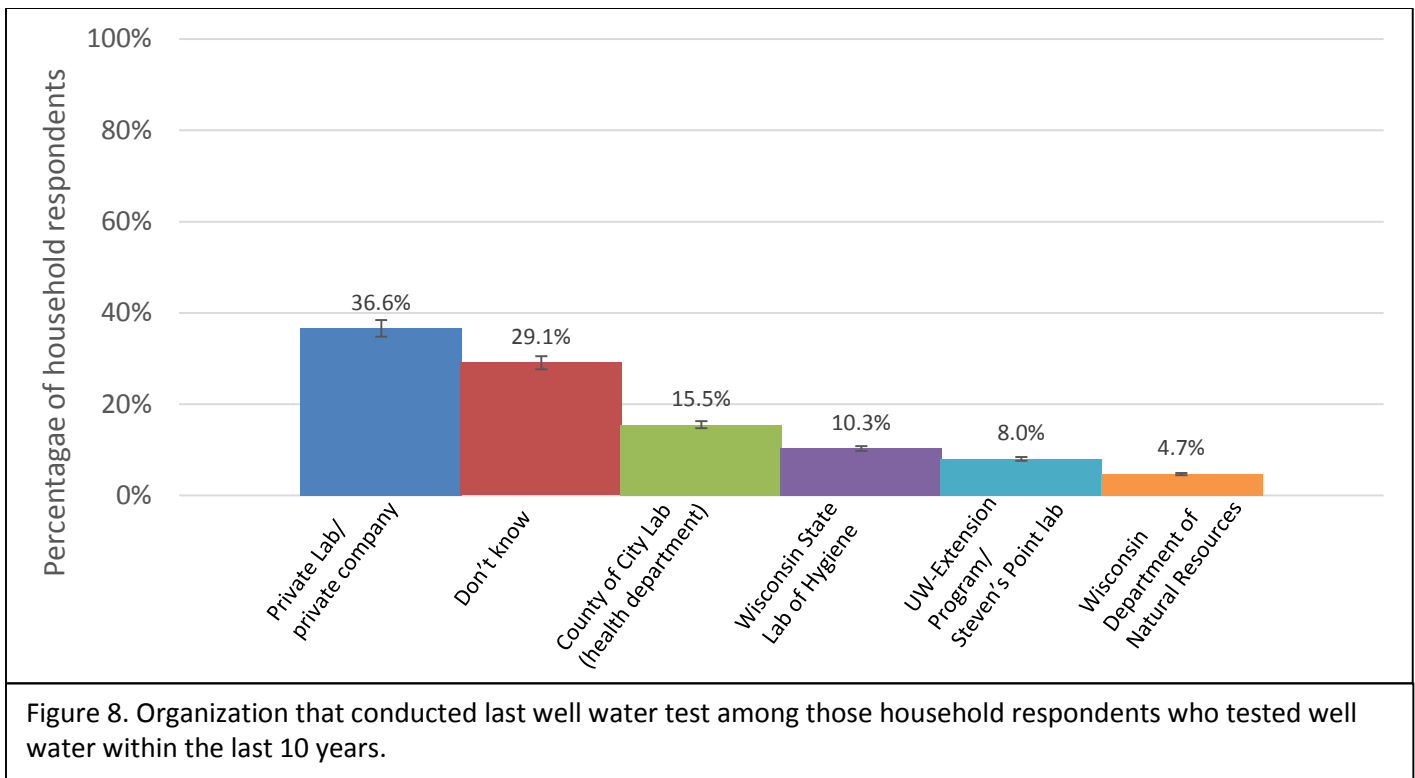
The main reasons household respondents tested their well water was *to know if their well water is safe to drink* (34.1%) and/or *due to a real estate transaction* (19.2%). *A well test program offered in the area* (13.6%) and/or *the presence of children, babies, or pregnant women in the home* (13/6%) were both the third most selected reason for testing well water.

Table 1a. The main reasons household respondents test their water among those who reported testing. *Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.		
Main reasons household respondents tested their water:	n	% (95% CI)
To know if my well water is safe to drink	73	34.1 (27.7-40.5)
Real estate transaction (buying or selling a home)	41	19.2 (75.5-86.2)
A well test program was offered in area	29	13.6 (8.9-18.2)
Children, babies, or pregnant women in home	29	13.6 (8.9-18.2)
I test my water on a regular basis	27	12.6 (8.1-17.1)
Water quality can change from time to time	25	11.7 (7.3-16.0)
Other - Specify	24	11.2 (7.0-15.5)
A new well was constructed	23	10.8 (6.6-14.9)
Testing was needed after our well was repaired	21	9.8 (5.8-13.8)
Well water testing is recommended by state or local agency	19	8.9 (5.0-12.7)
There was a problem (smell, taste, quality) with our well	16	7.5 (3.9-11.0)
A promotional offer from a private company	12	5.6 (2.5-8.7)
Water test needed to inform a decision about treating our well	10	4.7 (1.8-7.5)
I read or heard about a groundwater problem in our area	8	3.7 (1.2-6.3)
Don't know	2	0.9 (0.0-2.2)

Twenty-four household respondents selected “other-specify” as their main reasons for testing their well. Four common trends in “other-specify” responses were identified. *Installation of a new water pump, piping, or tank* (n =4, 1.9%), *occurrence of a natural or man-made disaster* (n =4, 1.9%), *to acquire water softener specification* (n = 4, 1.9%), and/or *concern about contamination from nearby factory or dairy farm* (n = 2, 0.9%) are among “other-specify” responses reported by more than one household respondent.

Table 1b. Main reasons household respondents tested their water – “Other –Specify” response trends.		
“Other –Specify” categorized from Table 1a.	n	%
Other	10	4.7 (1.8-7.5)
Other - new water pump, piping, tank	4	1.9 (0.04-3.7)
Other - natural disaster (ex: flooding) or man-made disaster (ex: gas/oil leak)	4	1.9 (0.04-3.7)
Other - to test for water softener specifications	4	1.9 (0.04-3.7)
Other - concerned about nearby factory farm or dairy farm	2	0.9 (0.0-2.2)

Organization that conducted test



While the majority of household respondents who tested their well water, did so through a private laboratory or private company (36.6%), many did not know what organization tested their well water (29.1%). The remaining household respondents tested through the county or city health department (15.5%), the Wisconsin State Laboratory of Hygiene (10.3%), a UW-extension program (8.0%), or the Wisconsin Department of Natural Resources (4.7%). The number one main reason household respondents had their well water tested remained *to know if my well water is safe* when stratified by the organization where their most recent test occurred (See table A1IX).

Contaminants Tested for, Water Quality Issues Identified, and Actions Taken

Contaminants tested for

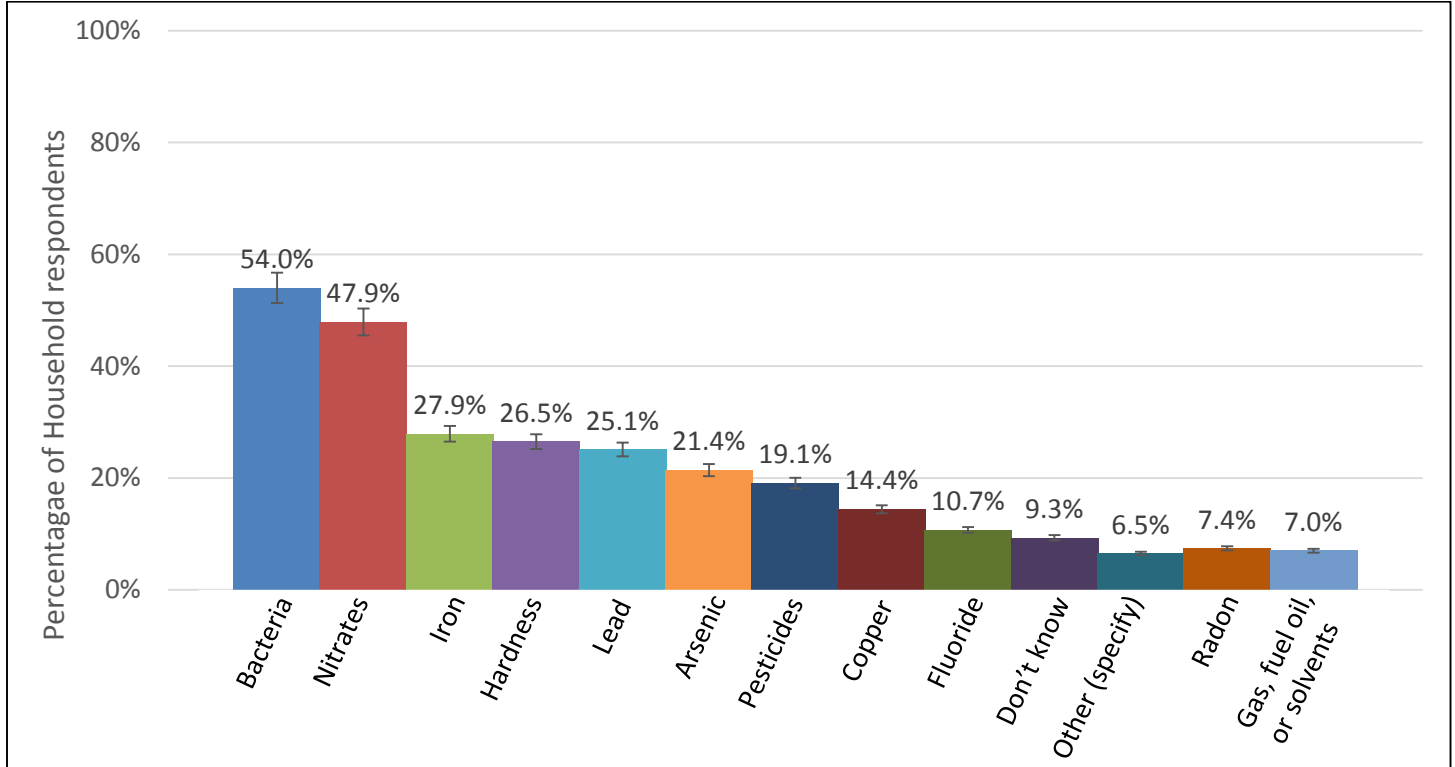


Figure 9. The percent of household respondents who tested for each contaminant type. *Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.

The contaminants most tested for were bacteria (54%) and nitrates (47.9%). Iron (27.9%) and hardness (26.5%), along with lead (25.1%) were tested for by about a quarter of household respondents who test their well. Since some household respondents were likely to select both iron and hardness, the results were analyzed to see how many household respondents selected iron OR hardness. The number of household respondents who selected Iron OR hardness resulted in 74 people (34.4%). Household respondents who selected “other (specify)” reported testing pH and/or alkalinity (n = 3; 1.4%), Magnesium (n =3; 1.4%), conductivity (n =2; 0.9%), and three household respondents listed more than 7 other chemicals and metals they tested for other than the ones listed above, including cadmium, cobalt, aluminum, sulfur, chloride, nickel, zinc, cadmium, calcium, chromium, strontium.

Contamination problems identified

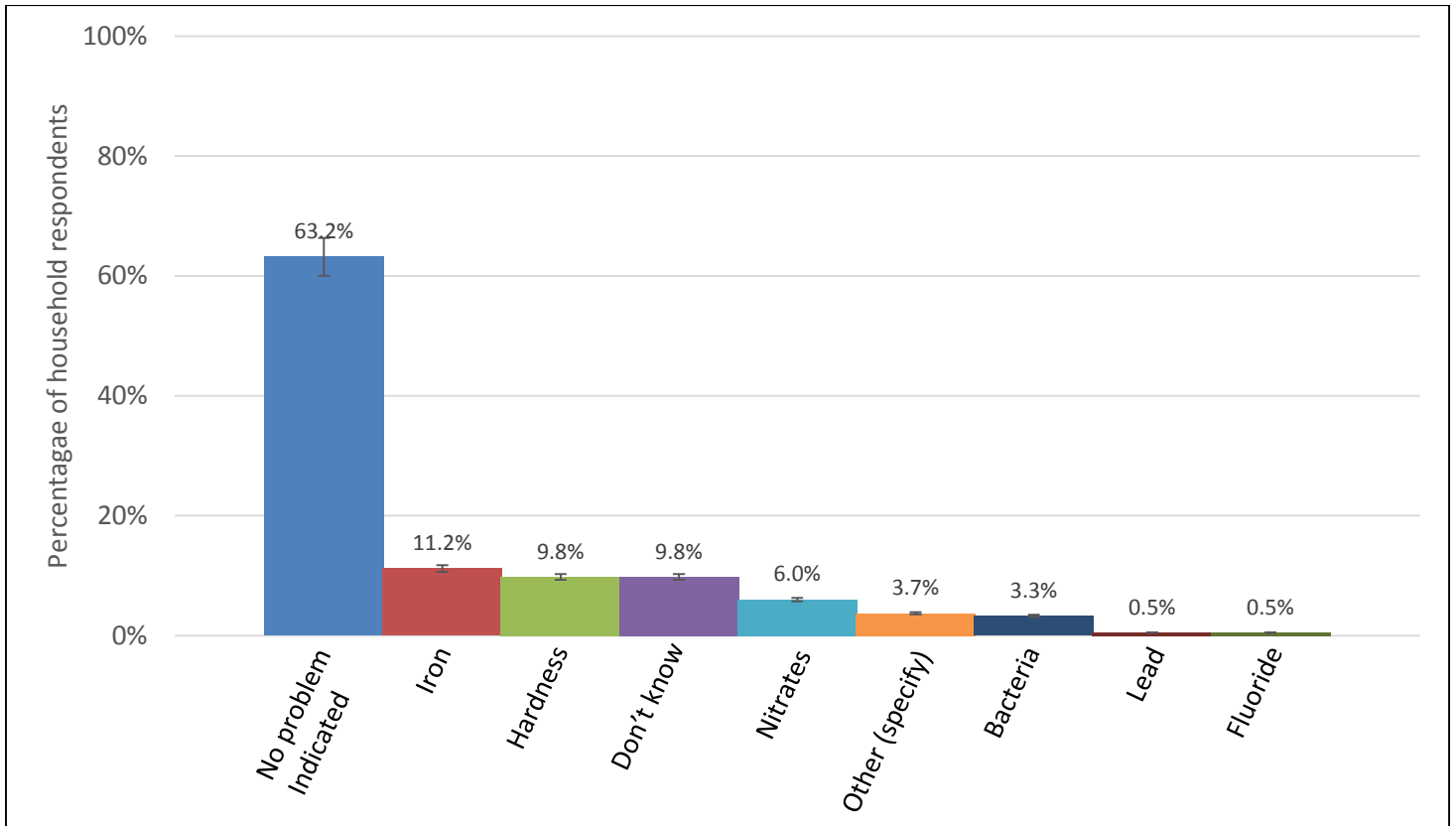


Figure 10. The percent of household respondents whose well water test indicated a problem for each contaminant type. *Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not

Sixty-three percent of household respondents who tested their well reported not having a problem with any contaminant they tested for. However, it is important to note that many household respondents only tested one or two contaminants, and not all of the contaminants options listed. Of the contaminants that indicated a problem from tests, iron (11.2%) and hardness (9.8%) were the ones that most often indicated a problem among household respondents who tested their well water. Since some household respondents were likely to select both iron and hardness, the results were analyzed to see how many household respondents selected iron OR hardness as having a problem (n = 35; 16.7%). Manganese (n = 2; 1.0%), sulfur (n = 2; 1.0%), and aluminum (n=1; 0.5%) were among the “other (specify)” responses. No problems were indicated for Arsenic, Copper, Pesticides, Gasoline, fuel oil, solvents, or Radon.

Actions taken after water was tested

Table 2. Percent of household respondents who took the following actions after well water was tested. **Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.*

Actions taken:	n	% (95% CI)
No action - test results indicated no problem	149	70.6 (64.4-76.8)
Treat, filter, or soften water	49	23.2 (17.5-29.0)
Ensure cap is water tight and vermin-proof	16	7.6 (4.0-11.2)
No action because of other reason – specify:	14	6.6 (3.2-10.0)
Replace or secure the well cap	8	3.8 (1.2-6.4)
Stopped using the well for drinking water	4	1.9 (0.04-3.8)
Did additional water testing	2	1.0 (0.0-2.3)
Contact property owner	2	1.0 (0.0-2.3)
Well sealed to DNR specifications/no longer used	1	0.5 (0.0-1.4)
Divert rain or flood water flow away from the well	1	0.5 (0.0-1.4)
Drilled a new well	1	0.5 (0.0-1.4)
Began to test more frequently/routinely	0	0.0 (0.0-0.0)

Actions Taken Among Those with Water Quality Issues Identified

Most household respondents who tested their well did not indicate having any contamination issues, so it is not surprising that 70.6% of household respondents did not take any action after testing their well. The most common action was treating, filtering, or softening water (23.2%). To a lesser extent, household respondents ensured the well cap is water tight and vermin-proof (7.6%). Among the household respondents who indicated having a contamination problem after testing their well, 74.2 percent took one of the above actions. Roughly a quarter of household respondents whose well water test indicated a problem, did not take any further actions (25.8%).

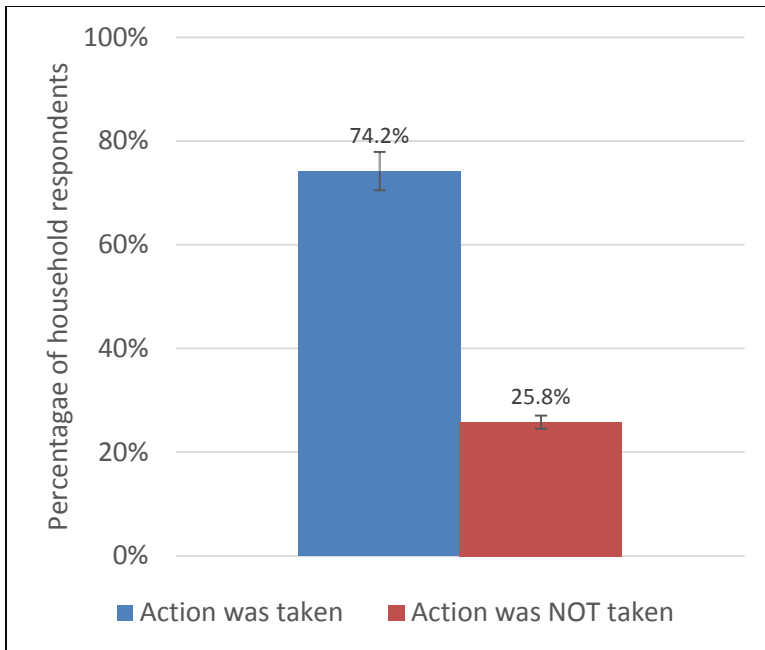


Figure 11. Percentage of household respondents who took action after testing their well among those whose well water test indicated a problem.

Among the 194 household respondents who reported not testing their well water within the last 10 years, 66 percent reported they *have been drinking the well water for years without any problem* and 45.9 percent reported their *water is probably fine* as the top two main reasons household respondents did not test well. In addition, *not having heard of any water quality problems in the area* (39.2%), *not knowing how to test well water* (33.5%), *not knowing what to test for* (27.8%), *not having children, babies, or pregnant women drinking the water* (26.8%), and *treating and/or filtering water so water testing is not needed* (21.1%) were among the other reasons for household respondents not having tested their well water in last 10 years.

Main reasons household respondents did <u>not</u> test their water:	n	% (95% CI)
Have been drinking the well water for years without any problem	128	66.0 (59.3-72.7)
Our water is probably fine	89	45.9 (38.8-53.0)
Others in our area have not had any water quality problems	76	39.2 (32.2-46.1)
I don't know how to have my well water tested	65	33.5 (26.8-40.2)
I don't know what to test for	54	27.8 (21.5-34.2)
There are no children, babies, or pregnant women drinking the water	52	26.8 (20.5-33.1)
We treat and/or filter our water so water testing is not needed	41	21.1 (15.3-26.9)
I did not know testing was available	38	19.6 (14.0-25.2)
It costs too much to have my well water tested	33	17.0 (11.7-22.3)
I did not know it was my responsibility to test the water	20	10.3 (6.0-14.6)
I missed the well testing program offered in our area	20	10.3 (6.0-14.6)
A well water quality problem would be too expensive to fix	16	8.3 (4.3-12.2)
I do not want to know if there is a problem with my well water	10	5.2 (2.0-8.3)
Contamination is a result of urban growth/ land use - not in my control	9	4.6 (1.7-7.6)
We do not drink the well water	6	3.1 (0.6-5.6)

Reasons to test well water in the future

All household respondents were asked to give the top two main reasons that would prompt them to test their well water in the future. *Change in taste, smell, or appearance* of well water would be the number one reason that would prompt household respondents to test their well in the future (49.3%). About 14 percent of household respondents claimed that *learning that my neighbor's well is contaminated* would be the number one reason that would prompt them to test their well water in the future. Household respondents who selected "Other – specify" listed additional reasons including *a nearby CAFO and/or farms where fertilizers/pesticides are used* (n = 3; 0.7%), *General interest in the safety and/or quality of the our water* (n = 3; 0.7%), *Real estate transaction and/or new well or pump* (n = 2; 0.4%), *Regular testing is required due to shared well* (n = 2; 0.4%), *Gas/oil spill nearby* (n = 1; 0.2%).

Table 4a. The first main reason that would prompt household respondents to test their well in the future.

<i>Number one reason to test your well water in the future:</i>	n	% (95% CI)
Change in taste, smell, or appearance	207	49.3 (44.5-54.0)
Learning that my neighbor's well is contaminated	57	13.6 (10.3-16.9)
Unexplained health problems	26	6.2 (3.9-8.5)
Learning some wells in my town are contaminated	22	5.2 (3.1-7.4)
State and/or local authorities advise that wells in my area should	22	5.2 (3.1-7.4)
Testing price is reduced or free	20	4.8 (2.7-6.8)
Knowing there is going to be a well test program in our town	19	4.5 (2.5-6.5)
Other – Specify:	12	2.9 (1.3-4.5)
None of the above	11	2.6 (1.1-4.2)
A baby or a child living in, or visiting, my home	9	2.1 (0.8-3.5)
A health care provider advises that I test my well water	9	2.1 (0.8-3.5)
Getting a reminder to test my well water	6	1.5 (0.3-2.6)

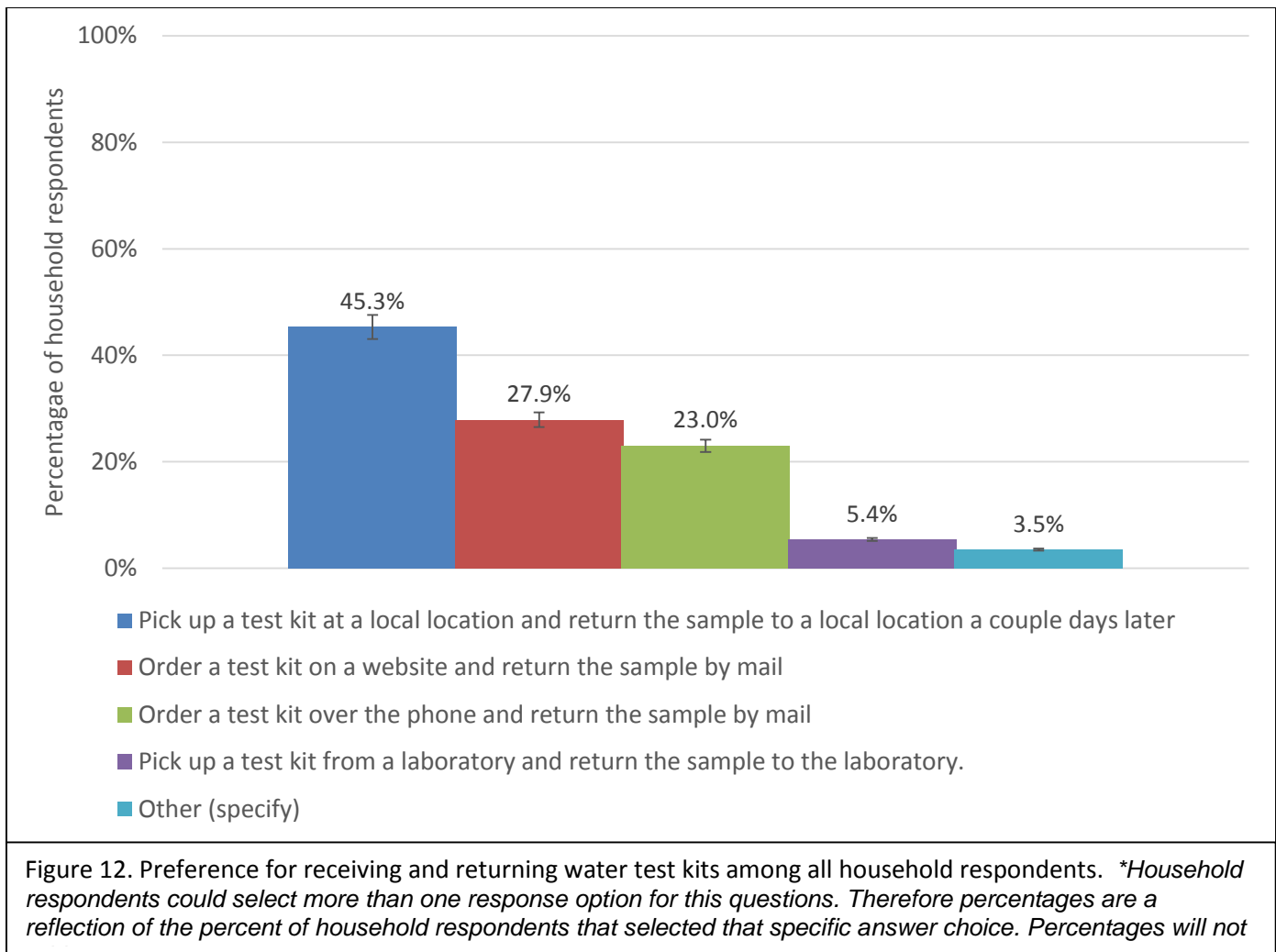
The most selected number two reasons that would prompt household respondents to test their well in the future were similar to those selected for the number one reasons. Twenty-four percent reported *Learning that my neighbor's well is contaminated* to be the number two reason to test their well water in the future. Additionally, *Change in taste, smell, or appearance* (16%) and *testing price is reduced or free* (16%) were among the top number two reasons.

Table 4b. The second main reason that would prompt household respondents to test their well in the future.

<i>Number two reason to test your well water in the future:</i>	n	% (95% CI)
Learning that my neighbor's well is contaminated	75	24 (19.2-28.7)
Change in taste, smell, or appearance	50	16 (11.9-20.0)
Testing price is reduced or free	50	16 (11.9-20.0)
Learning some wells in my town are contaminated	40	12.8 (9.1-16.5)
Knowing a well test program will be in town	35	11.2 (7.7-14.7)
Unexplained health problems	34	10.9 (7.4-14.3)
A health care provider advises that I test my well water	14	4.5 (2.2-6.8)
Getting a reminder to test my well water	9	2.8 (1.0-4.7)
A baby or a child living in, or visiting, my home	6	1.8 (0.4-3.4)

Convenience of Testing as a Potential Barrier

Water test kit preferences



Almost half of all household respondents prefer to pick up a water test kit at a local location and return the sample to a local location a couple days later (45.3%). Ordering a test kit on a website (27.9%) or over the phone (23.0%) and returning by mail were the two next most favorable options. Picking up a test kit from a laboratory and returning the sample to the laboratory was least favorable (5.4%). There were no common answers among the “Other (specify)” responses.

Knowledge as a Potential Barrier

Information to make decisions about testing

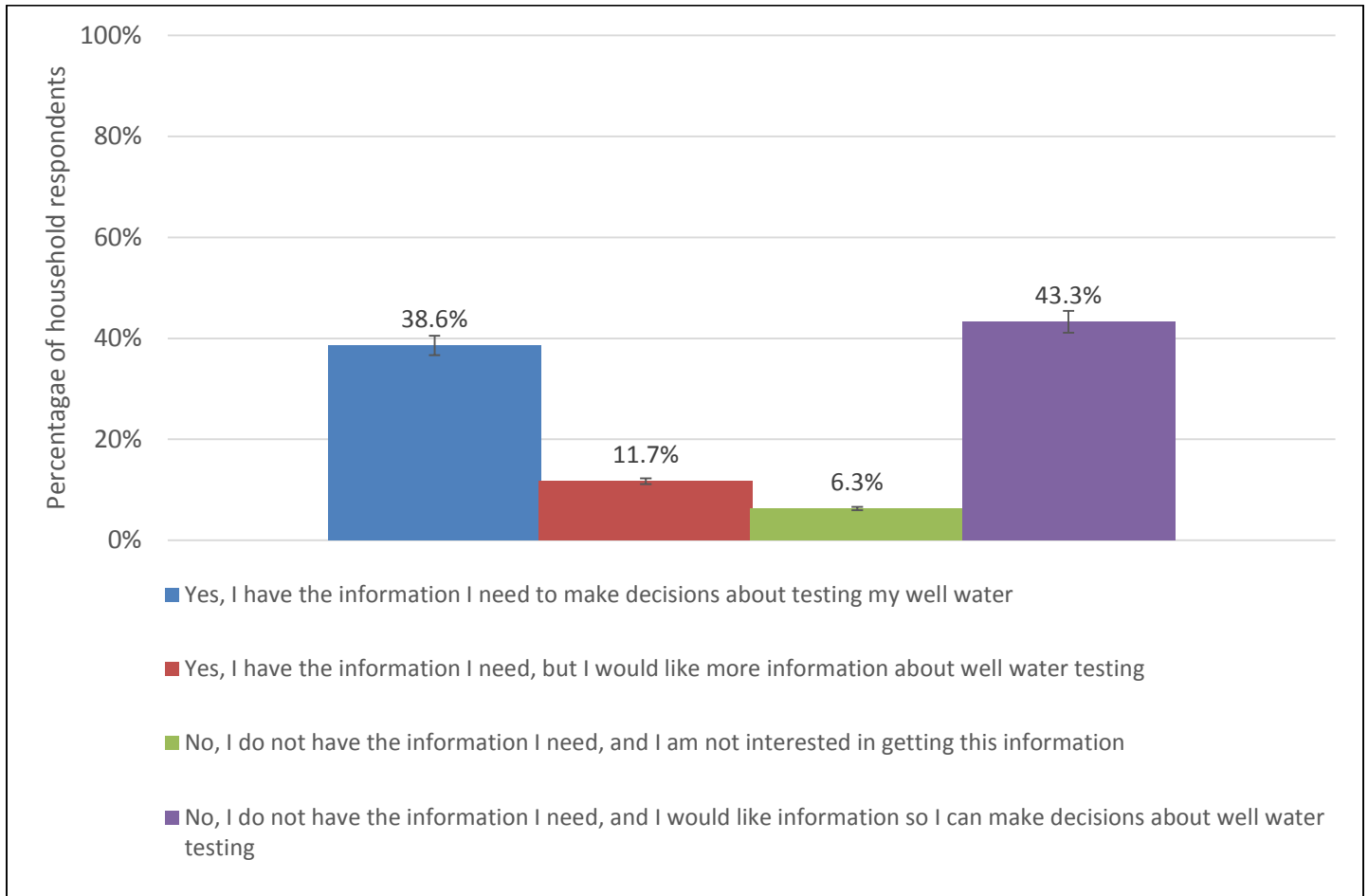


Figure 13. Percentage of household respondents who claim to have, or not have, the information they need to make decisions about well water testing.

Forty-three percent of household respondents claim that they do not have the information they need to make decisions about the well water testing, and would like information. This is compared with only 6.3% who claim they do not have the information they need, but are not interested in getting any information. Thirty-nine percent of household respondents have the information, compared with 11.7% who also have the information they need but would still like more information.

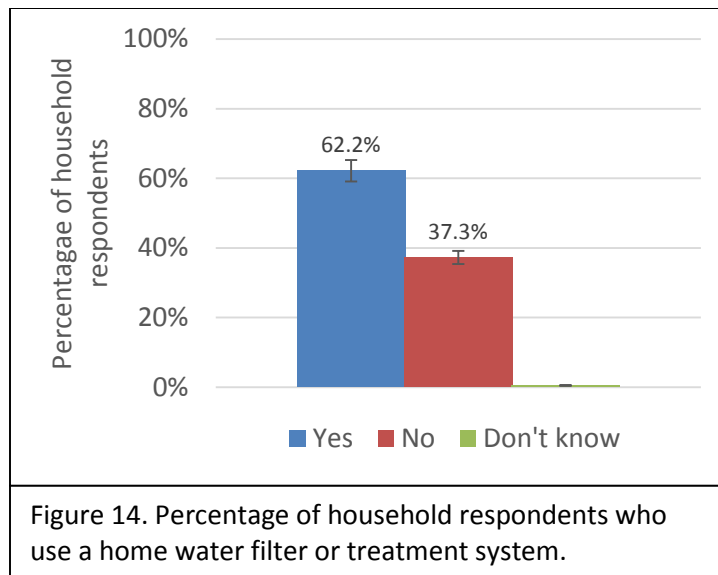
Knowledge as a Predictor of Testing

Table 5. Percent of household respondents who tested their well water in the last 10 years stratified by the information they about testing they claim to have.				
	HAD WELL WATER TESTED BY LAB IN LAST 10 YEARS:			
	Yes		No	
YOU HAVE THE INFORMATION YOU NEED TO MAKE DECISIONS ABOUT TESTING WELL WATER:	n	% (95% CI)	n	% (95% CI)
Yes, I have the information I need to make decisions about testing my well water	119	73.9 (67.1-80.7)	42	26.1 (19.3-32.9)
Yes, I have the information I need, but I would like more information about well water testing	36	72 (59.5-84.5)	14	28 (15.5-40.5)
No, I do not have the information I need, and I am not interested in getting this information	11	44.0 (24.5-63.5)	14	56.0 (36.5-75.5)
No, I do not have the information I need, and I would like information so I can make decisions about well water testing	54	31.2 (24.3-38.1)	119	68.8 (61.9-75.7)

Having information does make a difference in testing behaviors among private well-owners. Among the household respondents who indicated they had the information they needed to make decisions about testing their well water, a little more than seventy percent tested their well in the last 10 years, compared to only 30% of those indicated they did not have the information they needed. This holds true among those who have the information they need, but would still like more as well. Among those household respondents who claim they do not have the information they need, but would like more, 65% did not test their well in the last 10 years.

Treatment Prevalence and Type of Treatment

Treatment Prevalence



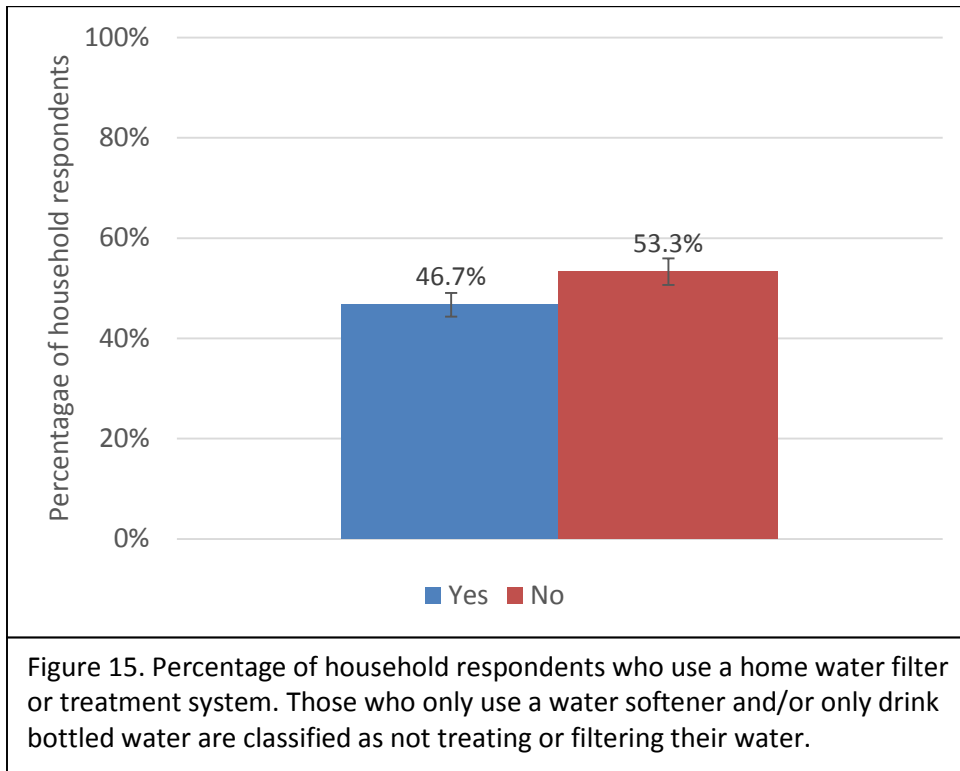
Household respondents were asked whether they use a home water filter or treatment system, such as an aerator, Brita filter, carbon filter, water softener, refrigeration filtration, distillation, reverse osmosis, or other filtration system. Over 62% of household respondents reported using some water treatment device including a home water filter or treatment system, while 37% do not.

Treatment/filtration system used

Table 6. Treatment or filter type used on well water among household participants who reported treating and/or filtering their water. *Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.		
Treatment/filter type:	n	% (95% CI)
Water Softener	193	42.0 (37.4-46.5)
Refrigeration system	86	18.7 (15.1-22.3)
Carbon filter	62	13.5 (10.3-16.6)
Pitcher-type water filter	37	8.0 (5.5-10.5)
Absorbent media (Iron-oxide filter)	31	6.7 (4.4-9.0)
Reverse osmosis	30	6.5 (4.3-8.8)
Drink only bottled water	22	4.8 (2.8-6.7)
Don't know	15	3.2 (1.6-4.9)
Other (specify): (all other responses)	12	2.6 (1.1-4.1)
Distillation	6	1.3 (0.2-2.3)
Other (specify): Sediment filter	4	0.9 (0.0-1.7)
Other (specify): Culligan Water	2	0.4 (0.0-1.0)
Other (specify): Micronizer/Aerator	2	0.4 (0.0-1.0)

A little less than half of household respondents who treat their well water (n = 265) use a water softener (42%). Refrigeration was the second most commonly used water treatment system (18.7%), followed by a carbon filter

(13.5%). Only 5% of household respondents drink only bottled water. Reverse osmosis and Absorbent media (iron-oxide) filters designed specifically to treat household water supplies for chemical contamination were reported as being used in approximately 5% and 7% of households respectively.



Since an aim of this study was to better understand vulnerability among private well owners, prevalence of treatment excluding water softeners or bottled water was calculated. Water softeners work to combat hardness and while they do filter some chemical contaminants, they were not designed to offer protection against a majority of contaminants of concern. After re-classification, the proportion of household respondents who treat and/or filter their water dropped from 62% to 47%.

Motivation and Barriers to Treatment

Reasons to treat and/or filter

Table 7a. The main reasons household respondents treat and/or filter their water among those who reported treating and/or filtering their well water. *Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.		
Reasons you filter or treat water:	n	%
Hardness or iron in the water	197	73.2 (68.0-78.6)
I believe it is healthier and safer	98	36.4 (30.6-42.2)
Tastes and/or smells better	88	32.7 (27.1-38.4)
Other - specify	46	17.1 (12.6-21.6)
Heard/read filtration and treatment can minimize health problems	20	7.4 (4.3-10.6)
Children, babies, and/or pregnant women in the home	16	6.0 (3.1-8.8)
Other people in the area filter or treat their water	16	6.0 (3.1-8.8)
change in the quality of the well water	11	4.1 (1.7-6.5)
Well tested and contaminants were found	11	4.1 (1.7-6.5)
Heard/know of contamination problems in our area	6	2.2 (0.5-4.0)
Health problems such as diarrhea were occurring in the home	1	0.4 (0.0-1.1)

Similar to findings regarding treatment type, the main reason household respondents filtered or treated their well water was due to *hardness or iron in the water* (73.2%). Only a little over one-third of household respondents filter or treat their well water because they *believe it is healthier and safer* (36.4%) and/or because it *tastes and/or smells better* (32.7%). Nearly half of all “other-specify” reasons household respondents filter and/or treat their water is because the filter system came with the refrigerator and/or came with their home (n = 20; 7.4%). Other reasons household respondents treat or filter their water include sand, sediment, or pipe build-up (n = 11; 4.1%) and the benefit of the treatment/filtration system keeping water cold (n = 4; 1.5%).

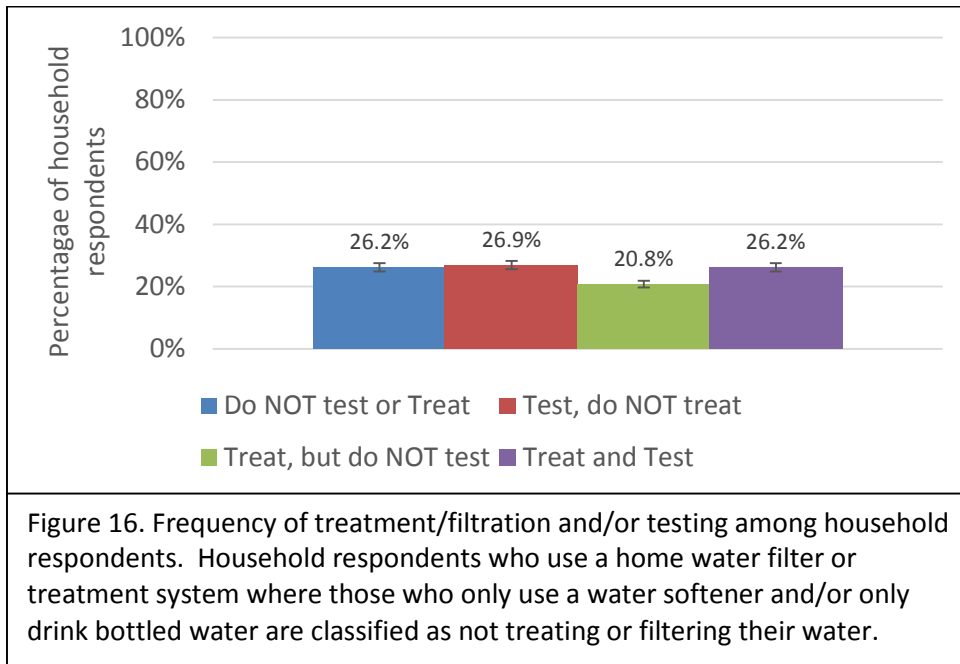
Reasons for not treating or filtering

Table 7b. The main reasons household respondents do not treat/filter their water among those who reported not treating and/or filtering their well water. **Household respondents could select more than one response option for this questions. Therefore percentages are a reflection of the percent of household respondents that selected that specific answer choice. Percentages will not add up 100.*

<i>Reasons you do NOT filter or treat water:</i>	n	%
Our water does not smell or taste bad	119	77.8 (71.1-84.4)
We have been drinking this water for years without any problems	118	77.1 (70.4-83.9)
Our water is safe to drink and/or use as is	107	69.9 (62.6-77.3)
Our water looks clean	104	68.0 (60.5-75.5)
It costs too much to filter or treat	23	15.0 (9.3-20.8)
Other – specify:	12	7.9 (3.6-12.2)
We do not have enough information about the subject	12	7.9 (3.6-12.2)
We do not drink the well water	5	3.3 (0.4-6.1)
We did not know filtering or treating our water were options	1	0.7 (0.0-1.9)
Don't know	1	0.7 (0.0-1.9)

Among household respondents who do not treat and/or filter their well water, more than three-quarters of do not treat and/or filter because *Our water does not smell or taste bad* (77.8%) and/or *We have been drinking this water for years without any problems* (77.1%). Additionally, about 70 percent of household respondents selected *Our water is safe to drink and/or use as is* (69.9%) and/or *Our water looks clean* (68.0%) as main reasons for not treating or filtering their well water. Only 15 percent considered cost to be a determining factor preventing them from treating and/or filtering their well water.

Treatment and Testing Patterns and Behaviors



About a quarter of household respondents test and treat/filter their well water (26.2%). However, an equal number of household respondents do not test nor treat/filter their well water (26.2%). Twenty-seven percent of household respondents test, but do not treat/filter, compared with twenty-one percent who treat/filter their well water but do not test it.

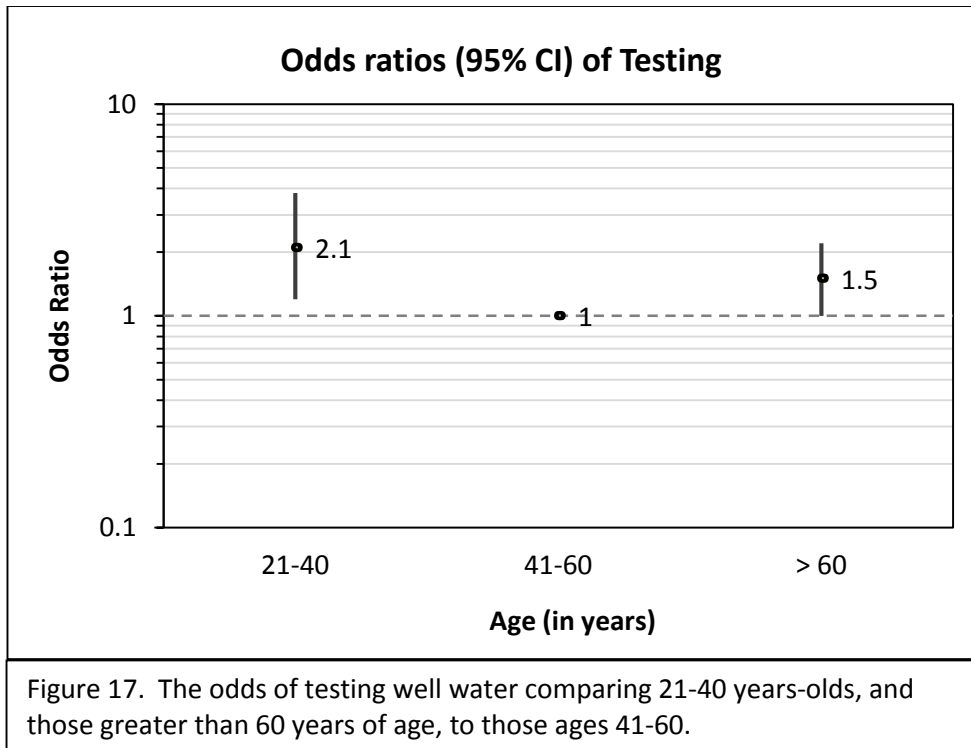
Predictors of Testing and Treatment

Demographic Predictors of Testing

Among private well owners, females, non-smokers, those with a higher family income, and those with more children in the home are more likely to test their well water. However, when comparing those who test to those who do not, age and health region are the only statistically significant demographic indicator that predict testing behavior. More details on demographic predictors of testing can be found in the appendix Table A1X.

To estimate statistically significant differences in testing odds ratios were calculated and can be interpreted as increased odds of testing vs. not testing comparing different demographic groups. Household respondents age 21-40 have 2.1 greater odds and respondents older than 60 have 1.5 greater odds of testing compared to household respondent ages 41-60 (see Figure 17). When compared to household respondents in the southeast health region, those in the south region are 2.4 increased odds of testing their well water. In fact, all other health regions are more likely to test their well water when compared to the southeast health region, however, the difference is not statistically significant for the other health regions. Hypertension, diabetes, and cancer (any type) were not predictive of testing behavior, nor were differences seen in health conditions when comparing those who test with those who do not test with their well water. A cumulative chronic conditions score was calculated by summing the number of chronic conditions a household respondent has. Chronic conditions include heart attack/myocardial infarction, stroke, cancer, diabetes, hypertension, obesity (BMI > 30), osteoarthritis, depression, high cholesterol, and respiratory disease. All of these conditions were collected via self-report during the SHOW survey, except BMI, which was calculated via measured weight and height. Logistic regression analysis was used to assess whether the number of total chronic health conditions was associated with testing behavior. No significant associations were shown (results are not shown).

Table 8. Individual characteristics as predictors of testing and treatment among private well owners		
Individual Demographics	Testing	
	% who test (Row %)	OR (95% CI)
Gender		
Male	49.5	(ref)
Female	56.5	1.3 (0.9-2.0)
Age		
21-40	65.6	2.1 (1.2-3.8)
41-60	47.4	(ref)
> 60	56.8	1.5 (1.0-2.2)
Family Income		
< \$25,000	45.3	(ref)
\$25,000 - \$49,999	53.0	1.4 (0.7-2.7)
\$50,000 - \$99,999	53.7	1.4 (0.8-2.6)
>\$99,999	54.7	1.5 (0.7-2.9)
Education status		
H.S./GED or less	57.8	1.5 (0.9-2.5)
some college	47.1	(ref)
Bachelors or higher	56.5	1.5 (0.9-2.3)
BMI^a		
< 25	56.6	1.1 (0.7-1.8)
>=25 and < 30	49.6	0.8 (0.5-1.3)
>= 30	53.9	(ref)
Smoking Status		
Current	45.1	(ref)
Former	51.0	1.3 (0.7-2.4)
Never	56.0	1.5 (0.8-2.9)
# of Children ≤ 20 yrs		
0	52.1	(ref)
1 or 2	55.8	1.2 (0.6-2.3)
3 or more	59.0	1.3 (0.5-3.3)
Health Region		
Southeast	44.8	(ref)
South	66.2	2.4 (1.2-4.8)
West	48.1	1.1 (0.6-2.2)
North	53.0	1.4 (0.7-2.6)
Northeast	58.2	1.5 (0.8-2.8)



Predictors of NOT testing

Household respondents who do not test their well were asked to identify the main reasons why they do not test (see table 3). Household respondents who selected *I don't know what to test for, I don't know how to have my well water tested, I did not know it was my responsibility to test the water, and/or I did not know testing is available* were compared with all other participants by demographic stratum in order to identify any differences among those who claim to not have the information or knowledge needed to test their well. Age and gender were the only demographic variables where statistically significant differences are seen. Males and household participants ages 41-60 appear to have less information about testing and were more likely to list *I don't know what to test for, I don't know how to have my well water tested, I did not know it was my responsibility to test the water, and/or I did not know testing is available* as a main reason for not testing.

	^a Don't know what to test for, how to have water tested, that testing is my responsibility and/or that testing is available						Significance
	Selected			All other participants			p-value
	n	% (Column %)	95% CI	n	% (Column %)	95% CI	
Gender							0.0454
Male	94	48.5	(41.4-55.5)	104	39.1	(33.2-45.0)	
Female	100	51.5	(44.5-58.6)	162	60.9	(55.0-66.8)	
Age group							0.025
21-40	22	11.4	(6.8-15.8)	51	19.2	(14.4-23.9)	
41-60	112	57.7	(50.7-64.7)	124	46.6	(40.6-52.7)	
> 60	60	30.9	(24.4-37.5)	91	34.2	(28.5-39.9)	
Marital status							0.83
Married/with partner	144	80	(74.1-85.9)	205	82	(77.2-86.8)	
Single (divorced/widowed)	32	17.8	(12.1-23.4)	39	15.6	(11.1-20.1)	
Never Married	4	2.2	(0.05-4.4)	6	2.4	(0.5-4.3)	
Education							0.18
H.S./GED or less	46	23.7	(17.7-29.7)	75	28.2	(22.8-33.6)	
some college	81	41.8	(34.8-48.8)	89	33.5	(27.8-39.2)	
Bachelors or higher	67	34.5	(27.8-41.3)	102	28.3	(22.5-34.2)	
Income							0.77
< \$25,000	29	15.3	(10.1-20.4)	30	11.9	(7.9-15.9)	
\$25,000 - \$49,999	47	24.7	(18.5-30.9)	66	26.2	(20.7-31.7)	
\$50,000 - \$99,999	74	38.9	(31.9-45.9)	99	39.3	(33.2-45.4)	
> \$99,999	40	21.1	(15.2-26.9)	57	22.6	(17.4-27.8)	
BMI							0.68
< 25	57	29.4	(22.9-35.8)	85	32	(26.3-37.6)	
>=25 and < 30	66	34	(27.3-40.7)	77	28.9	(23.5-34.4)	
>= 30	71	36.6	(29.8-43.4)	104	39.1	(33.2-45.0)	
Smoking Status							0.62
Current	29	15.5	(10.3-20.7)	31	12.4	(8.3-16.6)	
Former	70	37.4	(30.4-44.4)	88	35.3	(29.4-41.3)	
Never	88	47.1	(39.8-54.3)	130	52.3	(46.0-58.5)	
Urbanicity^b							0.49
Urban Areas/urban clusters	168	86.6	(81.8-91.4)	226	85	(80.6-89.3)	
Rural	26	13.4	(8.6-18.2)	40	15	(10.7-19.4)	
Children							0.89
0	57	67	(56.9-77.3)	73	64	(55.1-73.0)	
1 or 2	19	22.4	(13.3-31.4)	27	23.7	(15.8-31.6)	
3 or more	9	10.6	(3.9-17.3)	14	12.3	(5.8-19.6)	
Health Region							0.13
Southeast	37	19.1	(13.5-24.6)	40	15	(10.7-19.4)	
South	23	11.9	(7.3-16.4)	53	19.9	(15.1-24.8)	
West	41	21.1	(15.3-26.9)	44	15.6	(12.0-21.0)	
North	47	24.2	(18.1-30.3)	60	22.6	(17.5-27.6)	
Northeast	46	23.7	(17.7-29.7)	69	25.9	(20.6-31.2)	

^aThe three response options were grouped due to small number of respondents so that a household respondent was included if he/she answered yes to any one or more of the three responses; ^bUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010

The private well water survey contained an optional section where household respondents could write any questions or suggestions they have regarding well water testing (results may be seen in tables A1VII & A1IIX). Majority of questions pertained to seeking more information about testing. There were four categories of questions where respondents are seeking more information regarding testing. Adjusted odds ratios were calculated to investigate whether the odds of not testing was greater among those reaching out and seeking more information. Respondents who provided questions on their survey seeking more information about testing were 2.17 times more likely to have not tested their well water in the last ten years. This indicates that a lack of awareness and knowledge may be a barrier to testing.

Additionally, a large number of respondents who provided suggestions on their survey desired testing to be more convenient and local, and for a local venue to provide additional information. Adjusted odds ratios were calculate to investigate whether of the odds of not testing was greater among those who suggest testing be more local and convenient. Respondents who provided suggestions on their survey seeking more convenient and local testing had 1.87 greater odds or were 87% more likely to not test their well. This indicates that a lack of convenience and availability locally may be barriers to testing.

Table 10. Odds of not testing well water regarding questions and suggestions household respondents included pertaining to testing.		
	% who wrote statement	Odds of NOT Testing
Household respondent listed one or more of the following <i>questions</i> regarding testing:	%	Adjusted OR^a (95% CI)
[5] I would like to know what the best test is, how often to test, what the cost is, and/or where to test my water	9.8	2.17 (1.1-4.2)
[6] I Would like to know if free water testing is possible and where to go		
[7] I would like to know if I should get my water tested even if it has no problems		
[8] I would like more information (and/or recommendations) or additional information from what I can find online		
Household respondent had one or more of the following <i>suggestions</i> regarding testing:		
[6] Make testing convenient & local (Provide local pick-up and drop-off at the township or county level - at least once a year)	12.6	1.87 (1.0-3.4)
[7] Provide local venues of information, local informational class, information in newspaper, and/or community involvement		
^a Adjusted for age		

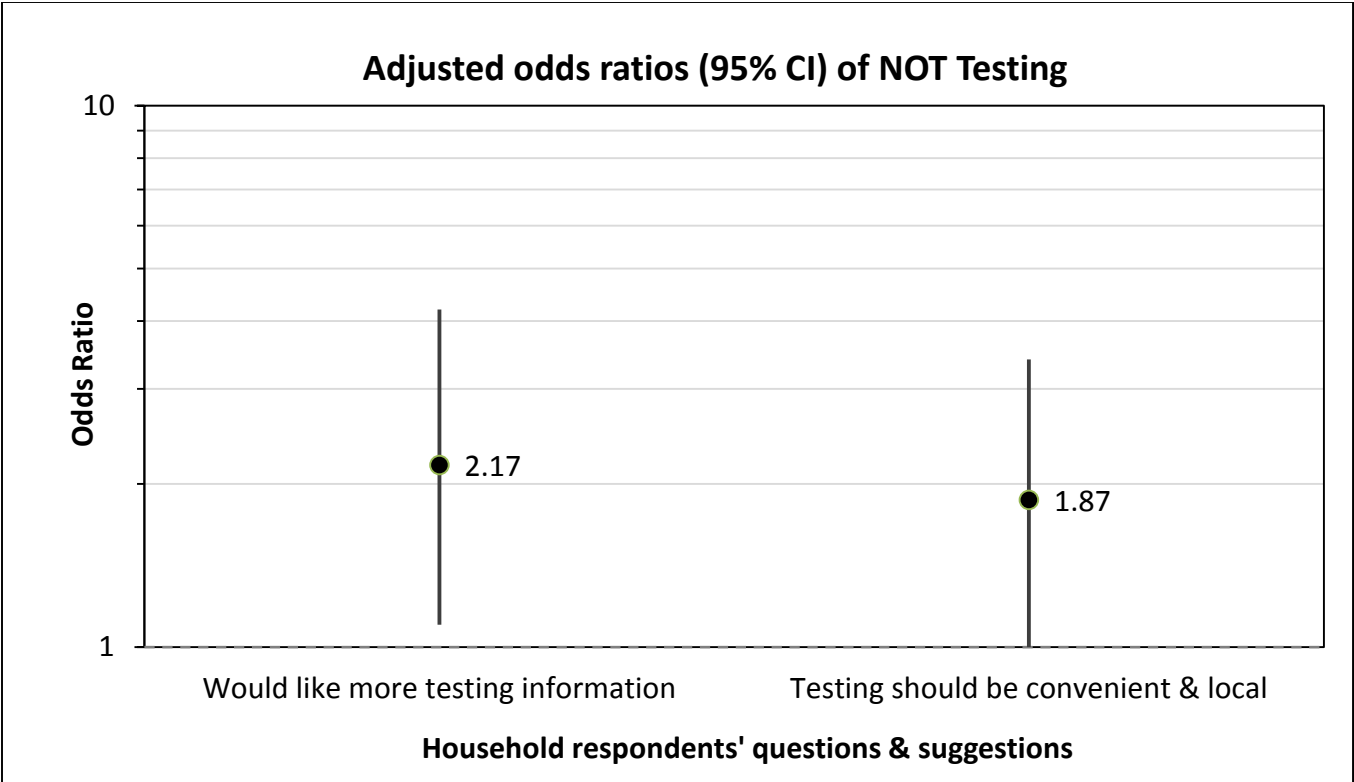


Figure 18. The adjusted odds ratio of not testing based on respondents' seeking more information and desirability of local testing. Model adjusted for age.

Perceptions of Well-Water Quality

Table 12 lists beliefs and attitude statements regarding the quality of water and risk perceptions. The majority of respondents perceived their groundwater quality was good and safe. Over 70-80% of respondents are happy with the taste, smell, and appearance of their untreated well water and 80 percent believe their *untreated water is safe to drink*. At the same time, almost all household respondents agreed that *Well water quality can change over time* (88.3%). Only 40 percent of household respondents are *happy with the hardness of their untreated water*, which is consistent with patterns of testing and/or treatment behaviors that may be driven by hardness of water.

Table 11. Attitudes and beliefs as predictors of testing and treatment among private well owners		
	Agreement with statements	Testing
Beliefs and attitudes statements :	% Agreement ^a	Adjusted OR ^b (95% CI)
I am happy with the taste of my untreated well water.	72.8	1.05 (0.7-1.7)
I am happy with the smell of my untreated well water.	74	1.00 (0.6-1.6)
I am happy with the appearance of my untreated well water.	78.3	0.91 (0.5-1.5)
I am happy with the hardness of my untreated well water.	39.2	1.10 (0.7-1.7)
My untreated water is safe to drink.	80.9	1.16 (0.7-2.0)
Yes, I have the information I need to make decisions about testing my well water	50.4	5.78 (3.7-9.0)
I know one or more households where the owners have tested their well in the last 5 years	34.5	4.08 (2.4-7.1)
I feel better knowing what is in my well water.	85.5	3.11 (1.7-5.7)
Homeowners are responsible for having their well water tested.	76.5	1.93 (1.2-3.1)
My well water is at risk of being contaminated.	21.1	1.19 (0.8-2.0)
Wells in my township are at risk of being contaminated.	21.8	0.98 (0.6-1.6)
I am not concerned about the safety of my well water. I have been drinking it with no problem.	49.5	1.15 (0.8-1.7)
I am concerned about the safety of my well water. Contaminated well water can cause serious health problems.	59.4	1.06 (0.7-1.6)
My family could have health problems from our well water.	21.6	1.34 (0.8-2.2)
Adverse health effects from drinking well water tend to be overstated.	14.1	0.59 (0.3-1.1)
Well water quality can change over time.	88.3	1.56 (0.8-2.9)
Yes, I have the information I need to manage the safety and quality of my well water	47.5	5.02 (3.2-7.8)
^a Agreement includes those who 'strongly agree' and 'agree' with the statement; Non-agreement includes those who 'strongly disagree', 'disagree', or 'neither agree nor disagree' with the statement.		
^b Adjusted for age		

In order to identify whether beliefs and attitudes are associated with testing behavior, adjusted odds ratios were also calculated to determine if agreement with statements from Table 11 are predictive of testing. Household respondents who agreed with the statement *Yes, I have the information I need to make decisions about testing my well water* had a 5.78 times increased odds of testing their well water in the last 10 years. Similarly, those who had the information needed to manage the safety and quality of their well water were 5.02 times more likely to have tested their well water in the last 10 years. These results provide additional evidence that awareness and knowledge regarding well water testing is likely an important determinant of testing behavior. Additionally, those who know one or more households where the owners have tested their well in the last 5 years were 4.08 odds of testing in the last ten years.

Curiosity and responsibility are also driving factors in predicting testing behavior. Respondents who feel better knowing what is in their water have 3.11 increased odds of testing their water in the last 10 years. Those who agree that testing is their responsibility are 93% times more likely to have tested their well water in the last 10 years.

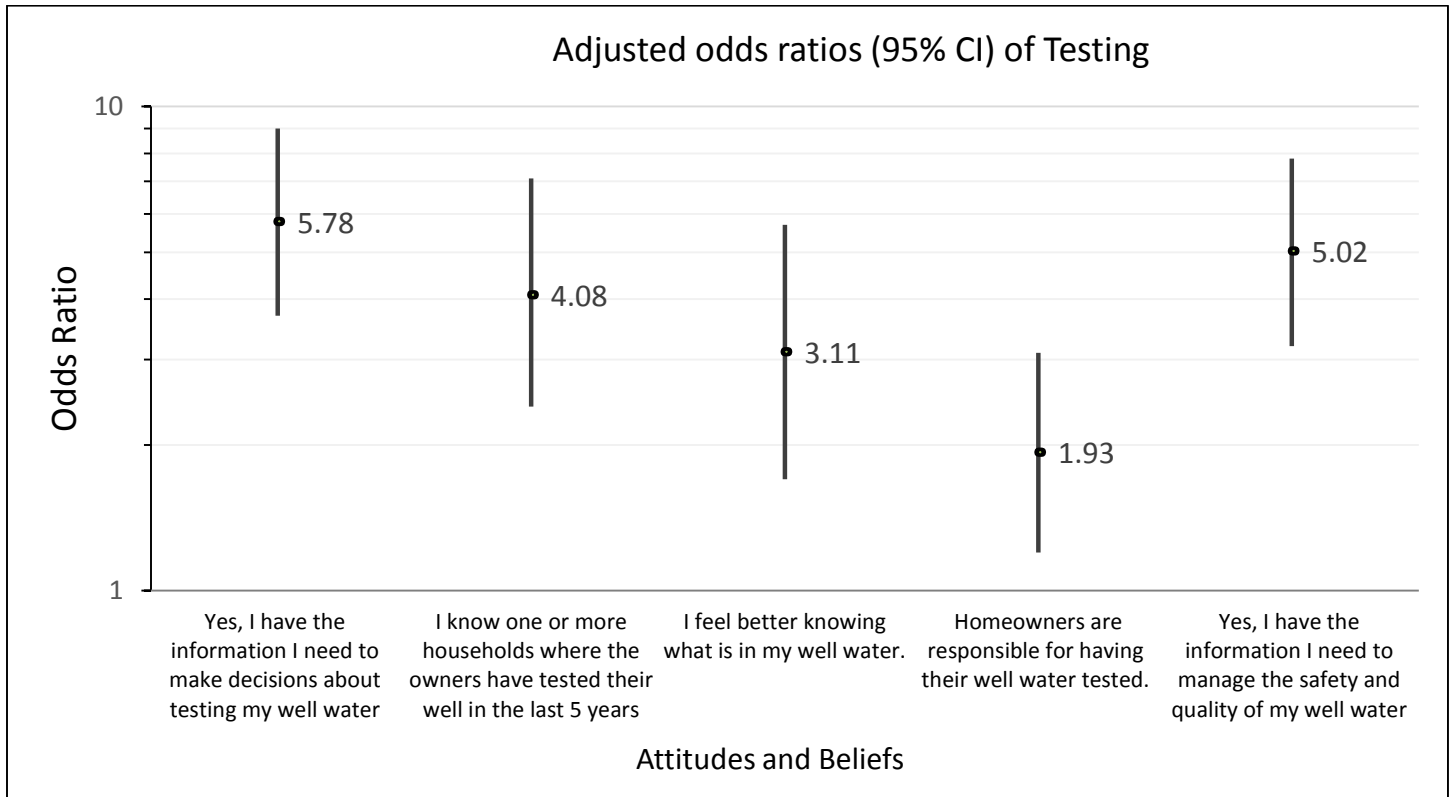
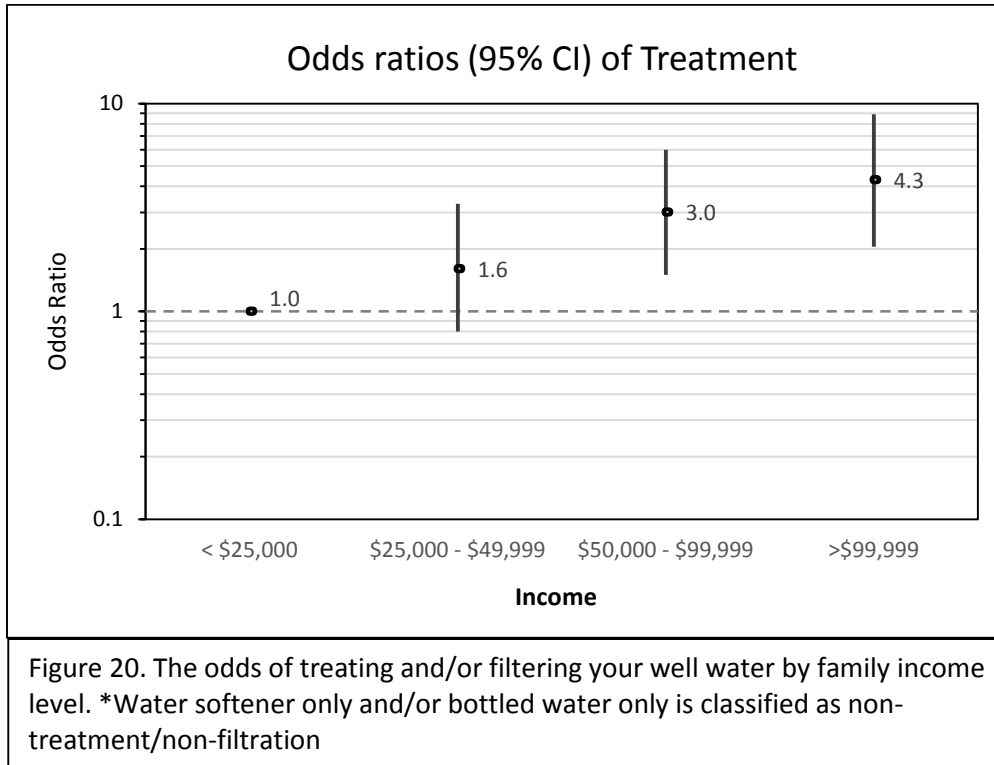


Figure 19. Adjusted odds of testing well water based on agreement with belief and attitude statements regarding well water

Predictors of treatment

Demographics

Males, non-smokers, those with more children in the home, those with a higher family income, and those in the southeast, south, and northeast health regions are more likely to treat and/or filter their well water (see appendix table A1XI). However, the only demographic characteristics that are statistically significantly different among those who treat and those who do not treat their well water are income and health region. When respondents who only use water softeners as a treatment and/or only drink bottled water are re-classified as respondents who do not treat and/or filter, health region no longer becomes statistically significantly different as water hardness is largely a geographically regional problem (see appendix table A1XII). Income still remains to be a significant predictor of treatment behavior.



Odds ratios were calculated to determine whether any demographic characteristics were predictive of treatment behavior. Respondents who only use water softeners as a treatment and/or only drink bottled water are re-classified as respondents who do not treat and/or filter for the odds ratios presented in table 12. The odds of treating and/or filtering well water is 4.3 times greater among those with a family income greater than \$99,999, 3.0 times greater among those with a family income of \$50,000-\$99,000, and 1.6 times greater among those with a family income of \$25,000-\$49,000 when compared with those having less than a \$25,000 family income.

Table 12. Individual characteristics as predictors of testing and treatment among private well owners		
Individual Demographics	Treatment^a	
	% who treat	OR ^b (95% CI)
Gender		
Male	43.9	(ref)
Female	39.3	0.8 (0.6-1.2)
Age		
21-40	42.5	(ref)
41-60	43.2	1.0 (0.6-1.8)
> 60	37	0.8 (0.5-1.5)
Family Income		
< \$25,000	22	(ref)
\$25,000 - \$49,999	31	1.6 (0.8-3.3)
\$50,000 - \$99,999	46.3	3.0 (1.5-6.0)
>\$99,999	54.6	4.3 (2.05-8.9)
Education status		
H.S./GED or less	37.2	(ref)
some college	40	1.1 (0.7-1.8)
Bachelors or higher	45.6	1.4 (0.9-2.3)
BMI^a		
< 25	41.6	(ref)
>=25 and < 30	45.5	1.2 (0.7-1.9)
>= 30	37.7	0.9 (0.5-1.3)
Smoking Status		
Current	36.7	(ref)
Former	46.2	1.5 (0.8-2.7)
Never	41.3	1.2 (0.7-2.2)
# of Children ≤ 20 yrs		
0	39.2	(ref)
1 or 2	43.5	1.2 (0.6-2.4)
3 or more	47.8	1.4 (0.6-3.5)
Health Region		
Southeast	49.4	1.7 (0.9-3.2)
South	46.1	1.5 (0.8-2.8)
West	36.5	(ref)
North	32.7	0.8 (0.5-1.5)
Northeast	44.4	1.4 (0.8-2.5)

Perceptions and beliefs

Appearance, smell and taste of well water are strong predictors of treatment/filtration behavior. Household respondents who are happy with taste, smell, appearance, and hardness of their well water, and believe their untreated water is safe to drink are statistically significantly less likely to treat and/or filter their water. Those who believe their untreated water is safe to drink are 40% less likely to treat and/or filter their water.

Respondents are:

- 65% less likely to treat/filter their water if they are happy with the smell of their untreated water
- 63% less likely to treat/filter their water if they are happy with the taste of their untreated water
- 55% less likely to treat/filter their water if they are happy with the hardness of their untreated water
- 55% less likely to treat/filter their water if they are happy with the appearance of their untreated water
- 40% less likely to treat/filter their water if they believe their untreated water is safe to drink

	Agreement with statements	Treatment^a
Beliefs and attitudes statements :	% Agreement^b	Adjusted OR^d (95% CI)
I am happy with the taste of my untreated well water.	72.8	0.37 (0.23-0.58)
I am happy with the smell of my untreated well water.	74	0.35 (0.22-0.57)
I am happy with the appearance of my untreated well water.	78.3	0.45 (0.27-0.74)
I am happy with the hardness of my untreated well water.	39.2	0.45 (0.29-0.71)
My untreated water is safe to drink.	80.9	0.60 (0.35-1.02)
Yes, I have the information I need to make decisions about testing my well water	50.4	0.90 (0.60-1.35)
I know one or more households where the owners have tested their well in the last 5 years	34.5	1.33 (0.8-2.2)
I feel better knowing what is in my well water.	85.5	0.82 (0.5-1.5)
Homeowners are responsible for having their well water tested.	76.5	1.33 (0.8-2.4)
My well water is at risk of being contaminated.	21.1	1.48 (0.9-2.4)
Wells in my township are at risk of being contaminated.	21.8	1.39 (0.9-2.3)
I am not concerned about the safety of my well water. I have been drinking it with no problem.	49.5	1.17 (0.8-1.8)
I am concerned about the safety of my well water. Contaminated well water can cause serious health problems.	59.4	1.10 (0.7-1.7)
My family could have health problems from our well water.	21.6	1.04 (0.6-1.7)
Adverse health effects from drinking well water tend to be overstated.	14.1	0.92 (0.5-1.6)
Well water quality can change over time.	88.3	0.93 (0.52-1.69)
Yes, I have the information I need to manage the safety and quality of my well water	47.5	0.94 (0.6-1.4)
^a Water softener only and/or bottled water only are re-classified as non-treatment/non-filtration		
^b Agreement includes those who 'strongly agree' and 'agree' with the statement; Non-agreement includes those who 'strongly disagree', 'disagree', or 'neither agree nor disagree' with the statement.		
^c Adjusted for income		

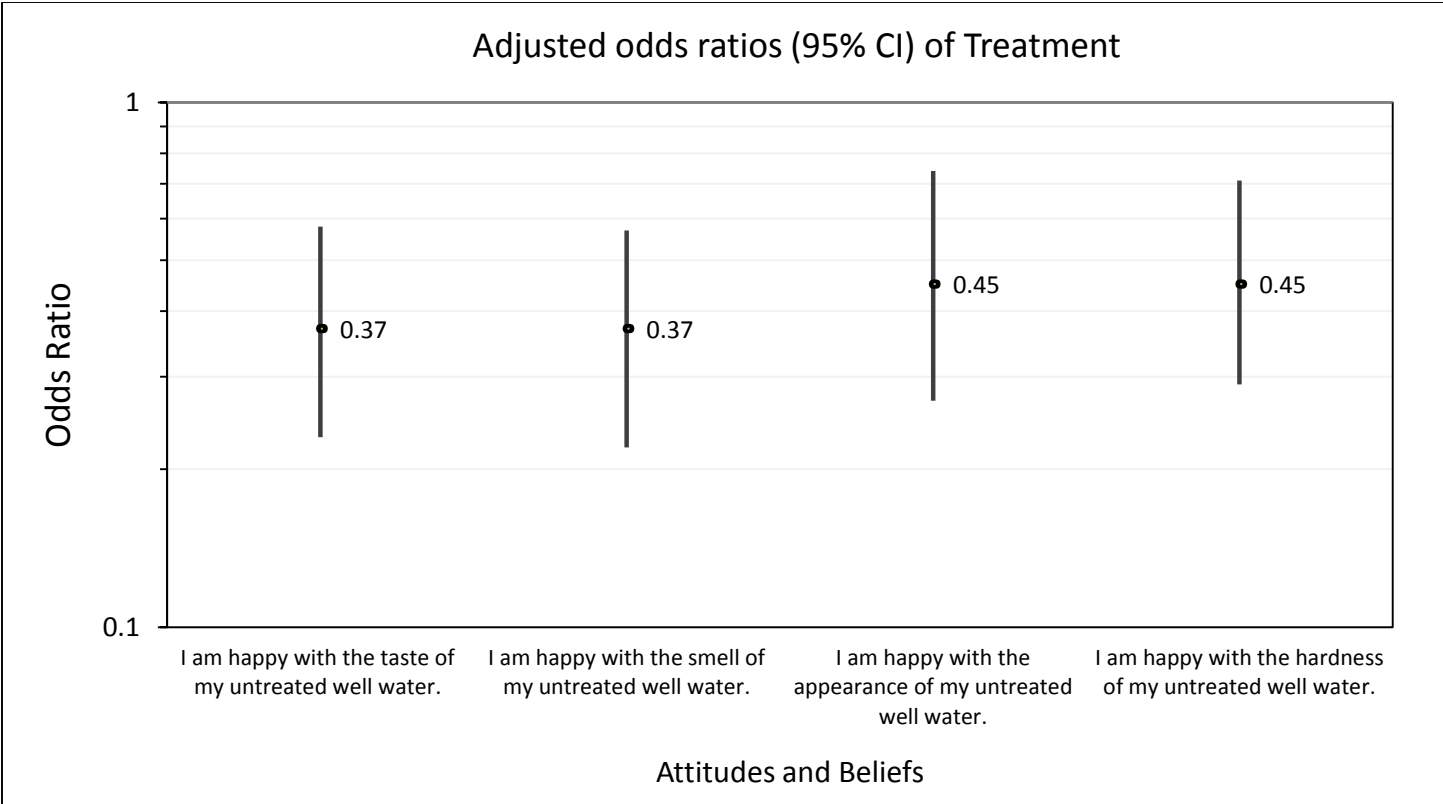


Figure 21. Odds of treatment/filtration by agreement with attitude and belief statement. Odds ratios adjusted by income.

Water Quality and Safety

Household respondents who agreed that *well water contamination can cause serious health problems*, are *concerned about the safety of their well water*, and/or that *their family could have health problems from their well water* were compared with respondents who disagreed with the above statements in order to identify any demographic differences that may be associated with beliefs about well water quality. Those who agree with the above statements were older (more likely to be ages 41 or older) and more likely to live in a rural area. Those living in an urban setting and those age 21-40 were less likely to be concerned with well water contamination and health problems.

Table 14. Belief about well water safety and quality by demographic strata							
<i>I am concerned about the safety of my well water. Contaminated well water can cause serious health problems AND/OR My family could have health problems from our well water.</i>							
	Agree ^a			Disagree ^b			Significance
	n	Row %	95% CI	n	Row %	95% CI	p-value
Gender							
Male	124	65.3	(58.5-72.1)	66	34.7	(27.9-41.5)	0.037
Female	135	56.5	(50.2-62.8)	104	43.5	(50.2-62.8)	
Age group							
21-40	30	46.2	(34.0-58.3)	35	53.8	(41.7-66.0)	0.44
41-60	140	63.6	(57.3-70.0)	80	36.4	(30.0-42.7)	
> 60	89	61.8	(53.8-69.8)	55	38.2	(30.2-46.2)	
Marital status							
Married/with partner	196	59.8	(54.4-65.1)	132	40.2	(34.9-45.5)	0.49
Single (divorced/widowed)	39	60	(48.0-72.0)	26	40	(28.0-52.0)	
Never Married	8	80	(55.1-100)	2	20	(0.0-44.9)	
Education							
H.S./GED or less	68	60.7	(51.6-69.8)	44	39.3	(30.2-48.4)	0.54
some college	90	57	(49.2-64.7)	68	43	(35.3-50.8)	
Bachelors or higher	101	63.5	(56.0-71.0)	58	36.5	(29.0-44.0)	
Income							
< \$25,000	32	60.4	(47.2-73.6)	21	39.6	(26.4-52.8)	0.35
\$25,000 - \$49,999	59	57.3	(47.7-66.9)	44	42.7	(33.1-52.3)	
\$50,000 - \$99,999	108	64.3	(57.0-71.6)	60	35.7	(28.4-43.0)	
> \$99,999	50	56.2	(45.8-66.5)	39	43.8	(33.5-54.2)	
BMI							
< 25	84	63.6	(55.4-71.9)	48	36.4	(28.1-44.6)	0.11
>=25 and < 30	86	62.3	(54.2-70.4)	52	37.7	(29.6-45.8)	
>= 30	89	56	(48.2-63.7)	70	44	(36.3-51.8)	
Smoking Status							
Current	33	58.9	(46.0-71.9)	23	41.1	(28.1-54.0)	0.029
Former	101	66.9	(59.3-74.4)	50	33.1	(25.6-40.7)	
Never	113	55.9	(49.1-62.8)	89	44.1	(37.2-50.9)	
Urbanicity^c							
Urban Areas/urban clusters	28	47.5	(34.7-60.3)	31	52.5	(39.7-65.3)	0.12
Rural	231	62.4	(57.5-67.4)	139	37.6	(32.6-42.5)	
Children							
0	70	59.8	(50.9-68.8)	47	40.2	(31.2-49.1)	0.47
1 or 2	24	54.5	(39.7-69.4)	20	45.5	(30.6-60.3)	
3 or more	8	36.4	(16.1-56.7)	14	63.6	(43.3-83.9)	
Health Region							
Southeast	43	61.4	(50.0-72.9)	27	38.6	(27.1-50.0)	0.12
South	46	65.7	(54.6-76.9)	24	34.3	(23.1-45.4)	
West	43	53.1	(42.2-64.0)	38	46.9	(36.0-57.8)	
North	59	57.8	(48.2-67.5)	43	42.2	(32.5-51.8)	
Northeast	68	64.2	(55.0-73.3)	38	35.8	(26.7-45.0)	

^aAgree = Strongly agree or agree; ^bDisagree = Strongly disagree, disagree, or neither; ^cUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010

Conclusions

This study suggests that private well owners in Wisconsin are vulnerable to potential contamination from private wells in the state of Wisconsin. Findings are consistent with previous estimates that testing rates among Wisconsin private well-owners is low despite information provided by state agencies. Motivations for testing are largely driven by personal perceptions of safety and risk and/or being informed that a neighbor had a health issue. Information and convenience as well as costs three significant factors in determining future testing and treatment by private well owners and should be considered in designing future interventions. While not many contaminant issues were reported in this study, over ½ of the individuals in this study actually tested and among those who tested, less than half tested for chemical contaminants. Therefore, findings of a problem may be due to limited regular testing practices. Many individuals who do not test their wells feel they do not have the information they need regarding what to test for. This information barrier seemed to be the most significant barrier to testing.

Education, information and knowledge sharing regarding what and how to treat for chemical contaminants is also important. Despite concern regarding health issues as a primary reason for treatment, treatment among private well owners is largely driven by issues of water hardness and not to address issues of chemical contamination. Given that income was a significant predictor of treatment, the most vulnerable are those with incomes below 50,000 per year who may not have the resources to prioritize water treatment over other costs, and are therefore less likely to treat. Should testing lead to problems, some resources may be needed for private well owners to subsidize drinking water treatment systems, should programs aim to or be interested in mitigating public health risks and reduce health care expenditures. If treatment is provided only after regular testing indicates a problem, the public health risks should not be problematic.

Risk perceptions are also important predictors of testing and treatment behaviors in this study population. Suggesting that communication strategies should aim to support testing among this potentially high risk population.

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Appendix 1

Table A1II. Survey of the Health of Wisconsin cohort 2008-2013 demographic table by Water Supply source							
Individual Demographics	Total Population		Population on Private Well		Population on Municipal		Significance
	(n=3384)	% (95% CI)	(n = 1106)	% (95% CI)	(n = 2069)	% (95% CI)	
Gender							
Male	1504	44.4 (42.8-46.1)	497	44.9 (42.0-47.9)	904	43.7 (41.6-45.8)	0.5
Female	1880	55.6 (53.9-57.2)	609	55.1 (52.1-58.0)	1165	56.3 (54.2-58.4)	
Age							
21-40	992	29.3 (27.8-30.8)	222	20.1 (17.7-22.4)	685	33.1 (31.1-35.1)	<0.0001
41-60	1616	47.8 (46.1-49.4)	580	52.4 (49.5-55.4)	945	45.7 (43.5-47.8)	
> 60	776	22.9 (21.5-24.3)	304	27.5 (24.9-30.1)	439	21.2 (19.5-23.0)	
Race/Ethnicity							
White (non-hispanic)/Caucasian	3051	90.2 (89.2-91.2)	1046	94.6 (93.2-95.9)	1841	89.0 (87.6-90.3)	<0.0001
Non-White	333	9.8 (8.8-10.8)	60	5.4 (4.1-6.8)	228	11.0 (9.7-12.4)	
Marital Status							
Married	2298	78.9 (77.4-80.3)	853	82.8 (80.5-85.1)	1304	75 (73.9-78.0)	0.0001
Single	522	17.9 (16.5-19.3)	153	14.9 (12.6-17.0)	351	20.4 (18.5-22.4)	
Never Married	94	3.2 (2.6-3.9)	24	2.3 (1.4-3.3)	62	3.6 (2.7-4.5)	
Education status							
H.S./GED or less	1025	30.3 (28.8-31.9)	371	33.6 (30.8-36.4)	580	28.1 (26.1-30.0)	<0.01
some college	1315	38 (37.3-40.6)	411	37.2 (34.3-40.0)	827	40.0 (37.9-42.1)	
Bachelors or higher	1038	30.7 (29.2-32.3)	323	29.2 (26.5-31.9)	659	31.9(29.9-33.9)	
Family Income							
< \$25,000	635	19.6 (18.2-20.9)	147	13.9 (11.8-16.0)	443	22.2 (20.4-24.0)	<0.0001
\$25,000 - \$49,999	800	24.6 (23.2-26.1)	263	24.8 (22.2-27.4)	487	24.4 (22.5-26.3)	
\$50,000 - \$99,999	1181	36.4 (34.7-38.0)	428	40.4 (37.4-43.3)	689	34.5 (32.4-36.6)	
> \$100,000	630	19.4 (18.0-20.8)	222	20.9 (18.5-23.4)	376	18.9 (17.1-20.6)	
BMI							
< 25	1333	39.4 (37.7-41.0)	393	35.5 (32.7-38.4)	816	39.4 (37.3-41.5)	0.004
>=25 and < 30	923	27.3 (25.8-28.8)	347	31.4 (28.6-34.1)	535	25.9 (24.0-27.7)	
>= 30	1128	33.3 (31.7-34.9)	366	33.1 (30.3-35.9)	718	34.7 (32.6-36.8)	
Smoking Status							
Current	496	17 (15.7-18.4)	176	18.1 (15.7-20.5)	291	16.3 (14.6-18.1)	0.11
Former	879	30.3 (28.6-31.9)	311	32.0 (29.1-34.9)	529	29.6 (27.5-31.8)	
Never	1530	52.7 (50.9-54.5)	485	49.9 (46.7-53.0)	965	54.1 (51.7-56.4)	
Urbanicity^a							
Urban Areas/clusters	1890	55.9 (54.2-57.5)	129	11.7 (9.8-13.6)	1253	60.6 (37.3-41.5)	<0.0001
Rural	1494	44.1 (42.5-45.8)	977	88.3 (86.4-90.2)	816	39.4 (58.5-62.7)	
Children							
0	959	63.0 (60.5-65.4)	331	66.6 (62.4-70.8)	544	61.7 (58.5-65.0)	<0.01
1 or 2	407	26.7 (24.5-28.9)	107	21.5 (17.9-25.2)	254	28.8 (25.8-31.8)	
3 or more	157	10.3 (8.8-11.8)	59	11.9 (9.0-14.7)	83	9.5 (7.5-11.4)	
Health Region							
Southeast	700	20.7 (19.3-22.1)	145	13.1 (11.1-15.1)	778	23.9 (22.0-25.7)	<0.0001
South	710	21.0 (19.6-22.4)	197	17.8 (15.6-20.1)	467	22.0 (20.3-23.8)	
West	598	17.7 (16.4-19.0)	190	17.2 (15.0-19.4)	243	18.4 (16.7-20.0)	
North	642	19.0 (17.7-20.3)	292	26.4 (23.8-29.0)	170	15.1 (13.6-16.7)	
Northeast	734	21.6 (20.3-23.1)	282	25.5 (22.9-28.1)	411	20.6 (18.8-22.3)	
Ever told had Cancer							
Yes	314	10.7 (9.6-11.7)	107	10.9 (9.0-12.9)	195	10.6 (9.2-12.0)	0.09
No	2634	89.3 (88.3-90.4)	871	89.1 (87.1-91.0)	1649	89.4 (88.0-90.8)	
Ever told had Diabetes							
Yes	361	10.7 (9.6-11.7)	99	9.0 (7.3-10.6)	244	11.8 (10.4-13.2)	0.01
No	3017	89.3 (88.3-90.4)	1006	91.0 (89.4-92.7)	1823	88.2 (86.8-89.6)	
Hypertension^b							
Yes	1182	34.9 (33.3-36.5)	417	37.7 (34.8-40.6)	700	33.8 (31.8-35.9)	0.03
No	2202	65.1 (63.5-66.7)	689	62.3 (59.4-65.2)	1369	66.2 (64.1-68.2)	

^aUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010

^bMeasure of hypertension is defined as a participant having systolic blood pressure equal to or greater than 140 mm Hg and/or diastolic blood pressure equal to or greater than 90 mm Hg and/or self-report of currently taking anti-hypertensive medication

** Numbers determined from SHOW question HQ070: "Is your home connected to a private well or to a community water supply?" The number of SHOW participants listed here on private wells is higher than the number eligible for participation in the groundwater ancillary study due to eligibility requirements - need to have consented to future studies.

Table A1III. Participation by demographic strata							
	Total Study Sample		Participants (household respondents)		Non-participants from non-participant households		Significance
Individual Demographics	(n = 1050)	% (95% CI)	(n = 460)	% (95% CI)	(n = 379)	% (95% CI)	p-value
Gender							0.65
Male	480	45.7 (42.7-48.7)	198	43.0 (38.5-47.6)	169	44.6 (39.6-49.6)	
Female	570	54.3 (51.3-57.3)	262	57.0 (52.4-61.5)	210	55.4 (50.4-60.4)	
Age							<0.0001
21-40	227	21.6 (19.1-24.1)	73	15.9 (12.5-19.2)	120	31.7 (27.0-36.4)	
41-60	546	52.0 (49.0-55.0)	236	51.3 (46.7-55.9)	199	52.5 (47.5-57.6)	
> 60	277	26.4 (23.7-29.1)	151	32.8 (28.5-37.1)	60	15.8 (12.1-19.5)	
Race/Ethnicity							0.04
White (non-hispanic)/Caucasian	990	94.3 (92.9-95.7)	439	95.4 (93.5-97.3)	349	92.1 (89.4-94.8)	
Non-White	60	5.7 (4.3-7.1)	21	4.6 (2.7-6.5)	30	7.9 (5.2-10.6)	
Marital Status							0.31
Married/with partner	802	82.8 (80.4-85.1)	349	81.2 (77.5-84.9)	265	78.2 (73.8-82.6)	
Single (divorced/widowed)	139	14.3 (12.1-16.6)	71	16.5 (13.0-20.0)	60	17.7 (13.6-21.8)	
Never Married	28	2.9 (1.8-3.9)	10	2.3 (0.9-3.8)	14	4.1 (2.0-6.3)	
Education status							<0.0001
H.S./GED or less	340	32.4 (29.6-35.2)	121	26.3 (22.3-30.3)	149	39.3 (34.4-44.3)	
some college	405	38.6 (35.7-41.6)	170	37.0 (32.5-41.4)	157	41.4 (36.4-46.4)	
Bachelors or higher	304	29.0 (26.2-31.7)	169	36.7 (32.3-41.2)	73	19.3 (15.3-23.2)	
Family Income							0.047
< \$25,000	147	14.6 (12.4-16.8)	59	13.4 (10.2-16.5)	70	19.3 (15.2-23.4)	
\$25,000 - \$49,999	258	25.6 (22.9-28.3)	113	25.6 (21.5-29.6)	97	26.8 (22.2-31.4)	
\$50,000 - \$99,999	392	39.0 (35.9-42.0)	173	39.1 (34.6-43.7)	136	37.6 (32.6-42.6)	
>\$99,999	209	20.8 (18.3-23.3)	97	21.9 (18.1-25.8)	59	16.3 (12.5-20.1)	
Urban/Rural (Census 2010)							0.42
Urban Area / Urban clusters ^a	147	14.0 (11.9-16.1)	66	14.3 (11.1-17.6)	62	16.4 (12.6-20.1)	
Rural	903	86.0 (83.9-88.1)	394	85.7 (82.4-88.9)	317	83.6 (79.9-87.4)	
BMI							0.02
< 25	355	33.8 (30.9-36.7)	142	30.9 (26.6-35.1)	149	39.3 (34.4-44.3)	
>=25 and < 30	307	29.2 (26.5-32.0)	143	31.1 (26.8-35.3)	93	24.5 (20.2-28.9)	
>= 30	388	37.0 (34.0-39.9)	175	38.0 (33.6-42.5)	137	36.2 (31.3-41.0)	
Smoking Status							<0.01
Current	152	16.2 (13.8-18.6)	60	13.8 (10.5-17.0)	68	21.9 (17.2-26.5)	
Former	313	33.4 (30.3-36.4)	158	36.2 (31.7-40.8)	93	29.9 (24.8-35.0)	
Never	473	50.4 (47.2-53.6)	218	50.0 (45.3-54.7)	150	48.2 (42.6-53.8)	
# of Children ≤ 20 yrs							0.57
0	321	63.2 (59.0-67.4)	130	65.3 (58.7-72.0)	119	60.4 (53.5-67.3)	
1 or 2	122	24.0 (20.3-27.7)	46	23.1 (17.2-29.0)	50	25.4 (19.3-31.5)	
3 or more	65	12.8 (9.9-15.7)	23	11.6 (7.08-16.0)	28	14.2 (9.3-19.1)	
Health Region							0.21
Southeast	161	15.4 (13.2-17.5)	77	16.7 (13.3-20.2)	56	14.8 (11.2-18.4)	
South	186	17.7 (15.4-20.0)	76	16.5 (13.1-19.9)	76	20.0 (16.0-24.1)	
West	206	19.6 (17.2-22.0)	85	18.5 (14.9-22.0)	78	20.6 (16.5-24.7)	
North	255	24.3 (21.7-26.9)	107	23.3 (19.4-27.1)	96	25.3 (20.9-29.7)	
Northeast	242	23.0 (20.5-25.6)	115	25.0 (21.0-29.0)	73	19.3 (15.3-23.2)	
Ever told have Cancer							0.31
Yes	115	12.1 (10.0-14.2)	56	12.7 (9.6-15.9)	33	10.3 (7.0-13.7)	
No	837	87.9 (85.8-90.0)	384	87.3 (84.1-90.4)	287	89.7 (86.3-93.0)	
Even told have Diabetes							0.59
Yes	98	9.3 (7.6-11.1)	45	9.8 (7.1-12.5)	33	8.7 (5.9-11.6)	
No	951	90.7 (88.9-92.4)	415	90.2 (87.5-92.9)	346	91.3 (88.4-94.1)	
Current Hypertension^b							0.89
Yes	387	36.9 (33.9-39.8)	166	36.1 (31.7-40.5)	135	35.6 (30.8-40.5)	
No	663	63.1 (60.2-66.1)	294	63.9 (59.5-68.3)	244	64.4 (59.5-69.2)	

^aUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010 ^bMeasure of hypertension is defined as a participant having systolic blood pressure equal to or greater than 140 mm Hg and/or diastolic blood pressure equal to or greater than 90 mm Hg and/or self-report of currently taking anti-hypertensive medication

Table A1IV. Variable frequencies from survey.

Variable	n	% (95% CI)
<i>Current home has a private well that supplies water to the home:</i>		
Yes	434	94.4 (92.2-96.5)
No	24	5.2 (3.2-7.3)
Don't know	2	0.4 (0.0-1.0)
<i>Frequency well water is used for drinking:</i>		
Never	9	2.1 (0.7-3.5)
Rarely	18	4.2 (2.3-6.1)
Sometimes	25	5.8 (3.6-8.1)
Mostly	54	12.6 (9.4-15.7)
Always	323	75.3 (71.2-79.4)
<i>Well water has been tested in last 10 years:</i>		
Yes	222	51.3 (46.5-56.0)
No	194	44.8 (40.1-49.5)
Don't know	17	3.9 (2.1-5.8)
<i>Well water has been tested in last 10 years:</i>		
Within past 12 months	40	18.8 (13.5-24.1)
1-5 years ago	87	40.8 (34.2-47.5)
6-10 years ago	79	37.1 (30.5-43.6)
Don't know	7	1.2 (0.9-5.7)

Table A1V. Variable frequencies from survey.

Variable	n	% (95% CI)
<i>Contaminants well water was tested for:</i>		
Bacteria	116	54.0 (47.5-60.9)
Nitrates	103	48.1 (41.4-54.9)
Iron	60	28.0 (22.0-34.1)
Hardness	57	26.5 (20.7-32.6)
Lead	54	25.1 (19.4-31.1)
Arsenic	46	21.4 (15.9-27.0)
Pesticides	41	19.1 (13.8-24.5)
Copper	31	14.4 (9.7-19.2)
Fluoride	23	10.7 (6.6-14.9)
Don't know	20	9.3 (5.4-13.3)
Other (specify)	14	6.5 (4.5-9.6)
Radon	16	7.4 (3.9-11.0)
Gasoline, fuel oil, solvents	15	7.0 (3.6-10.5)
<i>Water test indicated a problem with:</i>		
No problem indicated	132	63.2 (56.6-69.8)
Iron	24	11.2 (7.1-15.8)
Hardness	21	9.8 (5.9-14.1)
Don't know	21	9.8 (5.9-14.1)
Nitrates	13	6.0 (2.9-9.5)
Other (specify)	8	3.7 (1.2-6.3)
Bacteria	7	3.3 (0.9-5.8)
Lead	1	0.5 (0.0-1.4)
Fluoride	1	0.5 (0.0-1.4)
Arsenic	0	0.0
Copper	0	0.0
Pesticides	0	0.0
Gasoline, fuel oil, solvents	0	0.0
Radon	0	0.0
<i>Preference for receiving and returning water test kit:</i>		
Pick up a test kit at a local location and return the sample to a local location a couple days later	193	45.3 (40.6-50.0)
Order a test kit on a website and return the sample by mail	119	27.9 (23.7-32.2)
Order a test kit over the phone and return the sample by mail	98	23 (19.0-27.0)
Pick up a test kit from a laboratory and return the sample to the laboratory.	23	5.4 (3.2-7.6)
Other (specify)	15	3.5 (1.8-5.3)

Table A1VI. Variable frequencies from survey.

Variable	n	% (95% CI)
<i>You have the information you need to make decisions about testing well water:</i>		
Yes, I have the information I need to make decisions about testing my well water	165	38.6 (34.0-43.3)
Yes, I have the information I need, but I would like more information about well water testing	50	11.7 (8.6-14.8)
No, I do not have the information I need, and I am not interested in getting this information	27	6.3 (4.0-8.6)
No, I do not have the information I need, and I would like information so I can make decisions about well water testing	185	43.3 (38.6-48.0)
<i>Use a home water filter or treatment system:</i>		
Yes	256	60.1 (55.4-64.8)
No	159	39.9 (34.8-44.1)
Don't know	2	0.5 (0.0-1.1)
<i>Frequency of treatment/filtration, where those who selected 'only drink bottled water' and/or 'water softener' as their only treatment/filter systems are reclassified as 'Do Not treat/filter'</i>		
Yes	197	46.2 (41.5-51.0)
No	229	53.8 (49.0-58.5)
<i>Frequency of testing and treatment among participants: *treat/filter excludes drinking bottled water only and/or treatment with water softener only</i>		
Test and treat/filter well water	107	26.2 (21.9-30.4)
Test, but do NOT treat/filter well water	110	26.9 (22.6-31.2)
Do NOT test, but treat/filter well water	85	20.8 (16.8-24.7)
Do NOT test and do NOT treat/filter well water	107	26.2 (21.9-30.4)
<i>[Derived Variable] Reasons you filter or treat your water: Household respondents who selected "Other: specify" were categorized by response trends</i>		
Other - Came with the refrigerator and/or came with the house	20	7.4 (4.3-10.6)
Other - (all other responses not categorized)	11	4.1 (1.7-6.5)
Other - Sand/sediment/pipe build-up	8	2.9 (0.9-4.5)
Other - Because it keeps the water cold	4	1.6 (0.3-3.6)
Other - Because it is high in nitrates	2	0.9 (0.0-1.7)
Other - Skin problems	1	0.4 (0.0-1.1)
Other - Live near a cemetery	1	0.4 (0.0-1.1)

Table A1VII. Variable frequencies from survey free response questions.

Variable	n	% (95% CI)
<i>Do you have any questions about your well water or about well water testing?^a:</i>		
[1] This survey was a reminder and I should test my water	6	1.3 (0.3-2.3)
[2] Our water has no problems	1	0.2 (0.0-0.6)
[3] I have never thought about getting the water tested until now	2	0.4 (0.0-1.0)
[4] I would like to know what safe contaminant levels are and if there is a website that indicates what test results are and if they are noncompliant	4	0.9 (0.0-1.7)
[5] I would like to know what the best test is, how often to test, what the cost is, and/or where to test my water	34	7.4 (5.0-9.8)
[6] I Would like to know if free water testing is possible and where to go	3	0.7 (0.0-1.4)
[7] I would like to know if I should get my water tested even if it has no problems	3	0.7 (0.0-1.4)
[8] I would like more information (and/or recommendations) or additional information from what I can find online	9	2.0 (0.7-3.2)
[9] I would like alerts about water contamination in the area	2	0.4 (0.0-1.0)
[10] I would like to know what to do if I am having water quality issues	1	0.2 (0.0-0.6)
[11] I would like to know where to test for contaminants other than bacteria, for example: pesticides	2	0.4 (0.0-1.0)
[12] I would like to know how to initiate regular testing (for example: kit automatically sent and charged once a year)?	2	0.4 (0.0-1.0)
[13] I worry about contamination due to a pipeline break nearby	2	0.4 (0.0-1.0)
[14] I worry about my well drying up due to development and being forced to go on municipal with no compensation	1	0.2 (0.0-0.6)
[15] I worry about contamination from pesticides (Round-up), crop-dusters, and larger dairy cow operations	2	0.4 (0.0-1.0)
[16] I would like to know if large dairy cow operations are responsible for paying for and cleaning up nearby residential wells due to contamination	1	0.2 (0.0-0.6)
[17] I would like to know how to stop irrigation wells in the area	1	0.2 (0.0-0.6)
[18] I would like to know if my well water is related to kidney stones, diarrhea, cancer or other health problems	2	0.4 (0.0-1.0)
[19] I would like to know if a water softener protects from unsafe water	1	0.2 (0.0-0.6)
[20] How do I know for sure if test was performed correctly/if reportedly safe levels are actually safe?	2	0.4 (0.0-1.0)
[21] Other	9	2.0 (0.7-3.2)
^a This was an optional, free response survey question. Similar responses were categorized under common language selected by the researcher.		

Table A1VIII. Variable frequencies from survey free response suggestions.

Variable	n	% (95% CI)
<i>Please tell us your suggestions for how well water testing could be made easier and more convenient for well owners^a:</i>		
[1] Send kits by mail and mail-in sample option	12	2.6 (1.1-4.1)
[2] The Tribal land should offer this service (I live on Tribal land)	1	0.2 (0.0-0.6)
[3] Private well testing reminder should be sent with septic system reminders and testing should be required when septic systems are required to be pumped; OR send testing reminder/kits to homeowners with tax bills	9	2.0 (0.7-3.2)
[4] Provide free or affordable well water testing	26	5.7 (3.5-7.8)
[5] Advertise/promote - (ex: The UW extension office and UW Stevens point lab process is very easy - they should promote)	6	1.3 (0.3-2.3)
[6] Make testing convenient & local (Provide local pick-up and drop-off at the township or county level - at least once a year)	47	10.2 (7.4-13.0)
[7] Provide local venue of information, local informational class, information in newspaper, and/or community involvement	16	3.5 (1.8-5.2)
[8] The State/legislation should require testing	7	1.5 (0.4-2.6)
[9] Have someone come to the house and test the water instead of mailing in a sample	5	1.1 (0.1-2.0)
[10] Private well owners should receive reminders with information (unknown preferred medium of delivery)	8	1.7 (0.5-2.9)
[11] Private well owners should receive reminders with information by mail	15	3.3 (1.6-4.9)
[12] Private well owners should receive reminders with information by phone	1	0.2 (0.0-0.6)
[13] Private well owners should receive reminders with information by email	4	0.9 (0.0-1.7)
[14] Testing kits and instructions should be automatically sent out annually / sign up for automatic testing kits that arrive periodically	9	2.0 (0.7-3.2)
[15] Laws should be passed to insure better inspection of gas lines and fine companies of gas spills	1	0.2 (0.0-0.6)
[16] Keep the state out of private well testing	2	0.4 (0.0-1.0)
[17] Other	3	0.7 (0.0-1.4)
^a This was an optional, free response survey question. Similar responses were categorized under common language selected by the researcher.		

Table A1IX. The main reasons participants had their water tested by the organization that conducted last well water test.

The Main Reason you had your water tested:	Private laboratory/ private company		Wisconsin State Laboratory of Hygiene		Wisconsin Department of Natural Resources		County or City Laboratory (health department)		UW-Extension program/ Steven's Point Laboratory	
	n	Column % (95% CI)	n	Column % (95% CI)	n	Column % (95% CI)	n	Column % (95% CI)	n	Column % (95% CI)
To know if my well water is safe to drink	32	41.0 (30.0-52.0)	8	36.4 (16.1-56.6)	4	44.4 (11.7-77.2)	12	36.4 (19.8-52.9)	8	47.1 (23.1-71.0)
Real estate transaction (buying or selling a home)	13	16.7 (8.3-25.0)	3	13.6 (0.0-28.1)	2	22.2 (0.0-49.6)	5	15.2 (2.8-27.5)	1	5.9 (0.0-17.2)
I test my water on a regular basis	12	15.4 (7.3-23.5)	4	18.2 (1.9-34.4)	2	22.2 (0.0-49.6)	5	15.2 (2.8-27.5)	2	11.8 (0.0-27.2)
Water quality can change from time to time	12	15.4 (7.3-23.5)	1	4.5 (0.0-13.3)	1	11.1 (0.0-31.8)	5	15.2 (2.8-27.5)	3	17.6 (0.0-35.9)
There are children, babies, and/or pregnant women in the home	11	14.1 (6.3-21.9)	4	18.2 (1.9-34.4)	1	11.1 (0.0-31.8)	4	12.1 (0.9-23.3)	0	-
Other	11	14.1 (6.3-21.9)	2	9.1 (0.0-21.2)	1	11.1 (0.0-31.8)	3	9.1 (0.0-19.0)	0	-
A promotional offer from a private company	8	10.3 (3.5-17.0)	1	4.5 (0.0-13.3)	1	11.1 (0.0-31.8)	0	-	0	-
There was a problem (smell, taste, quality) with our well	8	10.3 (3.5-17.0)	1	4.5 (0.0-13.3)	0	-	5	15.2 (2.8-27.5)	1	5.9 (0.0-17.2)
A new well was constructed	8	10.3 (3.5-17.0)	3	13.6 (0.0-28.1)	1	11.1 (0.0-31.8)	2	6.1 (0.0-14.3)	2	11.8 (0.0-27.2)
Testing was needed after our well was repaired	7	9.0 (2.6-15.4)	2	9.1 (0.0-21.2)	0	-	3	9.1 (0.0-19.0)	0	-
A water test was needed to inform a decision about treating our well	6	7.7 (1.7-13.7)	0	-	1	11.1 (0.0-31.8)	1	3.0 (0.0-8.9)	1	5.9 (0.0-17.2)
Well water testing is recommended by state or local agency	4	5.1 (0.2-10.1)	3	13.6 (0.0-28.1)	2	-	4	12.1 (0.9-23.3)	4	23.5 (3.2-43.9)
A well test program was offered in the area	2	2.6 (0.0-6.1)	6	-	1	11.1 (0.0-31.8)	5	15.2 (2.8-27.5)	3	17.6 (0.0-35.9)
I read or heard about a groundwater problem in our area	1	1.3 (0.0-3.8)	1	4.5 (0.0-13.3)	0	-	3	9.1 (0.0-19.0)	1	5.9 (0.0-17.2)
Don't know	1	1.3 (0.0-3.8)	0	-	0	-	0	-	0	-

Table A1X. Percentage of household respondents who test and do NOT test by demographic strata							
	Test			Do Not Test			Significance
	n	% (Column %)	95% CI	n	% (Column %)	95% CI	p-value
Gender							0.15
Male	92	41.5	(34.9-48.0)	94	48.5	(41.4-55.5)	
Female	130	58.6	(52.0-65.1)	100	51.5	(44.5-58.6)	
Age group							0.02
21-40	42	18.9	(13.7-24.1)	22	11.4	(6.8-15.8)	
41-60	101	45.5	(38.9-52.1)	112	57.7	(50.7-64.7)	
> 60	79	35.6	(29.2-41.9)	60	30.9	(24.4-37.5)	
Marital status							0.65
Married/with partner	171	81.4	(76.1-86.7)	145	80.5	(74.7-86.4)	
Single (divorced/widowed)	33	15.7	(10.8-20.7)	32	17.8	(12.1-23.4)	
Never Married	6	2.9	(0.6-5.1)	3	1.7	(0.0-3.6)	
Education							0.14
H.S./GED or less	63	28.4	(22.4-34.4)	46	23.7	(17.7-29.7)	
some college	72	32.4	(26.2-38.6)	81	41.8	(34.8-48.8)	
Bachelors or higher	87	39.2	(32.7-45.7)	67	34.5	(27.8-41.3)	
Income							0.71
< \$25,000	24	11.4	(7.1-15.7)	29	15.3	(10.1-20.4)	
\$25,000 - \$49,999	53	25.1	(19.2-31.0)	47	24.7	(18.5-30.9)	
\$50,000 - \$99,999	87	41.2	(34.5-47.9)	75	39.5	(32.5-46.5)	
> \$99,999	47	22.3	(16.6-27.9)	39	20.5	(14.7-26.3)	
BMI							0.52
< 25	73	32.9	(26.7-39.1)	56	28.9	(22.4-35.3)	
>=25 and < 30	66	29.7	(23.7-35.8)	67	34.5	(27.8-41.3)	
>= 30	83	37.4	(31.0-43.8)	71	36.6	(29.8-43.4)	
Smoking Status							0.33
Current	23	11	(6.7-15.3)	28	15	(9.8-20.1)	
Former	74	35.4	(28.9-41.9)	71	38	(30.9-45.0)	
Never	112	53.6	(46.8-60.4)	88	47	(39.8-54.3)	
Urbanicity^a							0.67
Urban Areas/urban clusters	33	14.9	(10.1-19.6)	26	13.4	(8.6-18.2)	
Rural	189	85.1	(80.4-89.9)	168	86.6	(81.8-91.4)	
Children							0.8
0	62	62.6	(52.9-72.3)	57	67	(56.9-77.3)	
1 or 2	24	24.3	(15.7-32.8)	19	22.4	(13.3-31.4)	
3 or more	13	13.1	(6.4-19.9)	9	10.6	(3.9-17.3)	
Health Region							0.11
Southeast	30	13.5	(9.0-18.0)	37	19.1	(13.5-24.6)	
South	45	20.3	(14.9-25.6)	23	11.9	(7.3-16.4)	
West	38	17.1	(12.1-22.1)	41	21.1	(15.3-26.9)	
North	53	23.9	(18.2-29.5)	47	24.2	(18.1-30.3)	
Northeast	56	25.2	(19.5-31.0)	46	23.7	(17.7-29.7)	
Ever told had Cancer							0.23
Yes	32	15.2	(10.3-20.0)	21	11.1	(6.6-15.6)	
No	179	84.8	(80.0-89.7)	168	88.9	(84.4-93.4)	
Ever told had Diabetes							0.26
Yes	16	7.2	(3.8-10.6)	20	10.3	(6.0-14.6)	
No	206	92.8	(89.4-96.2)	174	89.7	(85.4-94.0)	
Hypertension^b							0.82
Yes	80	36	(29.7-42.4)	72	37.1	(30.3-44.0)	
No	142	64	(57.6-70.3)	122	62.9	(56.0-69.7)	

^aUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010 ^bMeasure of hypertension is defined as a participant having systolic blood pressure equal to or greater than 140 mm Hg and/or diastolic blood pressure equal to or greater than 90 mm Hg and/or self-report of currently taking anti-hypertensive medication

Table A1XI. Demographic table comparing participants who treat/filter their well water versus those who do not							
	Treat/filter ^a			Do not treat/filter			Significance
	n	%	95% CI	n	%	95% CI	p-value
Gender							0.84
Male	88	43.4	(37.5-49.6)	100	43.7	(37.2-50.1)	
Female	109	56.6	(50.4-62.5)	129	56.3	(49.9-62.8)	
Age group							0.28
21-40	31	15.7	(10.6-20.9)	34	14.8	(10.2-19.5)	
41-60	108	54.8	(47.8-61.8)	111	48.5	(41.9-55.0)	
> 60	58	29.4	(23.0-35.9)	84	36.7	(30.4-42.9)	
Marital status							0.11
Married/with partner	158	85.4	(80.3-90.5)	166	77.2	(71.6-82.9)	
Single (divorced/widowed)	23	12.4	(7.6-17.2)	43	20.0	(14.6-25.4)	
Never Married	4	2.2	(0.05-4.3)	6	2.8	(0.6-5.0)	
Education							0.32
H.S./GED or less	46	23.4	(17.4-29.3)	67	29.3	(23.3-35.2)	
some college	73	37.1	(30.3-43.9)	84	36.7	(30.4-43.0)	
Bachelors or higher	78	39.6	(32.7-46.5)	78	34.1	(27.9-40.2)	
Income							0.0004
< \$25,000	17	9.0	(4.9-13.2)	38	17.1	(12.1-22.1)	
\$25,000 - \$49,999	37	19.7	(13.9-25.4)	65	29.3	(23.2-35.3)	
\$50,000 - \$99,999	80	42.6	(35.4-49.7)	86	38.7	(32.3-45.1)	
> \$99,000	54	28.7	(22.2-35.3)	33	14.9	(10.1-19.6)	
BMI							0.78
< 25	59	29.9	(23.5-36.4)	74	32.3	(26.2-38.4)	
>=25 and < 30	66	33.5	(26.9-40.2)	70	30.6	(24.6-36.6)	
>= 30	72	36.5	(29.8-43.3)	85	37.1	(30.8-43.4)	
Smoking Status							0.52
Current	23	12.0	(7.3-16.6)	33	15.6	(10.6-20.5)	
Former	74	38.5	(31.6-45.5)	74	34.9	(28.4-41.4)	
Never	95	49.5	(42.3-56.6)	105	49.5	(42.7-56.3)	
Urbanicity^b							0.44
Urban Areas/urban cluster	30	15.2	(10.2-20.3)	29	12.7	(8.3-17.0)	
Rural	167	84.8	(79.7-89.8)	200	87.3	(83.0-91.7)	
Children							0.85
0	53	61.6	(51.1-72.1)	65	65.6	(56.1-75.2)	
1 or 2	22	25.6	(16.2-35.0)	23	23.2	(14.8-31.7)	
3 or more	11	12.8	(5.6-20.0)	11	11.1	(4.8-17.4)	
Health Region							0.04
Southeast	38	19.3	(13.7-24.8)	31	13.5	(9.1-18.0)	
South	35	17.8	(12.4-23.2)	35	15.3	(10.6-20.0)	
West	30	15.2	(10.2-20.3)	49	21.4	(16.0-26.7)	
North	38	19.3	(13.7-24.8)	64	27.9	(22.1-33.8)	
Northeast	56	28.4	(22.1-34.8)	50	21.8	(16.4-27.2)	
Ever told had Cancer							0.97
Yes	24	12.4	(7.7-17.1)	27	12.6	(8.1-17.0)	
No	169	87.6	(82.9-92.3)	188	87.4	(83.0-91.9)	
Ever told had Diabetes							0.52
Yes	17	8.6	(4.7-12.6)	24	10.5	(6.5-14.5)	
No	180	91.4	(87.4-95.3)	205	89.5	(85.5-93.5)	
Hypertension^c							0.99
Yes	73	37.1	(30.3-43.9)	85	37.1	(30.8-43.4)	
No	124	62.9	(56.1-69.7)	144	62.8	(56.6-69.2)	

^aThose whose only treatment/filter method is a water softener and/or those who only drink bottled water have been reclassified as "Do Not Treat/filter" ^bUrban Area (>=50,000 people), Urban cluster (2,500-50,000). Rural (<2,500/anything else) as defined by Census 2010

^cMeasure of hypertension is defined as a participant having systolic blood pressure equal to or greater than 140 mm Hg and/or diastolic blood pressure equal to or greater than 90 mm Hg and/or self-report of currently taking anti-hypertensive medication

Appendix 2

Additional figures

Figure A2I. Distribution of household respondents in the private well water study by census block groups according to what type their home is connected to. Each census block group may represent anywhere between 1-29 household respondents.

