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DEQ Department of Environmental Quality

Statewide Groundwater Quality Monitoring Program:

Klamath Basin 2019-2022

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Groundwater Protection Program, Water Quality Division and
Laboratory and Environmental Assessment Division
700 NE Multnomah St., Portland OR, 97232

Contact: gwprotectionprogram@deq.oregon.gov

Phone: 541-388-6146

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Document Title: Statewide Groundwater Quality Monitoring Program: Klamath Basin 2019-2022

Document Authors: Amy Sager Patton

Document Date: August 14, 2026

Name of Oregon RPG: Amy Sager Patton (G2448)

REGISTERED
OREGON
AMY SAGER PATTON
G2448
GEOLOGIST

Signature of Oregon RPG: Amy Sager Patton

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Acknowledgements

This report represents the work of a team of people at the Department of Environmental Quality. Paige Haxton-Evans at the DEQ Laboratory created the Sampling and Analysis plan for this project under the Statewide Groundwater Quality Monitoring Quality Assurance Project Plan. Amy Patton and Paige Haxton-Evans wrote the report with contributions from Kat Maloney, Phil Richerson, Shersten Finley, and Grayson Fish, OWRD. The writing of this report was a joint effort between the DEQ Laboratory and the Groundwater Protection Program. The report review was provided by representatives of DEQ Laboratory, Water Quality and Regional management and technical staff, and the Oregon Health Authority, Oregon Department of Agriculture and Oregon Water Resources Department.

Laboratory Water Quality Monitoring Specialist, Matthew Schult, collecting a groundwater sample from a private well.

Executive summary

Oregon's overarching goal for groundwater quality is to prevent contamination of Oregon's groundwater resource while striving to conserve and restore this resource and to maintain the high quality of Oregon's groundwater resource for present and future uses (ORS 468B.155). Oregon DEQ's statewide groundwater quality monitoring program contributes to this goal by assessing the quality of groundwater across the state and identifying areas with widespread nonpoint source contamination. The goals of the statewide groundwater monitoring program are to evaluate existing groundwater conditions, identify emerging groundwater quality problems and inform groundwater users of potential risks from contamination.

The Klamath Basin study area was selected based on considerations of known water quality issues, the presence of shallow aquifers and agricultural activity in the area. In October/November 2019 and February/March of 2022, DEQ collected and analyzed water samples from 86 wells. Most of the sampled wells were single-family domestic wells, one was an irrigation well and 18 were public water supply wells. 59 wells were sampled in October/November 2019. 28 of those wells were resampled in February/March of 2022 along with 27 other wells for a total of 55 wells in 2022. Results from the study are summarized below and in Table 1 of the report.

- Nitrate was detected above 3 mg/L in seven wells (8%) with a high of 18.4. Only three wells (3%) had concentrations exceeding the EPA drinking water standard of 10 mg/L.
- Arsenic was detected in 51 of the wells tested (59%) including six wells (7%) exceeding the MCL of 10 µg/L, with a high of 54.2.
- In the 48 wells where lead was detected, concentrations were below the MCL of 15 µg/L.
- Total coliform bacteria were detected in nine wells (10.5%). E. coli was not detected.
- Aluminum exceeded the 70 µg/L USGS Health Based Screening Level in four wells (5%).
- Manganese was detected above 50 µg/L in 34 wells (40%) of wells and was detected at concentrations over the USGS Health Based Screening Level of 300 µg/L in two wells (2%).
- 11 pesticides were detected in six wells in the study area.
- Two Volatile Organic Compounds (VOCs), chloroform and Methyl-tert-butyl-ether (MTBE), were detected in three separate wells. One Semi-VOC (SVOC), Tris(1,3-dichloro-2-propyl) phosphate (TDCP), was detected in two separate wells.
- Only one of the 11 consumer product constituents analyzed, sulfamethoxazole, was detected during this study.

When results were available, well users who participated in the study received laboratory reports, educational resources about common groundwater contaminants and maintenance tips for wells and septic tanks. For questions related to health concerns, participants were referred to the Oregon Health Authority's Domestic Well Safety program toxicologists as well as county environmental and public health representatives to learn about water treatment options and well stewardship. In addition, DEQ laboratory staff shared results with interested parties.

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1. Background

Groundwater is a vital resource in Oregon. Over 600,000 Oregonians rely on private wells for their drinking water (Maupin et al., 2014). Public water systems, the agricultural community and industry all rely on groundwater to meet their operational needs. Oregon's rivers and streams depend on groundwater for the maintenance of summer flows and cooling temperatures for fish populations and recreation. Groundwater is a critical water reserve that can be used when surface water resources are inadequate to meet demands. It is important that Oregon's groundwater remain protected from contamination.

Oregon's overarching goal for groundwater quality is "to prevent contamination of Oregon's groundwater resource while striving to conserve and restore this resource and to maintain the high quality of Oregon's groundwater resource for present and future uses" (ORS 468B.155). Oregon DEQ's statewide groundwater quality monitoring program is in place to identify and characterize groundwater quality, identify areas that are vulnerable to contamination, identify long term trends in quality, determine ambient groundwater quality and evaluate any emerging concerns. Recent groundwater quality studies include the Mid-Rogue Basin (2011 and 2015), North Coast (2015-2016), the Walla Walla Basin (2016), the Mid-Willamette Basin (2017), Harney County (2018), and Southern Deschutes County (2023-2024), in addition to this study. DEQ conducts ongoing, long-term groundwater monitoring in the three Groundwater Management Areas (Lower Umatilla Basin, Northern Malheur County, and Southern Willamette Valley).

1.1 Statewide groundwater quality monitoring

The Oregon Department of Environmental Quality has conducted groundwater quality monitoring in various parts of the state since the agency's inception. In groundwater quality studies since 2015, DEQ has sampled and analyzed groundwater collected in two seasons from 60 to 100 wells in each groundwater area of interest.

Informed by previous investigations and guided by the objectives of the statewide groundwater quality monitoring program, the objectives of the 2019 Klamath Basin groundwater study were:

1. To collect high-quality data on nitrate, arsenic, coliform bacteria, pesticides, pharmaceutical and personal care products, and volatile organic compounds in groundwater throughout the study area
2. To identify areas of groundwater contamination related to these parameters
3. To inform well water users of the results of this study and provide information regarding potential risks to human health
4. To identify areas needing additional investigation and help focus efforts to prevent further contamination, and

5. To help establish long-term trending data and describe changes over time.

The following work products are outside the scope of this study and report:

- Hydrogeologic characterization of the study area and contamination
- Investigation of the sources of contamination
- Health risk assessments

Groundwater reports that DEQ's Laboratory and Environmental Assessment Division published from 2015 through 2021 summarized and provided context for the analytical data but had limited hydrogeological data interpretation. For this report, DEQ's groundwater protection program staff co-authored the report and provided additional data interpretation.

1.2 Study area description

The Klamath Basin study area boundary was selected based on historical data in the area, the presence of shallow and vulnerable aquifers (Sweet et al., 1980) and the presence of nitrate and arsenic detections in Oregon Real Estate Transaction data. The entirety of the Klamath Basin above the Oregon-California border was selected to capture a wide geographic area with a diversity of residential, urban and rural wells and opportunities to sample shallow and deep wells in areas with varying adjacent land uses. Figure 1 shows locations of sampled wells within the study area boundary.

DEQ's groundwater quality study in the Klamath Basin was initiated in November of 2019. Follow-up groundwater monitoring for this study was conducted in February and March of 2022. Eighty-six wells in total were included in this study, 59 in 2019, and 55 in 2022, with 28 of the same wells sampled in both years. Most of the sampled wells were domestic wells serving one household each, one was an irrigation well, and 18 wells sampled were public water supply wells serving parks, cities, or businesses.

Delays to this study in 2020-2021 were due to the COVID-19 pandemic, local political unrest in 2021, as well as the lightning-caused Bootleg Fire which burned 413,765 acres and destroyed 408 buildings in the northeastern part of the study area. A 10,000-acre fire in 2020 (the 242 Fire) also impacted some parts of the study area near Chiloquin.

1.2.1 Study area boundary

The Klamath Basin is one of 18 major river basins in Oregon, located in south central Oregon, straddling California-Oregon border. This study only covers groundwater quality in the Oregon portion of the basin. The study area extends 85 miles from its southern edge on the California border north to the town of Chemult. The basin occupies a broad, faulted volcanic plateau that extends from the Cascade Range in the west to the Gearhart and Yamsay mountains in the east. Altitudes range from the basin floor at 4,000 feet to the peaks of Mt. McLoughlin and Mt. Thielsen at over 9,000 feet (Gannett, 2010). Upper Klamath Lake and Klamath Marsh dominate the center of the study area. Forest lands are present in the uplands. Principal streams are the

Williamson, Sprague, Lost, Wood and Klamath rivers. Many small streams discharge into marshes or lose their flow in pumice or porous lava (Leonard, 1974).

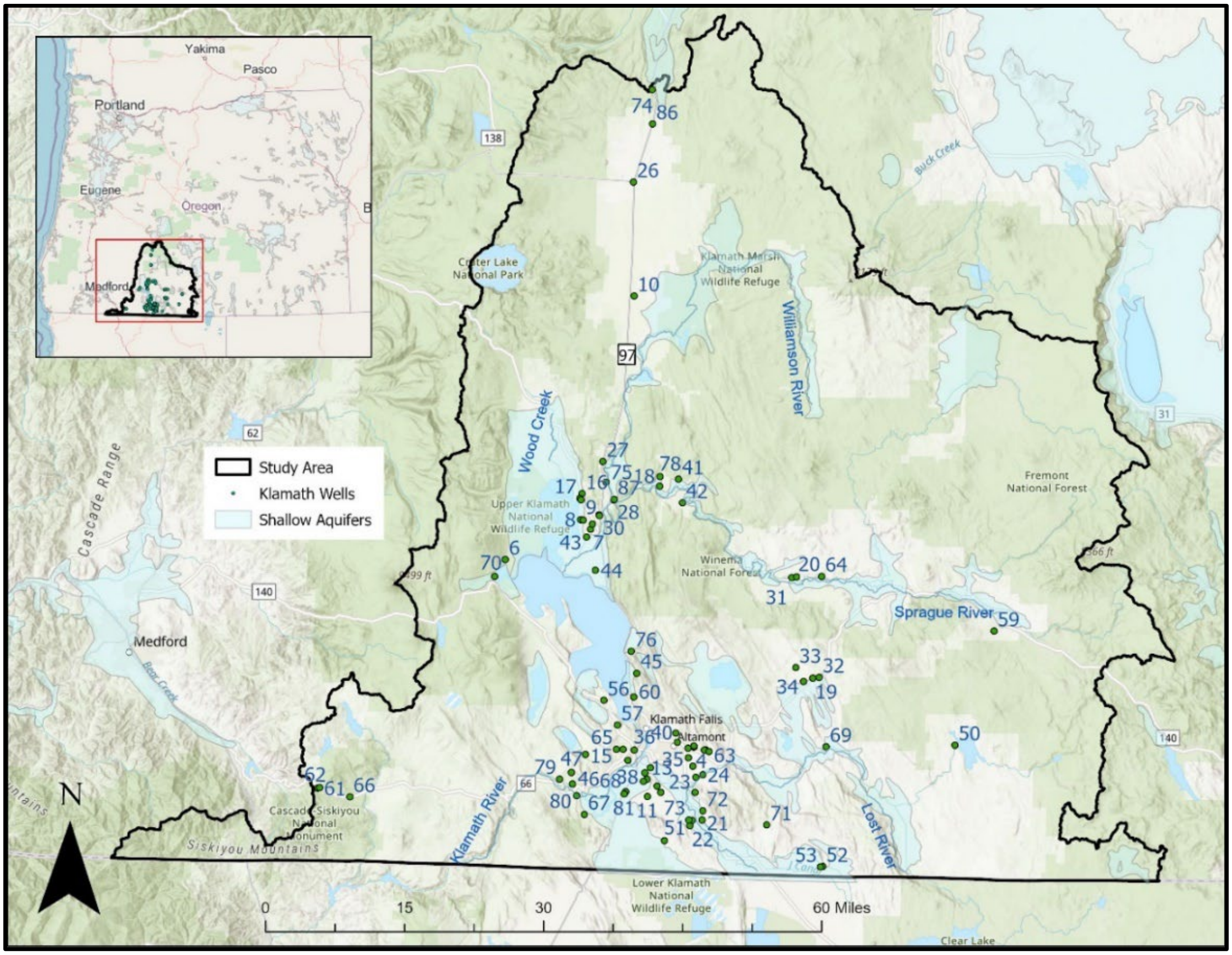

Figure 1. Distribution of study well locations (details in Figures 2 and 3).

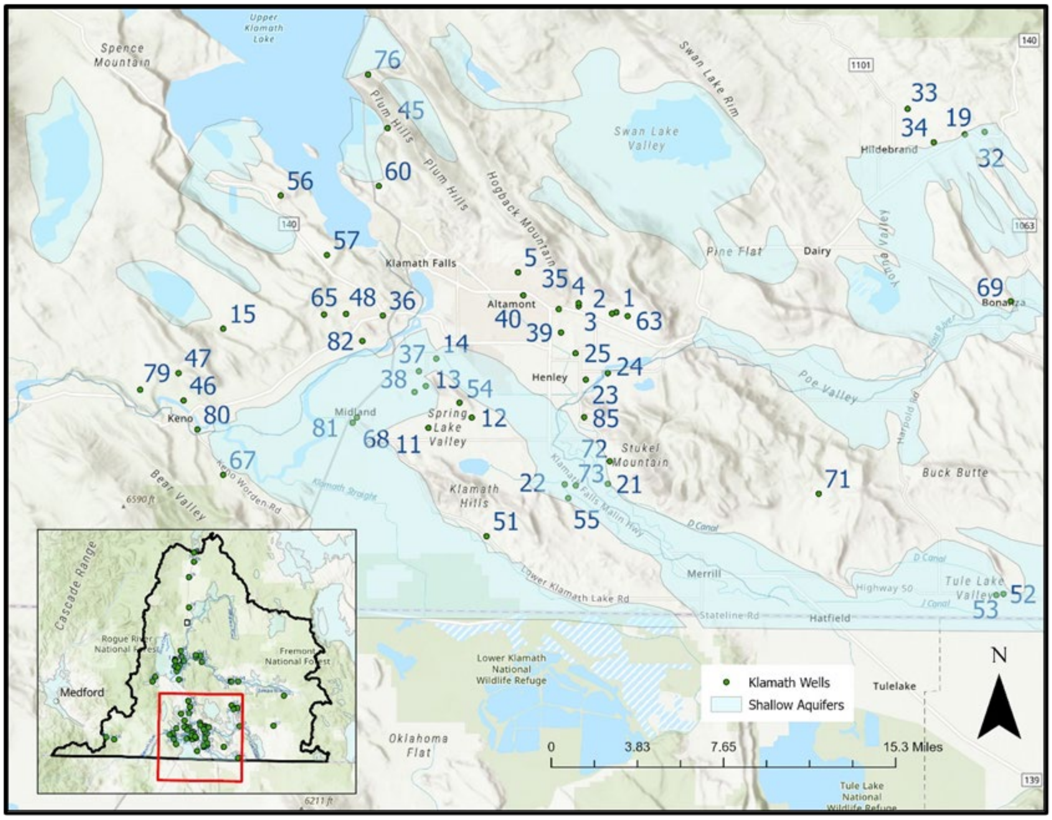

Figure 2. Study well locations (detail of southern study area near Klamath Falls).

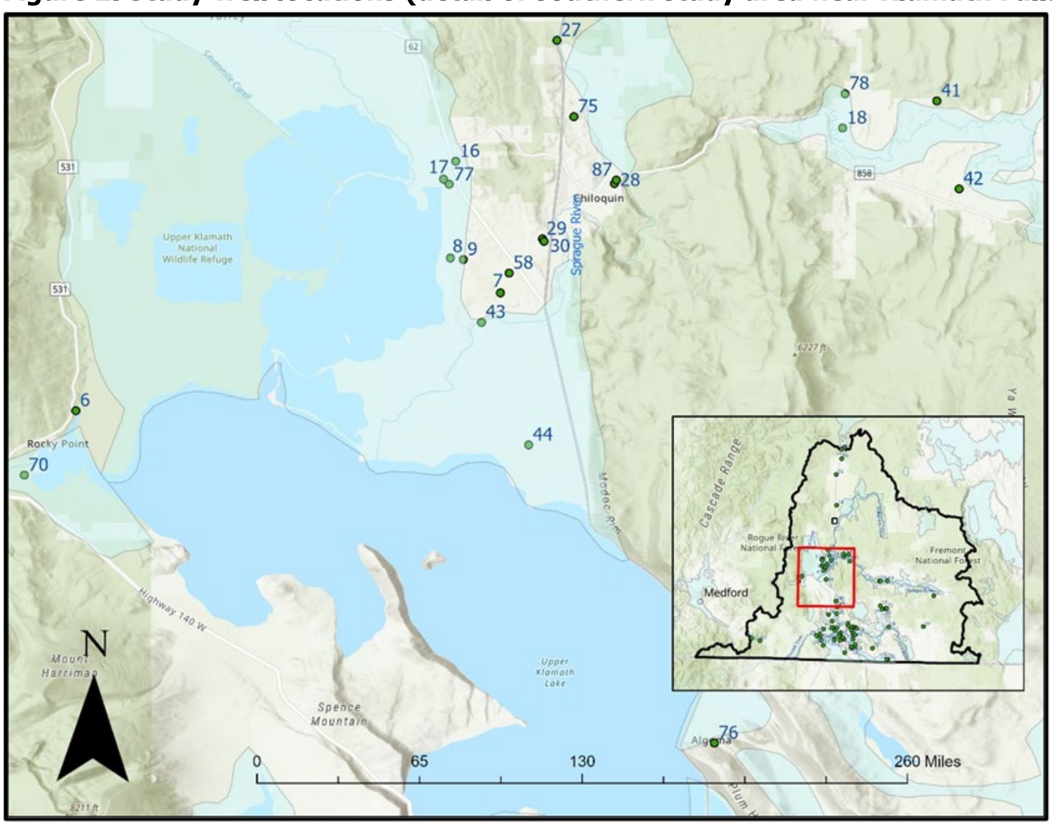

Figure 3. Study well locations (detail of Upper Klamath Refuge study area).

1.2.2 Geology

The study area is located in the transition zone between the Cascade volcanic arc and the Basin and Range province. The study area is underlain largely by late Tertiary and Quaternary volcanic rocks, including basaltic and andesitic lava flows, volcanic ash deposits, and pyroclastic materials. As a result of extensional forces beginning in the Miocene and extending into the Pliocene, crustal stretching and tectonic plate movement triggered north to northwest-trending faulting, extensive volcanism, and the development of the basin and fault block mountain topography characteristic of the Basin and Range province (Orr et al, 1992). A more detailed description of the geologic units in the study area follows.

A small amount of Mesozoic-aged rocks are found in an area of less than 50 square miles in the extreme southwest portion of the study area. The area comprises less than one percent of the study area and includes the Applegate Group, the Nevadan Intrusives, and the Mitchell Group (DOGAMI, 2020). The Applegate Amphibolite (part of the Applegate Group) is the oldest rock found in the study area (DOGAMI, 2020). It is late Triassic/early Jurassic in age and is part of a complex assemblage of accreted rocks of oceanic origin called an ophiolite (Orr, 1992). Other Mesozoic-aged rocks exposed at land surface include the Late Jurassic-aged Grayback Plutons (part of the Nevadan Intrusives terrane) and the Early Cretaceous-aged Hornbrook Formation of the Mitchell Group that includes deep marine sandstones, shales, and conglomerates (DOGAMI, 2020).

Approximately 85% of the study area is covered by Cenozoic-aged volcanics. Volcanic units span the Cenozoic Era with the largest exposures from Pliocene/Pleistocene/Quaternary Winema Volcanic Field and both Early and Late High Cascade Volcanics. Volcanic activity over the last 35 million years has created a complex assemblage of basaltic to andesitic volcanic vents, lava flows, pyroclastic deposits, and volcanically derived sedimentary deposits.

Quaternary-aged surficial deposits make up the remaining 14% of the study area (DOGAMI, 2020). The fault-bounded valleys are filled with younger sedimentary deposits derived from ancient lakes and streams. These basin-fill sediments consist largely of fine-grained lacustrine deposits, silts, clays, and volcanic-derived sediments. In many areas, these sediments act as confining or semi-confining units that restrict vertical groundwater movement (Gannett, 2010).

1.2.3 Hydrogeology

Gannett (2010) divides the basin into eight hydrogeologic units based on lithology and hydraulic properties. These include Quaternary volcanic rocks, Quaternary basin-fill sediments, Tertiary volcanic rocks, Tertiary sedimentary rocks, and older volcanic and sedimentary rocks that form relatively impermeable boundaries to the regional groundwater system.

The Upper Klamath basin contains a substantial regional groundwater flow system where the volcanic aquifers are highly transmissive, with estimated transmissivities ranging from approximately 1,000 to more than 100,000 ft^2/day. The most productive aquifers occur in fractured volcanic rocks, whereas the fine-grained Tertiary sedimentary deposits generally have low permeability and poor aquifer characteristics. The volcanic rock aquifers are interconnected over large distances and support extensive regional groundwater flow. The sedimentary units can separate shallow and deep flow systems and create artesian conditions in some areas.

Recharge occurs primarily from snowmelt and precipitation in the Cascade Range, high-elevation uplands surrounding the basin, and infiltration from streams and irrigated lands. The basin receives roughly 10 million acre-feet of precipitation annually, of which approximately 2 million acre-feet enters the groundwater system.

Groundwater generally moves from recharge areas in the Cascades and uplands toward lower-elevation valleys, lakes, wetlands, and stream corridors. Regional flow directions are controlled by topography, distribution of recharge, structural basin geometry, faulting, and stream network configuration. Faulting created sediment-filled valleys that compartmentalize portions of the groundwater system. The major groundwater flow paths converge toward the Williamson River, Sprague River, Wood River, Lost River, and Upper Klamath Lake systems (Gannett, 2010).

Much of the basin's baseflow and lake inflow originates as groundwater discharge. Approximately 1.8 million acre-feet per year of groundwater discharges to streams. Much of the streamflow in the basin, especially during summer and drought periods, is sustained by groundwater.

Major discharge areas include the Cascade Range margin, the Wood River Valley spring complexes, Spring Creek and the lower Williamson River area near Chiloquin, Upper Williamson River springs near Yamsay Mountain, Bonanza Springs in the Lost River basin, and Klamath River Canyon below John C. Boyle Dam.

A large fraction of inflow to Upper Klamath Lake originates as groundwater discharge to springs and streams near the lake. Groundwater-fed systems such as the Wood River and Spring Creek provide stable flows that buffer the lake from short-term climatic fluctuations and drought. Much of the water entering the lake has traveled through the regional volcanic aquifer system before discharging to streams and springs.

In 2001, limits on surface water use for irrigation began, which resulted in increased groundwater use for irrigation from an estimated 28,600 acre-feet per year to approximately 128,740 acre-feet per year in Klamath Project area (Gannett, 2015). OWRD tracks water levels in select wells in the area which show water level decreases of 5 to over 30 feet from 2019 to 2022 in the Klamath Basin (see section 1.2.5). Another indication of declining groundwater levels in the study area is illustrated by a heat map produced by OWRD showing a large number of reports of dry or nearly dry wells in the Klamath Falls area since 2021 (OWRD, 2026).

1.2.4 Land use

Although much of the uplands in the basin are forested, land use in the valleys and flat lands of the Klamath Basin is predominantly agricultural, including sheep and cattle ranches, dairies, and irrigated acreage. Irrigation is from surface and groundwater; surface water is distributed through irrigation canals overseen by irrigation districts and the U.S. Bureau of Reclamation Klamath Project (Grondin, 2004).

The population of the Klamath County was estimated by the American Community Survey at just over 70,000 in 2023. (CensusReporter.org).

Groundwater use includes municipal, community, domestic, commercial-industrial, agricultural, livestock, and fish and wildlife. Sources of anthropogenic contamination may include manure, fertilizers and pesticides on domestic or agricultural lands. Land application of wastewater for fertilization may be another source of contamination including nitrate and consumer use sewage related products. Septic tanks are a possible source of contamination in urban to rural transition areas that are not connected to a sewer. In addition, groundwater contamination can result from spills and leaks at businesses that handle chemicals and petroleum products.

1.2.5 Climate

The Klamath Basin area is semi-arid due to interception of precipitation by the Cascade Mountains, reducing rainfall in the lower elevations of the basin to about 14 to 18 inches per year in Klamath Falls (although precipitation in the mountains, particularly at Crater Lake, is considerably higher at over 60 inches per year). Most precipitation falls as snow at higher elevations. October through March accounts for 70% of precipitation in the Klamath Falls area. The interior of the basin is mostly dry during spring and summer. Winters are generally cold. The growing season is short, particularly at high elevations. Annual temperatures in Klamath Falls generally range from 20˚F to the mid-80˚s (Gannett, 2010 and Leonard, 1974).

In the time period of this study, between October 2019 and March 2022, the basin went from a precipitation year of 15.5 inches in 2019 at the Klamath Falls Agrimet Station through two drought years of 10.7 and 8.4 inches, in 2020 and 2021 respectively. Drought declarations in 2020 and 2021 allowed irrigators to pump groundwater instead of surface water due to surface water flow deficits. Groundwater elevations during this period declined by 8 feet in a Klamath Falls municipal well and by over 30 feet in some wells measured by OWRD and the USGS (KLAM 53043, KLAM 52194) (Schibel, 2023).

1.3 Previous groundwater quality efforts

The following sections summarize groundwater quality studies and actions in the area over several decades to provide context for the findings of the 2019-2022 study.

1.3.1 DEQ, USGS, and WRD groundwater quality studies

In the Klamath Marsh area, the water is largely sodium bicarbonate type and in the four southern valleys, the water is predominantly calcium bicarbonate or calcium magnesium bicarbonate type (Gannett, 2010). USGS studies across the country (including Hobza and Flynn (2021) have shown that young shallow groundwater in recharge areas is commonly dominated by calcium and bicarbonate ions. As groundwater moves deeper and resides longer in the aquifer, ion exchange and water-rock interaction commonly removes calcium from solution and adds sodium, resulting in older sodium-bicarbonate groundwater.

Two wells in a USGS study from the 1970s had elevated iron concentrations (0.5 mg/L) and one had elevated nitrate of 17 mg/L, possibly from a nearby corral. Boron was found to be at acceptable levels, below 0.05 mg/L (Leonard, 1974).

DEQ collected samples from 51 wells in the Klamath Falls-Merrill area in February 1987, as part of an Assessment of Oregon's Groundwater for Agricultural Chemicals and conducted follow-up testing on a subset of the same wells in March 1987 and in November 1989. Nitrate was detected above the EPA drinking water standard (otherwise known as maximum contamination level or MCL) of 10 mg/L in 4-5 wells each time (9% of wells tested) and arsenic in 2-3 wells (6%) above 10 ug/L. Intermediate levels of nitrate (between 2 mg/L and 10 mg/L) were also detected in 2-4 wells each time (8%). A short list of volatile organic compounds and pesticides were analyzed for the March 1987 and 1989 samples; none were detected (Cole, 2006).

USGS and the Oregon Water Resources Department conducted additional studies in the Klamath Basin starting in 1999 to better understand groundwater resources and regional flow (Gannett, 2010). A study published in 2021 attributed the groundwater contribution to silica, dissolved phosphate-phosphorus and total phosphorus inflow to Upper Klamath Lake to be as high as 33%, 67% and 61%, respectively, considering groundwater enrichment by lakebed nutrients as it flowed upward into the lake, particularly in spring (Essaid, 2021).

1.3.2 Real estate transaction domestic well testing

Since 1989, Oregon statute (ORS 448.271) requires that groundwater wells that are used for domestic purposes be sampled for nitrate and bacteria when a house is sold or transferred. Background concentrations of nitrate in groundwater have been conservatively estimated by the United States Geological Survey as 1.1 mg/L (Nolan, 2003). Other reports (Mueller, 1996 and Madison, 1985) have estimated background levels of 2 or 3 mg/L. RET requirements for arsenic testing were added in 2009. Additional requirements for lead testing, and notification to tenants of well water quality within Groundwater Quality Management Areas, were added in 2025 (ORS 90.321), effective 1/1/2027. The Oregon Health Authority houses this data.

Figure 4 illustrates Real Estate Transaction data from the OHA DWTA-RET database 1989-2020 in the Klamath Basin. The map shows only a few wells with nitrate above the MCL of 10 mg/L, and several wells with nitrate above estimated background concentrations of 2 mg/L. Figure 5 illustrates elevated levels of arsenic primarily in the Klamath Falls–Altamont area from the OHA DWTA-RET database for arsenic in groundwater.

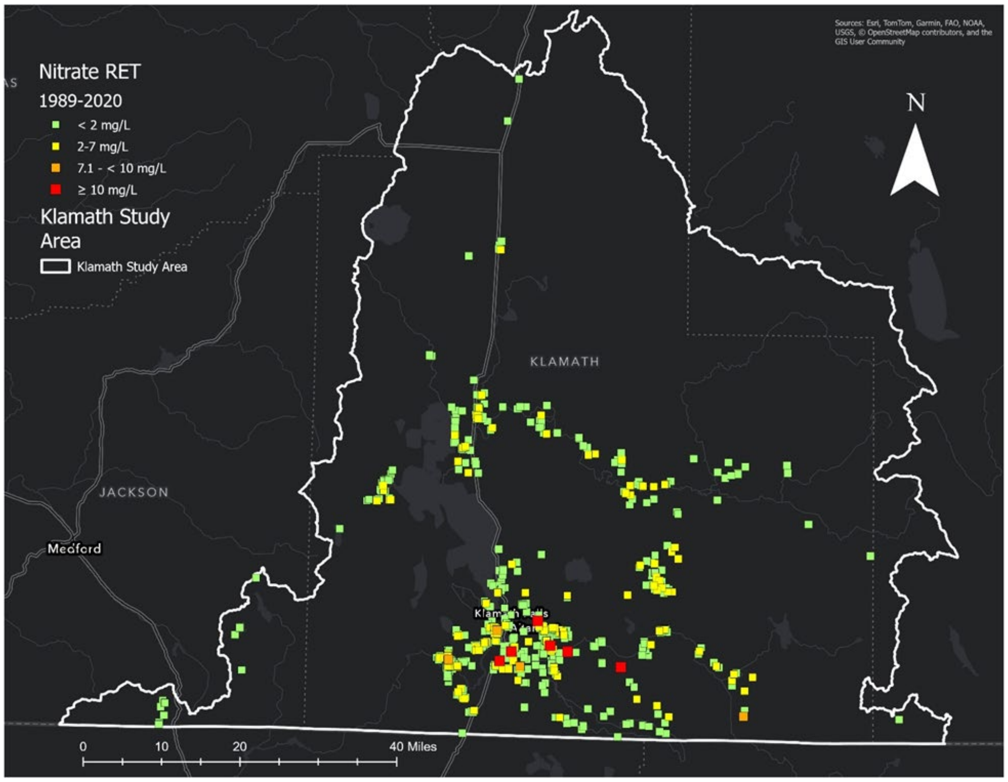

Figure 4. Nitrate in groundwater – Oregon Health Authority Real Estate Transaction data.

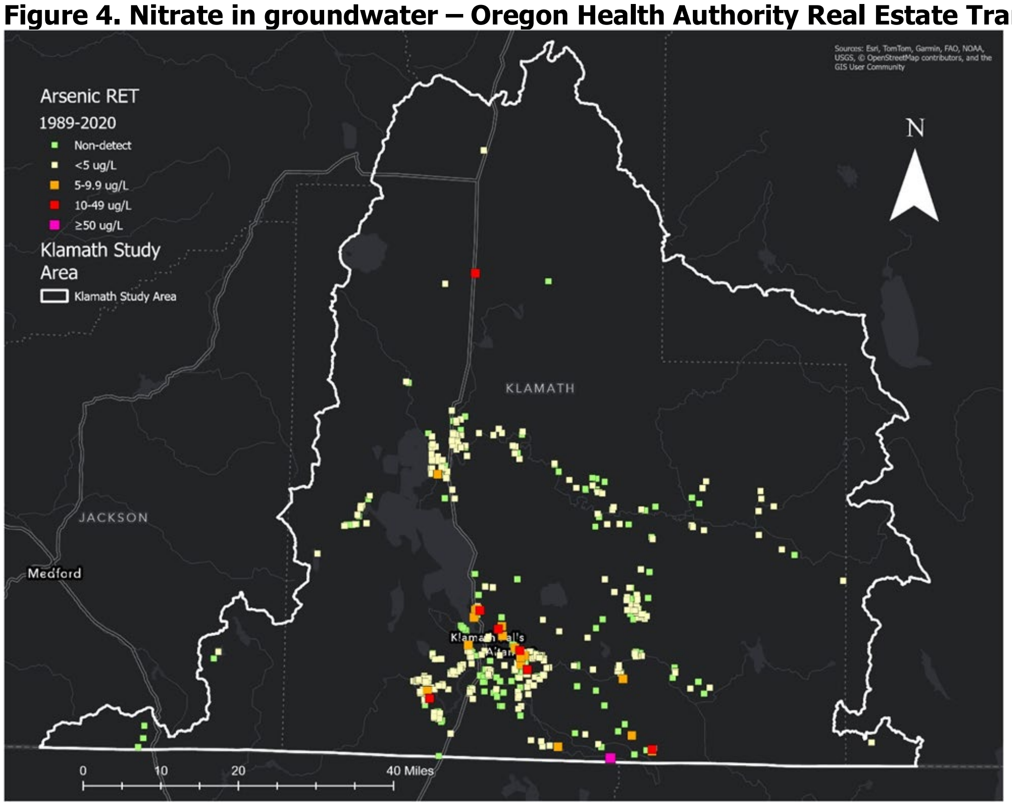

Figure 5. Arsenic in groundwater – Oregon Health Authority Real Estate Transaction data.

1.3.3 Public drinking water systems

There are 125 public water systems using groundwater wells with drinking water source areas that intersect the study area. These systems serve approximately 62,700 people. A drinking water source area is defined as the area of land which contributes water to the drinking water supply and where potential contamination from human activities or natural sources may pose a threat to the water quality. Of the 125 public water systems in the study area, 26 are active "community" public water systems which use groundwater sources to serve approximately 47,500 people on a regular basis, in addition to visitors at recreation sites. There are seven active "non-transient, non-community" PWS (for workplaces or schools) which serve 1,587 people regularly. There are 57 public water systems that are "transient, non-community" systems and state-regulated systems (such as for gas stations or campgrounds) with an estimated service population of 6,700. The remaining 35 public water systems in the study area are currently inactive. See Appendix A for a list of the public water systems, their classifications, primary source, activity status, and populations served.

Bacteria:

Total coliform bacteria alerts and E. coli bacteria alerts for public water systems are generated by the Oregon Health Authority when their presence is detected in sample results. Water systems sample for total coliform bacteria and confirmed detections trigger additional sampling for fecal coliforms or E. coli. Within the study area, six public water systems had one or more alerts for detections of E. coli bacteria in the past ten years (Appendix A). When E. coli is detected, additional site-specific review is typically needed to evaluate the source of E. coli, which may not be related to impacts to groundwater quality. If confirmed E. coli detections are considered to be contributing to groundwater contamination, PWS repairs are required by OHA. Public water systems with E. coli detections are dispersed in the study area indicating regional aquifer contamination issues are not likely.

Nitrates, arsenic, and other contaminants:

An alert for elevated nitrate concentrations is generated by the Oregon Health Authority when nitrate sample results for public water systems exceed 5 mg/L, which is half the EPA's maximum contaminant level. Within the study area, two of the public water systems had one or more alerts for elevated nitrate results in the past ten years.

One of the (inactive) study area's public water systems had an alert for arsenic concentrations exceeding 10 µg/L in the past ten years.

"Community" and "Non-Transient, Non-Community" public water systems in Oregon are testing for six PFAS compounds in their water supplies. Results are due to OHA by April 2027. Many tests have been completed and data is available on OHA's online PWS database or under individual PWS data at OHA's Drinking Water Data Online site. More details about PFAS testing requirements for PWS are provided on OHA's website.

2. Well selection, sampling and analysis

The study design for this Klamath Basin groundwater quality monitoring is similar in structure to previous DEQ studies since 2015, with the intention of monitoring ambient groundwater quality, identifying water quality and health concerns and presenting results to well users. The availability and diversity of wells change with each study area identified, as does the list of relevant contaminants based on historical data, current use conditions and interests of local partners. Analytical methodologies available at the DEQ Laboratory also shift over time. This section details the consideration that went into sample site selection, analyte selection, sampling methods and context for data interpretation. DEQ quality assurance documents referenced in this report can be made available upon request.

2.1 Sample site (well) selection

DEQ's statewide groundwater monitoring program relies primarily on well owners who volunteer to have their wells tested in exchange for a complete report of the analytical results from their well. A limitation of using active, private wells versus monitoring wells installed specifically for this purpose is that private wells are not always available in the desired locations or constructed to desired depths. However, partnerships with dozens of well users within a geographic area can allow access to a range of well depths and locations with the aquifer area of interest. This approach meets the objectives of the DEQ Statewide Groundwater Quality Monitoring Quality Assurance Project Plan (DEQ93-LAB-0024-QAPP). DEQ recruited well owner volunteers for this study using flyers, emails, a press release, and other local announcements. Communications offering free well water testing to participants in this study were provided in English and Spanish to reach a diversity of well users. Flyers were posted at libraries and post offices in target communities.

DEQ continued to recruit well user volunteers until adequate options were available to select 86 study wells of various depths and geographic locations sufficient to represent conditions in the study area (Figure 1). Well selection was limited to the availability of well users who volunteered, the accessibility of their well and the location of an access point prior to water treatment. Wells without a working pump could be included when the well head was available for the use of a submersible pump. Most of the sampled wells were single-family domestic wells, one was an irrigation well, and 18 were public water supply wells.

The Oregon Department of Water Resources has required filing records of drilled wells in the state since 1955. These records, called well logs in this report, are available on the OWRD website at Well Report Query. Well logs contain valuable information such as depth of well, depth of first water, well construction materials, screened interval, materials encountered while drilling (to evaluate aquifer type), seal depth and material, use of well, age of the well, and estimated yield. Many of these well characteristics are helpful in the evaluation of which aquifer a water sample might represent. An example well log is included in Appendix B.

Seventy-eight of the 86 wells selected for this study had a documented well log. Appendix C presents a list of all sampled wells and pertinent well log information. Although more detailed information about the aquifer from which samples are collected is not available for all wells, the analytical data from wells both with and without logs offers valuable insight into groundwater quality in the area.

Sample collection dates attempted to capture seasonal and land activity differences between the spring and fall in Oregon. Fifty-nine wells were sampled in the Fall of 2019. Twenty-eight of those wells were resampled in February-March of 2022 along with 27 additional wells for a total of 55 wells in the spring and 86 wells sampled for the whole project. The wells selected for resampling were chosen based on spatial distribution, availability and cooperation of the well owners. Detections of contaminants in the fall sampling event influenced the wells that were selected for resampling in the spring. Some wells could only be sampled once due to permission restrictions. Section 3.2 provides DEQ's evaluation of correlations between water quality sampling results and the season in which samples were collected.

Personal data collected from participants during this study is not included in this report. All volunteer well owners received an individualized copy of their groundwater quality laboratory report in the summer 2020 and/or the fall of 2022, along with resources for data interpretation and well maintenance. Appendix D provides an example of the letter and laboratory report that participants received.

2.2 Analyte selection

Sample analyses included common ions and common field parameters, nitrate/nitrite as N (referred to as nitrate in this report), total coliform bacteria, E. coli bacteria, arsenic, other metals, current use and legacy pesticides, and volatile and semi-volatile organic compounds (VOCs and SVOCs). Pharmaceuticals and personal care products (referred to as consumer product constituents in this report) were included in this study based on the knowledge of high septic tank densities in the area. In total, 241 chemicals or water quality parameters were analyzed for each well water sample tested in 2019 and 231 analytes for each well sampled in 2022. Ten consumer product analytes were not included in the 2022 testing suite due to laboratory analytical capacity. A complete analyte list can be found in Appendix E. The corresponding laboratory methods and reporting limits are in the Sampling and Analysis Plan (DEQ21-LAB-0024-SAP). Isotope samples were also collected and submitted to USGS for analysis.

2.3 Sampling methods

DEQ water quality monitoring staff collected and processed samples according to standard procedures found in the Mode of Operations Manual: Field Collection Methods (DEQ03-LAB-0036-SOP_V3) and the project Sampling and Analysis Plan (DEQ21-LAB-0024-SAP). Where possible, samples were collected from an outdoor spigot closest to the well head, and always before any water filtration or treatment. Some samples were collected from a pressure tank or large storage reservoir when access to water directly from the well was not available. In those cases, the pressure or storage tank volume was purged prior to collecting the sample to ensure a representative sample from the aquifer. Wells with active pumps were purged for at least five minutes and until field readings of conductivity, temperature and dissolved oxygen stabilized. Bacteria samples were collected last, after the sample point was disinfected with isopropyl alcohol.

Determination of a direct connection between the spigot used for sample collection and the well was evaluated based on best available information. It was either visually clear that the spigot was plumbed to the wellhead, or the well user or well owner confirmed verbally or with written instructions that the spigot was connected to the wellhead.

For collection of samples for lead analysis, the goal was to measure the quality of the water coming from the aquifer rather than from static water in piping. Therefore, pipes were flushed for 5-10 minutes before the lead sample was collected. For homeowners to evaluate for potential worst case lead contamination of drinking water from plumbing, samples should be collected differently, using the first draw method described in the EPA document, Module 5: Conducting Sampling and Interpreting Results - 2-Step Sampling Protocol

2.4 Context for data interpretation

Many of the chemicals analyzed in this study are not found naturally in groundwater (e.g., pesticides, personal care products, volatile organic compounds) or have very low natural background concentrations (e.g. nitrate). Detection of these chemicals indicates an influence from human activities such as leaching from agricultural or residential use of fertilizers and pesticides, improperly designed or maintained septic systems, poor well construction, or improper storage/disposal of solvents or leaking underground storage tanks. These contaminants, along with minerals and elements generally considered to be naturally occurring, such as arsenic and manganese, may be harmful to human health when present in drinking water above certain levels.

The quality and safety of drinking water from private, domestic wells is generally not regulated. However, as mentioned in section 1.2.7, domestic well testing is required at the time of real estate transactions that involve a drinking water well.

For this study, the water quality results have been compared to various health-based screening levels. For public water systems, EPA sets a maximum contaminant level goal (MCLG) as the concentration of a contaminant below which there is no known or expected health risk. The EPA then sets the maximum contaminant level (MCL) as close to the MCLG as feasible considering treatment technologies and cost. MCLs, otherwise known as drinking water standards, are enforceable water quality criteria for public water systems. Secondary MCLs (SMCLs) are non-enforceable guidelines indicating concentrations at which aesthetic effects might be noticeable (scaling, odor, taste) which are not health related. EPA also develops Action Levels for responses to concentrations of copper or lead in drinking water (U.S. EPA, 2018). DEQ's analytical reports sent to well owners included information on the MCLs for relevant contaminants. See Appendix D for an example of a laboratory report.

For this project, results are compared to maximum contaminant level goal and maximum contaminant levels, when available. If no maximum contaminant level is available, the result is compared to the lowest value of the current Human Health Benchmarks for Pesticides, Regional Screening Levels, or USGS Health-Based Screening Levels. HBSLs are non-regulatory screening values based on available toxicological research and can be used to determine whether the concentration of a contaminant in drinking water may pose a risk to human health (Toccalino, 2014 and USGS, 2024). Table 1 lists the relevant screening level for each detected analyte.

Health screening levels related to soil health, crops, or livestock are not widely available. DEQ referred participants in this study to their local Oregon State University (OSU) Extension Service Agent to discuss the impacts that particular contaminants may have on their soil, crops, livestock management, or food gardens.

A note about quantitative data summaries of analytes: due to quality assurance measures related to sampling, sample preparation and analysis, some samples or analytes were downgraded to a lower data quality level (DQL) and rejected from the data used in Table 1. Only samples and analytes that maintained an A or B data quality level were included in the quantitative analysis described in this report. All other data in this study were associated with non-detect results.

3. Water quality results and discussion

The results of the Klamath Basin Groundwater Quality Study are presented below. The complete raw data from this study may be obtained through the Ambient Water Quality Monitoring System (AWQMS) data portal or by contacting DEQ at Groundwater.Monitoring@deq.oregon.gov.

3.1 Water quality results

Table 1 identifies the maximum concentrations for all detected parameters out of the 241 separate parameters analyzed for the study. The health-based screening levels for each parameter are also listed in the tables as well as how many samples exceeded the screening level for each parameter. The following sub-sections of the report highlight results that may present a potential human health risk for people drinking the water and/or may indicate contamination of groundwater due to human activities.

Factors that influence the likelihood of groundwater contamination include: 1) proximity of a well to the source of contamination, 2) the concentration of chemical naturally present in soils, native rock, 3) chemicals that are applied, spilled, or discharged to the ground or below the ground surface, 4) depth of groundwater accessed by a well (shallow groundwater is affected by surface spills or discharges more quickly and more severely than deep groundwater), 5) local geology (aquifers present below a clay or other confining layer are less vulnerable to

Table 1. Summary of 39 detected analytes, maximum concentrations, and number of wells with detections exceeding health-based screening levels.

Characteristic	Units	Screening Level*	# Wells w/ Detections	Max Conc	# Wells with Detections above Screening Levels
General Chemistry/Common Ions (Ca, SO_4)					
Alkalinity, total	mg/L	not available	86	1200	NA
Calcium	mg/L	not available	86	86.5	NA
Chloride	mg/L	250[3]	83	54.9	0
Conductivity	umhos/cm	not available	86	2122	NA
Dissolved oxygen (DO)	mg/L	not available	75	11.5	NA
Hardness, Ca, Mg	mg/L	not available	86	529	NA
pH	SU	<6.5, >8.5[3]	86	9.2	0<6.5, 8>8.5
Sodium	mg/L	not available	86	187	NA
Sulfate	mg/L	250[3]	72	336	1
Total Dissolved Solids	mg/L	not available	86	1040	NA
Nutrients					
Nitrate + Nitrite	mg/L	10[1]	60	18.4	3
Total Phosphorus, mixed forms	mg/L	not available	84	7.26	NA
Bacteria					
Total Coliform	MPN/100mL	0	9	6	9
Escherichia coli	MPN/100mL	0	0	0	0
Metals					
Aluminum	µg/L	70[2]	10	334	4
Arsenic	µg/L	10/zero[1]	51	54.2	6 >MCL, 51>MCLG
Boron	µg/L	5,000[2]	49	3190	0
Iron	µg/L	300[3]	49	5770	27
Lead	µg/L	15/zero[1]	48	7.84	0>MCL, 48>MCLG
Magnesium	mg/L	not available	85	93.4	NA
Manganese	µg/L	300[2]	65	488	2
Potassium	mg/L	NA	86	16.7	NA
Uranium	µg/L	30[1]	34	2.8	0
Vanadium	µg/L	86[4]	41	36.2	0
Pesticides					
2,6-Dichlorobenzamide	ng/L	270,000[5]	1	28.1	0
Permethrin	ng/L	2,900,000[5]	3	78	0
Triazine Pesticides					
Atrazine	ng/L	3,000[1]	2	20.3	0
Deisopropylatrazine	ng/L	10,000[2]	1	6.11	0
Desethylatrazine	ng/L	not available	3	97.2	NA
Propazine	ng/L	40,000[2]	1	8.37	0
Simazine	ng/L	4,000[1]	1	20.9	0
Legacy Pesticides					
p,p'-DDE (4,4'-DDE)	ng/L	46[4]	1	0.0702	0
p,p'-DDT (4,4'-DDT)	ng/L	230[4]	2	0.275	0
Aldrin	ng/L	2-200[2]	1	0.153	0
Methoxychlor	ng/L	40,000[1]	1	0.889	0
VOCs and SVOCs					
Chloroform	µg/L	80/70[1]	2	26.7	0
Methyl tert-butyl ether (MTBE)	µg/L	14[4]	1	1.1	0
Tris(1,3-dichloro-2-propyl)phosphate (TDCP)	ng/L	360,000[4]	2	139	0
Consumer Product Constituents					
Sulfamethoxazole	ng/L	not available	1	214	NA

*If an EPA MCL is not available, the lowest concentration of other available screening levels is referenced.
NA = Not applicable
[1]EPA MCL/MCLG (drinking water standards/goals)
[2]USGS Non-Cancer HBSL-Health Based Screening Levels for evaluating water quality
[3]EPA Secondary MCL for aesthetic purposes
[4]EPA Regional Screening Levels
[5]EPA HHBP-Human Health Benchmarks for Pesticides

contamination), and 6) time (groundwater generally moves slowly, so it can take months or years for surface contamination to reach well water). In addition, OWRD hydrographs show water level decreases of 5 to over 30 feet between 2019 and 2022 in the Klamath Basin which has the potential to influence water quality (Schibel, 2023).

3.1.1 Nitrate

Nitrate in this study was measured as nitrate/nitrite. While nitrite is rarely found naturally in groundwater at significant levels due to geochemical conditions, these results represent a conservative measurement of nitrate. Nitrate is a natural and necessary nutrient found in soil and surface water. Human activities, however, can influence the concentrations of nitrate found in soil and water. Nitrate-enriched water can leach into aquifers from areas of fertilizer use, improper composting, manure storage or application, or from improperly designed or maintained septic systems (Powers, 1989). Background concentrations of nitrate in groundwater have been conservatively estimated by the United States Geological Survey as 1.1 mg/L (Nolan, 2003). Other reports (Mueller, 1996 and Madison, 1985) have estimated background levels of 2 or 3 mg/L. For the purposes of this report, any concentrations at or above 3 mg/L will be considered as levels sufficiently above background to indicate an impact from human activities on groundwater quality.

Only 7 of the 86 wells (8%) tested had detections of nitrate above 3 mg/L and three wells had concentrations (3%) exceeding the EPA drinking water standard of 10 mg/L. The range of concentrations was from non-detect to 18.4 mg/L. Most elevated nitrate concentrations were detected in the southern portion of the project area. Three wells with concentrations above the MCL were located in the Altamont, Henley and Hildebrand areas northeast of Klamath Falls. These towns are mapped in Figure 2. Most wells with detections that were sampled in both 2019 and 2022 showed slight increases in nitrate concentrations over that period. One (Well 35) showed a significant increase (5.1 mg/L in 2019, 11.8 mg/L in 2022). One well (Well 16) showed a decrease (6.9 mg/L to 4.1 mg/L).

Compared with the 1987-1989 DEQ groundwater testing results when 9% of wells tested had nitrate over the MCL, fewer of the wells tested in 2019-2022 (3%) had nitrate levels over 10 mg/L and the highest concentration of nitrate detected in 2019-2022 (18.4 mg/L) was lower than the maximum concentration detected in the area in 1987-1989 (42 mg/L) (Cole, 2006).

Note that the 1985-1987 sampling area included only the southern section of the 2019-2022 study. Even if only wells in the southern part of the 2019-2023 study are considered, (50 wells with two above 10 mg/L [4%]), this represents a decrease in high nitrate since the previous study. To most accurately compare past versus present data, however, it is best to compare samples from the same wells.

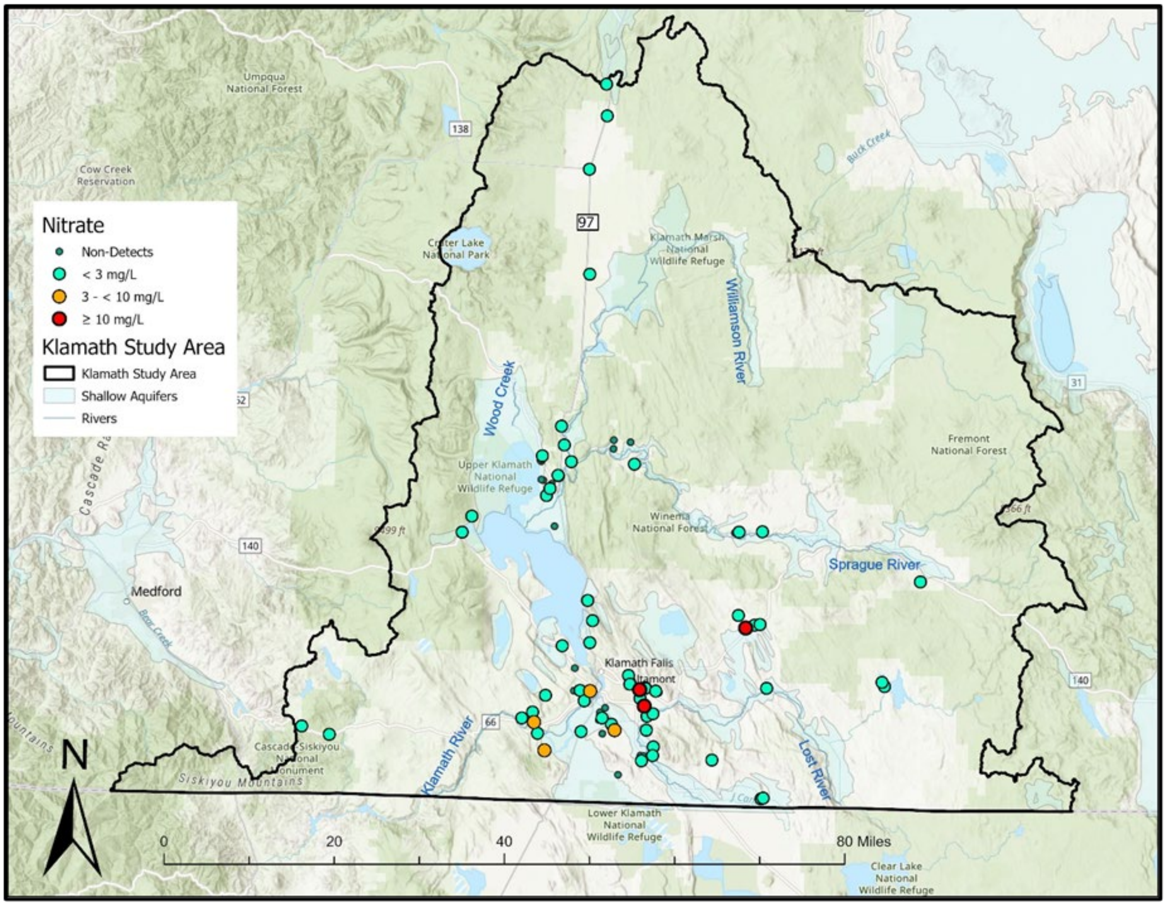

Figure 6. Nitrate concentrations in sampled wells.

Health concerns associated with elevated nitrate in drinking water include potential problems for infants, pregnant women and nursing mothers. More information for well users about nitrate in drinking water can be found on the Oregon Health Authority's Well User Resource Toolkit web page.

3.1.2 Arsenic

Arsenic is a naturally occurring element found in the earth's crust. It is found in groundwater in many areas of Oregon, often due to dissolution of arsenic-containing minerals associated with volcanic rock or soils. Other potential sources include use as a wood preservative, historic uses as an insecticide for orchards, and for embalming fluids prior to 1945, indicating that historic cemeteries and orchards may be potential sources of arsenic in addition to the natural sources. Arsenic geochemistry is complex, and several factors may influence its mobility through soils and into shallow groundwater and wells (Welch, 2000). Arsenic in drinking water presents a health risk and EPA has established an MCL of 10 µg/L for total arsenic. The MCLG is zero.

Figure 7 indicates the distribution of wells with arsenic concentrations of ND (non-detect), <10, >10 and >35 µg/L. Arsenic was detected in 51 of the 86 wells tested (59%), including six wells (7%) with concentrations exceeding the MCL of 10 µg/L. The range of arsenic concentrations was from non-detect to 54.2 µg/L. Most elevated arsenic concentrations were detected in the various parts of the southern project area. Three wells with the highest concentrations were located in a cluster in the Green Springs area, on the far southwestern border of the study area where the Mesozoic-aged Applegate Amphibolite (part of the Applegate Group) occurs (Orr, 1992). Amphibolites and other mafic rocks are frequently associated with elevated natural arsenic concentrations.

Concentrations for the 28 wells sampled in October/November of 2019 and again in February/March of 2022, were similar in most cases, however two wells had lower concentrations of arsenic in March of 2022 than in November of 2019 (showing reductions of 0.75 and 5.16 µg/L, respectively).

In the 1987 groundwater study, fewer of the sampled wells (4-6% vs. 8%) had arsenic above the MCL and the highest concentration detected in 1987 was 15 µg/L vs. the high of 54.2 µg/L detected in 2022.

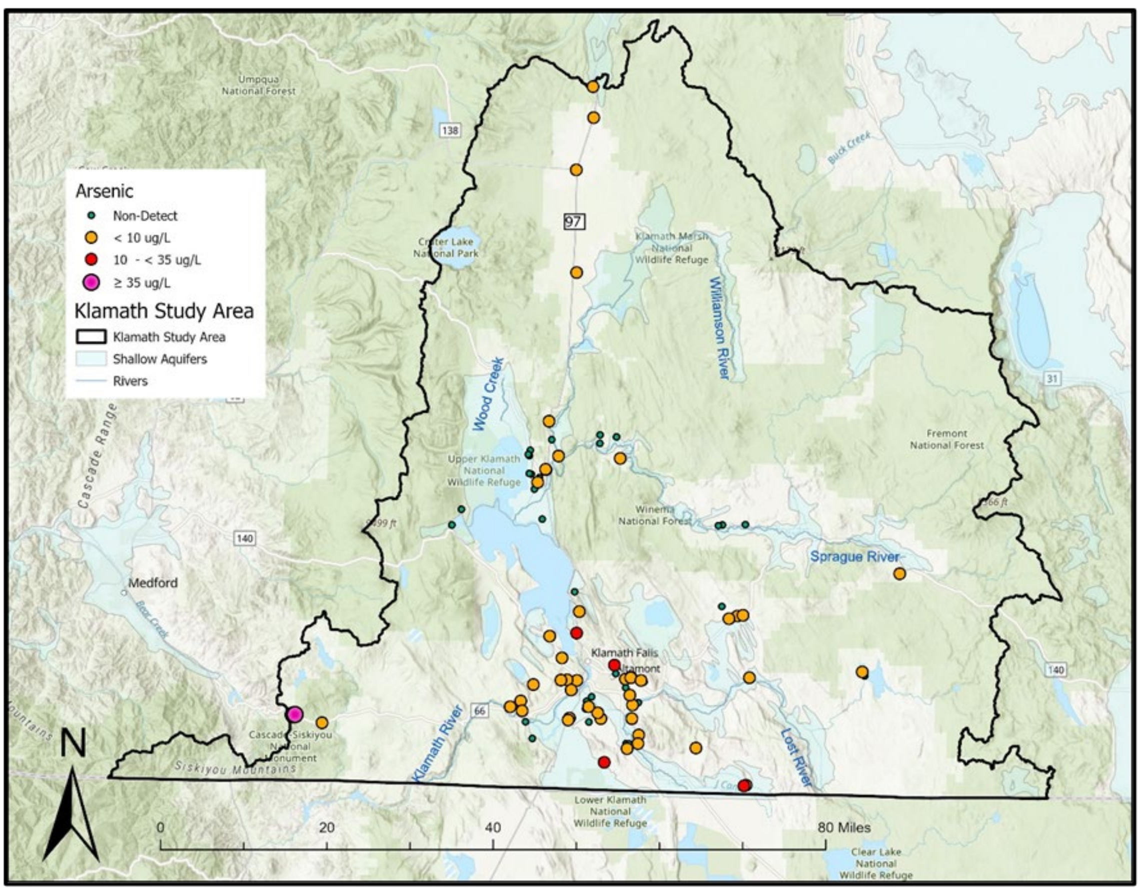

Figure 7. Arsenic concentrations in sampled wells.

3.1.3 Lead

DEQ includes lead in the statewide groundwater monitoring program as a public health screen. Although there are naturally occurring sources of lead, most lead detections in drinking water are from localized contamination, not an area-wide concern. Lead in drinking water is often the result of leaching from pipes, plumbing, solder used in well construction, and pump machinery, typically from older wells and plumbing in the household. Acidity, temperature and the concentration of other minerals in well water can influence the lead leaching rate. To avoid detecting lead from stagnant water inside plumbing, DEQ followed sampling methods described in Section 2.3 to ensure that pipes were flushed adequately before sampling. Lead in drinking water presents a health risk and EPA has established an MCL for lead of 15 µg/L. The MCLG is zero. The United States Center for Disease Control and Prevention (CDC) states that lead can be harmful to human health even at low exposure levels since lead can accumulate in the body over time (USCDC, 2025). For adults, high lead can result in high blood pressure or kidney problems.

All of the wells sampled in this study had lead concentrations below the MCL of 15 µg/L. Eighteen (21%) of the wells tested had concentrations greater than 1 µg/L. Seven of the 18 wells with results above 1 µg/L in October/November of 2019 were sampled again in February/March of 2022. Of those seven resampled wells, only one (Well 14) had results over 1 µg/L in 2022.

More information for well users about lead in drinking water can be found on the Oregon Health Authority's Well User Resource Toolkit web page

3.1.4 Aluminum, manganese, iron

Aluminum, manganese and iron were also detected in well water sampled for this study. Metals in groundwater typically are the result of the interaction of water with soils and rock of the aquifer (USGS.gov, 2026). Concentrations can be influenced by pH and oxidation as well as the general chemistry of natural groundwater. USGS established a Non-Cancer Health-Based Screening Level for aluminum at 70 µg/L and for manganese at 300 µg/L. There is no HBSL for iron. Secondary MCLs are established for some constituents by EPA, primarily as an advisory regarding aesthetic impacts (discoloration or scaling) rather than due to health concerns. The SMCL for these metals are: aluminum (50-200 µg/L), manganese (50 µg/L) and iron (300 µg/L).

Of the 86 wells tested, 10 had detections of aluminum ranging from 21.1 µg/L to 334 µg/L. Four wells (5%) exceeded the 70 µg/L USGS HBSL. Two of the wells (Wells 17 and 43) with the highest concentrations were located in the northwest corner of Upper Klamath National Wildlife Refuge, west of Chiloquin. Four of the 10 wells with aluminum detections were sampled both in 2019 and 2022. One of those had reduced concentrations (to non-detect) in their second sampling round and three had increased concentrations in their second sampling round. One well (Well 17) showed an increase from 170 µg/L to 334 µg/L in aluminum concentrations between 2019 and 2022. Another well (Well 38) showed an increase in aluminum concentration from <20 µg/L to 126 µg/L in that period. Six wells, three with detections in 2019 and three with detections in 2022, were not sampled more than once.

Two wells (2%) had detections of manganese over the USGS HBSL of 300 µg/L, and 34 wells (40%) had manganese concentrations over the SMCL of 50 µg/L, indicating a potential for scaling of plumbing or discoloration.

Iron concentrations were elevated above the SMCL of 300 µg/L in 27 of the 86 wells (31%) tested. The range of iron detections was 55.4 to 5770 µg/L. Nine wells showed concentrations above 1000 µg/L, three of which were sampled twice and tested above or close to 1000 µg/L on both sampling dates. Iron concentrations above the SMCL of 300 µg/L are not expected to cause human health concerns but may lead to discoloration of sinks and scaling issues.

3.1.5 Coliform bacteria and Escherichia coli

Coliform bacteria are a group of closely related bacteria that are typically not harmful to humans. However, coliform bacteria are a useful indicator to determine if similar, disease-causing microorganisms (e.g. bacteria, viruses) may be present in water bodies. E. coli is a specific class of coliform bacteria more commonly associated with illness. The presence of coliform bacteria may indicate a problem with the integrity of a well's construction, allowing contamination from surface or soil sources into the well. Bacterial contamination may also indicate potential contamination in shallow groundwater from improperly designed or maintained septic systems, or from leaching of materials through soils where manure is stored or has been spread. The MCLG for coliform bacteria is zero.

Total coliform bacteria were detected in nine of the 86 wells tested (10.5%), all but one of which were detected in the fall 2019 sampling event. Five of the wells that had total coliform detections in 2019 no longer had total coliform detections when resampled in 2022. One re-sampled well had lower levels of total coliform in 2022 than in 2019, and one new well had total coliform in 2022. E. coli was not detected in any well.

More information for well users about testing for bacteria and understanding test results is available from the Oregon Health Authority's Well User Resource Toolkit web page

3.1.6 Pesticides

Pesticides are a broad class of chemicals that includes insecticides, herbicides and fungicides. This study tested for pesticides that are currently used and legacy pesticides. Legacy pesticides are no longer in use since many have been banned from use for environmental reasons.

The study also measured several chemicals that are the breakdown products of the original pesticides. Physical processes, such as photo-degradation from sunlight, or biological processes, such as metabolism from bacteria, can break parent pesticides down into different chemicals. In some cases, the breakdown products can be more toxic than the parent compound. In addition, some breakdown products may have different chemical structures making them more soluble and mobile in the groundwater or more resistant to further degradation. In general, less is known about the potential health impacts of the breakdown products than the parent pesticides or mixtures of multiple pesticides. Due to chemical properties or time passed since application, often the breakdown products are detected, and not the parent (Mitra, 2024).

Of the 136 pesticides analyzed, 93 were current use pesticides and 43 were legacy pesticides. Table 1 lists the 11 pesticides detected in six area wells. These 11 pesticides represent eight different parent pesticides. One well had detections of seven different pesticides from four parent compounds.

The primary current use pesticides detected were the triazine herbicides; atrazine, propazine and simazine, and degradation products of those triazines: desethylatrazine (also known as DEA or 2-chloro-4-isopropylamino-6-amino-s-triazine) and deisopropylatrazine (DIA). In addition, permethrin and 2,6-dichlorobenzamide (BAM) were detected.

Atrazine and simazine are pre-emergent herbicides used for grass and weed control. Atrazine uses were canceled in 2021 for roadsides and Conservation Reserve Program land. Atrazine and simazine uses were cancelled for forestry in 2021 (USEPA, 2021). Permethrin is an insecticide, used for livestock parasites, food and feed crops, lawns, and sometimes for public mosquito control (Toynton, 2009). The chemical 2,6-dichlorobenzamide is a breakdown product of dichlobenil, which is an herbicide used for weed control, mainly in non-agricultural areas and in the aquatic environment (Bjorklund, 2011). Although referred to as a current use pesticide when this study began in 2019, propazine was banned by EPA in 2021. This terminated the last propazine products registered in the United States, due to its link to increased risk of cancer and reproductive problems.

Figures 8 and 9 show current use pesticides detected in wells in 2019 and 2022. Figure 8 shows that one, three and four of the triazine herbicides/degradation products were detected in Wells 36, 25 and 35, respectively, in 2019. In addition, permethrin was detected in Wells 35, 26 and 28 in 2019. Laboratory method detection limits for permethrin were higher in 2022 than the concentrations detected in 2019 so it was not confirmed if permethrin was still present in Wells 26, 28 and 35 in 2022. Figure 9 shows all the same pesticides detected in Well 25 in 2019 were still present in 2022. The pesticide BAM was also detected in Well 25 in 2022 but not in 2019.

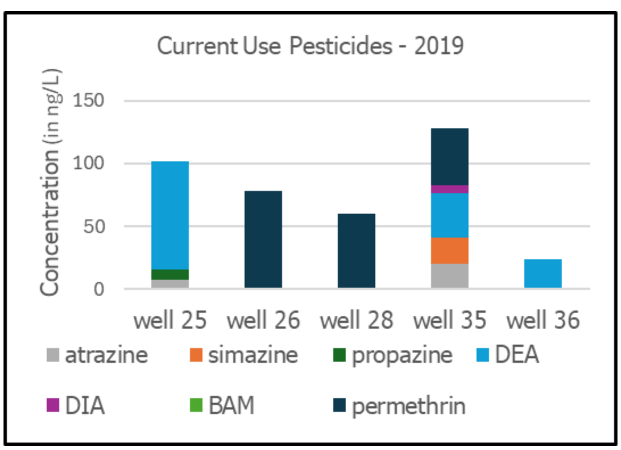

Figure 8. Current use pesticides in 2019.

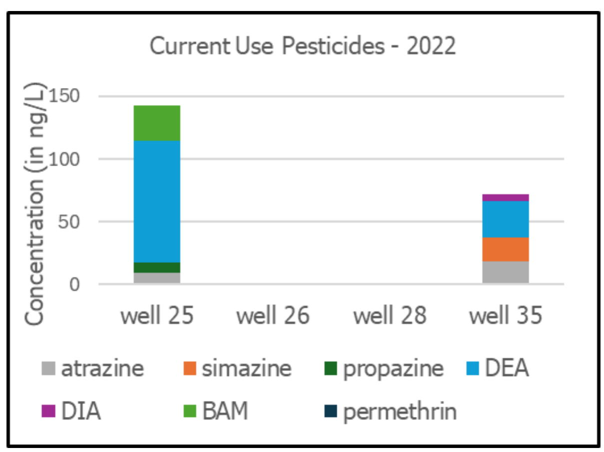

Figure 9. Current use pesticides in 2022.

Four legacy pesticides were detected in the study. All four (aldrin, DDE, DDT and methoxychlor) are chlorinated insecticides. Figure 10 illustrates detections of these four legacy pesticides. Two wells (wells 34 and 35) had detections of p,p'-DDE, p,p'-DDT and/or methoxychlor in 2019. Only one of the two (well 35) was sampled on both dates, and the pesticides were not detected in 2022. Aldrin was detected in well 25 in 2022, but not in 2019. Note that different analytical methods were used for these analyses in 2019 and 2022, although the detection limits were similar.

As shown in Table 1, all pesticide detections were at low concentrations, below health-related screening levels.

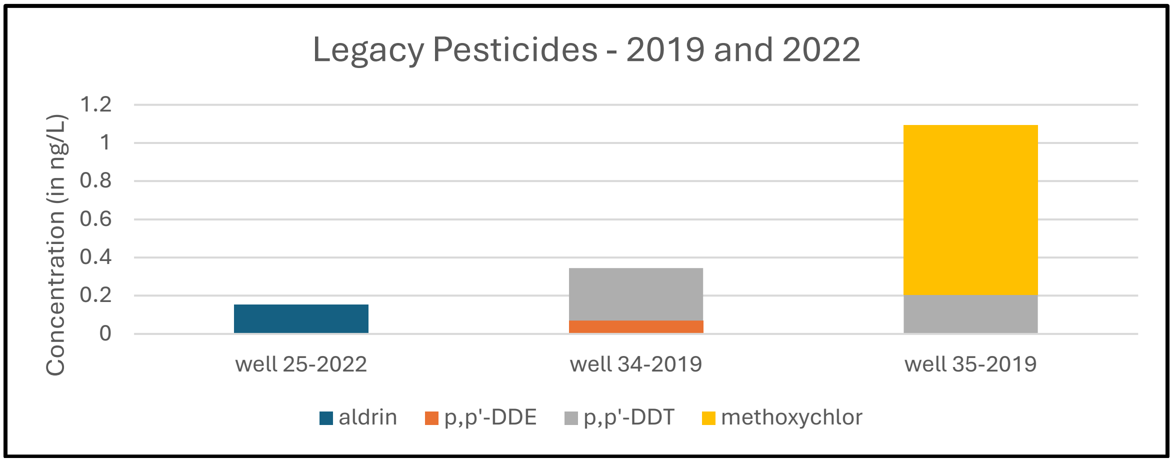

Figure 10. Detections of legacy pesticides in wells sampled November 2019 and 2022.

Figure 11 shows that Wells 25 and 35 had detections of 5 and 7 of the 11 detected pesticides, respectively, in the Klamath study. Both wells are located in residential areas with small farms south of Klamath Falls. Well 25 is a shallow well and Well 35 had no well records. Well 34 had two DDT-related detections and also had no well records. It is located in an agricultural area near Hildebrand, east of Klamath Falls.

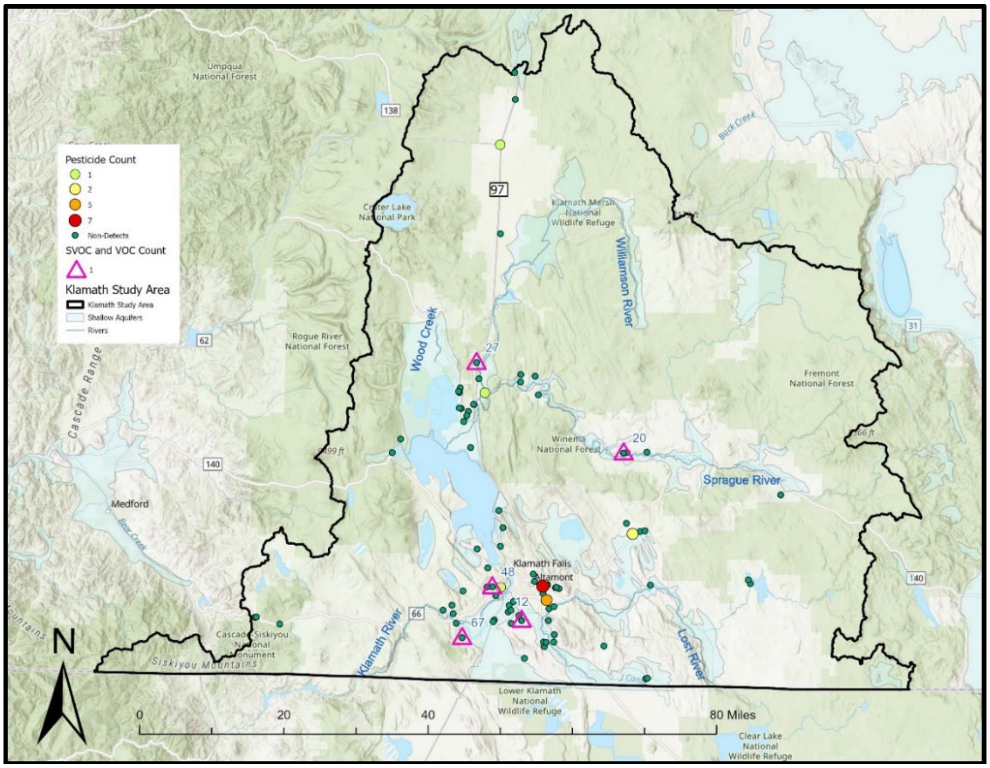

Figure 11. Number of pesticides, VOCs and SVOCs detected in sampled wells.

3.1.7 Volatile organic and semi-volatile organic compounds

Volatile organic compounds are a class of chemical compounds that share two main properties: (1) they evaporate easily from water into the air and (2) they contain carbon. They are associated with products such as plastics, adhesives, cleaning fluids, paints, gasoline and other fuels, fumigants, refrigerants, and dry-cleaning fluids. Biological sources of VOCs are from the degradation of organic matter in feed and manure. VOCs may be released into the environment and may reach groundwater through many sources and pathways, including leaking storage tanks, landfills, infiltration of urban stormwater and wastewater, septic systems, and injection through wells. Some VOCs are known or suspected human carcinogens and their concentrations in drinking water from public water systems are regulated by the EPA (Zogorski, 2006). A fact sheet about VOCs for well owners is available on the wellcarehotline.org website.

Of the 65 VOCs analyzed in this study, two were detected in three separate wells (Figure 11). Two separate wells showed detectable chloroform. Well 27 had non-detectable levels in 2019 (when the laboratory detection level was 5 µg/L) but showed trace levels in 2022 (when the lab detection level was 0.5 µg/L). Well 12 was only sampled once, in 2019, and had a chloroform concentration of 26.7 µg/L. The owners of well 12 mentioned that they had shock-chlorinated the well the week before the well was sampled in 2019. Chloroform is a disinfection by-product commonly produced during chlorination of water or wastewater (Ivahnenko, 2006).

Methyl tert-butyl ether (MTBE) was detected in 2022 in one well, Well 67, at a level slightly above the detection level. The laboratory detection level was 1 µg/L in 2019 and 0.5 µg/L in 2022. MTBE was used as a replacement for lead to boost octane in gasoline for automobiles. In the 1990s it was frequently found as a contaminant in groundwater due to its high solubility and mobility, low sorption to soils, and resistance to degradation by bacteria. EPA drafted plans to phase out the use of MTBE in 2000, but changes to the oxygenate requirement for gasoline in 2005 effectively reduced its use in the U.S. (Wikipedia, 2025). No other gasoline-related VOCs were detected in the well although a gasoline leak or spill is the likely source of this detection.

Semi-Volatile Organic Compounds (SVOCs) are less volatile than VOCs. One of the two SVOCs sampled for this study, Tris(1,3-dichloro-2-propyl)phosphate (TDCP), was detected in two separate wells (Well 20 and Well 48). Both concentrations were below the EPA regional screening level. TDCP belongs to the family of organophosphate flame retardants, (OPFRs) which may be used as flame retardants in flexible PUR foams found in baby mattresses, car safety seats, residential upholstered furniture, and paints and coatings. These chemicals have been detected in sewage effluent, river water, seawater, drinking water, sediment, and fish throughout the world. In laboratory animal studies, TDCP has been associated with cancer of the liver, kidney, brain and testis (NRDC, 2010).

3.1.8 Consumer product constituents

Consumer product constituents include fragrances, pharmaceuticals, insect repellants and other products found in everyday household chemicals, cleaning products, beauty products, clothing, and medications. One of the goals for the statewide groundwater monitoring program is to investigate emerging groundwater quality problems. Consumer product constituents detected in groundwater are considered indicators of nearby septic or ground discharging wastewater treatment systems that have not been primarily designed to function as treatment for pharmaceuticals and personal care products (Phillips, 2015).

Examples of commonly detected consumer products in other studies include the insect repellant DEET, the stimulant caffeine, and the antibiotic sulfamethoxazole (Groundwater Foundation, 2022). These constituents likely make their way into the water through wastewater discharges and septic systems. Although concentrations detected in this study were significantly lower than a human pharmaceutical dose, the presence of these chemicals in groundwater may lead to aquatic life impacts through surface and groundwater interactions (Hejna, 2022). No water quality criteria or benchmarks currently exist for most of these compounds.

Only one of the 11 consumer product constituents analyzed was detected during this study. Sulfamethoxazole was detected in Well 25 in November 2019. Well 25 is a shallow well (57 feet deep) that also had high nitrate concentrations and pesticide detections, indicating contamination from surface and near surface activities in the surrounding small farm and residential areas or from the nearby irrigation ditch.

Ten consumer product analytes (not including DEET) were excluded from the 2022 analysis due to laboratory analytical capacity at that time of year.

3.2 Effects of season or depth of groundwater on water quality

3.2.1 Seasonal characteristics

To evaluate the potential for seasonal variations in nitrate concentrations in groundwater due to agricultural activities, irrigation or precipitation levels, nitrate concentrations were compared for samples collected at 28 of the same wells in both October/November (fall) 2019 and in February/March (early spring) 2022. Most of the 28 wells with detections that were sampled in both seasons showed slight increases in nitrate concentrations over that period. As mentioned in section 3.1.1, one (Well 35) showed a significant increase and one well (Well 16) showed a decrease; however, the sample size of wells with nitrate detections did not allow for a statistically significant evaluation.

Over the 2019 to 2022 project time period, precipitation in the Klamath Basin was very low and a number of drought permits were issued to irrigators, resulting in an increase of groundwater pumping and water level decreases of 5 to over 30 feet demonstrated by OWRD hydrographs over the two-year period. It is possible that the sharp decrease in groundwater levels influenced detections found in this study.

3.2.2 Depth of water in contributing aquifer

A thorough evaluation of factors affecting nitrate concentrations in groundwater was beyond the scope of this project. Shallow groundwater often has higher nitrate concentrations because (1) nitrate contamination originates at land surface, (2) shallow groundwater generally represents recent recharge, (3) deep groundwater is often older and was recharged before modern land uses, and (4) denitrification can remove nitrate as groundwater moves deeper into reducing environments. Groundwater nitrate concentrations are often best explained by the combination of land use in the recharge area, groundwater age, well depth, redox conditions, and aquifer geology (Burow, 2010, MacLeod, 1995, Frans, L., 2000).

To evaluate the potential relationship between concentrations of nitrate and the depth of groundwater sampled in this project, 60 available well logs from this project were reviewed to determine whether the samples were likely collected from a deep or shallow groundwater aquifer.

DEQ does not collect groundwater level data from domestic wells since the tools and process for this measurement could introduce contaminants into the wells. Therefore, the likely depth of groundwater collected from each well was estimated using data from 60 available well logs. Well logs provide information on first water encountered while drilling, static water level (the level of the water in the well after drilling), and depth of well screen interval or other well openings. For this project, a combination of first water level information and the shallowest depth of well screening were used to estimate the depth of groundwater sampled at the site. Factors such as confining clay layers and different aquifer materials at the well screen depth were also considered in the evaluation. Note that since well log notations are recorded by well drillers on the date the well is drilled, actual water levels could have changed over time.

As described in Section 2.1, Appendix C has a list of wells, well depths, and estimated depth to water. Thirty-six of the wells with well logs were determined to draw water from 100 or more feet below ground surface or were considered to have a confining layer above the aquifer. These were labelled deep water wells. Twenty-four of the wells with well logs indicating the wells drew water from depths of less than 100 feet below ground or where aquifers were considered unconfined were labelled shallow water wells.

The Peto & Peto modification of the Gehan-Wilcoxon test was conducted to compare nitrate concentrations between samples collected from deep water wells versus from shallow water wells. The test was run in R using the Cendiff function in the NADA package. This test is used in environmental statistics to analyze data with non-detects (censored data) and determine if there is a difference in the distribution of data across multiple groups.

For the 60 wells evaluated in this study, well completion in shallow aquifer wells versus deep aquifer wells was not a robust predictor of nitrate concentrations. Specifically, the evaluation of nitrate concentrations versus water depth in the contributing aquifer indicated there was not a statistically significant difference between nitrate concentrations in well water supplied by a shallow aquifer versus nitrate in well water supplied by a deep aquifer (n = 24 [shallow], 36 [deep], $X^2 = 0.0486$, $p = 0.8$).

4. Summary

The 2019-2022 Klamath Basin groundwater quality study met the following study objectives:

1. **To collect high-quality data on nitrate, arsenic, coliform bacteria, metals, pesticides, volatile organic compounds, and personal care products in groundwater throughout the study area.** Groundwater samples were collected from 86 wells within the study area and analyzed for 241 chemical parameters. The data collection and analysis were quality-controlled, allowing the data to be useable for future data comparisons.
2. **To identify areas of groundwater contamination related to these parameters.** **Nitrate:** Only three wells had nitrate concentrations exceeding the EPA drinking water standard of 10 mg/L. Those wells were south and east of Klamath Falls. Seven of the wells tested (8%) had detections of nitrate above 3 mg/L. The range of detections was from non-detect to 18.4 mg/L. DEQ's 1987-1989 study of 51 wells in the Klamath Falls-Merrill area showed that nitrate was detected above 10 mg/L in 9% of wells and the maximum concentration detected was 42 mg/L (Cole, 2006). Note that more wells with concentrations

of nitrate at levels above 3 mg/L but below 10 mg/L were detected in the recent study than previously (8% [2019-2022] vs 4% [1987-1989]). Note also that the wells sampled in each study are not the same but represent similar areas. Real Estate Transaction testing data (OHA Well Testing & Regulations web page) indicated nitrate levels mostly below 7 mg/L in the study area with a few above 10 mg/L in the Klamath Falls region over the past 30 years.

Arsenic: Fifty-one wells (59%) had detections of arsenic including 6 wells (7%) exceeding the MCL of 10 µg/L. The range of arsenic concentrations was from non-detect to 54.2 µg/L. Most elevated arsenic concentrations were detected in the southern project area. The RET arsenic data indicated some elevated arsenic in wells east of Klamath Falls and Altamont.

In the 1987 groundwater study, fewer of the sampled wells (4-6%) had arsenic above the MCL and the highest concentration detected in 1987 was 15 µg/L vs. the high of 54.2 µg/L detected in 2022.

Lead: In the 48 wells where lead was detected, all concentrations were below the MCL of 15 µg/L.

Bacteria: Total coliform bacteria were detected in nine of the 86 wells tested (10.5%). E. coli was not detected in any well.

Aluminum: Of the 86 wells tested, 10 had detections of aluminum ranging from 21.1 µg/L to 334 µg/L. Four wells (5%) exceeded the 70 µg/L USGS HBSL. Two of the wells (wells 17 and 43) with the highest concentrations were located in the northwest corner of Upper Klamath National Wildlife Refuge, west of Chiloquin. Four of the 10 wells with aluminum detections were sampled both in 2019 and 2022. One of those had reduced concentrations (to non-detect) in their second sampling round and three had increased concentrations in their second sampling round. One well (Well 17) showed an increase from 170 µg/L to 334 µg/L in aluminum concentrations between 2019 and 2022. Another well (Well 38) showed an increase in aluminum concentration from non-detect to 126 µg/L in that period.

Manganese: Only two wells had manganese over the USGS HBSL of 300 µg/L. Manganese was detected in 34 wells (40%) over the SMCL of 50 µg/L.

Pesticides: Eleven pesticides were detected in five wells in the study area. The majority of detections were the triazine herbicides atrazine, propazine and simazine, and degradation products of those triazines: desethylatrazine (also known as DEA or 2-chloro-4-isopropylamino-6-amino-s-triazine) and deisopropylatrazine (DIA). In addition, permethrin and 2,6-dichlorobenzamide (BAM) were detected. The legacy pesticides p,p′-DDE, p,p′-DDT, aldrin and methoxychlor were detected in three wells. Atrazine, simazine and propazine were banned by EPA in 2021 for some uses due to links to increased risk of cancer and reproductive problems.

VOCs/SVOCs: The VOCs chloroform and MTBE were detected in 3 separate wells. One SVOC was detected, Tris(1,3-dichloro-2-propyl)phosphate (TDCP), in 2 separate wells. All detections were at low concentrations. A short list of volatile organic compounds and pesticides were also analyzed for the March 1987-1989 samples and none were detected (Cole, 2006).

Pharmaceuticals: Only one of the 11 consumer product constituents analyzed, sulfamethoxazole, was detected during this study, suggesting that septic system waste is not likely a primary source of groundwater contamination.

Precipitation in the Klamath Basin was very low during the study period of 2019 through 2022. A number of drought permits were issued to irrigators and groundwater pumping sharply increased in that period leading to water level decreases of 5 to over 30 feet demonstrated by OWRD hydrographs over the two-year period. It is possible that the sharp decrease in groundwater levels influenced concentrations of analytes detected.

3. **To inform well water users of the results of this study and provide information regarding potential risks to human health.** All well owners who participated in this study received a report of test results for their wells and information related to health-based screening levels in Summer 2020 and Fall 2022. DEQ provided educational packets of information about contaminants, potential health concerns, and actions that can be taken to reduce risk. Contacts for toxicologists at the Oregon Health Authority were provided as well as local county public environmental health representatives to assist with questions related to health concerns or well inspections or treatment options. In addition, DEQ laboratory staff shared results in packaged data sets with any interested parties who inquired.

4. **To identify areas needing additional investigation in order to describe the extent of contamination and help focus efforts to prevent further contamination.** The study showed some nitrate in wells south and southwest of Klamath Falls and a few wells had multiple pesticides which might warrant additional investigation. Where this study has confirmed elevated arsenic concentrations, also evident in the RET map, this study might be useful for targeting outreach in those areas.

5. **To help establish long-term trending data and describe changes over time.** Conducting future testing of groundwater from selected wells from this and previous studies, if possible (with permission from well owners), would allow comparison of data and trend analyses over time.

5. Recommendations

Based on the evaluation of current and past data from the area, DEQ recommends the following future actions that DEQ could take, in collaboration with others, as resources allow.

Additional Evaluation of Hot Spots and Determination of Trends: DEQ recommends additional sampling to investigate nitrate concentrations and areas of pesticide detections in addition to elevated arsenic as indicated by this study and RET test data. As possible, select wells from this and previous studies should be re-sampled on a regular basis to evaluate groundwater quality trends.

RET test data is a useful screening tool to highlight areas of potential concern for domestic drinking water wells. Samples are required to be collected and analyzed prior to every sale of a home supplied by a domestic well. Education and outreach to realty organizations in the area (and banks that provide mortgage loans) may increase the number of wells tested and provide the state with valuable and updated information about well water quality in the region.

Another means of conducting wide-ranging community nitrate screening is by using colorimetric (pH dip-stick like) tests run by volunteers. These low-cost, quick screening tests for nitrate can be conducted by community organizations, providing an on-the-spot result for well users. These tests have been provided at county fairs, Soil & Water Conservation District offices, and earth day celebrations by organizations with minor training from OSU or DEQ staff.

Public Education and Training: DEQ recommends public education about the presence of nitrate, arsenic and other potential contaminants in the area. This could be provided through OHA's Domestic Well Safety program, DEQ's ongoing work with OHA's Drinking Water Source Protection program, the county health departments and through local drinking water testing laboratories, well drillers and water well maintenance providers. Education would ensure that well owners are aware of potential contaminants in groundwater and potential health considerations of drinking and cooking with elevated concentrations of these chemicals in their water supply, where to find assistance, and what steps they can take to test their wells and treat their well water if needed.

The study results also indicated groundwater contamination that may be from residential or commercial applications of fertilizers and pesticides. Improved education about proper use of pesticides and alternatives for weed removal along roadways or on farmland, private lawns or golf courses could reduce the concentrations of pesticides reaching groundwater supplies in the area. Educational outreach to well users encouraging evaluation of practices in and around their wells may prevent additional introduction of these chemicals.

Resources:

The **U.S. Environmental Protection Agency** website has links and information for private well owners.

The **Oregon State University** Well Water Program website is dedicated to protection of the groundwater that provides our drinking water through education. Their site has many resources and a wealth of information about Willamette Valley groundwater quality.

The Oregon Health Authority runs the Oregon Domestic Well Safety Program which has resources to assist private well owners, including the Well User Resource Toolkit. OHA partners with other state agencies to assess health risks associated with private wells and promote domestic well safety. The program currently includes a special focus on domestic wells in the Lower Umatilla Basin Groundwater Quality Management Area.

The **Oregon Department of Agriculture** works with landowners to implement the Agricultural Water Quality Rules to prevent and control water pollution from agricultural activities. ODA created 38 watershed-based regions with focused Area Plans and required Area Rules for each. There are Area Plans for the Klamath Headwaters and the Lost River areas with recommended practices for farmers and ranchers. Landowners must prevent movement of excess sediment, animal waste, fertilizers, or excess chemicals into groundwater or surface water and protect streamside vegetation. The Klamath Soil and Water Conservation District is available to provide technical and financial assistance with these efforts. Site specific information about these programs are available on ODA's Agricultural Water Quality website.

The **Oregon Water Resources Department** and Oregon Health Authority jointly publish The Water Well Owners Handbook, also available in Spanish (Pozos de Agua: Manual para el Propietario This guide to water wells in Oregon is a useful resource for well owners and available online or at your local watermaster's office.

The **Oregon Water Resources Department** operates a Well Abandonment, Repair and Replacement Fund (WAARF) which provides grants to qualifying low to moderate income homeowners and tribal members to address dry wells due to declining water levels in counties with drought declarations and for wells damaged by wildfire.

A **Department of Environmental Quality** proposal for an Oregon Environmental Restoration Fund project to finance the repair and replacement of failing septic systems for low to moderate income households was accepted in 2026. Final approvals and administrative details were not available at the time of this report's publication. Prioritization for funding under this program will be in the LUB GWMA and South Coast areas of Oregon. However, funding may be available for septic needs in other areas of the state as well. Look for updates on DEQ's Water Quality Grants website.

The **Department of Environmental Quality's** Groundwater Protection Program website has links to previous groundwater studies around the state and information about grants, loans and technical assistance for communities or individuals. DEQ's Drinking Water Protection Program has developed many tools to assist public water systems to prevent contamination of their groundwater supplies. Many of the tools are also applicable to domestic well users.

- Basic Tips for Keeping Drinking Water Clean and Safe
- Groundwater Basics for Drinking Water Protection

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Appendix A – Public Water Systems

Note: This summary does not include public water systems that purchase drinking water from these water systems.

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4194794	AMA MINI MART #1	GW	NC	150	Nitrate
4194209	ASPEN INN MOTEL	GW	NC	27	n/a
4100129	BLY WATER DISTRICT	GW	C	310	n/a
4190813	BONANZA BIG SPRINGS PARK/REC	GW	NC	30	E. coli
4194034	BONANZA BUSINESS CENTER	GW	NC	110	E. coli
4194440	BONANZA CITY LIBRARY	GW	NC	40	n/a
4190550	BONANZA HIGH/ELEM SCHOOLS	GW	NTNC	425	n/a
4191560	CABINS AT HYATT LAKE	GW	OVS	10	n/a
4194807	CACTUS J	GW	NC	75	n/a
4105174	CAMP ESTHER APPLEGATE LDS	GW	NC	100	n/a
4105171	CAMP MCLOUGHLIN	GW	NC	30	n/a
4193639	CASCADE WTR IMPROVEMENT DIST	GW	NC	230	n/a
4194028	CHEMULT BUDGET INN	GW	NC	50	n/a
4194023	CHEMULT MOTEL, THE	GW	NC	100	n/a
4100184	CHILOQUIN MUNICIPAL WATER DEPT	GW	C	730	n/a
4194178	CINDERS CAFE & BAR	GW	NC	150	n/a
4101522	COLLIER LANE HOA	GW	C	60	n/a
4193995	COLLINS PRODUCTS LLC	GW	NTNC	260	n/a
4194403	COLUMBIA PLYWOOD CORP	GW	NTNC	280	n/a
4194026	COVE PARTNERSHIP	GW	C	40	E. coli
4194858	CRATER LAKE RESORT	GW	NC	40	n/a
4100446	CROSSROADS MOBILE HOME PARK	GW	C	150	n/a
4194405	DAIRY DINER	GW	NC	40	n/a
4190379	DIAMOND LAKE JUNCTION CAFE	GW	NC	100	n/a
4190367	EAGLE CRATER LAKE INN	GW	NC	32	n/a

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4101075	FALCON HEIGHTS	GW	C	559	n/a
4194801	FAST BREAK BONANZA MARKET	GW	NC	250	n/a
4105101	FORT KLAMATH MUSEUM	GW	NC	50	n/a
4190643	GERBER WATER SYSTEM	GW	NC	100	n/a
4193994	GREEN DIAMOND RESOURCE CO	GW	NTNC	50	n/a
4194027	HARRIMAN SPRINGS RV & CABINS	GW	OVS	20	n/a
4191538	HYATT LAKE RESORT	GW	NC	50	E. coli
4190737	JACKSON CO PKS LILY GLEN #2	GW	NC	25	n/a
4194555	JELD WEN INC	GW	NTNC	227	n/a
4194236	JOS MOTEL & CAMPGROUND	GW	NC	30	n/a
4100425	KENO WATER CO INC	GW	C	290	n/a
4194727	KLAMATH AUCTION CAFETERIA	GW	NC	70	n/a
4190818	KLAMATH CO PKS HAGELSTEIN PARK	GW	NC	50	n/a
4190159	KLAMATH CO PROJECT HOMEFRONT	GW	C	37	n/a
4100443	KLAMATH FALLS WATER DEPT	GW	C	40475	n/a
4195426	KLAMATH OUTDOOR SCIENCE SCHOOL	GW	NC	50	n/a
4194522	KLAMATH SPORTSMAN PARK	GW	NC	25	n/a
4194040	KLAMATH TRAVEL INN	GW	NC	60	n/a
4100450	LAKESIDE MOBILE HOME & RV PARK	GW	C	110	n/a
4101497	LAKEWOODS WATER DISTRICT	GW	NC	30	n/a
4100183	LANTERN TRAILER PARK	GW	OVS	23	n/a
4194775	LONE PINE TRAILER PARK	GW	NC	25	n/a
4190552	LOST RIVER HIGH SCHOOL	GW	NTNC	320	n/a
4194391	MACS STORE	GW	NC	30	n/a

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4100504	MALIN MUNICIPAL WATER	GW	C	815	n/a
4100518	MERRILL WATER DEPARTMENT	GW	C	907	n/a
4194124	MOUNTAIN LAKES BIBLE CAMP	GW	NC	65	n/a
4101080	NPS ANNIE SPRINGS	GW	C	200	n/a
4194903	ODESSA MARKET	GW	NC	50	n/a
4191110	ODOT HD MIDLAND INFO CTR RA	GW	NC	1000	n/a
4191038	OPRD COLLIER STATE PARK	GW	NC	325	n/a
4101327	OREGON SHORES BEACH CLUB INC	GW	C	352	n/a
4101285	OREGON SHORES RECREATION CLUB	GW	C	275	n/a
4101475	OREGON WATER UTILITIES - MOUNTAIN LAKES	GW	C	770	n/a
4101503	OREGON WATER UTILITIES - SOUTHVIEW	GW	C	250	n/a
4101128	OREGON WATER UTILITIES-PINECREST	GW	C	78	n/a
4194766	OTIC BEAVER MARSH RA-SOUTH	GW	NC	750	n/a
4191111	OTIC HD BEAVER MARSH RA-NORTH	GW	NC	750	n/a
4106000	PALOMINO DELI & MINI MART	GW	NC	50	n/a
4195315	PILOT TRAVEL CENTER-CHEMULT	GW	NC	500	n/a
4100437	PINE GROVE WATER DIST (KLAMATH)	GW	C	180	n/a
4105016	PINEHURST SD	GW	OVS	20	n/a
4195317	POINT COMFORT	GW	NC	26	n/a
4194059	POTTERS TRAILER PARK	GW	OVS	10	n/a
4195058	PRODUCTION METAL FORMING INC	GW	NTNC	25	n/a
4190172	ROCKY POINT MARINA	GW	NC	100	n/a
4100438	ROUND LAKE WATER UTILITIES	GW	C	250	n/a

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4105181	SAND CREEK STATION	GW	NC	25	n/a
4101484	SHIELD CREST CONDOS	GW	C	45	n/a
4194722	SHIELD CREST GOLF CLUB	GW	NC	60	n/a
4101500	SHIELD CREST WATER ASSN	GW	C	65	n/a
4100439	SKYLINE VIEW DIST IMPROVEMENT	GW	C	250	n/a
4194151	SPORTSMANS PARADISE MOTEL/TC	GW	C	52	n/a
4194712	SPORTSMANS RIVER RV PARK	GW	NC	55	n/a
4100831	SPRAGUE RIVER WATER ASSN	GW	C	60	E. coli
4194808	TRAIN MTN RAILROAD MUSEUM	GW	NC	25	n/a
4101083	USFS CHEMULT RANGER STATION	GW	NC	20	n/a
4192830	USFS DIGIT POINT CG	GW	NC	140	n/a
4192826	USFS LAKE OF THE WOODS	GW	NC	350	n/a
4192825	USFS WILLIAMSON RIVER CG	GW	NC	50	n/a
4194049	WALTS RV PARK	GW	NC	70	n/a
4194435	WATER WHEEL CAMPGROUND	GW	NC	32	n/a
4194164	WHISPERING PINES MOTEL	GW	NC	30	n/a
4100431	WISEMANS MOBILE COURT	GW	C	114	E. coli
4190376	YMCA LOW ECHO	GW	NC	35	n/a
4194052	18 WHEELER TRUCK STOP (Inactive)	GW	NC	67	n/a
4195198	AGENCY LAKE RESORT 2 SOUTH (Inactive)	GW	OVS	15	n/a
4194390	AMA MINI MART #2 (Inactive)	GW	OVS	5	n/a
4194031	BIG MOUNTAIN DRIVE-UP (Inactive)	GW	NC	100	n/a
4190626	BLM HYATT LAKE REC SITE (Inactive)	GW	NC	150	n/a
4105999	BONANZA-BOWNE PARK (Inactive)	GW	NC	50	n/a

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4194377	CASCADE 97 SHELL & FOOD MART (Inactive)	GW	NC	75	n/a
4105151	CRATER LAKE RV PARK (Inactive)	GW	NC	50	n/a
4195057	EL RODEO (Inactive)	GW	NC	50	n/a
4194146	GREEN SPRINGS INN - LODGE (Inactive)	GW	NC	75	n/a
4193730	HENLEY HIGH/JR HIGH/ELEMENTARY (Inactive)	GW	NTNC	1500	n/a
4191034	JACKSON COUNTY TUB SPRINGS WAYSIDE (Inactive)	SW	NC	150	n/a
4193734	KENO ELEMENTARY COUNTY UNIT (Inactive)	GW	NTNC	200	n/a
4194173	KENO MERCANTILE (Inactive)	GW	NC	100	n/a
4105261	KLAMATH CO PKS HENZEL PARK (Inactive)	GW	NC	57	n/a
4194774	KLAMATH VENEER INC (Inactive)	GW	NTNC	32	n/a
4194030	LOREES CHALET RESTAURANT (Inactive)	GW	NC	60	n/a
4194053	MELITAS RV PARK (Inactive)	GW	NC	100	n/a
4194530	MOUNTAIN MARKET (Inactive)	GW	NC	100	n/a
4195038	NEW ALGAE CO HARVEST WS (Inactive)	GW	NC	90	n/a
4194925	ODFW KLAMATH FISH HATCHERY (Inactive)	GW	OVS	12	n/a
4193997	OREGON INSTITUTE OF TECHNOLOGY (Inactive)	GW	NTNC	3250	Arsenic
4195162	PERKED UP (Inactive)	GW	NC	50	n/a
4194828	PP&L-KENO RECREATION PARK (Inactive)	GW	NC	25	n/a
4194697	R & D MARKET (Inactive)	GW	NC	50	Nitrate
4194165	RAPIDS MOTEL (Inactive)	GW	NC	25	n/a

Public Water System ID	Public Water System Name	Primary Source	System Type	Population	MCL Alerts
4195101	RICK & TAMIS COFFEE SHOP (Inactive)	GW	NC	30	n/a
4194860	SAGE COMMUNITY SCHOOL (Inactive)	GW	NTNC	90	n/a
4195430	TRANSFORMATION WELLNESS CENTER (Inactive)	GW	NC	28	n/a
4101084	USFS CHILOQUIN RANGER STATION (Inactive)	GW	NTNC	70	n/a
4195082	USFS FOURMILE CG HP 2 (Inactive)	GW	NC	100	n/a
4192829	USFS FOURMILE LAKE CG (Inactive)	GW	NC	100	n/a
4195465	WALTS MUSHROOM CAMP (Inactive)	GW	NC	30	n/a
4190400	WHOA TAVERN (Inactive)	GW	NC	25	n/a
4105189	WILSON COTTAGES (Inactive)	GW	NC	25	n/a

System Type:

C - "Community Water System (C)" means a public water system that has 15 or more service connections used by year-round residents, or that regularly serves 25 or more year-round residents.

NTNC - "Non-Transient Non-Community Water System (NTNC)" means a public water system that is not a Community Water System and that regularly serves at least 25 of the same persons over 6 months per year.

NC - "Transient Non-Community Water System (NC)" means a public water system that serves a transient population of 25 or more persons.

NP or OVS - "State Regulated Water System (NP)" means a public water system, which serves 4 to 14 service connections or serves 10 to 24 people. Monitoring requirements for these systems are the same as those for Transient Non-Community water systems. This designation was recently changed to OVS for Oregon Very Small systems. Both designations are still used.

Appendix B – Example Well Report (Log)

WATER WELL REPORT
STATE OF OREGON

KLAM
15097

RECEIVED MAR 31 1982 WATER RESOURCES DEPT SALEM, OREGON

State Well No. 41S/12E-16da
State Permit No.

(1) OWNER:
Name City of Malin
Address
City Malin, State Ore. 97632

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary Air ☐ Driven ☐
Rotary Mud ☐ Dug ☐
Cable ☒ Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐
Thermal: Withdrawal ☐ Reinjection ☐

(5) CASING INSTALLED: Steel ☒ Plastic ☐ Threaded ☐ Welded ☒
12" Diam. from 0 ft. to 181 ft. Gauge .250
" Diam. from ft. to ft. Gauge

LINER INSTALLED: none
" Diam. from ft. to ft. Gauge

(6) PERFORATIONS: Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot Size Set from ft. to ft.
Diam. Slot Size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? Interstate Pump Co.
Yield: 1000 gal./min. with 83 ft. drawdown after 3 hrs.
" 800 " 53 " 3 "
Air test gal./min. with drill stem at ft. hrs.
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m.
Temperature of water 54 Depth artesian flow encountered ft.

(9) CONSTRUCTION: Special standards: Yes ☐ No ☒
Well seal—Material used cement
Well sealed from land surface to ~~40~~ 50 ft.
Diameter of well bore to bottom of seal 16 in.
Diameter of well bore below seal 10 in.
Number of sacks of cement used in well seal 45 sacks
How was cement grout placed? grout pump

Was pump installed? no Type HP Depth ft.
Was a drive shoe used? ☐ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☒ Yes ☐ No
Type of Water? surface depth of strata 15
Method of sealing strata off casing & cement
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Klamath Driller's well number
N.E. ¼ S.E. ¼ Section 16 T. 41S R. 12E. W.M.
Tax Lot # Lot Blk Subdivision
Address at well location:

(11) WATER LEVEL: Completed well.
Depth at which water was first found 194 ft.
Static level 25 ft. below land surface. Date 10/12/81
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 10
Depth drilled 300 ft. Depth of completed well 300 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
top soil	0	4	
brown clay & sand	4	17	
yellow clay	17	65	
gray clay	65	73	
yellow clay & coarse sand	73	117	
gray lava & clay	117	126	
gray shale	126	175	
gray lava	175	194	25
brown lava	194	207	"
gray lava	207	214	"
brown lava	214	221	"
gray lava	221	229	"
brown lava	229	260	"
gray lava	260	300	"

Work started 9/17 19 81 Completed 10/12 19 81
Date well drilling machine moved off of well 10/12 19 81

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] John A. Van Meter (Drilling Machine Operator) Date 3/29, 19 82
Drilling Machine Operator's License No. 118

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name John A. Van Meter (Person, firm or corporation) (Type or print)
Address P.O. Box 204 Malin, Ore. 97632
[Signed] John A. Van Meter (Water Well Contractor)
Contractor's License No. 170 Date 3/29, 19 82

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the WATER RESOURCES DEPARTMENT, SALEM, OREGON 97310 within 30 days from the date of well completion.

SP*12658-690

Appendix C – Study well log information

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
Both	40803	KBGW-001	Domestic	42.1931	-121.6554	KLAM_13051	647	617	D	green clay	1977
Both	40804	KBGW-002	Domestic	42.1925	-121.6581	KLAM_10515	443	410	D	soft black rock	1992
Both	40805	KBGW-003	Domestic	42.1973	-121.6795	KLAM_12873	350	334	NA	grey crevised lava	1978
2019	40806	KBGW-004	Irrigation	42.1990	-121.6796	KLAM_12944	406	385	D	broken lava, confined	1961
2019	40807	KBGW-005	Domestic	42.2190	-121.7186	not found	not found	not found	NA	not found	not found
Both	40808	KBGW-006	Domestic	42.4859	-122.0838	KLAM_53562	99	78-99	S	grey basalt	2002
Both	40809	KBGW-007	Domestic	42.5355	-121.9050	KLAM_55881	99	90-118	S	brown sand-clay	2007
Both	40810	KBGW-008	Domestic	42.5502	-121.9260	KLAM_55065	143	65-95, 110-140	S	fine black sand	2005
2019	40811	KBGW-009	Domestic	42.5496	-121.9206	KLAM_55875	369	225-248, 314-369	D	grey clay w/ black sandstone, sand	2007
2019	40812	KBGW-010	Domestic	42.9016	-121.8211	KLAM_57533	40	23-41	S	grey pumice, broken/sand	2010

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
Both	40813	KBGW-011	Domestic	42.1191	-121.7761	KLAM_14503	643	250-643	D	sandy blue clay	1983
2019	40814	KBGW-012	Domestic	42.1257	-121.7481	KLAM_14499	78	48	S	blue clay and sand	1976
Both	40815	KBGW-013	Domestic	42.1461	-121.7776	KLAM_59677	721	630-720	D	black sandstone	2016
Both	40816	KBGW-014	Domestic	42.1636	-121.7710	KLAM_56123	508	280-302, 480-508	D	fine gravel	2007
2019	40817	KBGW-015	Domestic	42.1828	-121.9079	not found	not found	not found	NA	not found	not found
Both	40818	KBGW-016	Domestic	42.5909	-121.9238	KLAM_929	196	132	S	layers coarse sand/blue clay	1981
Both	40819	KBGW-017	Domestic	42.5834	-121.9289	KLAM_1075	110 or 175	100	S	black sand	1980
Both	40820	KBGW-018	Domestic	42.6050	-121.7607	KLAM_59662	161	119-132, 143-161	S	black sandstone, clay w/ sand	2016
2019	40821	KBGW-019	Domestic	42.3073	-121.4314	KLAM_55278	280	240-280	D	black/brown lava rock with red cinders	2006
Both	40822	KBGW-020	Domestic	42.4646	-121.4782	KLAM 58436	320	55-320	D	sandstone, claystone, basalt layers	1991
Both	40823	KBGW-021	Domestic	42.0831	-121.6609	not found	not found	not found	NA	not found	not found

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
2019	40824	KBGW-022	Domestic	42.0742	-121.6862	KLAM_14652_59318	252	159, 198	D	black lava rock, cinders	1986-original 2015-deepening, 37 ft seal
2019	40825	KBGW-023	Domestic	42.1500	-121.6749	KLAM_52521	751	700-750	D	grey sand	2000
2019	40826	KBGW-024	Domestic	42.1542	-121.6608	not found	not found	not found	NA	not found	not found
Both	40827	KBGW-025	Domestic	42.1671	-121.6815	KLAM_13195	57	40	S	sandstone	1977
Both	40828	KBGW-026	PWS-Domestic	43.0802	-121.8263	KLAM_568	135	73-135	S	sand	1965
Both	40829	KBGW-027	PWS-Domestic	42.6419	-121.8812	KLAM_11796	221	42	S	rock	not found
Both	40830	KBGW-028	Domestic	42.5815	-121.8569	KLAM_990	237	225	D	sandstone	1979
2019	40831	KBGW-029	PWS-Domestic	42.5582	-121.8872	KLAM_1220	320	310	D	black sandstone, loose sand	1980
2019	40832	KBGW-030	PWS-Domestic	42.5572	-121.8865	KLAM_1152	385	210, 344	D	black rock	1986
Both	40833	KBGW-031	Domestic	42.4656	-121.4685	not found	not found	not found	NA	not found	not found
Both	40834	KBGW-032	Domestic	42.3088	-121.4187	KLAM_55733	462	unknown	NA	not found	not found
2019	40835	KBGW-033	Domestic	42.3236	-121.4681	KLAM_10499	385	183, 378-384	D	fractured black lava	1992
2019	40836	KBGW-034	Domestic	42.3022	-121.4514	not found	not found	not found	NA	not found	not found

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
Both	40837	KBGW-035	Domestic	42.1952	-121.6923	not found	not found	not found	NA	not found	not found
2019	40838	KBGW-036	Domestic	42.1913	-121.8053	KLAM_12551	234	228	D	porous basalt	1957
2019	40839	KBGW-037	Domestic	42.1554	-121.7822	not found	not found	not found	NA	not found	
Both	40840	KBGW-038	Domestic	42.1421	-121.7850	KLAM_53532	107	87-89, 103-107	S	black sand/gravel	2002
2019	40841	KBGW-039	Domestic	42.1803	-121.6909	not found	not found	not found	NA	not found	not found
2019	40842	KBGW-040	Domestic	42.2040	-121.7152	not found	not found	not found	NA	not found	not found
2019	40843	KBGW-041	Domestic	42.6164	-121.7210	not found	not found	not found	NA	not found	not found
Both	40844	KBGW-042	Domestic	42.5793	-121.7116	not found	not found	not found	NA	not found	not found
2019	40845	KBGW-043	Domestic	42.5231	-121.9129	not found	not found	not found	NA	not found	not found
Both	40846	KBGW-044	Domestic	42.4714	-121.8930	not found	not found	not found	NA	not found	not found
2019	40847	KBGW-045	Domestic	42.3114	-121.8024	not found	not found	not found	NA	not found	not found
Both	40848	KBGW-046	Domestic	42.1367	-121.9333	not found	not found	not found	NA	not found	not found
2019	40849	KBGW-047	Domestic	42.1543	-121.9366	KLAM_50645	391	350-386	D	broken black lava rock w/ cinders	1997
2019	40850	KBGW-048	Domestic	42.1922	-121.8290	not found	not found	not found	NA	not found	not found
2022	40851	KBGW-049	Municipal			KLAM_54689	454	454-488	D	broken basalt	2004
2019	40852	KBGW-050	PWS-Domestic	42.2047	-121.1315	KLAM_13609	260	not found	NA	not found	not found

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
2019	40853	KBGW-051	Domestic	42.0498	-121.7386	KLAM_51157	360	82, 312	D	grey clay and shale	1998
Both	40854	KBGW-052	Municipal	42.0128	-121.4066	KLAM_15096	380	370-380	D	heavy black water sand under lava rock	1937
Both	40855	KBGW-053	Municipal	42.0120	-121.4114	KLAM_15097	300	194	D	brown, grey lava	1982
2019	40856	KBGW-054	PWS-Domestic	42.1353	-121.7560	KLAM 12811	392	328-392	D	black volcanic, porous lava	1958
Both	40857	KBGW-055	Domestic	42.0822	-121.6813	not found	not found	not found	NA	not found	not found
2019	40858	KBGW-056	PWS-Domestic	42.2681	-121.8710	KLAM_53270	545	130, 295, cased to 545	D	greyish-red broken basalt; cinders	2002
2019	40859	KBGW-057	PWS-Domestic	42.2300	-121.8413	KLAM_55522	1355	1st wtr=399'. screen at 955+ ft.	D	Klamath volcanics-fractured zones	2006
2019	40860	KBGW-058	Domestic	42.5438	-121.9013	KLAM_1281	265	255-265	D	streaks of coarse sand/clay	1986

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
2019	40861	KBGW-059	Municipal	42.3836	-121.0510	KLAM_2415	277	259	D	broken brown lava rock	1973
2019	40862	KBGW-060	Domestic	42.2742	-121.8080	not found	not found	not found	NA	not found	not found
2022	40863	KBGW-061	PWS-Domestic	42.1222	-122.4651	JACK_57776	381	337-361	D	dk grey volcanic conglomerate, brown broken volcanics	2005
2022	40864	KBGW-062	PWS-Domestic	42.1219	-122.4681	JACK_59146_dpn	1240	post deepening: 542-645	D	grey-blue sandstone	Prev-2007, deepened-2009
2022	40865	KBGW-063	Domestic	42.1908	-121.6481	KLAM_50152	1111	587-601, 998-1111	D	black sand	1995
2022	40866	KBGW-064	Domestic	42.4668	-121.4153	KLAM_10225	176	59-70, 148-149	S	black sand	1991
2022	40867	KBGW-065	Domestic	42.1918	-121.8430	KLAM_14138	360	324, 342, 353	D	black rock w/ sand, red cinder rock	1988
2022	40868	KBGW-066	PWS-Domestic	42.1095	-122.4005	JACK_56127	300	140	D	Grey granite; weathered basalt	2003
2022	40869	KBGW-067	Domestic	42.0891	-121.9079	not found	not found	not found	NA	not found	not found

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
2022	40870	KBGW-068	Domestic	42.1257	-121.8221	KLAM_50237	129	78-129	S	black sandrock and gravel	1996
2022	40871	KBGW-069	Domestic	42.2002	-121.4020	KLAM_60712	110	62-110	S	black basalt	2020
2022	40872	KBGW-070	Domestic	42.4586	-122.1055	KLAM_51835	140	128	S	brown & grey gravel	1999
2022	40873	KBGW-071	Domestic	42.0770	-121.5254	KLAM_10231	822	95	S	black sand	1972
2022	40874	KBGW-072	Domestic	42.0977	-121.6595	KLAM_57601	350	240-350	D	grey, brown broken basalt	2010
2022	40875	KBGW-073	Domestic	42.0831	-121.6884	not found	not found	not found	NA	not found	not found
2022	40876	KBGW-074	PWS-Domestic	43.2254	-121.7891	KLAM_496	262	257	D	broken lava rock	1961
2022	40877	KBGW-075	Domestic	42.6097	-121.8740	KLAM_856	287	130, cased to 40'	S	blue clay w/ black sandstone	1981
2022	40878	KBGW-076	Domestic	42.3457	-121.8148	KLAM_2216	77	57	S	black lava boulders, fractures	1978
2022	40879	KBGW-077	Domestic	42.5813	-121.9265	KLAM_55375	84	66-85	S	coarse black sand	2006
2022	40880	KBGW-078	Domestic	42.6194	-121.7597	KLAM_54437	220	71-220	S	grey clay w/ blk sandstone,	2004

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
										sand,fine gravel	
2022	40881	KBGW-079	Domestic	42.1436	-121.9612	KLAM_60448	604	572-604	D	grey basalt-clay-red lava rock	2019
2022	40882	KBGW-080	Domestic	42.1180	-121.9244	KLAM_13713	303	32-303 est	S	hard blue lava rock	1987
2022	40883	KBGW-081	domestic	42.1225	-121.8247	KLAM_11268/57520	125	56-125	S	basalt	2010
2022	40884	KBGW-082	domestic	42.1748	-121.8185	KLAM_60665	105	72-105	S	brown claystone over black lava rock	2020
2022	40885	KBGW-083	PWS-Domestic	42.1225	-122.4642	not found	not found	not found	NA	not found	not found
	40886	KBGW-084	not sampled			not sampled			NA		
2022	40887	KBGW-085	domestic	42.1261	-121.6760	KLAM_53025	186	150-186	D	grey, brown broken basalt	2001
2022	40888	KBGW-086	municipal	43.1713	-121.7871	KLAM_518	181	131-181	NA	porous black lava under	1959

Year Well Sampled (2019 or 2022)	Well ID	Klamath Basin GW Study ID	Type of Well	Latitude	Longitude	WRD Well Log # (estimated in gray)	Depth of Well in ft. (estimated in gray)	Depth to water in contributing aquifer in ft. (estimated)*	Deep or Shallow water?	Water-bearing Geology	Year well completed (estimated in gray)
										cemented gravel	
2022	40889	KBGW-087	domestic	42.5830	-121.8561	KLAM_57519	241	187-241	D	brown sandstone w/clay	2010

D = Considered deep water well

S = Considered shallow water well

NA = Data not available

*First water level information and the shallowest depth of well screening were used to estimate the depth of groundwater sampled at the site

Gray shading indicates information was obtained from well owner, not an official well record or could not confirm well log number

Appendix D – Example Results Letter and Laboratory Report

Oregon

Kate Brown, Governor

Department of Environmental Quality
Laboratory and Environmental Assessment Division
3150 NW 229th, Suite 150
Hillsboro, OR 97124
Voice & TTY (503) 693-5700
FAX (503) 693-4999

September 2022

[redacted]

Station Description: 40803 - Klamath Basin Groundwater Well 001
Well Address: [redacted]
Well Location, depth: [redacted], 647 ft

Thank you for volunteering to have your well sampled in Winter 2022 as part of the Statewide Groundwater Monitoring Program in Klamath Basin. Your test results will help us develop a better understanding of the quality of Oregon's groundwater resources, including any potential health concerns in Klamath Basin. With this letter, we have included a report of your well water analytical test results.

We would like to assist you with the following:

- Understanding how the report is presented
- Providing the Analytical Report for your records
- Understanding what your results mean for your health
- Explaining the terms and definitions used in the report

Should you or other members of the household have health concerns that you feel may be related to your domestic well, we encourage you to talk with your physician or contact the **Oregon Health Authority's (OHA)** Domestic Well Safety Program (DWSP) at **971-673-0440**.

For additional questions about:

- **Your report,** call DEQ at 503-693-5736
- **Water treatment options,** call your County Environmental Health Representative: Lance Lindow | llindow@klamathcounty.org rquinn@co.klamath.or.us | 541 851 3740
- **For agricultural questions** related to livestock watering or irrigation, call your local OSU Extension service at 1-541-883-7131

Understanding your Report

The Analytical Report is organized so that the chemicals that were detected in your well water are **highlighted in bold** and at the top of the list. Many of these are basic parameters used to characterize the groundwater aquifer (under the headings *Nutrients, General Chemistry, Total Metals by Inductively Coupled Mass Spectrometry and General Field Parameters*). Bacteria (coliform, total and *E. coli*) are also listed (*Microbiology*). The last few sections contain the results for the pesticides, and volatile organic compounds (VOCs) tested. If there was a detection of any of these pesticides in your water it will be listed in bold at the top of the report, all other analytes are considered non-detect, designated by "<". If there were any detections of contaminants known to have a potential health risk (such as bacteria, nitrate, arsenic, lead, manganese, pesticides or VOCs), we provided a brief description of the chemical, compared your result to the known risk levels, and made recommendations for follow-up testing or treatment at the end of the report. These recommendations are provided with cooperation from OHA.

Translation or other formats
Español | 简体中文 | 繁體中文 | Русский | Tiếng Việt
800-452-4011 | Oregon TTY: 711 | deqinfo@deq.state.or.us

A note about lead results: Your well water was tested for lead. However, in order to measure the quality of the water coming from the aquifer, rather than the water sitting in the pipes, our sampling procedures include a 5-10 minute flushing period before we collect a sample. If you are concerned about lead contamination from your plumbing you should retest your water using the "first flush" method.

A note about *radiochemistry:* Radionuclides occur naturally in rocks and soils from the radioactive decay of uranium-238 and thorium-232. Breathing air or drinking water contaminated with radionuclides can have health effects. This study did not have the capacity to sample for radiochemistry, however, if you are concerned about radionuclides in your well water, please visit these webpages to learn more.

>> https://www3.epa.gov/radtown/private-wells.html

>> http://wellowner.org/water-quality/radionuclides/

A note about isotopes: A few wells in this study were tested for isotopes in partnership with the U.S. Geological Survey. These samples will help to determine where and when that groundwater infiltrated into the ground and "recharged" the groundwater flow system. A *separate letter attached explains where you can access those results* from the USGS.

There are also some online tools you may find helpful in understanding your results:

- Drinking Water Interpretation Tool: https://extension.psu.edu/drinking-water-interpretation-tool-dwit
- Well Water Interpretation Tool: http://ohiowatersheds.osu.edu/know-your-well-water/well-water- interpretation-tool

We are available to answer questions you may have about this analytical report or to provide additional resources on groundwater quality. Please feel free to contact us at: groundwater.monitoring@deq.state.or.us or **503-693-5736**

If we do not know the answer, we will direct you to health professionals at OHA or technical experts at your local health authority to assist you. Thank you again for participating in this study!

Sincerely,

Paige Haxton-Evans
Oregon Department of Environmental Quality
Laboratory Environmental Assessment Program

Translation or other formats
Español | 简体中文 | 繁體中文 | Русский | Tiếng Việt
800-452-4011 | Oregon TTY: 711 | deqinfo@deq.state.or.us

DEQ Laboratory and Environmental Assessment Division

Analytical Report

Station: 40803
Station Description: Klamath Basin Groundwater Well 001
Sampled Date/Time: 3/9/2022 2:14:00PM
Laboratory ID: 2203047-04
Sample Type: Grab Sample::GS

Analysis Summary

Analyte Name	Result:	Units:	DQL:
Nutrients			
Nitrate/Nitrite as N	**1.43**	mg/L	A
Phosphate, Total as P	**0.48**	mg/L	A
General Chemistry			
Alkalinity, Total as CaCO3	**167**	mg/L	A
Chloride	**3.75**	mg/L	A
Sulfate	**49.8**	mg/L	A
Total Dissolved Solids	**300**	mg/L	A
Total Metals by Inductively Coupled Plasma Mass Spectrometry			
Arsenic, Total recoverable	**0.38**	µg/L	A
Boron, Total recoverable	**27.6**	µg/L	A
Calcium, Total recoverable	**27.5**	mg/L	A
Hardness as CaCO3, Total recoverable	**155**	mg/L	A
Iron, Total recoverable	**134**	µg/L	A
Magnesium, Total recoverable	**21.1**	mg/L	A
Manganese, Total recoverable	**125**	µg/L	A
Potassium, Total recoverable	**4.18**	mg/L	A
Sodium, Total recoverable	**16.6**	mg/L	A
General Field Parameters			
Conductivity at 25°C	**436**	µmhos/cm	A
Dissolved Oxygen, Saturation	**2**	%	A
pH	**7.1**	pH Units	A
Temperature	**15.8**	°C	A
Microbiology			
Coliform, Total	< 1	MPN/100 mL	A
E. Coli	< 1	MPN/100 mL	A
General Chemistry			
Total Suspended Solids	< 1	mg/L	A
Total Metals by Inductively Coupled Plasma Mass Spectrometry			
Aluminum, Total recoverable	< 20.0	µg/L	A
Lead, Total recoverable	< 0.20	µg/L	A
Selenium, Total recoverable	< 2.00	µg/L	A
Uranium, Total recoverable	< 0.10	µg/L	A
Vanadium, Total recoverable	< 2.00	µg/L	A
General Field Parameters			
Dissolved Oxygen	< 0.2	mg/L	A
Low Level Analysis of Pesticides by Gas Chromatography/Mass Spectrometry			
2,4´-DDD	< 0.0517	ng/L	A

<u>**DEQ Laboratory and Environmental Assessment Division**</u>

Analytical Report

Station: 40803
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Analyte Name	Result:	Units:	DQL:
Low Level Analysis of Pesticides by Gas Chromatography/Mass Spectrometry			
2,4´-DDE	< 0.0517	ng/L	A
2,4´-DDT	< 0.0517	ng/L	A
2,6-Dichlorobenzamide	< 21.6	ng/L	A
4,4´-DDD	< 0.0517	ng/L	A
4,4´-DDD	< 21.6	ng/L	A
4,4´-DDE	< 0.103	ng/L	A
4,4´-DDE	< 21.6	ng/L	A
4,4´-DDT	< 0.103	ng/L	A
4,4´-DDT	< 21.6	ng/L	A
Acephate	< 43.3	ng/L	A
Aldrin	< 0.0517	ng/L	A
Aldrin	< 21.6	ng/L	A
alpha-BHC	< 0.0517	ng/L	A
alpha-BHC	< 21.6	ng/L	A
alpha-Chlordane	< 0.0517	ng/L	A
Azoxystrobin	< 21.6	ng/L	A
beta-BHC	< 0.0517	ng/L	A
beta-BHC	< 21.6	ng/L	A
Bifenthrin	< 54.1	ng/L	A
Bromacil	< 21.6	ng/L	A
Butachlor	< 21.6	ng/L	A
Butylate	< 21.6	ng/L	A
Chlorobenzilate	< 54.1	ng/L	A
Chloroneb	< 21.6	ng/L	A
Chlorothalonil	< 21.6	ng/L	A
Chlorpropham	< 21.6	ng/L	A
Chlorpyrifos	< 21.6	ng/L	A
cis-Chlordane	< 21.6	ng/L	A
cis-Nonachlor	< 0.0517	ng/L	A
Cyanazine	< 54.1	ng/L	A
Cycloate	< 21.6	ng/L	A
Dacthal (DCPA)	< 21.6	ng/L	B
delta-BHC	< 0.0517	ng/L	A
delta-BHC	< 21.6	ng/L	A
Diazinon	< 21.6	ng/L	A
Dichlobenil	< 21.6	ng/L	A
Dichlorvos	< 21.6	ng/L	A

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Analyte Name	Result:	Units:	DQL:
Low Level Analysis of Pesticides by Gas Chromatography/Mass Spectrometry			
Dieldrin	< 0.0517	ng/L	A
Dieldrin	< 21.6	ng/L	A
Dimethenamid	< 21.6	ng/L	A
Dimethoate	< 21.6	ng/L	A
Diphenamid	< 21.6	ng/L	A
Endosulfan I	< 0.259	ng/L	A
Endosulfan I	< 21.6	ng/L	A
Endosulfan II	< 0.0517	ng/L	A
Endosulfan II	< 21.6	ng/L	A
Endosulfan sulfate	< 21.6	ng/L	A
Endosulfan sulfate	< 0.0517	ng/L	A
Endrin	< 0.103	ng/L	A
Endrin	< 54.1	ng/L	A
Endrin aldehyde	< 54.1	ng/L	A
Endrin ketone	< 0.517	ng/L	A
EPTC	< 54.1	ng/L	A
Ethoprop	< 21.6	ng/L	A
Etridiazole	< 54.1	ng/L	A
Fenamiphos	< 21.6	ng/L	A
Fenarimol	< 21.6	ng/L	A
Fenvalerate+Esfenvalerate	< 216	ng/L	A
Fluridone	< 54.1	ng/L	A
gamma-BHC (Lindane)	< 0.0517	ng/L	A
gamma-BHC (Lindane)	< 21.6	ng/L	A
gamma-Chlordane	< 0.0517	ng/L	A
Heptachlor	< 21.6	ng/L	A
Heptachlor	< 0.0517	ng/L	A
Heptachlor epoxide	< 21.6	ng/L	A
Heptachlor epoxide	< 0.0517	ng/L	A
Hexachlorobenzene	< 0.259	ng/L	A
Hexazinone	< 54.1	ng/L	A
Malathion	< 54.1	ng/L	A
Methoxychlor	< 54.1	ng/L	A
Methoxychlor	< 0.207	ng/L	A
Methyl paraoxon	< 21.6	ng/L	A
Mevinphos	< 21.6	ng/L	A
MGK 264	< 21.6	ng/L	A

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Low Level Analysis of Pesticides by Gas Chromatography/Mass Spectrometry			
Mirex	< 21.6	ng/L	B
Mirex	< 0.0517	ng/L	A
Molinate	< 21.6	ng/L	A
Napropamide	< 21.6	ng/L	A
Norflurazon	< 54.1	ng/L	A
Oxychlordane	< 0.0517	ng/L	A
Oxyfluorfen	< 21.6	ng/L	A
Parathion-ethyl	< 21.6	ng/L	A
Parathion-methyl	< 54.1	ng/L	A
Pebulate	< 21.6	ng/L	A
Pendimethalin	< 108	ng/L	A
Permethrin	< 108	ng/L	A
Pronamide	< 21.6	ng/L	A
Propachlor	< 21.6	ng/L	A
Pyraflufen ethyl	< 21.6	ng/L	A
Pyriproxyfen	< 216	ng/L	A
Tebuthiuron	< 54.1	ng/L	B
Terbacil	< 21.6	ng/L	A
Terbufos	< 21.6	ng/L	A
Tetrachlorvinphos (Stirophos)	< 54.1	ng/L	A
trans-Chlordane	< 21.6	ng/L	A
trans-Nonachlor	< 0.0517	ng/L	A
trans-Nonachlor	< 21.6	ng/L	A
Triadimefon	< 21.6	ng/L	A
Tricyclazole	< 21.6	ng/L	A
Trifloxystrobin	< 21.6	ng/L	A
Trifluralin	< 54.1	ng/L	A
Trifluralin	< 0.517	ng/L	A
Tris (1,3-dichloro-2-propyl) phosphate (TDCP)	< 216	ng/L	A
Tris (2-chloroethyl) phosphate (TCEP)	< 21.6	ng/L	A
Vernolate	< 21.6	ng/L	A
Pesticides by Liquid Chromatography/Tandem Mass Spectrometry			
Acetamiprid	< 4.33	ng/L	A
Acetochlor	< 10.8	ng/L	A
Alachlor	< 10.8	ng/L	A
Ametryn	< 4.33	ng/L	B
Aminocarb	Void	ng/L	D

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Analyte Name	Result:	Units:	DQL:
Pesticides by Liquid Chromatography/Tandem Mass Spectrometry			
Atrazine	< 4.33	ng/L	A
Azinphos-methyl (Guthion)	< 21.6	ng/L	A
Baygon (Propoxur)	< 4.33	ng/L	A
Carbaryl	< 5.41	ng/L	A
Carbofuran	< 4.33	ng/L	A
DEET	< 32.5	ng/L	A
Deisopropylatrazine	< 4.33	ng/L	A
Desethylatrazine	< 4.33	ng/L	A
Diuron	< 4.33	ng/L	A
Fluometuron	< 4.33	ng/L	A
Imazapyr	< 43.3	ng/L	A
Imidacloprid	< 21.6	ng/L	A
Linuron	< 4.33	ng/L	A
Methiocarb	< 4.33	ng/L	A
Methomyl	< 4.33	ng/L	A
Metolachlor	< 10.8	ng/L	A
Metribuzin	< 4.33	ng/L	A
Metsulfuron Methyl	< 4.33	ng/L	C
Mexacarbate	< 4.33	ng/L	B
Neburon	< 5.41	ng/L	A
Oxamyl	< 4.33	ng/L	A
Prometon	< 4.33	ng/L	B
Prometryn	< 4.33	ng/L	B
Propazine	< 4.33	ng/L	A
Propiconazole	< 21.6	ng/L	A
Pyraclostrobin	< 4.33	ng/L	A
Siduron	< 4.33	ng/L	A
Simazine	< 4.33	ng/L	A
Simetryn	< 4.33	ng/L	B
Sulfometuron-methyl	< 4.33	ng/L	B
Terbutryn (Prebane)	< 4.33	ng/L	B
Terbutylazine	< 4.33	ng/L	A
Phenoxy Herbicides by Electron Capture Detector			
2,4,5-T	< 0.3	µg/L	B
2,4,5-TP (Silvex)	< 0.1	µg/L	B
2,4-D	< 0.1	µg/L	B
2,4-DB	< 0.6	µg/L	B

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Analysis Summary

Analyte Name	Result:	Units:	DQL:
Phenoxy Herbicides by Electron Capture Detector			
3,5-Dichlorobenzoic acid	< 0.3	µg/L	B
Acifluorfen	< 0.2	µg/L	B
DCPA acid metabolites	< 0.6	µg/L	C
Dicamba	< 0.3	µg/L	B
Dichloroprop	< 0.3	µg/L	B
Dinoseb	< 0.3	µg/L	B
MCPA	< 20.8	µg/L	B
MCPP	< 62.4	µg/L	B
Pentachlorophenol	< 0.1	µg/L	B
Picloram	< 0.6	µg/L	B
Triclopyr	< 0.3	µg/L	B
Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry			
1,1,1,2-Tetrachloroethane	< 0.500	µg/L	A
1,1,1-Trichloroethane	< 0.500	µg/L	A
1,1,2,2-Tetrachloroethane	< 0.500	µg/L	A
1,1,2-Trichloroethane	< 0.500	µg/L	A
1,1-Dichloroethane	< 0.500	µg/L	A
1,1-Dichloroethylene	< 0.500	µg/L	A
1,1-Dichloropropene	< 0.600	µg/L	A
1,2,3-Trichlorobenzene	< 0.500	µg/L	A
1,2,3-Trichloropropane (TCP)	< 0.500	µg/L	A
1,2,4-Trichlorobenzene	< 0.500	µg/L	A
1,2,4-Trimethylbenzene	< 0.500	µg/L	A
1,2-Dibromo-3-chloropropane (DBCP)	< 1.25	µg/L	A
1,2-Dibromoethane (EDB)	< 0.500	µg/L	A
1,2-Dichlorobenzene	< 0.500	µg/L	A
1,2-Dichloroethane (EDC)	< 0.500	µg/L	A
1,2-Dichloropropane	< 0.500	µg/L	A
1,2-Dimethylbenzene	< 1.00	µg/L	A
1,3,5-Trimethylbenzene	< 0.800	µg/L	A
1,3-Dichlorobenzene	< 0.500	µg/L	A
1,3-Dichloropropane	< 0.500	µg/L	A
1,4-Dichlorobenzene	< 0.500	µg/L	A
1,4-Dimethylbenzene + 1,3-Dimethylbenzene	< 1.50	µg/L	A
2,2-Dichloropropane	< 0.500	µg/L	A
2-Butanone (MEK)	< 50.0	µg/L	A
2-Chlorotoluene	< 0.500	µg/L	A

<u>**DEQ Laboratory and Environmental Assessment Division**</u>

Analytical Report

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Analysis Summary

Analyte Name	Result:	Units:	DQL:
Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry			
4-Chlorotoluene	< 0.800	µg/L	A
4-Isopropyltoluene	< 0.500	µg/L	A
4-Methyl-2-pentanone (MIBK)	< 5.00	µg/L	A
Acetone	< 40.0	µg/L	B
Benzene	< 0.500	µg/L	A
Bromobenzene	< 0.500	µg/L	A
Bromochloromethane	< 0.600	µg/L	A
Bromodichloromethane	< 0.500	µg/L	A
Bromoform	< 0.500	µg/L	A
Bromomethane	< 1.00	µg/L	A
Carbon disulfide	< 2.00	µg/L	A
Carbon tetrachloride	< 0.500	µg/L	A
Chlorobenzene	< 0.500	µg/L	A
Chloroethane	< 0.500	µg/L	A
Chloroform	< 0.500	µg/L	A
Chloromethane	< 1.00	µg/L	A
cis-1,2-Dichloroethene	< 0.500	µg/L	A
cis-1,3-Dichloropropene	< 0.500	µg/L	A
Dibromochloromethane	< 0.500	µg/L	A
Dibromomethane	< 0.500	µg/L	A
Dichlorodifluoromethane (Freon 12)	< 0.500	µg/L	A
Dichloromethane	< 1.00	µg/L	A
Ethylbenzene	< 1.00	µg/L	A
Hexachloro-1,3-butadiene	< 1.00	µg/L	A
Isopropylbenzene (Cumene)	< 0.500	µg/L	A
Methyl tert-butyl ether (MTBE)	< 0.500	µg/L	A
Naphthalene	< 2.50	µg/L	A
n-Butylbenzene	< 2.50	µg/L	A
n-Propylbenzene	< 0.800	µg/L	A
sec-Butylbenzene	< 0.500	µg/L	A
Styrene	< 0.500	µg/L	A
tert-Butylbenzene	< 0.500	µg/L	A
Tetrachloroethylene	< 0.500	µg/L	A
Toluene	< 0.500	µg/L	A
trans-1,2-Dichloroethene	< 0.500	µg/L	A
trans-1,3-Dichloropropene	< 0.500	µg/L	A
Trichloroethylene	< 0.500	µg/L	A

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Analysis Summary

Analyte Name	Result:	Units:	DQL:
Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry			
Trichlorofluoromethane (Freon 11)	< 0.500	µg/L	A
Vinyl chloride	< 0.500	µg/L	A
Xylenes, total	< 2.50	µg/L	A

DEQ Laboratory and Environmental Assessment Division

Analytical Report

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Sampled Date/Time: 03/09/2022 02:14 PM

Laboratory ID: 2203047-04

Sample Type: Grab Sample::GS

Information about your detection

Nitrate/Nitrite as N

Nitrate is a naturally occurring oxide of nitrogen and is an essential component of all living things. It is the primary source of nitrogen for plants and it occurs naturally in soil and water. But if the levels of nitrate get too high it can pose a potential health risk. Sources of excess nitrate in water include fertilizers, septic systems, wastewater treatment effluent, animal wastes, industrial wastes, and food processing wastes. Nitrite is a chemical related to nitrate that quickly converts to nitrate in the presence of oxygen. The DEQ laboratory measures nitrate and nitrite together and reports the amount of nitrogen (nitrate/nitrite as N). Since the concentration of nitrate is often much higher than nitrite, we compare the combined nitrate/nitrite concentration to the nitrate MCL to evaluate risk. Nitrate levels of up to 2 mg/ L (milligrams per liter) in well water may be naturally-occurring or possibly indicates some low level of contamination. The EPA has set an MCL of 10 mg/L for nitrate (nitrate as N) for drinking water. Nitrate levels above 10 mg/L may present a serious health concern for infants and pregnant or nursing women. The concentration of nitrate in your well was **1.43 mg/L**.

Less than 2 mg/L -- no or very little impact from human activities and your results likely represent natural background levels.
2 to 4 mg/L-- a small impact from human activities may be present. However, this level of nitrate is not a health concern for most people.
4 to 7 mg/L-- obvious impact from human activities
7 to 9.9 mg/L-- obvious impact from human activities. Your water is approaching public health limits for nitrate (10 mg/L).

Recommendations for non-detect (ND) up to 10 mg/L:

1. Nitrate in this range does not pose a significant health risk for healthy individuals, but increased monitoring for nitrate is recommended.

2. Annual testing for nitrate is recommended. Seasonal monitoring once every six months in the middle of the wet and dry seasons is best for detecting seasonal highs and lows

3. When considering nitrate treatment options remember to account for individual tolerance to risk. For example, dietary exposure to foods that have nitrates, such as cured meats; pregnant women, infants, and children; pre-existing medical conditions; or persons who are 65 years of age or older may be at higher risk. We recommend that you share these test results with your physician if you have health concerns.

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Sample Type: Grab Sample::GS

Information about your detection

Sulfate

As water moves through soil and rock formations that contain sulfate minerals, some of the sulfate dissolves into the groundwater. Minerals that contain sulfate include magnesium sulfate (Epsom salt), sodium sulfate (Glauber's salt), and calcium sulfate (gypsum). People unaccustomed to drinking water with elevated levels of sulfate, above 250 mg/L, can experience diarrhea and dehydration. Infants are often more sensitive to sulfate than adults. **As a precaution, water with a sulfate level exceeding 500 mg/L should not be used in the preparation of infant formula.** Older children and adults become accustomed to high sulfate levels after a few days.

Animals are also sensitive to high levels of sulfate. In young animals, high levels may be associated with severe, chronic diarrhea, and in few instances, death. As with humans, animals tend to become accustomed to sulfate over time. **Diluting water high in sulfate with water low in sulfate can help avoid problems of diarrhea and dehydration in young animals and animals not accustomed to drinking high sulfate water.** The ratio of water high in sulfate to water low in sulfate can be gradually increased until the animals can tolerate the high sulfate water.

If sulfate in water exceeds 250 mg/L, a bitter of medicinal taste may render the water unpleasant to drink. High sulfate levels may also corrode plumbing, particularly copper piping. In areas with high sulfate levels, plumbing materials more resistant to corrosion, such as plastic pipe, are commonly used.

Three types of treatment systems will remove sulfate from drinking water: reverse osmosis, distillation, or ion exchange. Water softeners, carbon filters, and sediment filters do **not** remove sulfate. Water softeners merely change magnesium or calcium sulfate into sodium sulfate, which is somewhat more laxative.

The EPA has established a Secondary MCL for sulfate at 250 mg/L (ppm). The concentration of sulfate in your well water was **49.8 mg/L**.

Up to 250 mg/L: This concentration is not expected to have any aesthetic effects or pose a significant health risk to you or your family.

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Information about your detection

Chloride

Chloride occurs naturally in groundwater but is found in greater concentrations where seawater and run- off from road salts (salts used to de-ice icy roads) can make their way into water sources. It generally combines with calcium, magnesium, or sodium to form various salts: for example, sodium chloride (NaCl) is formed when chloride and sodium combine. Over time, sodium chloride's high corrosivity will also damage plumbing, appliances, and water heaters. There is no federally enforceable standard for chlorides in drinking water.
Although chlorides are harmless at low levels, well water high in sodium chloride can damage plants if used for gardening or irrigation, and give drinking water an unpleasant taste. Chlorides can be removed from water with either a reverse osmosis system or a distiller.

The EPA has established a Secondary MCL level of 250 mg/L to avoid salty tastes and undesirable odors.

The concentration of chloride in your well water was **3.75 mg/L**.

Up to 250 mg/L: This concentration is not expected to have any aesthetic effects or pose a significant health risk to you or your family.

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Information about your detection

Arsenic

Arsenic is a naturally occurring element found in the earth's crust. As water flows through certain rock formations, arsenic can be dissolved and carried into underground aquifers, streams or rivers. In addition to naturally occurring arsenic, in the past arsenic was also used in some agricultural practices as a component of pesticides. Drinking water with high levels of arsenic can cause health effects such as:

- Thickening and discoloration of the skin;
- Stomach pain, nausea, vomiting and diarrhea;
- Heart, lung, liver, immune, nervous or reproductive system disorders and diabetes; and
- Cancer of the bladder, lungs, skin, kidney, liver and prostate.

The EPA has established an MCL for arsenic at 10 ug/L (parts per billion). **Total Recoverable Arsenic was detected in your well water at a concentration of 0.38 µg/L** .

Arsenic equal to 9.99 ppb or below -- Arsenic in this range does not pose a significant health risk for healthy individuals.

Recommendations:

1. Treatment of the well water is not recommended.
2. If considering treatment, think about how much risk you are willing to accept, including your dietary exposure to foods that have naturally occurring arsenic, your current or past occupational exposure to arsenic, and pre-existing medical conditions. Pregnant women, children, and persons who are 65 years of age or older may be at higher risk. We recommend that you share these test results with your physician if you have health concerns.
3. Your well should be tested for arsenic should at least once to see if it is present and at what levels . If arsenic is present in an initial test above 8 µg/L, you should retest. Upon the retest, if high concentrations continue, a treatment system should be installed. With a treatment system, testing should be done each year at point of use and every three years at the well head.

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Sample Type: Grab Sample::GS

Information about your detection

Iron

EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) do not have health-based guidelines for concentrations of Iron in drinking water. EPA's secondary contaminant level for iron which is set at 300 ug/L is designed to prevent water with a rusty color, metallic taste, or reddish/orange staining but is not associated with health effects.

Total Recoverable Iron was detected in your well water at a concentration of 134 µg/L .

Up to 300 ug/L: This concentration of Iron is not expected to cause health effects for children or adults in your family or affect the taste, color, or smell of your water.

>300 ug/L: This concentration may affect the taste, color, or smell of your water, however it is not expected to pose a significant health risk to you or your family.

DEQ Laboratory and Environmental Assessment Division

Analytical Report

Station: 40803

Station Description: Klamath Basin Groundwater Well 001

Sampled Date/Time: 03/09/2022 02:14 PM

Laboratory ID: 2203047-04

Sample Type: Grab Sample::GS

Information about your detection

Manganese

Manganese is a natural mineral commonly found in groundwater. If the groundwater is oxygen poor, manganese (and iron) will dissolve more readily, particularly if the pH of the water is on the low side (slightly more acidic) and or soils are enriched with dissolved organic carbon. At high concentrations manganese can cause water to have a brown or black color and cause staining and a bitter metallic taste. To avoid these potential health effects, the EPA Lifetime Health Advisory for manganese is set at 300 µg/L. The EPA also has a 10-day exposure health advisory for children of 1000 ug/L and for bottle-fed infants under 6 months they recommend avoiding short-term exposure above 300 ug/L. These short term levels are a safe range designed to prevent effects on children's developing brains, and do not necessarily reflect a level where health effects will occur.

Total Recoverable Manganese was detected in your well water at a concentration of 125 µg/L .

Up to 50 ug/L: This concentration is not expected to have any aesthetic effects or pose a significant health risk to you or your family.

>50 and <300 ug/L: This concentration may cause discoloration, staining or a metallic taste, however it is not expected to pose a significant health risk to you or your family.

>300 ug/L: This concentration is above the EPA Lifetime Health Advisory and may be a risk to your health. It is recommended that you consider finding a safe source of drinking water or use bottled water from an approved source. Boiling your water will **not** remove the manganese. There are several water treatment options available for manganese. If you choose to treat your water, make sure your system is certified by NSF (www.nsf.org <http://www.nsf.org>) to remove manganese.

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Analytical Report

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Sampled Date/Time: 03/09/2022 02:14 PM

Laboratory ID: 2203047-04

Sample Type: Grab Sample::GS

Information about your detection

Boron

Boron is a non-metallic, naturally-occurring, element found in rocks, soil, and water. Boron does not exist as a pure element but is combined with oxygen as borate minerals and various boron compounds such as boric acid, borax, and boron oxide. Boron compounds are used primarily in the production of glass and ceramics, pesticides, fire retardants, plus insulation-grade- and textile-grade-glass fibers. Boron can be present in commercial plant foods and fertilizers. Boron compounds are often found in household laundry and cleaning products. Boron gets into drinking water from both naturally-occurring and man-made sources. Some areas in the western United States (California, Nevada, Oregon) have high concentrations of boron in some of their soils.

Contamination of water can come directly from industrial wastewater and municipal sewage, as well as indirectly from air deposition and soil runoff. Natural weathering processes, burning of coal in power plants, chemical plants, and manufacturing facilities releases boron into the air; and fertilizers, herbicides, and industrial wastes are among the sources of soil contamination. Boron is found in soil and is taken up by plants. It found naturally in fruits, legumes, nuts, vegetables, and grains. The average intake of boron in the U.S. diet ranges from 0.85 mg B/day (4-8 year old child) to 1.47 mg B/day (male vegetarian). Dietary levels can be as high as 5-6 mg/day for some individuals.

An acute boron overdose to infants has caused diarrhea, vomiting, signs of irritability, redness in the diaper area, a mild red rash on the face and neck, a pus-like discharge or mild congestion of the eye, and possibly convulsive seizures. In adults, an acute overdose causes nausea, vomiting, redness of the skin, difficulty swallowing due to ulcers in the throat, and a non-bloody diarrhea. In animals, acute excessive exposure has caused lethargy, rapid respiration, eye inflammation, swelling of the paws, shedding of the skin on the paws and tails, excitation during handling, and changes in the cells of the forestomach.

Continued on next page.

DEQ Laboratory and Environmental Assessment Division

Analytical Report

The EPA has set a One-Day and Ten-Day Health Advisory (HA) at 3.0 mg/L (3000 ppb or ug/L) and a Longer-Term Health Advisory of 2.0 mg/L (2000 ppb or ug/L) for children. A Lifetime Health Advisory for adults is set at 6 mg/L (6000 ppb or ug/L). Water containing boron at levels above the HA should not be used to prepare food or formula for infants and children.

Total Recoverable Boron was detected in your well water at a concentration of 27.6 µg/L .

Up to 2000 ppb (2.0mg/L): This concentration is below EPA Health Advisory Levels, and is not expected to pose a significant health risk to you or your family.

>2000 and <6000 ppb (2-6 mg/L): This concentration exceeds EPA Lifetime Health Advisory for children and may be a risk to children drinking the water. If children are drinking the water, it is recommended that you find a safe source of drinking water or use bottled water from an approved source. Boiling your water will **not** remove the Boron. If you choose to treat your water, make sure your system is certified by NSF (www.nsf.org) to remove Boron.

>6000 ppb (6.0 mg/L): This concentration exceeds EPA Lifetime Health Advisory for adults and may be a risk to your health. It is recommended that you consider finding a safe source of drinking water or use bottled water from an approved source, until you can talk with a health professional about your exposure risks. Boiling your water will **not** remove the Boron. There are several water treatment options available for vanadium. If you choose to treat your water, make sure your system is certified by NSF (www.nsf.org) to remove Boron.

DEQ Laboratory and Environmental Assessment Division

Analytical Report

Explanation of terms and phrases used in your Analytical Report

Data Quality Levels (DQL) listed on your Analytical Report:

A = Data of known Quality; meets Quality Control (QC) limits established in a DEQ approved plan.

B = Data of known but lesser quality; Data may not meet established QC but is within marginal acceptance criteria; or data value may be accurate, however controls used to measure Data Quality Objective elements failed (e.g. batch failed to meet blank QC limit); the data is generally usable for most situations or in supporting other, higher quality data.

C= Data of unacceptable quality; Generally due to QC failures but may be related to other known information about the sample. Data should not be used for a single result but may provide information about water quality in general.

D= No data available; No sample collected or no reportable results. Samples are either voided or cancelled.

E= Data of unknown quality; Insufficient QA/QC or other information available to make determination. Data could be acceptable; however, no evidence is available to prove either way. Data is provided for Educational Use Only.

F= An exceptional event occurred. Results may not be representative of the resource sampled. Laboratory analysis meets quality assurance criteria.

Terms

mg/L (milligrams per liter; parts per million; ppm)
Unit of concentration equivalent to one penny in $10,000; or 2 quarts (half gallon) in an Olympic sized swimming pool (- 600,000 gallons).

µg/L (micrograms per liter; parts per billion; ppb)
Unit of concentration equivalent to one second in 32 years; or 1 gallon jug of milk distributed in Detroit Lake Reservoir at it's fullest (-1.5 billion gallons). There are 1,000 µg/L in 1 mg/L.

ng/L (nanograms per liter; parts per trillion; ppt)
Unit of concentration equivalent to one 5 gallon bucket of liquid distributed in the entirety of Crater Lake (-4.6 trillion gallons). There are 1,000 ng/L in 1 µg/L and 1,000,000 ng/L in 1 mg/L.

EPA United States Environmental Protection Agency

MCL Maximum Contaminant Level defined by EPA as the maximum permissible level of a contaminant in water, which is delivered to any user of a public water system. There are no regulations for water that comes from a private, domestic well. However, the MCL set for public water systems is a very reliable health based standard for domestic wells. http://water.epa.gov/drink/contaminants

SMCL EPA has established National Secondary Drinking Water Regulations (NSDWRs) that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these "secondary maximum contaminant levels" (SMCLs). They are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the SMCL. https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

Human health benchmark for pesticides (HHBP), Regional Screening Level (RSL) and Health-based screening level (HBSL)
Non-Enforceable benchmark concentrations in water below which adverse health effects are not expected over a lifetime of exposure calculated by the EPA and the United States Geological Survey, respectively. http://www.epa.gov/region9/superfund/prg/, http://water.usgs.gov/nawqa/HBSL

Breakdown product
A new chemical that results from the degradation of another (parent) chemical. Degradation may occur because of biological activity, exposure to light or air, or by another similar process.

Appendix E – Complete Analyte List

Klamath Basin Groundwater Study 2019/2022 Analyte List of 241

Analyte group, *Analyte sub-group*, Analyte Name 1/4

Bacteria

- Total Coliform
- *E. coli*

Consumer Product Constituents

- Acetaminophen
- Caffeine
- Carbamazepine
- Codeine
- Cotinine
- N,N-Diethyl-m-toluamide (DEET)
- Diphenhydramine, Ethanamine, 2-(diphenylmethoxy)-N,N-dimethyl-
- Ibuprofen, Benzeneacetic acid, .alpha.-methyl-4-(2-methylpropyl)-
- Sulfamethoxazole
- Triclosan
- Venlafaxine

Pesticides (current use and legacy)

Fungicides

- Azoxystrobin
- Chloroneb
- Chlorothalonil
- Etridiazole
- Fenarimol
- **Hexachlorobenzene (banned in US in 1984)**
- Propiconazole
- Pyraclostrobin
- Triadimefon
- Tricyclazole
- Trifloxystrobin

Herbicides

- **2,4,5-T (banned in US since 1985)**
- **2,4,5-TP (Silvex) (herbicide banned in US since 1985)**
- 2,4-D
- 2,4-DB
- 2,6-Dichlorobenzamide (DBA)
- Acetochlor
- Acifluorfen
- Alachlor
- Ametryn
- Aminocarb

Pesticides (current use and legacy) cont'd

Herbicides

- Atrazine
- Bromacil
- Butachlor
- Butylate
- Chlorpropham
- Cyanazine
- Cycloate
- **Dacthal (DCPA) (Chlorthal-dimethyl) (banned in US in 2024)**
- DCPA acid metabolites (Chlorthal monoacid and diacid degradates)
- Deisopropylatrazine [diaminochlorotriazine (DACT)]
- Desethylatrazine (2-Chloro-4-isopropylamino-6-amino-s-triazine)
- Dichlobenil
- Dichlorprop
- Dimethenamid
- **Dinoseb (banned in 1986)**
- Diphenamid
- Diuron
- EPTC (S-Ethyl dipropylthiocarbamate)
- Fluometuron
- Fluridone
- Hexazinone
- Imazapyr
- Linuron
- MCPA
- Mecoprop-p (MCPP-P)
- Metolachlor
- Metribuzin
- Metsulfuron-methyl
- Molinate
- Napropamide
- Neburon
- Norflurazon
- **Oxyfluorfen (not banned but heavily regulated)**
- Pebulate
- Pendimethalin
- Picloram
- Prometon

Analyte group, *Analyte sub-group*, Analyte Name 2/4

Pesticides (current use and legacy) cont'd

Herbicides

- Prometryn
- Pronamide
- **Propachlor (discontinued in 1998)**
- **Propazine (banned in 2021)**
- Pyraflufen-ethyl
- Siduron
- Simazine
- Simetryn
- Sulfometuron methyl
- Tebuthiuron
- Terbacil
- Terbutryn (Prebane)
- Terbuthylazine
- Triclopyr
- Trifluralin
- Vernolate

Insecticides

- 3,5-Dichlorobenzoic acid
- Acephate
- Acetamiprid
- Azinphos-methyl (Guthion)
- Bifenthrin
- Carbaryl
- **Carbofuran (banned in US in 2009)**
- Chlorpyrifos
- Diazinon
- Dicamba
- Dichlorvos
- Dimethoate
- Ethoprop
- Fenamiphos
- Fenvalerate + Esfenvalerate
- Imidacloprid
- Malathion
- Methiocarb

Pesticides (current use and legacy) cont'd

Insecticides

- Methomyl
- Methyl paraoxon
- **Methyl parathion (banned in US in 2014)**
- Mevinphos
- **Mexacarbate (Zectran) (considered discontinued as of 2009)**
- MGK264 (N-2-Ethylhexylbicycloheptenedicarboximide)
- Oxamyl
- **Parathion (banned in US in 1998)**
- Permethrin
- Propoxur (Baygon)
- Pyriproxyfen
- Terbufos
- Tetrachlorvinphos (Stirophos)

Other Legacy Pesticides

- **Aldrin (banned in US in 1987)**
- **Chlorobenzilate (banned in US in 1999)**
- **Dieldrin (banned in US in 1987)**
- **alpha.-Endosulfan, Endosulfan I (banned in US in 2010)**
- **beta.-Endosulfan, Endosulfan II (banned in US in 2010)**
- **Endosulfan sulfate (banned in 2010)**
- **Endrin (banned in US in 1986)**
- **Endrin aldehyde (banned in US in 1986)**
- **Endrin ketone (banned in US in 1986)**
- **Endrin + cis-Nonachlor (banned in US in 1986)**
- **Heptachlor (banned in 1988)**
- **Heptachlor epoxide (banned in 1988)**
- **Methoxychlor (banned in US in 2003)**
- **Mirex (banned in US in 1978)**
- **Pentachlorophenol (banned in US in 2024)**

BHC-Technical (HCH)

- **alpha.-Hexachlorocyclohexane (alpha BHC) (banned in US in 1985)**
- **beta.-Hexachlorocyclohexane (beta BHC) (banned in the 1980s)**
- **delta.-Hexachlorocyclohexane (delta-BHC) (banned in 1976)**
- **gamma-BHC (Lindane) (banned in US in 2023)**

Analyte group, *Analyte sub-group*, Analyte Name	3/4
Other Legacy Pesticides, cont'd	**Standard Parameters, cont'd**
Chlordane	Hardness as CaCO3, Total recoverable
cis-Chlordane (alpha-chlordane) (banned in US in 1988)	Nitrate + Nitrite as N
cis-Nonachlor (banned in US in 1988)	Phosphate, Total as P
gamma-Chlordane + trans-Nonachlor (banned in 1988)	Sulfate
Oxychlordane (banned in US in 1998)	Total Dissolved Solid
trans-Chlordane (banned in 1988)	Total Suspended Solids
trans-Nonachlor (banned in 1988)	**Field Parameters**
Total DDT	Conductivity
o,p'-DDD (2,4´-DDD) (banned in US in 1972)	Dissolved oxygen (DO)
o,p'-DDE (2,4´-DDE) (banned in US in 1972)	pH
o,p'-DDT (2,4´-DDT) (banned in US in 1972)	Temperature
p,p'-DDD (4,4´-DDD) (banned in US in 1972)	**Volatile Organic Compounds**
p,p'-DDE (4,4´-DDE) (banned in US in 1972)	1,1,1,2-Tetrachloroethane
p,p'-DDT (4,4´-DDT) (banned in US in 1972)	1,1,1-Trichloroethane
Metals, Total Recoverable	1,1,2,2-Tetrachloroethane
Aluminum	1,1,2-Trichloroethane
Arsenic	1,1-Dichloroethane
Boron	1,1-Dichloroethylene
Calcium	1,1-Dichloropropene
Iron	1,2,3-Trichlorobenzene
Lead	1,2,3-Trichloropropane (TCP)
Magnesium	1,2,4-Trichlorobenzene
Manganese	1,2,4-Trimethylbenzene
Potassium	1,2-Dibromo-3-chloropropane
Selenium	1,2-Dichloroethane (EDC)
Sodium	1,2-Dichloropropane
Uranium	1,3,5-Trimethylbenzene
Vanadium	1,3-Dichloropropane
Standard Parameters	2,2-Dichloropropane
Alkalinity, total as CaCO3	Acetone
Chloride	Benzene

Analyte group, *Analyte sub-group*, Analyte Name	4/4
Volatile Organic Compounds, cont'd	**Volatile Organic Compounds, cont'd**
Bromobenzene	Naphthalene
Carbon disulfide	n-Butylbenzene
Carbon tetrachloride	n-Propylbenzene
CFC-11 (Trichlorofluoromethane (Freon 11))	o-Chlorotoluene
CFC-12 (Dichlorodifluoromethane (Freon 12))	o-Dichlorobenzene (1,2-Dichlorobenzene)
Chlorobenzene	o-Xylene (1,2-Dimethylbenzene)
Chlorodibromomethane (Dibromochloromethane)	p-Chlorotoluene
Chloroethane	p-Cymene, 4-Isopropyltoluene
Chloroform	p-Dichlorobenzene (1,4-Dichlorobenzene)
Chloromethane	sec-Butylbenzene
cis-1,2-Dichloroethylene	Styrene
cis-1,3-Dichloropropene	tert-Butylbenzene
Cumene (Isopropylbenzene)	Tetrachloroethylene
Dibromomethane	Toluene
Dichlorobromomethane (Bromodichloromethane)	trans-1,2-Dichloroethylene
Ethylbenzene	trans-1,3-Dichloropropene
Ethylene dibromide (1,2 Dibromoethane) (EDB)	Tribromomethane (Bromoform)
Halon 1011 (Bromochloromethane)	Trichloroethylene
Hexachlorobutadiene	Vinyl chloride
m,p-Xylene (1,4-Dimethylbenzene + 1,3-Dimethylbenzene)	Xylenes
m-Dichlorobenzene (1,3-Dichlorobenzene)	**Semi-volatiles**
Methyl bromide(Bromomethane)	Tris (1,3-dichloro-2-propyl) phosphate (TDCP)
Methyl ethyl ketone (2-Butanone (MEK))	Tris (2-chloroethyl) phosphate (TCEP)
Methyl isobutyl ketone (MIBK)	
Methyl tert-butyl ether	
Methylene chloride	