University of Oregon
Department of Planning, Public Policy, and Management
Master in Public Administration Capstone Project 2017

Oregon DEQ: Southern Willamette Valley Groundwater Management Area Outreach and Survey

Final Report

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Executive Summary

The Southern Willamette Valley Groundwater Management Area (SWV GWMA) is a 230-square mile boundary that begins at the northern edge of the Eugene/Springfield metropolitan area and extends 100 miles north to Corvallis. In 2001, more than twenty percent of five hundred groundwater drinking samples contained nitrate levels that exceeded Oregon's limit of (7 ppm) of what the Oregon Department of Environmental Quality (DEQ) considers to be safe for consumption; the United States Environmental Protection Agency (EPA) has a threshold of 10 ppm. Over 21,000 residents in the growing cities of Coburg and Junction City, as well as the rural areas in between, rely on this groundwater as their sole source of drinking water.

In 2004, Oregon DEQ designated the SWV GWMA. DEQ formed a stakeholder group known as the Groundwater Management Area Committee, which represents a cross-section of land use sectors in the region. The SWV GWMA Committee makes action and policy recommendations to help guide and inform efforts to reduce nitrate contamination in the SWV GWMA. The Committee partners with many regional associations, city governments, universities, and private landowners. DEQ and another GWMA stakeholder, Lane Council of Governments (LCOG), are the project clients and sponsors funding all research and providing access to information databases.

Perceptions regarding contamination of groundwater vary widely. Rural residents within the SWV GWMA who took part in public focus groups strongly associated color, smell, and taste with safe drinking water. The issue with nitrate contamination in groundwater is that it is colorless, odorless, and tasteless. This study's primary research questions focused on the differences and relationships between knowledge and behaviors. Understanding this relationship is important because encouraging people to make behavioral changes that benefit their health requires that they first have complete information on the potential risks associated with drinking water contaminated with nitrate.

In terms of knowledge, the focus is on answering the following questions: 1) how many people know that a problem exists, 2) to what extent are people concerned about the problem, and 3) whether either of the first two factors are associated with demographics.

In terms of behavior, interest centers on 1) how many people test their water for nitrate and know the risk level in their household, 2) how many people have installed a treatment system that effectively removes nitrate, and 3) which media sources do different demographics use to connect with the world.

Overview

The Oregon Department of Environmental Quality (DEQ) designated the Southern Willamette Valley (SWV) Groundwater Management Area (GWMA) in 2004. Various agencies and

organizations performed extensive groundwater testing and monitoring beginning in the 1980's, but it was ultimately declared due to elevated nitrate concentrations found between 2000 and 2002. Testing of groundwater in this area revealed many contaminants, but nitrate posed the biggest concern because of the high concentrations found throughout the region – over twenty percent of five hundred samples had nitrate levels exceeding the state threshold (7 ppm) set by DEQ, and the federal limit (10 ppm) as determined by the Environmental Protection Agency (EPA).

Since the designation in 2004, Oregon DEQ and other agencies have implemented measures to reduce nitrate concentration in the groundwater. However, since it is a large and widespread problem, the issue needs the help of the public and residents living in the area. To engage the public on the issue of nitrate contamination, residents' perceptions of this problem are important. Past research on this topic has revealed a variety of perception, knowledge, and awareness on the issue. Because of this, organizations like DEQ have trouble figuring out appropriate outreach and education efforts with messages that will resonate with residents. Due to a lack of staffing and funding, the Oregon DEQ reached out to the Masters in Public Administration program at the University of Oregon.

In their second and final year, Masters in Public Administration (MPA) students partake in an applied research project spanning two terms. Students work as consultant groups to address a real-world policy or research project for agencies at local, state, and federal levels in the public or nonprofit sectors. The terminal project serves as a way for students to grow their professional skills, work as a team, and manage a project. Projects can vary from policy analyses, needs assessments, and evaluations.

The Department of Environmental Quality contracted with our group of three MPA students to conduct research on residents within the GWMA. The research was to gain insight into and generate awareness of the issue of groundwater nitrate contamination. Based on the expectations of the Oregon DEQ (see Appendix A), the goal was to craft targeted messaging campaigns surrounding contamination in the GWMA, as well as develop public outreach and education strategies to help inform the public about how to mitigate the risks of drinking water in their area.

Our research team developed a survey to learn about demographics, public perceptions, and information regarding treatment systems and effective outreach methods. To guide our research, we formulated four primary research questions:

1. Are residents aware of the Groundwater Management Area designation?
2. What is the best strategy to raise public awareness of local groundwater contamination?
3. What types of messaging strategies will be most effective with rural residents to encourage water testing, treatment, and public participation?
4. To what extent does the time and effort necessary to test water represent a barrier to residents?

Literature Review

Groundwater monitoring and research in the Southern Willamette Valley Groundwater Management Area began in the 1980's. Once the DEQ designated the GWMA, many Committee members initiated studies and plans to address the issue of nitrate contamination in the groundwater. The following is a list of past research and studies that were most relevant to our research. This section also includes Action Plans constructed by the GWMA Committee. A comprehensive list of previous studies can be found in Appendix B.

- In 2006, the GWMA Committee members were required by the DEQ to craft an Action Plan as a part of the GWMA designation. This document is meant to determine appropriate strategies to reduce the concentration of nitrate in the groundwater. The plan was approved by the DEQ, and represents various stakeholders across the region. The goals of the Action Plan are to:
    - Reduce nitrate concentrations below 7 ppm to eventually rescind the GWMA designation.
    - Inform the public about the issues and health risks related to nitrate contamination in the groundwater.
    - Involve local, state, and federal governments in protection efforts for the drinking water sources in the area.
    - Ensure proper efforts to protect sources of water while still supporting historic land uses (LCOG 2006, 1-2).

- An Action Plan Addendum was released in 2015 as an update to the progress from the Action Plan. The addendum provides an evaluation of the measures implemented previously, and discusses past efforts that have been conducted. The document also serves as a guide to future activities and research in the GWMA (GWMA Committee 2015, 2).

- In 2009, an Oregon State University graduate student, Paris Edwards, studied knowledge and awareness of residents within the area by distributing a survey to 923 randomly selected residents within the SWV GWMA. The survey received a 49 percent response rate, for a total of 451 survey participants (Edwards 2009, 12). The survey first asked about general groundwater terminology for a base scale of knowledge. Then, Edwards asked participants about their own awareness of issues relating to ground and drinking water. The independent variable of interest that these questions meant to determine were mainly socio-economic, but included control variables such as age, gender, education, and income.

Once the data were gathered, Edwards conducted various statistical tests including ANOVA, multivariate regression, and t-tests. Based on these tests, the study found that residents had a general lack of knowledge of the GWMA. The research also found that television and Oregon Public Broadcasting were the two main information sources used by GWMA residents to learn about groundwater issues. Edwards' recommendation was that public service announcements should be made through television, radio, and newspaper (Edwards 2009, 29-30). Additionally, internet was less common than was expected; however, it would be interesting to note the shift in that finding from the time frame of 2009 to 2017.

- As a part of the Action Plan Update, the Partnership to Improve Nutrient Efficiency (PINE) Project (GWMA Committee 2015, 4) began in 2013. Organizations like the EPA, Benton and Linn Counties, LCOG, Upper Willamette Soil & Water Conservation Districts, DEQ, Oregon Department of Agriculture (ODA), Natural Resources Conservation Service, and Willamette Partnership are collaborating on the PINE project. The effort is jointly funded, and involves the Fertilizer Grant from ODA/Benton County, and the EPA. This program aims to assess fertilizer use and address potential shifts in practices to quantify nitrate leaching into groundwater. Goals include:

    - Increasing stakeholder engagement and outreach
    - Assessing current farm practices and new technology for reducing nitrate leaching (GWMA Committee 2015, 4-5)

  The project also includes farmer interviews, lysimetric and groundwater monitoring, and pre- and post-harvest soil samples in Linn, Benton, and Lane Counties. By conducting this project with the involvement and coordination of a multitude of agencies, actions within the GWMA can move in the right direction to decrease duplicative efforts and increase coordination.

- 2013: Oregon DEQ and the GWMA Outreach and Education Team hosted a booth at the Daffodil Festival in Junction City. The effort allowed children to learn about the process of nitrate contamination through interactive activities (Pedersen 2015, 18). No information is available on how effective this effort was, but it is an important activity because it informs children and other participants of the problem of nitrate and groundwater contamination at an early age.

- [NO DATE, BUT ONGOING]: The OSU Extension Service previously hosted roughly 20 outreach events throughout the year, funded through the DEQ's 319 Clean Water Grant Program between 2009 and 2014. Classes used a curriculum designed by OSU Extension for

the SWV GWMA. Classes included well and septic system maintenance, free nitrate screenings, "living on the land" series of classes, and even classroom education in public schools (Pedersen 2015, 18). By offering these classes on a consistent basis, it allowed residents and interested populations to learn about various preventive measures. Additionally, residents may not have known of the issue at a certain point in time, then they found out, and were able to attend classes as they were offered throughout the year. Budget constraints in 2015 prevented this program from continuing.

Study Design and Methodology

Our study included 327 rural residents from a sample frame of 3,500 households without access to municipal water because they live outside the service district of local municipalities. Our group designed a randomized survey for residential participants located at addresses within the SWV GWMA to study public perceptions of nitrate contamination in groundwater.

To test for our independent variable of interest (*Time and Effort*), an identical survey was administered to a Test Group and Control Group. The survey administered to each Group was similar except for the final question. The Control Group was asked to bring a sample of their water to one of several testing facilities located in their area as listed in the materials provided to participants. The Test Group was asked to participate in a follow-up Water Sample Visit, in which go to test participants' water at their residence.

A 20-percent response rate was expected to provide 60 to 70 participants in total. The total response rate for all participants included a combination of the telephone surveys recorded using the following 1 - 5 scale:

1 - Completed
2 - Call back at specified time
3 - Wrong telephone number
4 - No answer
5 - Do not call

Data Collection

Data from Governments and Past Research

GIS

Geographic Information System (GIS) software was used to delineate the SWV GWMA from surrounding city limits as well as identify which addresses and tax lots were located within the

boundary.

Survey questions

To help guide our survey design and research questions, we used information from background research and a review of the relevant literature. Survey questions (see Table 1) were developed with response options for each control variable in addition to the independent variable of interest: *Time and Effort*.

Addresses

We identified all addresses within the GWMA, eliminated those that were non-residential (i.e. commercial, industrial, etc.), and focused only on rural residential addresses. Tax lot data were publicly available for download from the Tax Assessors' website in two of the three counties in the study area (Linn and Benton). Lane Council of Governments supplied the addresses for Lane County, as these otherwise require a fee. The entire sample frame was recorded in an Excel document, where the addresses were ordered alphabetically by city, and numbered 1-3,500.

Voter records

Voter records were obtained from the Oregon Secretary of State through a public request form. The records include all Lane, Linn, and Benton County addresses within the SWV GWMA. The records were received in a text document format and then converted into a .csv format in Excel.

Voter records provided researchers with telephone numbers that corresponded to residential addresses. We then cross-referenced the participant's number and associated tax lot with the voter records. Voter records yielded telephone numbers for 10-percent of the sample frame.

White Pages

Telephone numbers that could not be acquired through voter records were obtained using the whitepages.com online reverse address lookup tool. Researchers manually obtained telephone numbers for an additional 25-percent of the sample frame. Since researchers had telephone numbers for just registered voters in the sample frame, collecting publicly listed telephone numbers from non-registered voters was necessary to eliminate an important source of bias.

Randomization

Online software called Research Randomizer was used to select 1,000 addresses from the sample frame. Each participant was then randomly assigned to the Test Group or Control Group. This randomized selection process ensured that each address within the SWV GWMA had an equal chance of being among those selected for this study. A properly randomized study allows for the results to be generalized across populations, and used for future research and outreach.

Survey

An online version of the survey was designed using the Qualtrics survey software provided by the University of Oregon. Survey participants who received a mail-in survey have the option to take the online version if they feel that is more convenient.

Through this administration, along with the real-time entrance of responses by the researchers calling participants, information was compiled in a spreadsheet. This allowed for fast and accurate processing of the data once all responses were recorded. Another reason for using Qualtrics' software was to create appropriate visualizations to present summaries of single-variable statistics.

It is important to note that through the Qualtrics survey, a "force response" mechanism was implemented to ensure that each question must be answered for the survey to be submitted; this feature ensures the highest validity and reliability possible through online administration since we will not receive any unfinished surveys.

Table 1

Variable	**Survey Selections**	
Treatment *	**Yes/No**	**Has a treatment system been installed?**
Past Testing *	**1-5 scale**	**Is there, or has there been, actionable concern?**
Age	**Numerical**	**Do perceptions change with age?**
Gender	**Multiple choice**	**Do perceptions differ by gender?**
Occupation	**Enter text**	**Does approx. education impact behavior?**
Single- or multi-family	**Multiple choice**	**Could some family members be aware and others unaware?**

Home ownership	**Yes/No**	**Does tenure impact treatment install?**
Years in household	**Numerical**	**Are new residents too new to know?**
Awareness*	**Yes/No**	**Who knows about the problem?**
Facilities	**Yes/No**	**Who knows testing services exist?**
Media sources	**Multiple choice**	**How do people connect with the world?**
Literature	**Yes/No**	**Who has received information?**
Concern*	**1-5 scale**	**Who is concerned about the problem?**
Time and effort **	**Yes/No**	**Does convenience impact testing?**

**Dependent variable of interest*
***Independent variable of interest*

Telephone Recruitment

Participants were contacted via telephone for those who had numbers listed. When researchers contacted participants, responses to the survey were noted in real-time directly into the online survey. 39 participant responses constitute the full sample for which results are reported in this document.

Questions in both groups were identical with exception to the follow-up variable, which differentiates the two groups. Participants were contacted nine days after taking the survey. In the Control Group, participants were asked whether they successfully delivered a sample of their water to a local testing facility. In the Test Group, participants were asked to confirm a time for GWMA researchers to visit their home to take a water sample on a later date.

Mail Recruitment

The list of addresses and unique ID numbers for participants without listed telephone numbers were

given to LCOG who mailed the survey to those on the list. Respondents who mailed in the survey were provided an enclosed return envelope pre-addressed to the Department of Planning, Public Policy and Management at the University of Oregon.

Participants' responses from the online version were received and recorded immediately; those who return the survey through mail will be included this ongoing study that GWMA researchers will continue after the MPA graduate research team leaves the study.

Excel

Qualtrics was used to perform an initial inspection of the data to check for errors, outliers, or any other issues. Aggregated responses were exported from Qualtrics to Excel to perform further statistical tests and data comparisons, as well as to create additional visualizations of the data. This single Excel workbook includes additional worksheets into which data from addresses and voter records were copied to utilize Excel functional analysis tools between datasets.

Analysis and Results

We first performed a Chi-Square test using the Follow-up variable to determine if the two groups were statistically different, both in their survey responses, as well as the follow-up one week after the survey. Researchers then completed two multivariate regression equations, a process that tests the weight of all variables of interest. Then, two binary logistic regressions were performed. This estimates the percentage probability of each independent variable of interest contributing to whether a resident takes a specific action. The multivariate regressions consisted of an equation for Awareness and another for level of Concern, while the binary logistic regressions consisted of a Treatment equation and Testing equation.

Who participated?

A total of 39 participants--11-percent of the sample frame--completed the survey, however, 142 could not be reached and another 97 were wrong numbers. Below we prove response rates as well as summary statistics for the survey variables.

Completed	39	11.11%
Call Back	8	2.47%
Wrong Number	97	29.94%
No Answer	142	43.83%
Do Not Call	41	12.65%
	327	100.00%

Table 2

Variable	Survey Selections	
Treatment *	Yes/No	92% DO NOT treat their water
Past Testing *	1-5 scale	56% have not tested their water
Age	Numerical	62 years
Gender	Multiple choice	15% male, 85% female *(non-generalizable)*
Occupation	Enter text	26% require above High School
Single- or multi-family	Multiple choice	89% single-family
Home ownership	Yes/No	95% homeowners

Years in household	**Numerical**	**87% longer than 10 years**
Awareness	**Yes/No**	**23% are aware**
Facilities	**Yes/No**	**84% know where to test their water**
Literature	**Yes/No**	**74% have NOT received literature**
Concern	**1-5 scale**	**43% at least moderate; 4% extremely**

Are Time and Effort barriers to testing?

We found that the two groups differed greatly during follow-up, indicating that *Time and Effort* represent significant barriers to residents testing their water. (Figure 1) Most notably, none of the twelve Control participants who agreed to deliver a sample did so, while all sixteen of the Test participants who agreed to participate in a follow-up visit had scheduled tentative appointments with researchers.

At the time when participants took the survey, there was no difference between the two groups. This is important because researchers had initially posited that success rates in the Test Group might be different due to a lack of trust for researchers visiting their homes based on the previous experiences of GWMA Committee members.

	During survey				*One week after*			
Observed		Control	Test	Total		Control	Test	Total
	Yes	12	16	28	Yes	0	16	16
	No	7	4	11	No	7	4	11
	Total	19	20	39	Total			27
Expected		Control	Test			Control	Test	
	Yes	14	14	28	Yes	14	14	28
	No	5	6	11	No	5	6	11
	Total	19	20	39	Total	19	20	39
	p	=	0.242695815		p	=	0.000118999	
	Groups are equally as willing to agree				Time & convenience are barriers			

Figure 1

What raises concern?

Researchers ran a multivariate regression with *Concern* as the dependent variable and age, gender, rent/own, years in household, whether GWMA newsletters or literature had been received, and awareness as the variables of interest. (see Appendix C)

Results showed that three independent variables impact concern: awareness, rent/own, and age. (Figure 2) The level of concern reduces by 1.64 on a 1-5 scale for residents who own their homes compared to those who rent, while awareness increases concern by .82 if a participant is "maybe" aware of nitrate contamination and 1.64 if a participant states that "yes", they are aware. Age reduces concern by .02 per year. This is particularly concerning given that the average age of the sample was 62 years.

	Coefficients	*Standard Err.*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6.80396279	1.85364521	3.67058525	0.0009041	3.02342845	10.5844971	3.02342845	10.5844971
Age	-0.0184216	0.01077795	-1.7091894	0.09741039	-0.0404033	0.00356022	-0.0404033	0.00356022
Gender	-0.2423938	0.35573548	-0.6813877	0.50068522	-0.9679211	0.48313353	-0.9679211	0.48313353
Rent/Own	-1.642955	0.79224328	-2.0738012	0.04649367	-3.2587459	-0.0271642	-3.2587459	-0.0271642
Years	-0.018335	0.07334404	-0.2499868	0.80424677	-0.1679212	0.13125112	-0.1679212	0.13125112
Aware	0.81768881	0.23989283	3.40855876	0.00182915	0.32842415	1.30695346	0.32842415	1.30695346
Testing	-0.3489366	0.37207329	-0.937817	0.35558811	-1.1077851	0.40991183	-1.1077851	0.40991183
Literature	-0.3478967	0.41454308	-0.8392292	0.40776612	-1.1933628	0.49756953	-1.1933628	0.49756953

Figure 2

The age variable was statistically significant at the 90-percent level, rather than at the 95-percent level. We use the 90-percent threshold in this case, given the small sample size (n=39) and that the 90-percent level is conventionally used in research, albeit less often.

What raises awareness?

Researchers ran a multivariate regression with *Awareness* as the dependent variables and age, gender, years in household, whether GWMA newsletters or literature had been received, and seven media sources as the independent variables of interest. (see Appendix C)

	Coefficients	*Standard Err.*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3.5238906	1.29643455	-2.71814	0.01132643	-6.1839546	-0.8638266	-6.1839546	-0.8638266
Age	0.02165556	0.01018572	2.12607125	0.04278972	0.0007562	0.04255492	0.0007562	0.04255492
Gender	-0.0108273	0.25421449	-0.0425911	0.96634094	-0.5324323	0.51077779	-0.5324323	0.51077779
Years	0.17267351	0.03761584	4.59044645	9.1547E-05	0.09549218	0.24985484	0.09549218	0.24985484
Television	0.33806305	0.31913115	1.05932329	0.2988378	-0.31674	0.99286608	-0.31674	0.99286608
Radio	0.0739303	0.12030304	0.61453395	0.54400696	-0.1729112	0.32077176	-0.1729112	0.32077176
Newspaper	0.32584374	0.09243573	-3.5250843	0.00153137	-0.5155062	-0.1361813	-0.5155062	-0.1361813
Magazine	0.25072163	0.15161522	1.65367056	0.10977625	-0.0603671	0.56181037	-0.0603671	0.56181037
Social Media	0.20243624	0.08233296	2.45875086	0.02064041	0.03350296	0.37136952	0.03350296	0.37136952
Online News	0.13196467	0.08406887	1.56972093	0.12812662	-0.0405304	0.30445974	-0.0405304	0.30445974
Meetings	-0.3573755	0.27904742	-1.2806981	0.21119225	-0.9299335	0.2151825	-0.9299335	0.2151825
Literature	0.80818322	0.24451075	3.30530753	0.00268441	0.3064886	1.30987784	0.3064886	1.30987784

Figure 3

Results showed that three independent variables significantly raise awareness: GWMA literature, social media, and newspaper. (Figure 3) Just having received literature raises an individual's awareness by .81 on a 1-3 scale (No, maybe, yes), while newspaper and social media can raise awareness by .33 and .20, respectively.

What encourages testing?

Researchers ran a binary logistic regression with *Testing* as the dependent variable and awareness, years in household, knowledge of local testing facilities, and concern as the independent variables of interest. (see Appendix C)

	coeff b	*s.e.*	*Wald*
Intercept	-74.6011	34578.14	4.65E-06
Years	6.326835	2881.511	4.82E-06
Aware	0.483789	0.557446	0.753192
Services	-21.9705	15425.03	2.03E-06
Concern	-0.75922	0.427386	3.155716

Figure 4

Results showed the probability that a participant in the sample had previously tested their water

increases by 6-percent for each year they have lived in the household. (Figure 4) Conversely, this probability decreases by 21-percent once participants become aware of the existence of testing facilities in their area.

Initially, the idea of participants being less likely to have their water tested after becoming aware of testing facilities may appear counterintuitive. However, this result reflects the experiences of researchers who administered the survey to the Control Group. Few had been previously aware of these services, and once they were informed by researchers, the primary response for why participants in the Control group chose not to agree to deliver their water to a facility was inconvenience. A few examples are, "I'm working out of town a lot," "I don't have time," "It sounds like a bother" and "I'm busy over the next few weeks."

What encourages treatment?

Researchers ran a binary logistic regression with *Treatment* as the dependent variable and age, rent/own, years in household, awareness, testing, and concern as the independent variables of interest. (see Appendix C)

	coeff b	*s.e.*	*Wald*
Intercept	-92.5413	55497.25	2.78E-06
Age	-0.25129	0.186151	1.822349
Rent/Own	19.11595	23405.88	6.67E-07
Years	6.71996	2464.483	7.44E-06
Aware	-2.49839	5.03866	0.245861
Testing	-25.4865	3740.909	4.64E-05
Concern	4.242182	4.681602	0.821088

Figure 5

Results showed the probability that a participant in the sample had installed a treatment system increased by 19-percent if they own their home compared to renting. (Figure 5) Years in household further increased this probability by 6-percent per year. However, these results indicate a reduction by 25-percent if the participant had previously tested their water.

The latter of these results might again appear on the surface as a potential outlier. However, renters who are concerned are less likely to get a system, which is expensive to install and maintain, and increases the value of a home they do not own. Moreover, as shown above, previous testing does not raise concern level, particularly since participants largely did not perceive a health risk in water that is clear, odorless, and tasteless.

Discussion

GWMA Committee Meetings

To gather a full picture of the GWMA Committee, we synthesized the meeting minutes since the GWMA designation and first meetings in 2004. By doing this, we could see how committee members acted in the past, where certain pitfalls arose, and how to change for more effective use of time and resources. It is important to note that the GWMA Committee is made up of various stakeholders, such as prominent farmers and community members. LCOG and the OSU Extension Service were the lead agencies funded to work within the GWMA through the DEQ 319 grant, which originated from funding from the EPA.

Research, outreach, and education have been high priorities for the GWMA Committee from its inception. In 2005, the committee announced a joint grant proposal for research, outreach, and education by Oregon State University and their Extension Service, University of Oregon, LCOG, and DEQ (GWMA Committee 2005). Though it was not reported if the committee received the grant, it emphasized the coordination they had from the start of these strategies.

Prior to developing the Action Plan, four target working groups were identified based on needs and strategies to reduce nitrate contamination in the groundwater: Agricultural, Residential, Commercial/Industrial, and Public Water Supply (GWMA Committee 2005). These working groups were formed as subcommittees to analyze specific aspects and report to the group. Once the Action Plan began to be developed in 2005, members of the committee noted the potential problems of listing multiple agencies as responsible parties (GWMA Committee 2005); that could lead to a sort of "free rider" problem where no single agency took charge of implementation. Additionally, once the Action Plan was enacted in April 2006, stakeholders were concerned that strategies that crossed jurisdictions would not have coordination (GWMA Committee 2006).

Following the trend of coordinating efforts, the Benton County Extension Service through OSU took the lead on the DEQ 319 grant in late 2007 (GWMA Committee 2007). This block grant was secured by the Linn, Benton, and Lane County Soil and Water Conservation Districts (SWCD). At this same time, LCOG submitted a grant for pesticide collection and monitoring and an OSU student applied to the Institute of Water and Watersheds to complete a survey of GWMA residents (this OSU student was Paris Edwards - see Appendix B) (GWMA Committee 2007).

In 2014, federal funding for the 319 grant program was significantly reduced. This set off a chain reaction of reduced funding; DEQ significantly reduced grant money available, which led to LCOG and OSU Extension Service having less access to funds as well. At the same timeframe, DEQ reduced their half-time GWMA Coordinator position to a quarter-time employee in response to agency budget reductions. The culmination of these events has made it difficult to maintain the strategies implemented and address other efforts to inform the public through outreach and education programs, and to reduce nitrate contamination in the region (Kalakay 2017).

From 2008 until now, the GWMA Committee meetings have contained a discussion of ideas and updates on prior efforts. Our research into these documents has informed us that there is potential for GWMA Committee meetings to be used more effectively as a tool to reduce concentration of nitrate in the groundwater.

GWMA Community Meeting

On April 21, 2017, our research team presented our study design to the GWMA Committee at the second community meeting of the year. After attending and then presenting, we determined several takeaways from our experience.

A few weeks prior to the meeting, an agenda was sent out, but there was no evidence that committee members and stakeholders collaborated on what would be discussed in the meeting. As there are three to four months between meetings, more coordination in the agenda's development may improve productivity. This finding supports trends we noticed from reviewing previous GWMA Committee meeting minutes. In addition to our presentation, multiple other groups and stakeholders presented to the committee. For example, a researcher who studied nitrate leaching in California revealed the methods farmers were using to monitor and address the problem. While gaining insight into a variety of issues that contribute to groundwater contamination and the solutions being employed in other regions is necessary, there was no plan moving forward for organizations working on similar projects to collaborate amongst themselves to incorporate potential opportunities into their research.

Additionally, during our presentation, we polled the audience to see how many attendees were residents of the GWMA. Of the 30-40 attendees, three lived within the GWMA, and they were all members on the committee. We then asked who had a home water treatment system for nitrate, to which only one of three raised their hand. As highlighted during the meeting by a key employee from DEQ, this poses the problem of representation; if community members are not present, their concerns will not be heard, and their problems will not be addressed. It is important to note that the committee provided us with valuable feedback on our survey and strategies for future steps, which were incorporated into our developing research design.

Relating back to problems of coordination, at the meeting we learned that the Benton County OSU Extension Service is performing a study like the one we are conducting. What was more surprising was that no other committee member was aware of this. After the meeting, we also received an email from Oregon Health Authority that stated they, too, were doing the same study; no committee member was aware of this either. These instances demonstrate a potential lack of overall coordination, communication, and awareness of what is happening and what is being presented at meetings. Therefore, we have crafted recommendations that align directly with the problems we discovered.

Recommendations

Before discussing the recommendations, it is important to note that, while financial feasibility was considered in developing the recommendations, the primary focus was to provide a range of ideas from which the DEQ could choose. Thus, while funding may limit the extent to which the DEQ can engage in the recommended activities, we also provide recommendations for ways to increase funding and capacity for the DEQ and GWMA partners.

Recommendation 1: Increase Stakeholder Collaboration

The DEQ and other GWMA stakeholders can increase collaboration in four ways: increase information sharing throughout the year, use GWMA Committee meetings to build strategic partnerships, provide a space for GWMA community members to meet, and collaborate on grant proposals.

Recommendation 1.1

First, we recommend that the DEQ and other stakeholders use social media (i.e. Facebook, Twitter or LinkedIn) as a platform to share information and communicate work they are doing during the periods between GWMA Committee meetings. This way, the GWMA stakeholders may keep each other up to date on the latest work, research studies, and grant awards. This will then offer greater opportunity for organizations to combine efforts to increase the overall effectiveness of work being done in the GWMA.

Recommendation 1.2

Using social media between GWMA Committee meetings will also improve the amount of collaboration that can occur when the DEQ and other organizations convene at in-person meetings. Therefore, we recommend that the structure of these meetings not only provide a time for presenting new and ongoing work in the GWMA, but also provide a more structured opportunity for subcommittees to collaborate and discuss strategic partnerships. For example, attendees whose work relates to education and outreach will form a subcommittee and be given a period where they can have a discussion within themselves. Providing this structure may also be conducive to new partnerships within GWMA stakeholders that functions to increase the effectiveness of their work.

Recommendation 1.3

Another dimension in which GWMA Committee meetings may be improved is to begin hosting meetings focused solely on providing a space for GWMA residents to meet. This would emphasize the GWMA Committee's mission of increasing participation, as well as provide insight into public perceptions. Doing this would also entail efforts to increase public messaging to increase the number of residents who would attend these meetings.

Recommendation 1.4

Finally, a significant limitation to engaging in optimal education and outreach campaigns is funding. As a result, we recommend that the DEQ work on collaborating with relevant partners when applying for grants. In doing so, the GWMA committee could develop a grant writing subcommittee consisting of employees from multiple organizations that could work together to create more competitive grant proposals. This could increase the chances of being awarded funding,

and therefore increase the overall capacity of GWMA stakeholders. In addition, we advise that the subcommittee rotates which organization sends the application and receives the grant to promote equal responsibility in the application process and equal say in the activities that are funded by the grants.

Recommendation 2: Use Survey Data for Targeted Outreach Campaigns

We recommend using the data from our survey to produce outreach campaigns that target specific demographics, using strategic messaging based on their perceptions, through the media source the demographic is most likely to consume. For instance, if the DEQ wanted to target older demographics in the GWMA, it would be optimal to use messaging that increases the level of concern, and to use television as the primary media source. On the other hand, if the DEQ is looking to target younger demographics the ideal messaging strategy would aim to increase awareness and knowledge of nitrate contamination, and use social media as the primary media outlet.

Recommendation 3: Expand Water Testing Services

Our survey found that time and effort provided an insurmountable barrier to many GWMA residents taking a sample of their tap water to a lab for nitrate testing. We recommend two approaches to decreasing these barriers: conduct an at-home testing service; provide periodic free water testing at community events.

Recommendation 3.1

The at-home water testing program would decrease the amount of time and effort required to get water tested to the extent that we believe the DEQ could provide this service for a small fee without decreasing the number of people who would use the service. In addition, the DEQ could have a "Free Home Water Testing Day" periodically to increase the number of people getting their water testing and improve public relations. In carrying out these services, the DEQ may consider prioritizing elderly and disabled GWMA residents. This recommendation comes from an experience during a telephone interview with a resident who, when asked if they could take a sample of their water to a testing lab, responded, 'I'm mostly blind and my husband is disabled too. Could you come take a sample of our water?' As a result, we believe this service is necessary, and that residents would take advantage of it.

Furthermore, it is understood that, inevitably, some GWMA residents have a negative association with the DEQ. On one hand, we were surprised by the fact that, throughout our surveying, we had no interactions that we would consider hostile. On the other hand, many residents were friendly and open with us. Therefore, we believe that partnering with local universities or high schools in administering at-home tests may increase the number of residents who would use this service. This has the potential to be an effective and inexpensive method for getting more residents to get their tap water tested.

Recommendation 3.2

Next, providing free water testing at community events would also decrease the time and effort needed for residents to test their water; if they are already going to the event they can simply fill up a container with tap water and bring it with them. We understand that this has been done before at the Daffodil Festival, and indeed this was the only occasion in which several of the residents we surveyed had ever gotten their water tested. This suggests that continuing to make testing available at community events may decrease the time and effort necessary for many residents to test their water.

Recommendation 4: Decrease Barriers to Treatment System Installation

To decrease the barriers that prevent GWMA residents from installing in-home treatment systems we recommend partnering with treatment system vendors, and inviting them to attend community events. This would allow both the DEQ and vendors to engage with the public and increase their awareness of the systems that treat for nitrates. Furthermore, using this method would increase business for treatment system vendors, and provide the opportunity for the DEQ to propose offering discounts to residents who attend these events. This approach has the potential both increase public knowledge of the proper nitrate treatment systems, as well as decrease the financial barriers to their installation.

Recommendation 5: Implement Social Media Plan for GWMA

To adopt the comprehensive social media plan (Appendix D) it is first recommended that the DEQ launch social media accounts specifically for the Southern Willamette Valley Groundwater Management Area Committee. There is a link to a Facebook page for the Southern Willamette Valley GWMA on OSU Extension's GWMA page (http://wellwater.oregonstate.edu/swvgwma), however the Facebook page does not exist. In addition to Facebook, our survey suggests that Twitter and Snapchat are the two other social media networks that have the highest potential for reaching GWMA residents. Thus, we recommend creating these and giving administrator status to other GWMA Committee members to optimize the capacity of outreach through social media.

Appendix A

GWMA Research Project Task List

We divided the task list into 3 major categories: survey, outreach and GIS

Survey

Task 1: Perform initial analysis of demographics, well data, etc. to inform survey development.
Task 2: Identify hypotheses/research questions you are seeking to answer.
Task 3: Develop survey to answer research questions.
Task 4: Get survey approval from University
Task 5: Administer survey (after some discussion we have some concern about the potential to administer a digital survey)

- Should include some reference or control group
- Potential differences due to age, economic status, education level

Task 6: Statistical survey results reported in scientific paper format or white paper
Task 7*: Present results/preliminary results at April 20th GWMA meeting
Task 8*: Organize and facilitate community meeting

Outreach

Task 1*: Present results/preliminary results at April 20th GWMA meeting
Task 2*: Organize and facilitate community meeting
Task 3: Create outreach materials that are audience appropriate designed from survey results
Task 4: Develop lessons learned from each task (survey development, administration, meetings, etc.)
Task 5: Create list of next steps for GWMA outreach

GIS

Task 1: Use GIS to analyze demographics and inform survey development and outreach
Task 2: Focus on Coburg and Junction City "neighborhoods" which are artificially designed geographic areas.
Task 3: Verify well elevation data in Groundwater contour flow path model to inform outreach materials.

*Indicates task identified in more than one category

Appendix B

Comprehensive list of previous studies within the GWMA

- 1974 (Safe Drinking Water Act): As required by the Safe Drinking Water Act, the Oregon Health Department (OHD) must receive tests for public drinking water. In the SWV GWMA, OHD found around 112 public water systems that rely on groundwater. These systems must test their water on a routine basis, and samples are determined to have a mixed level of quality. Within the area, at least one in eight systems exceeded ten ppm of nitrate concentration (Altken et al. 2003, 18).

- 1985-1987: Oregon DEQ partnered with local, state, and federal agencies to sample 16 shallow wells (under 75 feet) in Coburg and 29 in North Albany. Of those tested, nine in Coburg had nitrate levels between three and seven parts per million (ppm); the rest had lower than three. In North Albany, eight wells had concentrations above five ppm, and none had above ten ppm (Altken et al. 2003, 12).

- 1989: Oregon Health Division Real Estate Transaction Testing (Altken et al. 2003, 16). Since 1989, ORS 448.271 has required sellers of residential property with domestic wells to test for nitrate and bacteria. The data are routinely submitted, but became difficult to access after 1996, due to staff and resource limitations and poor organization.
    - Between 1989 and 1996, 564 samples were tested from Linn, Lane, and Benton counties in the GWMA. Of those, 34 wells had over ten ppm of nitrate, and 175 had levels between three and ten ppm.

- 1991 & 1993: U.S. Geological Survey's (USGS) Willamette Valley Groundwater Assessment (Altken et al. 2003, 20). The USGS tested 30 wells under high quality control, strict well selection, and under field sampling and lab analysis protocols. Of those tested, four had nitrate concentrations above ten ppm, and six ranged from three to ten ppm. These higher concentrations supported other findings of high contamination around Junction City, Harrisburg, and Coburg.

- 1992-93: Oregon DEQ sponsored a voluntary nitrate testing program that allowed 34 domestic wells to be tested in the Coburg area. Testing quality was considered low, but all samples showed concentrations above three ppm, and six exceeded ten ppm (Altken et al. 2003, 20)

- 1993-1994: Oregon DEQ conducted multiple groundwater assessments in the Willamette Valley. Samples taken between Eugene and Albany documented significant nitrate contamination, as well as other pollutants. 20 percent of wells tested had concentrations above ten ppm, and the highest finding was 31 ppm (DEQ 2003, 4). Additionally, in 1993, DEQ initiated the Statewide Groundwater Quality Monitoring Program. Because of that, 61 wells were sampled in Coburg, Junction City, and Albany-Lebanon Plain between 1993 and 1994. In Coburg, four wells had concentrations above ten ppm; Junction City showed eight wells above ten ppm; and the Albany-Lebanon Plain showed none above ten ppm. These tests found that nitrate is the most common contaminant in Oregon.

- 2000-2002: Oregon DEQ performed two studies to examine reach and concentration of nitrate in shallow groundwater (LCOG 2006, 8). From 2000-2001, a sample of 476 wells found over 20 percent (100 wells) had nitrate equal to or above seven ppm. In 2002, DEQ resampled those that were above seven, and found levels to be consistent with previous tests. Deep wells (75+ feet) examined in 2002 had lower nitrate concentrations.

- 2006: The GWMA Committee formed four groups to aid the development of the DEQ-approved Action Plan. Thus, the committee addressed the Residential Working Group and Agriculture Working Groups. The Residential Working Groups focused on lawn and garden activities, septic systems, and wells. The Agriculture Working Groups focused on pollution control, outreach, and education. In 2006, DEQ, EPA, and others began conducting quarterly groundwater monitoring efforts for nitrate, pesticides, and analyses for stable oxygen and hydrogen isotopes (GWMA Committee 2015, 4). A long-term monitoring program also initiated in 2006. DEQ installed 26 small diameter monitoring wells and received permission from 17 landowners to track their wells. DEQ monitored 25 of those wells quarterly, nine semi-annually, and five annually - only 24 made up the long-term monitoring program. This study tested for pH, specific conductance, dissolved oxygen, temperature, nitrate and sulfate, and the EPA began testing for stable isotopes in 2012. In 2014, a groundwater nitrate evaluation found nitrate increasing for nine well, decreasing for ten, and stable for five (GWMA Committee 2015, 4).

- 2006: Farm Chemical Collection Events (LCOG 2008, 11) sponsored through grant funding acquired by LCOG led to the collection and safe disposal of 90,000 pounds of obsolete fertilizer from 126 growers in Lane County alone.

- 2008: The Lane Council of Governments (LCOG) prepared a Nitrate/Nitrogen budget funded through a U.S. EPA Regional Geographic Initiatives Grant. Goals were to:
    - "Provide a tool for assessing nitrogen/nitrate contributions to groundwater in the GWMA."
    - "Identify and quantify how much nitrogen/nitrate specific land uses are contributing and how much nitrate reduction can be expected as strategies from the GWMA Action Plan are implemented."
    - "Facilitate sound decision-making that results in policy adoption and prioritized strategy development and implementation to reduce nitrate contributions."
    - "Preserve and enhance the health of the aquifer while maintaining traditional and/or locally appropriate land uses. Emphasis on the development of specific voluntary strategies that avoid leaching nitrate to groundwater." (GWMA Committee 2015, 3).

  The project used best available data to estimate nitrate contributions from four sources: agricultural crops, confined animal feeding operations (CAFOs), large on-site sewerage systems, and rural residential septic systems. The study found 96 percent of the total contributions came from CAFOs and agricultural crops. The budget is meant to serve as a planning tool to assess potential land use changes and reduce nitrate contamination

- 2013 & 2014: The GWMA team organized and met with two focus groups, a Rural Residential group and an Agricultural group (GWMA Committee 2013). The goal was to explore barriers to residents having their well water tested and barriers to residents acting to protect groundwater. To the first point, the focus group found that time, knowledge of location of testing facilities, and the belief that you cannot fix the problem anyway were among some of the barriers identified. To the second point, people felt that the big contributors should be identified and address the problem, and that the problem of nitrate contamination was due to a wide range of contribution. The focus groups also found that none of the participants were aware of the GWMA.

- 2013: Oregon DEQ conducted a Public and Private Water Supply Analysis as follow-up to a 2012 USDA study that found pesticides in groundwater wells supplying water to two Corvallis schools. DEQ conducted groundwater testing in the area, and targeted northern Benton County and northwest Linn County. A sample of 33 domestic wells in October 2013 allowed DEQ to share the results with homeowners by letter and public meeting in early 2014. The studies found 9 pesticides detected at low levels, and the most common was desethylatrazine (found in 67% of wells tested) The study also found the average nitrate concentration to be 4.5 ppm (Pedersen 2015, 18).

- 2015: DEQ partners with one Lane County High School Chemistry Class to collect samples of groundwater. Students take samples to the school lab and test for nitrate; then, their

results are compared with DEQ results to check for accuracy. This service allows students to learn about groundwater contamination in their own way (Pedersen 2015, 18).

- April 21, 2016: Committee meeting minutes reflect that GWMA Coordinator position previously held by Audrey Eldridge could not be filled due to budgetary constraints (GWMA Committee 2016). DEQ staff Zach Laboy recommended reducing the number of GWMA meetings from 4 to 2 per year; this was supported by reasoning that such a reduction would reflect the parallel reduction in GWMA progress.

Appendix C (Data)

Multiple Variable Regression - Awareness

Awareness	Intercept	Age	Gender	Years	Received	Television
y =	b0 +	b1 +	b2 +	b6 +	b15 +	b11_1 +

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.8378397
R Square	0.70197536
Adjusted R Sc	0.58055792
Standard Errc	0.56251331
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	20.1232937	1.82939034	5.78150331	9.8574E-05
Residual	27	8.54337297	0.31642122		
Total	38	28.6666667			

	Coefficients	*Standard Err.*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-3.5238906	1.29643455	-2.71814	0.01132643	-6.1839546	-0.8638266
Age	0.02165556	0.01018572	2.12607125	0.04278972	0.0007562	0.04255492
Gender	-0.0108273	0.25421449	-0.0425911	0.96634094	-0.5324323	0.51077779
Years	0.17267351	0.03761584	4.59044645	9.1547E-05	0.09549218	0.24985484
Television	0.33806305	0.31913115	1.05932329	0.2988378	-0.31674	0.99286608
Radio	0.0739303	0.12030304	0.61453395	0.54400696	-0.1729112	0.32077176
Newspaper	0.32584374	0.09243573	-3.5250843	0.00153137	-0.5155062	-0.1361813
Magazine	0.25072163	0.15161522	1.65367056	0.10977625	-0.0603671	0.56181037
Social Media	0.20243624	0.08233296	2.45875086	0.02064041	0.03350296	0.37136952
Online News	0.13196467	0.08406887	1.56972093	0.12812662	-0.0405304	0.30445974
Meetings	-0.3573755	0.27904742	-1.2806981	0.21119225	-0.9299335	0.2151825
Literature	0.80818322	0.24451075	3.30530753	0.00268441	0.3064886	1.30987784

Multiple Variable Regression - Concern

Concern	intercept	Age	Gender	Rent/Own	Years	Aware
y =	b0	b1	b2	b5	b6	b7

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.60028922
R Square	0.36034715
Adjusted R Sc	0.21590941
Standard Errc	1.02660574
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	18.4054235	2.62934622	2.49482681	0.0372728
Residual	31	32.6714995	1.05391934		
Total	38	51.0769231			

	Coefficients	*Standard Err.*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	6.80396279	1.85364521	3.67058525	0.0009041	3.02342845	10.5844971
Age	-0.0184216	0.01077795	-1.7091894	0.09741039	-0.0404033	0.00356022
Gender	-0.2423938	0.35573548	-0.6813877	0.50068522	-0.9679211	0.48313353
Rent/Own	-1.642955	0.79224328	-2.0738012	0.04649367	-3.2587459	-0.0271642
Years	-0.018335	0.07334404	-0.2499868	0.80424677	-0.1679212	0.13125112
Aware	0.81768881	0.23989283	3.40855876	0.00182915	0.32842415	1.30695346
Testing	-0.3489366	0.37207329	-0.937817	0.35558811	-1.1077851	0.40991183
Literature	-0.3478967	0.41454308	-0.8392292	0.40776612	-1.1933628	0.49756953

Binary Logistic Regression - Testing

	Treatment	intercept	Years	Aware	Services	Concern
	y =	b0	b6	b7	b15	b16

Logistic Regression

Years	*Aware*	*Services*	*Concern*	*Success*	*Failure*	*Total*	*p-Obs*	*p-Pred*	*Suc-Pred*	*Fail-Pred*	*LL*	*% Correct*	*HL Stat*
1	1	0	2	0	2	2	0	7.93E-31	1.59E-30	2	0	100	1.59E-30
4	1	0	4	0	1	1	0	3.04E-23	3.04E-23	1	0	100	3.04E-23
9	1	0	2	0	1	1	0	7.61E-09	7.61E-09	1	-7.6E-09	100	7.61E-09
9	2	0	3	0	1	1	0	5.78E-09	5.78E-09	1	-5.8E-09	100	5.78E-09
12	1	0	1	1	0	1	1	0.739907	0.739907	0.260093	-0.30123	100	0.351522
12	1	0	2	2	1	3	0.666667	0.57108	1.713241	1.286759	-1.96694	66.66667	0.111902
12	1	0	3	0	1	1	0	0.383915	0.383915	0.616085	-0.48437	100	0.623154
12	1	1	1	0	1	1	0	8.17E-10	8.17E-10	1	-8.2E-10	100	8.17E-10
12	2	0	2	0	1	1	0	0.683532	0.683532	0.316468	-1.15053	0	2.159873
12	2	0	4	1	1	2	0.5	0.321171	0.642342	1.357658	-1.52317	50	0.293366
12	2	1	2	0	1	1	0	6.21E-10	6.21E-10	1	-6.2E-10	100	6.21E-10
12	2	1	3	0	1	1	0	2.9E-10	2.9E-10	1	-2.9E-10	100	2.9E-10
12	3	0	1	1	0	1	1	0.882162	0.882162	0.117838	-0.12538	100	0.133579
12	3	0	2	4	1	5	0.8	0.777964	3.889818	1.110182	-2.50922	80	0.014056
12	3	0	3	5	3	8	0.625	0.621193	4.969544	3.030456	-5.29275	62.5	0.000493
12	3	0	4	1	2	3	0.333333	0.434231	1.302694	1.697306	-1.97332	66.66667	0.124316
12	3	0	5	1	2	3	0.333333	0.264282	0.792846	2.207154	-1.94456	66.66667	0.073568
12	3	1	1	0	1	1	0	2.15E-09	2.15E-09	1	-2.2E-09	100	2.15E-09
12	3	1	4	0	1	1	0	2.21E-10	2.21E-10	1	-2.2E-10	100	2.21E-10
12	3	1	5	0	1	1	0	1.03E-10	1.03E-10	1	-1E-10	100	1.03E-10
				16	23	39			16	23	-17.2715	76.92308	3.885829

	coeff b	*s.e.*	*Wald*	*p-value*	*exp(b)*	*lower*	*upper*
Intercept	-74.6011	34578.14	4.65E-06	0.998279	3.99E-33		
Years	6.326835	2881.511	4.82E-06	0.998248	559.3836	0	#NUM!
Aware	0.483789	0.557446	0.753192	0.385468	1.622209	0.544011	4.837331
Services	-21.9705	15425.03	2.03E-06	0.998864	2.87E-10	0	#NUM!
Concern	-0.75922	0.427386	3.155716	0.075661	0.46803	0.202527	1.081597

Binary Logistic Regression - Treatment

	Treatment	intercept	Age	Rent/Own	Years	Aware	Testing	Concern
	y =	b0	b1	b5	b6	b7	b8	b16

Logistic Regression

Age	Rent/Own	Years	Aware	Testing	Concern	Success	Failure	Total	p-Obs	p-Pred	Suc-Pred	Fail-Pred	LL	% Correct	HL Stat
18	2	9	1	1	2	0	1	1	0	1.76E-08	1.76E-08	1	-1.8E-08	100	1.76E-08
18	2	12	1	1	2	1	0	1	1	0.909399	0.909399	0.090601	-0.09497	100	0.099627
24	2	12	2	4	4	0	1	1	0	5.5E-31	5.5E-31	1	0	100	5.5E-31
38	2	9	2	1	3	0	1	1	0	6.62E-10	6.62E-10	1	-6.6E-10	100	6.62E-10
45	2	12	2	1	3	0	1	1	0	0.060951	0.060951	0.939049	-0.06289	100	0.064907
45	2	12	3	4	3	0	1	1	0	3.32E-36	3.32E-36	1	0	100	3.32E-36
54	2	12	1	4	2	0	1	1	0	7.36E-37	7.36E-37	1	0	100	7.36E-37
55	1	12	2	1	4	0	1	1	0	1.83E-09	1.83E-09	1	-1.8E-09	100	1.83E-09
55	2	12	1	1	3	0	1	1	0	0.060124	0.060124	0.939876	-0.06201	100	0.063971
55	2	12	3	1	4	0	1	1	0	0.029201	0.029201	0.970799	-0.02964	100	0.030079
55	2	12	3	4	2	0	1	1	0	3.87E-39	3.87E-39	1	0	100	3.87E-39
57	2	12	3	1	5	0	1	1	0	0.558647	0.558647	0.441353	-0.81791	0	1.265758
59	2	1	1	1	2	0	2	2	0	2.66E-36	5.31E-36	2	0	100	5.31E-36
60	1	4	1	1	4	0	1	1	0	2.84E-32	2.84E-32	1	0	100	2.84E-32
60	2	12	3	4	2	0	1	1	0	1.1E-39	1.1E-39	1	0	100	1.1E-39
60	2	12	3	4	3	0	1	1	0	7.66E-38	7.66E-38	1	0	100	7.66E-38
61	2	12	3	1	3	0	1	1	0	9.57E-05	9.57E-05	0.999904	-9.6E-05	100	9.57E-05
61	2	12	3	4	2	0	1	1	0	8.57E-40	8.57E-40	1	0	100	8.57E-40
62	2	12	3	1	5	1	0	1	1	0.264873	0.264873	0.735127	-1.3285	0	2.775394
64	2	12	3	1	3	0	1	1	0	4.5E-05	4.5E-05	0.999955	-4.5E-05	100	4.5E-05
66	2	12	3	1	5	0	1	1	0	0.116504	0.116504	0.883496	-0.12387	100	0.131867
66	2	12	3	4	3	0	1	1	0	1.7E-38	1.7E-38	1	0	100	1.7E-38
68	2	12	3	4	5	0	1	1	0	4.96E-35	4.96E-35	1	0	100	4.96E-35
70	2	12	2	1	2	0	1	1	0	1.74E-06	1.74E-06	0.999998	-1.7E-06	100	1.74E-06
71	2	12	3	1	1	0	1	1	0	1.6E-09	1.6E-09	1	-1.6E-09	100	1.6E-09
73	2	12	3	1	3	0	1	1	0	4.69E-06	4.69E-06	0.999995	-4.7E-06	100	4.69E-06
73	2	12	3	4	4	0	1	1	0	2.03E-37	2.03E-37	1	0	100	2.03E-37
74	2	12	3	4	3	0	1	1	0	2.27E-39	2.27E-39	1	0	100	2.27E-39
75	2	12	2	1	2	0	1	1	0	4.96E-07	4.96E-07	1	-5E-07	100	4.96E-07
76	2	12	1	4	1	0	1	1	0	4.2E-41	4.2E-41	1	0	100	4.2E-41
76	2	12	3	1	4	0	1	1	0	0.000154	0.000154	0.999846	-0.00015	100	0.000154
76	2	12	3	4	2	0	1	1	0	1.98E-41	1.98E-41	1	0	100	1.98E-41
77	2	12	3	0	4	1	0	1	1	1	1	7.15E-08	-7.1E-08	100	7.15E-08
78	2	12	3	4	1	0	1	1	0	1.72E-43	1.72E-43	1	0	100	1.72E-43
79	2	12	1	4	2	0	1	1	0	1.38E-39	1.38E-39	1	0	100	1.38E-39
82	2	12	3	1	2	0	1	1	0	7.03E-09	7.03E-09	1	-7E-09	100	7.03E-09
83	2	12	1	1	1	0	1	1	0	1.16E-08	1.16E-08	1	-1.2E-08	100	1.16E-08
86	2	12	3	4	3	0	1	1	0	1.11E-40	1.11E-40	1	0	100	1.11E-40
						3	36	39			3	36	-2.52009	94.87179	4.431904

	coeff b	s.e.	Wald	p-value	exp(b)	lower	upper
Intercept	-92.5413	55497.25	2.78E-06	0.99867	6.45E-41		
Age	-0.25129	0.186151	1.822349	0.177034	0.777795	0.540024	1.120254
Rent/Own	19.11595	23405.88	6.67E-07	0.999348	2E+08	0	#NUM!
Years	6.71996	2464.483	7.44E-06	0.997824	828.7843	0	#NUM!
Aware	-2.49839	5.03866	0.245861	0.620005	0.082217	4.23E-06	1599.114
Testing	-25.4865	3740.909	4.64E-05	0.994564	8.54E-12	0	#NUM!
Concern	4.242182	4.681602	0.821088	0.364862	69.55947	0.007201	671959.3

Appendix D

Social Media Plan

Goal

The primary goals for the DEQ's use of social media to increase public engagement with GWMA residents are to 1.) Raise awareness of nitrate contamination in the area, 2.) Educate residents on steps they can take to prevent ingesting nitrates through their tap water, and 3.) Announce promotional events hosted by the DEQ and GWMA partners.

Technology

Our survey results suggest that Facebook and Twitter are the most common social media outlet used by GWMA residents. We therefore recommend focusing on public outreach through these networks. However, as younger residents are more likely to use Snapchat, we recommend utilizing this emerging social media network as a tool to target messaging towards younger GWMA residents who may be less aware of the issue.

Target

The target population for social media campaigns are going to be the approximately 21,000 residents living in the GWMA. More specifically, we recommend targeting the demographics our survey found to be most likely to use social media regularly, which are women across all ages, and men under 30 years of age.

Strategy

The primary strategy for the social media plan is to maintain a consistent presence on Facebook, which entails at least one post every week that aims towards raising awareness, educating, or publicizing an event. Additionally, social media will promote fast information delivery, increase public relations, and help gain further insight and data on the perceptions of GWMA residents. Below is a list of tactics to employ while developing content.

Tactic 1: Frame actions as something their peers are doing.
Tactic 2: Provide specific actions followers can take.
Tactic 3: Ask questions to increase engagement and start a conversation.
Tactic 4: Research and employ hashtags.
Tactic 5: Recruit key community influencers (i.e. GWMA Committee members or other Prominent people in the community) to contribute to social media messaging, and increase trust and engagement.
Tactic 6: Promote your social media accounts through other networks.

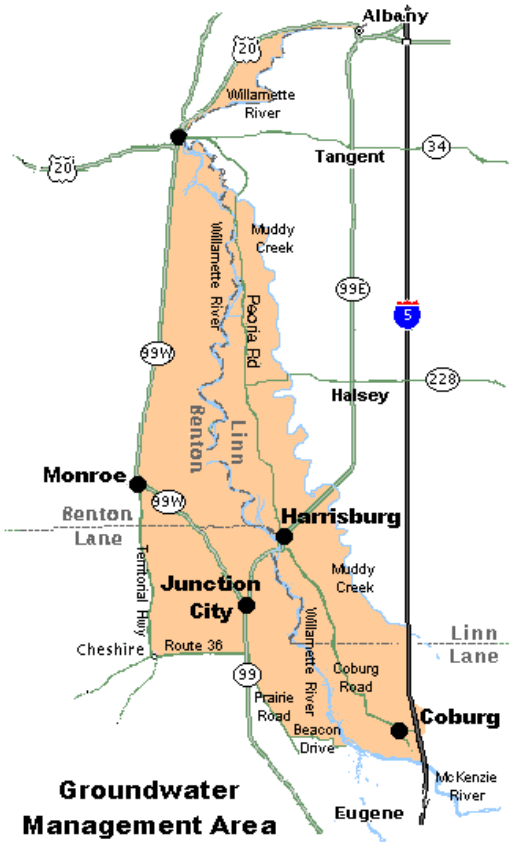
Sample Content

Below are sample posts that could be used by the DEQ to carry out the goals of the social media

plan:

Facebook/Twitter Post:

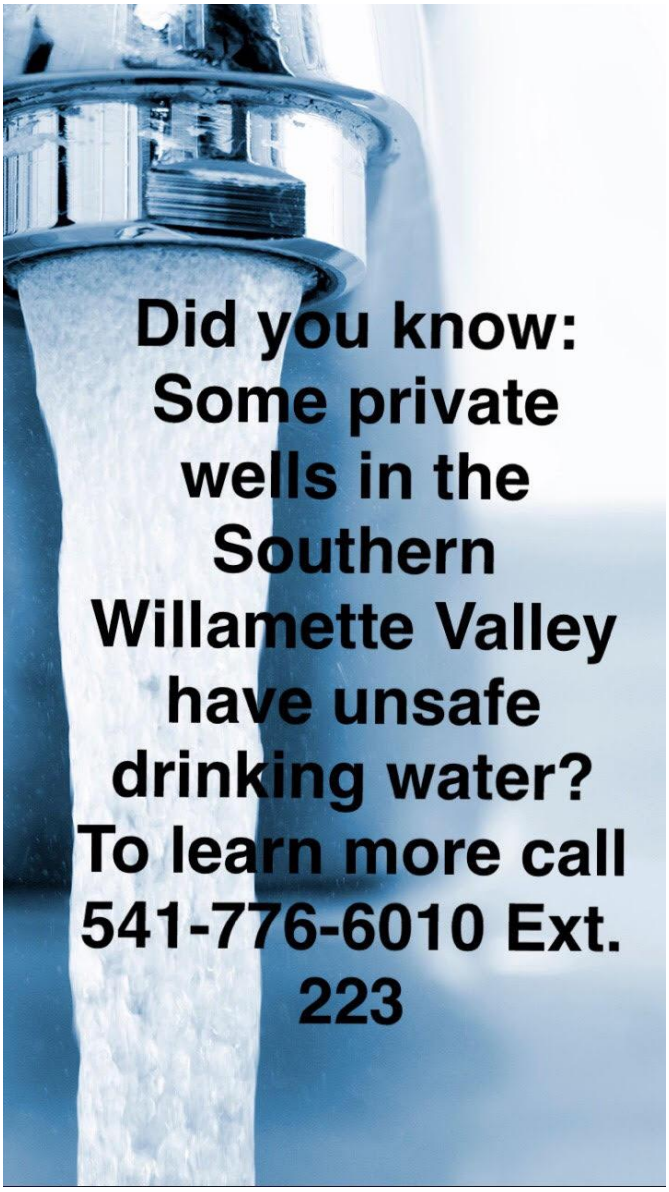
Did you know that the DEQ has found elevated levels of nitrate in this area? If you live in this part of the Southern Willamette Valley and use a private well for your drinking water call the DEQ at 541-776-6010 Ext. 223 or 877-823-3216 Ext. 223



Facebook Event

Has it been more than a year or two since you last had your tap water tested for nitrates? If so, we welcome you to join us in our Free Home Water Testing Day. Just follow the link below to schedule a time when an OSU Extension employee can come to your home and administer a FREE nitrate test. Results will be ready in ten minutes! #gwma

Snapchat post


Did you know:
Some private wells in the Southern Willamette Valley have unsafe drinking water?
To learn more call 541-776-6010 Ext. 223

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