“We Are All Here to Learn”: A Qualitative Study on Perceptions of Private Well Water Testing Within a Rural Latinx Community

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Abstract

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Background: The US Safe Drinking Water Act does not regulate private wells, leaving over 42 million US residents with little regulatory oversight of their water quality. Trends in public water systems suggest that private wells in Latinx communities may have higher nitrate concentrations than wells in other communities. Well stewardship promotion is critical in rural Latinx communities, but few studies have examined their unique barriers and facilitators for well stewardship behaviors such as well water testing. This study sought to identify the barriers and facilitators of private well water testing in Latinx communities.

Methods: We conducted 4 focus groups (FG) with private well users, 2 in Spanish and 2 in English. We recruited 37 participants from the Lower Yakima Valley, WA, a community with a large Latinx population and elevated nitrate concentrations in groundwater. Questions on testing barriers and facilitators were drawn from the RANAS model for water-related health behaviors. Inductive thematic analysis was conducted by two coders to identify common themes.

Results: Although the study sought to investigate barriers and facilitators of testing, themes around barriers and facilitators to well stewardship behaviors, including well maintenance, testing, and treatment, emerged more frequently. Facilitators of well stewardship included strong concerns about well water contamination; knowledge of contamination sources; do-it-yourself (DIY) home repair expertise; a desire for information; and a sense of duty to protect family. Barriers included limited actionable information on testing and treatment as well as

financial costs and time limitations, which may be exacerbated for residents with limited socioeconomic means.

Conclusions: Private well users in this predominantly Latinx community may have increased concerns about well water contamination, but may lack actionable information to act on those concerns. Well stewardship programs should provide actionable information to private well users and make testing and treatment more affordable and convenient. Additionally, programs in rural Latinx communities should leverage community strengths, such as DIY home repair expertise and a commitment to family.

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INTRODUCTION

The US Safe Drinking Water Act does not regulate private wells, leaving over 42 million US residents with little regulatory oversight of their water quality [1]. Therefore, private well users are responsible for ensuring that their water is safe to drink, which includes testing and treating their well water as necessary. According to a survey of domestic wells conducted by the US Geological Survey (USGS) in 48 states, 23% of domestic wells in the US contained one or more contaminants at a concentration exceeding a human health standard [2]. Nitrate is the most common anthropogenic contaminant in private wells [2]. Common anthropogenic sources of nitrate include synthetic fertilizers, fossil fuel combustion, animal waste, and wastewater [3]. The maximum contaminant level (MCL) for nitrate in regulated drinking water sources is 10 mg/L NO_3-N [4].

Consuming water with nitrates above the MCL may lead to methemoglobinemia, developmental effects, and gastrointestinal cancers. Methemoglobinemia, also known as blue baby syndrome, impairs the ability of red blood cells to carry oxygen giving the skin a blue hue. Infants younger than 6 months are particularly susceptible to methemoglobinemia after consuming formula prepared with drinking water that exceed recommended nitrate levels [5]. Left untreated, the condition can be fatal [5].

Some investigators have reported statistically significant associations between nitrate in drinking water and developmental effects such as birth defects and spontaneous abortion, but other investigators have not [5]. The evidence of association is limited by incomplete exposure estimates and other case control study limitations [5]. Stronger evidence exists for the association between nitrite and gastrointestinal cancers such as gastric and colorectal cancer. The relative risk of gastric cancer was 2.5 (95% CI: 1.4, 4.3) at nitrite intakes of ≥ 6 mg/day [6, 7]. The International Agency for Research on Cancer (IARC) determined that nitrate and nitrite are probably carcinogenic to humans (Group 2A) under conditions that result in endogenous

nitrosation [8]. Endogenous nitrosation increases with consumption of cured meats like bacon and decreases with the consumption of vitamin C and antioxidants in fruits and vegetables [8]. Unfortunately, the small number of prospective epidemiology studies on nitrate-related health effects hinders our understanding of this issue.

Nitrate contamination in drinking water supplies is an environmental justice issue disproportionately impacting Latinx communities [9, 10]. Across the United States, public water systems in the top quartile of percent Latinx residents served are nearly three times more likely to exceed 5 mg/L of nitrate than public water systems in the bottom quartile [10]. These disparities may occur because agriculture is the largest input of nitrogen in US water resources [3], and 83% of farm workers are Latinx [11]. We expect a similar trend in communities that rely on private wells.

The Lower Yakima Valley (LYV) in Central Washington is a clear example of this environmental justice issue. LYV is a vast agricultural region with a predominantly Latinx community and a history of nitrate groundwater contamination [12]. Approximately 24,400 or 34% of LYV residents live in unincorporated areas that typically rely on domestic well water [12]. In 2010, the Washington State Department of Ecology estimated that 12% of domestic private well users, or 2,000 people, are exposed to nitrate above the MCL [12]. In 2016, the local groundwater advisory committee (GWAC) contracted USGS to survey 156 domestic water wells distributed across LYV with the purpose of rigorously assessing the valley's baseline water quality [13]. The study observed that 26% of wells had at least one water sample with a nitrate concentration exceeding the MCL [13]. Fortunately, no cases of methemoglobinemia in LYV have been linked to nitrate groundwater contamination [14]. However, action is needed to reduce nitrate exposures and prevent nitrate-related health effects in LYV and other rural Latinx communities.

To effectively promote well stewardship behaviors in rural Latinx communities, we must understand how Latinxs perceive well water quality and how their perceptions shape decisions to test well water. The RANAS model for health behaviors related to water quality can provide an evidence-based framework for understanding well stewardship behavior [15–19]. The model (see Figure 1) is composed of five concepts (Risk, Attitudes, Norms, Ability, and Self-Regulation) drawn from established health behavior theories, including the Health Belief Model, the Integrated Behavioral Model, and Social Cognitive Theory [20–22].

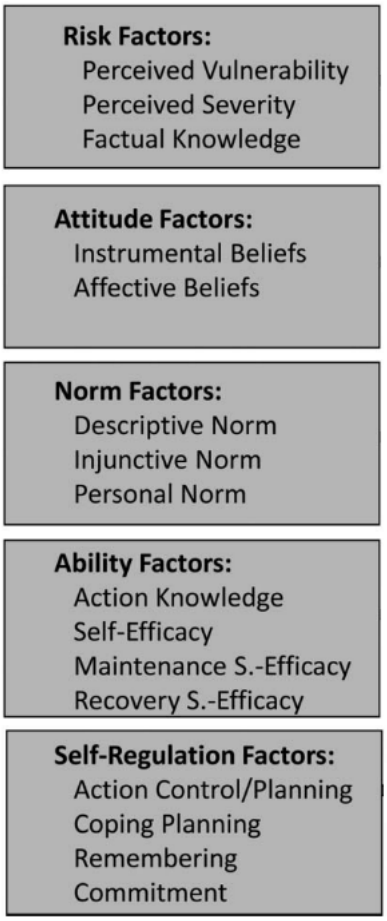

Figure 1. The RANAS model for water safety behaviors. Source: Mosler et al. 2012.

In the RANAS model, risk factors include perceived vulnerability, perceived severity, and factual knowledge [15]. Perceived vulnerability is an individual's beliefs about their chances of getting a disease or condition. Perceived severity is an individual's beliefs about how serious the condition will be. Factual knowledge may or may not inform a person's perceptions of vulnerability and severity. Attitude factors can be either instrumental or affective [15]. Instrumental attitudes are beliefs about the outcomes of a health behavior weighing its costs (time, money, etc.) and benefits (health, savings, etc.). An affective attitude is an individual's emotional response to the idea of the health behavior.

Norm factors include descriptive, injunctive, and personal norms [15]. Descriptive norms are beliefs about whether most people perform the behavior and injunctive norms are beliefs about whether other people approve or disapprove of the behavior. Personal norms are an individual's internal standards regarding the behavior, such as feeling morally obligated to perform the

behavior. Ability factors represent an individual's confidence in their ability to perform a behavior [15]. Action knowledge, or knowing how to perform a behavior, is a pre-condition for having self-efficacy, the confidence in one's ability to act. Maintenance and recovery self-efficacy are beliefs about one's ability to maintain a behavior over time and return to the behavior if a person stops doing the health behavior.

Lastly, self-regulation factors are the strategies individuals use to manage their own behavior despite short-term negative outcomes [15]. These strategies include action control/planning, coping planning, remembering and commitment. Action control is evaluating current behavior by comparing it to a behavioral standard. Action planning is planning how to conduct the behavior, specifying how, when, and where to do it. Coping planning represents the prediction of potential barriers and identifying ways to overcome them. Finally, committing to a health behavior and remember to do it are needed to successfully complete the behavior.

Research shows that a combination of RANAS factors determines well stewardship behaviors. Many may not see the need for testing or treatment due to low perceived risk [23–25], and note the good taste, smell, and clarity of well water [23, 25–28]. Private well users are often satisfied with the quality of their well water and confident that it is safe to drink [23, 25, 28–31]. Attitude factors such as financial cost and inconvenience deter testing and treatment, as well as lack of knowledge and lack of social norms around well stewardship [18, 23–25, 32]. Because the majority of these studies were conducted in primarily white, English-speaking regions, additional research is needed to determine the validity of these results for Latinx communities.

Rural Latinx communities may face different barriers to private well stewardship than white communities and require different health communication strategies. Latinxs tend to have lower household income and educational attainment than whites and are less likely to own their homes [33–35], which are associated with lower rates of testing and treatment [36–39]. Additionally, limited technical and financial capacity in rural communities may impact a

household's ability to cope with contaminated drinking water [40]. Public water systems in rural areas have higher rates of health-related violations [41], and private well users may also have limited financial and technical capacity to test and treat their wells.

Latinx perspectives of water quality may facilitate well stewardship behaviors. In a national survey, more Latinxs agreed that bottled water is safer to drink than tap water [42], and more Latinxs report that they avoid tap water because they believe it can cause illness [43]. Additionally, the cultural and sociopolitical context in Latinx communities should be incorporated into private testing promotion efforts. Latinx health experts call for health communication that appeals to the values of family, cultural traditions, and collectivism and address issues of acculturation, language, generation, and national origin [44]. In our understanding, there are no previous studies on how these factors may impact well stewardship behaviors.

Testing is a critical first step towards ensuring safe drinking water, but some well users report never testing their wells [31, 36, 45, 46] and few testing at recommended frequencies [18, 25, 37, 46, 47]. Additionally, several studies have observed socioeconomic disparities in testing behavior [36, 39]. There is inadequate research reporting on racial or ethnic disparities in well water testing behavior, but surveys conducted among Latinx well users show low testing rates compared to non-Latinx groups from other studies. Vanderslice et al. observed that only 48% of well users in primarily Latinx communities in Central Washington, including LYV, had ever tested their wells [31]. In contrast, surveys conducted in primarily white communities in Canada and the Eastern US report that 78% to 94% of well users have ever tested their well water [18, 25, 29, 38, 47]. This preliminary research suggests that racial/ethnic disparities in testing exist, and culturally-appropriate testing promotion may be needed.

The purpose of this study is to understand perceptions of private well water quality in a predominantly Latinx community and identify the barriers and facilitators of private well water testing reported by those residents. Due to the complexity of behaviors needed for proper well

stewardship, we chose to focus on private well water testing as a critical first step in well stewardship. Additionally, we focused on LYV, an agricultural community in rural central Washington State with elevated nitrate concentrations.

MANUSCRIPT: "WE ARE ALL HERE TO LEARN": A QUALITATIVE STUDY ON PERCEPTIONS OF PRIVATE WELL WATER TESTING WITHIN A RURAL LATINX COMMUNITY

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Methods: We conducted four focus groups (FG) with private well users, two in Spanish and two in English. We recruited 37 participants from the Lower Yakima Valley, WA, a community with a large Latinx population and elevated nitrate concentrations in groundwater. Questions on testing barriers and facilitators were drawn from the RANAS model for water-related health behaviors. Inductive thematic analysis was conducted by two coders to identify common themes.

Results: Although the study sought to investigate barriers and facilitators of testing, themes around barriers and facilitators to well stewardship behaviors, including well maintenance, testing, and treatment, emerged more frequently. Facilitators of well stewardship included strong concerns about well water contamination; knowledge of contamination sources; do-it-yourself (DIY) home repair expertise; a desire for information; and a sense of duty to protect family. Barriers included limited actionable information on testing and treatment as well as financial costs and time limitations, which may be exacerbated for residents with limited socioeconomic means.

Conclusions: Private well users in this predominantly Latinx community may have increased concerns about well water contamination, but may lack actionable information to act on those concerns. Well stewardship programs should provide actionable information to private well users and make testing and treatment more affordable and convenient. Additionally, programs in rural Latinx communities should leverage community strengths, such as DIY home repair expertise and a commitment to family.

Introduction

The US Safe Drinking Water Act does not regulate private wells, leaving over 42 million US residents with little regulatory oversight of their water quality [1]. Therefore, private well users are responsible for ensuring that their water is safe to drink, which includes testing and treating their well water as necessary. According to a survey of domestic wells conducted by the US Geological Survey (USGS) in 48 states, 23% of domestic wells in the US contained one or more contaminants at a concentration exceeding a human health standard [2]. Nitrate is the most common anthropogenic contaminant in private wells [2]. Common anthropogenic sources of nitrate include synthetic fertilizers, fossil fuel combustion, animal waste, and wastewater [3]. The maximum contaminant level (MCL) for nitrate in regulated drinking water sources is 10 mg/L NO_3-N [4]. Consuming water above this concentration may lead to developmental effects, gastrointestinal cancer, and methemoglobinemia [5]. Methemoglobinemia, also known as blue baby syndrome, can be fatal in infants if not treated [5].

Nitrate contamination in drinking water supplies is an environmental justice issue disproportionately impacting Latinx communities [9, 10]. Public water systems in the top quartile of percent Latinx residents served are nearly three times more likely to exceed 5 mg/L of nitrate than public water systems in the bottom quartile [10]. These disparities may occur because agriculture is the largest input of nitrogen in US water resources [3], and 83% of farm workers are Latinx [11]. We expect a similar trend in communities that rely on private wells. For example,

the Lower Yakima Valley (LYV) in Central Washington is home to an agricultural Latinx community with a history of nitrate groundwater contamination [12]. Approximately 24,400 or 34% of LYV residents live in unincorporated areas that typically rely on domestic well water [12]. A USGS survey of domestic water wells in LYV found that 26% of wells had at least one water sample with a nitrate concentration exceeding the MCL [13]. Action is needed to reduce nitrate exposures in rural Latinx communities like LYV.

To effectively promote well stewardship in rural Latinx communities, we must understand how Latinxs perceive well water quality and how their perceptions shape well stewardship behavior. Research shows that private well users are often satisfied with the quality of their well water and confident that it is safe to drink [23, 25, 28–31]. Many note its good taste, smell, and clarity [23, 25–28] and may not see the need for testing and treatment due to low perceived risk [23–25]. Other barriers to testing and treatment include cost, inconvenience, not knowing how to test, and lack of social norms [18, 23–25, 32]. Because the majority of these studies were conducted in primarily white, English-speaking regions, additional research is needed to determine the validity of these results for Latinx communities.

Rural Latinx communities may face different barriers to well stewardship than white communities and require different health communication strategies. Latinxs tend to have lower household income and educational attainment than whites and are less likely to own their homes [33–35], which are associated with lower rates of testing and treatment [36–39]. Additionally, limited technical and financial capacity in rural communities may impact a household's ability to cope with contaminated drinking water [40]. Public water systems in rural areas have higher rates of health-related violations [41], and private well users may also have limited financial and technical capacity to test and treat their wells.

On the other hand, Latinx perspectives of water quality may facilitate well stewardship behaviors. More Latinxs than whites agree that bottled water is safer to drink than tap water and

report that they avoid tap water because they believe it can cause illness [42, 43]. Additionally, health communication in Latinx communities “need to focus on family, cultural traditions, and collectivism while attending to acculturation, language, generation, and national origin” [44]. In our understanding, there are no previous studies on how these factors may impact well stewardship behaviors.

Testing is a critical first step towards ensuring safe drinking water, but some well users have never tested their wells [31, 36, 45, 46] and few test at recommended frequencies [18, 25, 37, 46, 47]. Additionally, several studies have observed socioeconomic disparities in testing behavior [36, 39]. There is little research on racial or ethnic disparities in well water testing behavior, but an initial survey of Latinx well users points to disparities [31]. Vanderslice et al. observed that only 48% of well users in primarily Latinx communities in Central Washington, including LYV, had ever tested their wells [31]. In contrast, surveys conducted in primarily white communities in Canada and the Eastern US report that 78% to 94% of well users have ever tested [18, 25, 29, 38, 47]. This preliminary research suggests that racial/ethnic disparities in testing may exist, and culturally appropriate health information on well water testing is needed.

The purpose of this study is to understand perceptions of private well water quality in a predominantly Latinx community and identify the barriers and facilitators of private well water testing. Due to the complexity of behaviors needed for proper well stewardship, we chose to focus on private well water testing as a critical first step in well stewardship. We focus on LYV, an agricultural community in rural central Washington State with elevated nitrate concentrations.

Methods

We conducted four focus groups (FGs) between November 2018 and January 2019 with private well users in LYV, WA: two in Spanish and two in English. FGs are excellent tools for studying perceptions with cultural sensitivity because they are less intimidating than one-on-one settings,

fit cultures that value collectivism, and shift the power balance from researchers to participants [48–50]. The University of Washington Institutional Review Board determined that this study was exempt from federal human subjects regulations.

Setting

LYV is an agricultural region comprised of many small cities and unincorporated communities. Yakima County ranks 12th in the nation for total value of agricultural products sold and ranks first in the state for the quantity or sales of apples, grapes, hops, cattle, and cow milk [51]. According to the 2013-2017 American Community Survey, census tracts located within LYV have a total population of 60,958, of which 71.4% is Latinx [52]. Many Latinxs work in the agricultural industry, including farm work, warehouse packaging, and other related positions. Compared to the state average, LYV communities have lower household income and a higher percentage of the population with no high school degree [53, 54]. Thirty-four percent of LYV residents are renters [55]. Lastly, 58.2% of the population speaks Spanish [56] and 16% speaks English "less than well" [57]. Table 1 shows these demographic variables for LYV and WA state.

Table 1. Demographics of Lower Yakima Valley compared to Washington State.

Characteristic	Lower Yakima Valley*	Washington State
Race [52] Latinx Non-Latinx White	 71.4% 26.4%	 12.3% 69.8%
Household income [58]	$49,155	$66,174
No high school degree (among population 25 years and over) [54]	36.4%	9.2%
Renters [55]	34.0%	37.3%
Uninsured [59]	16.4%	8.3%
Speaks Spanish [60]	58.2%	8.4%
Speaks English less than "very well" [57]	16.0%	7.6%

Source: 2013-2017 American Community Survey.

*An average of data for census tracts within the Lower Yakima Valley.

Recruitment

We used purposive sampling to recruit individuals based on self-reported private well use, including renters and homeowners. We sampled for both Spanish and English speakers based on self-reported language preference for FG discussion. To avoid sampling individuals involved in community action on groundwater contamination, we excluded individuals who had attended a meeting of the local groundwater management committee. Recruitment was limited to individuals who had one of the following members in their household: a child, a pregnant individual, or an adult 65 years or older. These populations are highly susceptible to health effects related to nitrate and total coliform, which are common well water contaminants in LYV. All participants were 18 years or older. Individuals received $25 for participating.

Partnering with community-based organizations, we used multiple methods to recruit participants including radio, flyers, phone calls, door-to-door canvassing, community meetings and participant referrals. When other methods yielded few English-speaking participants, we cold-called individuals who had participated in a free well water testing program organized by the county. As shown in Table 2, 59% of English FG participants were recruited though the county testing program. Sixty-one percent of Spanish FG participants were recruited through a Spanish-language public radio station. The radio station has an audience of 20,000 listeners and is known as a trusted source of information in the community. A bilingual and bicultural member of the research team (ET) recruited Spanish-speaking participants with Spanish-language materials. Before the FGs, participants completed a phone questionnaire on demographics and well stewardship information.

Table 2. Recruitment methods and recruitment response rates.

Recruitment Method	Response		
	All FGs	English FGs	Spanish FGs
Radio, Spanish language	37%	12%	61%
Radio, English language	0%	0%	0%
County testing program	29%	59%	0%
Flyers	14%	12%	17%
Community meetings and participant referrals	20%	18%	22%
Door-to-door	3%	0%	6%

Data Collection

Each FG lasted 1.5 to 2 hours and was conducted at a community center that serves a large farm worker community and houses the Spanish-language radio station used for recruitment. Participants were identified during the FG sessions by an ID number. A bilingual and bicultural member of the research team (ET) moderated each FG. ET is a research coordinator and resident in LYV with previous training and experience moderating FGs. Because LYV is a close-knit community, ET was known as a trusted research coordinator in the field of environmental and occupational health.

FG questions were informed by the RANAS model for water-related health behaviors [15–17], which has been applied to well water testing previously [18, 19, 37–39]. The RANAS model is composed of five concepts (Risk, Attitudes, Norms, Ability, and Self-Regulation) drawn from health behavior theories such as the Health Belief Model, Integrated Behavioral Model, and Social Cognitive Theory [20–22]. In the first segment of the moderator guide, questions addressed participants' baseline perceptions of well water quality, water-related health risks, and well water testing. In the second segment, participants read an agency factsheet on well water testing. The factsheet communicated agency recommendations for nitrate and coliform bacteria testing, provided information needed to conduct testing, and discussed blue baby syndrome. After reading the factsheet, FG questions focused on the perceptions of well water

testing and intentions to test. ET reviewed the guide for cultural appropriateness. FG questions are provided in Appendix A and the factsheet is provided in Appendix B.

Analysis

FG discussions were audio recorded, transcribed verbatim, and checked for accuracy. A certified translator from the community translated the Spanish transcripts into English. All identifying information was removed during transcription. The English transcripts were analyzed with inductive thematic analysis and ATLAS.ti Version 8 software [61]. This inductive, data-driven approach minimizes researcher bias [62] and is particularly appropriate for studies where researchers do not share the identities of study participants. An initial codebook was developed by identifying main ideas in the four transcripts, clustering similar ideas into groups, and naming and defining the groups. Four other members of the research team reviewed one English FG transcript and provided feedback on the codebook. The final codebook is provided in Appendix C. Two researchers (KAV and DOD) used the final codebook to independently code the transcripts and met regularly to reconcile discrepancies. ET attended reconciliation meetings to provide contextual information and resolve coding disagreements between KAV and DOD. Following the methods outlined by Braun and Clark, we used thematic mapping to identify themes across codes [62]. We constructed an initial map illustrating the relationships between codes. Then we revisited the transcripts, revising the maps until the concepts formed a clear and succinct pattern that accurately represented the data.

Results

A total of 37 people participated in four FGs, with 20 participants in the Spanish FGs and 17 in the English FGs (Table 3). Each FG had 7-11 participants. All the Spanish FG participants and 65% of English FG participants were Latinx. The remaining participants were non-Latinx white. Spanish FG participants tended to be younger and have lower income and educational

attainment than English speakers. Half of the Spanish FG participants worked in agriculture compared to 7% of English participants.

Seventy percent of English FG participants reported ever testing their well water compared to 44% of Spanish FG participants. Bottled water was purchased for in-home use by 59% of English FG participants and 78% of Spanish FG participants. Only two participants reported using water treatment systems capable of removing nitrate; both reported using reverse osmosis systems.

Thematic analysis revealed themes that extended beyond the scope of well water testing, which was our intended research question. Although moderator questions addressed well water testing and not well maintenance or well water treatment, participants in every focus group frequently shifted the conversation towards these other topics. Therefore, the themes presented here represent the barriers and facilitators that are common to the many well stewardship actions that participants discussed, which included well maintenance, testing, treatment, and bottled water use. These themes are 1) concerns about water contamination, 2) desire for information, 3) protecting health, and 4) contextual barriers. See Table 4 for a summary of each theme.

Table 3. Participant demographics and - n (%) or mean (SD)

Characteristic	Total	English Focus Groups	Spanish Focus Groups
Number of participants, n	37*	17	20*
Gender			
Female	19 (54%)	10 (59%)	9 (50%)
Male	16 (46%)	7 (41%)	9 (50%)
Age, years	49 (14)	54 (16)	43 (10)
Race			
Latinx	29 (83%)	11 (65%)	18 (100%)
Non-Latinx White	6 (17%)	6 (35%)	0 (0%)
Income			
< $25,000	11 (31%)	2 (12%)	9 (50%)
$25,000 to $50,000	13 (37%)	5 (29%)	8 (44%)
> $50,000	10 (29%)	10 (59%)	0 (0%)
Declined to answer	1 (3%)	0 (0%)	1 (6%)
Education			
Grade school or junior high	11 (31%)	1 (6%)	10 (56%)
High school or GED	11 (31%)	5 (29%)	6 (33%)
Trade school, associate's degree, college	10 (29%)	9 (53%)	1 (6%)
Graduate school	3 (9%)	2 (12%)	1 (6%)
Home ownership			
Owner	32 (91%)	17 (100%)	15 (83%)
Renter	3 (9%)	0 (0%)	3 (17%)
Employment status			
Full time	16 (46%)	9 (53%)	7 (39%)
Part time	10 (29%)	5 (29%)	5 (28%)
Not employed	9 (26%)	3 (18%)	6 (33%)
Occupation			
Agriculture	7 (27%)	1 (7%)	6 (50%)
Transportation	5 (19%)	4 (29%)	1 (8%)
Social services & administration	4 (15%)	4 (29%)	0 (0%)
Sales, food service, & personal care	3 (12%)	2 (14%)	1 (8%)
Health, sciences & engineering	3 (12%)	2 (14%)	1 (8%)
Construction, installation & maintenance	2 (8%)	0 (0%)	2 (17%)
Other	2 (8%)	1 (7%)	1 (8%)
Have ever tested well water†	20 (57%)	12 (70%)	8 (44%)
Water Treatment			
Purchased water	24 (69%)	10 (59%)	14 (78%)
Water softener	6 (17%)	4 (24%)	2 (11%)
Particle filter	5 (14%)	5 (29%)	0 (0%)
Pitcher, fridge, or faucet-mounted filter	11 (31%)	1 (6%)	10 (56%)
Boil	3 (9%)	2 (12%)	1 (6%)
Carbon filtration POE/POU‡	4 (11%)	2 (12%)	2 (11%)
Reverse osmosis POE/POU‡	2 (6%)	1 (6%)	1 (6%)
Unknown POE/POU‡	2 (6%)	0 (0%)	2 (11%)

*Demographic data for two Spanish FG participants were missing.

†Fifty-nine percent of English participants were recruited from a list of participants in a county private well water testing program.

‡POE: point of entry (treats water for whole house). POU: point of use (treat water at one faucet).

Table 4. Barriers and facilitators of well stewardship among FG participants

Themes	Summary
Concerns about water contamination	**Sources of concern:** Private well users expressed concerns about 1) contamination from nearby agriculture and 2) deposits, discoloration, and foul odors in well water. **Knowledge and expertise:** Private well users demonstrated 1) knowledge of sources and transport of contamination and 2) do-it-yourself (DIY) home repair expertise.
Desire for information	**Seeking information on solutions:** Private well users sought information on how to prevent well water contamination and reduce exposure to contaminants. **Help interpreting results:** Private well users wanted help reading their well reports and asked how to act based on their results. **Limited information on testing:** Many private well users were unaware of agency recommendations on testing and did not have action knowledge needed for testing.
Protecting health	**Idea of sickness is worrying:** Private well users expressed worry about sickness from well water, but specific illnesses were rarely discussed. **Responsibility to protect family:** Private well users discussed their responsibility to protect vulnerable family members.
Contextual barriers	**Cost, time, and technical support:** Financial costs, time limitations, and lack of technical support for well stewardship are burdensome, particularly for families with low socioeconomic status. Bottled water is cheaper and more convenient than water treatment systems. **Renters & shared wells:** Issues of responsibility and collaboration are barriers for renters and shared well users.

Concerns about water contamination

Participants extended and dynamic discussions about well water contamination in which many spoke with a sense of concern, worry, or suspicion. Many stated that they did not drink their well water and instead used it for cooking, cleaning, or gardening. Although they were not asked about sources of well water contamination, participants across all FGs expressed concern about contamination from nearby agricultural activities or sources on their property. Conversations in the English FGs demonstrated a good understanding of the sources and transport of nitrate in the area. These participants described the nuanced processes that transport nitrate through the

environment, discussing manure lagoons at industrial dairies, the use of manure to fertilize crop fields, infiltration into groundwater, and the impact of well depth and water table height on water quality. When discussing potential sickness from well water, one English FG participant relied on her knowledge of the sources and transport of contamination.

> *"Our water doesn't taste horrible if we bypass the filter. However, we know that our water table is really high and we're virtually surrounded by dairies. And so it crosses your mind. You think how much of what's being sprayed right next door is infiltrating the ground around us and then seeping into the water table." (ENG2, P3)*

Participants in both the English and Spanish FGs also contemplated contamination from pesticide application on crop fields and expressed that well water should be tested for pesticides and other agricultural chemicals. Several participants also reflected on the ubiquity of contamination in their communities, mentioning air pollution, surface water contamination, and occupational exposures in addition to groundwater contamination . An exchange between two FG participants demonstrates this sentiment:

> *"P4: Is there actual good water? With all the contaminants in the air? With all the [agricultural] practices? [Background laughter.]*
>
> *P5: Is there such a thing, is that what you're asking?*
>
> *P4: Yes. [Background laughs.] Yeah, is there really such a thing? [Group laughs]" (ENG1)*

In addition to dairies and crop agriculture, Spanish FG participants also considered sources of contamination on their properties, revealing do-it-yourself (DIY) home repair expertise. Many Spanish FG participants raised concerns about discolored or foul-smelling water and deposits left on faucets, pipes, and appliances, as did several English FG participants. Unlike the English FG participants, several Spanish FG participants identified aging piping components as a major

source of contamination. Frustrated with the look and smell of their water, several Spanish FG participants described the actions they had taken to address these issues: opening pipes, discovering extensive corrosion, consulting neighbors, flushing water lines with chlorine, and researching anti-corrosion pipes online. Additionally, one gentleman shared his observations of his employer's well renovation project:

> *"I saw when they took out the steel pipes […] [and] put in another type of material. Since then I was thinking, because if we [live] about half a mile from where he has his well and I could see the tubes that are about this thick, they are like 7 tubes deep and each is about 15 or 20 feet long. […] we can see that although they are made of steel they are falling apart, they are very rusty. That's why I get the idea that it's necessary to do that." (SPAN2, P7)*

Participants in the Spanish FGs also discussed septic tanks as a potential source of contamination in their wells, reflecting on the proximity of their well to neighboring tanks and the need for regular maintenance.

Desire for information

Throughout each FG, participants raised questions about preventing and mitigating well water contamination and many expressed gratitude for information they had received at the FGs. For example, one woman described her need for general well stewardship education:

> *"My father, he is the one that did the maintenance on [the well], put whatever he had to do to make sure that the water was good. He passed away two years ago on [DATE]. Now, I'm new. I saw what he, you know, certain things that he used to do. I don't know anything else, so how do I know if it's good?" (ENG1, P1)*

Spanish FG participants sought information to address the deposits, discoloration, and foul smells they observed in their well water. Some asked questions about basic well water

treatment, describing situations that could be resolved with particle filters and water softeners. Participants across all FGs often used the word “filter” to describe many types of water treatment systems and some expressed confusion about the purpose of different treatment systems. Spanish FG participants with DIY home repair expertise asked detailed questions about pipe corrosion and financial support for well renovations.

Some participants shared that their wells had been tested once or twice in the past. Some reported satisfactory results and others learned that they had elevated nitrate levels or bacterial contamination. Those who had received satisfactory results still sought information about future contamination or contaminants that had not been tested. When asked specifics about the testing procedure, including when to test and what to test for, many participants admitted that they had little knowledge on the topic. Most participants across the four FGs were unaware of government recommendations to test every year for nitrate and total coliform, and only one participant reported testing his well water on a yearly basis. Many participants did not know testing costs or who to contact for testing. Even participants who had tested their wells in the past admitted that they had little knowledge of these specifics. Many had their wells tested by a third party during groundwater monitoring studies, and so had little knowledge of how to test on their own. One woman explained this when the moderator asked if participants knew how to test their well water:

> *“No. We do not know, and like when the lady, one day they were doing it for free. But it is to just to know and they said [the water] was fine, but no, we do not know how to do it.” (SPAN2, P6)*

Lastly, participants who had not tested previously were unfamiliar with the testing process itself, asking if they could purchase a home testing kit or if an inspector would conduct the test at their house.

Participants who had tested their wells expressed the need for assistance in interpreting water quality results. Several participants stated that they did not know the relevant water quality standards and questioned whether the standards were protective of infants and children. After reading the factsheet on nitrate and coliform bacterial testing, several participants asked how they could use contaminated water (e.g. cooking, bathing) and how to improve their water quality.

The need for more information on well stewardship was recognized by participants across all FGs. Although several described their lack of knowledge as a deficit, some participants emphasized it as an opportunity for community learning. For example, one gentleman expressed regret for not knowing more, stating, “I can send my family and myself to the hospital for not paying a little bit of attention” (SPAN1, P9). One woman responded to this participant with an alternate perspective :

> *“[…] I can say that maybe one in 100 people knows this about the water, so do not feel bad saying that you do not know much about water because I think […] that I do not know much either, so do not feel bad. We are all here to learn.” (SPAN1, P5)*

Protecting health

Many participants expressed worry or fear of sickness from contaminated well water, but rarely discussed specific health effects unprompted. This worry about sickness seemed to be based on what could happen, rather than knowledge of specific water-related health effects. An older gentleman shared,

> *“I tried to monitor my health yet not be paranoid. I just went through a nasty gallbladder operation. Anything that happens to me, I wonder is it just getting old or is there something hurting me? […] I’m not sixteen anymore.” (ENG2, P4)*

In contrast, several participants stated their well water had positive or neutral effects on their health. Several said that when a family member gets sick, they drink more well water. Despite positive perceptions of their well water, these participants described water contamination as a concern that "sits in the back of your mind" (ENG1, P5) and emphasized the need to be aware of well contamination issues.

Some participants discussed protecting their family from contaminated water with a strong sense of responsibility. They mentioned children, pregnant women and older adults as particularly vulnerable to water-related health effects. Many participants described testing, buying filters, being aware of contamination, and renovating wells as ways to protect their family's health. Protecting family as a moral obligation was a strong theme in one Spanish FG. When discussing the need for information on well water contamination, a woman in this FG said,

> *"The responsibility always ends with us. We are the owners of our family, of our children, and we are the ones who have to look for what we should do." (SPAN1, P3)*

Contextual barriers

After reading the factsheet and learning about well water testing, participants were asked what makes it difficult to test well water. The most common response from participants across all FGs was financial cost. Additionally, several English FG participants described the installation and maintenance costs of water treatment systems as burdensome, particularly for community members with limited financial means. In contrast, two English FG participants stated that recurring testing costs and reverse osmosis installation were worthwhile in order to protect their families. Participants in three FGs stated that taking time off work is also a major barrier to testing. One Spanish FG participant described how substantial socioeconomic challenges take priority over water quality for community members who have immigrated from Mexico.

"When you arrive here all you do is to think about tomorrow: 'Tomorrow I have to work, I have to do so much and what to eat,' or 'I only have so much,' but [water] is the least you think about." (SPAN1, P5)

Many participants stated that they drank bottled water, but few compared the value of testing and treatment to that of bottled water. One Spanish FG participant stated that well water testing was important in areas where water is said to be good and residents drink their well water. Another participant described how his family tended to purchase bottled water because it was cheaper and more convenient than replacing the filters in his reverse osmosis system. Participants also mentioned other challenges with their treatment systems, including reduced pressure, changes in taste, and distrust filter effectiveness.

Several English FG participants described difficulties receiving adequate technical support and navigating services during well water testing and treatment. These participants expressed that testing laboratories provided insufficient guidance on how to address contaminated well water and water treatment companies often recommended expensive treatment options. Greatly frustrated, one English FG participant described her difficulties treating E. coli in her well, "playing phone tag" with treatment companies, implementing various treatment methods, and still not being satisfied with the quality of her well water. She concluded, "I literally thinking of selling my house and getting out of here" (ENG1, P6).

Finally, renters and residents on shared wells described significant barriers to good water quality. At the start of one Spanish FG, a renter asked with great concern whether she or her landlord was responsible for ensuring the safety of her water. Another woman, one who knew the renter outside of the study, commented that the renter's water smells terrible. The renter explained that her landlord "doesn't want to help." She was grateful to hear that she could test her well water quality independent of her landlord. An English FG participant who shared her well with her neighbor described her difficulties in treating her well for bacterial contamination.

She explained that she did not treat her well because her neighbor drank bottled water and was not interested in treatment. Recalling her thought process at the time, she said, “Well, I’m not doing anything if the neighbor's not doing it” (ENG2, P6).

Discussion

Concerns about well water quality was a major theme across all FGs. Using the RANAS model, this theme can be described as participants’ perceptions of well contamination risk. Although few other studies have observed poor perceptions of well water quality, literature does indicate that perceived risk is a significant predictor of well water testing and treatment. In Maine well users who knew that arsenic risk increases over time were more likely to test their wells for arsenic [18], and those who believed that untreated water is not safe to drink were more likely to treat their water [19]. Additionally, well users in Ontario, CA were more likely to test their wells when they suspected or noticed a problem with their well water [47]. This suggests that FG participants may be better stewards of their wells than the general population.

Perceptions of well contamination risk among private well users is likely based on perceptions of contamination sources and the sensory characteristics of their water. Many participants were concerned about their well water because of the well’s proximity to agriculture, a perceived source of water contamination. This is similar to private well users in Ireland, who perceived nearby anthropogenic sources of contamination, such as agriculture and mining, as larger threats to their well water than geogenic sources of contamination [27]. Participants’ personal experiences living next to and employed in agriculture likely heightened their perceptions of risk. Testing promotion efforts should emphasize that regular testing is needed regardless of a well’s proximity to agriculture.

Additionally, local media may have informed participants’ knowledge and perceptions on the sources of groundwater contamination. Spanish and English-language media in LYV have

covered local groundwater issues, reporting on topics ranging from a lawsuit against local dairies to the actions of the local groundwater management committee [63]. We are not aware of any robust analyses that describe how the coverage of this issue in Spanish and English media differ. English FG participants demonstrated a thorough understanding of the sources and transport of nitrate in their communities, which was not evident in the Spanish FGs. This difference is likely due to our recruitment methods. Fifty-nine percent of English FG participants were recruited from a list of individuals whose wells were tested by the county compared to zero percent of Spanish FG participants. These English FG participants likely had greater knowledge of and interest in well water quality because they had previously volunteered for testing, observed or participated in the testing process, and received their testing results. This knowledge disparity may also be due to limited access to information in Spanish speaking communities, as is common for other health issues [64]. For this reason, future public outreach should prioritize well stewardship promotion within Spanish speaking communities.

Participants used sensory characteristics of their water to form their perceptions of well water quality, which has been well documented in the literature [27, 28]. Well users in previous studies have reported satisfaction with their well water [23, 25, 28–30] and incorrectly assume that water with good taste, smell, and clarity is safe to drink [27]. In contrast, FG participants communicated many issues with discoloration, foul odors, and deposits, particularly in the Spanish FGs. This is an important reminder that well stewardship promotion must address issues of water hardness and aesthetics in addition to potential health risks.

Although participants were knowledgeable about nitrate contamination and highly concerned about their well water contamination, they had limited action knowledge for well water testing and treatment. English FG participants displayed a nuanced understanding of sources and transport of contamination, but they still lacked key information about testing, such as agency recommendations on when to test, who to contact for testing, and interpreting test results. This

difference in knowledge may be influenced by previous media coverage and testing campaigns. Previous studies indicate that media can help with “agenda setting,” pushing individuals to believe they should have an opinion on an issue, but do little to influence action on that opinion [65]. For example, in their 1987 survey on radon testing, Weinstein et al. observed that only 46% of respondents had thought about testing their homes for radon, even though they all lived in a high-risk region and had reported that they knew what radon was [66]. Additionally, because many participants had their wells tested by third parties during groundwater studies and county testing campaigns, few had tested on their own and had not yet gained key action knowledge needed to test again. Knowing who to contact for testing is a significant predictor of testing [19], so this and other action knowledge should be prioritized in public outreach on well stewardship.

Many Spanish FG participants were highly concerned about water contamination and skilled in the field of home maintenance; however, they lacked information on well maintenance and treatment, including basic treatment techniques such as water softeners and particle filters. Action knowledge is an important antecedent of self-efficacy, and self-efficacy is a significant predictor of treatment and well maintenance behavior [19, 47]. The home maintenance expertise and action-oriented perspectives observed in the Spanish FGs represent important community strengths that can be leveraged to foster well stewardship behavior in Latinx communities like the LYV.

Protecting family was a strong motivator for well stewardship among FG participants in this predominantly Latinx community. Familismo, defined as “feelings of loyalty, reciprocity, and solidarity towards members of the family, as well as the notion of the family as an extension of the self,” is an important value in Latinx culture [67]. Thus, it is logical that protecting family emerged as a strong motivator for well stewardship in LYV. In other rural communities, the belief that testing is useful for protecting family was also observed as a significant predictor of

testing behavior [19]. However, this belief is associated with higher income [39], which suggests diverse attitudes about the costs and benefits of well water testing and treatment. FG participants reported significant costs of testing and treatment, including financial cost and taking time off work, which appear to be exacerbated by socioeconomic barriers. Therefore, appeals to protect family members during testing promotion should be accompanied by testing subsidies in rural Latinx communities.

Questionnaire results show that 78% of Spanish FG participants and 59% of English FGs participants purchase their drinking water, and during the FG sessions participants often described drinking bottled water instead of well water. This contrasts with other well water stewardship literature, where the majority of participants report drinking their well water [27, 28]. However, this finding agrees with studies that observe that Latinxs are more likely to drink bottled water than tap water than non-Latinxs whites, due to the belief that tap water would make them sick [42, 43, 68]. Additionally, a survey of well water users in Maine observed that the use of a treatment system was associated with higher income and higher education while drinking bottled water was associated with lower income and lower education [19]. Although treatment for contaminants such as arsenic is more cost-effective than purchased water for households with more than one person [69], our FG results suggest that water treatment is burdensome - involving vigilant maintenance, recurring costs, and uncertainty about treatment effectiveness. Bottled water, in comparison, may be a more sensible choice for well users that are already stressed by limited socioeconomic means.

This was the first study to explore perceptions of private well water testing in a rural Latinx community. Another strength of this study is having a bilingual and bicultural research coordinator from LYV as a member of the research team, moderating the focus groups and participating in data analysis, which increases the validity of study results. Inductive qualitative analysis also proved to be critical in this study, allowing us to capture participant concerns about

treatment and prevention of water contamination even though such topics were outside the intended research question. Because well users do not artificially separate testing from other aspects of well stewardship, community engagement on well water contamination should be sure to address treatment and prevention in addition to testing.

The perspectives shared by FG participants may not be representative of other agricultural Latinx communities because recruitment methods likely sampled participants with increased knowledge on and heightened concern for well water contamination. Additionally, previous media coverage and public outreach has likely increased public awareness of groundwater contamination in LYV. Regardless, results suggest that even highly engaged and knowledgeable private well users face significant barriers to well stewardship, which may be common in other rural communities. Although we believe we reached saturation and themes were validated by a bilingual and bicultural team member from LYV, additional research is needed to explore the impact of acculturation, language, and national origin on well stewardship in Latinx communities.

Conclusion

This study suggests that private well users in this environmental justice community have increased knowledge and concern about well water contamination than well users in other communities. However, even among this group, participants lacked key information needed to complete well stewardship behaviors. Promoting the belief that wells can be contaminated is important for promoting well stewardship in any community, but interventions to increase risk perceptions must be accompanied by action information on testing and treatment. Additionally, within this predominantly Latinx community, home maintenance expertise and a duty to protect family present important facilitators of well stewardship behaviors. Lastly, barriers to well stewardship such as financial cost and time limitations may be exacerbated for Latinx communities with low socioeconomic status. Well stewardship programs in rural Latinx

communities should leverage community strengths and implement interventions that make testing and treatment more affordable and convenient.

CONCLUSION

Lessons learned from this study differ by audience. Here I discuss detailed implications for two stakeholders: the agricultural safety and health research center that supported this work and public health agencies working in the Lower Yakima Valley.

Agricultural Safety and Health Research Center

The Pacific Northwest Agricultural Safety and Health Center (PNASH) at the University of Washington provided technical, financial, and social support for this project. PNASH is a one of the Centers for Agricultural Safety and Health funded by the National Institute for Occupational Safety and Health (NIOSH). The center conducts research and promotes best safety and health practices in the farming, fishing, and forestry industries in the Northwest US [70]. The center has worked for many years in LYV, conducting research on a variety of topics including pesticide exposure, sexual harassment among agricultural workers, and environmental triggers of childhood asthma. The center engages stakeholders to establish research priorities and respond to regional needs, and transfers solutions through outreach and participatory research. Considering their mission and approach we make the following recommendations:

- **Use qualitative methods to understand stakeholder needs and develop effective and culturally relevant interventions**. While quantitative research is crucial to identify and characterize environmental health risks, qualitative research is needed to understand how communities experience and act on these problems [71]. For example, a quantitative approach to private well contamination in LYV could have been testing a sample of private wells and returning results to participants. As was observed in this study, participation in groundwater quality studies does little to promote private well water testing behavior or illuminate strategies for promotion. This study revealed complex psychological processes in the decision to test private water, and highlighted

how LYV residents react to environmental health information in their cultural and socioeconomic context. Qualitative methods can improve PNASH's efforts on health communication, intervention design and evaluation, and data return.

- **Incorporate health behavior theory in environmental and occupational health interventions**. Many environmental and occupational exposures can be controlled through behavior change. Evidence indicates that health interventions based on behavioral science theory are more effective than those that do not use theory [72–74]. Health behavior theories allow researchers to consider multiple psychosocial determinants of behavior and the different levels of behavior change (e.g. individual, organizational, and community) [75]. This study observed a clear community need for knowledge on private well water testing. However, as the RANAS model suggested, perceptions of risk and attitudes about the costs and benefits of testing are also crucial determinants of testing behavior. Health behavior theories that would serve PNASH well in the future include the Health Belief Model and the Transtheoretical Model. The Health Belief Model has been commonly applied to preventative and asymptomatic health issues, such as cancer screening [75]. Many concepts in the RANAS model, such as perceived vulnerability, perceived severity, self-efficacy, and perceived barriers and benefits, were drawn from the Health Belief Model. The Transtheoretical Model is useful when describing the stages of changes a health behavior, moving individuals from a stage where they have never contemplated changing their behavior to contemplating the change, preparing for the change, and then maintaining a new behavior [22].
- **Address community concerns about pesticides in water.** FG participants expressed a clear concern for pesticides in their private wells. There have been few studies on the prevalence of pesticides in LYV private wells. However, in their study of the potential source of groundwater nitrate in LYV, the US Environmental Protection Agency (EPA) observed concentrations of pesticides such as atrazine and alachlor in wells near dairies

and crop fields [76]. Levels of these pesticides did not exceed any established maximum contaminant limits [76]. Additional research is needed to characterize the extent of pesticide contamination in LYV private wells and effective public outreach is needed to communicate the health risks of pesticides in well water.

LYV Public Health Agencies

- **Partner with agencies and universities to develop a well stewardship program in Washington.** Private well users need information and financial and technical support on multiple fronts. Public outreach that promotes testing and provides resources to assist with the treatment process are necessary, but so is support on basic well stewardship such as proper well maintenance, water softeners, and particle filters. FG participants described many issues with deposits and well as the color, odor, and taste of their well water. Although not directly a public health issue, these issues are critical community needs. The Private Well Class, a well stewardship program developed by the Illinois State Water Survey, would serve as an excellent model for public outreach [77]. Potential partners in this work include the Washington State Departments of Ecology and Health, the Rural Community Assistance Partnership, and Yakima Health District.
- **Prioritize action awareness and action knowledge in testing promotion efforts.** Residents in LYV may have a heightened sense of risk due to previous outreach efforts, media coverage, and experiences with environmental and occupational exposures. After tapping into this existing perceptions of risk, private well users need to be made aware of testing as the first step to prevent exposure, and then given the information to carry out that step. A portion of private well users in LYV have tested their wells, but because their wells were tested by other parties (the Groundwater Management Area Advisory Committee, the US EPA, etc.), many do not know how to test on their own.

- **Prioritize Spanish-speaking community during well stewardship outreach.** Spanish FG participants had less knowledge of nitrate contamination in their communities than English FG participants. They had less knowledge of the potential sources and transport of nitrate in the environment. They also reported more water issues related to nuisance and aesthetics than English FG participants, suggesting different needs between language communities.

This study suggests that private well users in this environmental justice community have increased knowledge and concern about well water contamination than well users in other communities. However, even among this group, participants lacked key information needed to complete well stewardship behaviors. Promoting the belief that wells can be contaminated is important for promoting well stewardship in any community, but interventions to increase risk perceptions must be accompanied by action information on testing and treatment. Additionally, within this predominantly Latinx community, home maintenance expertise and a duty to protect family present important facilitators of well stewardship behaviors. Lastly, barriers to well stewardship such as financial cost and time limitations may be exacerbated for Latinx communities with low socioeconomic status. Well stewardship programs in rural Latinx communities should leverage community strengths and implement interventions that make testing and treatment more affordable and convenient.

REFERENCES

1. Dieter CA, Maupin MA, Caldwell RR, Harris MA, Ivahnenko TI, Lovelace JK, et al. Estimated Use of Water in the United States in 2015. Reston, Virginia: U.S. Geological Survey; 2018. https://pubs.usgs.gov/circ/1405/. Accessed 11 Jan 2019.

2. DeSimone LA, Hamilton PA, Gilliom RJ. Quality of Water from Domestic Wells in Principal Aquifers of the United States, 1991-2004: Overview of Major Findings. U.S. Geological Survey; 2009. doi:10.3133/cir1332.

3. Sobota DJ, Compton JE, Harrison JA. Reactive nitrogen inputs to US lands and waterways: how certain are we about sources and fluxes? Frontiers in Ecology and the Environment. 2013;11:82–90.

4. Maximum contaminant levels for inorganic contaminants. 2012.

5. ATSDR. Toxicological Profile For Nitrate and Nitrite. 2017. https://www.atsdr.cdc.gov/toxprofiles/tp204.pdf.

6. Engel LS, Chow W-H, Vaughan TL, Gammon MD, Risch HA, Stanford JL, et al. Population attributable risks of esophageal and gastric cancers. J Natl Cancer Inst. 2003;95:1404–13.

7. Mayne ST, Risch HA, Dubrow R, Chow WH, Gammon MD, Vaughan TL, et al. Nutrient intake and risk of subtypes of esophageal and gastric cancer. Cancer Epidemiol Biomarkers Prev. 2001;10:1055–62.

8. IARC Working Group on the. Ingested Nitrate and Nitrite, and Cyanobacterial Peptide Toxins. Lyon, France: International Agency for Research on Cancer (IARC); 2010.

9. Balazs C, Morello-Frosch R, Hubbard A, Ray I. Social Disparities in Nitrate-Contaminated Drinking Water in California's San Joaquin Valley. Environ Health Perspect. 2011;119:1272–8.

10. Schaider LA, Swetschinski L, Campbell C, Rudel RA. Environmental justice and drinking water quality: are there socioeconomic disparities in nitrate levels in U.S. drinking water? Environ Health. 2019;18:3.

11. U.S. Department of Labor. Findings from the National Agricultural Workers Survey (NAWS) 2015-2016: A Demographic and Employment Profile of United States Farmworkers.

12. Washington State Department of Agriculture, Washington State Department of Ecology, Washington State Department of Health, Yakima County Public Works Department, U.S. Environmental Protection Agency. Lower Yakima Valley Groundwater Quality: Preliminary Assessment and Recommendations Document. 2010. http://www.yakimacounty.us/DocumentCenter/View/2357. Accessed 26 Feb 2018.

13. Huffman RL. Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017. Data Series. Reston, Virginia: U.S. Geological Survey, U.S. Department of Interior; 2018. https://doi.org/10.3133/ds1084.

14. Yakima Health District. Yakima Health District Bulletin. 2014.

15. Mosler H-J. A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: a conceptual model, a review, and a guideline. Int J Environ Health Res. 2012;22:431–49.

16. Inauen J, Tobias R, Mosler H-J. Predicting water consumption habits for seven arsenic-safe water options in Bangladesh. BMC Public Health. 2013;13:417.

17. Inauen J, Mosler H-J. Developing and testing theory-based and evidence-based interventions to promote switching to arsenic-safe wells in Bangladesh. J Health Psychol. 2014;19:1483–98.

18. Flanagan SV, Marvinney RG, Zheng Y. Influences on domestic well water testing behavior in a Central Maine area with frequent groundwater arsenic occurrence. Sci Total Environ. 2015;505:1274–81.

19. Flanagan SV, Marvinney RG, Johnston RA, Yang Q, Zheng Y. Dissemination of well water arsenic results to homeowners in Central Maine: Influences on mitigation behavior and continued risks for exposure. Science of The Total Environment. 2015;505:1282–90.

20. Karen Glanz. Health Behavior and Health Education: Theory, Research, and Practice. 4th edition. San Francisco, CA: Jossey-Bass; 2008.

21. Montaño DE, Kasprzyk D. Theory of Reasoned Action, Theory of Planned Behavior, and the Integrated Behavioral Model. In: Health Behavior and Health Education: Theory, Research, and Practice. 4th edition. San Francisco, CA: Jossey-Bass; 2008.

22. Prochaska JO, Redding CA, Evers KE. Transtheoretical Models and Stages of Change. In: Health Behavior and Health Education: Theory, Research, and Practice. 4th edition. San Francisco, CA: Jossey-Bass; 2008.

23. Jones AQ, Dewey CE, Doré K, Majowicz SE, McEwen SA, David W-T, et al. Public perceptions of drinking water: a postal survey of residents with private water supplies. BMC Public Health. 2006;6:94.

24. Malecki KMC, Schultz AA, Severtson DJ, Anderson HA, VanDerslice JA. Private-well stewardship among a general population based sample of private well-owners. Science of The Total Environment. 2017;601–602:1533–43.

25. Roche SM, Jones-Bitton A, Majowicz SE, Pintar KDM, Allison D. Investigating public perceptions and knowledge translation priorities to improve water safety for residents with private water supplies: a cross-sectional study in Newfoundland and Labrador. BMC Public Health. 2013;13:1225.

26. Fizer C, de Bruin WB, Stillo F, Gibson JM. Barriers to Managing Private Wells and Septic Systems in Underserved Communities: Mental Models of Homeowner Decision Making. Journal of Environmental Health; Denver. 2018;81:8–15.

27. Hooks T, Schuitema G, McDermott F. Risk Perceptions Toward Drinking Water Quality Among Private Well Owners in Ireland: The Illusion of Control. Risk Analysis. 2019;0. doi:10.1111/risa.13283.

28. Jones AQ, Dewey CE, Doré K, Majowicz SE, McEwen SA, Waltner-Toews D, et al. Public perception of drinking water from private water supplies: focus group analyses. BMC Public Health. 2005;5. doi:10.1186/1471-2458-5-129.

29. Chappells H, Campbell N, Drage J, Fernandez CV, Parker L, Dummer TJB. Understanding the translation of scientific knowledge about arsenic risk exposure among private well water users in Nova Scotia. Science of The Total Environment. 2015;505:1259–73.

30. Schwartz JJ, Waterman AB, Lemley AT, Wagenet LP, Landre P, Allee DJ. Homeowner perceptions and management of private water supplies and wastewater treatment systems. Journal of Soil and Water Conservation. 1998;53:315–9.

31. VanDerslice J. Dose-Response of Nitrate and Other Methemoglobin Inducers on Methemoglobin Levels of Infants. US Environmental Protection Agency, Washington State Department of Health; 2007. https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.highlight/abstract/5379/report/F. Accessed 5 Sep 2018.

32. Straub CL, Leahy JE. Application of a Modified Health Belief Model to the Pro-Environmental Behavior of Private Well Water Testing. JAWRA Journal of the American Water Resources Association. 2014;50:1515–26.

33. United States Census Bureau. Current Population Survey, 2017 and 2018 Annual Social and Economic Supplements.

34. United States Census Bureau. Current Population Survey/Housing Vacancy Survey. 2018.

35. United States Census Bureau. Current Population Survey (CPS), October 1990 through 2015.

36. Postma J, Butterfield PW, Odom-Maryon T, Hill W, Butterfield PG. Rural children's exposure to well water contaminants: Implications in light of the American Academy of Pediatrics' recent policy statement. Journal of the American Academy of Nurse Practitioners. 2011;23:258–65.

37. Flanagan SV, Spayd SE, Procopio NA, Chillrud SN, Braman S, Zheng Y. Arsenic in private well water part 1 of 3: Impact of the New Jersey Private Well water testing Act on household testing and mitigation behavior. Sci Total Environ. 2016;562:999–1009.

38. Flanagan SV, Spayd SE, Procopio NA, Chillrud SN, Ross J, Braman S, et al. Arsenic in private well water part 2 of 3: Who benefits the most from traditional testing promotion? Sci Total Environ. 2016;562:1010–8.

39. Flanagan SV, Spayd SE, Procopio NA, Marvinney RG, Smith AE, Chillrud SN, et al. Arsenic in private well water part 3 of 3: Socioeconomic vulnerability to exposure in Maine and New Jersey. Sci Total Environ. 2016;562:1019–30.

40. Balazs CL, Ray I. The Drinking Water Disparities Framework: On the Origins and Persistence of Inequities in Exposure. Am J Public Health. 2014;104:603–11.

41. Allaire M, Wu H, Lall U. National trends in drinking water quality violations. Proc Natl Acad Sci USA. 2018;115:2078–83.

42. Onufrak SJ, Park S, Sharkey JR, Sherry B. The relationship of perceptions of tap water safety with intake of sugar-sweetened beverages and plain water among US adults. Public Health Nutrition. 2014;17:179–85.

43. Hobson WL, Knochel ML, Byington CL, Young PC, Hoff CJ, Buchi KF. Bottled, Filtered, and Tap Water Use in Latino and Non-Latino Children. Arch Pediatr Adolesc Med. 2007;161:457–61.

44. Elder JP, Ayala GX, Parra-Medina D, Talavera GA. Health Communication in the Latino Community: Issues and Approaches. Annual Review of Public Health. 2009;30:227–51.

45. Murti M, Yard E, Kramer R, Haselow D, Mettler M, McElvany R, et al. Impact of the 2012 extreme drought conditions on private well owners in the United States, a qualitative analysis. BMC Public Health. 2016;16. doi:10.1186/s12889-016-3039-4.

46. Swistock BR, Clemens S, Sharpe WE, Rummel S. Water Quality and Management of Private Drinking Water Wells in Pennsylvania. Journal of Environmental Health. 2013;75:60–7.

47. Kreutzwiser R, de Loë R, Imgrund K, Conboy MJ, Simpson H, Plummer R. Understanding stewardship behaviour: factors facilitating and constraining private water well stewardship. J Environ Manage. 2011;92:1104–14.

48. Denzin NK, Lincoln YS. The discipline and practice of qualitative research. In: Handbook of qualitative research. 2nd edition. Thousand Oaks, CA: Sage; 2000.

49. Madriz E. Focus groups in feminist research. In: Handbook of qualitative research. 2nd edition. London: Sage; 2000.

50. Kieffer EC, Salabarria-Pena Y, Odoms-Young AM, Willis SK, Baber KE, Guzman JR. Chapter 7. The Application of Focus Group Methodologies to Community-Based Participatory Research. In: Methods in Community-Based Participatory Research for Health. San Francisco, CA: Jossey-Bass; 2005.

51. US Department of Agriculture, National Agricultural Statistics Service. Yakima County, Washington, County Profile, 2012 Census of Agriculture. 2012. https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/County_Profiles/Washington/cp53077.pdf.

52. American Fact Finder, United States Census Bureau. DP05: ACS Demographic and Housing Estimates. In: 2013-2017 American Community Survey 5-Year Estimates.

53. American Fact Finder, United States Census Bureau. DP03: Selected Economic Characteristics. In: 2013-2017 American Community Survey 5-Year Estimates.

54. American Fact Finder, United States Census Bureau. S1501: Educational Attainment. In: 2013-2017 American Community Survey 5-Year Estimates.

55. American Fact Finder, United States Census Bureau. DP04: Selected Housing Characteristics. In: 2013-2017 American Community Survey 5-Year Estimates.

56. United States Census Bureau, American Fact Finder. S1601: Language Spoken At Home. In: 2012-2016 American Community Survey. United States Census Bureau, American Community Survey Office; 2016. https://factfinder.census.gov/. Accessed 26 Apr 2018.

57. American Fact Finder, United States Census Bureau. B16001: Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over. In: 2013-2017 American Community Survey 5-Year Estimates.

58. United States Census Bureau, American Fact Finder. B19013: Median Household Income in the Past 12 Months (in 2016 Inflation-Adjusted Dollars). In: 2012-2016 American Community Survey. United States Census Bureau's American Community Survey Office; 2013. https://factfinder.census.gov/. Accessed 26 Apr 2018.

59. American Fact Finder, United States Census Bureau. S2701: Selected Characteristics of Health Insurance Coverage in the United States. In: 2013-2017 American Community Survey 5-Year Estimates.

60. American Fact Finder, United States Census Bureau. S1601: Language Spoken at Home. In: 2013-2017 American Community Survey 5-Year Estimates.

61. ATLAS.ti 8. Berlin, Germany: ATLAS.ti Scientific Software Development GmbH; 2018.

62. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3:77–101.

63. Timeline: The fight over clean drinking water in the Yakima Valley. Yakima Herald Republic. 2017. https://www.yakimaherald.com/the-fight-over-clean-drinking-water-in-the-yakima-valley/collection_b5e5d520-1a11-11e7-9bc9-9b9c50fddfbe.html.

64. Berland GK, Elliott MN, Morales LS, Algazy JI, Kravitz RL, Broder MS, et al. Health Information on the Internet: Accessibility, Quality, and Readability in English and Spanish. JAMA. 2001;285:2612–21.

65. Finnegan Jr. JR, Viswanath K. Communication Theory and Health Behavior Change: The Media Studies Framework. In: Health Behavior and Health Education: Theory, Research, and Practice. 4th edition. San Francisco, CA: Jossey-Bass; 2008.

66. Sandman PM, Weinstein ND, Klotz ML. Public Response to the Risk from Geological Radon. Journal of Communication. 1987;37:93–108.

67. Portes A. Segmented assimilation among new immigrant youth: a conceptual framework. In: Rumbaut RG, Cornelius WA, editors. California's Immigrant Children: Theory, Research, and Implications for Educational Policy. San Diego, US: Center for Us-Mexican Studies; 1995. p. 71–76.

68. Scherzer T, Barker JC, Pollick H, Weintraub JA. Water consumption beliefs and practices in a rural Latino community: implications for fluoridation. Journal of Public Health Dentistry. 2010;70:337–43.

69. Sargent-Michaud J, Boyle KJ, Smith AE. Cost Effective Arsenic Reductions in Private Well Water in Maine1. JAWRA Journal of the American Water Resources Association. 2006;42:1237–45.

70. Pacific Northwest Agricultural Safety and Health Center, University of Washington. Overview. Pacific Northwest Agricultural Safety and Health Center. https://deohs.washington.edu/pnash/overview. Accessed 3 May 2019.

71. Brown Phil. Qualitative methods in environmental health research. Environmental Health Perspectives. 2003;111:1789–98.

72. Ammerman AS, Lindquist CH, Lohr KN, Hersey J. The Efficacy of Behavioral Interventions to Modify Dietary Fat and Fruit and Vegetable Intake: A Review of the Evidence. Preventive Medicine. 2002;35:25–41.

73. Legler J, Meissner HI, Coyne C, Breen N, Chollette V, Rimer BK. The Effectiveness of Interventions To Promote Mammography among Women with Historically Lower Rates of Screening. Cancer Epidemiol Biomarkers Prev. 2002;11:59–71.

74. Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. Psychological Bulletin. 2007;133:673–93.

75. Glanz K, Bishop DB. The Role of Behavioral Science Theory in Development and Implementation of Public Health Interventions. Annual Review of Public Health. 2010;31:399–418.

76. U.S. Environmental Protection Agency. Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington. U.S. Environmental Protection Agency; 2013. https://www.epa.gov/sites/production/files/2017-12/documents/lower-yakima-valley-groundwater-report-2013.pdf.

77. Illinois State Water Survey and Illinois Water Resources Center. The Private Well Class: Free Online Training for Homeowners with Water Wells. 2018.

APPENDICES

Appendix A – Focus Group Questions

Baseline Perceptions on Well Water Quality and Testing

I will start with some general questions about well water and well water testing.

A) What does it mean to have safe drinking water? When you hear the term “good water quality,” what do you think of?
B) What do you think about your well water? Tell me about its taste, smell, and appearance.
C) Do you think your well water is safe to drink? Why do you think that?
    i. If someone in your family was sick, would you be worried that well water made them sick? Why or why not?
D) Have you tested your well water? Why or why not?
E) What do you know about well water testing?
    i. Do you know what to test for?
    ii. Do you know when to test?
    iii. Do you know how to test?
F) Do you have any plans to test your well water in the next 3 months? How come?
G) Do your friends, family, or people in your community test their well water? Why/why not?

Reviewing Agency Factsheet

Health information can be shared in different ways. Websites, TV, radio, and brochures are examples. We want to know the best ways to share health information with you. We are going to look at some examples and hear your feedback on them. First we will look at a factsheet about well water.

A. Take a look at this factsheet. If you saw this at the doctor’s office, would you read it? Why or why not?
    i. What catches your eye?
    ii. What doesn’t catch your eye?

Now we are going to read parts of this factsheet. If you have any questions about the factsheet, feel free to interrupt me as we read. [Read first two paragraphs of factsheet, which briefly discuss why wells should be tested and who should be testing.]

B. When you hear this information, what do you think of?

[Read the rest of page 1, which discusses what contaminants to test for, when to test, where to get a test, and how much tests cost.]

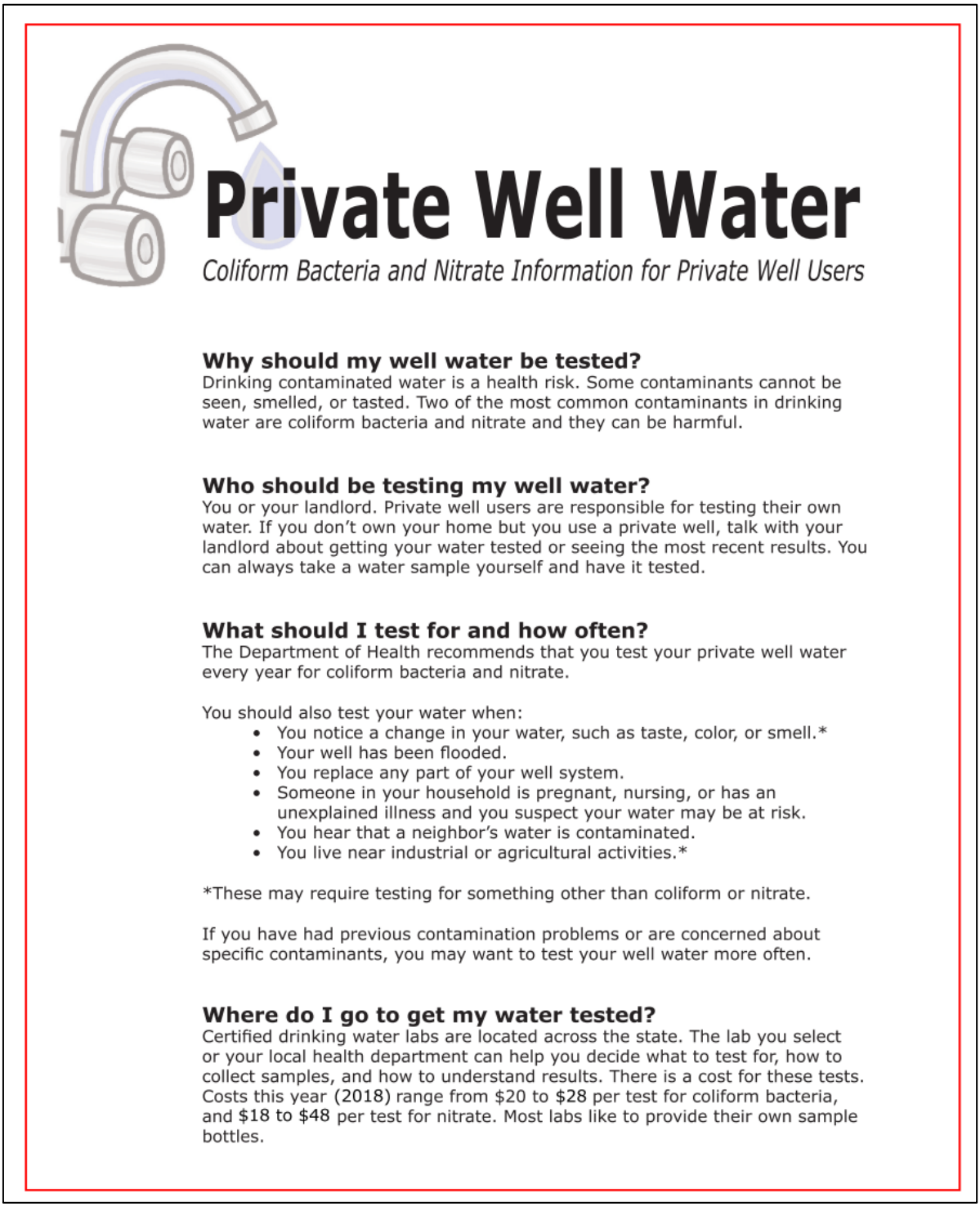
C. Do you have any thoughts about this information?

[Read the insets on page 2, which define nitrate and coliform bacteria and discuss blue baby syndrome.]

D. When you hear this information, what do you think of?
E. To test your water for nitrate, you have to call a certified testing laboratory. There is one in Yakima, one in Union Gap, and one in Sunnyside. You can pick up a bottle from the laboratory. They will give you instructions. Go to a tap in your house or at the well and take off any hoses or filters. Turn on the water and let it run for a couple of minutes. Then you fill up the bottle with water and you have to drop it off at the laboratory within 24 hours. You have to keep the bottle cold and you need to fill out a form with your name and address. The instructions for coliform bacteria are a little different – you need to clean the faucet with bleach, use clean hands, and keep the bottle clean.
    i. What makes it difficult to test your well water?
    ii. Do you feel like you know how to test your well water?
F. Now that you know more about well water testing, would you test your well water in the next 3 months? Why or why not?
G. If we had to convince your friends, family, or neighbors to test their well water, what should we tell them?

Appendix B – Agency Factsheet

The factsheet read by focus group participants was the Washington State Department of Health document number 333-171. The agency's logo was removed and the contact information for the local health district was added to the factsheet. The red boxes indicate which portions of the factsheet were read with focus group participants.



Private Well Water

Coliform Bacteria and Nitrate Information for Private Well Users

Why should my well water be tested?

Drinking contaminated water is a health risk. Some contaminants cannot be seen, smelled, or tasted. Two of the most common contaminants in drinking water are coliform bacteria and nitrate and they can be harmful.

Who should be testing my well water?

You or your landlord. Private well users are responsible for testing their own water. If you don't own your home but you use a private well, talk with your landlord about getting your water tested or seeing the most recent results. You can always take a water sample yourself and have it tested.

What should I test for and how often?

The Department of Health recommends that you test your private well water every year for coliform bacteria and nitrate.

You should also test your water when:

- You notice a change in your water, such as taste, color, or smell.*
- Your well has been flooded.
- You replace any part of your well system.
- Someone in your household is pregnant, nursing, or has an unexplained illness and you suspect your water may be at risk.
- You hear that a neighbor's water is contaminated.
- You live near industrial or agricultural activities.*

*These may require testing for something other than coliform or nitrate.

If you have had previous contamination problems or are concerned about specific contaminants, you may want to test your well water more often.

Where do I go to get my water tested?

Certified drinking water labs are located across the state. The lab you select or your local health department can help you decide what to test for, how to collect samples, and how to understand results. There is a cost for these tests. Costs this year (2018) range from $20 to $28 per test for coliform bacteria, and $18 to $48 per test for nitrate. Most labs like to provide their own sample bottles.

My nitrate level is *less than* 10 ppm, what should I do?

Nitrate levels can vary throughout the year, so if your level is 5 ppm or higher, you may want to re-sample in six months.

My nitrate level is *more than* 10 ppm, what should I do?

If your nitrate test shows levels higher than 10 parts per million, find a different and safe drinking water supply. The quickest thing to do is to begin using bottled water for drinking and food preparation. Do NOT boil water with high nitrate. Boiling water may actually increase the nitrate level, making the problem worse!

Another option is to install a device or filter designed to remove nitrate from your water. These devices are often installed on kitchen faucets, where people get their water for drinking and cooking. Nitrate is not absorbed through the skin, so it is safe to clean and bathe with it.

Other, longer term solutions include:

- Drilling a deeper well into a different groundwater source;
- Connecting to a public water system; or
- Working with others in your community to develop a new public water system to serve your home and nearby neighbors.

My test results came back with coliform in the water, what should I do?

Coliform tests usually come back as SATISFACTORY or UNSATISFACTORY. If you receive a SATISFACTORY report, it means your water was free of these bacteria at the time of the sample. Be sure to test every year for coliform bacteria.

If you receive an UNSATISFACTORY report, it may be contaminated. Do not drink the water until it tests SATISFACTORY. Find a different and safe drinking water supply. The quickest thing to do is either begin using bottled water or boil all water for drinking and food preparation. This also includes water used for making ice or coffee, brushing teeth, and washing fruits and vegetables you eat raw. Boiling water rapidly for one minute usually kills bacteria.

Your lab and local health department can help you determine if you should resample, disinfect your well, or take other action based on your results.

What are coliform bacteria and why should I care?

Coliform bacteria are organisms that are present in the environment and in the feces of humans and animals. Coliform bacteria will not likely cause illness, but their presence in drinking water indicates disease-causing organisms may also be present.

What is nitrate?

Nitrogen is a chemical found in most fertilizers, animal manure, and in septic tanks. Natural bacteria in the soil can change nitrogen into nitrate. Rain water and irrigation water can carry nitrate down through the soil into the groundwater.

What can nitrate do to me?

Too much nitrate in your body makes it harder for red blood cells to carry oxygen. While many people do not notice a difference, this can be very dangerous for infants and pregnant women. Infants exposed to high amounts of nitrate may develop "blue –baby syndrome," a condition that is rare but can be fatal.

What are the symptoms of blue-baby syndrome?

Symptoms can be confused with other illnesses. An infant with mild to moderate blue-baby syndrome may have diarrhea, vomiting, and be lethargic.

In more serious cases, the infant may have:

- skin that becomes gray, darker brown, or blue, or
- lips, finger or toe nails with a blue-like color, or
- trouble breathing.

My test results came back with *both* coliform and nitrate, what should I do?

Find a different and safe drinking water supply. The quickest thing to do is to begin using bottled water for drinking and food preparation. Boiling water kills coliform bacteria, but does not remove nitrate. Do NOT boil water with both coliform and nitrate. It may increase the nitrate level, making the problem worse! See other options under nitrate and coliform above.

My test results came back OK, but I don't like the taste/smell/ appearance of my water. What is wrong with it?

Some contaminants make water smell, taste, or look bad but are not harmful to your health. Your lab and local health department can help you determine if you need to test or treat your water.

What about Home Water Treatment Units? I've heard that these can help.

Point of use (POU) filter systems treat water at a single tap. Point of entry (POE) filter systems treat water used throughout the house.

Three types of systems that can remove nitrate from your water are:

- Reverse Osmosis Unit
- Distillation Unit
- Anion Exchange Unit

Important: All POU and POE filter systems or treatment units need maintenance to operate effectively. If they are not maintained properly, contaminants may accumulate in the units and make your water worse. In addition, some vendors may make claims about their effectiveness that are not based on science. The EPA does not test or certify treatment units, but two organizations that do are NSF International and Underwriters Laboratory.

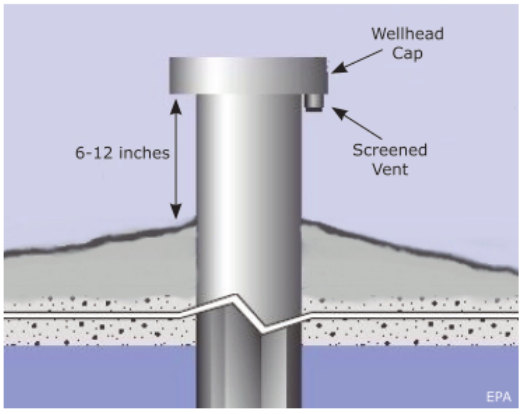
How can I protect my well water from contamination?

Make sure your wellhead extends 6 to 12 inches above the surface of the ground and is capped to keep contaminants out. Seal the ground around the wellhead and slope it away so water does not collect and seep into the well.

It is important to keep your well safe from potential contaminants that may be around your home. The further away from contamination sources, the better.

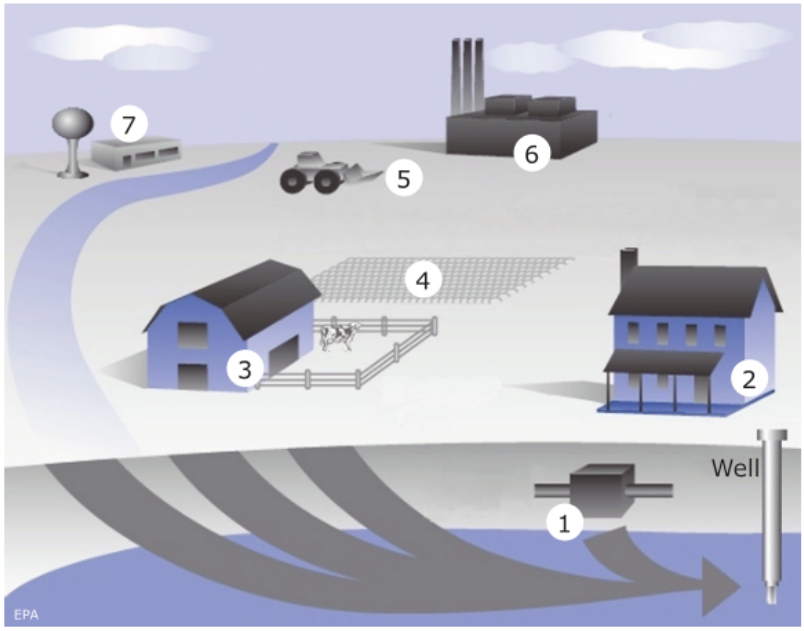
Experts suggest your well should be at least:

- 50 feet from a septic tank,
- 100 feet from the edge of a drainfield, fuel tank, barn, and any storage shed for fertilizers and pesticides, and
- 250 feet from a manure stack.



Potential Well Contaminants

1. Septic Tank
2. Household Wastes
3. Livestock Wastes
4. Pesticides and Fertilizers
5. Landfills
6. Local Industries
7. Underground Storage Tanks



Additional Resources

Local Health Departments
www.doh.wa.gov/LHJMap/LHJMap.htm

Certified Labs in Your Area
www.ecy.wa.gov/apps/eap/acclabs/labquery.asp

Certifying Organizations for Home Water Treatment Units
NSF International (Formerly National Sanitation Foundation), www.nsf.org
Underwriters Laboratory, www.ul.com

Center for Disease Control and Prevention Publications
Private Wells, www.cdc.gov/healthywater/drinking/private/wells/location.html
Emergency disinfection of wells, http://emergency.cdc.gov/disasters/wellsdisinfect.asp

Environmental Protection Agency Publications
Household wells, www.epa.gov/safewater/privatewells/pdfs/household_wells.pdf
Secondary Standards, www.epa.gov/safewater/consumer/2ndstandards.html
Filtration Facts booklet, www.epa.gov/safewater/faq/pdfs/fs_healthseries_filtration.pdf
Source Water Protection, http://cfpub.epa.gov/safewater/sourcewater

Questions about your well?

Yakima Health District
Help Desk Line
509-249-6508

For persons with disabilities, this document is available in other formats.
To make a request, call 1-800-525-0127 or 1-800-833-6388 (TTY/TDD).

Appendix C – Abbreviated & Extended Codebooks

Abbreviated Codebook

1.0 Perception of Water Quality	
1.1 Suspicion of Water	Suspicion of well water and what it could contain.
1.2 Positive Views of Water	Positive comments about well water quality (cleanliness, taste, etc.).
2.0 Perception of Health Risks	
2.1 Water & Health	Comments about how well water gets into a person's body and affects their health.
2.2 Protecting Family	Comments about protecting family members, pets/livestock, and vulnerable groups from well water.
3.0 How to Know If Your Water is Bad	
3.1 Testing/Data	Comments about the value of/desire for testing or data on well water contaminants.
3.2 Clues About Water Quality	Information about sources of contamination sources, well depth, aquifers, and effects on the environment that participants use as clues to figure out if their well is contaminated.
3.3 Look/ Taste/ Smell	Comments about the look/taste/smell of well water or the experience of drinking well water.
4.0 Testing Barriers & Facilitators	
4.1 Costs	Comments about the cost of testing well water.
4.2 Other	Comments about what makes it difficult or easy for a person to test their well water. Does not include cost or lack of education.
5.0 "Educate Us Up"	
5.1 How to Test	Comments about not knowing how to test one's well (who to contact, when to test, etc.).
5.2 Understanding Results	Comments about not knowing how to understand test results for private well water quality.
5.3 How to Prevent/Treat	Lack of knowledge related to constructing a well, maintaining a well, preventing well water contamination, and treating a contaminated well.
5.4 Other	General comments about education or not knowing they had a well.
6.0 Treatment Barriers & Facilitators	
6.1 Costs	Comments about the cost of treating well water.
6.2 "I Still Don't Like It"	Comments about treating well water but still not liking it or knowing if it is safe to drink.
6.3 Other	Comments about what makes it difficult or easy for a person to treat their well water. Does not include cost or lack of education.
7.0 Communication & Sharing Data	
7.1 Preferred Channel	Comments about preferred communication formats for well water information; how participants heard about testing; and where or how information can be disseminated in the community.
7.2 Trusted Sources	Sources that people trust to give them information about well water. Includes comments about sources that are not trusted.

7.3 Feedback on Materials	Feedback shared when reviewing the radionovela, fotonovela, comic, or factsheet. **Subcodes: A: Factsheet, B: Radionovela, C: Fotonovela/Comic.**
7.4 Feedback on Data Visualizations	Feedback shared when reviewing the data visualizations. Subcodes: A: Numbers only, B: Thermometer, C: Histogram, D: Map, E: Other.
8.0 Miscellaneous	
8.1 Responsibility	Comments about who is responsible for preventing/reducing contamination, testing and treating private wells, or being aware of well contamination. Subcodes: A: Dairies/Agriculture, B: Landlords/Shared Wells, C: Well Users, D: Gov./Community.
8.2 Culture, Country of Origin, Language	Comments about culture, country of origin, and language that are connected to water quality, testing, treatment, and communication.
8.3 What Others Do	Comments about what neighbors, family, or countries do to make sure their water is safe to drink.

Extended Codebook

1.0 Perception of Water Quality

Secondary code	1.1 Suspicious of Water
Description	Suspicion of well water and what it could contain.
Includes	• When participants use words like "worry," "concern," "skeptical," or "fear" when describing their well water. • Comments about how all groundwater in the Valley is or will be contaminated. • Comments about how residents should test for contaminants other than nitrate and total coliform.
Excludes	Comments related to health risks. (2.1 or 2.2)
Typical examples	"Is there actual good water? With all the contaminants in the air, with all the practices?" "We're probably sitting on top of a river that runs underneath us so no matter where we dig our well, a new well, it's going to hit the same darn river, you know." "But the problem is that there's only…I've had [my] well tested, what, twice right. There's only two things they test for. What about everything else? What about everything else? That's my question"
Unusual examples	"I really believe that the next round of testing well waters, they should include in the analysis for other chemicals other than nitrate. And the reason for that is because the last testing that was done, this gentleman who is, I believe, a retired physician from Zillah, he mentions that they were also testing for dioxin in the well water. That the previous testing of wells did not, were not designed to identify dioxins or some other herbicides in the well water. Knowing that we are all surrounded by orchards I really believe that the testing should include other chemicals other than nitrate."
Close but no	"If [the nitrate levels are] increasing, then we are all at risk eventually, health wise." (2.1)

Secondary code	1.2 Positive Views of Water
Description	Positive comments about well water quality.
Includes	Comments about how water is clean, tastes good, etc. Being proud of water quality in private well.
Excludes	Comments related to health risks. (2.1 or 2.2)
Typical examples	"I say, 'Try our water. It's terrific,' and I give them a glass and they agree that it tastes really well." "I have not heard someone say that the water is bad; on the contrary, I have heard that they say that there is very clean water."

Secondary code	1.2 Positive Views of Water
Unusual examples	“Good water quality sounds like it’s not quite as good as excellent water quality, that’s what it sounds like to me. Acceptable.”
Close but no	“M: Is it safe to drink? P5: Until I guess until proven otherwise. [Laughs] I’m still drinking it, so.” (2.1)

2.0 Perception of Health Risks

Secondary code	2.1 Water & Health
Description	Comments about how well water gets into a person’s body and affects their health.
Includes	Comments can be about positive, negative, or neutral effects on health. How well water is needed for life. How participants drink well water “until proven otherwise.” How contaminants can get into food from well water. How well water may affect skin while bathing.
Excludes	Concerns about whether standards protect babies or other vulnerable groups. (2.2 & 5.2) Comments about the well water quality that do not mention health. (1.1 or 1.2)
Typical examples	“I think it’s our biggest fear: that we are going to get sick because of the same water we are drinking.” “When we get sick, we do drink more well water, so I can’t say that would be the first, you know that’s not first thing that comes to my mind, is that it’s the water. It’s one of those things that kind of sits in the back of your mind but you don’t like, it doesn’t jump out there.”
Unusual examples	“M: Is it safe to drink? P5: Until I guess until proven otherwise. [Laughs] I’m still drinking it, so.”
Close but no	“P3: P3 wants to know this, the 10 per whatever...is that on an average on an actual human being or are they taking into consideration babies? Just how much this is going to affect, I mean, it’ll be okay for us but how about the baby inside of you? How about the baby that’s a year old or two? I mean how safe is that?” (2.2 & 5.2)

Secondary code	2.2 Protecting Family
Description	Comments about protecting family members, pets/livestock, and vulnerable groups from well water.
Includes	Babies, pregnant women, elderly, immunocompromised people, pets, and livestock. Concerns about whether standards protect babies or other vulnerable groups. (Double code with 5.2)
Excludes	Children or elderly described as trusted sources of information. (7.2) Children's preferences for drinking water. (6.3) Comments from elderly participants about protecting their own health. (2.1) Sentinel animals (animals that show health effects before humans). (3.2)
Typical examples	"I raise animals, I have my grandchildren over, I have my mother over. So my concern is, you know, getting a more in depth test and my concern for not only my family, my animals."
Unusual examples	"P3: P3 wants to know this, the 10 per whatever...is that on an average on an actual human being or are they taking into consideration babies? Just how much this is going to affect, I mean, it'll be okay for us but how about the baby inside of you? How about the baby that's a year old or two? I mean how safe is that?" (Double code with 3.1)
Close but no	"Being the kids in. Teach the youth because these are the ones that need to learn how to [test and mitigate]. And then the youth will bring their parents in, because they, more of these, but an activity that has to do with whatever you're trying to get to." (7.2)

3.0 How to Know If Your Water is Bad

Secondary code	3.1 Testing/Data
Description	Comments about the value of/desire for testing or data on well water contaminants.
Includes	Tests used to create beliefs about water quality. Plans to test during a specific time. Desire for water quality data in a specific region or time. Criticism of water quality standards. Testing for hardness and pH. Comments about how testing is not useful.
Excludes	Specific feedback on data visualizations (7.4) or desire for maps of water quality. (7.4D) Questions about standards protecting babies and other groups of people. (2.2, 5.2)

Secondary code	3.1 Testing/Data
Typical examples	“The test was done, I qualify for a reverse osmosis. They told us don’t drink the water out the faucet from the household. Cook with the reverse osmosis… I’m not scared of my water because I barely qualify.” “I’d like to test in the winter and I can test in the summer too. During irrigation and other weather-wise. I think twice a year would be ideal for us.” “P2: It's just that when they put in the regulations and the limits of saying, “Ok, ten milligrams per liter is harmful,” and if P1 is at 9 mg, why does it make it that much safer?”
Unusual examples	“The taste is great, and our tests came back to where, not knowing what the minimum standards are, it was acceptable. It passed human consumption standards, so we, and again we had it tested twice, years ago we had it tested, so I am quite proud of our water.” (1.2, 3.1)
Close but no	“That map is okay, but I was looking for dairies and I didn’t see any up there… you should have a marker for dairies.” (7.4D) “My grandpa, parents live like 5 miles away. They live on STREET NAME. They test their water. Their water is perfectly fine. My mom tests her water. It’s decent, but she also buys.” (8.3)

Secondary code	3.2 Clues About Water Quality
Description	Information about sources of contamination sources, well depth, aquifers, and effects on the environment that participants use as clues to figure out if their well is contaminated.
Includes	Specific sources of contamination (dairies, agriculture, disposal of chemicals, “water terrorists,” etc.). Well depth, aquifer, and soil type. Well location or topography (location on hill vs. valley). Sentinel animals (animals that show health effects before humans do). Environmental effects of contamination on wildlife, plants, and surface water.
Excludes	Comments about who is responsible for testing/treating well water or preventing/reducing contamination. (8.1) Comments about how all groundwater is contaminated. (1.1)
Typical examples	When discussing well water contamination: “I just, it really depends on where you live. And how deep your well is. I think.” “However, we know that our water table is really high and we're virtually surrounded by dairies…You think how much of what's

Secondary code	3.2 Clues About Water Quality
	being sprayed right next door is infiltrating the ground around us and then seeping into the water table.”
Unusual examples	N/A
Close but no	“Is there actual good water? With all the contaminants in the air, with all the practices?” (1.1) “They went after them and said, “Well, you need to make some changes to your dairy. You need to put liners in your ponds so it's not seeping into the underground water aquifers and artesian wells.” So I think that kinda died down when they said, “Well, ok, we're taking steps to try to prevent this,” but I don't think it's gonna solve the whole problem. As long as the dairy is there and they're putting more in, cattle in there, they're gonna continue to have that problem.” (8.1A)

Secondary code	3.3 Look/Taste/Smell
Description	Comments about the look/taste/smell of well water or the experience of drinking well water.
Includes	Temperature of water and water deposits. Comments about how you cannot see, taste, or smell nitrates in water.
Excludes	Irrigation water or river water. (3.2) Comments about bottled water. (Not coded) General comments about water quality. (1.1 or 1.2)
Typical examples	“The water is no longer enjoyable. Um, it tends to be warm, on the warm side and not very good tasting.”
Unusual examples	“So if I don't smell it and I don't taste it and I haven't seen anything in the water, it raises an alarm.” (Double code with 1.1)
Close but no	“You’ll see those irrigation spouts pushing manure around the corn fields.” (3.2) “Good water quality sounds like it’s not quite as good as excellent water quality, that’s what it sounds like to me. Acceptable.” (1.2)

4.0 Testing Barriers/Facilitators

Secondary code	4.1 Costs
Description	Comments about the cost of testing well water.
Includes	Ideas about how to make testing more affordable for people.
Excludes	Costs about treating water or buying bottled water. (6.1)

Secondary code	4.1 Costs
Typical examples	“There is a certain population or there’s people that just can't afford 48 dollars. Some people can’t even afford 18 dollars for that matter. You know what I’m saying? I mean it would be nice if it was a little more reasonable...for those people. Or a grant or you know what I’m saying? Like something that would help, like a community fund or something that you know if they were concerned or they need to do that, they would have the money to do so.”
Unusual examples	N/A
Close but no	“But how can you afford to dig deeper because they charge so much per foot?” (6.1)

Secondary code	4.2 Other Testing Barriers & Facilitators
Description	Comments about what makes it difficult or easy for a person to test their well water. Does not include cost or lack of education.
Includes	Comments about inconvenience, issues with shared wells, decreasing property values, distrust in testing laboratories, navigating services, and beliefs that testing is useless because mitigation may not be possible. Ideas about how to address these issues.
Excludes	Comments about cost (4.1), not knowing how to test (5.1), understanding results (5.2), or barriers to treatment. (6.1 or 6.2)
Typical examples	“You see we’re calling them for our answers, we’re playing phone tag with them, we are trying to reach them. They’re making it hard for us to get our results and then when we get them it’s probably time to test the water again.”
Unusual examples	N/A
Close but no	“Sometimes price can be prohibitive. I mean I think there is a certain population or there’s people that just can’t afford 48 dollars.” (4.1) “P6: I’ve heard about [testing] because my mother got her water tested and I talked to the gentleman and I had to go test my water because I thought it was normal because I was a first time home buyer and I was too young to know. Moderator: It was worth your time? P6: No because he didn’t give me answers.” (5.4, 3.1)

5.0 “Educate Us Up”

Secondary code	5.1 How to Test
Description	Comments about not knowing how to test one’s well.
Includes	Not knowing who to contact, where to test, how often to test, how to take a sample, and what to test for.
Excludes	Lack of knowledge about how the samples are analyzed. (4.2 if lack of knowledge is linked to suspicion of labs.) Comments about needing education in general or not knowing they had a well. (5.4)
Typical examples	On the topic of testing: “That’s what I would like to know. My father took care of all that stuff, I didn’t have to, never seen him do it. Do they go to their house? Do they test it? Do you take, I don’t know, that’s what I would like to know.”
Unusual examples	“P1: P1, my daughter worked for the lab, is that the same kind of lab that this is? P8: Is this a medical lab? They probably deal with plasma and blood and that kind of stuff. M: No, it’s a special lab that tests for water, different water sources.”
Close but no	“I’d like to know what kind of equipment is used for testing…It must be something bigger than can fit in the backseat of your corvette or they’d do it right there on the spot right. They have to go back to Yakima, Sunnyside, and get back to you, well there’s always a possibility that they put your results, your little canister, out the wrong label on it and mixed yours up with mine and you didn’t get the right report. If you get it on the spot, all that gray area or a suspicion would be removed.” (4.2)

Secondary code	5.2 Understanding Results
Description	Comments about not knowing how to understand test results for private well water quality.
Includes	Lack of knowledge about: • Water quality standards; • Whether standards protect babies and other vulnerable groups; (double code with 2.2) • Terminology (e.g. satisfactory vs unsatisfactory); and • What to do based on your results (e.g. test every six months).
Excludes	Lack of knowledge about • how to test, (5.1) • how samples are analyzed, (No code) • how to prevent contamination, or (5.3) • how to treat water. (5.3)

Secondary code	5.2 Understanding Results
	Comments about needing education in general or not knowing they had a well. (5.4)
Typical examples	“Instead of like here is your guys’ spreadsheet, you guys want to look at it and sit down and explain it to you step by step like your doctor should do. Explain it to us. Dumb it down. I’m sorry, dumb it down for us, like tell us what exactly we should be looking at.”
Unusual examples	When giving feedback on factsheet: “I want to know, um you know, it says the coliform is either satisfactory or unsatisfactory. Well, what’s satisfactory?” (Double code with 7.3A)
Close but no	Moderator asks who is responsible for making water safe to drink: “Us. Our practices that we do even our day to day products, how we dispose of our products…the thing is that it’s what we do to our properties and how we practice and how we conserve our water and how do we do. It’s basically being, it’s like P8 said, its being more educated, not dumbing down but being more educated and practicing the right way.” (5.4, 8.1C)

Secondary code	5.3 How to Prevent/Treat
Description	Lack of knowledge related to constructing a well, maintaining a well, preventing well water contamination, and treating a contaminated well.
Includes	Questions about renovating wells, maintaining well heads, using water softeners, etc. Questions about how to remove nitrates from water (boiling, straining, filters, etc.). Questions about what treatment system is needed.
Excludes	Knowledge related to testing (5.1) and interpreting test results (5.2). Comments about needing education in general or not knowing they had a well. (5.4)
Typical examples	“How recommendable is it to replace the tubes that go all the way down? What is your advice? Should I leave them like this or could you in some way remove and clean them? Put them in acid and then put them back or what would you recommend? I really do not know.”
Unusual examples	“We hope everyone’s well head is covered, you know, sealed.”
Close but no	On the topic of testing: “That’s what I would like to know. My father took care of all that stuff, I didn’t have to, never seen him do it. Do they go to their house? Do they test it? Do you take, I don’t know, that’s what I would like to know.” (5.1)

Secondary code	5.4 Other Education
Description	General comments about education or not knowing they had a well.
Includes	See above.
Excludes	Lack of knowledge about testing (5.1, 5.2), treatment (5.3), or maintaining well (5.3).
Typical examples	“They should inspect well water especially if you are buying a property because I didn’t know. I thought it, my line was connected to the water of Sunnyside and it wasn’t until I was having problems, like, "Wait. What? I have a well?" “Main thing is educate. Educate, not fear factors.”
Unusual examples	N/A
Close but no	“How do we know? I mean, my water tastes good. It's fresh. I've been living there for 40 years. Never had problems but my father, he is the one that did the maintenance on it, put whatever he had to do to make sure that the water was good. He passed away two years ago on the 15th of December. Now, I’m new. I saw what he, you know, certain things that he used to do. I don’t know anything else, so how do I know if it’s good?” (3.3 and 5.3)

6.0 Treatment Barriers & Facilitators

Secondary code	6.1 Costs
Description	Comments about the cost of treating well water.
Includes	Costs of installation and maintenance. Ideas about how to make treatment more affordable for people. Costs of buying bottled water.
Excludes	Costs of testing water. (4.1)
Typical examples	“But how can you afford to dig deeper because they charge so much per foot?” “Well, we, we drink out of the reverse osmosis and we know it's getting close to our filter's going out and go into the bottled water. And we've gotten used to just buying the bottled water 'cause it's a lot easier. It can add over a hundred dollars just to go out and get the filters and get them back in again and for another six months and you're right back in the same, so we just tend to buy the bottled water and Costco is our friend.” (Double code with 6.3)
Unusual examples	N/A
Close but no	“There is a certain population or there’s people that just can't afford 48 dollars. Some people can’t even afford 18 dollars for that matter.” (4.1)

Secondary code	6.2 “I Still Don’t Like It”
Description	Comments about treating well water but still not liking it or knowing if it is safe to drink.
Includes	Installing treatment and still being frustrated with the water quality. Having treatment systems and not knowing if you can drink the water. (Double code with 5.3)
Excludes	Barriers to water testing or interpreting testing results. (4.1, 4.2, 5.1, or 5.2) Challenges with mitigation once a participant has identified the right mitigation action (e.g. installation or maintenance). (6.1 or 6.3)
Typical examples	“I don’t drink [the water] because I’ve already had it tested. I already had my lines pumped, my house, nothing seems to work. And we had the dairy, the E. coli. They said they’re going to come test the waters again and they never did.” (Double coded with 4.2) “I have that system outside, correct? The water softener and then inside, down where you wash your hands there are filters. There are 2 filters there for the water. There are 2 filters plus this one, combined with that, right? I do not know if that is what helps more so that the water comes out better.” (Double code with 5.3)
Unusual examples	N/A
Close but no	“You see we’re calling them for our answers, we’re playing phone tag with them, we are trying to reach them. They’re making it hard for us to get our results and then when we get them it’s probably time to test the water again.” (4.2) “If we have bad water, can we, we can’t clean it can we? Because it’ll just be restored by more bad water. If you sucked all the water out of your well [background laughter] and then thought, “Well, I took care of that” and [makes sound effect] and you have the same water back in it the next morning. You can’t fix it can you?” (5.3)

Secondary code	6.3 Other Treatment Barriers & Facilitators
Description	Comments about what makes it difficult or easy for a person to treat their well water. Does not include cost or lack of education.
Includes	Comments about inconvenience, kids’ preferences for drinking water, distrust of salesmen, working with a neighbor on a shared well, and difficulty navigating services. Ideas about how to address these issues. Treatment systems installed before house was purchased.

Secondary code	6.3 Other Treatment Barriers & Facilitators
	Comments about preventing pollution such as maintaining septic tanks, covering wellheads, and maintaining wells.
Excludes	Costs or lack of education.
Typical examples	“I have to go test my water from Tri Cities because no one else would do it. When they told me my result they were like yea you can just put Clorox in there. I was like okay and can you come and do it. They were like no you can do it. It’s cheaper for you to do it that way. Yep, I gave them a really bad review on google.” (Double coded with 6.1)
Unusual examples	“Then they changed [the filter] recently. Now my water tastes funny from the reverse osmosis. It tastes really, my kids don’t like it. And so I got bottled water because they won’t drink out of the reverse [osmosis]. I drink out of the, they prefer to drink out of the faucet because it tastes better, so.” (Do not double code with 2.2)
Close but no	“If we have bad water, can we, we can’t clean it can we? Because it’ll just be restored by more bad water. If you sucked all the water out of your well [background laughter] and then thought, “Well, I took care of that” and [makes sound effect] and you have the same water back in it the next morning. You can’t fix it can you?” (5.3)

7.0 Communication & Sharing Data

Secondary code	7.1 Preferred channel
Description	Comments about preferred communication formats for well water information; how participants heard about testing in the past; and where or how information can be disseminated in the community.
Includes	Television, radio, print media, internet, social media. General suggestions about tone (e.g. factual vs. fearful) or phrases to use. Comments expressing gratitude for the focus groups. Specific media organizations, such as Radio KDNA, should be double-coded with 7.2.
Excludes	Feedback specific to the factsheet, radionovela, comic, or fotonovela shown in the focus groups. (7.3A, 7.3B, or 7.3C)
Typical examples	When asked about preferred communication formats, “On our phones, on our computers because [there are] pop-up ads for everything. Just pop up and say, ‘Is your well water safe?’”

Secondary code	7.1 Preferred channel
Unusual examples	"There are some things we all do. We all pay certain bills, we all need to get our hair cut or we all need to do certain things periodically. At those places post it, at those clinics post it. 'Is your well water safe? Call this free number. It's free. Call a free service or something.' We all go some places. Everybody does." "Main thing is educate. Educate, not fear factors. I get it. This is ugly but I don't think none of us here have, wells that shut down, the health department has shut down."
Close but no	When giving feedback about comic shown at the focus group, "One thing, I work with elderlies…I think it would be a little bit harder for them to read the print. Maybe a little bit bigger for them because...some people have poor sight and I like the big one." (7.3C)

Secondary code	7.2 Trusted Sources
Description	Sources that people trust to give them accurate and useful information about well water contamination. Includes comments about sources that are not trusted.
Includes	A person or an organization: • specifically named (Yakima County, Radio KNDA or Flo from Progressive car insurance); or • generally discussed (a community member, doctors, or drilling companies). Comments about recognizable logos. May be double coded with 7.1
Excludes	Comments about communication formats or when/how to distribute information. (7.1)
Typical examples	When asked about trusted sources, "Radio Cadena. I think it's very reliable. We all grew up with it."
Unusual examples	Example of distrust: "Yea because the Culligan came up and did the little [makes a sound], their little colors and then they show their grids and, 'Here's where your water's at. Here's basically it.' And of course it's all…what is it called? The snake oil salesmen that they try to." (Double coded with 6.3)
Close but no	"There are some things we all do. We all pay certain bills, we all need to get our hair cut or we all need to do certain things periodically. At those places post it, at those clinics post it. 'Is your well water safe? Call this free number. It's free. Call a free service or something.' We all go some places. Everybody does." (7.1)

Secondary code	7.3 Feedback on Materials
Description	Feedback shared when reviewing the radionovela, fotonovela, comic, or factsheet. Includes negative, positive, and neutral feedback. Use subcodes only (see below).
Includes	Feedback related to • content (clarity of information, information that is missing, too much information); • design (formatting, pictures, color); • cultural relevance (stereotypes, music, language, etc.).
Excludes	General comments about communication channels (7.1) or trusted sources. (7.2)
Typical examples	"P5: That was like, not that I've ever heard anything like that, but it's just too dramatic, like it's more of a car- not a cartoon. What do you call it? P4: Soap opera? P5: Bingo, you got it."
Unusual examples	N/A
Close but no	When asked about trusted sources of information: "P4: Direct flyer. Yes, those uh, you know the Sunday paper, just put them in and … P6: Don't make the ads small so it's harder to see. You actually have to literally look for that. Make it a little bit like okay." (7.1)
Subcodes	7.3A: Factsheet 7.3B: Radionovela 7.3C Fotonovela/Comic

Secondary code	7.4 Feedback on Data Visualizations
Description	Feedback shared when reviewing the data visualizations. Use subcodes only (see below).
Includes	Includes negative, positive, and neutral feedback. Comments about wanting maps or region-specific water quality data, even if the comments are shared before the data visualizations are shown. (7.4D)
Excludes	Comments about wanting to test seasonally or the need for long-term monitoring. (3.1)
Typical examples	"I've never seen those charts before, but they are very visually, uh, I can understand you know, uh what the problem looks like and for me as a, drinking water from our well, we tell people where we're at and right now I'm glad, we haven't, we're not drinking the water at all. We haven't, I haven't for the last 10 years." (7.4E)

Secondary code	7.4 Feedback on Data Visualizations
	When viewing thermometer chart, “Right now, I’m going to have to put 48 dollars every 6 months to have my nitrates tested.” (7.4B)
Unusual examples	“If there were studies done, we talked earlier about, about uh the zone, the other zone and then the other zone, if there was that available, the data was available, I’d like to know on a sheet like this that you could tell us, you can find out what zone you’re in and if your area has a lot of contamination, it might prompt somebody to go get tested if they’re a B7 zone.” (7.4D)
Close but no	“I’d like to test in the winter and I can test in the summer too. During irrigation and other weather-wise. I think twice a year would be ideal for us.” (3.1)
Subcodes	7.4A: Numbers only 7.4B: Thermometer 7.4C: Histogram 7.4D: Map 7.4E: Other

8.0 Other

Secondary code	8.1 Responsibility for Testing/Treatment
Description	Comments about who is responsible for preventing and reducing contamination, testing and treating private wells, or being aware of well contamination.
Includes	Use subcodes only (see below). Comments about community-wide solutions that involve all stakeholders (8.1D)
Excludes	Comments about how being close to a dairy or other contamination sources indicates whether a well is contaminated. (3.2)
Typical examples	“I’m like with P8, like, so who’s responsible? If the big dairy people are contaminating our water it should, will you be paying the testing or should they because our water was fine then all of the sudden its going bad.” (8.1A) “The responsibility always ends with us. We are the owners of our family, of our children, and we are the ones who have to look for what we should do. It is always our responsibility and we must not wait for someone to come and tell us, we must search.” (8.1C)
Unusual examples	“Most of those who live around us with the exception of the American, they are all renting, no one has gone to do tests, and they have not put a lot of pressure, so they have not done it.” (8.1B, Double code with 8.2 & 8.3)

Secondary code	8.1 Responsibility for Testing/Treatment
Close but no	“However, we know that our water table is really high and we're virtually surrounded by dairies…You think how much of what's being sprayed right next door is infiltrating the ground around us and then seeping into the water table.” (3.2)
Subcodes	8.1A: Dairies and agriculture 8.1B: Landlords or households on a shared well 8.1C: Well users 8.1D: Government & community

Secondary code	8.2 Culture, Country of Origin, Language
Description	Comments about culture, country of origin, and language that are connected to water quality, testing, treatment, and communication.
Includes	Comments about ignorance connected to Mexican heritage. Socioeconomic barriers faced by immigrants. Language barriers faced by monolingual and bilingual residents. Feedback about cultural aspects of educational materials. (Double coded with 7.3)
Excludes	N/A
Typical examples	“Yes, I think it is our ignorance. I come from Mexico. Sometimes we talk to a friend who is also from Mexico where we think that it is okay to drink water from streams. And that is what we say and you know I surely did it. Nevertheless, I think that it is plain ignorance. [INAUDIBLE, 33: 07] different now I think that out of ignorance I can send my family and myself to the hospital for not paying a little bit of attention.” “My parents, they also own a well and I believe the Yakima County also went to go test their water but the same. He was like, ‘Well, here are the results," and they're only Spanish-speaking so they gave it to me. And I’m like, “Well, I don't know how to read it either!’” (Double code with 8.2, 5.2)
Unusual examples	“Most of those who live around us with the exception of the American, they are all renting, no one has gone to do tests, and they have not put a lot of pressure, so they have not done it.” (Double code with 8.1B)
Close but no	N/A

Secondary code	8.3 What Others Do
Description	Comments about what neighbors, family, or countries do to make sure their water is safe to drink.

Secondary code	8.3 What Others Do
Includes	Comments about anyone who is not a participant and whether they test or treat their well water. Comments about other people's perception of well water quality and health effects.
Excludes	Comments about the look/taste/smell of someone else's water. (3.3) Comments about where another person's well is located. (3.2)
Typical examples	"My grandpa, parents live like 5 miles away. They live on independence. They test their water. Their water is perfectly fine. My mom tests her water. It's decent, but she also buys."
Unusual examples	"Most of those who live around us with the exception of the American, they are all renting, no one has gone to do tests, and they have not put a lot of pressure, so they have not done it." (Double code with 8.1B & 8.2)
Close but no	"My grandparents have cows on his [property] and we, I'm sorry, we, we do put manure on our property because that is what fertilizes our alfalfa, but it's not even close to where our well is." (3.2)