Water Quality Report

Factors Influencing Nitrate Risks at Oregon Public Water Systems

November 2011

State of Oregon
Department of
Environmental
Quality

Last Updated: 01/05/2012
By: Joshua Seeds
DEQ 11-WQ-053

This report prepared by:

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204
1-800-452-4011
www.oregon.gov/deq

Contact:
Joshua Seeds
(503) 229-5081
seeds.joshua@deq.state.or.us

Table of Contents

Executive Summary 1
Introduction 2
Methods 3
Definitions 3
Selection of PWSs for Study 3
Probable Nitrate Source Tables 3
Land Use Categorization 3
Septic System Density 4
Probable Nitrate Source category assignment 4
Analysis of Vulnerability 4
Vulnerability Ratings 4
Soil Sensitivity Analysis 5
Statistical Analysis 5
Results 6
Public Water Systems with Substantial Nitrate Risks 6
Identification of Probable Nitrate Source Sector 9
Identification of Factors Connected to Elevated Nitrate 15
Aquifer Vulnerability 15
Importance of Aquifer Confinement 16
Well Construction 17
Soil Sensitivity to Nitrate Movement 18
Discussion 21
Recommendations and Next Steps 26
References 28
Appendix A: Public Water System Well Information and Soil Sensitivity Maps 32
Oakvilla Mobile Home Park (4100028) 32
City of Boardman (4100130) 33
Canby Regency (4100163) 35
City of Coburg (4100200) 36
Coburg/Pioneer Valley Estates (4100201) 37
Woodland Mobile Home Park (4100224) 38
Children's Farm Home Campus (4100226) 39
City of Hermiston (4100372) 40

North Hill Water Corporation (4100374) 42
Westland Estates Water System (4100376) 44
Olds Mobile Park (4100392) 45
City of Irrigon (4100403) 46
Junction City Water Utilities (4100418) 48
Vista Dale Water System (4100420) 49
Harwoods Mobile Manor (4100422) 50
Island City (4100454) 51
Flying K Trailer Ranch (4100455) 53
Fir Grove Mobile Court (4100472) 55
Vincent Water Company (4100521) 57
City of Monmouth (4100537) 59
Luckiamute Domestic Water Co-op (4100538) 60
City of Nyssa (4100579) 61
Odell Water Company (4100586) 62
Golf Mobile City (4100588) 62
Rickreall Water Association (4100704) 64
Rufus Public Works (4100723) 66
Helton Tracts (4100741) 68
City of Keizer (4100744) 69
Labish Village Water Commission (4100745) 73
Salem Mobile Estates/Shady Acres (4100779) 75
Harmony Acres Mobile Park (4100810) 77
Pinewood Mobile Manor (4100872) 78
City of Vale (4100917) 80
Kountry Village (4101002) 81
Dun-Rollin Mobile Home Park (4101044) 82
Riverview Trailer Park (4101129) 83
Country Garden Estates Mobile Home Park (4101182) 84
Deer Island Waterworks (4101233) 85
City Bible Church (4101267) 86
Hat Rock Water Company (4101309) 87
Prineville Mobile Home Park (4101317) 88
Port of Morrow (4101328) 89
Oakdale Trailer Park (4101416) 91
Shoun Crossroads (4105239) 92

Sunridge Water Incorporated (4105798) 93
River Village MHP (4105854) 94
Harris Private School (4190568) 95
West Stayton Elementary (4190577) 96
Bethany Elementary School (4190586) 97
Sauvie Island School (4190590) 98
Annex Elementary, SD #29 (4190889) 99
Hat Rock Mobile Court (4191232) 100
Clover Ridge Elementary (4191663) 101
Tangent Elementary (4191716) 102
Waterloo Primary SD 89 (4191724) 103
Fairplay Elementary, SD 509J (4193711) 104
Willowcreek Elementary, SD #89 (4193750) 105
Evergreen Elementary (4193753) 106
Sherman Jr/Sr High School (4193912) 107
Mid Willamette Precut Inc (4194394) 108
Conagra-Lamb Weston (4194562) 109
Cascade Union Jr/Sr High SD#5 (4194593) 110
Columbia River PUD (4194717) 111
Wallowa Mtn Visitor Center (4194728) 112
Weyerhaeuser Company Coburg (4194800) 113
Townsend Farms Fairview (4194866) 114
Jefferson Baptist Church (4195136) 115
River Point Farms, LLC (4195213) 116
Select Onion Company (4195337) 117
Upper Columbia Mill (4195397) 118

Table of Figures

Figure 1: Map of Public Water Systems with Significant Nitrate Risks 8
Figure 2: Median Nitrate vs. Primary Nitrate Source 13
Figure 3: 90th Percentile Nitrate vs. Primary Nitrate Source 13
Figure 4: Median Nitrate vs. Aquifer Vulnerability 14
Figure 5: 90th Percentile Nitrate vs. Aquifer Vulnerability 14
Figure 6: Median Nitrate vs. Aquifer Confinement 15
Figure 7: 90th Percentile Nitrate vs. Aquifer Confinement 15
Figure 8: Median Nitrate vs. Well Construction in Confined Aquifers 16
Figure 9: 90th Percentile Nitrate vs. Well Construction in Confined Aquifers 17
Figure 10: Median Nitrate vs. Soil Sensitivity in 2yr Time-of-Travel Zone 18
Figure 11: Median Nitrate vs. Soil Sensitivity in 10yr Time-of-Travel Zone 19
Figure 12: 90th Percentile Nitrate vs. Soil Sensitivity in 10yr Time-of-Travel Zone 20
Figure 13: Real Estate Transaction Tests w/ Nitrate ≥10mg/L 21

List of Tables

Table 1: Systems Outside of Groundwater Management Areas 6
Table 2: Systems within Groundwater Management Areas 7
Table 3: Wells where Probable Nitrate Source is Agriculture 9
Table 4: Wells where Probable Nitrate Source is On-Site (Septic) Systems 11
Table 5: Wells where Probable Nitrate Source is Both Agriculture & On-Site (Septic) Systems . 11
Table 6: Significant Regression Coefficients & Associated Tests for Soil Sensitivity 18

Executive Summary

Nitrogen is the major component of the Earth's atmosphere, and fixed nitrogen (in a form available to plants) is a necessary nutrient for plant growth and the formation of proteins. However, nitrogen in the form of nitrate is a public health risk if concentrations in food or water get to high. Nitrate contamination of groundwater from agriculture and concentrated human and animal waste is an ongoing problem in the United States and in Oregon. By many metrics, the problem is increasing in severity. This analysis examines nitrate risk factors at Oregon Public Water Systems (PWSs) with the aim of determining how best to target contamination prevention and drinking water source protection activities.

There are seventy community (C) and non-transient non-community (NTNC) PWSs in Oregon that met the screening criteria for having current nitrate problems or being at risk of developing nitrate problems. There were many more transient non-community PWSs and state regulated non-public systems that also met the screening criteria; these systems were not analyzed because of limited public consumption water from these sources. Additional PWSs may have contaminated source water but are using nitrate removal treatment and so would not be detected using the finished water data in this screening and analysis. Generally, the C and NTNC systems identified in this report serve smaller populations, although there are some cities with high nitrate or at-risk wells. Many of the PWSs are mobile home parks or rural schools, raising possible environmental justice concerns about socioeconomically vulnerable populations being exposed disproportionately.

A rating of public supply well and aquifer vulnerability combining aquifer confinement (confined, semi-confined, or unconfined) and well construction (adequate or inadequate) proved to be a useful prioritization tool, with vulnerable and semi-vulnerable wells having higher median and 90th percentile nitrate than wells which are not rated as vulnerable. Likewise, aquifer confinement alone was a useful predictor of nitrate concentrations with confined aquifers having lower nitrate than semi-confined or unconfined aquifers. Well construction in confined aquifer systems was also an important factor. Inadequately constructed wells in confined aquifers tended to have higher nitrate than their adequately constructed counterparts, demonstrating that direct connections between the surface and confined aquifers can result in contamination of otherwise protected water sources.

Soil Sensitivity ratings (Very Low, Low, Moderate, High, Very High) from the Oregon Water Quality Decision Aid are based on a soil's nitrogen binding capacity and intrinsic leaching potential. Soil Sensitivity had a significant relationship to source water nitrate concentrations when analyzed by quantile regression to account for unquantified influential variables. Public Water Systems with larger proportions of their 2-year and 10-year Time-of-Travel zones having Sensitivity greater than Low were more prone to high nitrate concentrations. Accounting for natural soil conditions and their effect on nitrogen transport is an important part of managing soil nitrogen pools and preventing leaching to groundwater in agriculture and septic system siting and maintenance.

The high level evaluation of source sector (agriculture or septic systems) did not show any differences in nitrate concentrations based on a well's likely nitrate source sector. Nevertheless, detailed nitrate source identification is an important component of contamination prevention, so protection efforts will need to include this as a first step in reducing nitrate loads to vulnerable aquifers. Reducing septic system density, connection to sewers, installation of nitrate removing septic systems, and composting toilets are all possible methods to reduce septic system nitrate contributions. Agricultural contributions can be reduced by limiting nitrogen application to the amounts and timing best suited to the crop's needs and the current nitrogen pools on a piece of land. Amounts and timing of irrigation can also help prevent nitrate being leached past plants' root zone. Nitrate contamination is largely preventable, and implementation of available tools and knowledge can make a positive difference.

Introduction

Nitrate (NO_3^-) is a regulated chemical in drinking water from public water systems. Excessive consumption of nitrate can cause methemoglobinemia, where too much of the blood's hemoglobin is in an oxidized form called methemoglobin and unable to carry sufficient oxygen (Avery 1999, World Health Organization 2011). This condition is most common in infants ("blue baby syndrome") who lack the enzyme activity to convert methemoglobin back to hemoglobin. Nitrate has also been connected to cancers and other long-term health problems such as diabetes, hypertension, some cancers, and non-Hodgkin's lymphoma (Parslow *et al* 1997, Malberg *et al* 1978, Hill *et al* 1973, Ward *et al* 1996, respectively; also Ward *et al* 2005). Regulations promulgated by EPA under the Safe Drinking Water Act (SDWA) limit the concentration of nitrate-nitrogen (nitrate-N or NO_3-N) to 10 milligrams per liter (45 milligrams per liter of nitrate ion).

Some amount of nitrate is naturally occurring in surface and groundwater. Concentrations below 2-3 mg/L are generally considered background (Mueller *et al* 1995). However, surface water and groundwater can become polluted with excess amounts of nitrate due to human activities. Nitrate contamination of drinking water can come from numerous sources including fertilizers (particularly when used in irrigated agriculture), on-site (septic) systems for human waste, urban stormwater, effluent from sewage treatment, wastewater from food processing, and livestock wastes (see State-EPA Nutrient Innovations Task Group 2009 for summary and references). Nitrogen pollution is one of the biggest water quality problems in the United States with 32% of stream miles affected (USEPA 2006). Lakes, ponds, and reservoirs as well as estuaries and coastal waters are negatively affected by nutrient pollution, including excessive nitrogen (US EPA 2011). Likewise, nitrate pollution of groundwater is a major threat to the safety of drinking water. Nationwide, public drinking water systems reported 1,163 violation of the nitrate Maximum Contaminant Limit (MCL) in 2008, and the number of violations nearly doubled during the preceding decade (State-EPA Nutrient Innovations Task Group 2009). Nitrate was detected in 72% of private domestic wells, and 4% of those wells had unsafe levels of nitrate in US Geological Survey study (DeSimone 2009). The problem is growing in both extent and severity.

In the Pacific Northwest, nitrate contamination of the Yakima Valley aquifers resulted in an ongoing major study and remediation effort lead by the federal Environmental Protection Agency. Sources in Yakima are chemical fertilizers and human and animal waste (Washington State Department of Agriculture *et al* 2010). In Oregon, nitrate samples collected during home sales (Real Estate Transaction data) show several areas in the state where nitrate levels are above safe levels in private domestic wells, and 21 Oregon public water systems (PWSs) reported violations of the MCL in 2010 while 66 PWSs had nitrate concentrations equal to or greater than half the MCL (Oregon Safe Drinking Water Information System). The Oregon Department of Environmental Quality (DEQ) has three areas in the state designated as Groundwater Management Areas where efforts are underway to reduce nitrate contamination of groundwater. Unsafe nitrate concentrations in drinking water sources are therefore a local as well as a national problem.

The Drinking Water Program at Oregon Health Authority and the Drinking Water Protection Program at DEQ decided to evaluate community and non-transient, non-community public water systems to determine if they had ongoing nitrate problems or substantial risks of problems developing. For those systems identified as having unsafe nitrate concentrations in their water or being at risk of unsafe concentrations, the Drinking Water Protection Program at DEQ conducted this analysis of the potential sources and factors that may influence nitrate transport from the surface into aquifers.

Methods

Definitions

***Community Water System (C)*:** A public water system that supplies water to the same population year-round (EPA URL: http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm).

Confining Layer: A solid, impermeable layer of rock or other material that prevents water from the surface or another aquifer from moving into the aquifer below the confining layer.

Non-Transient Non-Community Water System (NTNC): A public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems (EPA URL: http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm).

Public water systems (PWSs): Provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year (EPA URL: http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm).

Time-of-Travel zone (TOT): The area within which a contaminant could be expected to reach the public supply well. For example, a contaminant in the 10-year TOT is predicted to reach the well within 10 years.

Transient Non-Community Water System (TNC): A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time (EPA URL: http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm).

Selection of PWSs for Study

Public water systems (PWSs) were selected for this study based on whether during the preceding ten years there was either an ongoing nitrate problem (i.e. exceedences of the Maximum Contaminant Limit (MCL)) or an elevated risk of nitrate problems (10+% of nitrate measurements exceeding ½ the MCL). Data were obtained from the Drinking Water Program at Oregon Health Authority and were current as of June 29, 2010. Data were queried using Microsoft Access 2007 to find all Community and Non-Transient Non-Community PWSs with nitrate-N measurements ≥10mg/L. An additional query found PWSs with nitrate-N measurements >5mg/L. Once candidate systems were identified, the most recent nitrate data were downloaded from the online Safe Drinking Water Information System (SDWIS) database as of November, 2010. Descriptive statistics including percentiles were worked up for all PWS found in the queries. Any PWSs with nitrate-N measurements ≥10mg/L or with the 90th percentile of nitrate-N measurements >5mg/L were tabulated as Table 1 if they were outside of any Groundwater Management Areas (GWMAs) and as Table 2 if within a GWMA. Systems with high nitrate in their source water which are using treatment technology to remove it could be missed using this approach.

Probable Nitrate Source Tables

Land Use Categorization

Two-year and ten-year time-of travel (TOT) zones for Public Water System wells were assessed using ArcGIS 9.3 and 2009 orthophotos from the National Agriculture Imagery Program (Farm

Service Agency, U.S. Department of Agriculture (USDA)), and the 2007 National Agricultural Statistics Service (Service Center Agencies, USDA) crop-type data layer. Percent area of agricultural land and residential land were estimated and categorized as follows:

Agricultural land area >70% → "Agriculture"
Agricultural land area >50%-70% → "Agriculture+Residential"
Agricultural land area >30%-50% → "Residential+Agriculture"
Agricultural land area ≤30% → "Residential"

Open space (rangeland, pasture, and woodland without any residences) and commercial land were included as needed in the above ranking if necessary (e.g. >70% rangeland → "Open", or 40% agricultural area with the remainder being commercial land → "Commercial+Agriculture"). Open space was not considered a potential nitrate source, nor was commercial space unless the businesses in question had septic systems or another type of Water Pollution Control Facility.

Septic System Density

Septic systems density estimate were done using a Geographical Information System analysis in ArcGIS 9.3. Septic system locations were estimated using 2009 orthophotos from the National Agriculture Imagery Program. Residences and commercial structures/businesses were marked as a septic system location unless:

1. they were inside the limits of a sewered city;
2. they were confirmed through telephone and/or internet investigation to be connected to a nearby sewer system; or
3. they had a permit on file with DEQ from a wastewater permit of a type that is not an on-site septic system (e.g. NPDES permit or WPCF permit with land application of wastewater).

The estimated number of septic systems in the 2-year and 10-year TOT zones was divided by the area of that TOT zone to get an estimate of density (in systems/acre). Time of Travel zone delineations and their areas are from DEQ/OHA Source Water Assessment GIS data.

Probable Nitrate Source Category Assignment

Agriculture:
Systems rated as "Agriculture", "Agriculture+Residential", or "Residential+Agriculture" in the TOT zones AND residential and commercial areas are sewered and/or septic systems are few and widely dispersed (<0.1 systems/acre in the 2-year TOT and <0.2 systems/acre in the 10-year TOT). In some cases, wells are assigned Agriculture as the probable source due to extensive agricultural area just outside the 10-year TOT and a lack of septic systems in the area.

On-Site Septic Systems:
Systems without agricultural land in or surrounding the 10-year TOT and with residential and/or commercial septic systems present.

Both Agriculture & On-Site Septic Systems:
Systems with agricultural land in or surrounding the 2- and/or 10-year TOTs AND with unsewered residential and/or commercial septic systems present at densities >0.1 systems/acre in the 2-year TOT or >0.2 systems/acre in the 10-year TOT. Systems with lower septic densities were also included in this category if it is probable that septic systems still exist inside a currently sewered area or if the septic systems existed in a tight cluster(s) that would concentrate the effluent.

Analysis of Vulnerability

Vulnerability Ratings

Rating of vulnerability to contamination from surface nitrate sources is based on well construction and whether the source aquifer is confined. Aquifers are rated as Confined, Semi-Confined, or

Unconfined, and well construction is rated as adequate or inadequate. Information regarding aquifer confinement and adequacy of well construction is from surveys done by Oregon Health Authority Drinking Water Program staff. This information is contained in the Source Water Assessments for these PWSs. Wells lacking information about their construction are assumed to be inadequate.

Is the aquifer potentially connected (vulnerable) to contamination from the surface?

- If construction is inadequate, well is marked “Yes”
- If construction is adequate but aquifer is unconfined, well is marked “Yes”
- If construction is adequate but aquifer is semi-confined, well is marked “Semi”
- If construction is adequate and aquifer is confined, well is marked “No”

Soil Sensitivity Analysis

Soil Sensitivity ratings are derived using the procedure from the Oregon Water Quality Decision Aid (OWQDA), publication EM 8708 of the Oregon State University Extension Service (Huddleston *et al* 1998). Soil Sensitivity has 5 classifications (Very Low, Low, Moderate, High, Very High) to rate the “soil’s general tendency to allow a chemical to be transported through the soil to groundwater.” Groundwater under soils with higher sensitivities is more likely to become contaminated than groundwater under soils with lower sensitivities. Water soluble chemicals, such as nitrate, are more prone to moving through the soil.

Soil Sensitivity is a combination of the soil’s leaching potential (how quickly water moves to the water table) and sorption potential (how well the soil binds chemicals). The soils were evaluated using the Soil Survey Geographic Database (SSURGO) from the Natural Resources Conservation Service of the US Department of Agriculture. Using database queries, calculations, and the tables in Huddleston *et al* (1998), the soil information from SSURGO was used to classify each soil polygon’s leaching potential, sorption potential, and the resulting Soil Sensitivity. The results were then joined to the maps of soil polygons’ locations in GIS to produce Soil Sensitivity maps. The database and calculation structure was used by Lane Council of Governments for their Southern Willamette Valley nitrogen budget (Lane Council of Governments 2008) and provided to DEQ for refinement and use. For each delineated 2-year and 10-year TOT zone, the percent of the total area in each soil sensitivity category was calculated in Arc GIS.

Statistical Analysis

Categorical data for probable source, overall vulnerability, confinement, and well construction were analyzed using Analysis of Variance (ANOVA) in Minitab 15.1. The data were tested for normal distributions. They did not meet this assumption; however, ANOVA is robust to departures from the normal distribution (Box 1953). All ANOVA analyses met the assumption of homogeneous variances when tested using Levene’s test (Levene 1960). When the factor in question had more than two levels, then Tukey comparison tests were used to show which levels were significantly different from which.

The level of significance for ANOVA tests was set at $\alpha=0.05$.

Quantile regression was used to estimate the effects of soil sensitivity on nitrate concentrations in the public supply wells in semi-confined and unconfined aquifers. Quantile regression allows quantification of the relationship between a predictor variable and a response variable in cases where there are factors that are unaccounted for that affect the response variable (Cade *et al* 1999). The 50th, 60th, 70th, 75th, 80th, 85th, 90th, and 95th quantiles were tested for statistical significance for each response/predictor variable pair. The level of significance was set at $\alpha=0.05$.

Results

Public Water Systems with Substantial Nitrate Risks

Tables 1&2 list community and non-transient, non-community Public Water Systems (PWSs) identified as having substantial nitrate problems or risks through having either a nitrate-N measurement at or above 10mg/L or by having the 90th percentile of the nitrate-N measurements greater than 5mg/L. Table 1 contains PWSs outside of Groundwater Management Areas (GWMAs), and Table 2 contains PWSs within GWMAs. These tables include community (C) and non-transient non-community (NTNC) PWSs. Figure 1 shows the locations of these PWSs. Smaller transient non-community PWSs and state regulated non-public systems were not included due to the limited exposure that populations generally have from those water providers. Additional PWSs may have contaminated source water but are using nitrate removal treatment and would not be apparent using the finished water data. Systems are marked as active (A) or inactive (I) with a note if nitrate removal treatment or new water sources are now in use.

Table 1: Systems Outside of Groundwater Management Areas

ID# (41---)	PWS Name	County	Sub-Basin (4th Field HUC)	Type	Active? Treated?
00028	Oakvilla MHP	Linn	Upper Willamette	C	A
00163	Canby Regency	Clackamas	Middle Willamette	C	A-Treated
00224	Woodland MHP	Linn	Upper Willamette	C	A-Treated
00392	Olds Mobile Park	Marion	Molalla/Pudding	C	A
00454	Island City	Union	Upper Grande Ronde River	C	A
00455	Flying K Trailer Ranch	Union	Upper Grande Ronde River	C	A
00472	Fir Grove Mobile Court	Linn	South Santiam	C	A
00521	Vincent Water Company	Umatilla	Walla Walla	C	A
00537	City of Monmouth	Polk	Middle Willamette	C	A
00538	Luckiamute Domestic Water Co-op	Polk	Middle Willamette	C	A
00586	Odell Water Company	Hood River	Middle Columbia/Hood	C	A
00704	Rickreall Water Assoc.	Polk	Middle Willamette	C	A
00723	Rufus Public Works	Sherman	Middle Columbia/Hood	C	A
00741	Helton Tracts	Marion	Molalla/Pudding	C	A
00744	City of Keizer	Marion	Middle Willamette	C	A
00745	Labish Village Water Commission	Marion	Molalla/Pudding	C	A
00779	Salem Mobile Estates/Shady Acres	Marion	Middle Willamette & Molalla/Pudding	C	A
00810	Harmony Acres Mobile Park	Linn	Upper Willamette	C	A-Treated
00872	Pinewood Mobile Manor	Wasco	Middle Columbia/Hood	C	A
01129	Riverview Trailer Park	Deschutes	Upper Deschutes	C	A
01233	Deer Island Waterworks	Columbia	Lower Columbia/Clatskanie	C	A
01267	City Bible Church	Multnomah	Lower Willamette	C	A
01317	Prineville MHP	Crook	Lower Crooked	C	A-Treated
01416	Oakdale Trailer Park	Marion	North Santiam	C	A
05239	Shoun Crossroads	Crook	Lower Crooked	C	A-New
90577	West Stayton Elementary	Marion	North Santiam	NTNC	A
90586	Bethany Elementary School	Marion	Molalla/Pudding	NTNC	A
90590	Sauvie Island School	Multnomah	Lower Willamette	NTNC	A
91663	Clover Ridge Elementary	Linn	North Santiam	NTNC	A
91716	Tangent Elementary	Linn	Upper Willamette	NTNC	A
91724	Waterloo Primary SD 89	Linn	Upper Willamette	NTNC	I
93753	Evergreen Elementary	Marion	Molalla/Pudding	NTNC	A
93912	Sherman Jr/Sr High School	Sherman	Lower John Day	NTNC	A
94394	Mid Willamette Precut Inc	Linn	South Santiam	NTNC	A
94593	Cascade Union Jr/Sr High SD 5	Marion	Middle Willamette	NTNC	A
94717	Columbia River PUD	Columbia	Lower Columbia/Clatskanie	NTNC	A-Treated
94728	Wallowa Mtn Visitor Center	Wallowa	Wallowa River	NTNC	A
94866	Townsend Farms Fairview	Multnomah	Lower Willamette	NTNC	A
95136	Jefferson Baptist Church	Marion	North Santiam	NTNC	A

Table 2: Systems within Groundwater Management Areas

ID# (41----)	PWS Name	County	Sub-Basin (4th Field HUC)	Type	Active? Treated?
00130	City of Boardman	Umatilla	Mid Columbia/Lake Wallula	C	A
00200	City of Coburg	Lane	Upper Willamette	C	A
00201	Coburg/Pioneer Valley Estates	Lane	Upper Willamette	C	I
00226	Children's Farm Home Campus	Benton	Upper Willamette	NTNC	A
00372	City of Hermiston	Umatilla	Umatilla	C	A
00374	North Hill Water Corp.	Umatilla	Umatilla	C	A
00376	Westland Estates Water System	Umatilla	Umatilla	C	I
00403	City of Irrigon	Morrow	Mid Columbia/Lake Wallula	C	A
00418	Junction City Water Util.	Lane	Upper Willamette	C	A
00420	Vista Dale Water System	Lane	N/A	C	I
00422	Harwoods Mobile Manor	Lane	Upper Willamette	C	A
00579	City of Nyssa	Malheur	Middle Snake/Payette	C	A
00588	Golf Mobile City	Malheur	Middle Snake/Payette	C	A
00917	City of Vale	Malheur	Lower Malheur	C	A-Treated
01002	Kountry Village	Lane	Upper Willamette	C	A
01044	Dun-Rollin MHP	Umatilla	Umatilla	C	A
01182	Country Garden Estates MHP	Morrow	Mid Columbia/Lake Wallula	C	A
01309	Hat Rock Water Company	Umatilla	Mid Columbia/Lake Wallula	C	A
01328	Port of Morrow	Morrow	Mid Columbia/Lake Wallula	NTNC	A
05798	Sunridge Water, Inc.	Umatilla	Umatilla	C	A
05854	River Village MHP	Malheur	Middle Snake/Payette	C	A
90568	Harris Private School	Linn	Upper Willamette	NTNC	A-Treated
90889	Annex Elementary SD 29	Malheur	Brownlee Reservoir	NTNC	A-Treated
91232	Hat Rock Mobile Court	Umatilla	Mid Columbia/Lake Wallula	C	A-New
93711	Fairplay Elementary SD 509J	Benton	Upper Willamette	NTNC	A
93750	Willowcreek Elem SD #89	Malheur	Willow (Mid Snake/Boise)	NTNC	A-Treated
94562	Conagra Lamb Weston	Umatilla	Umatilla	NTNC	A
94800	Weyerhaeuser Co Coburg	Lane	Upper Willamette	NTNC	I
95213	River Point Farms, LLC	Umatilla	Mid Columbia/Lake Wallula	NTNC	A-Treated
95337	Select Onion Company	Malheur	Middle Snake/Payette	NTNC	A
95397	Upper Columbia Mill	Morrow	Mid Columbia/Lake Wallula	NTNC	A-Treated

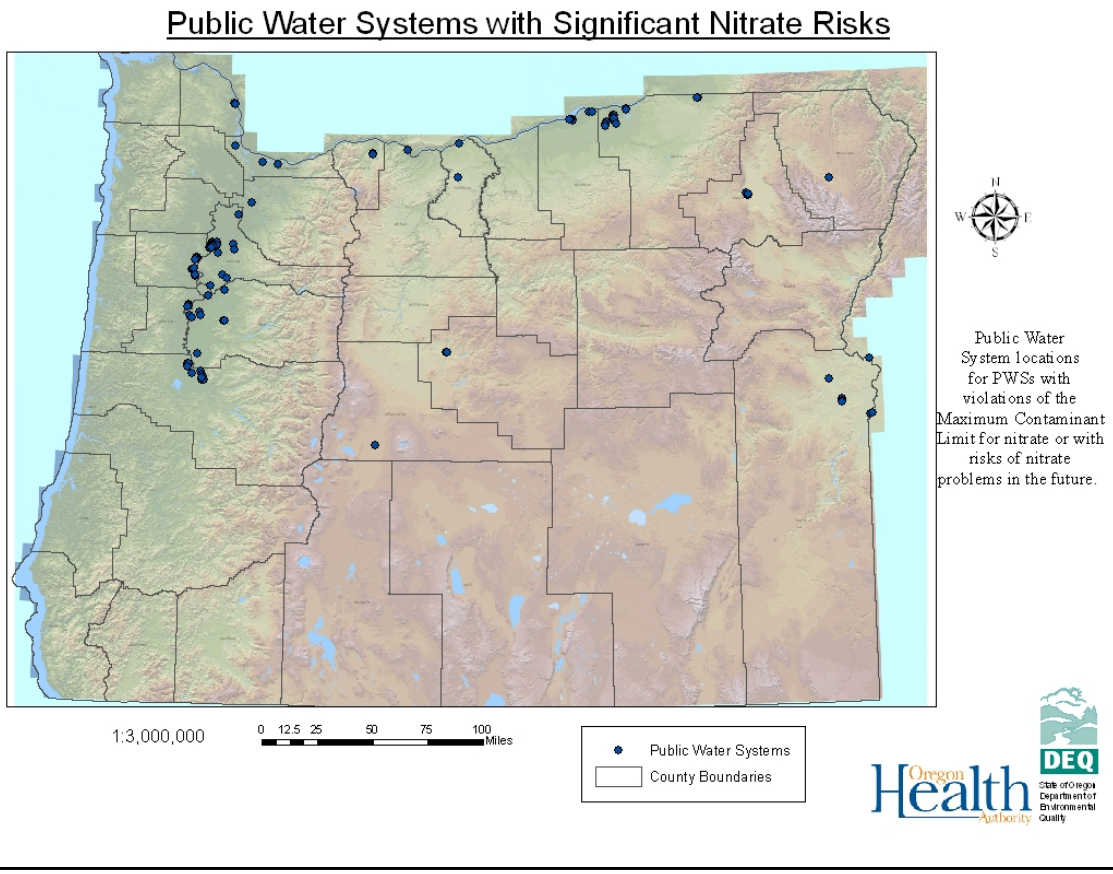


Figure 1: Locations of Oregon Public water systems with violations of the Nitrate MCL or with elevated nitrate, creating a risk of future nitrate problems.

Identification of Probable Nitrate Source Sector

Onsite (septic) system densities were estimated for the 2-year and 10-year Time-of-Travel (TOT) zones. Percentages of TOT zones in different land uses were also estimated (agriculture, open space, commercial, residential). These estimates were used to determine the most likely source of nitrate. Tables 3-5 list PWS wells by whether the probable nitrate source is agricultural (which could include land application of wastewater or biosolids in addition to manure or chemical fertilizers), septic systems, or both. Not all wells from a PWS have nitrate problems. In many cases, one or more wells showed no sign of nitrate contamination problems while other wells at the same PWS had elevated nitrate.

(Public Water System wells in **bold print** in the tables have been sampled for toxic pollutants as part of the Drinking Water Toxics sampling project.)

Table 3: Probable Nitrate Source is Agriculture

PWS ID	PWS Name	Well Number	Median NO_3	90th NO_3	County	PWS Population
4100028	OAKVILLA MOBILE HOME	1	5.5	5.66	Linn	136
4100028	OAKVILLA MOBILE HOME	3	4.6	6.34	Linn	136
4100028	OAKVILLA MOBILE HOME	4	5.55	6.15	Linn	136
4100130	BOARDMAN, CITY OF	1	0.89	2.068	Umatilla	3330
4100130	BOARDMAN, CITY OF	2	0.89	2.068	Umatilla	3330
4100130	BOARDMAN, CITY OF	3	4.4	4.4	Umatilla	3330
4100163	CANBY REGENCY	Spring	3.85	10.8	Clackamas	300
4100226	CHILDRENS FARM HOME	1	8.1	9.86	Benton	200
4100226	CHILDRENS FARM HOME	2	5.7	7.06	Benton	200
4100372	HERMISTON, CITY OF	4	0	3.6	Umatilla	15,410
4100403	IRRIGON, CITY OF	1	3.7	12.12	Morrow	1740
4100454	**ISLAND CITY**	**1**	6.5	10.24	Union	1033
4100454	ISLAND CITY	3	0.352	0.4608	Union	1033
4100454	ISLAND CITY	4	0	0.27	Union	1033
4100537	**MONMOUTH, CITY OF**	**1**	5.6	9.504	Polk	9125
4100538	LUCKIAMUTE DOMESTIC WATER CO-OP	1,2,4	0.9	4.5	Polk	2600
4100538	LUCKIAMUTE DOMESTIC WATER CO-OP	3	4.9	6.48	Polk	2600
4100579	NYSSA, CITY OF	1,2,3,4,5	3.88	6.455	Malheur	3170
4100579	NYSSA, CITY OF	7	1.715	2.645	Malheur	3170
4100579	NYSSA, CITY OF	9	1.715	2.645	Malheur	3170
4100586	**ODELL WATER COMPANY**	**Spring**	7	8.52	Hood River	355
4100704	RICKREALL WATER	2	3.4	9.58	Polk	1650
4100704	RICKREALL WATER	3	3.65	5.301	Polk	1650
4100704	RICKREALL WATER	4	5.5	8.382	Polk	1650
4100704	RICKREALL WATER	5	2.3	6.95	Polk	1650
4100704	RICKREALL WATER	6	2.3	6.95	Polk	1650
4100723	RUFUS PUBLIC WORKS	1	5.55	7.266	Sherman	250
4100723	RUFUS PUBLIC WORKS	3	0	0.045	Sherman	250
4100741	HELTON TRACTS	1	4.9	6.792	Marion	75
4100741	HELTON TRACTS	2	7	8.34	Marion	75

PWS ID	PWS Name	Well Number	Median NO_3	90th NO_3	County	PWS Population
4100744	KEIZER, CITY OF	13	5.3	6.6	Marion	33,500
4100744	KEIZER, CITY OF	12	5.03	6.18	Marion	33,500
4100744	KEIZER, CITY OF	14	0	0	Marion	33,500
4100745	LABISH VILLAGE WATER COMMISSION	1 (Webb-A)	4.4	6.52	Marion	500
4100745	LABISH VILLAGE WATER COMMISSION	4 (Scott-B)	4.5	5.97	Marion	500
4100745	LABISH VILLAGE WATER COMMISSION	2 (Dover-C)	5.3	7.38	Marion	500
4100745	LABISH VILLAGE WATER COMMISSION	3 (York-D)	3.835	4.8	Marion	500
4100779	SALEM MOBILE ESTATES/SHADY ACRES	1	6.6	6.9	Marion	150
4100810	HARMONY ACRES MOBILE	1	6.88	11.02	Linn	31
4100917	VALE, CITY OF	Washington St. Well	5.7	7.006	Malheur	1997
4100917	VALE, CITY OF	Airport Wells	7.105	13.69	Malheur	1997
4100917	VALE, CITY OF	Airport #1	5.78	6.768	Malheur	1997
4100917	VALE, CITY OF	Airport #2	3.03	5.516	Malheur	1997
4100917	VALE, CITY OF	Airport #3	6.03	8.924	Malheur	1997
4100917	VALE, CITY OF	Airport #4	11.7	14.06	Malheur	1997
4100917	VALE, CITY OF	Airport #5	13.6	13.76	Malheur	1997
4100917	VALE, CITY OF	Airport #6	12.2	13.78	Malheur	1997
4100917	VALE, CITY OF	Airport #7	13.7	17.56	Malheur	1997
4101328	PORT OF MORROW	East Beach	7	10	Morrow	1350
4101328	PORT OF MORROW	1	0	2.15	Morrow	1350
4101328	PORT OF MORROW	2	0	0.27	Morrow	1350
4101328	PORT OF MORROW	4	0	0.3	Morrow	1350
4191663	CLOVER RIDGE ELEMENTARY	1	5.4	6.4	Linn	350
4191716	TANGENT ELEMNTARY	1	4.2	5.0	Linn	178
4193912	**SHERMAN UNION HS SD 1**	**1**	6.1	7.8	Sherman	150
4194394	MID WILLAMETTE PRECUT	1	3.9	4.88	Linn	60
4194593	CASCADE UNION JR/SR HIGH	1	3.6	4.88	Marion	1300
4194800	WEYERHAEUSER CO COBURG	3	5.85	7.19	Lane	90
4194866	TOWNSEND FARMS FAIRVIEW	Small (AA)	7	8	Multnomah	250
4194866	TOWNSEND FARMS FAIRVIEW	Large (AB)	7	8	Multnomah	250
4194866	TOWNSEND FARMS FAIRVIEW	Well (AC)	7	8	Multnomah	250
4195213	RIVER POINT FARMS, LLC	1	6.105	23.9	Umatilla	250
4195337	SELECT ONION COMPANY	Wells	6.63	8.178	Malheur	250
4195397	UPPER COLUMBIA MILL	1	11	12.92	Morrow	50

Table 4: Probable Nitrate Source is On-Site (Septic) Systems

PWS ID	PWS Name	Well Number	Median NO_3	90th NO_3	County	PWS Population
4100372	HERMISTON, CITY OF	2	0	0.0077	Umatilla	15,410
4100372	HERMISTON, CITY OF	5	4.95	6.34	Umatilla	15,410
4100372	HERMISTON, CITY OF	6	0	0	Umatilla	15,410
4100374	NORTH HILL WATER CORPORATION	2	5.5	6.426	Umatilla	100
4101129	RIVERVIEW TRAILER PARK	1	5.48	7.95	Deschutes	50
4101129	RIVERVIEW TRAILER PARK	2	5.6	7.95	Deschutes	50
4101309	HAT ROCK WATER	Spring	6.8	8.5	Umatilla	75

Note: **Hermiston** well #5 has low septic density and no agricultural land; its nitrate levels are likely due to regional issues. Wells #2&6 are in a deep aquifer unconnected to the surface. The Drinking Water Protection Area for **Hat Rock Water Company's** spring has low septic density, but the area is mostly rangeland without any other apparent sources. Its nitrate levels could be due to regional issues.

Table 5: Probable Nitrate Source is Both Agriculture & On-Site (Septic) Systems

PWS ID	PWS Name	Well Number	Median NO_3	90th NO_3	County	PWS Population
4100200	COBURG, CITY OF	1	2.45	3.89	Lane	1069
4100200	**COBURG, CITY OF**	**2**	4.45	5.3	Lane	1069
4100201	COBURG/PIONEER VALLEY ESTATES	1	5.5	7.78	Lane	125
4100224	WOODLAND MOBILE HOME PARK	1,2	8.3	11.44	Linn	94
4100224	WOODLAND MOBILE HOME PARK	3	0	0	Linn	94
4100374	NORTH HILL WATER CORPORATION	1	0.18	4.018	Umatilla	100
4100374	NORTH HILL WATER CORPORATION	3	0	0.032	Umatilla	100
4100376	WESTLAND ESTATES WATER SYSTEM	2	9.75	13	Umatilla	60
4100392	OLDS MOBILE PARK	1	2.5	8.7	Marion	60
4100403	IRRIGON, CITY OF	2	0	2.48	Morrow	1740
4100403	IRRIGON, CITY OF	3	0.44	0.86	Morrow	1740
4100403	IRRIGON, CITY OF	4	0.44	0.86	Morrow	1740
4100418	**JUNCTION CITY WATER**	**1,5,6-Deep**	0	0.045	Lane	5385
4100418	JUNCTION CITY WATER	2,3-Shallow	5.16	9.2	Lane	5385
4100420	VISTA DALE WATER	1	5.05	6.63	Lane	60
4100422	HARWOODS MOBILE	1	6.95	8.91	Lane	70
4100455	FLYING K TRAILER RANCH	1	3.9	5.98	Union	96
4100455	FLYING K TRAILER RANCH	2	4.93	5.574	Union	96
4100472	FIR GROVE MOBILE COURT	1	3.8	4.87	Linn	80
4100472	FIR GROVE MOBILE COURT	2	3.8	4.87	Linn	80
4100521	VINCENT WATER COMPANY	1	3.49	5.764	Umatilla	80
4100521	VINCENT WATER COMPANY	2	4.355	5.119	Umatilla	80
4100588	GOLF MOBILE CITY	1	20.1	24.74	Malheur	32

PWS ID	PWS Name	Well Number	Median NO_3	90th NO_3	County	PWS Population
4100779	SALEM MOBILE ESTATES/SHADY ACRES	2	12.6	12.77	Marion	150
4100872	PINEWOOD MOBILE MANOR	1	2	3.8	Wasco	180
4100872	PINEWOOD MOBILE MANOR	Spring	6	6.21	Wasco	180
4101002	KOUNTRY VILLAGE	1	4.84	5.56	Lane	60
4101044	DUN-ROLLIN MOBILE HOME	1,2,3,4	3.75	5.156	Umatilla	130
4101182	COUNTRY GARDEN	1	6	7.2	Morrow	110
4101182	COUNTRY GARDEN	2	6	7.2	Morrow	110
4101233	DEER ISLAND	1	4.3	7.38	Columbia	90
4101267	CITY BIBLE CHURCH	1	6.05	7.235	Multnomah	300
4101317	PRINEVILLE MOBILE HOME	1	6.45	9.79	Crook	120
4101416	OAKDALE TRAILER PARK	1	7.9	9.68	Marion	40
4105239	SHOUN CROSSROADS	3	7	8.6	Crook	45
4105239	SHOUN CROSSROADS	4	7	8.6	Crook	45
4105798	SUNRIDGE WATER INC	1	7	9.656	Umatilla	100
4105798	SUNRIDGE WATER INC	2	7	9.656	Umatilla	100
4105854	RIVER VILLAGE MHP	1	3.97	7.3	Malheur	28
4190568	HARRIS PRIVATE SCHOOL	1	8.1	10.12	Linn	40
4190568	HARRIS PRIVATE SCHOOL	New	2.65	5.35	Linn	40
4190577	WEST STAYTON	1	4.4	7.34	Marion	50
4190586	BETHANY ELEMENTARY	1	3.3	9.1	Marion	90
4190590	SAUVIE ISLAND SCHOOL	1	4.6	5.18	Multnomah	80
4190889	ANNEX ELEMENTARY SD	Main	6.02	7.964	Malheur	50
4190889	ANNEX ELEMENTARY SD	Old well (AA)	12.15	12.39	Malheur	50
4191232	HAT ROCK MOBILE COURT	Back-	7.9	8.8	Umatilla	60
4191232	HAT ROCK MOBILE COURT	Main (Well 1)	7.9	8.8	Umatilla	60
4191232	HAT ROCK MOBILE COURT	New (Well 3)	0	0.35	Umatilla	60
4191724	WATERLOO PRIMARY (K-2)	1	2.7	4.12	Linn	235
4193711	FAIRPLAY ELEMENTARY,	1	7.3	8.94	Benton	80
4193750	WILLOWCREEK ELEMENTARY, SD #89	Main	3.475	8.48	Malheur	54
4193753	EVERGREEN ELEMENTARY	1	5.5	6.11	Marion	90
4194562	LAMB WESTON -	1	5.85	7.28	Umatilla	500
4194562	LAMB WESTON -	2	5.85	7.28	Umatilla	500
4194562	LAMB WESTON -	3	5.85	7.28	Umatilla	500
4194717	COLUMBIA RIVER PUD	1	14	27	Columbia	40
4194728	WALLOWA MTN VISTORS	1	4.6	5.499	Wallowa	90
4195136	JEFFERSON BAPTIST	A	4.45	5.94	Marion	110
4195136	JEFFERSON BAPTIST	B	0	0	Marion	110

Note: Several wells have septic densities lower than the thresholds but have septic systems as a probable source for other reasons. **Junction City** has many septic systems known within the sewered areas and may have more that are not known, in addition to a possible legacy effect from now decommissioned systems. **Pinewood Mobile Manor** has a small amount of agricultural land in the vicinity and its three high capacity septic systems; a golf course to the north (outside of the 10-year TOT) is the only other visible potential source. **Country Garden Estates MHP** and the surrounding area are on Irrigon's sewer system; however, there may be unconnected houses in the area or old septic systems that are not known. Septic contributions cannot be ruled out. **City Bible Church** is in the middle of Portland and nitrate sources are not ready visible. Landscaping

fertilizers and/or sewer leakage are possible sources. **Hat Rock Mobile Court** is mostly open space with a small area of agriculture and a dense subdivision with septic systems in the northern part of the 10-year TOT. The area to the south has a great deal of agriculture but the septic system cluster from the subdivision and the Court's own large capacity system should not be ruled out as sources. **Lamb Weston-Hermiston** has some clusters of septic systems in the northwestern part of the 10-year TOT; the main source is probably agriculture.

For each public water supply well, nitrate-N data were analyzed to determine the influence of probable nitrate source on the median and 90th percentile nitrate-N values. A one-factor analysis of variance (ANOVA) test shows no significant differences among the different primary sources for both average median nitrate (F=0.39, p=0.678, n=130, Figure 2) and average 90th percentile nitrate (F=1.03, p=0.362, n=130, Figure 3). While source identification will be important for any reduction efforts, the probable source at this broad level of evaluation does not appear to have much impact on actual nitrate concentrations in source water.

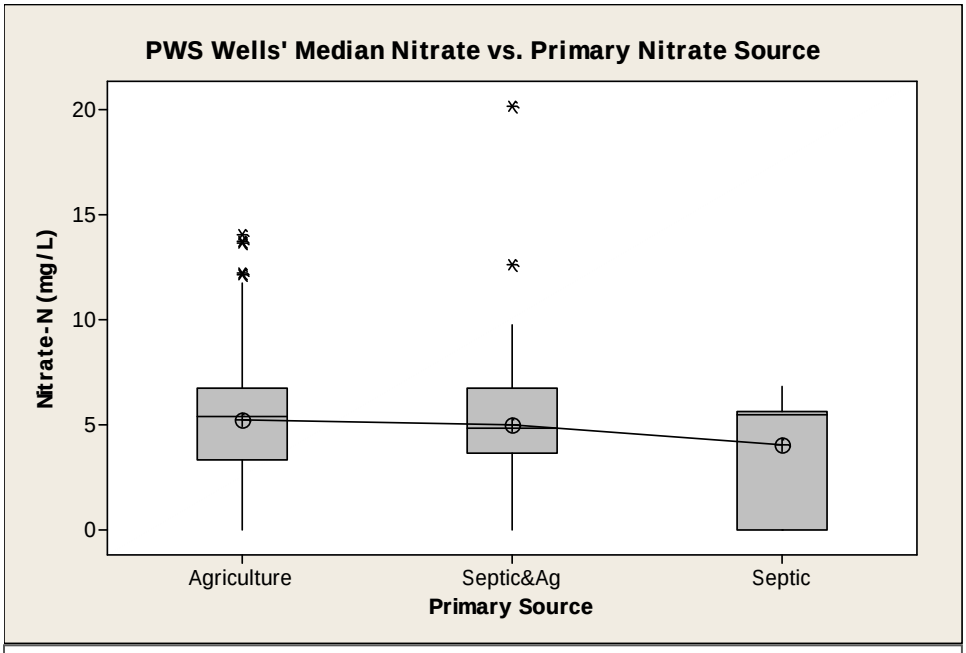


Figure 2: Median nitrate in these public water supply wells is not related to the most likely nitrate source identified from land use data and orthophotos.

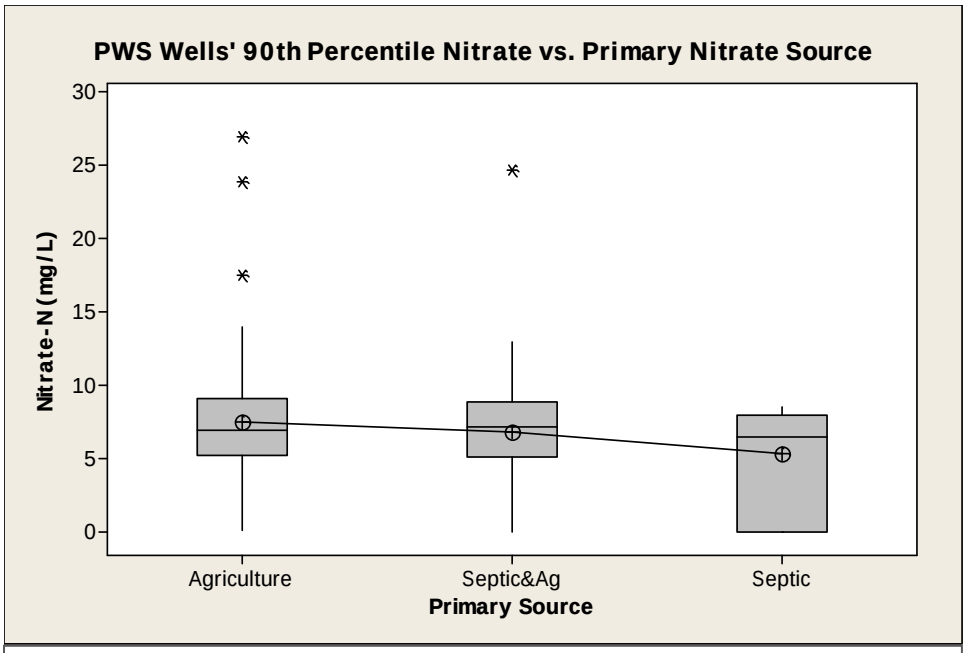


Figure 3: 90th percentile nitrate in these public water supply wells is not related to the most likely nitrate source identified from land use data and orthophotos.

Identification of Factors Connected to Elevated Nitrate

For each public water supply well, nitrate-N data were analyzed to determine the influence of aquifer vulnerability (a combined rating of aquifer confinement and well construction), aquifer confinement, well construction in confined aquifers, and soil sensitivity on the median and 90th percentile nitrate-N values for each well. One-factor analysis of variance (ANOVA) was used to test for significant differences.

Aquifer Vulnerability

Wells rated "Yes" are in an aquifer vulnerable to contamination due to a lack of a confining layer and/or have inadequate well construction that could allow contaminated water to flow down the well shaft. Wells rated "Semi-Vulnerable" ("Semi") have adequate well construction but their aquifers are only semi-confined, i.e. water can probably penetrate the confining layer to some degree. Wells rated "No" have both adequate well construction and a confining layer above the aquifer through which water cannot pass.

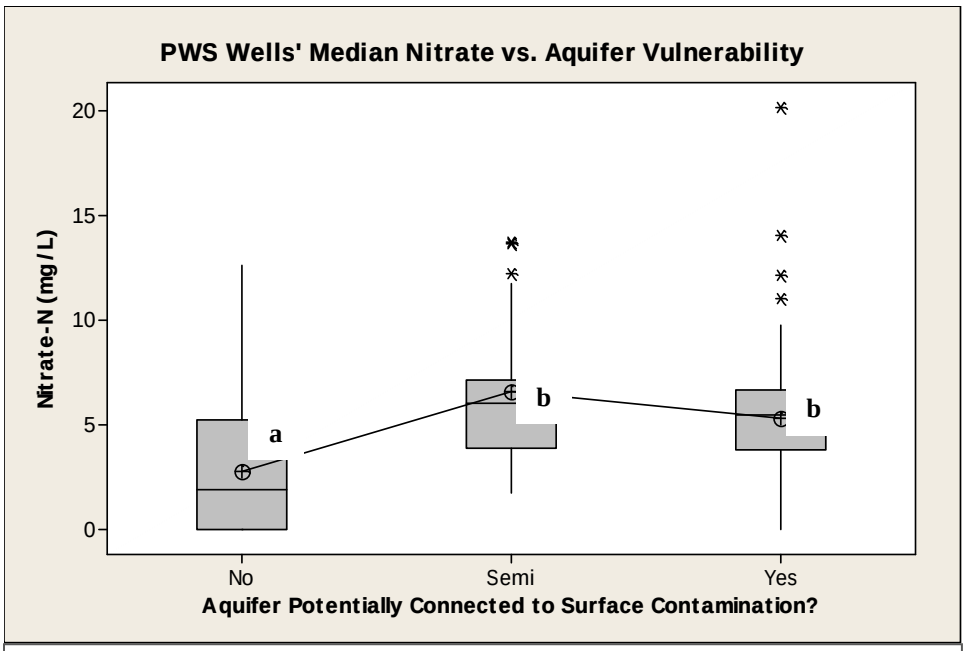


Figure 4: Median nitrate in water from aquifers which are not rated as vulnerable is significantly lower than water from semi-vulnerable or vulnerable aquifers (groups with different letters are significantly different).

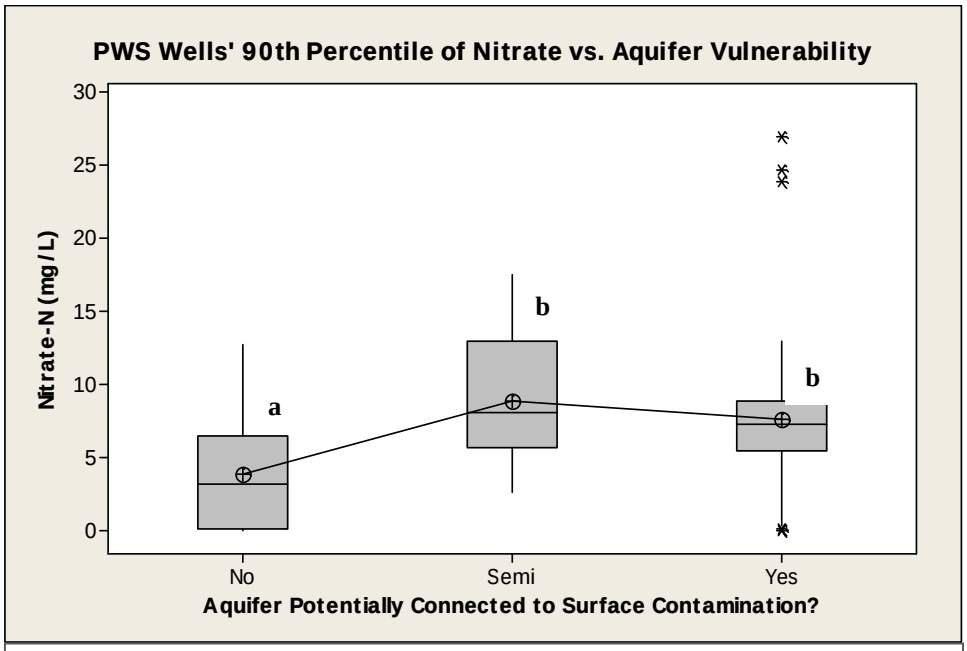


Figure 5: 90th percentile nitrate in water from aquifers which are not rated as vulnerable is significantly lower than water from semi-vulnerable or vulnerable aquifers (groups with different letters are significantly different).

Analysis of variance comparing nitrate-N concentration (in mg/L) among the different ratings for aquifer vulnerability showed a significant difference when using the median or 90th percentile of each public supply well's nitrate-N sample results from the last 10 years (median: $F=8.98$, $p<0.001$, $n=130$, Figure 4; 90th

percentile: F=9.79, p<0.001, n=130, Figure 5). Pairwise comparisons using Tukey's test demonstrate that nitrate-N is similar for vulnerable wells rated "Yes" (mean for median nitrate-N=5.33±3.00, 90th percentile=7.65±4.30) and wells rated "Semi" (mean for median=6.58±3.61, 90th percentile=8.86±3.88) while both have significantly higher nitrate than wells rated "No" (mean for median=2.76±3.29, 90th percentile=3.89±3.71). These results show the utility of rating a well's vulnerability based on whether the aquifer is confined and whether well construction is adequate.

Importance of Aquifer Confinement

We then compared nitrate-N concentration (in mg/L) among wells in confined, semi-confined, and unconfined aquifers without regard for well construction. These ANOVA results also showed significant differences in the median or 90th percentile of each public supply well's nitrate-N sample results from the last 10 years (median: F=4.79, p=0.003, n=130, Figure 6; 90th percentile: F=5.15, p=0.002, n=130, Figure 7). Pairwise comparisons using Tukey's test demonstrate that nitrate-N is similar for wells in unconfined aquifers (mean for median nitrate-N=5.40±3.21; 90th percentile=7.73±4.57) and semi-confined aquifers (mean for median=6.50±3.62; 90th percentile=8.46±3.95) while both have significantly higher nitrate concentrations than wells in confined aquifers (mean for median=3.65±3.16; 90th percentile=5.18±3.51). Results were mixed for wells where aquifer confinement status was unknown: comparisons based on median nitrate-N (mean=5.52±1.31) showed no difference compared to confined, semi-confined, or unconfined aquifers, but the mean 90th percentile nitrate-N (9.54±5.91) was significantly higher than the mean 90th percentile of confined aquifers. The presence or absence of a confining layer alone is shown to be a good predictor of a public water supply well's potential for nitrate contamination, and semi-confined aquifers do not appear to be better protected than totally unconfined aquifers.

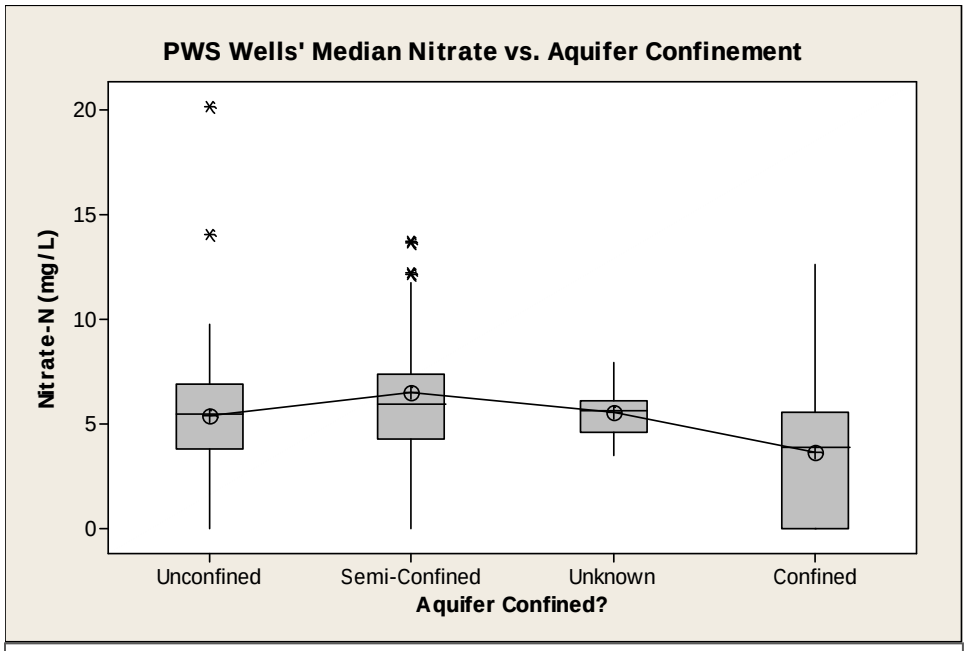
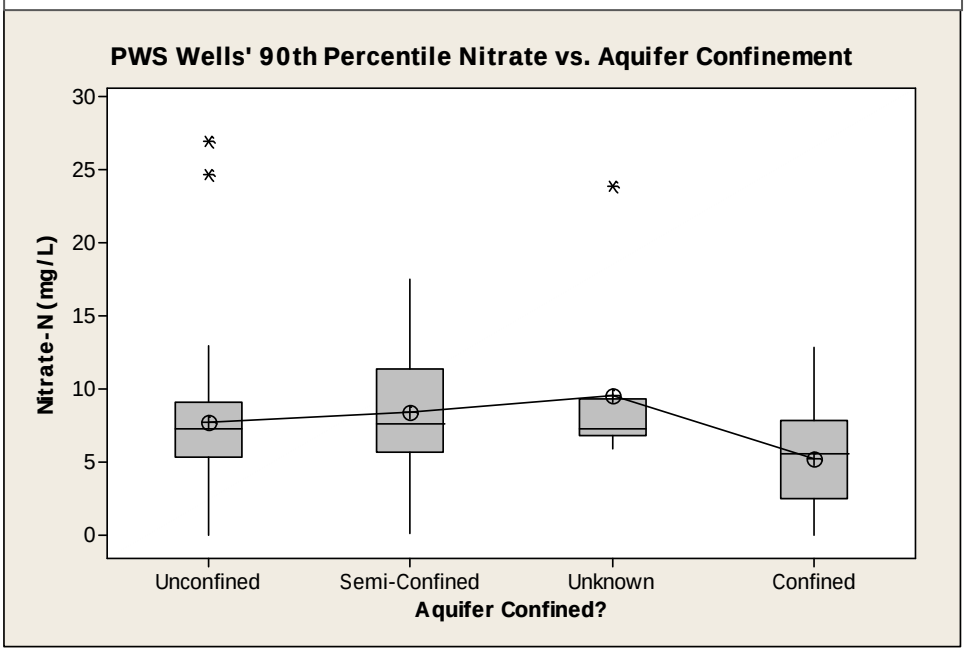


Figure 6: Median nitrate in water from confined aquifers is significantly lower than water from semi-confined or unconfined aquifers (groups with different letters are significantly different). Unknown aquifers are not distinct.

Figure 7: 90th percentile nitrate in water from confined aquifers is significantly lower than water from semi-confined, unconfined, or unknown aquifers (groups with different letters are significantly different).



Well Construction

The significance of whether or not a public supply well's aquifer is confined raised the question of whether the seal construction was an important predictor in those cases where the aquifer was protected by a confining layer. Limiting the analysis to wells in confined aquifers, an ANOVA of nitrate-N concentration (in mg/L) among wells with adequate or inadequate construction showed significant differences in both the median and 90th percentile nitrate-N (median: F=4.59, p=0.038, n=43; 90th percentile: F=8.72, p=0.005, n=43). In confined aquifers, average median nitrate-N for wells with inadequate construction is 4.76±2.67 while the average median is 2.76±3.29 for wells with adequate construction (Figure 8). Results for the average 90th percentile nitrate-N are similar (inadequate construction=6.82±2.48, adequate construction=3.89±3.71; Figure 9). Even in aquifers protected by a confining layer, poor

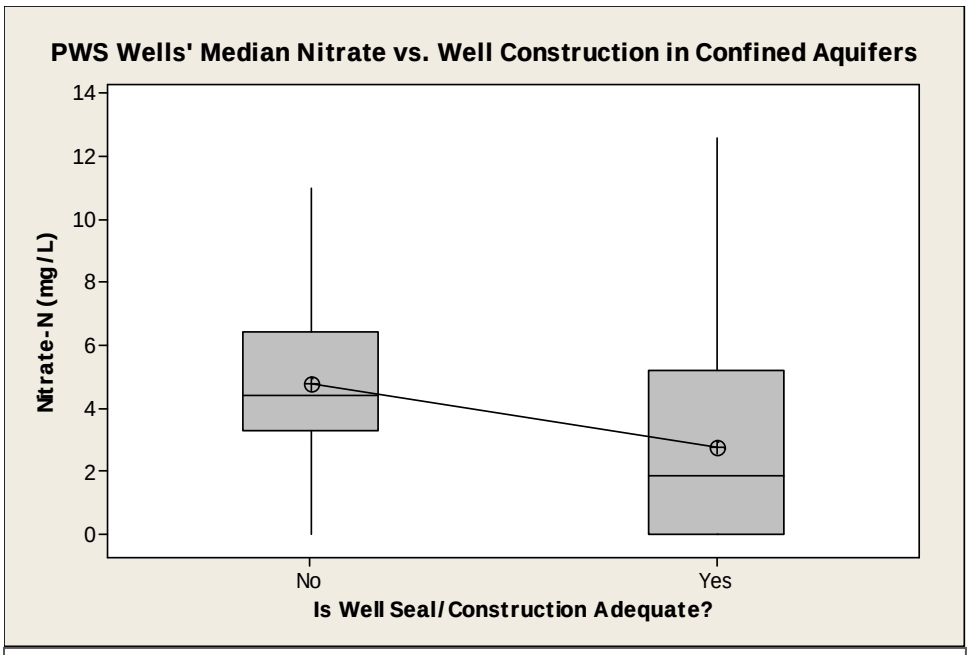


Figure 8: Median nitrate (in confined aquifers) in water from public supply wells with adequate construction is significantly lower than water from wells with inadequate construction.

construction and inadequate well seals on public supply wells are related to elevated nitrate levels in groundwater used as a drinking source.

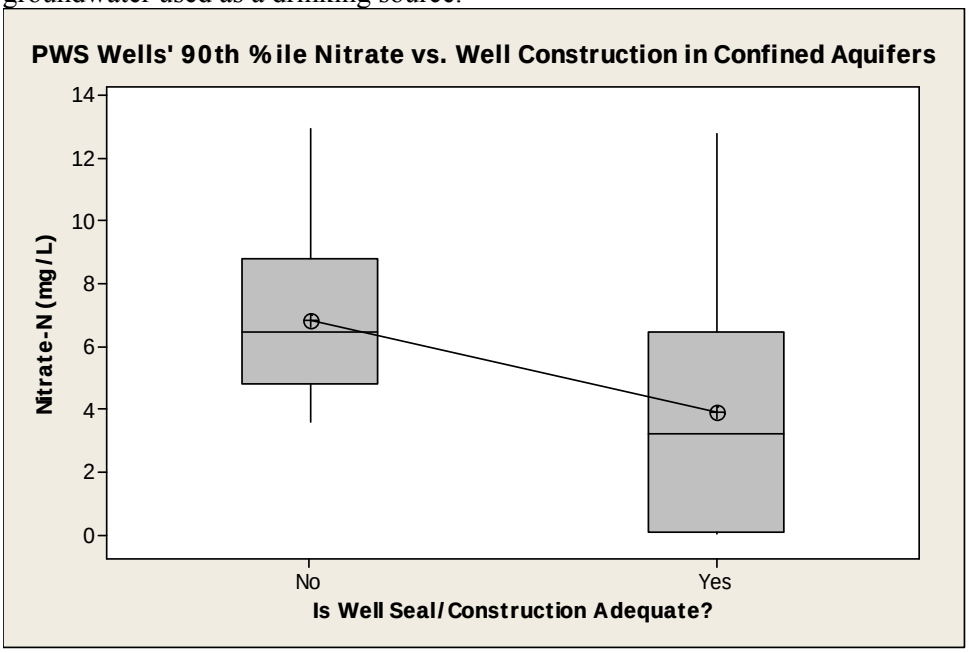


Figure 9: 90th percentile nitrate (in confined aquifers) in water from public supply wells with adequate construction is significantly lower than water from wells with inadequate construction.

Soil Sensitivity to Nitrate Movement

Nitrate-N values (median and 90th percentile for each public supply well) in unconfined and semi-confined aquifers were analyzed against the percentage of the Time-of-Travel (TOT) zones' total area that has soil sensitivity greater than Low (i.e. % area in Moderate, High, and Very High categories) using quantile regression. Quantile regression allows analysis of limiting factors by estimating relationships between variables at different response quantiles. Table 6 shows the slopes, intercepts, and the associated t-values and p-values for tests of statistical significance for those variables and quantiles with significant results. The quantile regression equations take the form: Nitrate = Slope*%Area >Low Sensitivity + Intercept.

Table 6: Significant Quantile Regression Coefficients and Associated Tests

Response/Predictor	Quantile	Intercept	t-value	P-value	Slope	t-value	P-value
Median NO_3/2yr TOT	75th	5.040	12961	<0.001	0.01910	4.9130	<0.001
Median NO_3/2yr TOT	80th	5.048	11.245	<0.001	0.01952	2.6279	0.011
Median NO_3/2yr TOT	85th	5.048	740.48	<0.001	0.01952	3.2650	0.002
Median NO_3/10yr TOT	75th	4.55932	16.124	<0.001	0.02441	4.4304	<0.001
Median NO_3/10yr TOT	80th	4.55932	56.521	<0.001	0.02441	3.4795	<0.001
90th %ile NO_3/10yr TOT	75th	6.05148	4.7227	<0.001	0.03502	2.0576	0.044

As with the analysis of well construction effects, this analysis was restricted to wells in unconfined aquifers where contamination is likely to reach the groundwater. The results show that soil sensitivity in the 2-year and 10-year TOTs is a significant predictor of median nitrate. In the 2-year TOT, median nitrate-N has slopes for the 75th, 80th, and 85th quantiles that are significant ($p<0.001$, $p=0.011$, and $p=0.002$, respectively), and the slopes and intercepts for these quantiles have nearly identical values (Table 6). In the 10-year TOT, median nitrate-N has a significant response at the 75th and 80th quantiles ($p<0.001$ for both). Again, these quantiles' slopes and intercepts are identical (Table 6). Soil sensitivity in the 10-year TOT zone is a significant predictor of the 90th percentile nitrate-N value with a significant response for the 75th quantile ($p=0.044$; Table 6). Results for the 2-year TOT zone and the 90th percentile of nitrate-N values had no significant quantiles (not shown). The proportion of the TOT zone that has Moderate, High, or Very High soil sensitivity is a useful predictor of nitrate contamination in unconfined wells with high nitrate values (75th quantile; Figures 10-12), demonstrating that soil sensitivity is important and is likely interacting with other factors (e.g. irrigation).

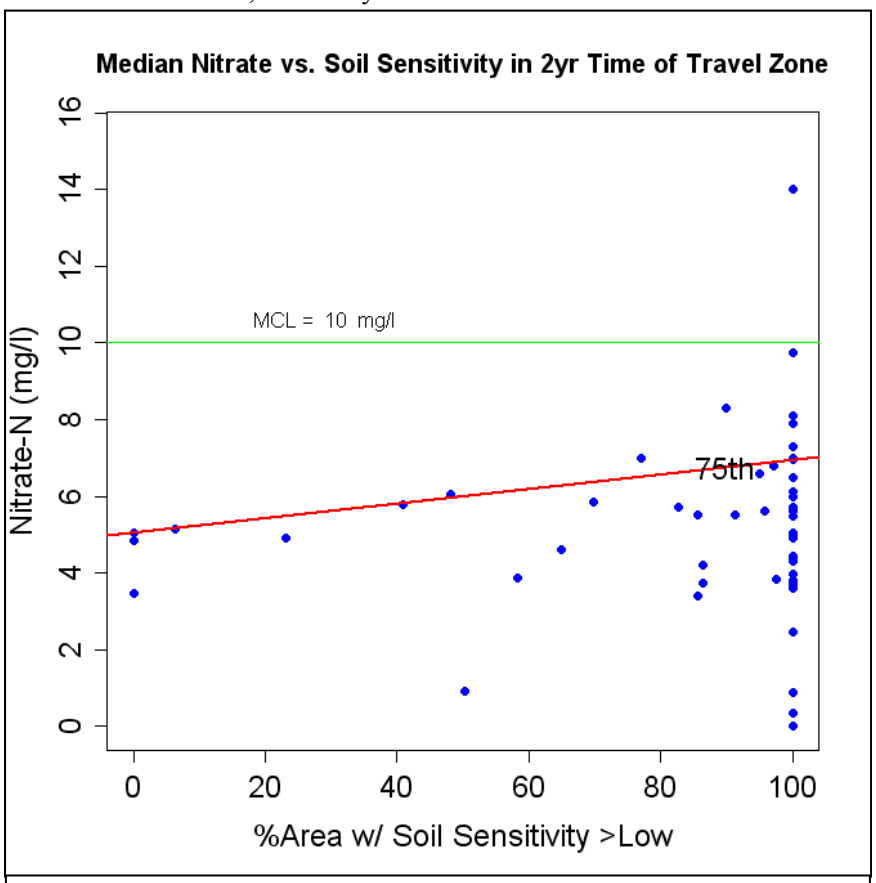


Figure 10: The quantile regression of median nitrate-N concentration against % area of the 2-year TOT zone with Sensitivity greater than Low. Soil Sensitivity is a significant factor controlling higher nitrate concentrations in public water supplies from unconfined and semi-confined aquifers. The 75th (shown), 80th, and 85th percentiles are statistically significant.

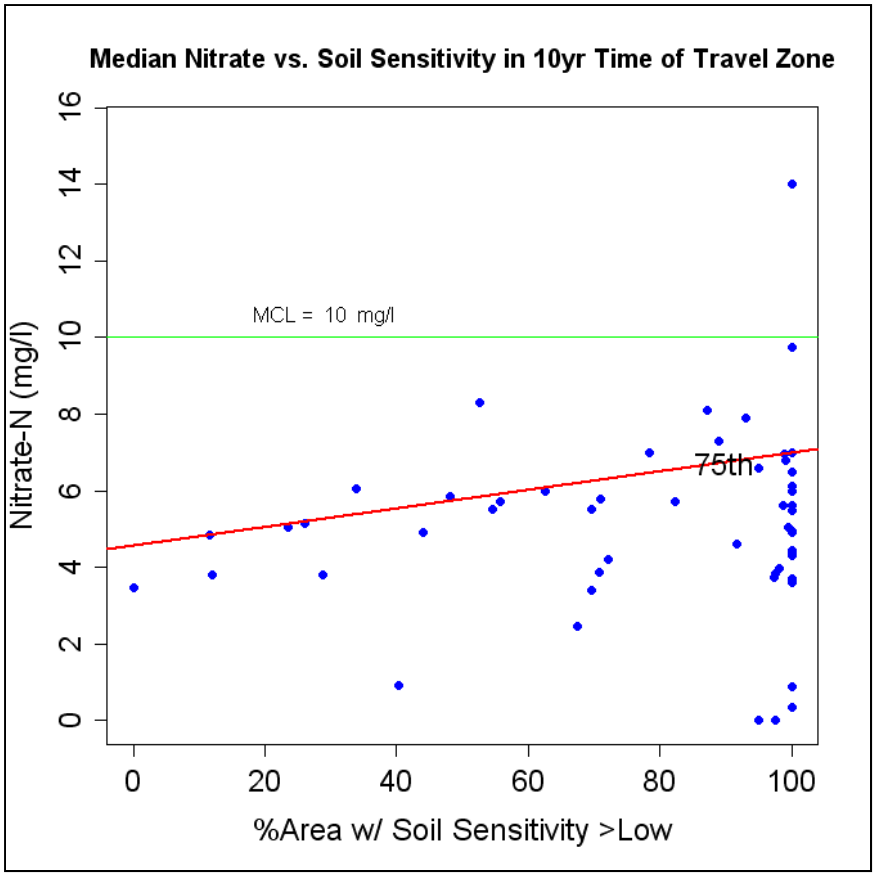


Figure 11: The quantile regression of median nitrate –N concentration against % area of the 10-year TOT zone with Sensitivity greater than Low. Soil Sensitivity is a significant factor controlling higher nitrate concentrations in public water supplies from unconfined and semi-confined aquifers. The 75th (shown) and 80th percentiles are statistically significant.

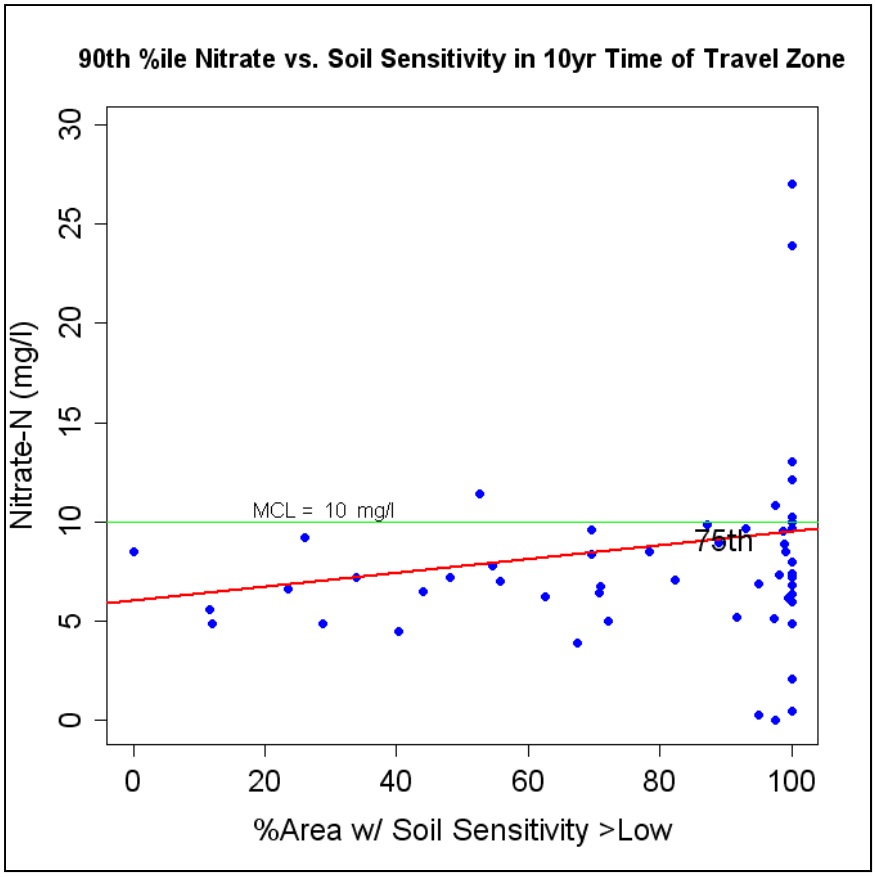


Figure 12: The quantile regression of 90th percentile nitrate-N concentration against % area of the 10-year TOT zone with Sensitivity greater than Low. Soil Sensitivity is a significant factor controlling higher nitrate concentrations in public water supplies from unconfined and semi-confined aquifers. The 75th (shown) percentile is statistically significant.

Discussion

There are 70 community and non-transient-non-community Public Water Systems (PWSs) in Oregon that are currently either having violations of the MCL for nitrate or at risk of having violations (Tables 1&2). This number is probably an underestimate as many systems are already removing nitrate from their drinking water, so the finished water data would not show a problem even though their aquifer is contaminated with unsafe concentrations of nitrate. There are numerous transient-non-community PWSs and state regulated non-public systems that are also having nitrate problems, but were not analyzed in this report. Also beyond the scope of this report are private wells, which provide drinking water to over 400,000 Oregon residents. Real Estate Transaction data have shown that many private wells have elevated or even unsafe nitrate concentrations (Figure 13). Nitrate contamination of groundwater is a statewide problem that goes beyond the three designated Groundwater Management Areas (GWMAs).

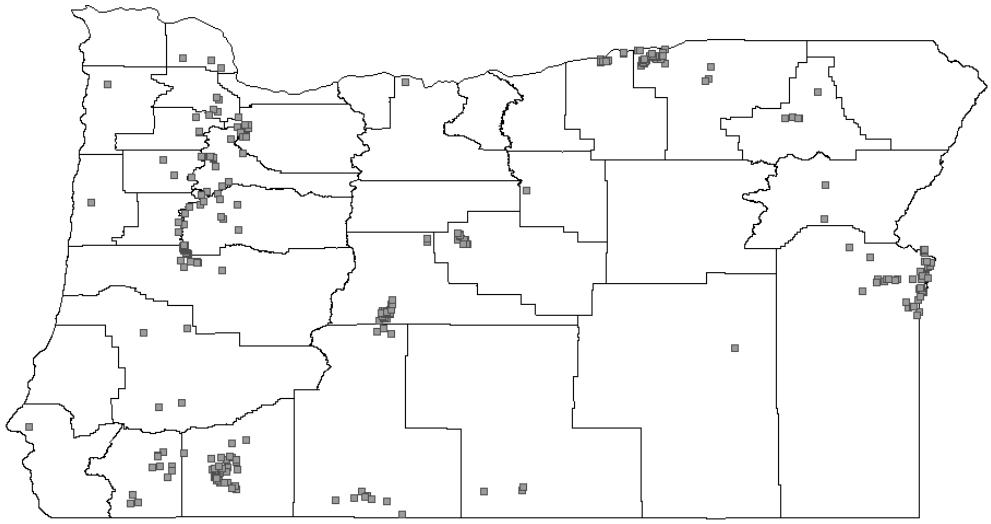


Figure 13: Real Estate Transaction tests that found nitrate-N at or above 10mg/L. These data show areas that have nitrate problems in private wells. Some areas may be underrepresented because few tests have been done or reported. Other areas may be overrepresented due to local testing efforts.

Previous studies have shown that agriculture is typically a larger nitrate source than urban development and onsite septic systems (Ceplecha *et al* 2004, McMahon *et al* 2008), but both are important contributors of nitrate (Mueller *et al* 1995). Even relatively low densities of septic systems (0.2 systems per acre) can cause violations of the nitrate drinking water criterion when there is little recharge from other sources (Bauman and Schafer 1985). Nitrate impacts of septic system could be exacerbated by the presence of antibiotics in the effluent if denitrifying bacteria are damaged, inhibiting the potential for nitrate to be reduced into a less harmful form of nitrogen (Underwood *et al* 2011). Some areas examined in this study (e.g. Irrigon) that currently have sewers may still be affected by past nitrate loading from now-unused septic systems.

While this study's analysis did not show the source sector (agriculture, residential, or both) having a significant effect on nitrate concentrations, other factors proved to be of importance. Whether a source aquifer is confined and hydrologically isolated from the land surface is known to be a major controlling factor in groundwater contamination, and this was true for PWS wells in Oregon. Previous studies have shown that aquifer characteristics are very important (Miller and Ortiz 2007). The significance of well construction in confined aquifers raises the possibility that nitrate and other types of contamination from the surface is travelling down improperly sealed PWS wells into the aquifers that supply those wells. Improperly dug or sealed wells have been known to serve as conduits for surface contamination or contamination from shallow aquifers into otherwise confined aquifers (Lane Council of Governments 2006). These two factors, well construction and aquifer confinement, give PWSs the ability to quickly assess which wells are most vulnerable to nitrate contamination. Protection and remediation strategies can be targeted to the most vulnerable wells, source reduction efforts can be implemented in their Time-of-Travel zones, and resources can be used to greatest positive impact.

The Soil Sensitivity Rating developed by Oregon State University as part of the Water Quality Decision Aid is shown to be a useful tool for predicting the potential for nitrate contamination in unconfined aquifers. Areas of higher sensitivity tended to have higher nitrate concentrations (Figures 10-12) although other untested factors are clearly influential. Soil Sensitivity is a combination of leaching potential and soil binding capacity. Soil binding capacity is based on clay and organic matter content. Since clays do not bind anions like nitrate, leaching potential alone may be a better predictor for vulnerability to nitrate leaching. Leaching of forms of nitrogen like ammonium and urea would be well described by the Soil Sensitivity tool. The form of nitrogen applied (urea, ammonium, nitrate, organic nitrogen, etc) will be an important factor in the likelihood of substantial nitrate leaching occurring. Transformations of nitrogen in the root zone by plants and soil microbes greatly influence concentration of the different nitrogen compounds in the soil and thereby alter the amounts of nitrate available for leaching (e.g. Butterbach-Nahl *et al* 2011).

Other possible factors or sources include amount and timing of irrigation, amount and timing of nitrogen fertilizer, manure, or wastewater application, crop type (Feaga *et al* 2004), tillage and organic matter content (Levanon *et al* 1993), and septic system density (e.g. Katz *et al* 1980, Yates 1985). Levanon *et al* (1993) showed that nitrate and several pesticides moved through the soil profile more readily in plowed fields compared to no-till fields. Hall *et al* (2001) found that soil type accounted for 5-10 kg/ha of nitrogen leaching, while crop rotations and land application of CAFO wastes accounted for most of the leached nitrogen (65 kg/ha and >100 kg/ha, respectively). The ratio of area in woodland, pasture, or rangeland versus cropland can also be influential; proportionally more pasture or woodland results in lower groundwater nitrate generally (Mueller *et al* 1995). However, even soils with Low Sensitivity can be susceptible to groundwater contamination if the soil's nitrogen binding capacity is overloaded by the large amounts of nitrogen from surface sources. In theory, Soil Sensitivity should not make any difference to water quality in confined aquifers, but natural or artificial flow paths into confined aquifers could make it important in some cases and make those aquifers "unconfined" in practice. This study did not explore the effects of anoxic zones where nitrate is converted to ammonia or nitrogen gas which can reduce loading to aquifers, but anoxic conditions should lower an area's sensitivity (McMahon *et al* 2008). Nitrogen sources in highly sensitive areas would warrant additional scrutiny.

Larger regional issues are also important. A PWS may have few sources inside its 10-year Time-of-Travel zone, but still be affected by long-term regional problems. Probable sources and, in some cases, source loads in the three Groundwater Management Areas (GWMAs) in Oregon have been identified (Malheur County Groundwater Management Committee 1991, Lane Council of Governments 2008, DEQ 2011). Agricultural sources include fertilizers used on crops, particularly where irrigation is present, domestic animals especially Concentrated Animal Feeding Operations (CAFOs), and land application of food processing wastewater and manure. Residential sources include onsite septic systems and land application of municipal wastewater. In some cases, there may

be industrial nitrate sources, but these are overshadowed by agricultural and residential inputs. In the Lower Umatilla GWMA, CAFOs and irrigated agriculture are the two largest sources of nitrogen (46% and 36%, respectively), and irrigated agriculture is responsible for the majority of leached nitrate (82%) with sources being fertilizers and land-applied CAFO wastes (DEQ 2011). Thirty-one of the seventy PWSs included in this analysis are in GWMAs. Nitrogen sources and movement pathways are unlikely to be different for those PWSs outside of the GWMAs as compared to those in the GWMAs. Particular attention should be paid to opportunities in sensitive areas in order to protect groundwater quality and prevent the need for expensive treatment, development of new sources, or pollution remediation.

Many of the community and non-transient, non-community Public Water Systems identified in this report are rural schools (14 of 70) or mobile home parks (18 of 70). The remainder includes several smaller municipalities. Mobile home parks are often occupied by low-income, minority, or elder populations, raising concerns about environmental justice and nitrate contamination in Oregon. Children are frequently more vulnerable to effects of pollution than adults, so the presence of nitrate risks at so many schools raises additional concerns. It is possible that these more vulnerable populations have increased exposure to nitrate pollution. Schools, small municipalities, and mobile home parks have limited resources, and installation of treatment equipment and/or a new well can represent a burdensome or cost-prohibitive expense. Any human health costs incurred would also be borne by these persons and communities that are little able to afford them (Moore *et al* 2011), and state and federal resources for water treatment or development of new sources are not sufficient to meet current needs and primarily limited to low-interest loans. While there is not sufficient information to definitively determine if environmental injustice is a problem is these cases, there is precedent in the Pacific Northwest in the Yakima River valley (Washington State Department of Agriculture *et al* 2010). Investigation of possible environmental justice issues is necessary.

Recommendations and Next Steps

DEQ makes the following recommendations to help further address the problem of high nitrate levels and public drinking water systems in Oregon:

- **Conduct more analysis/study of possible high nitrate sources.** More detailed source analysis using isotopic analysis or other means will help determine particular geographic areas that need more attention. (McMahon *et al* 2008). For example, determining ratios of chloride to bromide is a potential low-cost way to gauge septic system impact (Katz *et al* 2011). Presence of fecal bacteria and viruses, sterols, pharmaceuticals, and other wastewater compounds are good indicators of animal waste or septic system contributions to high nitrate levels. The co-occurrence of pesticides, meanwhile, would indicate agricultural activities as a likely source as well.

  Mass balance calculations in vulnerable areas using known nitrogen pollution loads and volume of water is one way of quantifying where new nitrate loads from new septic systems or agriculture may need to be restricted or where existing loads could be reduced through best management practices or modifications to wastewater disposal (Frimpter *et al* 1990). Soil sensitivity maps, aquifer and hydrogeology characteristics, or computer models such as the Nitrate Leaching and Economic Analysis Package (Shaffer *et al* 1991) and ArcNLET (Rios *et al* 2011) can prioritize the most vulnerable locations that need to be managed differently. Crop types and irrigation practices can also be evaluated for further insight about high-nitrate sources.

- **Deal with inadequately constructed public water supply wells.** Wells with inadequate seals or poor construction should be repaired, reconstructed, or abandoned to eliminate the potential for nitrate-laden water to reach the aquifer. Likewise, improperly constructed or unmaintained and unused wells of any type in 2- and 10-year time-of-travel zones should be identified and properly abandoned. Contamination of aquifers by direct conduits from the surface is preventable, and such conduits should be identified and repaired or abandoned.

- **Make further efforts to identify and eliminate sources of leachable nitrate, especially near wellheads.** Soil and plant testing of cropland and pasture in 2- and 10-year time-of-travel zones can help in calculating a nitrogen budget, allowing for more precise fertilizer applications that meet plants' needs without resulting in excess nitrogen that can leach to groundwater. Proper irrigation management, such as matching water volume to soil and crop needs, and frequent sprinkler head maintenance or replacement, can prevent excess water from leaching nitrate beyond plants' root zones. (See Sullivan *et al* 1999 for a summary of matching nitrogen and water needs to inputs.)

  In areas of with high groundwater nitrate, soils susceptible to leaching, and/or existing high septic tank densities, new septic systems should be capable of denitrifying wastewater and older systems should be retrofitted or replaced. Alternately, lot sizes could be made larger to match leaching risk, or new and existing households and businesses could be connected to sewer systems (Miller and Ortiz *2007*). Composting toilets are another human waste management option as long as wastes are properly handled and land-applied in a manner that prevents over-application of nitrogen or spread of pathogens (Crennan *1999*). Soil sensitivity and public water supply vulnerability can guide which areas to target with limited resources.

- **Foster increased cooperation and communication among government and academic entities to address nitrate problems.** State and federal agencies, state academic institutions, local and county governments, and soil and water conservation districts should work together to provide education, incentives, and regulatory requirements as needed to help land managers and property owners reduce or eliminate nitrogen pollution in groundwater. Factors identified in this report (aquifer confinement, well construction and maintenance, and soil sensitivity to leaching) and more-detailed identification of nitrate pollution sources can help prioritize locations that would receive the most benefit given limited financial and other resources.

  These entities should also focus on public water systems that are at risk but do not yet have high nitrate levels, as prevention now could prevent the need for expensive treatment and remediation in the future.

Oregon has the knowledge and tools to prevent further nitrate contamination of drinking water sources.

References

Avery, AA. 1999. Infantile methemoglobinemia—Reexamining the role of drinking water nitrates. *Environmental Health Perspectives* **107:** 583–586.

Bauman, BJ and WM Schafer. 1985. Estimating ground-water quality impacts from on-site sewage treatment systems. p. Z85-294. *In* On-site wastewater treatment. Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems, Dec 10-11, 1984, New Orleans, LA. ASAE Publication 07-85. Am. Soc. A9. Eng., St. Joseph, MI.

Butterbach-Bahl, K, P Gundersen et al. 2011. Nitrogen processes in terrestrial ecosystems. *In* The European Nitrogen Assessment. MA Sutton, CM Howard, JW Erisman, G Billen, A Bleeker, P Grennfelt, H van Grinsven, and B Grizzetti, eds. Cambridge University Press, New York NY. pp 99-125.

Box, GEP. 1953. Non-normality and tests on variances. *Biometrika* **40:** 318-335.

Cade, BS, JW Terrell, and RL Schroeder. 1999. Estimating effects of limiting factors with regression quantiles. *Ecology* **80:** 311-323.

Ceplecha, ZL, RM Waskom, TA Bauder, JL Sharkoff, and R Khosla. 2004. Vulnerability assessments of Colorado ground water to nitrate contamination. *Water, Air, and Soil Pollution* **159:** 373-394.

Crennan, L. (1999) Composting Toilet Trial Final Report, Tonga Water Board and AusAID, Tonga Water Board Institutional Development Project, AusAID, Canberra, ACT, Australia.

DEQ (Oregon Department of Environmental Quality). 2011. Estimation of Nitrogen Sources, Nitrogen Applied, And Nitrogen Leached to Groundwater in the Lower Umatilla Basin Groundwater Management Area. URL: http://www.deq.state.or.us/er/reports/11er001.pdf . 25pp.

DeSimone, LA. 2009. Quality of water from domestic wells in principal aquifers of the United States, 1991-2004. US Geological Survey Scientific Investigations Report 2008-5227. US Geological Survey, National Water-Quality Assessment Program, Reston, VA.

Feaga, J, R Dick, M Louie, and J Selker. 2004. Nitrates and groundwater: why should we be concerned with our current fertilizer practices? Oregon State University Special Report 1050.

Frimpter, MH, JJ Donohue, MV Rapacz. 1990. A mass-balance nitrate model for predicting the effects of land use on ground-water quality. US Geological Survey Open-File Report 88-493. 17pp and Appendices.

Hall, MD, MJ Shaffer, RM Waskom, and JA Delgado. 2001. Regional nitrate leaching variability: what makes a difference in northeastern Colorado. *Journal of the American Water Resources Association* **37:** 139-150.

Hill, M.J., Hawksworth, G., and Tattersall, G., 1973, Bacteria, nitrosamines and cancer of the stomach: British Journal of Cancer, v. 28, p. 562–567.

Katz, BG, JB Lindner, and SE Ragone. 1980. Comparison of nitrogen in shallow ground water beneath sewered and unsewered areas, Nassau County, New York, 1952 through 1976. *Ground Water* **18:** 607-616.

Huddleston, JH, WR Mendez, M Brett, EA Kerle, and PA Vogue. 1998. Determination of soil sensitivity ratings for the Oregon Water Quality Decision Aid (OWQDA). Oregon State University Extension Service: EM 8708.

Katz, BG, SM Eberts, and LJ Kauffman. 2011. Using Cl/Br rations and other indicators to assess potential impacts on groundwater quality from septic systems: a review and examples from principal aquifers in the United States. *Journal of Hydrology* **397:** 151-166.

Lane Council of Governments. 2006. Southern Willamette Valley Groundwater Management Area Action Plan. December 2006. 82pp.

Lane Council of Governments. 2008. Southern Willamette Valley Groundwater Management Area Nitrogen/Nitrate Budget Report. June 2008. 63pp.

Levanon, D, EE Codling, JJ Meisinger, and JL Starr. 1993. Mobility of agrochemicals through soil from two tillage systems. *Journal of Environmental Quality* **22:** 155-161.

Levene, H. 1960. Contributions to Probability and Statistics. Stanford University Press, CA.

Malberg, J.W., Savage, E.P., and Osteryoung, J., 1978, Nitrates in drinking water and the early onset of hypertension: Environmental Pollution, v. 15, p. 155–160.Malheur County Groundwater Management Committee. 1991. Northern Malheur County Groundwater Management Action Plan. URL: http://www.deq.state.or.us/wq/groundwater/docs/nmcgwma/actionplan.pdf

McMahon, PB, JK Bohlke, LJ Kauffman, KL Kipp, MK Landon, CA Crandall, KR Burow, and CJ Brown. 2008. Source and transport controls on the movement of nitrate to public supply wells in selected principal aquifers of the United States. *Water Resources Research* **44:** W04401, doi:10.1029/2007WR006252.

Miller, LD, and RF Ortiz. 2007. Ground-water quality and potential effects of individual sewage disposal system effluent on ground-water quality in Park County, Colorado, 2001-2004. US Geological Survey Scientific Investigations Report 2007-5220.

Moore, E, E Matalon, C Balazs, J Clary, L Firestone, S De Anda, and M Guzman. 2011. The human costs of nitrate-contaminated drinking water in the San Joaquin Valley. Pacific Institute, March 2011. 71pp.

Mueller, DK, PA Hamilton, DR Helsel, KJ Hitt, and BC Ruddy. 1995. Nutrients in ground water and surface water of the United States: An analysis of data through 1992. US Geological Survey Water Resources Investigations Report 95-4031. 74pp.

Oregon Safe Drinking Water Information System. URL: http://170.104.63.9/

Parslow, RC, PA McKinney, GR Law, A Staines, R Williams, and HJ Bodansky. 1997. Incidence of childhood diabetes mellitus in Yorkshire, northern England, is associated with nitrate in drinking water—An ecological analysis. *Diabetologia* **40:** 550–556.

Rios, JF, Ming Ye, and PZ Lee. 2011. ArcNLET: An ArcGIS-Based Nitrate Load Estimation Toolkit. URL: http://people.sc.fsu.edu/~mye/ArcNLET/index.html .

Shaffer, MJ, AD Halvorson, and FJ Pierce. 1991. Nitrate Leaching and Economic Analysis Package (NLEAP): model description and application. *In:* Managing Nitrogen for Groundwater Quality and Farm Profitability, RF Follett, DR Keeney, and RM Cruse, eds. Soil Science Society of America, Inc., Madison, Wisconsin. pp. 285-322.

State-EPA Nutrient Innovations Task Group. 2009. An Urgent Call to Action: Report of the State-EPA Nutrient Innovations Task Group. URL: http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2009_08_27_criteria_nutrient_nitgreport.pdf . August 2009. 170pp.

Sullivan, DM, JM Hart, and NW Christensen. 1999. Nitrogen uptake and utilization by Pacific Northwest crops. Oregon State University Extension/Pacific Northwest Extension publication, December 1999. PNW 513. 19pp.

Underwood, JS, RW Harvey, DW Metge, DA Repert, LK Baumgartner, RL Smith, TM Roane, and LB Barber. 2011. Effects of the antimicrobial sulfamethoxazole on groundwater bacterial enrichment. *Environ. Sci. Technol.* **45:** 3096-3101.

USEPA. 2006. Wadeable Streams Assessment. EPA 841-B-06-002. US Environmental Protection Agency, Washington, DC.

USEPA. 2011. National Summary of State Information. US Environmental Protection Agency, Washington, DC. URL: http://iaspub.epa.gov/waters10/attains_nation_cy.control . Accessed August 2011.

Ward, M.H., SD Mark, KP Cantor, DD Weisenburger, A Correa-Villasenor, and SH Zahm. 1996. Drinking water nitrate and the risk of non-Hodgkin's lymphoma: Epidemiology, v. 7, no. 5, p. 465–471.

Ward, MH, TM deKok, P Levallois, J Brender, G Gulis, BT Nolan, and J VanDerslice. 2005. Workgroup report: drinking-water nitrate and health—recent findings and research needs. *Environ Health Perspect* **113:** 1607–1614.

Washington State Department of Agriculture, WA Dept of Ecology, WA Dept of Health, Yakima County Public Health Department, and US Environmental Protection Agency. 2010. Lower Yakima Valley groundwater quality: preliminary assessment and recommendations document. Ecology Publication No. 10-10-009, February 2010. 87pp.

World Health Organization. 2011. Guidelines for drinking-water quality. 4th edition. URL: http://whqlibdoc.who.int/publications/2011/9789241548151_eng.pdf . 541pp.

Yates, MV. 1985. Septic tank density and ground-water contamination. *Ground Water* **23:** 586-591.

Appendix A: Public Water System Well Information and Soil Sensitivity Maps

Oakvilla Mobile Home Park (4100028)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 4.60/6.34

Wells 1 & 3

Median Nitrate-N
- #1: 5.50
- #3: 4.60

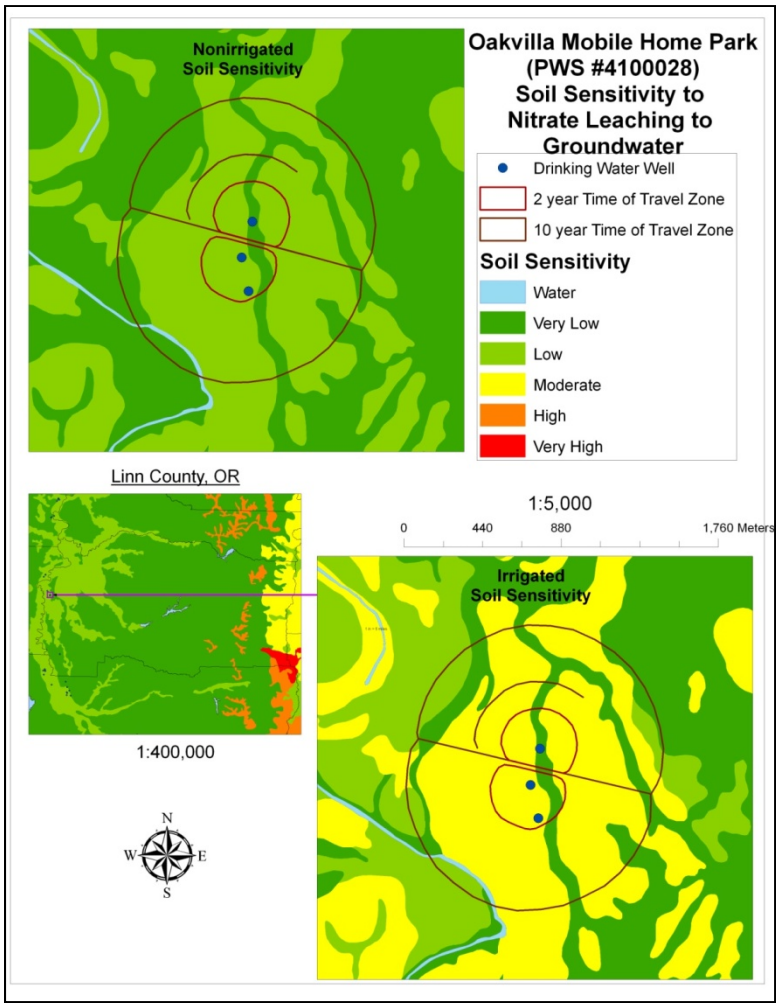
90th Percentile Nitrate-N
- #1: 5.66
- #3: 6.34

Aquifer Confinement
- #1: Semi-confined
- #3: Semi-confined

Well Construction
- #1: Inadequate
- #3: Adequate

Aquifer Vulnerable?
- #1: Yes
- #3: Semi

Probable Nitrate Source(s)
- Agriculture



2-year Time of Travel Zone

Nonirrigated Sensitivity
- 16.5% Very Low, 83.5% Low

Irrigated Sensitivity
- 16.5% Very Low, 83.5% Moderate

Septic Density (systems/acre)
- 0.035

10-year Time of Travel Zone [1.1% Surface Water]

Nonirrigated Sensitivity 17.5% Very Low, 81.4% Low

Irrigated Sensitivity 12.6% Very Low, 5.0% Low, 81.3% Moderate

Septic Density (systems/acre) 0.041

Well 4

Median Nitrate-N	5.55
90th Percentile Nitrate-N	6.15
Aquifer Confinement	Confined
Well Construction	Adequate
Aquifer Vulnerable?	No
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone

Nonirrigated Sensitivity	18.4% Very Low, 81.6% Low
Irrigated Sensitivity	18.4% Very Low, 81.6% Moderate
Septic Density (systems/acre)	0.034

10-year Time of Travel Zone

Nonirrigated Sensitivity	33.5% Very Low, 66.5% Low
Irrigated Sensitivity	24.3% Very Low, 9.2% Low, 66.5% Moderate
Septic Density (systems/acre)	0.031

City of Boardman (4100130)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 0.90/3.36

Wells 1, 2 &3

Median Nitrate-N
- #1: 0.89
- #2: 2.07
- #3: 4.40

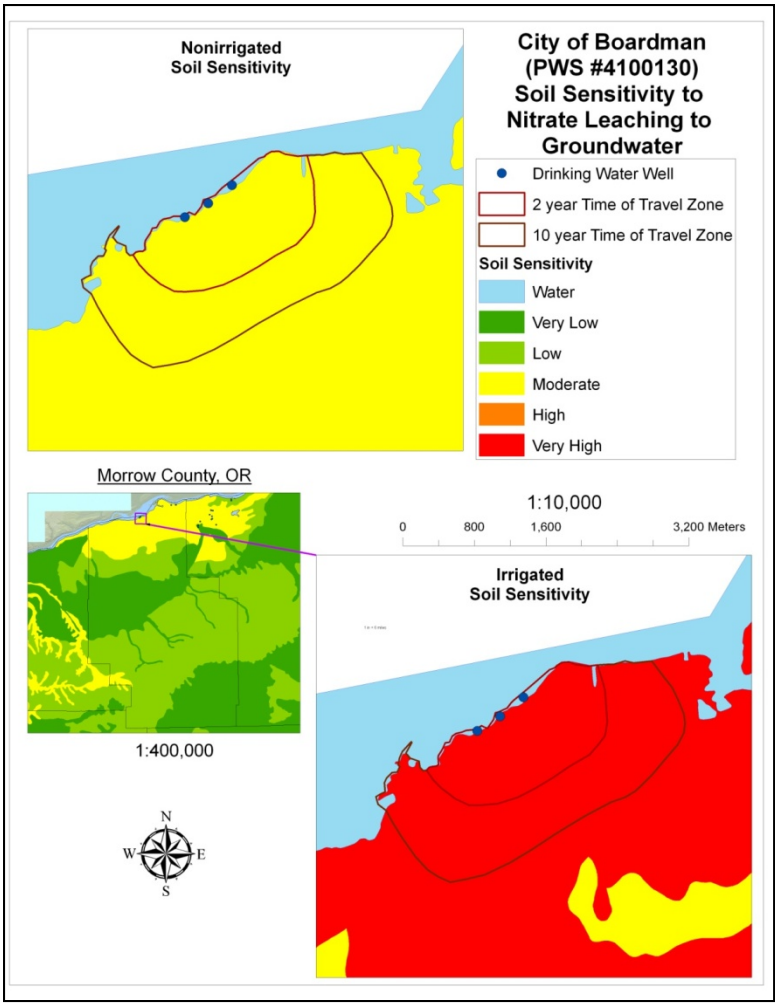
90th Percentile Nitrate-N
- #1: 0.89
- #2: 2.07
- #3: 4.40

Aquifer Confinement
- #1: Unconfined
- #2: Unconfined
- #3: Confined

Well Construction
- #1: N/A
- #2: N/A
- #3: Inadequate

Aquifer Vulnerable?
- #1: Yes
- #2: Yes
- #3: Yes

Probable Nitrate Source(s)
- Agriculture



2-year Time of Travel Zone

Nonirrigated Sensitivity	100% Moderate
Irrigated Sensitivity	100% Very High
Septic Density (systems/acre)	0
Probable Nitrate Source(s)	Agriculture

10-year Time of Travel Zone

Nonirrigated Sensitivity	100% Moderate
Irrigated Sensitivity	100% Very High
Septic Density (systems/acre)	0

Canby Regency (4100163)

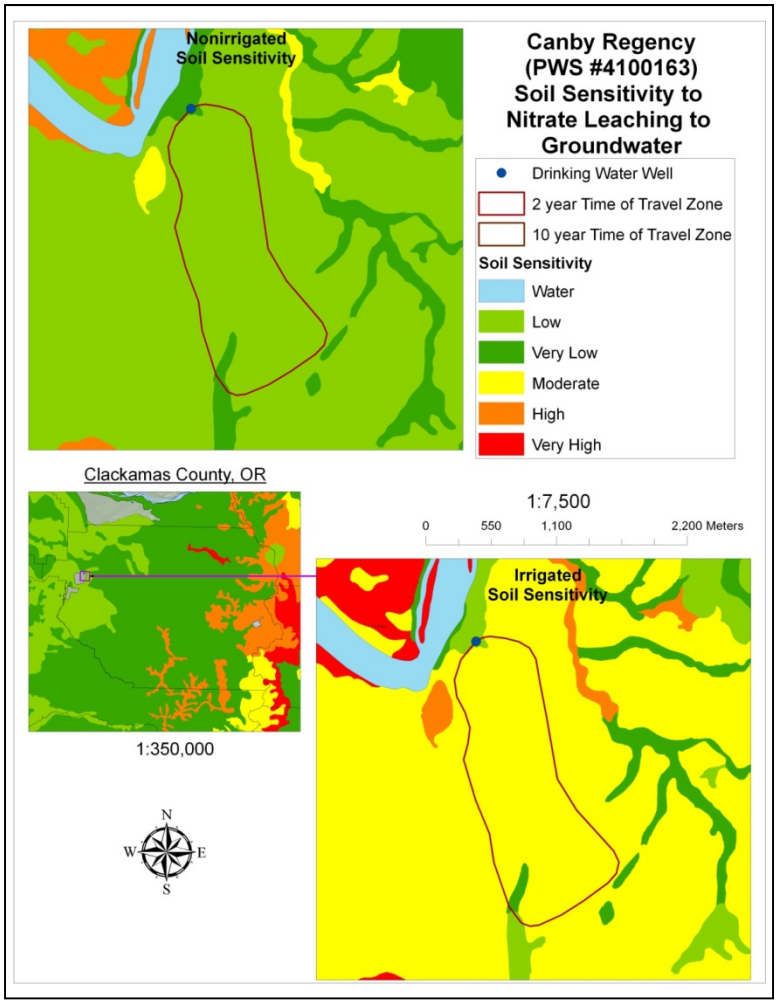
System currently active, uses ion exchange for nitrate removal.

Spring

Median Nitrate-N (mg/L)
3.85
90th Percentile Nitrate-N
10.8
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone

Nonirrigated Sensitivity
2.5% Very Low, 97.5% Low
Irrigated Sensitivity
1.8% Very Low, 0.7% Low, 97.5% Moderate
Septic Density (systems/acre)
0.067
Crops and Irrigation



10-year Time of Travel Zone
Not delineated/Same as 2-year Time of Travel

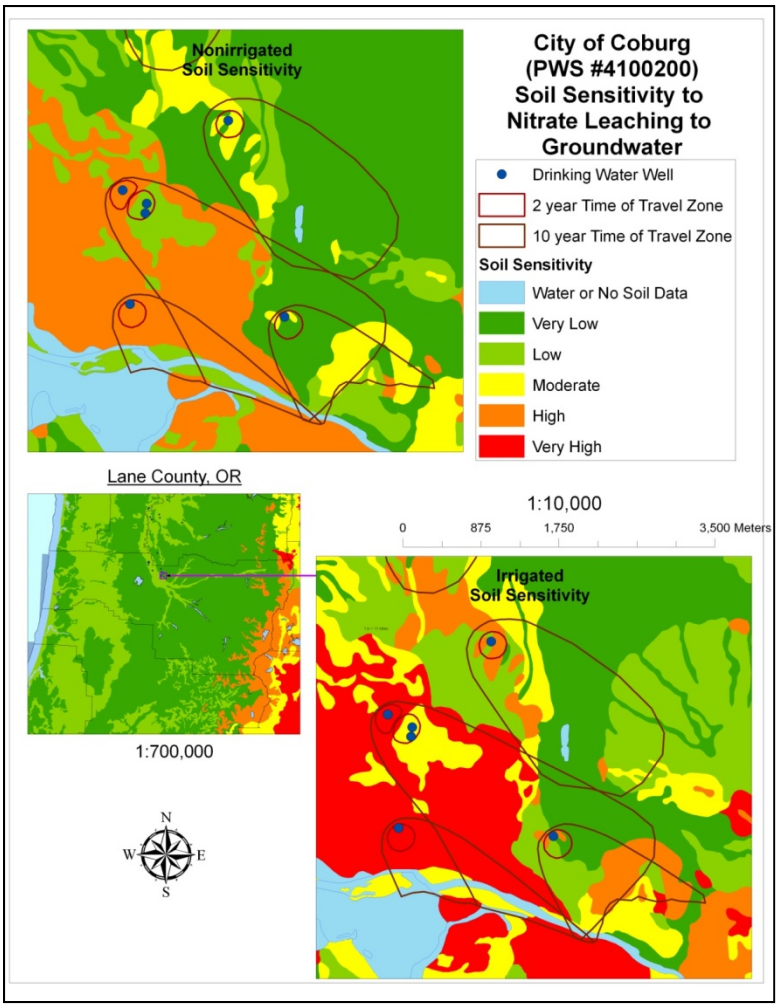
City of Coburg (4100200)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 3.30/5.20

Wells 1 & 2

Median Nitrate-N
#1: 2.45
#2: 3.89
90th Percentile Nitrate-N
#1: 4.45
#2: 5.30
Aquifer Confinement
#1: Unconfined
#2: Semi-confined
Well Construction
#1: Inadequate
#2: Adequate
Aquifer Vulnerable?
#1: Yes
#2: Semi
Probable Nitrate Source(s)
Agriculture



2-year Time of Travel Zone:

Nonirrigated Sensitivity:
21.2% Very Low, 17.6% Low, 20.1% Moderate, 41.2% High
Irrigated Sensitivity:
9.3% Very Low, 11.9% Low, 17.6% Moderate,

20.1% High, 41.2% Very High
Septic Density (systems/acre) 0.11

10-year Time of Travel Zone: [3.6% Water or No Soil Data]
Nonirrigated Sensitivity: 41.9% Very Low, 15.2% Low, 9.7% Moderate, 29.6% High
Irrigated Sensitivity: 24.6% Very Low, 17.3% Low, 15.2% Moderate,
9.7% High, 29.6% Very High
Septic Density (systems/acre) 0.057

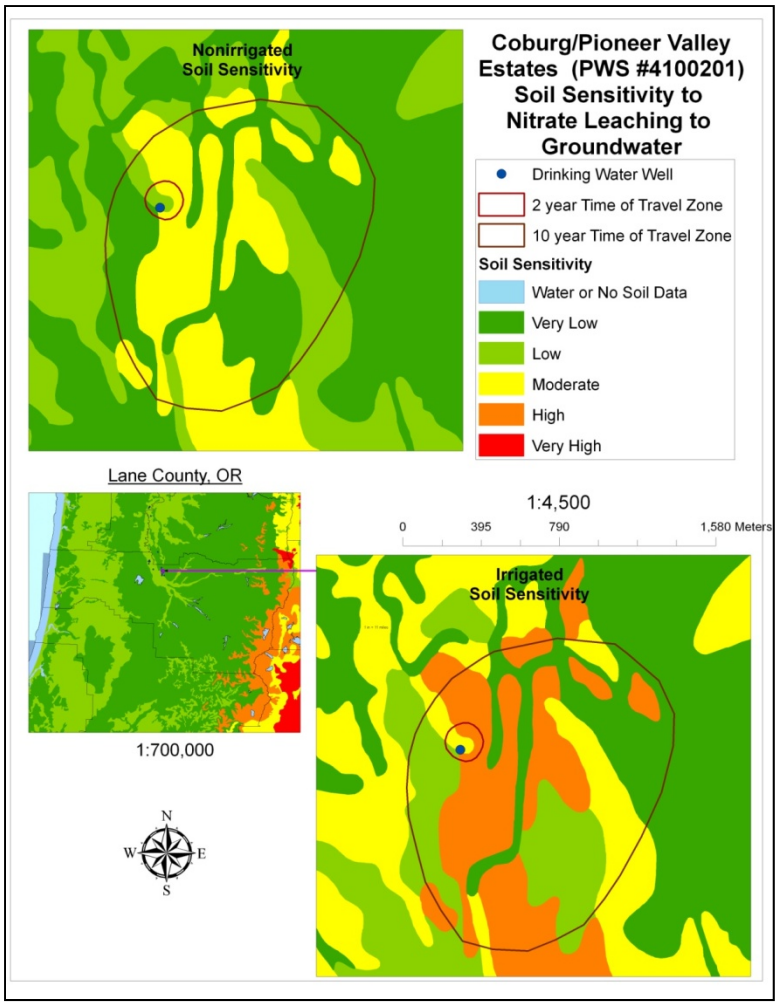
Coburg/Pioneer Valley Estates (4100201)

System currently inactive, no nitrate removal treatment.

Well 1

Median Nitrate-N
5.50
90th Percentile Nitrate-N
7.78

Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems



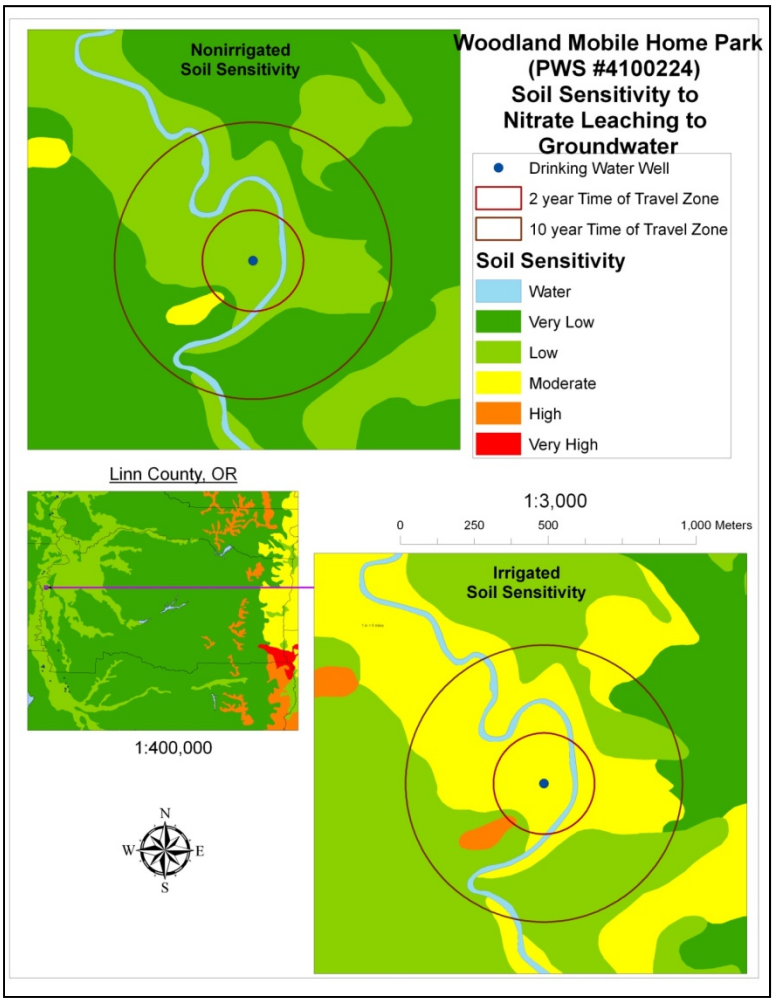
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
8.7% Very Low, 38.9% Low, 52.4% Moderate
Irrigated Sensitivity:
8.7% Very Low, 38.9% Moderate, 52.4% High
Septic Density (systems/acre)
2.25

10-year Time of Travel Zone:

Nonirrigated Sensitivity:
45.5% Very Low, 14.4% Low, 40.1% Moderate
Irrigated Sensitivity: 22.6% Very Low, 22.9% Low, 14.4% Moderate, 40.1% High
Septic Density (systems/acre) 0.16

Woodland Mobile Home Park (4100224)



System currently active, uses ion exchange for hardness and nitrate removal.

Composite Median/90th Percentile Nitrate-N (mg/L):
7.10/11.3

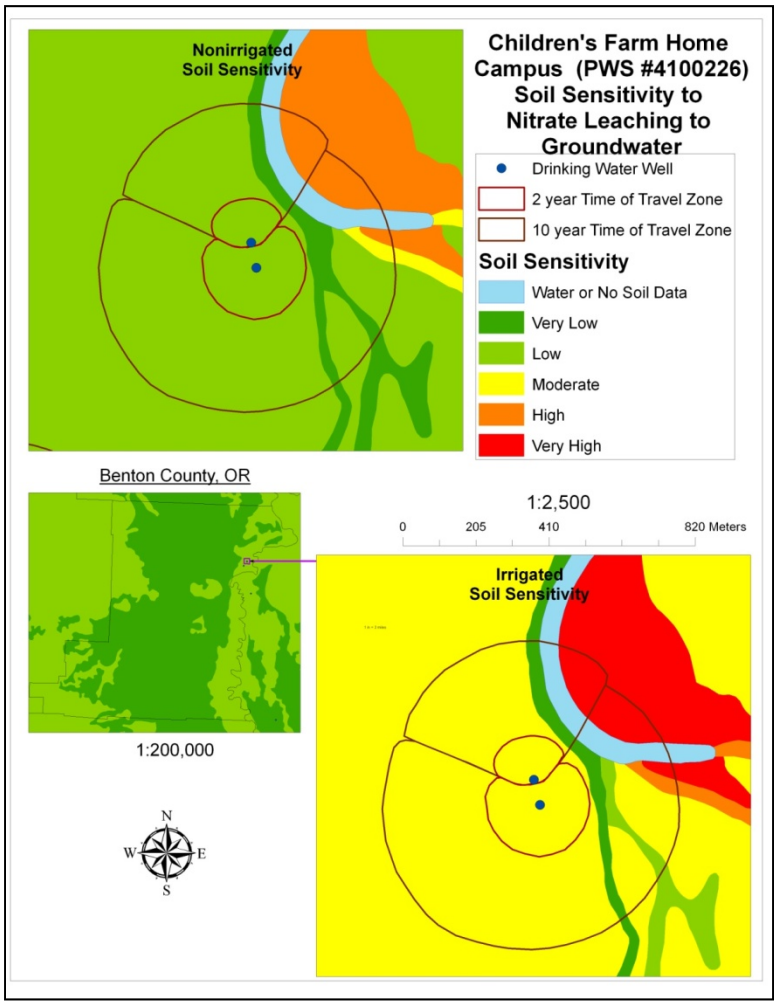
Wells 1, 2 & 3

Median Nitrate-N
1&2: 8.30
3: 0
90th Percentile Nitrate-N
1&2: 11.4
3: 0
Aquifer Confinement
1&2: Unconfined
3: Confined
Well Construction
1&2: Adequate
3: Adequate
Aquifer Vulnerable?
1&2: Yes
3: No
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone: [6.7% Water]
Nonirrigated Sensitivity: 3.3% Very Low, 89.4% Low, 0.6% Moderate
Irrigated Sensitivity: 3.3% Low, 89.4% Moderate, 0.6% High
Septic Density (systems/acre) 0.79

10-year Time of Travel Zone: [4.3% Water]
Nonirrigated Sensitivity: 43.1% Very Low, 50.8% Low, 1.8% Moderate
Irrigated Sensitivity: 3.7% Very Low, 39.4% Low, 50.8% Moderate, 1.8% High
Septic Density (systems/acre) 0.46

Children's Farm Home Campus (4100226)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
6.80/9.10

Well 1

Median Nitrate-N
8.10
90th Percentile Nitrate-N
9.86
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0.074

10-year Time of Travel Zone: [3.8% Water]
Nonirrigated Sensitivity: 7.0% Very Low, 82.5% Low, 1.3% Moderate, 5.4% High
Irrigated Sensitivity: 4.2% Very Low, 2.9% Low, 82.5% Moderate, 1.3% High, 5.3% Very
High
Septic Density (systems/acre) 0.030

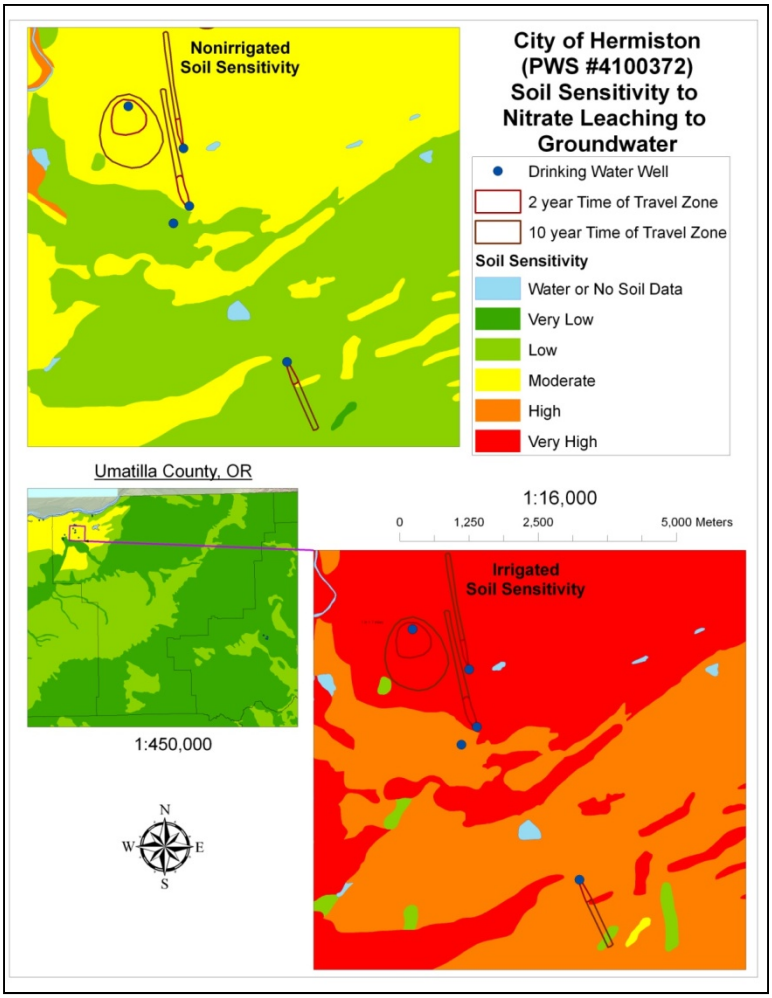
Well 2

Median Nitrate-N 5.70
90th Percentile Nitrate-N 7.06
Aquifer Confinement Unconfined
Well Construction Adequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone: [9.4% Water]
Nonirrigated Sensitivity: 8.3% Very Low, 71.9% Low, 10.4% High
Irrigated Sensitivity: 8.3% Very Low, 71.9% Moderate, 10.4% Very High
Septic Density (systems/acre) 0.052

City of Hermiston (4100372)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
0/5.58

Well 2
Median Nitrate-N
0
90th Percentile Nitrate-N
0.01
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0.18

Well 4

Median Nitrate-N	0
90th Percentile Nitrate-N	3.60
Aquifer Confinement	Confined
Well Construction	Inadequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0.010

Well 5

Median Nitrate-N	4.95
90th Percentile Nitrate-N	6.34
Aquifer Confinement	Unconfined
Well Construction	Adequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0.03

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0.021

Well 6

Median Nitrate-N	0
90th Percentile Nitrate-N	0
Aquifer Confinement	Confined
Well Construction	Adequate
Aquifer Vulnerable?	No
Probable Nitrate Source(s)	Septic Systems

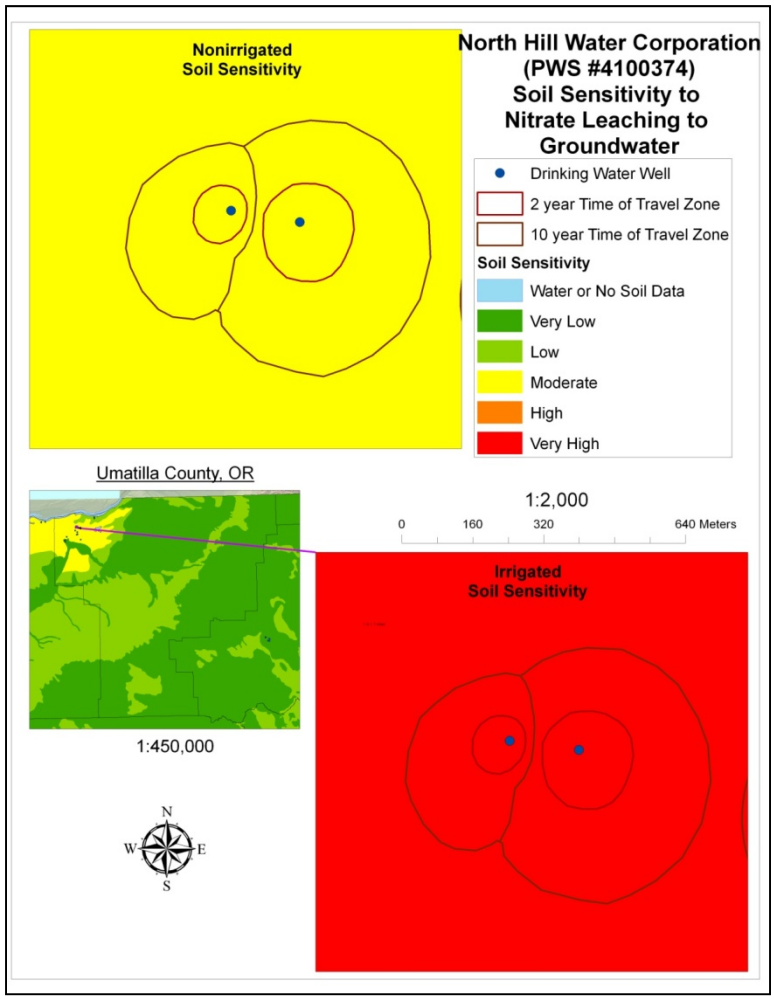
2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Low
Irrigated Sensitivity:	100% High
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	95.7% Low, 4.3% Moderate
Irrigated Sensitivity:	14.0% Low, 81.7% High, 4.3% Very High
Septic Density (systems/acre)	0

North Hill Water Corporation (4100374)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
2.40/6.28

Well 1

Median Nitrate-N
0.18
90th Percentile Nitrate-N
4.02
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
1.33

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0.57

Well 2

Median Nitrate-N	5.50
90th Percentile Nitrate-N	6.43
Aquifer Confinement	Confined
Well Construction	Inadequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	2.91

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	1.76

Well 3
(Added in 2009, same TOT zones as Well 1)

Median Nitrate-N	0
90th Percentile Nitrate-N	0.032
Aquifer Confinement	Confined
Well Construction	Adequate
Aquifer Vulnerable?	No
Probable Nitrate Source(s)	Agriculture & Septic Systems

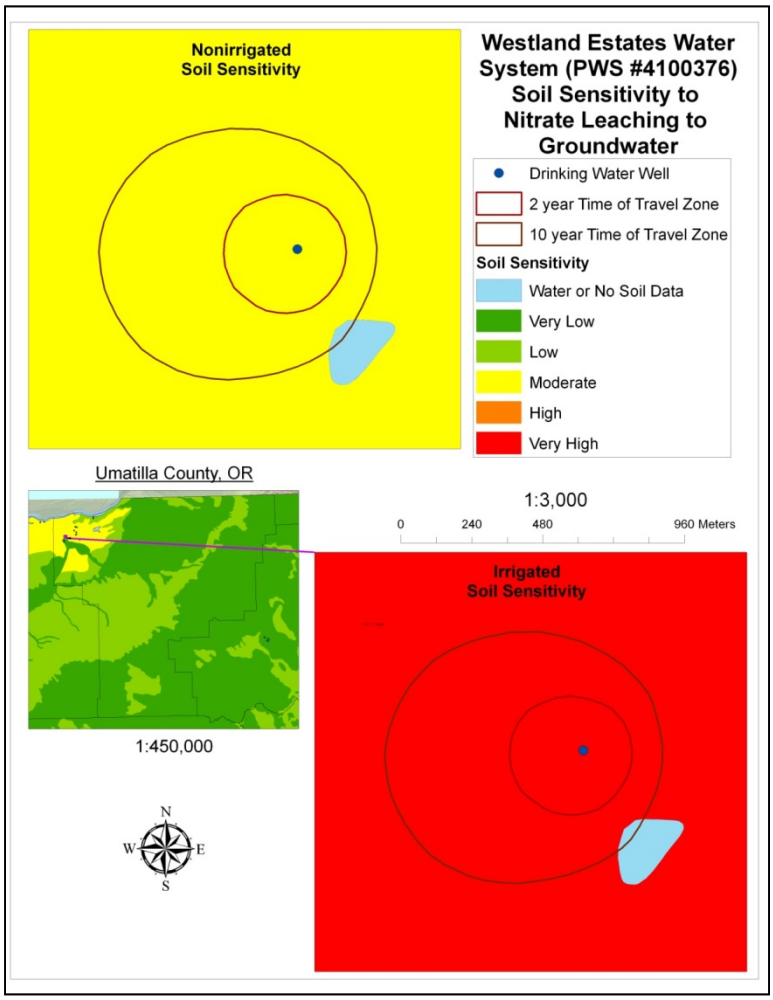
2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	1.33

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0.57

Westland Estates Water System (4100376)



System currently inactive, no nitrate removal treatment.

Wells 1&2

Median Nitrate-N
9.75
90th Percentile Nitrate-N
13.0
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

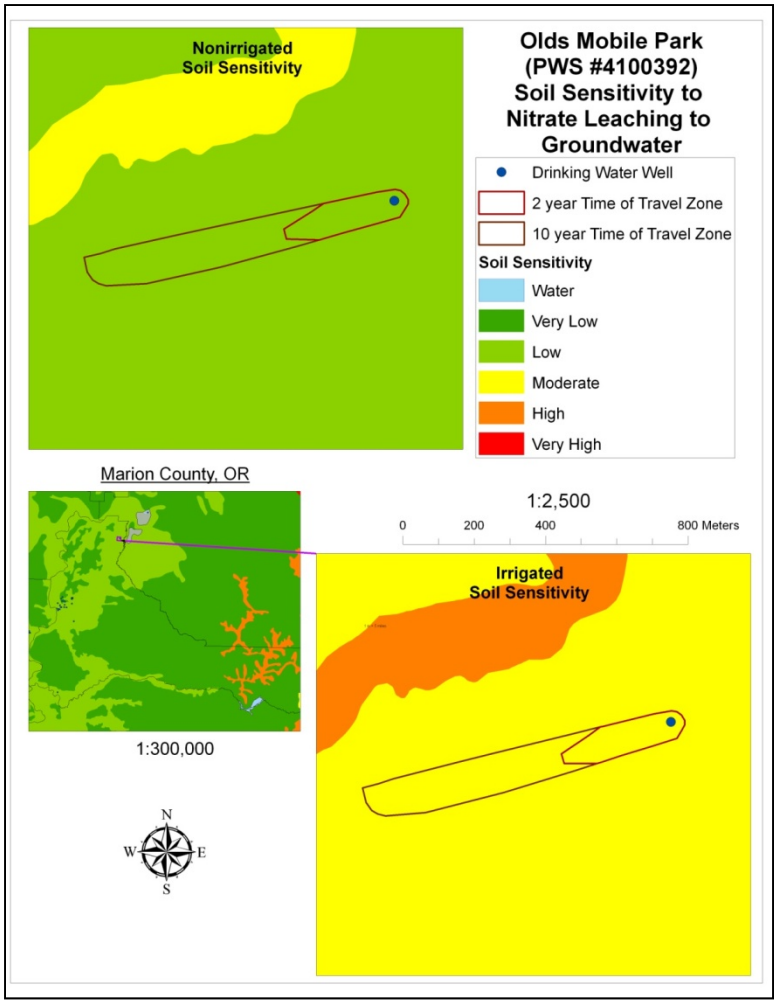
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0.40

10-year Time of Travel Zone: [Area of No Soil Data treated as identical to surrounding area]
Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0.17

Olds Mobile Park (4100392)

System currently active, no nitrate removal treatment.



Well

Median Nitrate-N
2.50
90th Percentile Nitrate-N
8.70
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

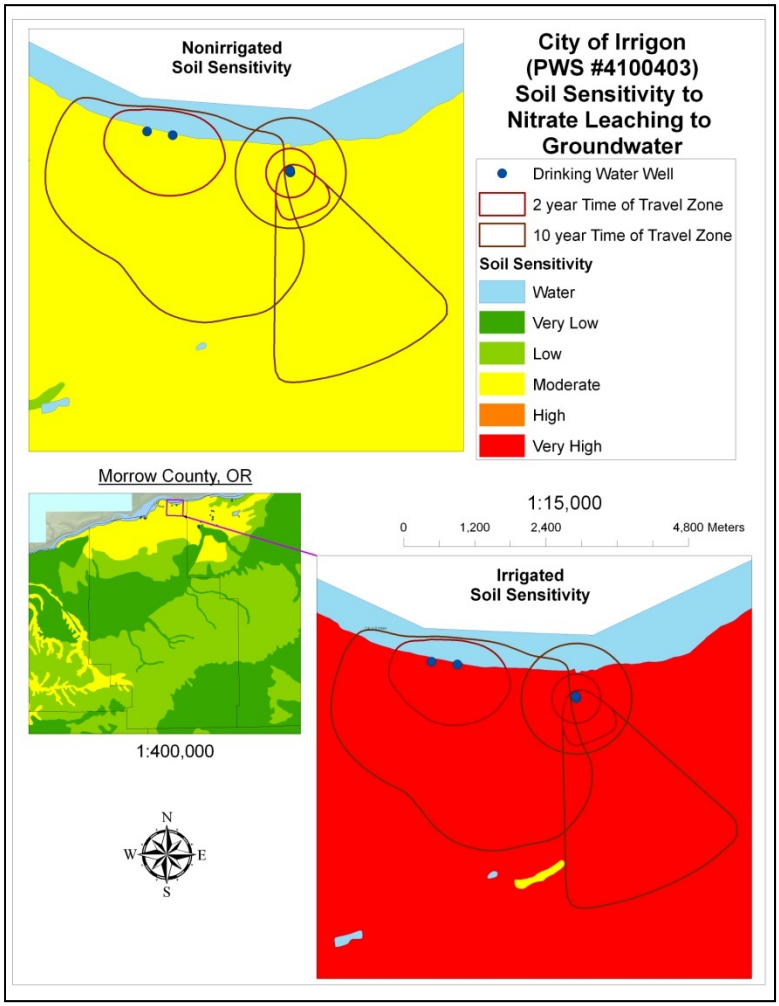
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.15

10-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.044

City of Irrigon (4100403)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
6.00/13.00

Well 1 (Shallow)

Median Nitrate-N
3.70
90th Percentile Nitrate-N
12.12
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0.021

Well 2 (Deep)

Median Nitrate-N 0
90th Percentile Nitrate-N 2.48
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture & Septic Systems (old systems)

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0

Wells 1&2 Combined

Median Nitrate-N	8.00
90th Percentile Nitrate-N	13.25

Wells 3&4

Median Nitrate-N	0.44
90th Percentile Nitrate-N	0.86
Aquifer Confinement	Unconfined
Well Construction	Adequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	N/A

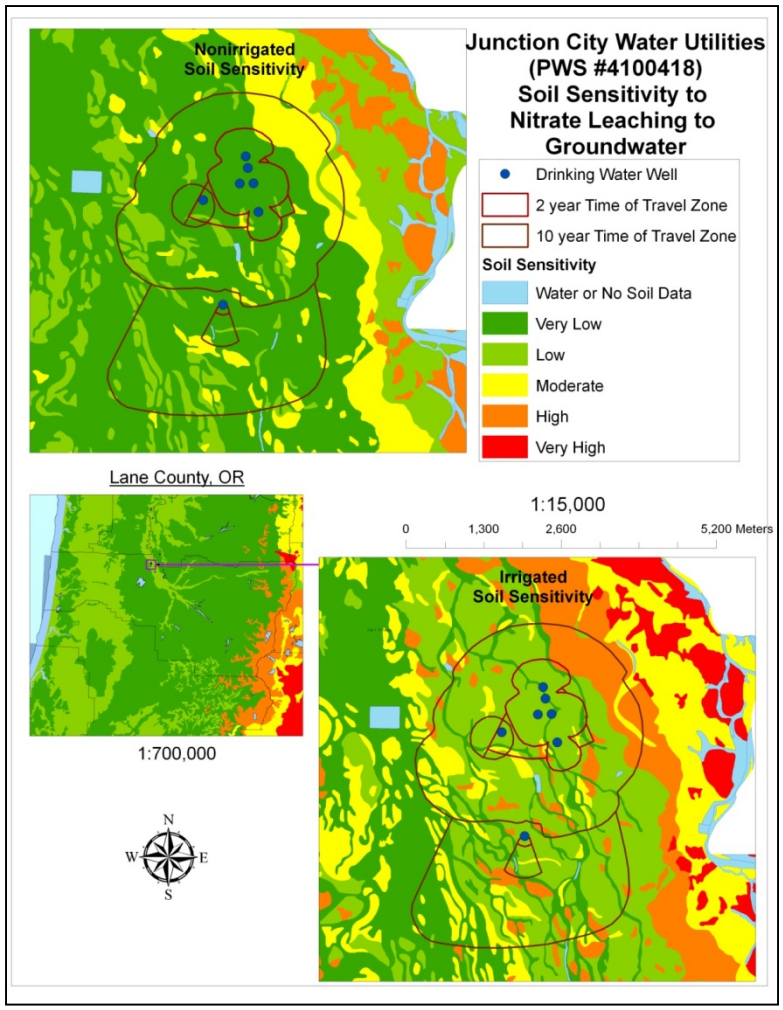
10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	N/A

Junction City Water Utilities (4100418)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 0/7.02



Deep Wells (1, 5&6)

Median Nitrate-N
0
90th Percentile Nitrate-N
0.045
Aquifer Confinement
Semi-confined
Well Construction
1: Adequate
5: Inadequate
6: Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
93.7% Very Low, 3.9% Low, 2.4% Moderate
Irrigated Sensitivity:
11.2% Very Low, 82.4% Low, 3.9% Moderate, 2.5% High
Septic Density (systems/acre)
0.092

10-year Time of Travel Zone: [0.3% Water or No Soil Data]
Nonirrigated Sensitivity: 73.6% Very Low, 12.3% Low, 13.8% Moderate
Irrigated Sensitivity: 19.8% Very Low, 53.9% Low, 12.4% Moderate, 13.9% High
Septic Density (systems/acre) 0.092

Shallow Wells (2&3)

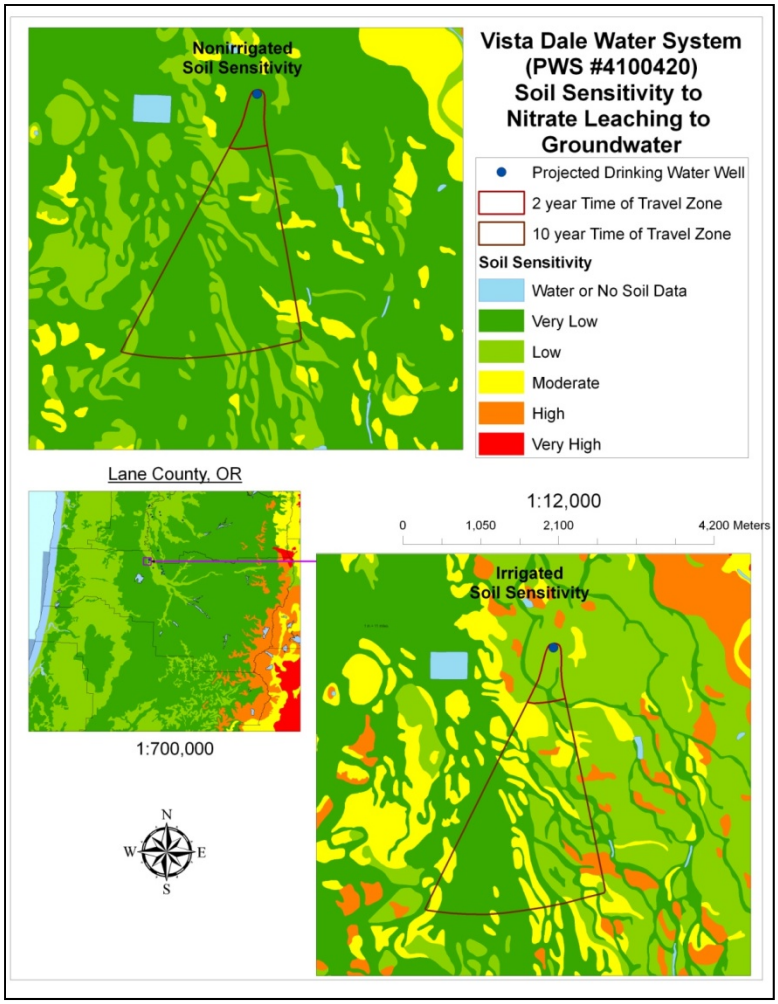
Median Nitrate-N 5.16
90th Percentile Nitrate-N 9.20
Aquifer Confinement Unconfined
Well Construction 2: Inadequate 3: Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture & Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 93.7% Very Low, 3.9% Low, 2.4% Moderate
Irrigated Sensitivity: 11.2% Very Low, 82.4% Low, 3.9% Moderate, 2.5% High

Septic Density (systems/acre) 0.092

10-year Time of Travel Zone: [0.3% Water or No Soil Data]
Nonirrigated Sensitivity: 73.6% Very Low, 12.3% Low, 13.8% Moderate
Irrigated Sensitivity: 19.8% Very Low, 53.9% Low, 12.4% Moderate, 13.9% High
Septic Density (systems/acre) 0.092

Vista Dale Water System (4100420)



System currently inactive, no nitrate removal treatment.

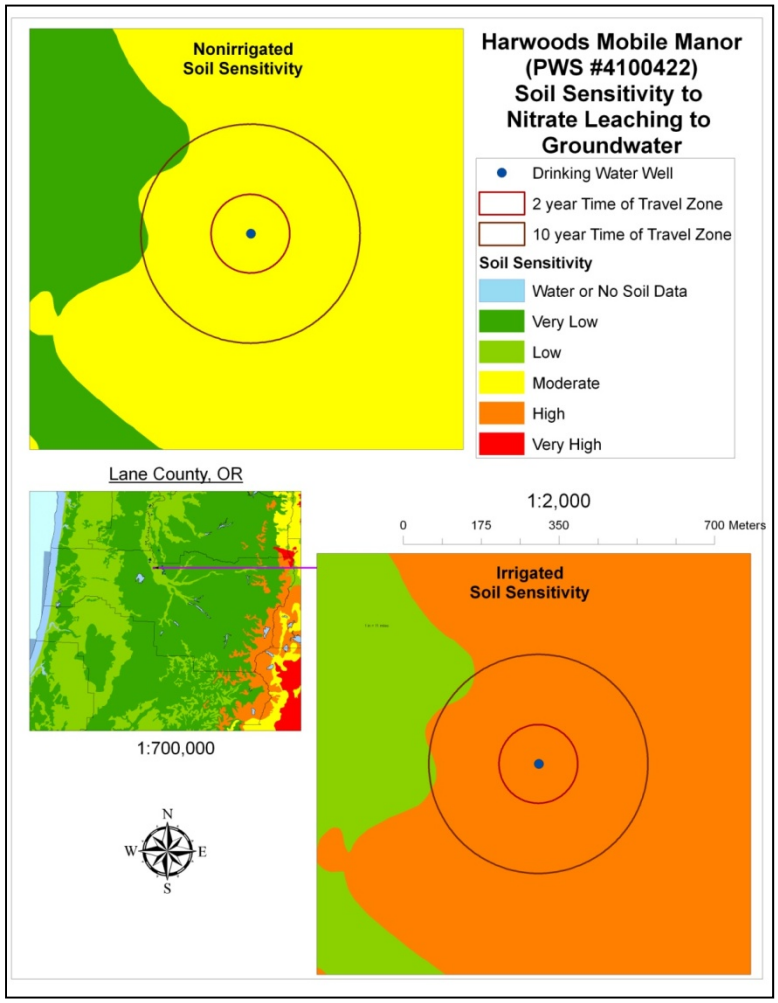
Well

Median Nitrate-N
5.05
90th Percentile Nitrate-N
6.63
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
99.9 % Very Low,
0.1% Low
Irrigated Sensitivity:
14.4 % Very Low,
85.5% Low,
0.1% Moderate
Septic Density (systems/acre)
0.75

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 76.5% Very Low, 20.8% Low, 2.7% Moderate
Irrigated Sensitivity: 50.6% Very Low, 25.9% Low, 20.8% Moderate, 2.7% High
Septic Density (systems/acre) 0.10

Harwoods Mobile Manor (4100422)



System currently active, no nitrate removal treatment.

Well

Median Nitrate-N
6.95
90th Percentile Nitrate-N
8.91
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

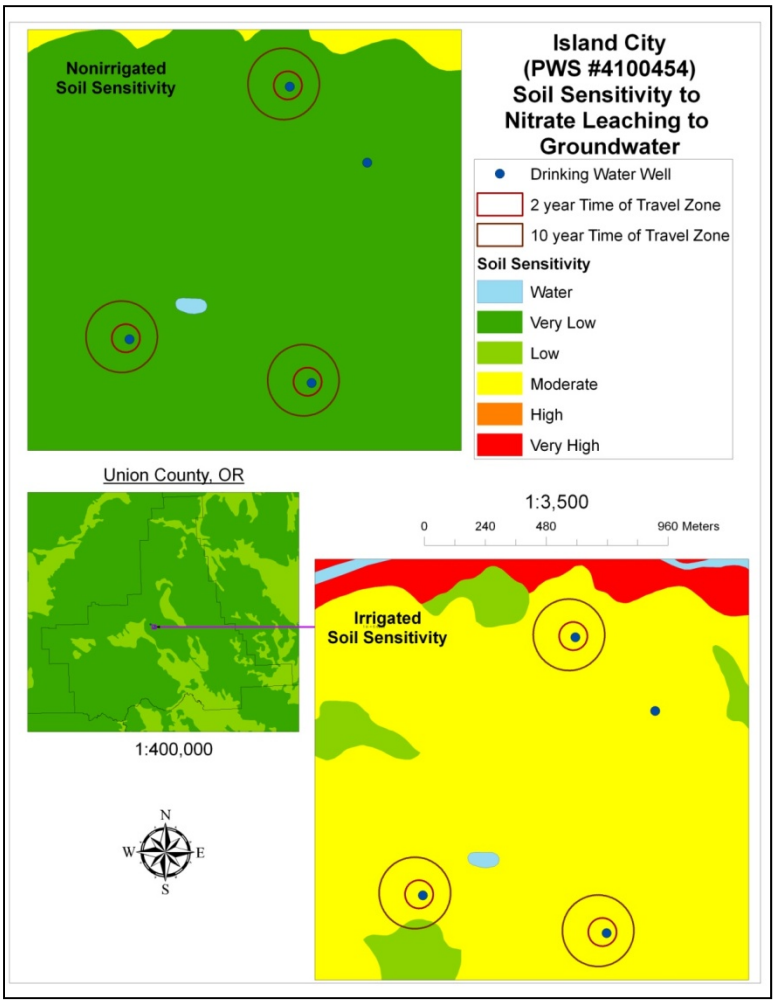
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
0.16

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 1.2% Very Low, 98.8% Moderate
Irrigated Sensitivity: 1.2% Low, 98.8% High
Septic Density (systems/acre) 0.16

Island City (4100454)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 1.40/9.37

Well 1

Median Nitrate-N
6.5
90th Percentile Nitrate-N
10.24
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0

Well 2

Median Nitrate-N N/A
90th Percentile Nitrate-N N/A
Aquifer Confinement Unconfined
Well Construction Adequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Moderate

Septic Density (systems/acre) 0

Well 3

Median Nitrate-N	0.652
90th Percentile Nitrate-N	0.461
Aquifer Confinement	Unconfined
Well Construction	Adequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Very Low
Irrigated Sensitivity:	100% Moderate
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Very Low
Irrigated Sensitivity:	100% Moderate
Septic Density (systems/acre)	0

Well 4

Median Nitrate-N	0
90th Percentile Nitrate-N	0.27
Aquifer Confinement	Unconfined
Well Construction	Adequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

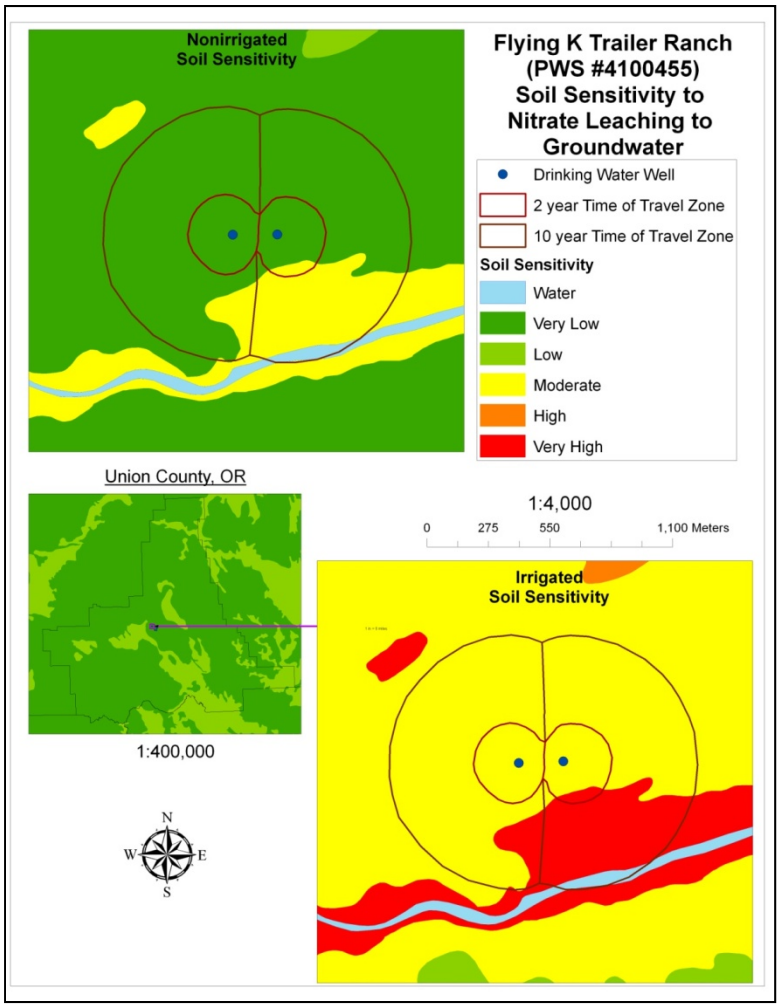
2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Very Low
Irrigated Sensitivity:	100% Moderate
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Very Low
Irrigated Sensitivity:	5.1% Low, 94.9% Moderate
Septic Density (systems/acre)	0

Flying K Trailer Ranch (4100455)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
4.70/5.74

Well 1

Median Nitrate-N
3.90
90th Percentile Nitrate-N
5.98
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.73

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 93.9%Very Low, 6.1% Moderate
Irrigated Sensitivity: 93.9% Moderate, 6.1% Very High
Septic Density (systems/acre) 0.35

Well 2

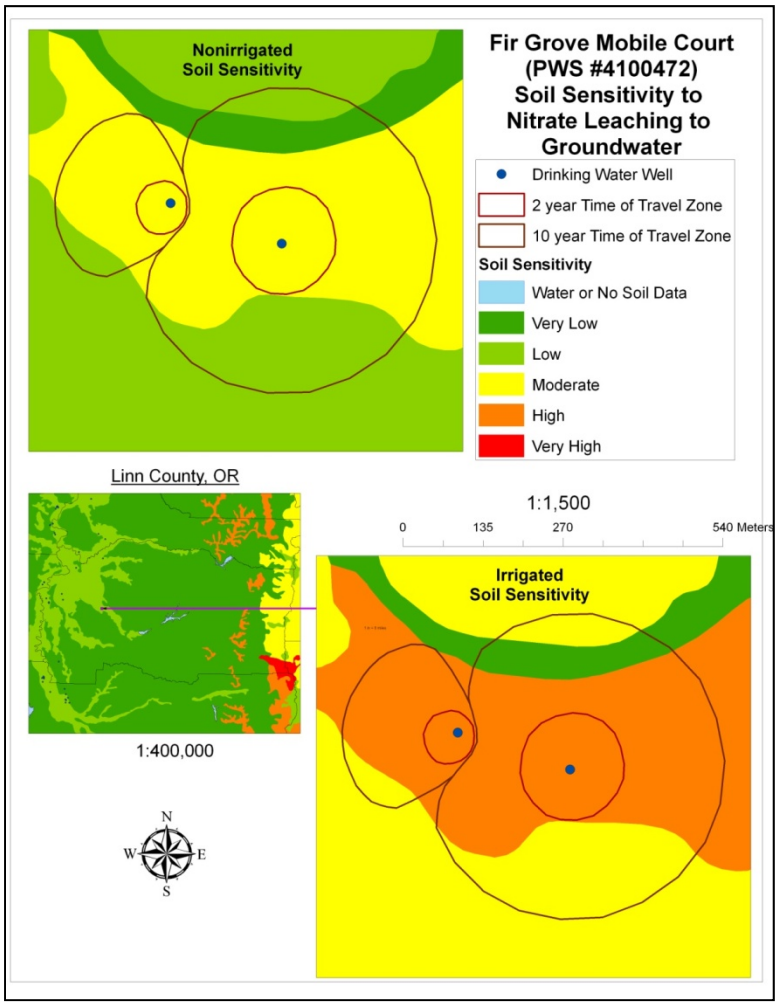
Median Nitrate-N 4.93
90th Percentile Nitrate-N 5.57
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 89.8%Very Low, 10.2% Moderate
Irrigated Sensitivity: 89.8% Moderate, 10.2% Very High
Septic Density (systems/acre) 0.64

10-year Time of Travel Zone:	[2.5% Surface Water]
Nonirrigated Sensitivity:	63.6%Very Low, 33.9% Moderate
Irrigated Sensitivity:	63.6% Moderate, 33.9% Very High
Septic Density (systems/acre)	0.26

Fir Grove Mobile Court (4100472)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
3.80/4.87

Well 1

Median Nitrate-N
3.80
90th Percentile Nitrate-N
4.87
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
0.97

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 8.6% Very Low, 28.8% Low, 62.6% Moderate
Irrigated Sensitivity: 8.6% Very Low, 28.8% Moderate, 62.6% High
Septic Density (systems/acre) 0.11

Well 2

Median Nitrate-N 3.80
90th Percentile Nitrate-N 4.87
Aquifer Confinement Unconfined
Well Construction Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture & Septic Systems

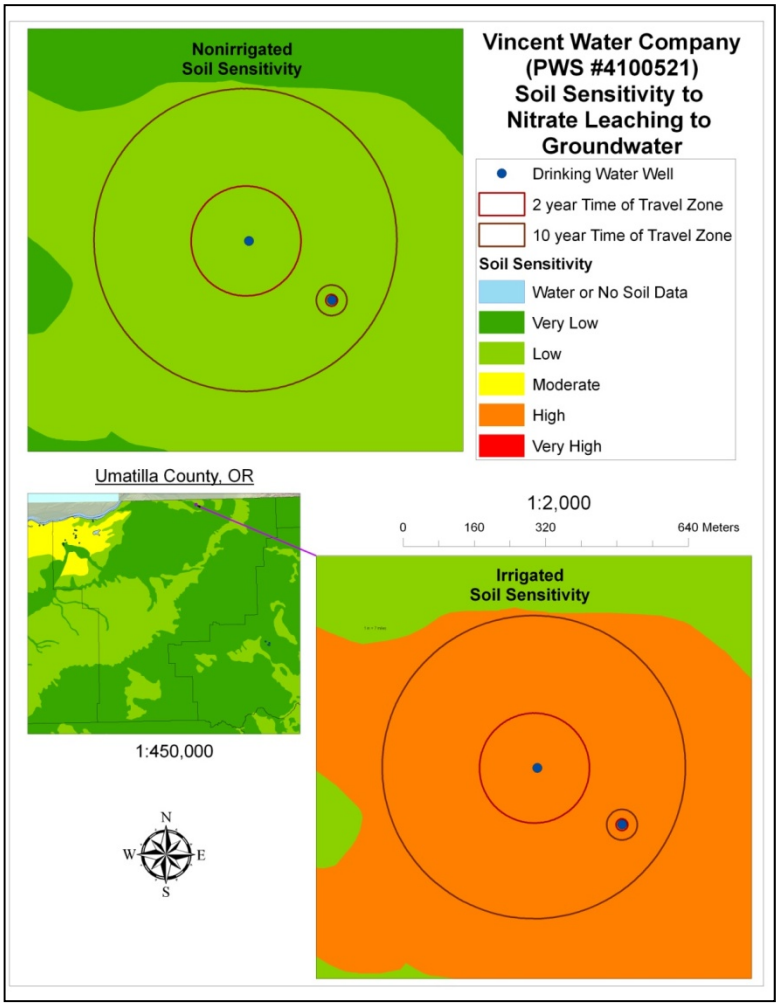
2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 1.35

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	11.9% Low, 88.1% Moderate
Irrigated Sensitivity:	11.9% Moderate, 88.1% High
Septic Density (systems/acre)	1.41

Vincent Water Company (4100521)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
3.90/6.16

Well 1

Median Nitrate-N
3.49
90th Percentile Nitrate-N
5.76
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
1.78

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 0.72

Well 2

Median Nitrate-N 4.36
90th Percentile Nitrate-N 5.12
Aquifer Confinement Confined
Well Construction Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture & Septic Systems

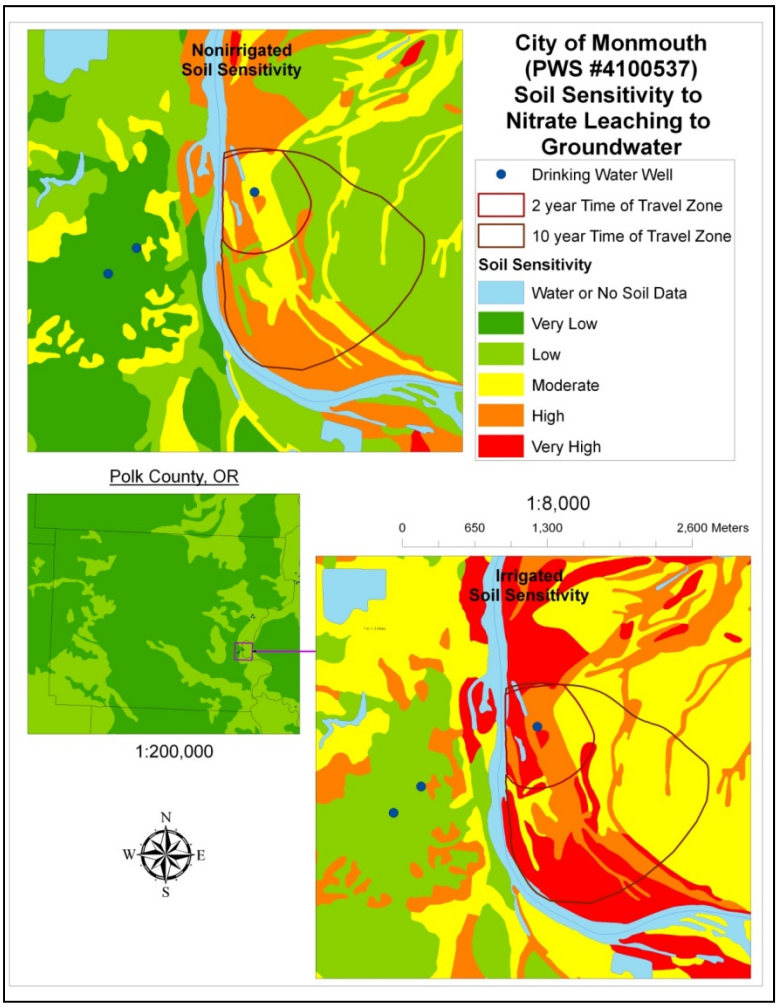
2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Low
Irrigated Sensitivity:	100% High
Septic Density (systems/acre)	1.09

City of Monmouth (4100537)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
5.50/9.97

Well 1

Median Nitrate-N
5.60
90th Percentile Nitrate-N
9.50
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

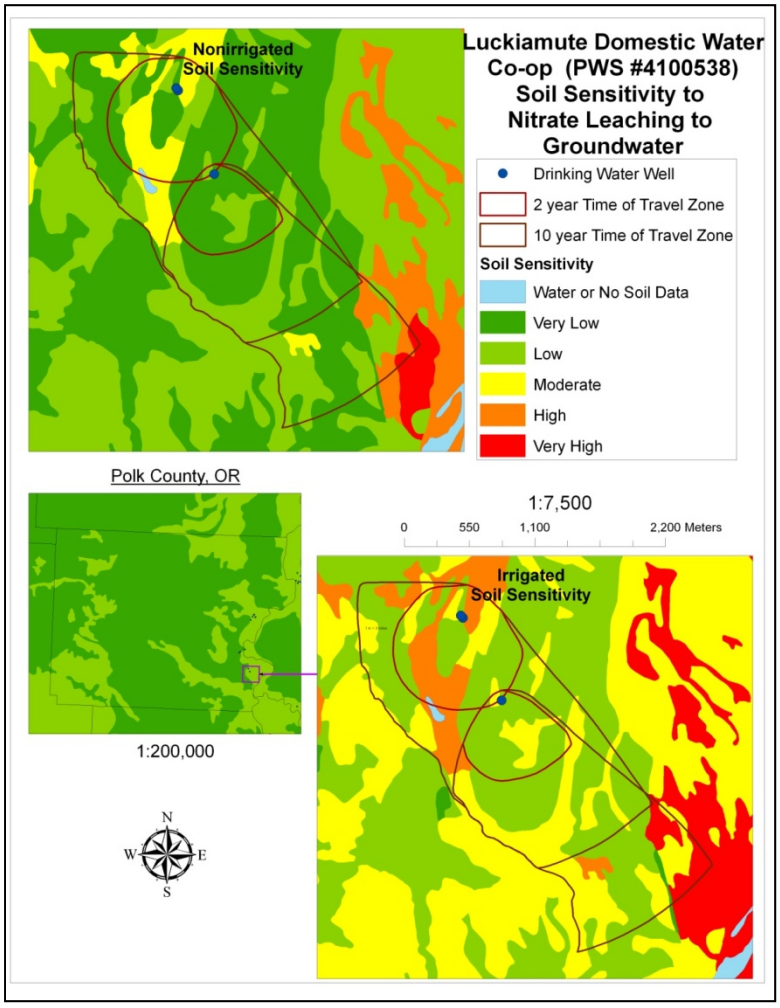
2-year Time of Travel Zone: [4.3% Water or No Soil Data]
Nonirrigated Sensitivity: 23.8% Low, 45.9% Moderate, 26.0% High
Irrigated Sensitivity: 23.8% Moderate, 45.9% High, 26.0%Very High
Septic Density (systems/acre) .027

10-year Time of Travel Zone: [1.4% Water or No Soil Data]
Nonirrigated Sensitivity: 46.0% Low, 25.0% Moderate, 27.6% High
Irrigated Sensitivity: 46.0% Moderate, 25.0% High, 27.6%Very High
Septic Density (systems/acre) 0.010

Wells 4&5

Median Nitrate-N 0.30
90th Percentile Nitrate-N 3.76
Aquifer Confinement Unconfined
Well Construction 4: Adequate 5: Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

Luckiamute Domestic Water Co-op (4100538)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
3.80/6.30

Well 1, 2&4

Median Nitrate-N
0.90
90th Percentile Nitrate-N
4.50
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone: [0.3% Water or No Soil Data]
Nonirrigated Sensitivity: 49.5% Very Low, 18.3%Low, 31.9% Moderate
Irrigated Sensitivity: 49.5% Low, 18.3% Moderate, 31.9% High
Septic Density (systems/acre) 0.0046

10-year Time of Travel Zone: [0.4% Water or No Soil Data]
Nonirrigated Sensitivity: 59.3% Very Low, 26.3% Low, 14.0% Moderate
Irrigated Sensitivity: 59.3% Low, 26.3% Moderate, 14.0% High
Septic Density (systems/acre) 0.0099

Well 3

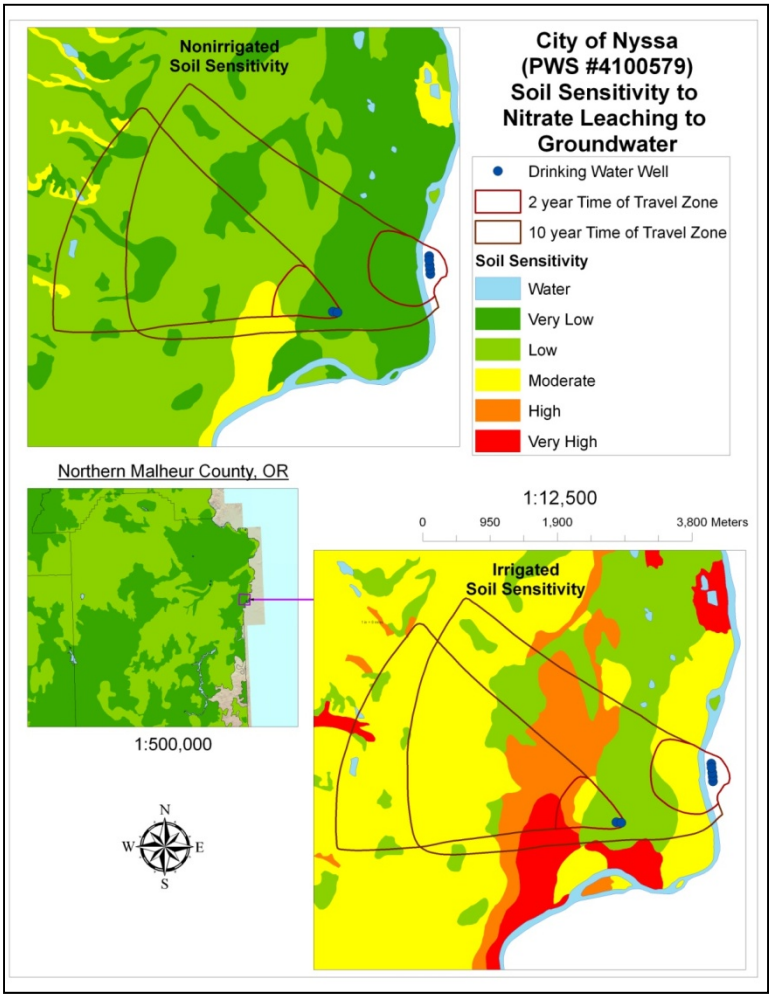
Median Nitrate-N 4.90
90th Percentile Nitrate-N 6.48
Aquifer Confinement Unconfined
Well Construction Adequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 76.9% Very Low, 23.1% Low

Irrigated Sensitivity: 76.9% Low, 23.1% Moderate
Septic Density (systems/acre) 0.017

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 55.9% Very Low, 36.0% Low, 2.2% Moderate, 5.2% High, 0.7% Very High
Irrigated Sensitivity: 0.7% Very Low, 55.2% Low, 36.0% Moderate, 2.2% High, 5.9% Very High
Septic Density (systems/acre) 0.015

City of Nyssa (4100579)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
3.13/6.15

Wells 1-5
Median Nitrate-N
3.88
90th Percentile Nitrate-N
6.46
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
[10.9% Water or No Soil Data]
Nonirrigated Sensitivity:
89.1% Very Low
Irrigated Sensitivity:
16.3% Low,
72.8% Moderate
Septic Density (systems/acre)
0.0047

10-year Time of Travel Zone: [0.9% Water or No Soil Data]
Nonirrigated Sensitivity: 38.1% Very Low, 57.0% Low, 4.0% Moderate
Irrigated Sensitivity: 27.1% Low, 46.4% Moderate, 21.5% High, 4.1% Very High
Septic Density (systems/acre) 0.035

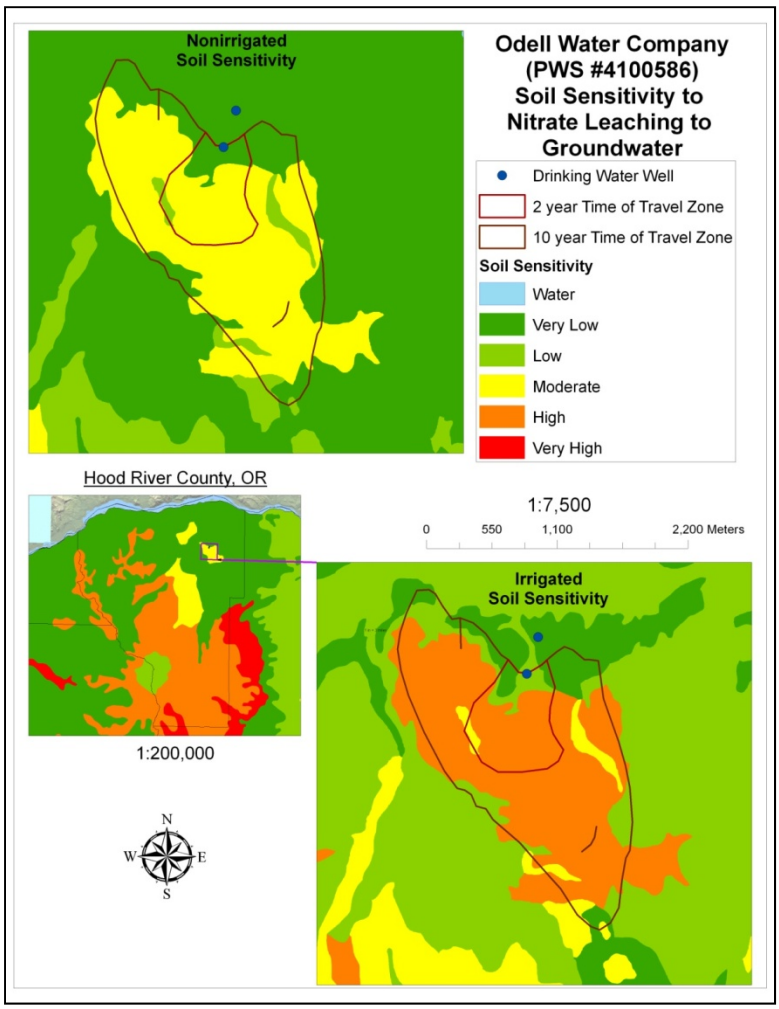
Well 7&9
Median Nitrate-N 1.72
90th Percentile Nitrate-N 2.65
Aquifer Confinement Confined

Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 43.2% Very Low, 49.4% Low, 7.4% Moderate
Irrigated Sensitivity: 43.2% Low, 23.8% Moderate, 25.6% High, 7.4% Very High
Septic Density (systems/acre) 0.067

10-year Time of Travel Zone: [0.4% Water or No Soil Data]
Nonirrigated Sensitivity: 19.4% Very Low, 76.1% Low, 4.1% Moderate
Irrigated Sensitivity: 10.2% Low, 72.2% Moderate, 13.6% High, 3.6% Very High
Septic Density (systems/acre) 0.034

Odell Water Company (4100586)



System currently active, no nitrate removal treatment.

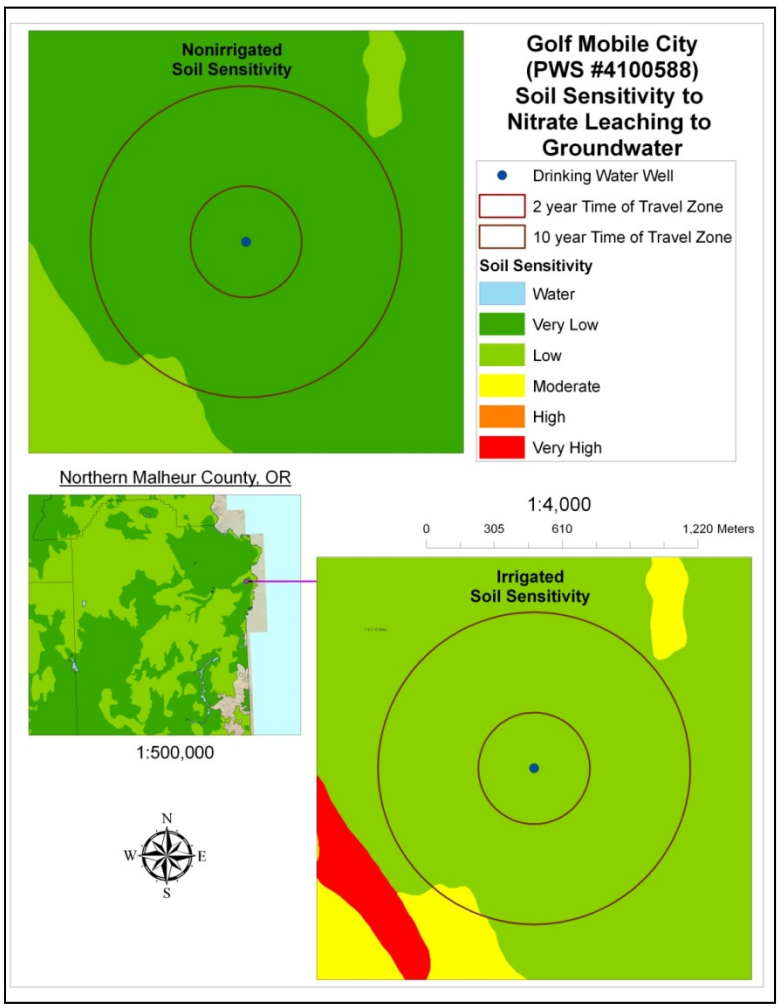
Spring

Median Nitrate-N 7.00
90th Percentile Nitrate-N 8.54
Aquifer Confinement Unconfined
Well Construction N/A
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 22.9% Very Low,
3.0% Low,
74.1% Moderate
Irrigated Sensitivity: 9.2% Very Low,
13.7% Low,
3.0% Moderate,
74.1% High
Septic Density (systems/acre) 0.088

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 21.6% Very Low, 5.0% Low, 73.4% Moderate
Irrigated Sensitivity: 8.7% Very Low, 12.9% Low, 5.0% Moderate, 73.4% High
Septic Density (systems/acre) 0.073

Golf Mobile City (4100588)



System currently active, no nitrate removal treatment.

Well

Median Nitrate-N
20.10
90th Percentile Nitrate-N
24.74
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

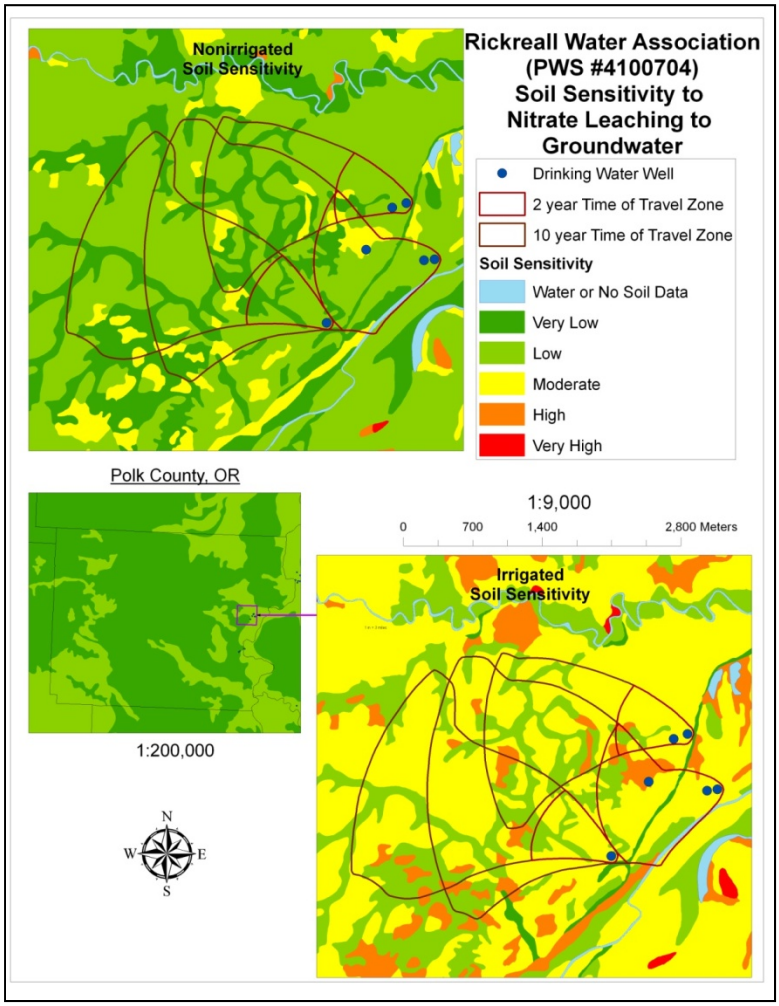
2-year Time of Travel Zone:
Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Low
Septic Density (systems/acre)
0.35

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 99.2% Very Low, 0.8% Low
Irrigated Sensitivity: 99.2% Low, 0.8% Moderate
Septic Density (systems/acre) 0.060

Rickreall Water Association (4100704)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 4.40/8.20



Wells 2&4

Median Nitrate-N
5.08
90th Percentile Nitrate-N
8.33
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
14.2% Very Low,
79.2% Low,
6.6% Moderate
Irrigated Sensitivity:
0.1% Very Low,
14.1% Low,
79.2% Moderate,
6.6% High
Septic Density (systems/acre)
0.012

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 30.4% Very Low, 62.7% Low, 6.9% Moderate
Irrigated Sensitivity: <0.1% Very Low, 30.4% Low, 62.7% Moderate, 6.9% High
Septic Density (systems/acre) 0.017

Well 3

Median Nitrate-N 3.65
90th Percentile Nitrate-N 5.30
Aquifer Confinement Semi-confined
Well Construction Adequate
Aquifer Vulnerable? Semi
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 30.8% Very Low, 69.2% Low
Irrigated Sensitivity: 0.1% Very Low, 30.7% Low, 69.2% Moderate
Septic Density (systems/acre) 0.010

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 31.4% Very Low, 62.4% Low, 6.2% Moderate
Irrigated Sensitivity: <0.1% Very Low, 31.4% Low, 62.4% Moderate, 6.2% High
Septic Density (systems/acre) 0.011

Wells 5&6

Median Nitrate-N	2.30	
90th Percentile Nitrate-N	6.95	
Aquifer Confinement	5: Confined	6: Semi-confined
Well Construction	5: Adequate	6: Adequate
Aquifer Vulnerable?	5: No	6: Semi
Probable Nitrate Source(s)	Agriculture	

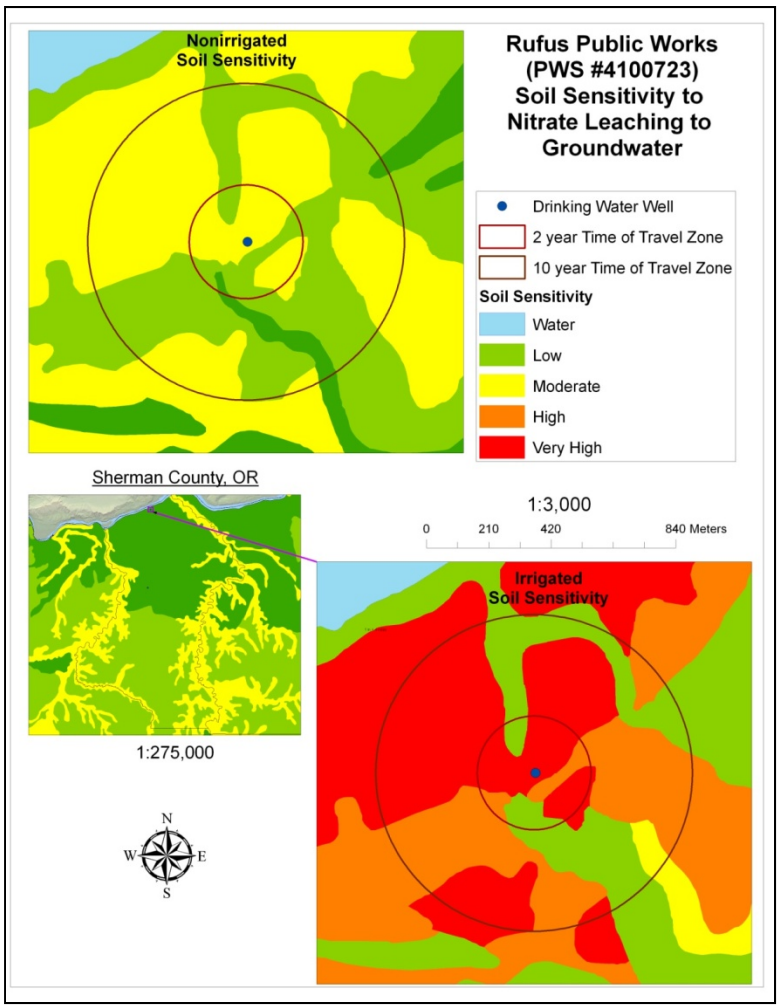
2-year Time of Travel Zone: [2.5% Water or No Soil Data]
Nonirrigated Sensitivity: 24.1% Very Low, 60.8% Low, 12.6% Moderate
Irrigated Sensitivity: 3.6% Very Low, 20.4% Low, 60.9% Moderate, 12.6% High
Septic Density (systems/acre) 0.042

10-year Time of Travel Zone: [0.6% Water or No Soil Data]
Nonirrigated Sensitivity: 30.0% Very Low, 61.0% Low, 8.4% Moderate
Irrigated Sensitivity: 1.0% Very Low, 29.0% Low, 61.0% Moderate, 8.4% High
Septic Density (systems/acre) 0.024

Rufus Public Works (4100723)

System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L): 3.70/6.66



Well 1

Median Nitrate-N
5.55
90th Percentile Nitrate-N
7.27
Aquifer Confinement
Unknown
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
N/A
Irrigated Sensitivity:
N/A
Septic Density (systems/acre)
N/A

*10-year Time of Travel Zone:*Nonirrigated Sensitivity:
N/A
Irrigated Sensitivity:
N/A
Septic Density (systems/acre)
N/A

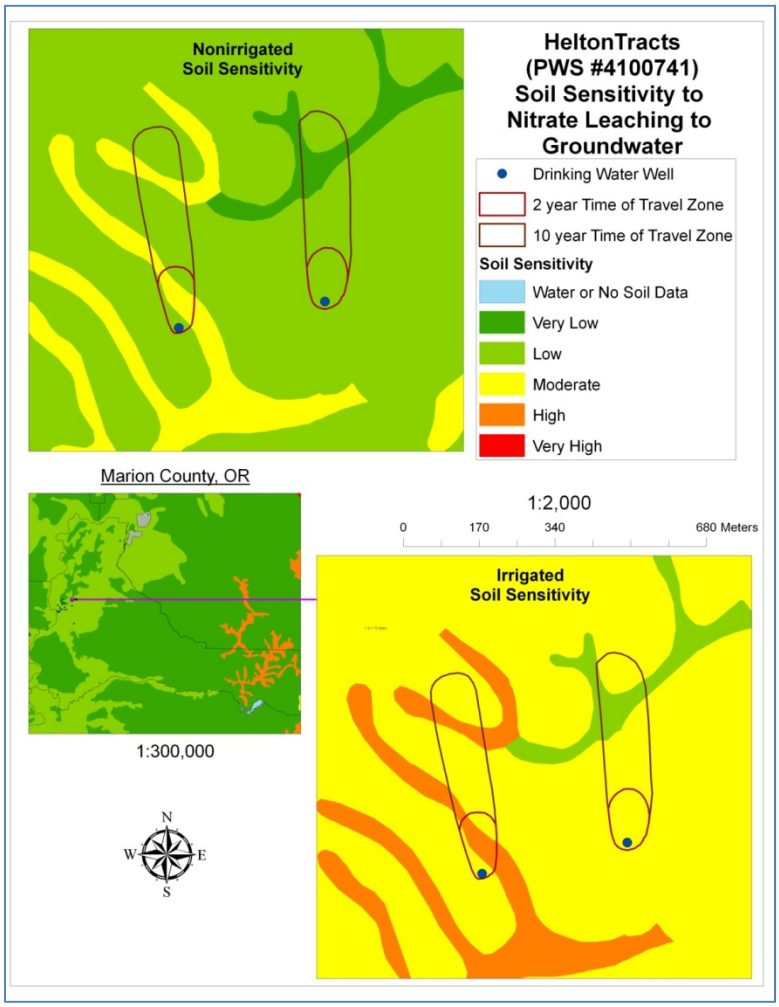
Well 3

Median Nitrate-N 0
90th Percentile Nitrate-N 0.045
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 1.8% Very Low, 33.7% Low, 64.5% Moderate
Irrigated Sensitivity: 19.2% Low, 16.3% High, 64.5% Very High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 3.4% Very Low, 43.3% Low, 53.3% Moderate
Irrigated Sensitivity: 21.5% Low, 1.6% Moderate, 31.1% High, 45.8% Very High
Septic Density (systems/acre) 0.0090

Helton Tracts (4100741)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
5.80/8.00

Well 1

Median Nitrate-N
4.90
90th Percentile Nitrate-N
6.79
Aquifer Confinement
Unknown
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
51.8% Low,
48.2% Moderate
Irrigated Sensitivity:
51.8% Moderate,
48.2% High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 76.6% Low, 23.4% Moderate
Irrigated Sensitivity: 76.6% Moderate, 23.4% High
Septic Density (systems/acre) 0.099

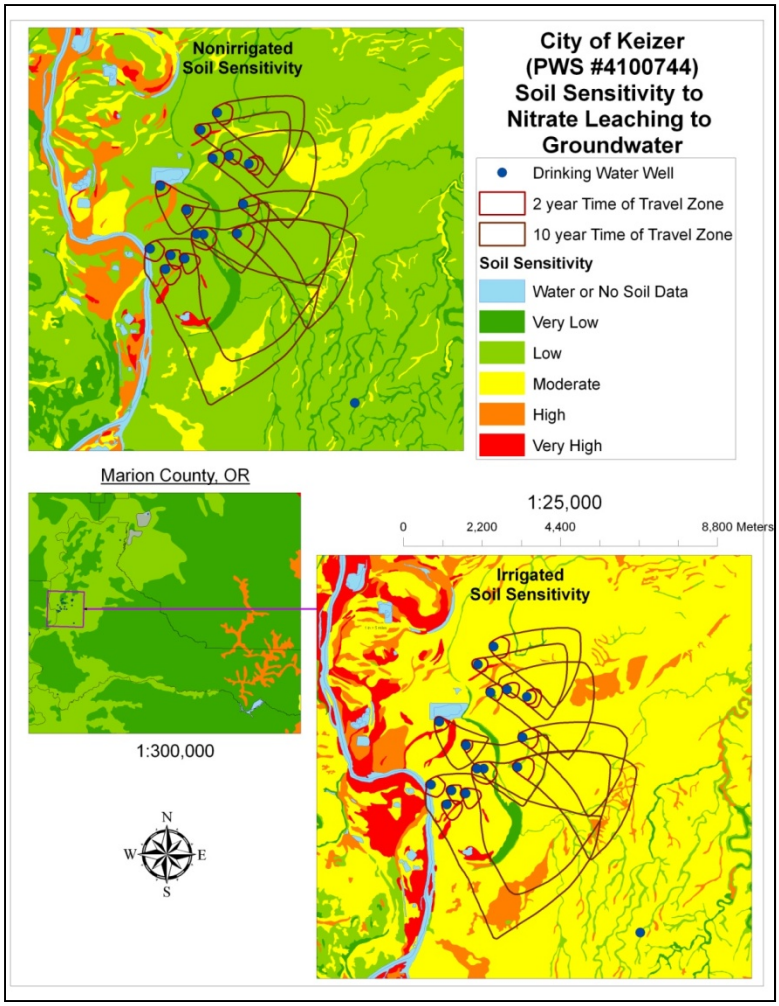
Well 2

Median Nitrate-N 7.00
90th Percentile Nitrate-N 8.34
Aquifer Confinement Confined
Well Construction Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 18.9% Very Low, 81.1% Low
Irrigated Sensitivity: 18.9% Low, 81.1% Moderate
Septic Density (systems/acre) 0

City of Keizer (4100744)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
1.01/6.13

Well 12
Median Nitrate-N
5.03
90th Percentile Nitrate-N
6.18
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 0.7% Very Low, 80.0% Low, 19.3% Moderate
Irrigated Sensitivity: 0.4% Very Low, 0.3% Low, 91.5% Moderate, 7.8% High
Septic Density (systems/acre) 0.0073

Well 13
Median Nitrate-N 5.30
90th Percentile Nitrate-N 6.60
Aquifer Confinement Confined
Well Construction Inadequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 13.9% Very Low, 86.1% Low
Irrigated Sensitivity: 13.9% Very Low, 86.1% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: Same 10-year TOT as Well #12
Irrigated Sensitivity: Same 10-year TOT as Well #12
Septic Density (systems/acre) 0.0073

Well 14

Median Nitrate-N 0
90th Percentile Nitrate-N 0
Aquifer Confinement Unconfined
Well Construction Adequate
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture & Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0.049

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 2.4% Very Low, 86.0% Low, 11.6% Moderate
Irrigated Sensitivity: 2.4% Very Low, 95.4% Moderate, 2.2% High
Septic Density (systems/acre) 0.037

Composite of All Wells
2-year Time of Travel Zone: [1.7% Water or No Soil Data]
Nonirrigated Sensitivity: 3.8% Very Low, 91.8% Low, 0.1% Moderate, 2.2% High, 0.4% Very High
Irrigated Sensitivity: 1.5% Very Low, 2.3% Low, 91.8% Moderate, 0.1% High, 2.6% Very High

10-year Time of Travel Zone: [0.7% Water or No Soil Data]
Nonirrigated Sensitivity: 5.4% Very Low, 80.9% Low, 11.1% Moderate, 0.8% High, 1.1% Very High
Irrigated Sensitivity: 2.8% Very Low, 2.6% Low, 83.4% Moderate, 8.7% High, 1.9% Very High

The aquifer throughout the area is divided into an upper and lower portion by a silt/clay layer. The silt/clay layer appears to play a significant role in protecting water quality in the lower portion of the aquifer. Groundwater flow direction within localized areas of the upper portion of the aquifer has been shown to seasonally vary by as much as 180°.
Keizer has been in the process of abandoning older, inadequately constructed sources and constructing new sources since the Source Water Assessment Report was released in 2004.

Source AA, Well #3 - Burnside Pump: Abandoned on 03/17/2004 (WRD well log # MARI57995).

Source BA, Well #6 – Carlhaven East: Abandoned. Can't identify abandonment well log at WRD website. May still exist but disconnected from system.

Source CA, Well #1 – Carlhaven West: Abandoned. Can't identify abandonment well log at WRD website. May still exist but disconnected from system.

Source DA, Well #10 – Chemawa: This well is adequately constructed to a depth of 255 feet and a casing seal that extends to 85 feet below ground. Well originally drilled in March 1981. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be confined at the well location.

Source EA, Well #5 – Cherry Avenue: This well is adequately constructed to a depth of 210 feet and a casing seal that extends to 80 feet below ground. Well originally drilled in January 1983. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be semi-confined (i.e., confining layer less than 15 feet thick) at the well location.

Source FA, Well #6 – Delta Pump – Old: Abandoned on 03/08/2006 (WRD well log # MARI59624). Source FA, Delta Pump – Old has been abandoned and replaced with Source RA, Well #8 – Delta.

Source GA, Well #11 – Lauderback: This well is adequately constructed to a depth of 155 feet and a casing seal that extends to 30 feet below ground. Well originally drilled in June 1973. Casing seal does not extend to 12-foot thick silt layer present at 107 feet. However, well casing is only perforated in the lower portion of the sand and gravel aquifer in the area. Due to well construction, the aquifer is considered to be unconfined at the well location.

Source HA, Well #9 – McNary Pump: This well is adequately constructed to a depth of 232 feet and a casing seal that extends to 96 feet below ground. Well originally drilled in April 1981. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be semi-confined (i.e., confining layer less than 15 feet thick) at the well location.

Source IA, Well #4 – Toni Avenue: Abandoned on 03/19/2004 (WRD well log # MARI57996).

Source JA, Well #7 – Weissner: This well is adequately constructed to a depth of 259 feet and a casing seal that extends to 30 feet below ground. Well originally drilled in December 1980. Casing seal does not extend to 17-foot thick silt and clay layer present at 115 feet. However, well casing is only screened in the lower portion of the sand and gravel aquifer in the area. Due to well construction, the aquifer is considered to be unconfined at the well location.

Source KA, Well #2 – Willamette Manor: The original Willamette Manor Well was abandoned on 05/10/2001. A replacement well was constructed roughly 10 to 15 feet away on 05/31/2000. Both wells were given the same name and Source ID (i.e., SRC-KA, so any chem results prior to 2000 would be from the older inadequately constructed well) The replacement well is adequately constructed to a depth of 195 feet with a casing seal that extends 95 feet below ground. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be semi-confined (i.e., confining layer less than 15 feet thick) at the well location.

Source LA, Well #13 – 13th Avenue: This well is inadequately constructed. Total depth is 140 feet. There is no information regarding the construction of the casing seal. Well originally drilled in April 1961. Well casing is perforated in both upper and lower portions of the sand and gravel aquifer. Both upper and lower portions of the aquifer are considered to be confined at the well location. **This well has a history of organic chemical detections.**

Source MA, Well #12 – 17th Avenue: This well is inadequately constructed. Total depth is 162 feet. The casing seal was constructed with inappropriate materials. Well originally drilled in September 1965. Well casing is perforated in both upper and lower portions of the sand and gravel aquifer. The

upper portion of the aquifer is considered to be unconfined at the well location. **This well has a history of organic chemical detections.**

Source NA, Well #14 – Meadows: This well is adequately constructed to a depth of 340 feet and a casing seal that extends to 52 feet below ground. Well originally drilled in May 1992. Casing seal does not extend to 35-foot thick silt and clay layer present at 141 feet. However, well is only screened in the lower portion of the sand and gravel aquifer. The upper portion of the aquifer is considered to be unconfined at the well location and the lower portion is considered to be confined.

Source OA, Well #15 – Ridge Drive: This well is adequately constructed to a depth of 260 feet and a casing seal that extends to 127 feet below ground. Well originally drilled in June 1999. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be confined at the well location.

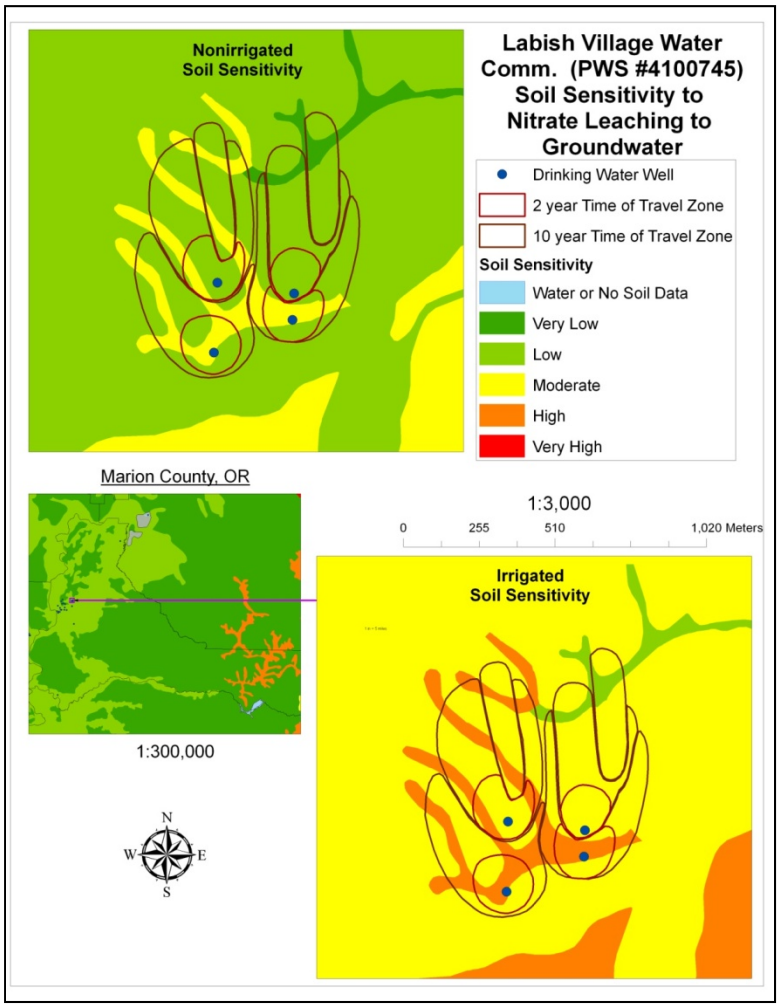
Source PA, Well #16 – Reitz Well: This well was not addressed in the Source Water Assessment Report. This well appears to be adequately constructed to a depth of 410 feet and a casing seal that extends to 180 feet below ground. Well originally drilled in October 2003. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be confined at the well location.

Source QA, Well #4 – Keizer Station: This well was not addressed in the Source Water Assessment Report. This well is adequately constructed to a depth of 270 feet and a casing seal that extends to 150 feet below ground. Well originally drilled in October 2005. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be semi-confined (i.e., confining layer less than 15 feet thick) at the well location.

Source RA, Well #8 – Delta: This well was not addressed in the Source Water Assessment Report. Replacement for nearby abandoned Source FA, Well #6 – Delta Pump – Old. This well is adequately constructed to a depth of 328 feet and a casing seal that extends to 165 feet below ground. Well originally drilled in April 2006. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be semi-confined (i.e., confining layer less than 15 feet thick) at the well location.

Source SA, Well #19 – City Hall: This well was not addressed in the Source Water Assessment Report. This well is adequately constructed to a depth of 290 feet and a casing seal that extends to 90 feet below ground. Well originally drilled in June 2006. This well draws water from the lower sand and gravel aquifer in the area, which is considered to be confined at the well location.

Labish Village Water Commission (4100745)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
4.30/6.66

Webb Well

Median Nitrate-N
4.40
90th Percentile Nitrate-N
6.52
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
60.0% Low,
40.0% Moderate
Irrigated Sensitivity:
60.0% Moderate,
40.0% High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 65.5% Low, 34.5% Moderate
Irrigated Sensitivity: 65.5% Moderate, 34.5% High
Septic Density (systems/acre) 0.037

Scott Well

Median Nitrate-N 4.50
90th Percentile Nitrate-N 5.97
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 74.9% Low, 25.1% Moderate
Irrigated Sensitivity: 74.9% Moderate, 25.1% High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	0.4% Very Low, 73.4% Low, 26.2% Moderate
Irrigated Sensitivity:	0.4% Low, 73.4% Moderate, 26.2% High
Septic Density (systems/acre)	0.071

Dover Well

Median Nitrate-N	5.30
90th Percentile Nitrate-N	7.38
Aquifer Confinement	Confined
Well Construction	Adequate
Aquifer Vulnerable?	No
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:	45.8% Low, 54.2% Moderate
Irrigated Sensitivity:	45.8% Moderate, 54.2% High
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	0.9% Very Low, 68.3% Low, 30.8% Moderate
Irrigated Sensitivity:	0.9% Low, 68.3% Moderate, 30.8% High
Septic Density (systems/acre)	0.051

York Well

Median Nitrate-N	3.84
90th Percentile Nitrate-N	4.80
Aquifer Confinement	Confined
Well Construction	Inadequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

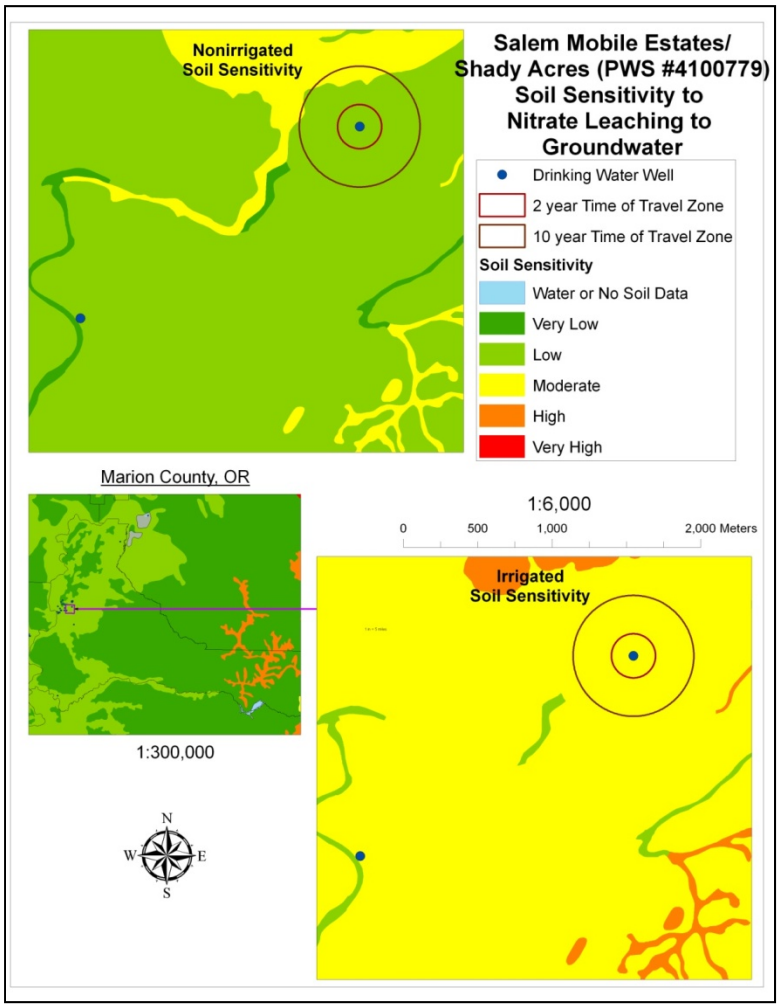
2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Low
Irrigated Sensitivity:	100% Moderate
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	6.4% Very Low, 93.6% Low
Irrigated Sensitivity:	6.4% Low, 93.6% Moderate
Septic Density (systems/acre)	0.15

Salem Mobile Estates/Shady Acres (4100779)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
6.20/8.89

Well 1

Median Nitrate-N
6.60
90th Percentile Nitrate-N
6.90
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
N/A
Irrigated Sensitivity:
N/A
Septic Density (systems/acre)
0

10-year Time of Travel Zone:
Nonirrigated Sensitivity: N/A
Irrigated Sensitivity: N/A
Septic Density (systems/acre) 0

Well 2

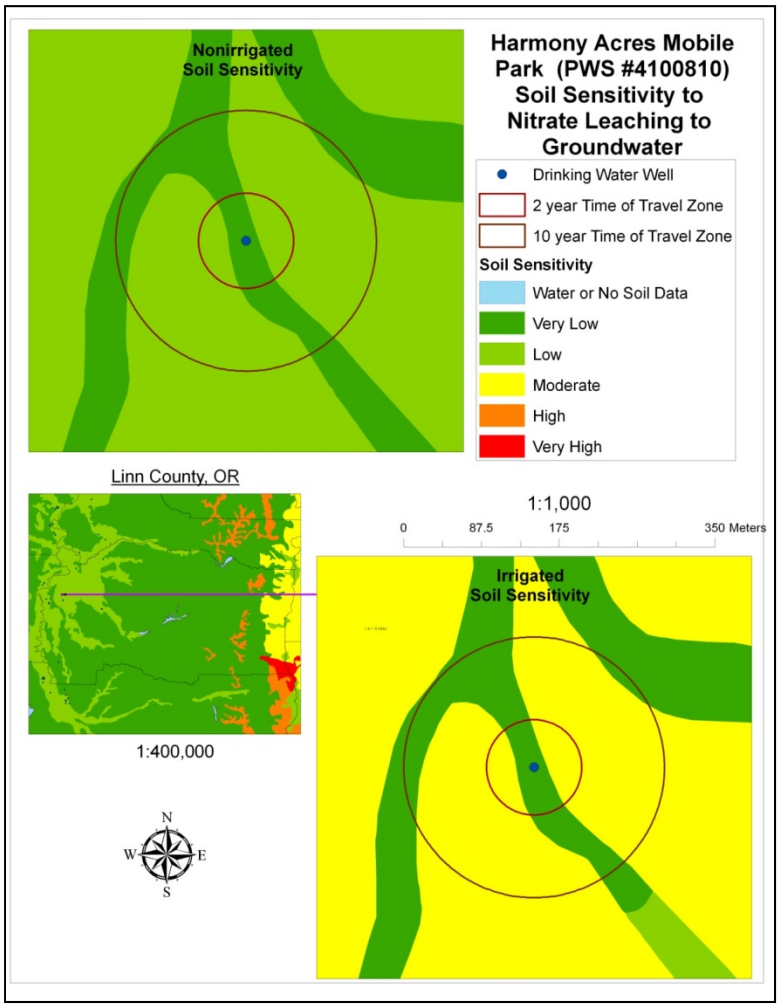
Median Nitrate-N 12.60
90th Percentile Nitrate-N 12.77
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture & Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0.47

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 92.5% Low, 7.5% Moderate

Irrigated Sensitivity:	100% Moderate
Septic Density (systems/acre)	0.23

Harmony Acres Mobile Park (4100810)



System currently active, uses reverse osmosis and ion exchange for inorganic chemical and hardness removal (includes nitrate).

Well 1

Median Nitrate-N
6.88 (Now has treatment installed and new well)
90th Percentile Nitrate-N
11.02 (Now has treatment installed and new well)
Aquifer Confinement
Semi-Confined
Well Construction
Adequate
Aquifer Vulnerable?
Semi
Probable Nitrate Source(s)
Agriculture

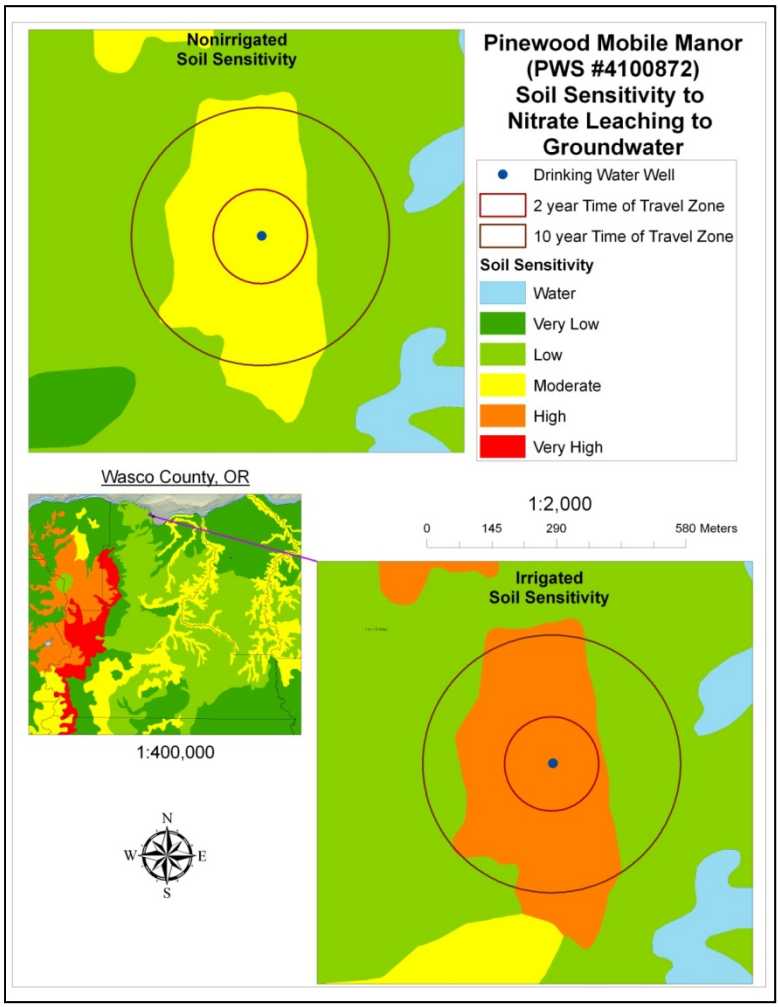
2-year Time of Travel Zone:

Nonirrigated Sensitivity: 40.4% Very Low, 59.6% Low
Irrigated Sensitivity: 40.4% Very Low, 59.6% Moderate
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 24.7% Very Low, 75.3% Low
Irrigated Sensitivity: 24.7% Very Low, 75.3% Moderate
Septic Density (systems/acre) 0

Pinewood Mobile Manor (4100872)



System currently active, no nitrate removal treatment.

Well

Median Nitrate-N
2.00
90th Percentile Nitrate-N
3.80
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 37.4% Low, 62.6% Moderate
Irrigated Sensitivity: 37.4% Low, 62.6% High
Septic Density (systems/acre) 0.046

Spring

Median Nitrate-N 6.00
90th Percentile Nitrate-N 6.21
Aquifer Confinement Unconfined
Well Construction N/A
Aquifer Vulnerable? Yes
Probable Nitrate Source(s) Agriculture & Septic Systems

2-year Time of Travel Zone:

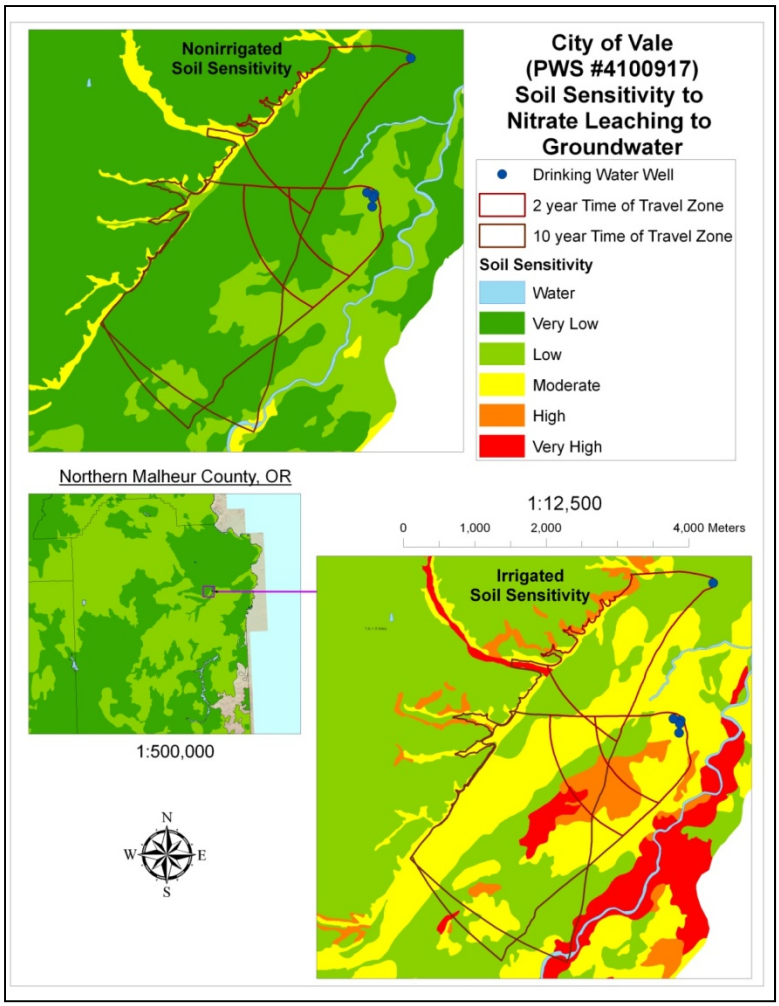
Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	37.4% Low, 62.6% Moderate
Irrigated Sensitivity:	37.4% Low, 62.6% High
Septic Density (systems/acre)	0.046

City of Vale (4100917)

System currently active, uses ion exchange at Airport Well Field for inorganic chemical removal (designed for arsenic removal but removes nitrate).



Composite Median/90th Percentile Nitrate-N (mg/L):
7.12/13.70

Wells 1-7 (Airport Well Field)
Median Nitrate-N
1: 5.78 2: 3.03
3: 6.03 4: 11.70

5: 13.60 6: 12.20
7: 13.70
90th Percentile Nitrate-N
1: 6.77 2: 5.52
3: 8.92 4: 14.06

5: 13.76 6: 13.78
7: 17.56
Aquifer Confinement
1: Unconfined
2-7: Semi-confined
Well Construction
1-7: Adequate
Aquifer Vulnerable?
1: Yes
2-7: Semi
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity: 66.9% Very Low, 33.1% Low
Irrigated Sensitivity: 17.4% Low, 51.9% Moderate, 29.6% High, 1.1% Very High
Septic Density (systems/acre) 0.0084

10-year Time of Travel Zone:
Nonirrigated Sensitivity: 71.4% Very Low, 27.9% Low, 0.7% Moderate
Irrigated Sensitivity: 29.1% Low, 54.6% Moderate, 11.7% High, 4.6% Very High
Septic Density (systems/acre) 0.0082

Washington St. Well

Median Nitrate-N	5.60
90th Percentile Nitrate-N	7.12
Aquifer Confinement	Unknown
Well Construction	Unknown
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

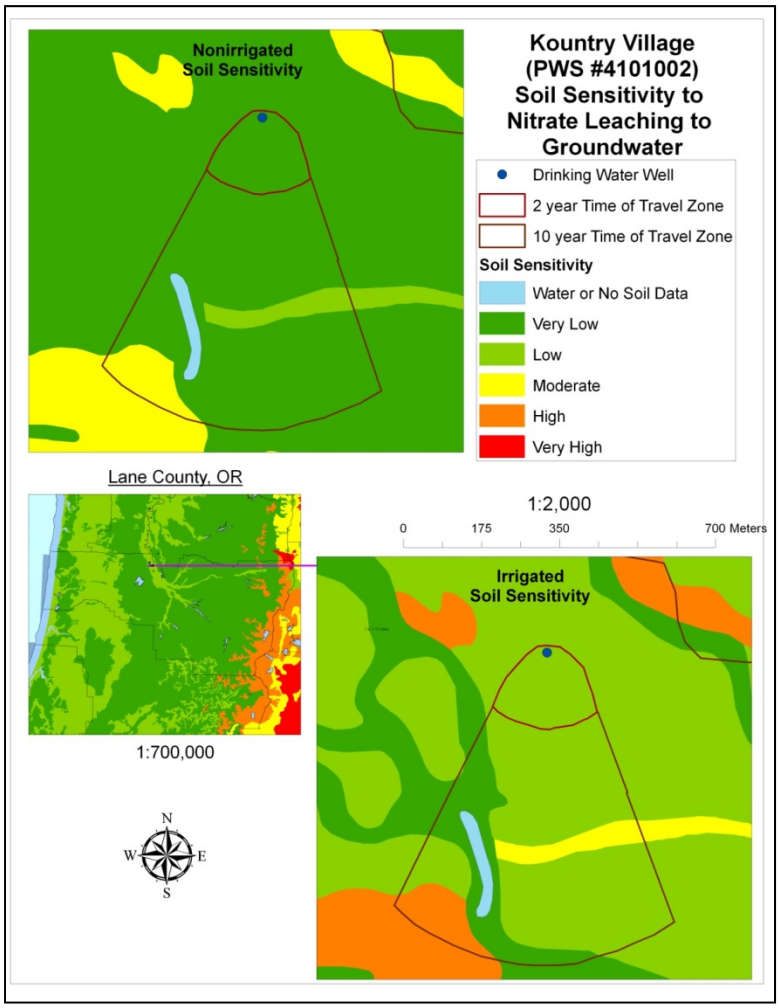
2-year Time of Travel Zone:

Nonirrigated Sensitivity: 93.9% Very Low, 2.2% Low, 3.9% Moderate
Irrigated Sensitivity: 59.0% Low, 38.7% Moderate, 2.2% High, 0.1% Very High
Septic Density (systems/acre) 0.015

10-year Time of Travel Zone: [0.2% Surface Water]

Nonirrigated Sensitivity: 83.0% Very Low, 13.4% Low, 3.4% Moderate
Irrigated Sensitivity: 44.1% Low, 45.7% Moderate, 5.1% High, 4.9% Very High
Septic Density (systems/acre) 0.011

Kountry Village (4101002)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.84
90th Percentile Nitrate-N
5.56
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

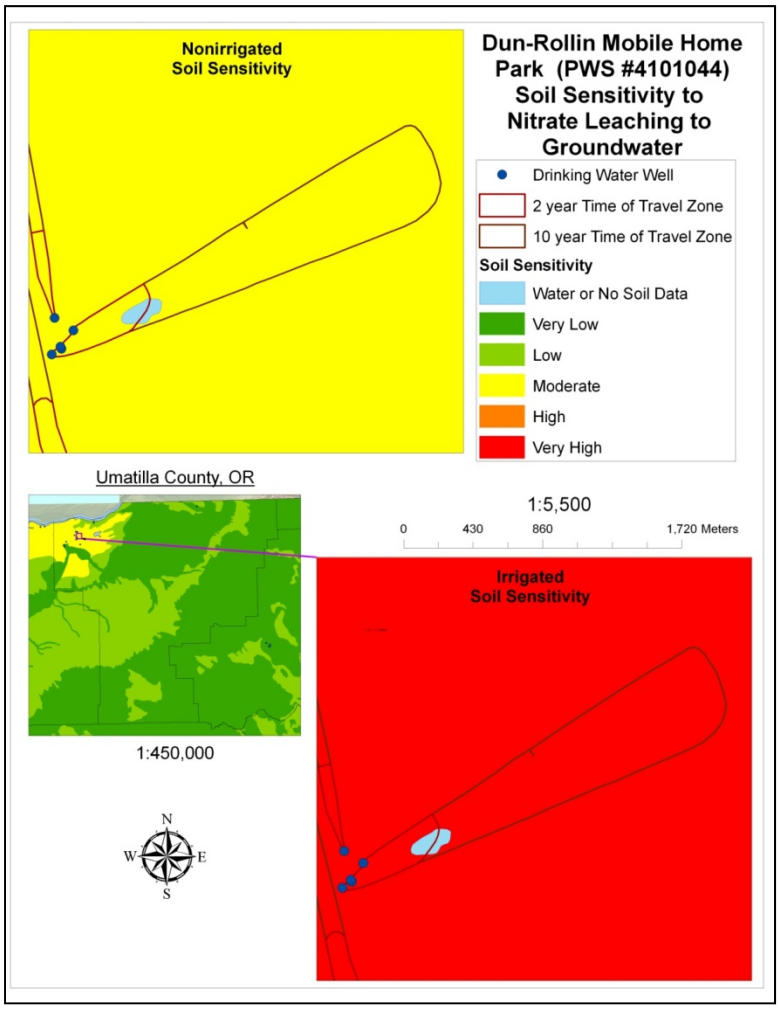
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Low
Septic Density (systems/acre)
0.79

10-year Time of Travel Zone: [2.3% Water or No Soil Data]

Nonirrigated Sensitivity: 86.2% Very Low, 5.2% Low, 6.3% Moderate
Irrigated Sensitivity: 15.1% Very Low, 71.1% Low, 5.2% Moderate, 6.3% High
Septic Density (systems/acre) 0.33

Dun-Rollin Mobile Home Park (4101044)



System currently active, no nitrate removal treatment.

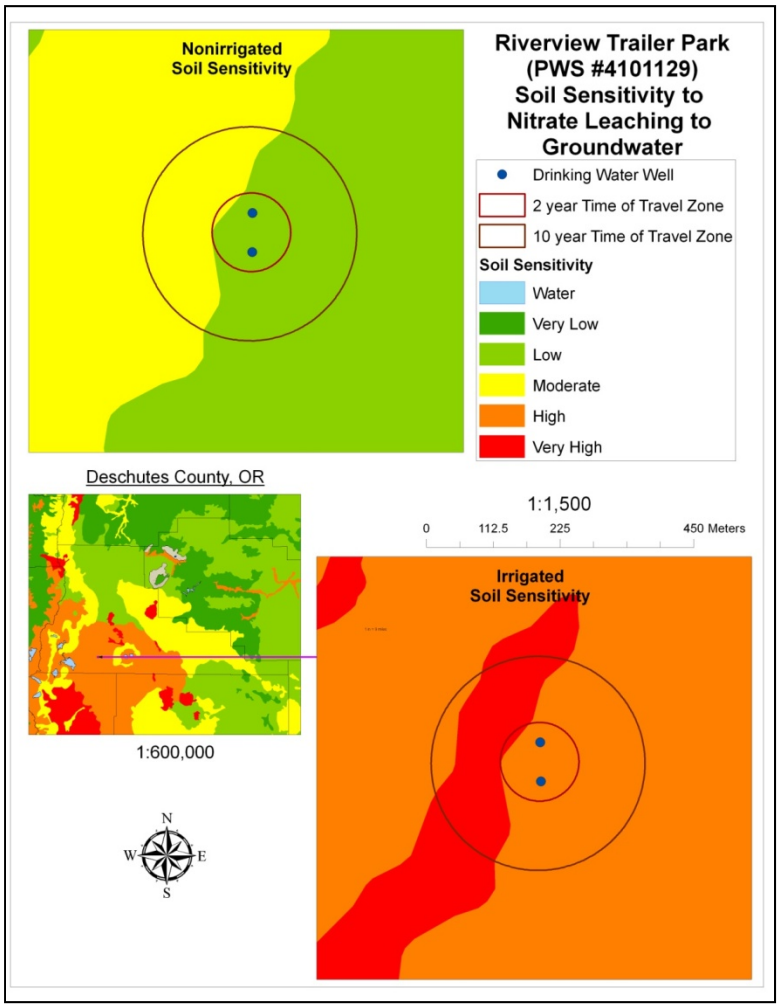
Wells 1-4

Median Nitrate-N
3.75
90th Percentile Nitrate-N
5.16
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:
[13.7% Water or No Soil Data]
Nonirrigated Sensitivity:
86.3% Moderate
Irrigated Sensitivity:
86.3% Very High
Septic Density (systems/acre)
0.038

10-year Time of Travel Zone: [2.7% Water or No Soil Data]
Nonirrigated Sensitivity: 97.3% Moderate
Irrigated Sensitivity: 97.3%Very High
Septic Density (systems/acre) 0.28

Riverview Trailer Park (4101129)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
5.86/7.77

Wells 1&2

Median Nitrate-N
1: 5.48 2: 5.60
90th Percentile Nitrate-N
1: 7.95 2: 7.95
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Septic Systems

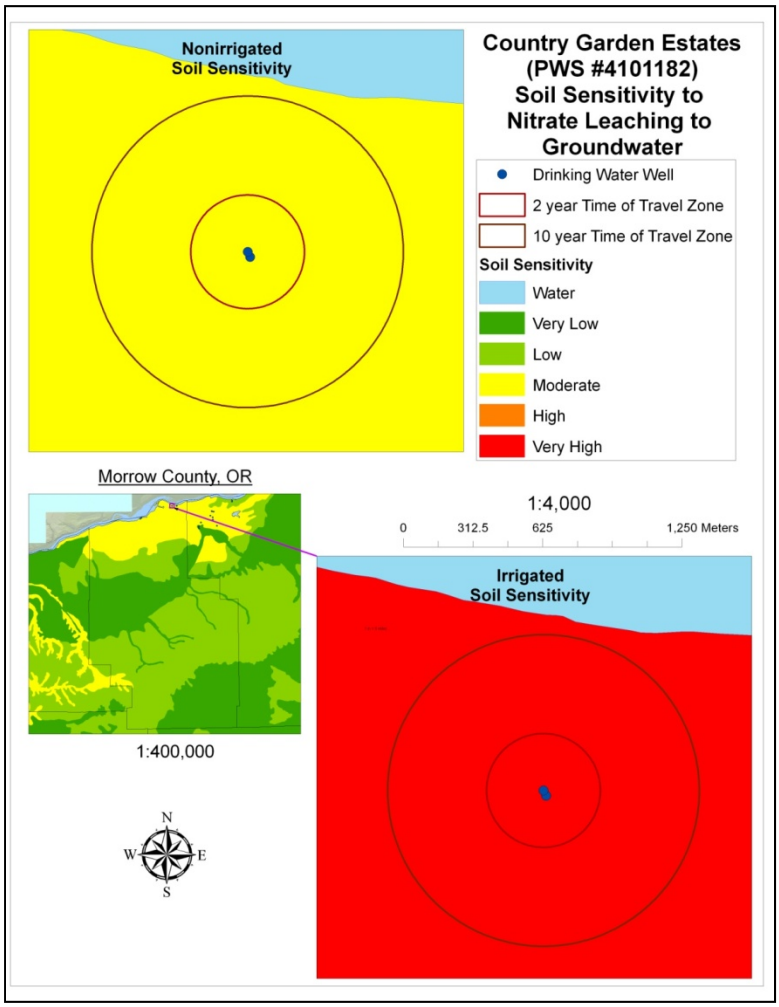
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
95.2% Low,
4.8% Moderate
Irrigated Sensitivity:
95.2% High,
4.8% Very High
Septic Density (systems/acre)
0.29

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 61.4% Low, 38.6% Moderate
Irrigated Sensitivity: 67.0% High, 33.0% Very High
Septic Density (systems/acre) 0.040

Country Garden Estates Mobile Home Park (4101182)



System currently active, no nitrate removal treatment.

Wells 1&2

Median Nitrate-N
6.00
90th Percentile Nitrate-N
7.20
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

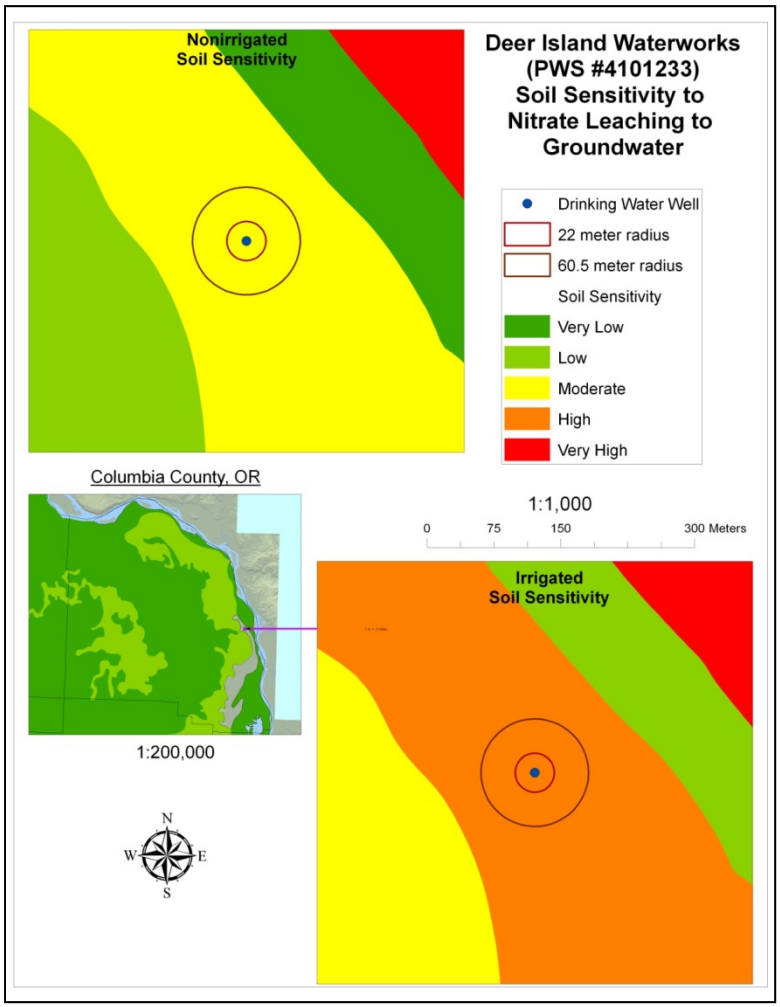
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100 % Very High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0.0053

Deer Island Waterworks (4101233)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.30
90th Percentile Nitrate-N
7.38
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

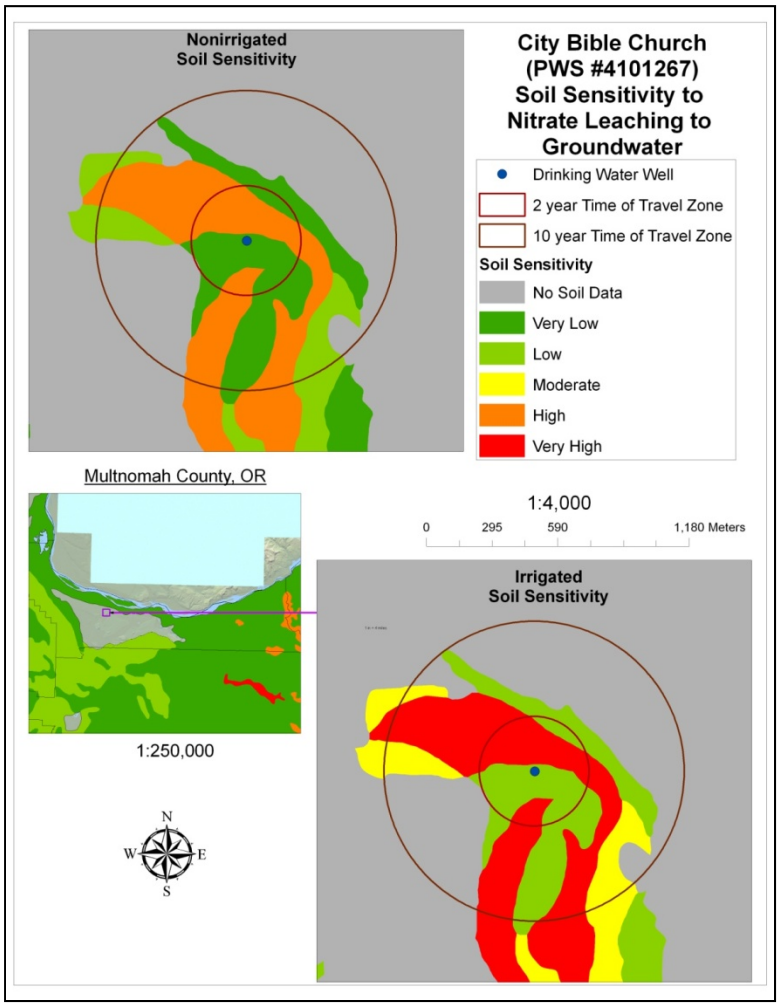
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
10.65

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 3.94

City Bible Church (4101267)



System currently active, no nitrate removal treatment.

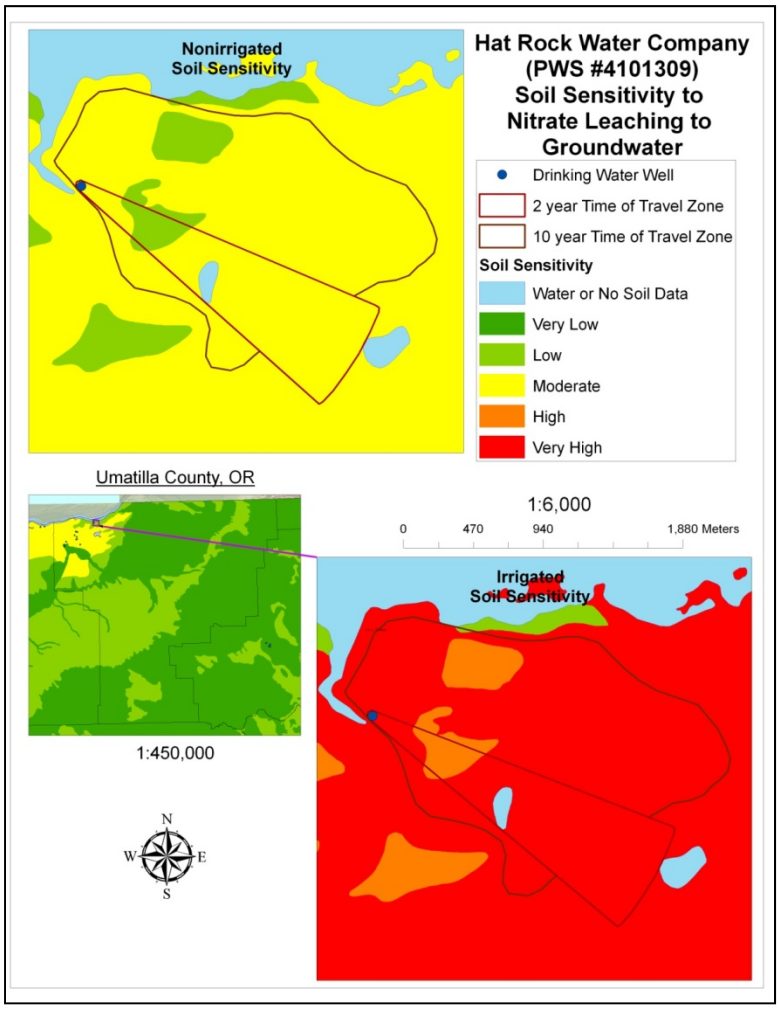
Well 1

Median Nitrate-N
6.05
90th Percentile Nitrate-N
7.24
Aquifer Confinement
Unknown
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Unknown (Possibly old septic systems or sewer leaks)

2-year Time of Travel Zone:
[0.2% No Soil Data]
Nonirrigated Sensitivity:
51.6% Very Low,
48.2% High
Irrigated Sensitivity:
51.6% Low,
48.2% Very High
Septic Density (systems/acre)
0

10-year Time of Travel Zone: [44.8% No Soil Data]
Nonirrigated Sensitivity: 21.4% Very Low, 7.3% Low, 26.5% High
Irrigated Sensitivity: 21.4% Low, 7.3% Moderate, 26.5% Very High
Septic Density (systems/acre) 0

Hat Rock Water Company (4101309)



System currently active, no nitrate removal treatment.

Spring

Median Nitrate-N
6.80
90th Percentile Nitrate-N
8.50
Aquifer Confinement
Unconfined
Well Construction
N/A
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Septic Systems

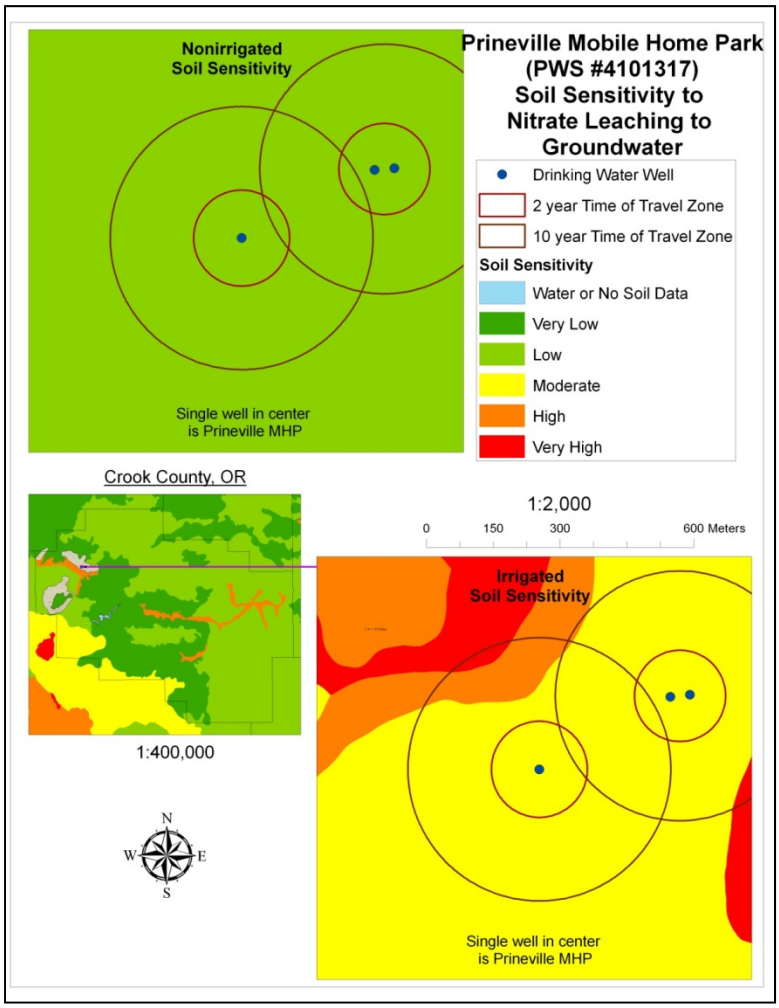
2-year Time of Travel Zone: [2.8% Surface Water/No Soil Data]

Nonirrigated Sensitivity:
8.8% Low,
88.4% Moderate
Irrigated Sensitivity:
8.8% High,
88.4% Very High
Septic Density (systems/acre)
0.0044

10-year Time of Travel Zone: [0.9% Surface Water/No Soil Data]

Nonirrigated Sensitivity: 9.0% Low, 90.1% Moderate
Irrigated Sensitivity: 0.1% Low, 9.0% High, 90.1% Very High
Septic Density (systems/acre) 0.036

Prineville Mobile Home Park (4101317)



System currently active, uses ion exchange for inorganic chemical (nitrate) removal.

Well 1

Median Nitrate-N
6.45
90th Percentile Nitrate-N
9.79
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

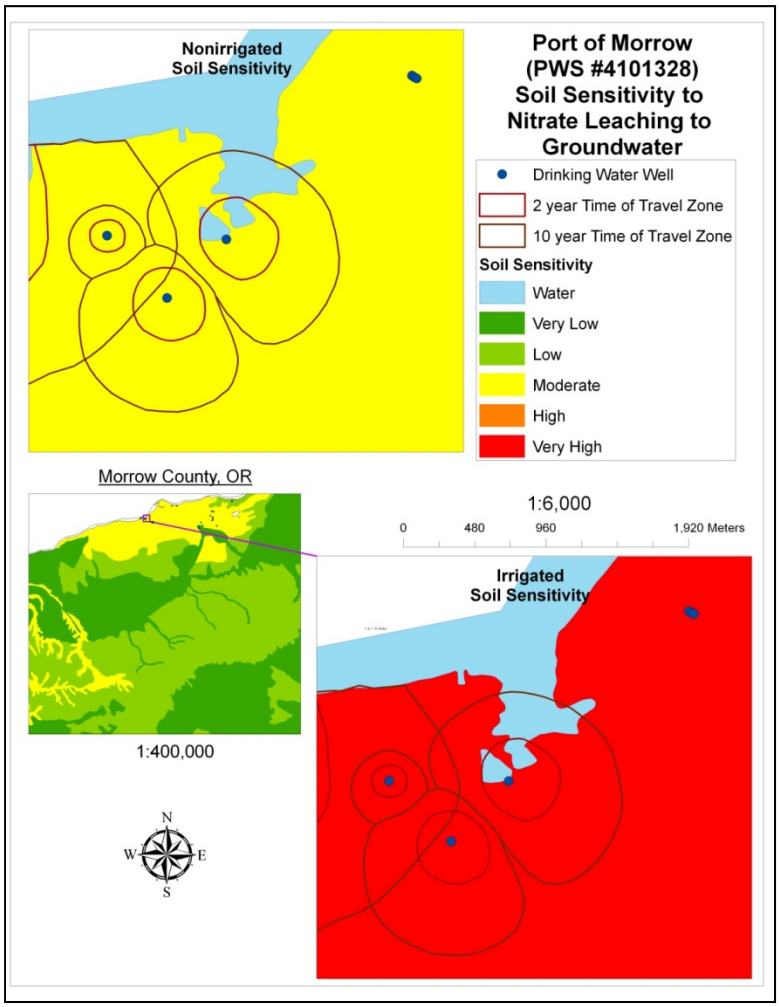
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.22

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 89.4% Moderate, 9.3% High, 1.3% Very High
Septic Density (systems/acre) 0.52

Port of Morrow (4101328)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
0.30/8.32

Well 1

Median Nitrate-N
0
90th Percentile Nitrate-N
2.15
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0

Well 2

Median Nitrate-N 0
90th Percentile Nitrate-N 0.27
Aquifer Confinement Confined
Well Construction Adequate
Aquifer Vulnerable? No
Probable Nitrate Source(s) Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0

Well 4

Median Nitrate-N	0
90th Percentile Nitrate-N	0.3
Aquifer Confinement	Confined
Well Construction	Adequate
Aquifer Vulnerable?	No
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone: [25.8% Surface Water]

Nonirrigated Sensitivity:	74.2% Moderate
Irrigated Sensitivity:	74.2% Very High
Septic Density (systems/acre)	0

10-year Time of Travel Zone: [17.0% Surface Water]

Nonirrigated Sensitivity:	83.0% Moderate
Irrigated Sensitivity:	83.0% Very High
Septic Density (systems/acre)	0.0036

East Beach Wells

Median Nitrate-N	7.00
90th Percentile Nitrate-N	10.00
Aquifer Confinement	Unconfined
Well Construction	Adequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

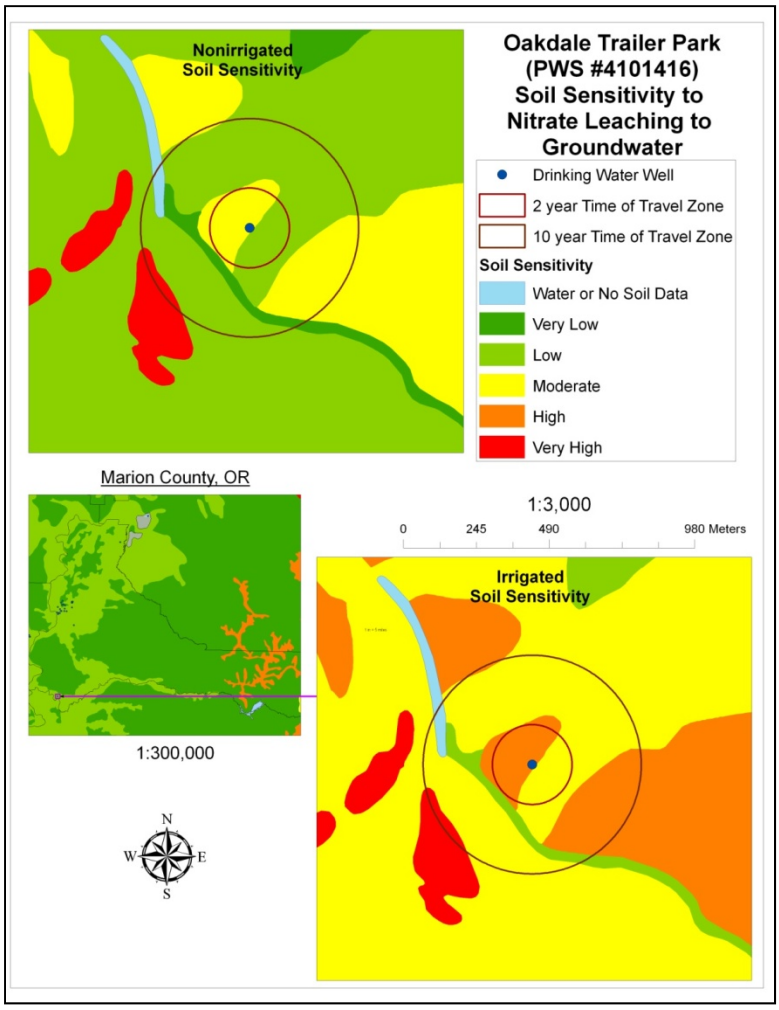
2-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0

10-year Time of Travel Zone:

Nonirrigated Sensitivity:	100% Moderate
Irrigated Sensitivity:	100% Very High
Septic Density (systems/acre)	0

Oakdale Trailer Park (4101416)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
7.90

90th Percentile Nitrate-N
9.68

Aquifer Confinement
Unconfined

Well Construction
Inadequate

Aquifer Vulnerable?
Yes

Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
43.2% Low,
56.8% Moderate

Irrigated Sensitivity:
43.2% Moderate,
56.8% High

Septic Density (systems/acre)
1.07

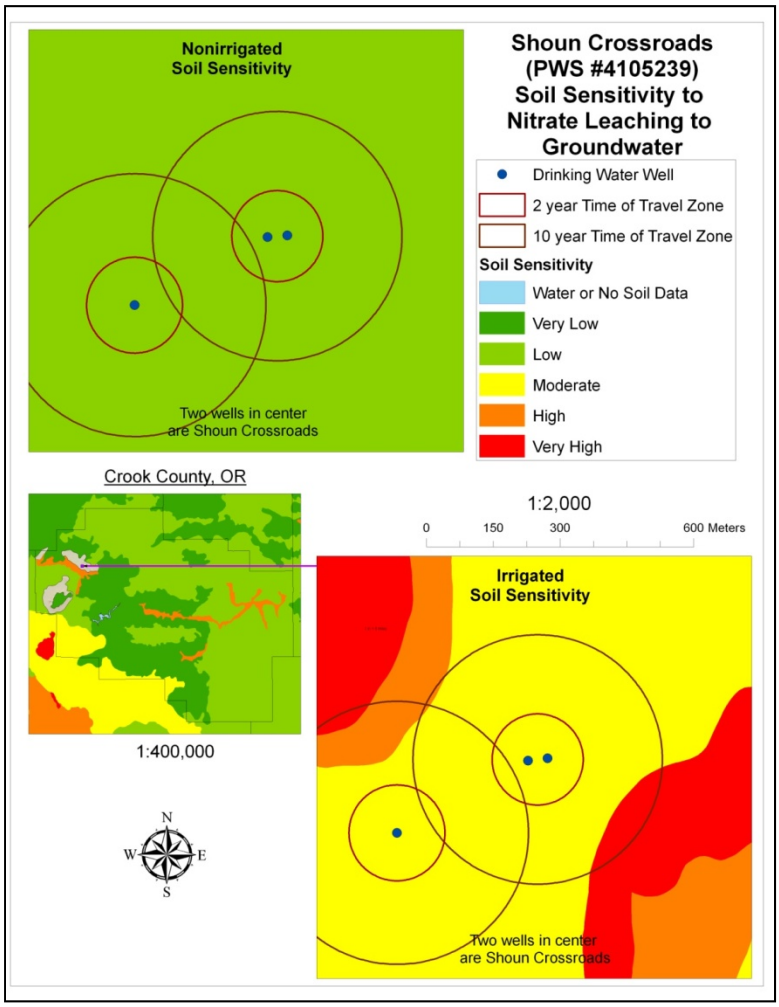
10-year Time of Travel Zone: [1.2% Water or No Soil Data]

Nonirrigated Sensitivity: 5.7% Very Low, 65.6% Low, 26.0% Moderate, 1.5% Very High

Irrigated Sensitivity: 5.7% Low, 65.6% Moderate, 26.0% High, 1.5% Very High

Septic Density (systems/acre) 0.37

Shoun Crossroads (4105239)



System currently active, no nitrate removal treatment.

Wells 3&4 (in use before 2004)
(The high-nitrate wells (#3 and #4) have been abandoned and replaced with newer, deeper Well #5.)

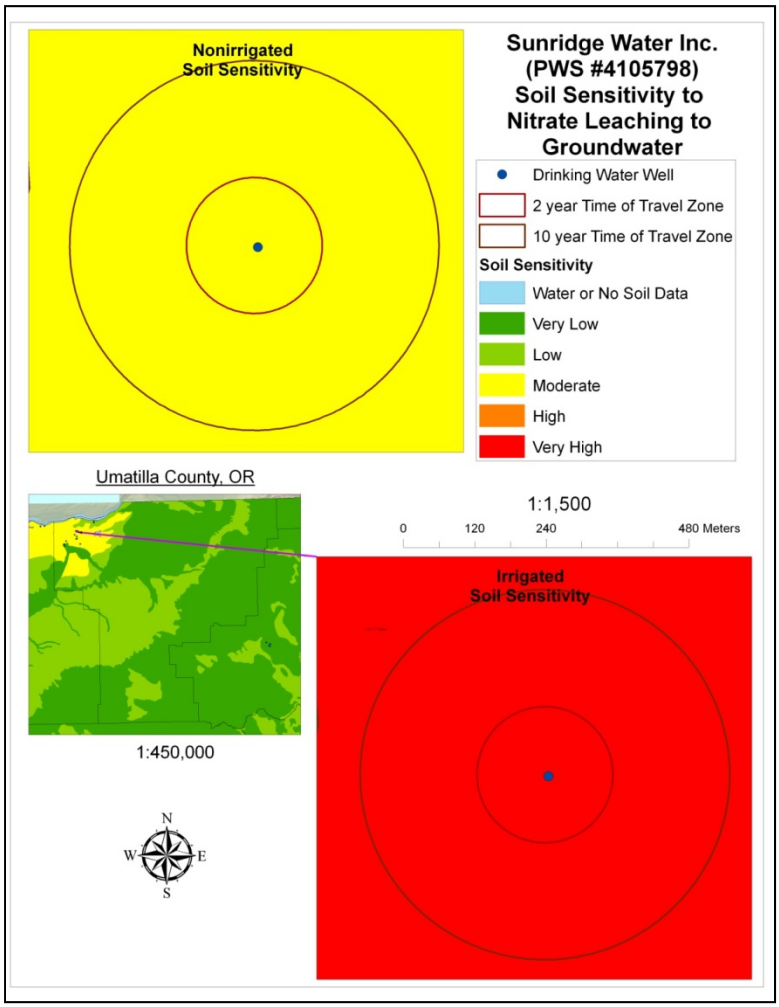
Median Nitrate-N
7.00
90th Percentile Nitrate-N
8.60
Aquifer Confinement
Semi-confined
Well Construction
Adequate
Aquifer Vulnerable?
Semi
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
1.35

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 94% Moderate, 0.3% High, 5.7% Very High
Septic Density (systems/acre) 0.56

Sunridge Water Incorporated (4105798)



System currently active, no nitrate removal treatment.

Wells 1&2

Median Nitrate-N
7.00
90th Percentile Nitrate-N
9.66
Aquifer Confinement
1: Unconfined
2: Confined
Well Construction
1: Adequate
2: Adequate
Aquifer Vulnerable?
1: Yes
2: No
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

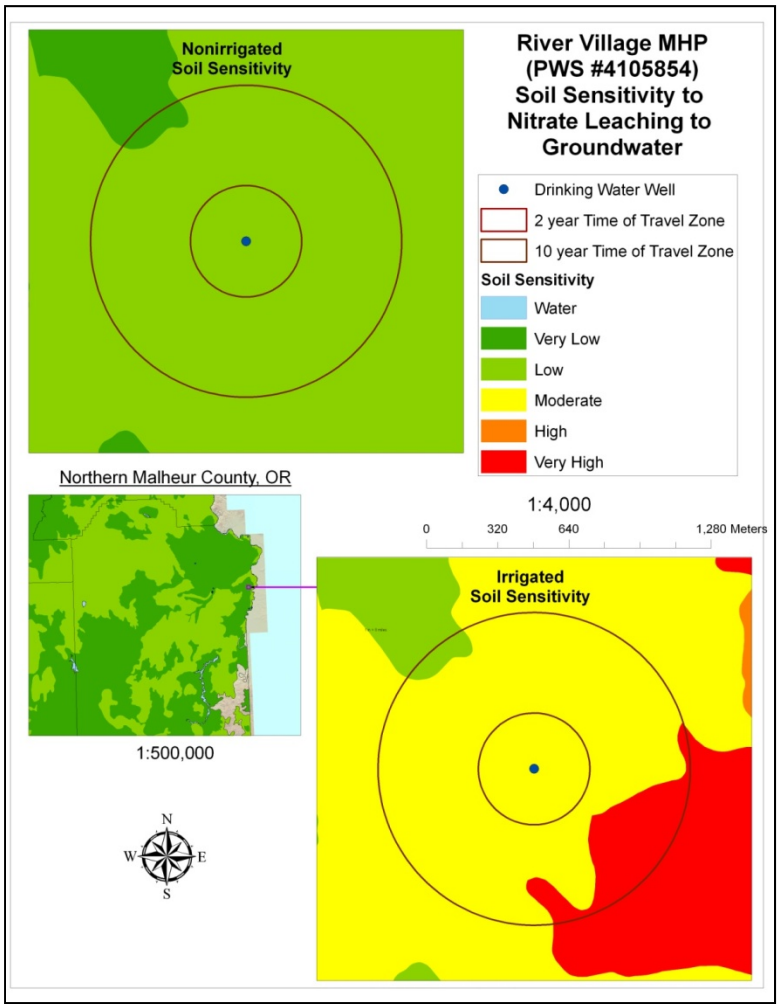
Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0.29

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% Very High
Septic Density (systems/acre) 0.23

Well #1 (Alluvial) is constructed adequately. Well #2 (Basalt) is constructed adequately, but North Hill Water Corp is ~1/2 mile away and has inadequately-constructed, unabandoned wells also in the deep aquifer, so could be allowing nitrate to travel down to the deeper basalt aquifer.

River Village MHP (4105854)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
3.97
90th Percentile Nitrate-N
7.30
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

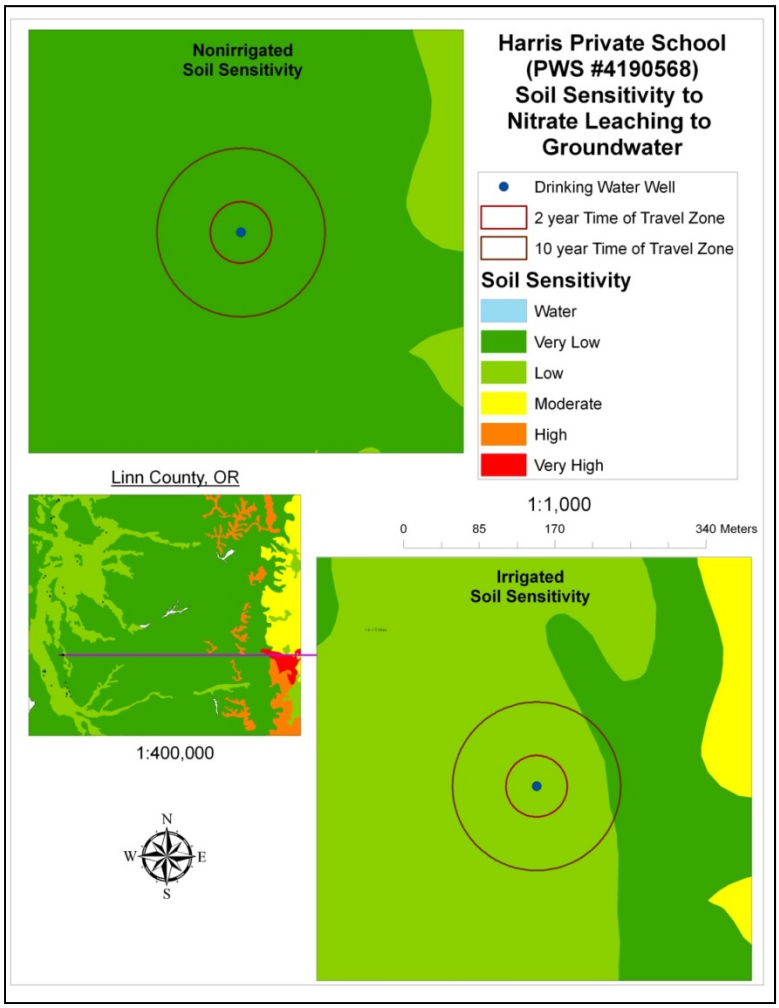
Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.29

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 1.8% Very Low, 98.2%Low
Irrigated Sensitivity: 1.8% Low, 85.7% Moderate, 12.5% Very High
Septic Density (systems/acre) 0.050

Potentially Groundwater Under Direct Influence (of surface water). Well possible open to two aquifers, the unconfined alluvial sand and gravel aquifer and the deeper confined Glenn's Ferry aquifer. Nitrate contamination is mainly confined to the shallow alluvial sand and gravel aquifer.

Harris Private School (4190568)



System currently active, uses ion exchange for inorganic chemical and hardness removal (includes nitrate).

Composite Median/90th Percentile Nitrate-N (mg/L):
7.10/10.00

Well 1 & New Well

Median Nitrate-N
1: 8.10
New: 2.65

90th Percentile Nitrate-N
1: 10.12
New: 5.35

Aquifer Confinement
1: Semi-confined
New: Semi-confined

Well Construction
1: Inadequate
New: Adequate

Aquifer Vulnerable?
1: Yes
New: Semi

Probable Nitrate Source(s)
Agriculture

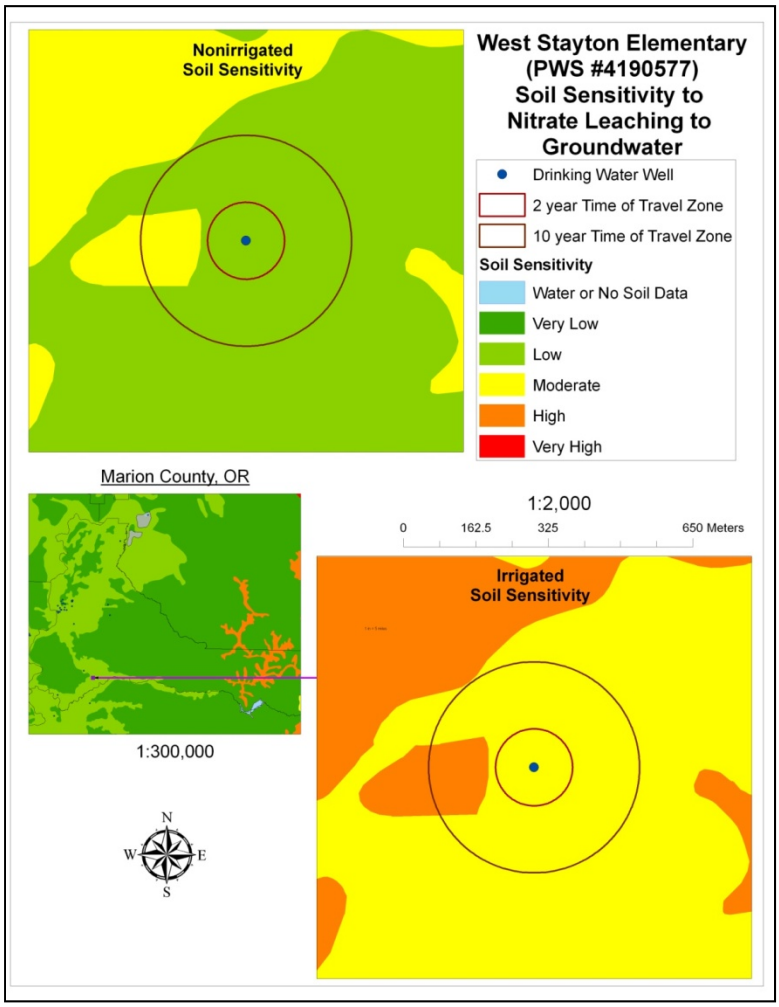
2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Low
Septic Density (systems/acre) 1.09

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 4.7% Very Low, 95.3% Low
Septic Density (systems/acre) 0.14

West Stayton Elementary (4190577)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.40
90th Percentile Nitrate-N
7.34
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

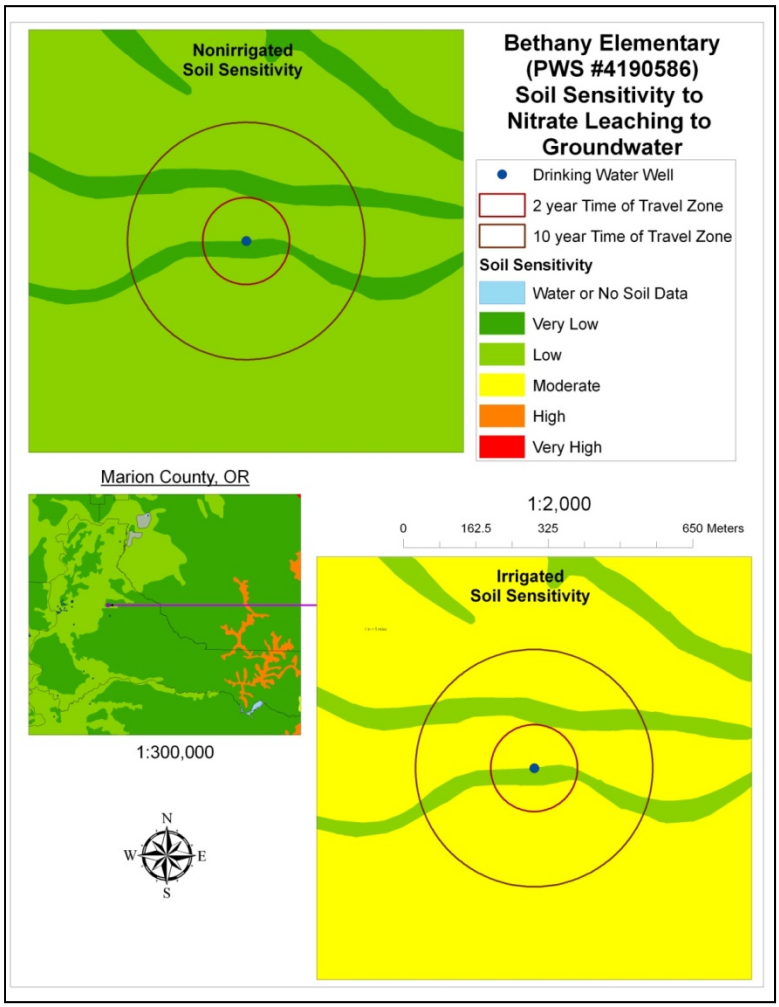
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.17

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 88.4% Low, 11.6% Moderate
Irrigated Sensitivity: 88.4% Moderate, 11.6% High
Septic Density (systems/acre) 0.11

Bethany Elementary School (4190586)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
3.30
90th Percentile Nitrate-N
9.10
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

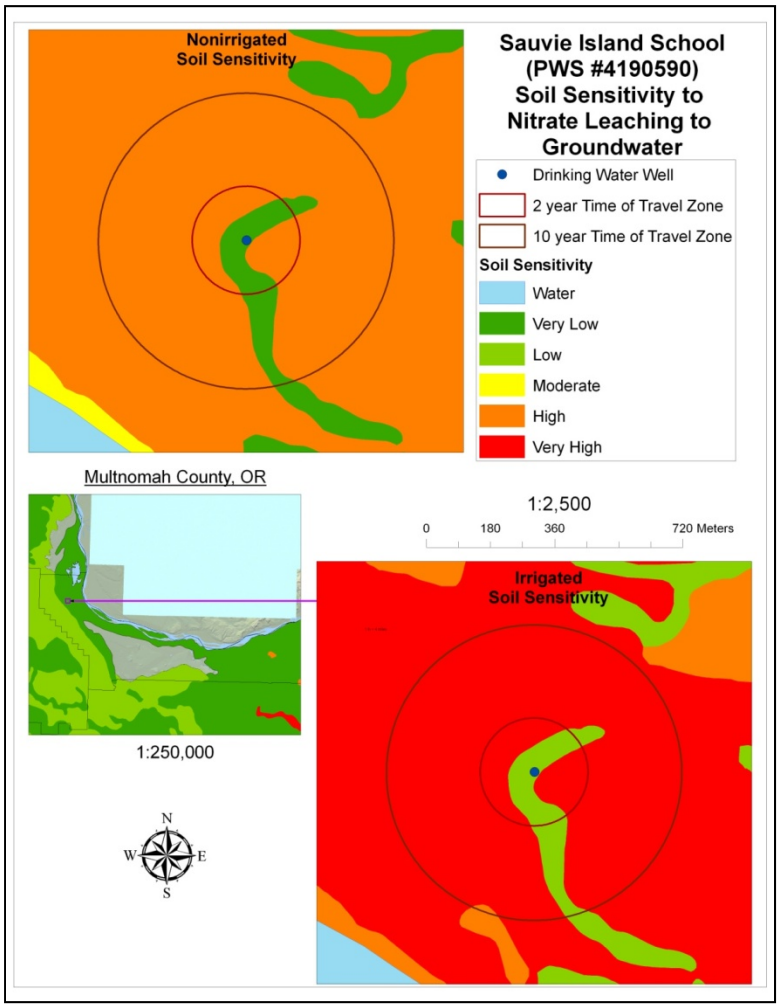
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
23.8% Very Low,
76.2% Low
Irrigated Sensitivity:
23.8% Low,
76.2% Moderate
Septic Density (systems/acre)
0.27

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 18.5% Very Low, 81.5% Low
Irrigated Sensitivity: 18.5% Low, 81.5% Moderate
Septic Density (systems/acre) 0.49

Sauvie Island School (4190590)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.60
90th Percentile Nitrate-N
5.18
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

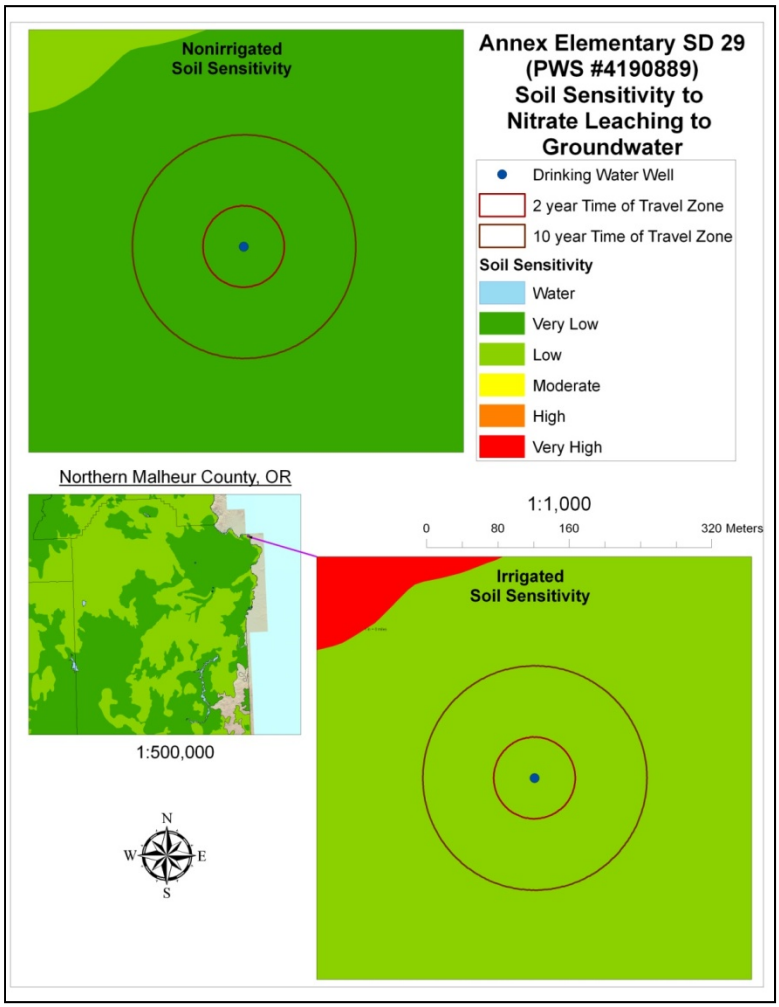
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
35.0% Very Low,
65.0% High
Irrigated Sensitivity:
35.0% Low,
65.0% Very High
Septic Density (systems/acre)
0.056

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 8.3% Very Low, 91.7% High
Irrigated Sensitivity: 8.3% Low, 0.2% High, 91.5% Very High
Septic Density (systems/acre) 0.25

Annex Elementary, SD #29 (4190889)



System currently active, uses ion exchange for inorganic chemical removal (includes nitrate).

[Nitrate values are for untreated samples.]

Composite Median/90th Percentile Nitrate-N (mg/L):
11.52/12.34

Main & Old Wells

Median Nitrate-N
Main: 6.02
Old: 12.15
90th Percentile Nitrate-N
Main: 7.96
Old: 12.39
Aquifer Confinement
Semi-confined
Well Construction
Main: Adequate
Old: Inadequate
Aquifer Vulnerable?
Main: Semi
Old: Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Low
Septic Density (systems/acre) 0.62

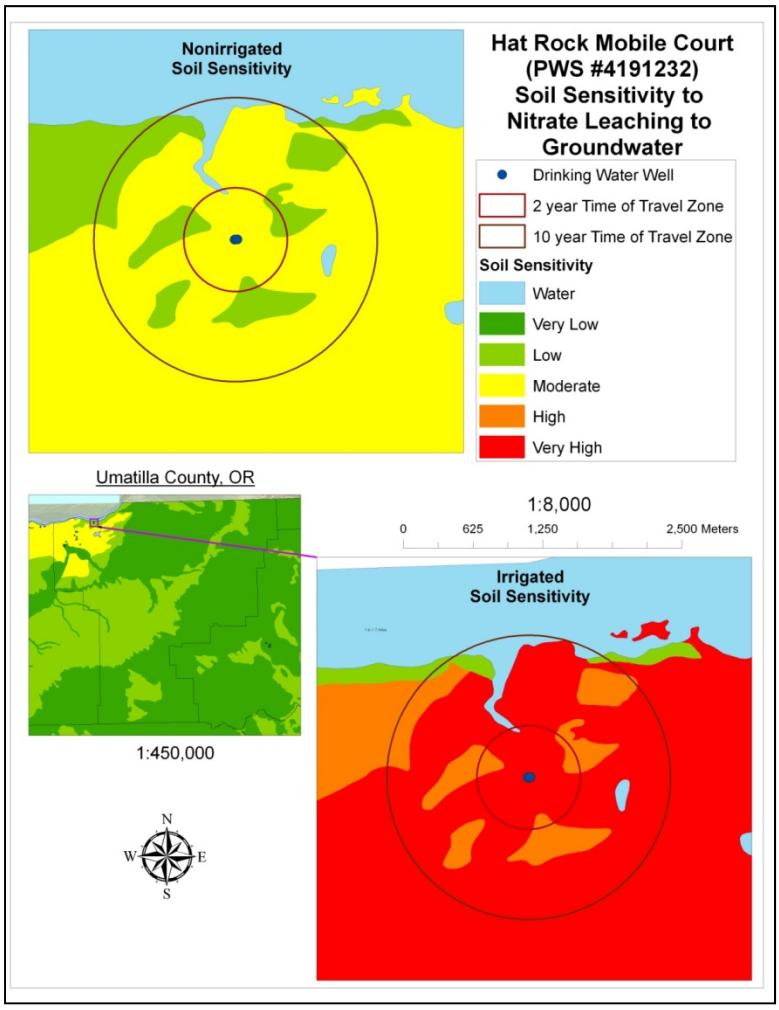
10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Low
Septic Density (systems/acre) 0.16

EP-A, SRC-AA: WELL, Old Well
Inactive, Abandoned
Inadequate - seal not constructed properly
Nitrate treatment installed August 1994.

EP-A, SRC-AB: WELL (L79329), Main Well
Active, Permanent
Adequate
New well constructed in 2005. Same aquifer as the old well.

Hat Rock Mobile Court (4191232)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
7.60/8.76

Wells 1, 2 &3

Median Nitrate-N
1&2: 7.90
3: 0

90th Percentile Nitrate-N
1&2: 8.80
3: 0.35

Aquifer Confinement
1&2: Confined
3: Confined

Well Construction
1&2: Inadequate
3: Adequate

Aquifer Vulnerable?
1&2: Yes
3: No

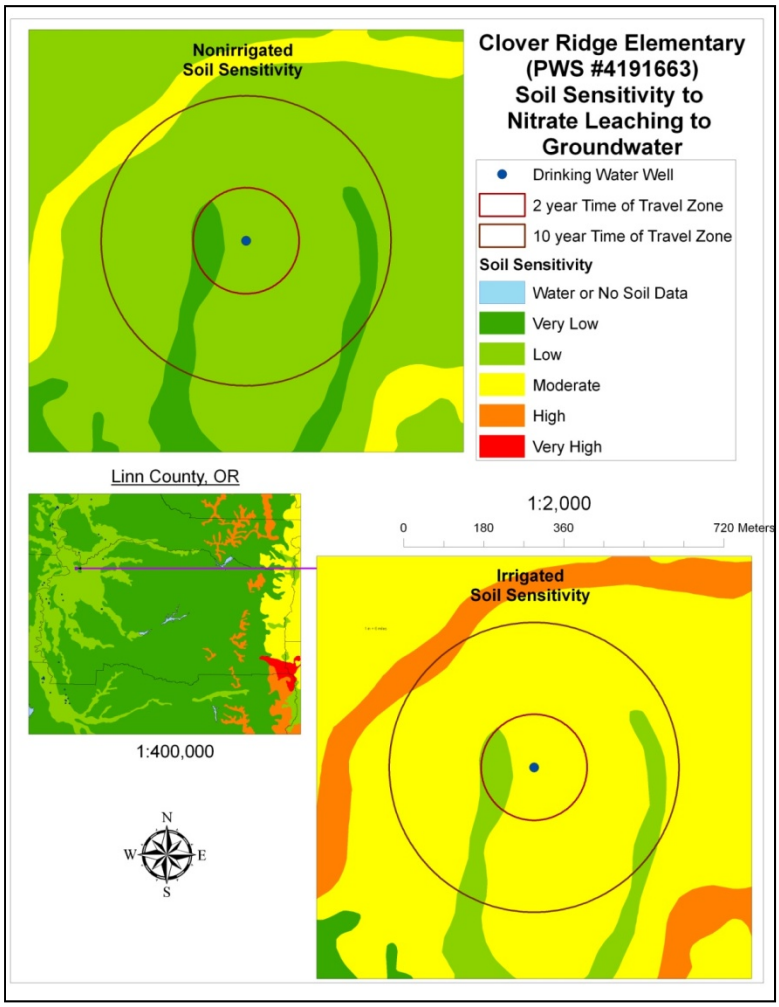
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone: [0.4% Surface Water]
Nonirrigated Sensitivity: 12.5% Low, 87.1% Moderate
Irrigated Sensitivity: 12.5% High, 87.1% Very High
Septic Density (systems/acre) 0.012

10-year Time of Travel Zone: [4.2% Surface Water]
Nonirrigated Sensitivity: 19.6% Low, 76.1% Moderate
Irrigated Sensitivity: 1.5% Low, 18.2% High, 76.1% Very High
Septic Density (systems/acre) 0.043

Wells #1 and #2 changed to emergency and new, deeper, Well #3 added to the system in early 2007.

Clover Ridge Elementary (4191663)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
5.40
90th Percentile Nitrate-N
6.40
Aquifer Confinement
Semi-confined
Well Construction
Adequate
Aquifer Vulnerable?
Semi
Probable Nitrate Source(s)
Agriculture

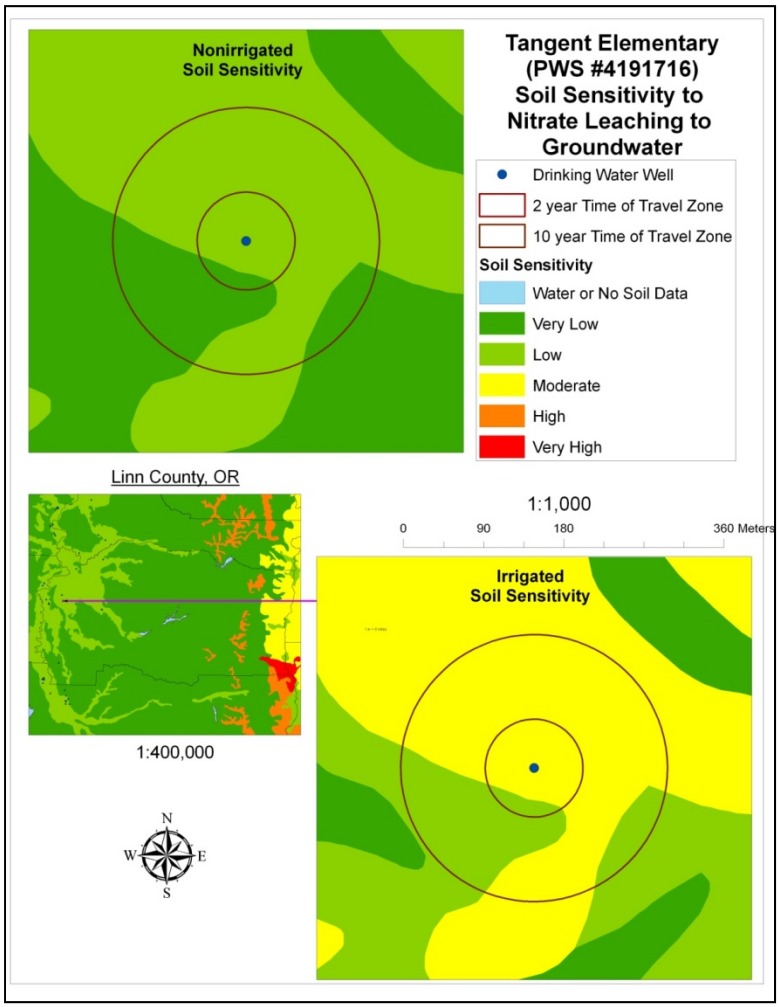
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
20.1% Very Low,
79.9% Low
Irrigated Sensitivity:
20.1% Low,
79.9% Moderate
Septic Density (systems/acre)
0.091

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 10.7% Very Low, 88.4% Low, 0.9% Moderate
Irrigated Sensitivity: 10.7% Low, 88.4% Moderate, 0.9% High
Septic Density (systems/acre) 0.12

Tangent Elementary (4191716)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.20
90th Percentile Nitrate-N
5.00
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

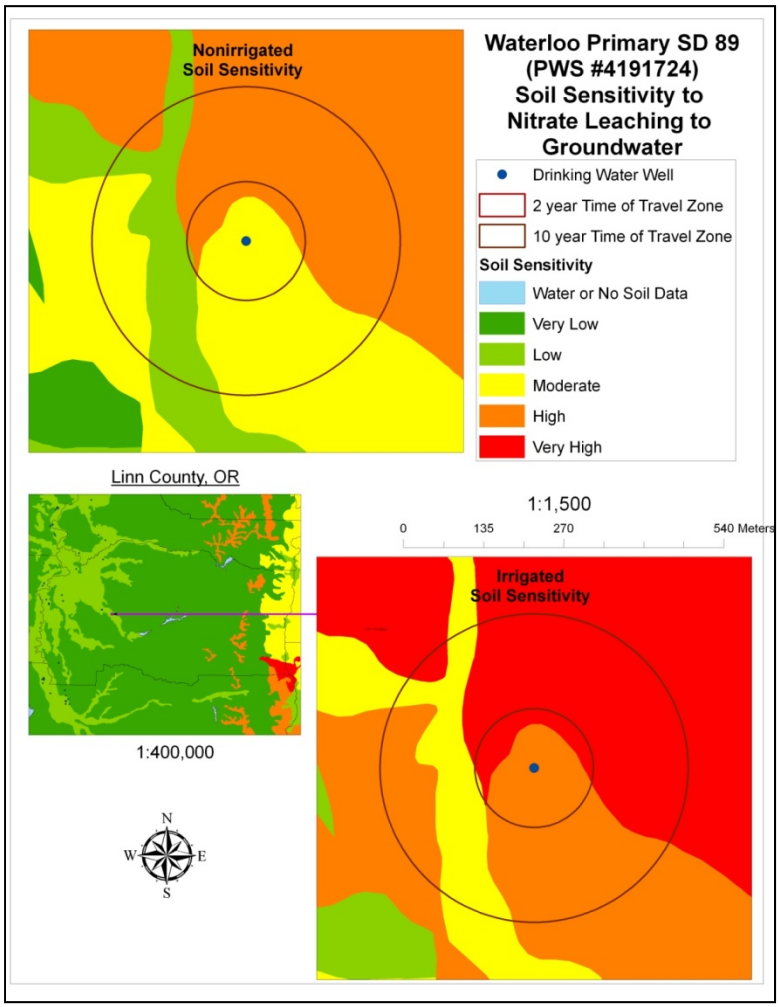
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
13.7% Very Low,
86.3% Low
Irrigated Sensitivity:
13.7% Low,
86.3% Moderate
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 27.8% Very Low, 72.2% Low
Irrigated Sensitivity: 27.8% Low, 72.2% Moderate
Septic Density (systems/acre) 0.40

Waterloo Primary SD 89 (4191724)



System currently inactive, no nitrate removal treatment.

Well 1

Median Nitrate-N
2.70
90th Percentile Nitrate-N
4.12
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

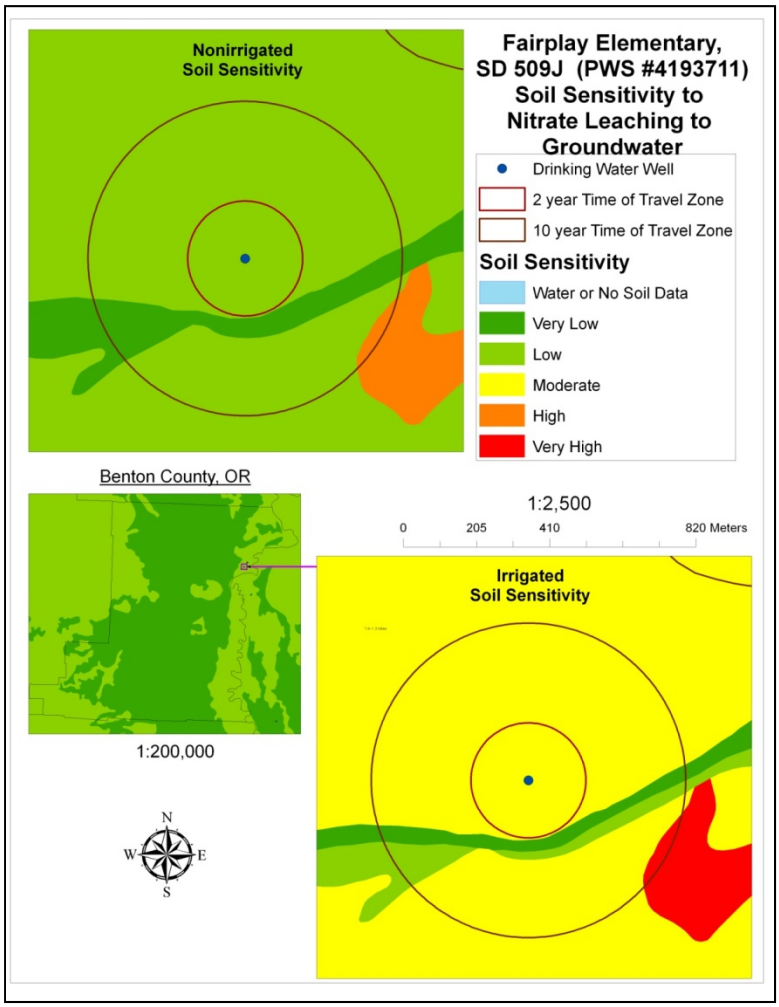
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
0.7% Low,
68.1% Moderate,
31.2% High
Irrigated Sensitivity:
0.7% Moderate,
68.1% High,
31.2% Very High
Septic Density (systems/acre)
0.39

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 16.8% Low, 39.6% Moderate, 43.6% High
Irrigated Sensitivity: 16.8% Moderate, 39.6% High, 43.6% Very High
Septic Density (systems/acre) 0.29

Fairplay Elementary, SD 509J (4193711)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
7.30
90th Percentile Nitrate-N
8.94
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

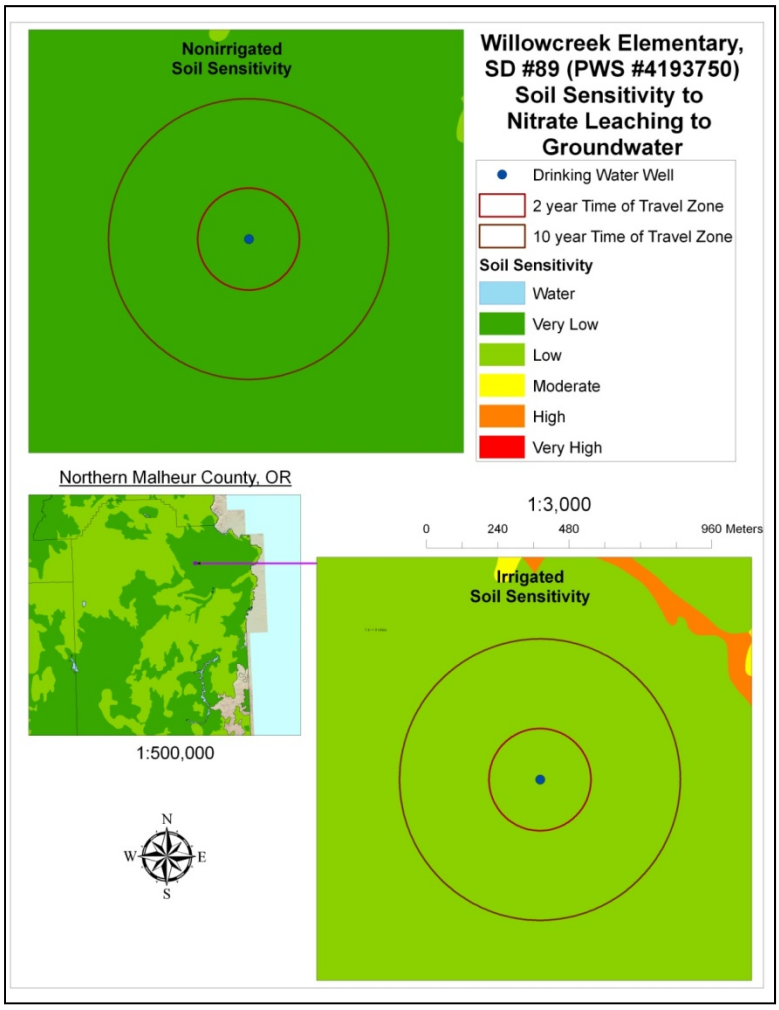
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0.59

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 11.1% Very Low, 88.0% Low, 1.0% High
Irrigated Sensitivity: 5.5% Very Low, 5.6% Low, 88.0% Moderate, 1.0% Very High
Septic Density (systems/acre) 0.16

Willowcreek Elementary, SD #89 (4193750)



System currently active, uses ion exchange for inorganic chemical removal (includes nitrate).

Composite Median/90th Percentile Nitrate-N (mg/L):
3.59/8.48

Main Well

Median Nitrate-N
3.48
90th Percentile Nitrate-N
8.48
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:
Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Low
Septic Density (systems/acre)
0.22

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Very Low
Irrigated Sensitivity: 100% Low
Septic Density (systems/acre) 0.075

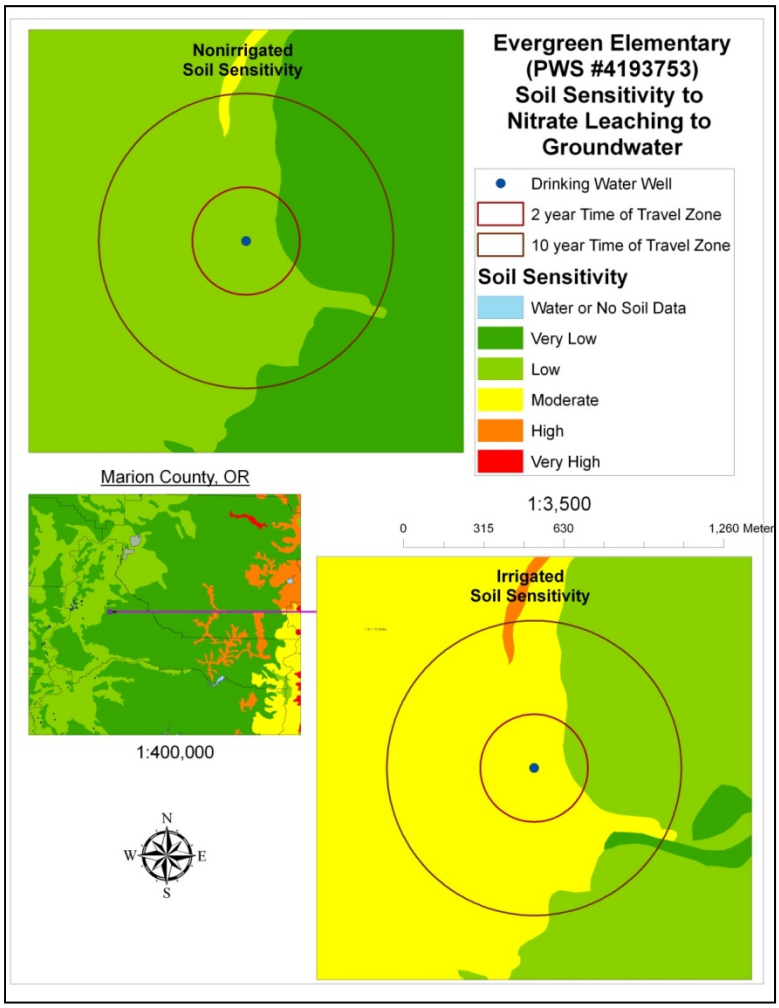
Irrigation Well (Back-up)

Median Nitrate-N	4.21
90th Percentile Nitrate-N	7.35
Aquifer Confinement	Unconfined
Well Construction	Inadequate
Aquifer Vulnerable?	Yes
Probable Nitrate Source(s)	Agriculture

2-year Time of Travel Zone: See Main Well

10-year Time of Travel Zone: See Main Well

Evergreen Elementary (4193753)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
5.50
90th Percentile Nitrate-N
6.11
Aquifer Confinement
Confined
Well Construction
Adequate
Aquifer Vulnerable?
No
Probable Nitrate Source(s)
Agriculture & Septic Systems

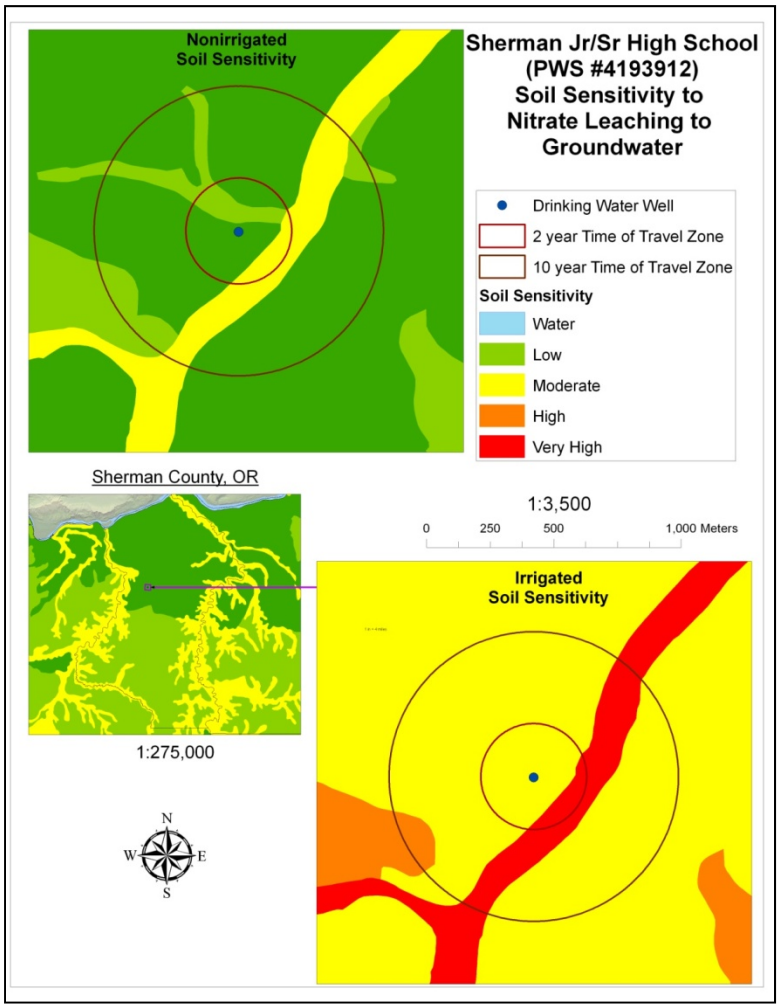
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
10.9% Very Low,
89.1% Low
Irrigated Sensitivity:
10.9% Low,
89.1% Moderate
Septic Density (systems/acre)
0.17

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 30.9% Very Low, 68.6% Low, 0.5% Moderate
Irrigated Sensitivity: 0.9% Very Low, 30.0% Low, 68.6% Moderate, 0.5% High
Septic Density (systems/acre) 0.18

Sherman Jr/Sr High School (4193912)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
6.10
90th Percentile Nitrate-N
7.80
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

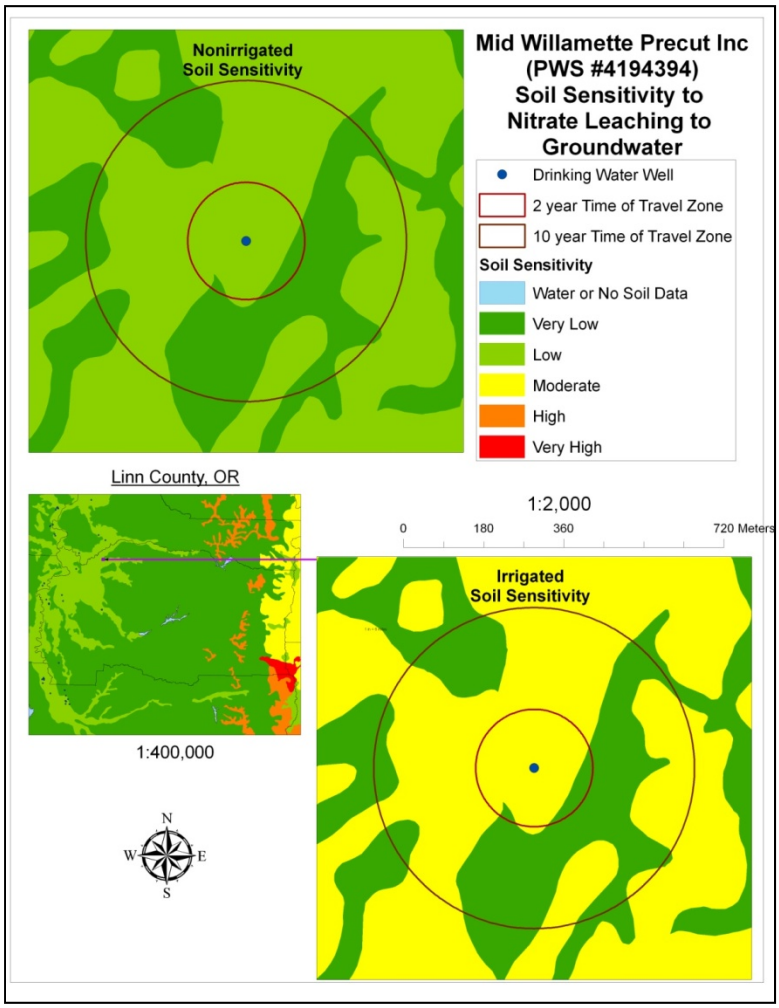
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
63.8% Very Low,
20.3% Low,
15.9% Moderate
Irrigated Sensitivity:
84.1% Moderate,
15.9% Very High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 73.5% Very Low, 12.0% Low, 14.5% Moderate
Irrigated Sensitivity: 83.3% Moderate, 2.1% High, 14.6% Very High
Septic Density (systems/acre) 0.0040

Mid Willamette Precut Inc (4194394)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
3.90
90th Percentile Nitrate-N
4.88
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

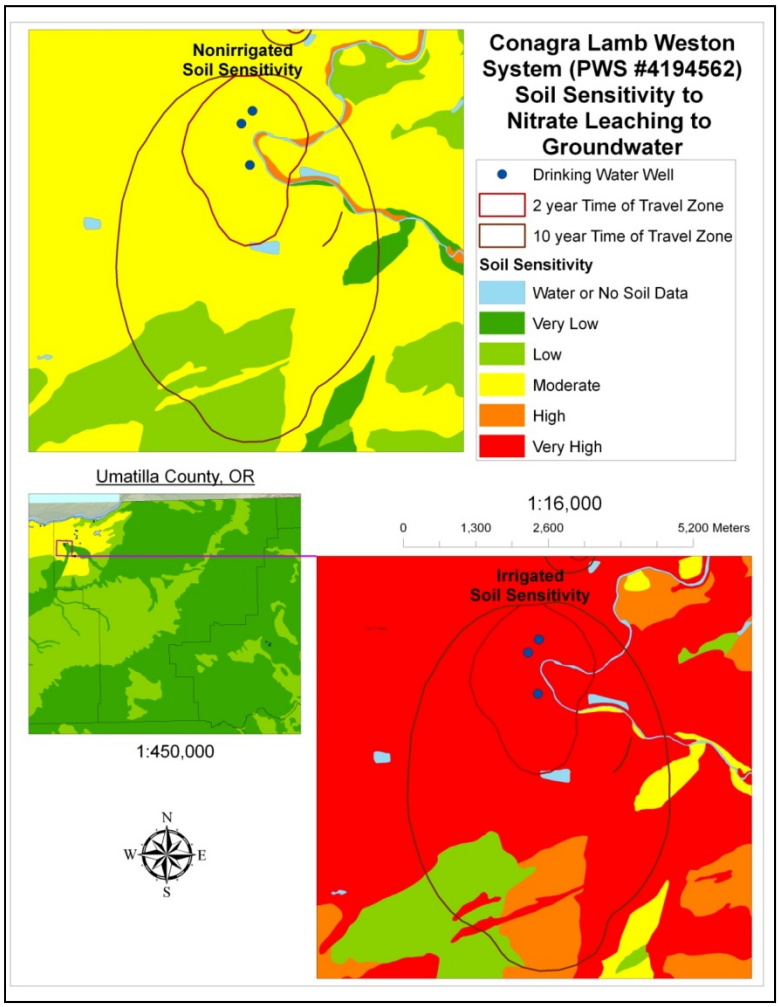
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
10.8% Very Low,
89.2% Low
Irrigated Sensitivity:
10.8% Very Low,
89.2% Moderate
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 37.5% Very Low, 62.5% Low
Irrigated Sensitivity: 37.5% Very Low, 62.5% Moderate
Septic Density (systems/acre) 0

Conagra-Lamb Weston (4194562)



System currently active, no nitrate removal treatment.

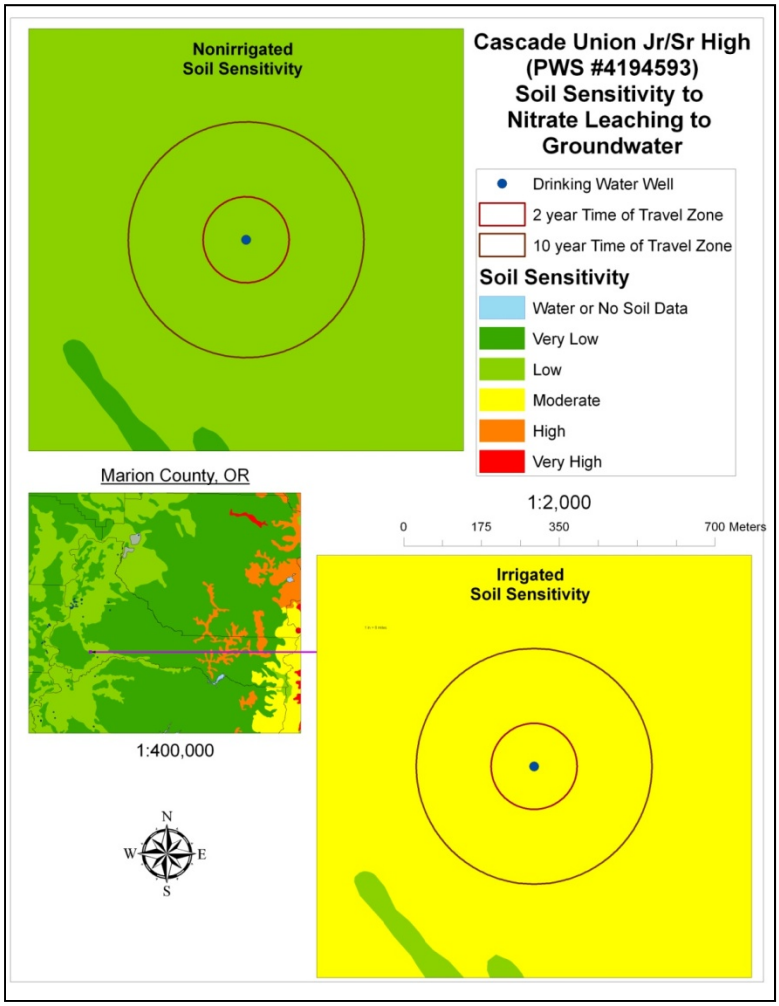
Wells 1, 2 & 3

Median Nitrate-N
5.85
90th Percentile Nitrate-N
7.28
Aquifer Confinement
Semi-confined
Well Construction
1&2: Inadequate
3: Adequate
Aquifer Vulnerable?
1&2: Yes
3: Semi
Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone: [1.5% Surface Water/No Soil Data]
Nonirrigated Sensitivity:
95.6% Moderate, 2.9% High
Irrigated Sensitivity:
98.5% Very High
Septic Density (systems/acre)
0.030

10-year Time of Travel Zone: [1.4% Surface Water/No Soil Data]
Nonirrigated Sensitivity: 1.7% Very Low, 18.4% Low, 77.3% Moderate, 1.2% High
Irrigated Sensitivity: 8.0% Low, 1.7% Moderate, 10.5% High, 78.5% Very High
Septic Density (systems/acre) 0.015

Cascade Union Jr/Sr High SD#5 (4194593)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
3.60
90th Percentile Nitrate-N
4.88
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

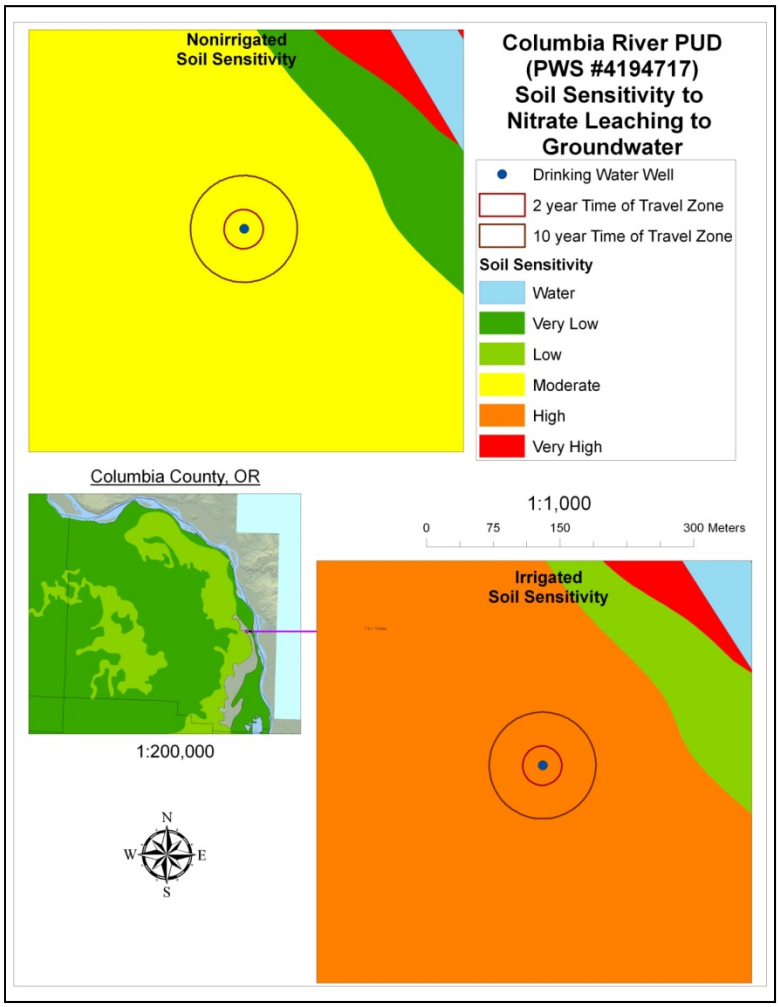
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0.11

Columbia River PUD (4194717)



System currently active, uses reverse osmosis and ion exchange for inorganic chemical and hardness removal (includes nitrate).

Well 1

Median Nitrate-N
14.00 (Pre-Treatment)
90th Percentile Nitrate-N
27.00 (Pre-Treatment)
Aquifer Confinement
Unconfined
Well Construction
Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

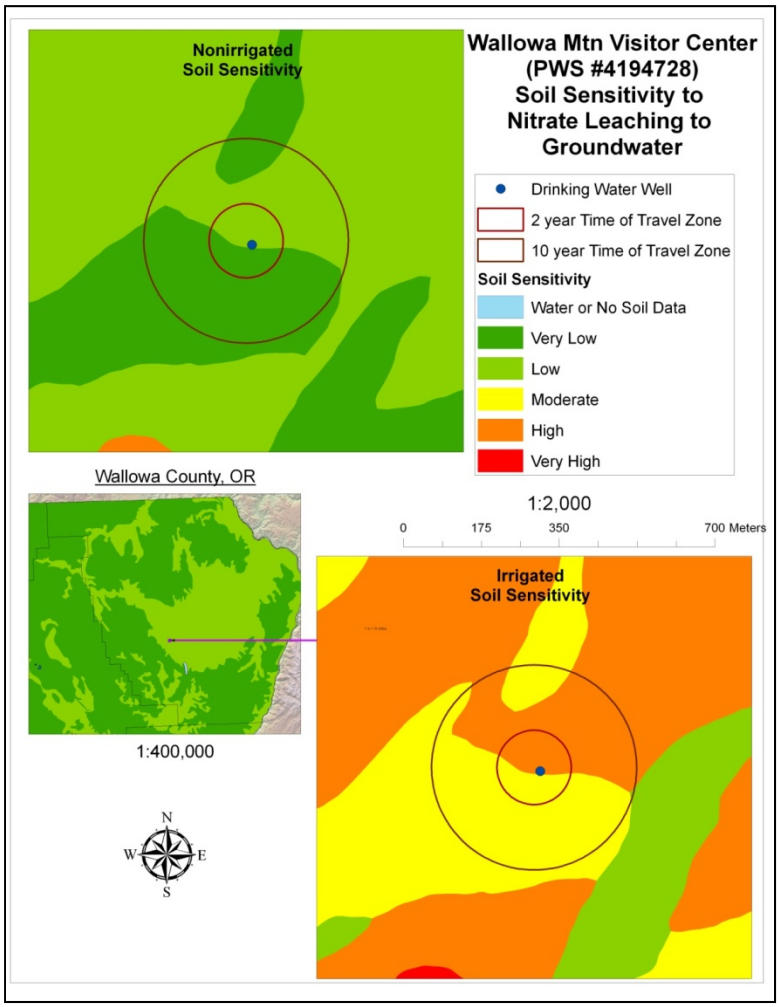
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Moderate
Irrigated Sensitivity: 100% High
Septic Density (systems/acre) 0.36

Wallowa Mtn Visitor Center (4194728)



System currently active, no nitrate removal treatment.

Well 1

Median Nitrate-N
4.60
90th Percentile Nitrate-N
5.50
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture & Septic Systems

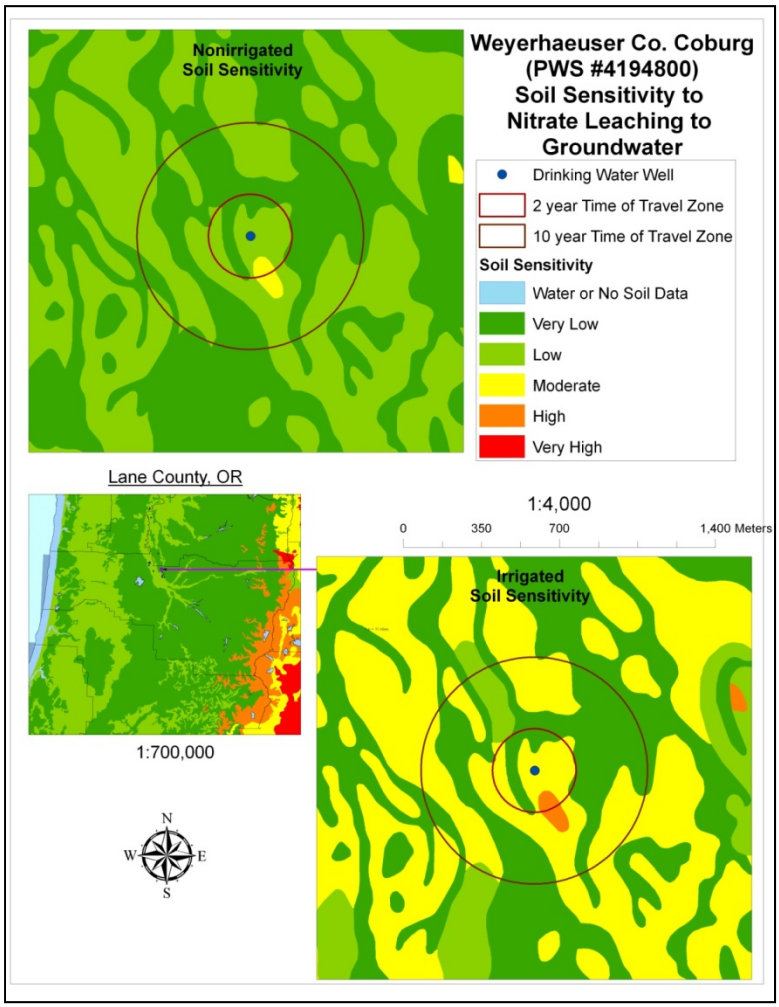
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
44.8% Very Low,
55.2% Low
Irrigated Sensitivity:
44.8% Moderate,
55.2% High
Septic Density (systems/acre)
0.19

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 57.9% Very Low, 42.1% Low
Irrigated Sensitivity: 0.1% Low, 59.9% Moderate, 40.0% High
Septic Density (systems/acre) 0.024

Weyerhaeuser Company Coburg (4194800)



System currently inactive, no nitrate removal treatment.

Well 3

Median Nitrate-N
5.85
90th Percentile Nitrate-N
7.19
Aquifer Confinement
Unconfined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

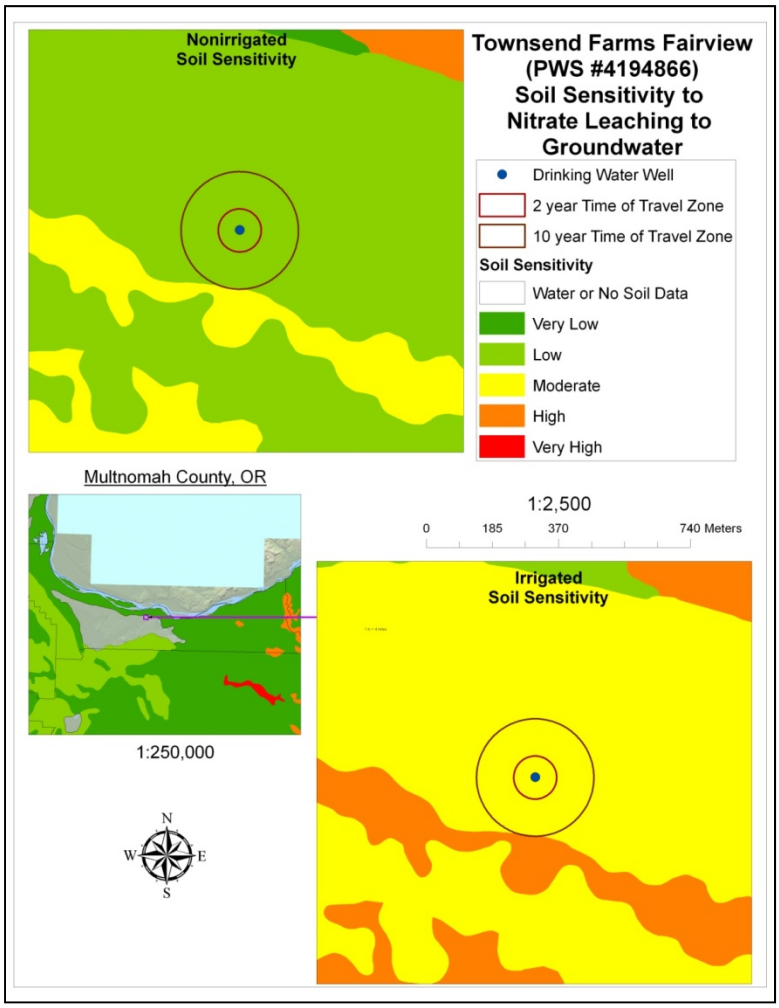
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
30.2% Very Low,
64.0% Low,
5.8% Moderate
Irrigated Sensitivity:
30.2% Very Low,
64.0% Moderate,
5.8% High
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 51.8% Very Low, 46.3% Low, 1.9% Moderate
Irrigated Sensitivity: 47.2% Very Low, 4.6% Low, 46.3% Moderate, 1.9% High
Septic Density (systems/acre) 0.010

Townsend Farms Fairview (4194866)



System currently active, no nitrate removal treatment.

Wells (Src-AA, Src-AB & Src-AC)

Median Nitrate-N
7.00
90th Percentile Nitrate-N
8.00
Aquifer Confinement
Unconfined
Well Construction
AA&AB: Inadequate
AC: Adequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

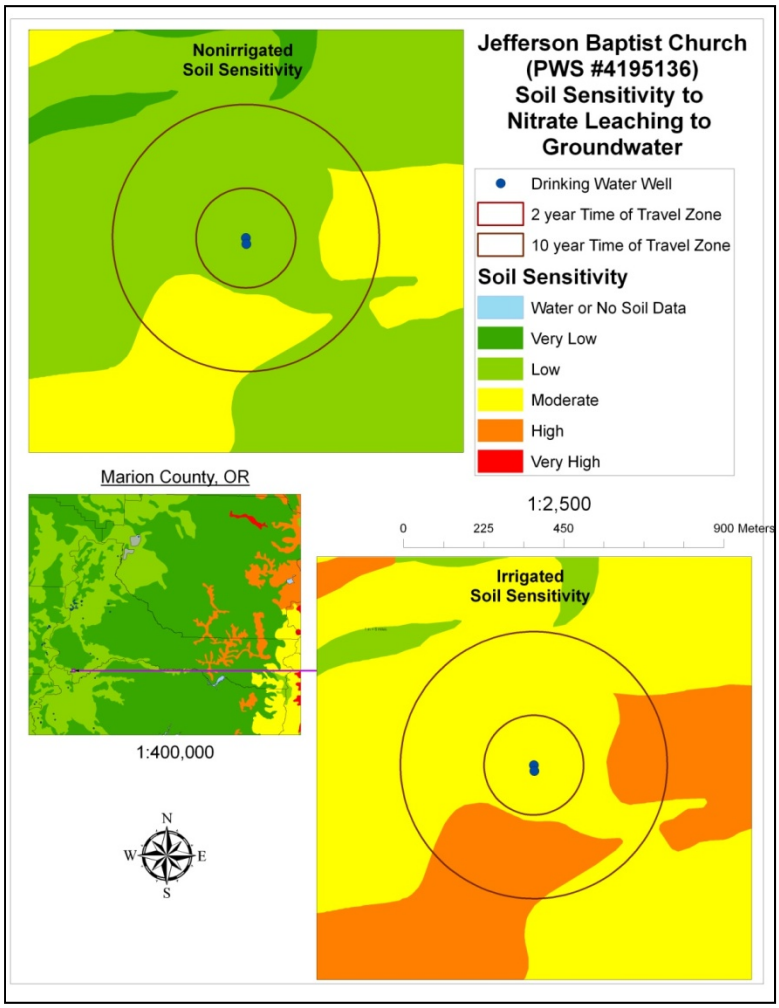
2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Low
Irrigated Sensitivity:
100% Moderate
Septic Density (systems/acre)
0

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 99.8% Low, 0.2% Moderate
Irrigated Sensitivity: 99.8% Moderate, 0.2% High
Septic Density (systems/acre) 0

Jefferson Baptist Church (4195136)



System currently active, no nitrate removal treatment.

Composite Median/90th Percentile Nitrate-N (mg/L):
3.50/5.70

Wells A & B

Median Nitrate-N
A: 4.45
B: 0

90th Percentile Nitrate-N
A: 5.94
B: 0

Aquifer Confinement
A: Unknown
B: Confined

Well Construction
A: Adequate
B: Adequate

Aquifer Vulnerable?
A: Unknown
B: No

Probable Nitrate Source(s)
Agriculture & Septic Systems

2-year Time of Travel Zone:

Nonirrigated Sensitivity: 100% Low
Irrigated Sensitivity: 100% Moderate
Septic Density (systems/acre) 0.20

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 70.6% Low, 29.4% Moderate
Irrigated Sensitivity: 70.6% Moderate, 29.4% High
Septic Density (systems/acre) 0.37

River Point Farms, LLC (4195213)

System currently active, uses reverse osmosis for inorganic chemical removal (includes nitrate).

Well 1

Median Nitrate-N
6.11

90th Percentile Nitrate-N
23.90

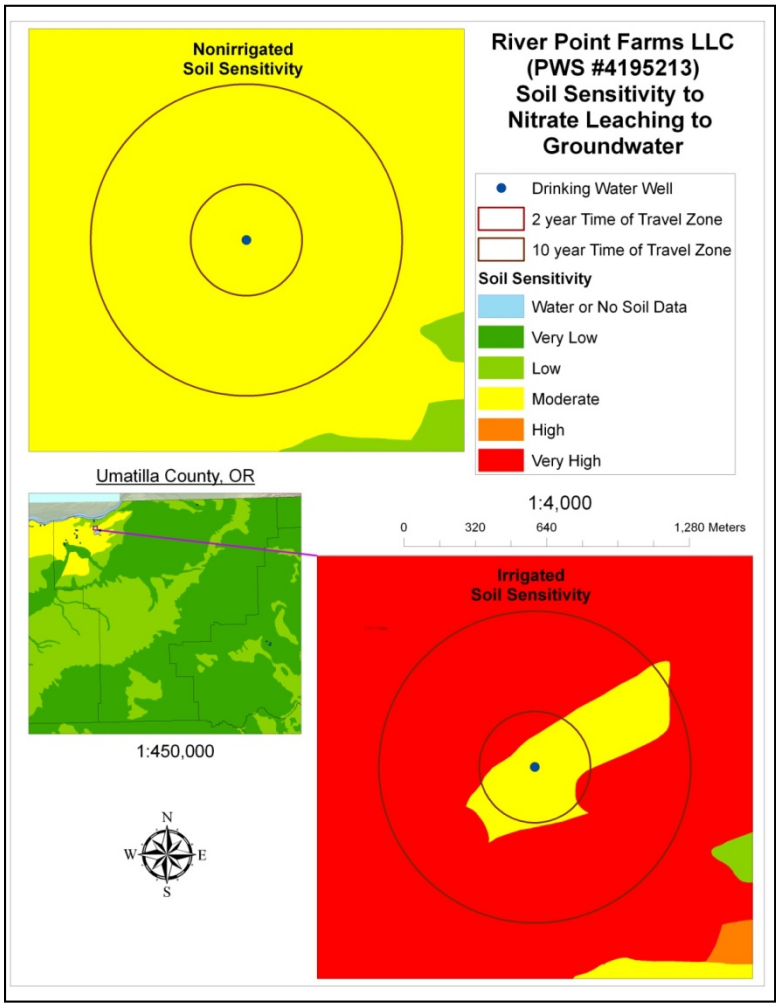
Aquifer Confinement
Unknown

Well Construction
Inadequate

Aquifer Vulnerable?
Yes

Probable Nitrate Source(s)

Agriculture



2-year Time of Travel Zone

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
73.9% Moderate
26.1% Very High
Septic Density (systems/acre)
0.041

10-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
19.6% Moderate, 80.4% Very High
Septic Density (systems/acre) 0.032

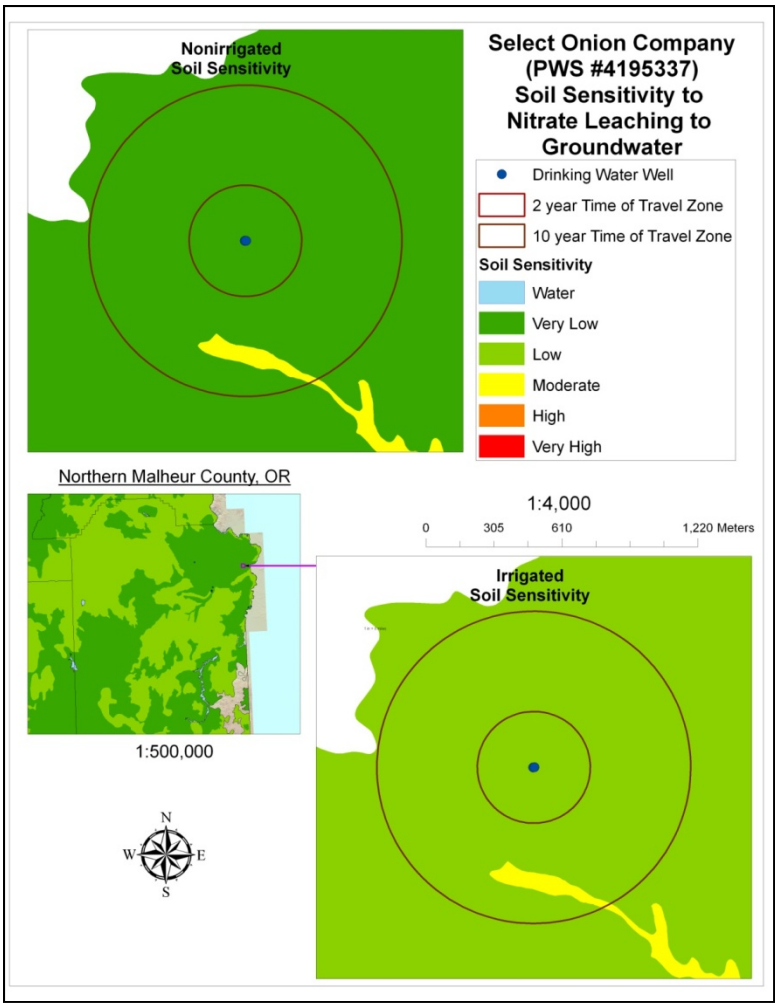
Select Onion Company (4195337)

System currently active, no nitrate removal treatment (there is arsenic removal).

Wells A & B

Median Nitrate-N
6.63
90th Percentile Nitrate-N
8.18
Aquifer Confinement
A: Semi-confined

B: Confined
Well Construction
A: Adequate
B: Adequate
Aquifer Vulnerable?
A: Semi
B: No
Probable Nitrate Source(s)
Agriculture



2-year Time of Travel Zone:

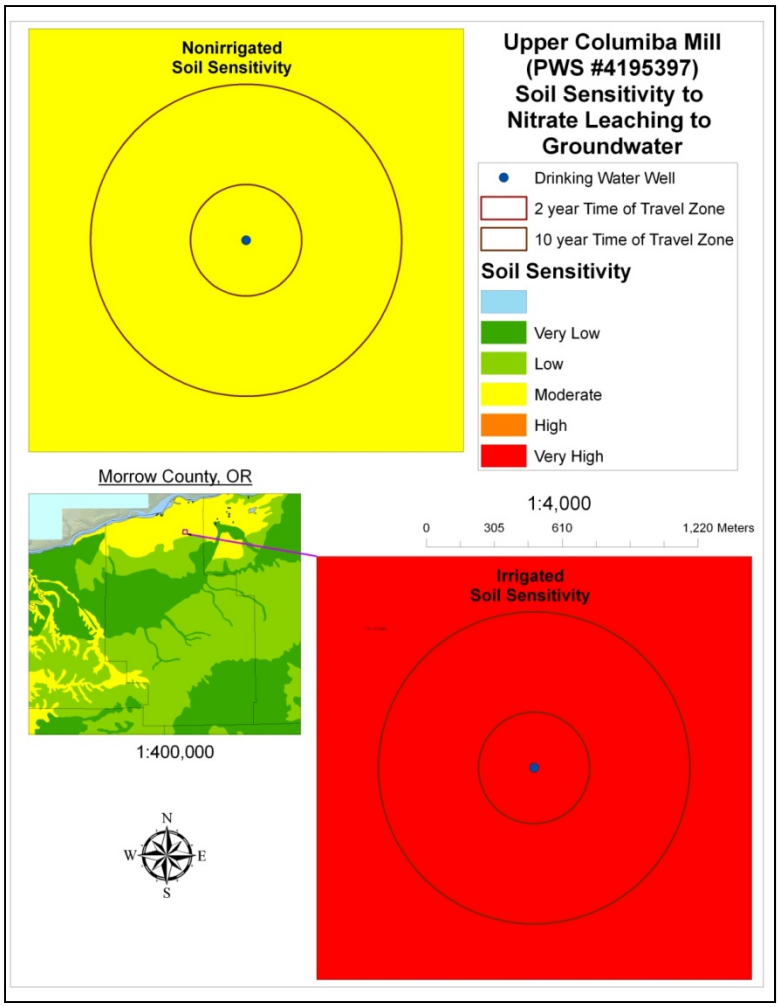
Nonirrigated Sensitivity:
100% Very Low
Irrigated Sensitivity:
100% Low
Septic Density (systems/acre)
0.021

10-year Time of Travel Zone:

Nonirrigated Sensitivity: 97.8% Very Low, 2.2% Moderate
Irrigated Sensitivity: 97.8% Low, 2.2% Moderate
Septic Density (systems/acre) 0.068

Upper Columbia Mill (4195397)

System currently active, uses reverse osmosis for inorganic chemical removal (includes nitrate).



Well

Median Nitrate-N
11.00
90th Percentile Nitrate-N
12.92
Aquifer Confinement
Confined
Well Construction
Inadequate
Aquifer Vulnerable?
Yes
Probable Nitrate Source(s)
Agriculture

2-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0.021

10-year Time of Travel Zone:

Nonirrigated Sensitivity:
100% Moderate
Irrigated Sensitivity:
100% Very High
Septic Density (systems/acre)
0.0026