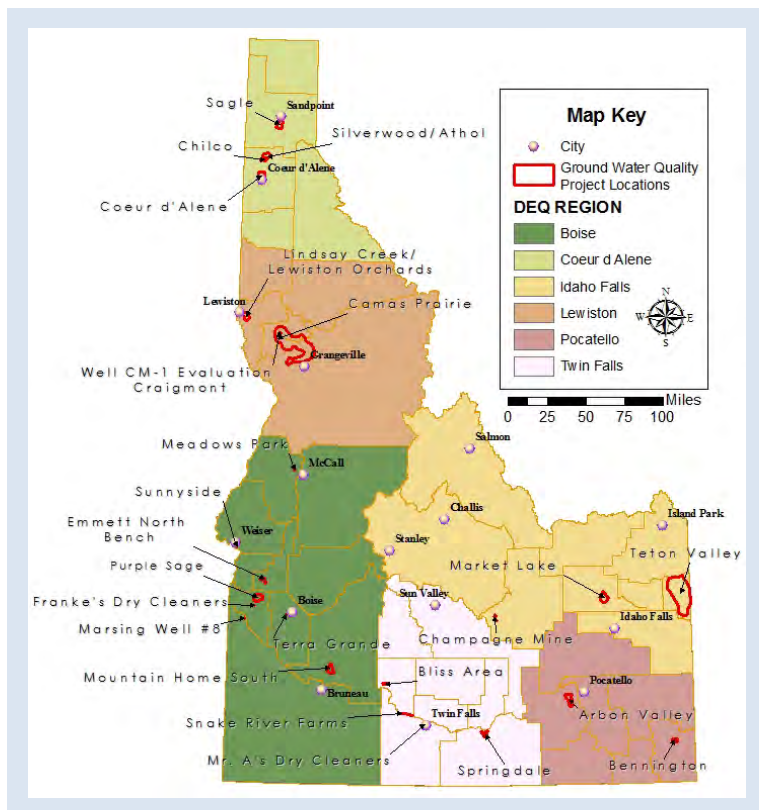


2007 and 2008 Ground Water Quality Monitoring Projects Summary Report Idaho Department of Environmental Quality



Idaho Department of Environmental Quality
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List of Acronyms, Abbreviations, and Symbols

$\delta^{15}\text{N}$	the ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{18}\text{O}$	the ratio of the two oxygen isotopes ^{18}O and ^{16}O
$\delta^2\text{H}$	deuterium, the ratio of the two hydrogen isotopes ^1H and ^2H , also denoted as δD
Al	aluminum
As	arsenic
bgs	below ground surface
BMP	best management practice
Ca	calcium
CAFO	confined animal feeding operation
Cl	chloride
CN	cyanide
CO_3	carbonate
Cu	copper
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
EPA	Environmental Protection Agency
Fe	iron
FTR	Friends of the Teton River
GMWL	global meteoric water line
GWQMP	ground water quality management plan
HCO_3	bicarbonate
IDTL	Idaho default target level
IDWR	Idaho Department of Water Resources
IGC	Idaho Gold Corporation
IOC	inorganic chemical
ISDA	Idaho State Department of Agriculture
K	potassium
LSCD	Lewis Soil Conservation District
MCL	maximum contaminant level
mg/L	milligrams per liter
Mn	manganese
MPN/100 ml	most probable number per 100 milliliters
Na	sodium
ND	non detect
ng/L	nanograms per liter
NO_3	nitrate
$\text{NO}_3\text{-N}$	nitrate as nitrogen
NPDES	national pollution discharge elimination system
PCE	tetrachloroethylene, or perchloroethylene
PCPP	personal care products and pharmaceuticals
per mil ($^0/_{00}$)	parts per thousand
PHD	Panhandle Health District
PWS	public water system

REM	risk evaluation manual
RPSRA	Rathdrum Prairie sensitive resource aquifer
SO ₄	sulfate
Sp Cond	specific conductivity
SRPA	Snake River plain aquifer
SWDH	Southwest District Health
TCE	trichloroethylene
TDS	total dissolved solids
TKN	total kjeldahl nitrogen
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
VOC	volatile organic compound
Zn	Zinc

1. Introduction

Ground water is one of Idaho's most valuable resources providing nearly all the state's drinking water and is a vital component of the state's economy.

Idaho Statute (Title 39, Chapter 1) designates the Idaho Department of Environmental Quality (DEQ) as the primary agency to coordinate and administer ground water quality protection programs for the state. DEQ is also responsible for collecting and analyzing data for ground water quality management purposes. The statute further directs DEQ, the Idaho Department of Water Resources, and the Idaho State Department of Agriculture to develop a ground water quality monitoring plan and promote public awareness of ground water quality by making results of ground water quality investigations available to the public.

Public Water Systems (PWS) are regulated by DEQ under the federal Safe Drinking Water Act and the Idaho Rules for Public Drinking Water Systems. These regulations require chemical analysis of drinking water for various constituents. DEQ follows up when contaminants of concern are detected in PWSs. DEQ also implements the Source Water Protection Program to help protect drinking water.

In order to identify degraded ground water, DEQ uses ground water quality monitoring data to delineate Nitrate Priority Areas (NPAs). NPAs were developed initially in 2002 and were updated in 2008. Ground water quality monitoring data are fundamental in determining the NPAs. DEQ has worked in coordination with other agencies as well as stakeholders to develop Ground Water Quality Management Plans (GWQMP) to address ground water degradation in NPAs. Ground water monitoring data are used to evaluate the effectiveness of GWQMP implementation.

Similar to responding to contamination in PWSs, DEQ also responds to detections of concern found by monitoring programs implemented by other entities, such as the Statewide Ambient Ground Water Quality Monitoring Network, administered by the Idaho Department of Water Resources. Follow-up investigations may develop into a DEQ local or regional monitoring project to assess background conditions and identify areas where public health may be threatened. The investigation results can facilitate management decisions that affect the resource and promote public awareness for ground water protection.

This report is intended to provide the public an overview of DEQ's ground water monitoring projects and investigation activities accomplished with public funds. Previously, the ground water quality monitoring activities were included as a chapter in the Integrated 305(b) Report for surface water, which DEQ submits to the Environmental Protection Agency (EPA).

This ground water quality report summarizes results from publically funded activities. It does not contain results from privately funded activities including monitoring required by permits or monitoring associated with ongoing environmental remediation projects.

2. Source Water Assessments

In 1996, Congress amended the Safe Drinking Water Act to emphasize the protection of surface and ground water sources used for public drinking water. The amendments require that each state develop a source water assessment plan for public drinking water sources, conduct assessments of all PWSs, and make the assessments available to the public. In 1999, the [Idaho Source Water Assessment Plan](#) (DEQ, 1999) was developed by DEQ and has been implemented by DEQ.

A PWS is defined by EPA and DEQ as a system for the conveyance of water to the public for human consumption, if the system has at least 15 service connections or regularly serves an average of at least 25 individuals at least 60 days per year. Based on EPA (2008a, 2008b) statistics compiled from state reported data, Idaho had 1,917 and 1,907 active PWSs that obtained their water from ground water sources in 2007 and 2008, respectively, accounting for 96 percent of all PWSs in the state.

DEQ administers the [Safe Drinking Water Act](#) and the [Idaho Rules for Public Drinking Water Systems \(IDAPA 58.01.08\)](#) through the Drinking Water Program. Approximately 96 percent of Idaho's PWSs use ground water as their source of drinking water. PWS sources (both ground water and surface water) are monitored under the DEQ Drinking Water Program. The DEQ Ground Water Program conducts additional monitoring when contaminants of concern are detected in PWSs. Please refer to the [DEQ Drinking Water](#) webpage for more information regarding the required monitoring at PWSs.

Source Water Assessments are the first step in protecting Idaho drinking water sources. Assessments summarize the likelihood of individual drinking water sources becoming contaminated and serve as the cornerstone of drinking water protection. DEQ completed assessments on all recognized public water sources in May 2003 and continues to complete assessments for new public water sources as well as update assessments as new information becomes available.

In 2007 and 2008, DEQ continued to delineate and assess public water sources in Idaho and develop source water assessment reports for these sources. A Source Water Assessment report includes the following elements: (a) source water delineations, (b) potential contaminant inventories, (c) susceptibility analyses, and (d) system summary information.

In 2007 DEQ completed 63 source water delineations and 55 source water assessment reports for public drinking water sources. In 2008 DEQ completed 60 source water delineations and 53 source water assessment reports for community and non-community public drinking water sources. Many source water assessment reports contain multiple source water delineations that are part of one public water system.

3. Nitrate Priority Areas

Although the quality of ground water in Idaho is generally good, ground water quality monitoring shows that in some areas Idaho's ground water has been significantly degraded. This localized degradation potentially threatens drinking water supplies, aquaculture, agriculture, mining, industry, future beneficial uses of ground water, and surface water.

Nitrate is one of the contaminants causing localized degradation and is one of the most widespread ground water contaminants in Idaho. Nitrate is a form of nitrogen, an element vital for plant growth and a component of food and fertilizers. Nitrate comes from a variety of sources, such as plants and other organic matter that return nitrate to the soil as they decompose. Nitrate that is not then taken up by living plants can build up in and move through the soil. Precipitation, irrigation, and sandy soils allow nitrate to move into surface water and ground water. Septic systems, waste from animal feedlots, and nitrogen-based fertilizers release nitrate to the environment.

While nitrate is just one of the potential ground water contaminants in Idaho, more is known about nitrate in ground water than any other contaminant. In addition, the presence of nitrate is a good indicator of other potential water quality problems.

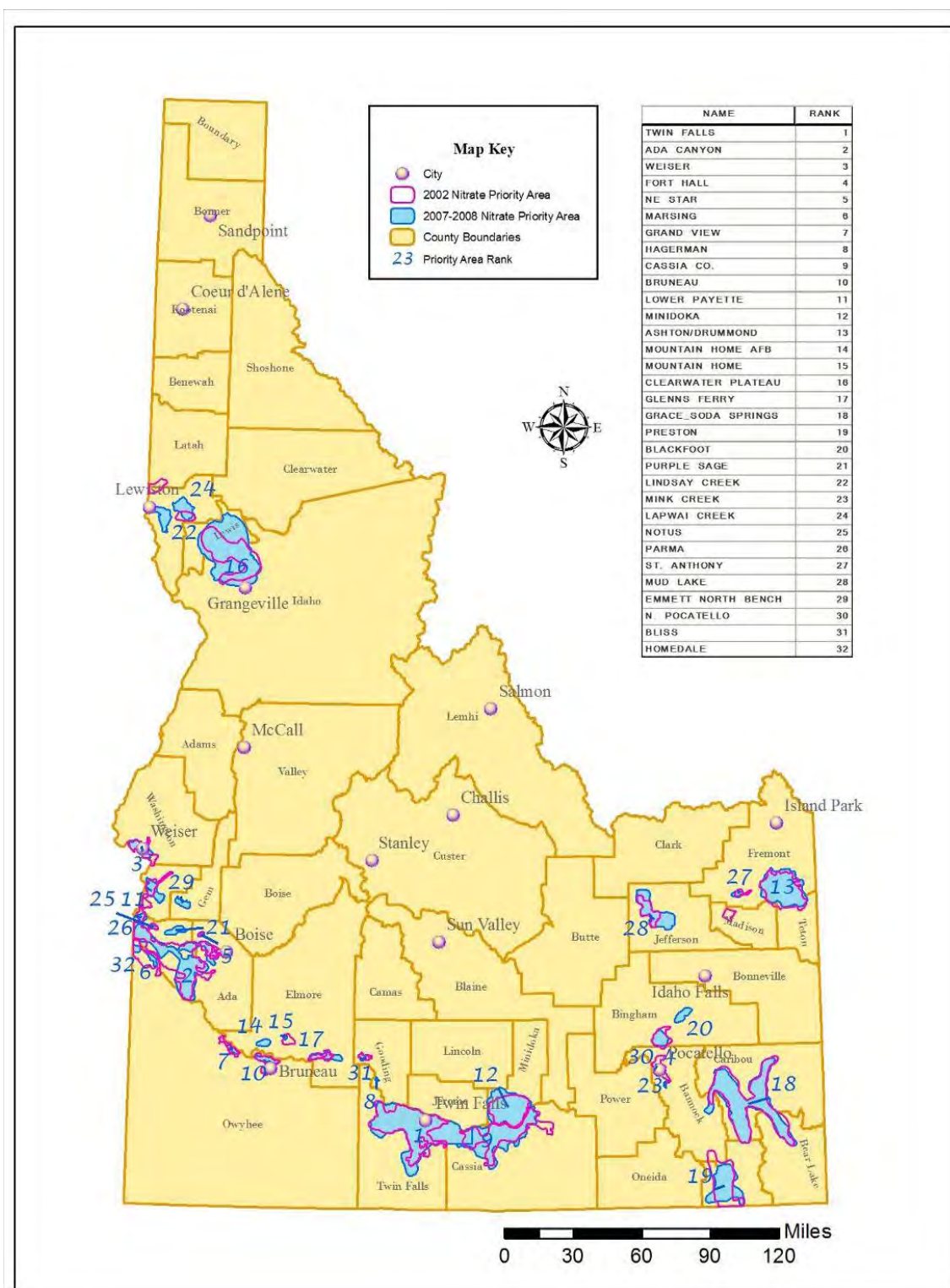
As part of DEQ's goal of restoring degraded ground water, DEQ has identified 32 ground water quality areas degraded by nitrate as Nitrate Priority Areas (NPAs). The criteria for the designation is when 25% of the ground water samples in an area contain nitrate levels equal or greater than 5 milligrams per liter (mg/L), which is one half of the maximum contaminant level (MCL) of 10 mg/L.

3.1. Five Year Review

Nitrate Priority Areas are ranked based on criteria such as population, existing water quality, and water quality trends. The ranking process takes into account impacts on beneficial uses of ground water in addition to drinking water supply. The data used to rank the priority of the areas are updated on a continual basis. The ranking was accomplished using a specific nitrate priority ranking process developed by the Ground Water Monitoring Technical Committee and is described in the [2008 Nitrate Priority Area Delineation and Ranking Process](#) document (DEQ, 2008a).

DEQ has developed a [list of degraded ground water areas](#) (DEQ, 2008b). This list ranks the 32 NPAs in the state based on the severity of the nitrate degradation; the rank of "1" indicates the most severely impacted area in the state. The NPA ranking was originally released in 2002 and was updated in 2008. Figure 1 compares the 2002 to the 2008 NPAs and shows the current ranking.

An [interactive mapping application of the NPAs](#) has been developed and is available on DEQ's website. The application contains nitrate concentrations detected in wells monitored by public water systems, DEQ, the Idaho Department of Water Resources in conjunction with the U.S. Geological Survey, and Idaho State Department of Agriculture.



3.2. Ground Water Quality Management Plans

The NPA ranking is used to prioritize the development and implementation of strategies to help reduce nitrate loading from land-use activities. DEQ, in coordination with other agencies, assists local ground water quality advisory groups in developing ground water quality management strategies for NPAs. The management strategies for each NPA are documented by DEQ in Ground Water Quality Management Plans (GWQMP) or Ground Water Quality Improvement Plans. For the purpose of this report they will be referred to as GWQMPs. Completed GWQMPs are available on DEQ's [Ground Water Management Plans and Guidance](#) web page. Table 1 summarizes the number of GWQMPs that have been completed up to 2008 and provides an estimated schedule for updating or completing additional plans.

Table 1. Summary of Ground Water Quality Management Plans by Regional Office.

Notes: NPA = Nitrate priority area; GWQMP = Ground water quality management plan; FY = state Fiscal Year (July 1 through June 30)

Regional Office	No. of NPA 2002	No. of NPA 2008	No. GWQMP Completed 2007 & 2008	Total No. GWQMP Completed	Estimated Completion Schedule
Boise Regional Office	10	15	1	4	Owyhee County - FY 2009 Ada County – FY 2010 Elmore County FY 2010 Gem County – FY 2011 Lower Boise/Canyon County (update) - FY 2011 Weiser (update) – FY 2011
Coeur d'Alene Regional Office	0	0	N/A	N/A	N/A
Idaho Falls Regional Office	4	3	0	0	Ashton – FY 2010
Lewiston Regional Office	3	3	1	1	Lindsay Creek Area – FY 2010
Pocatello Regional Office	4	6	0	0	N. Pocatello – FY 2010 plan initiated and combines NPA strategies with Source Water Protection
Twin Falls Regional Office	4	5	2	4	Twin Falls County and Cassia County update – FY2010
Total	25	32	4	9	

4. Summary of Ground Water Quality Projects by Region

This section presents the ground water quality monitoring and investigation projects that were conducted by DEQ in 2007 and 2008. Projects are presented by region. Figure 2 identifies project locations and DEQ regions. An [interactive mapping application](#) of DEQ ground water quality data is available on DEQ's website. The application contains ground water quality data that DEQ or its contractors have collected.

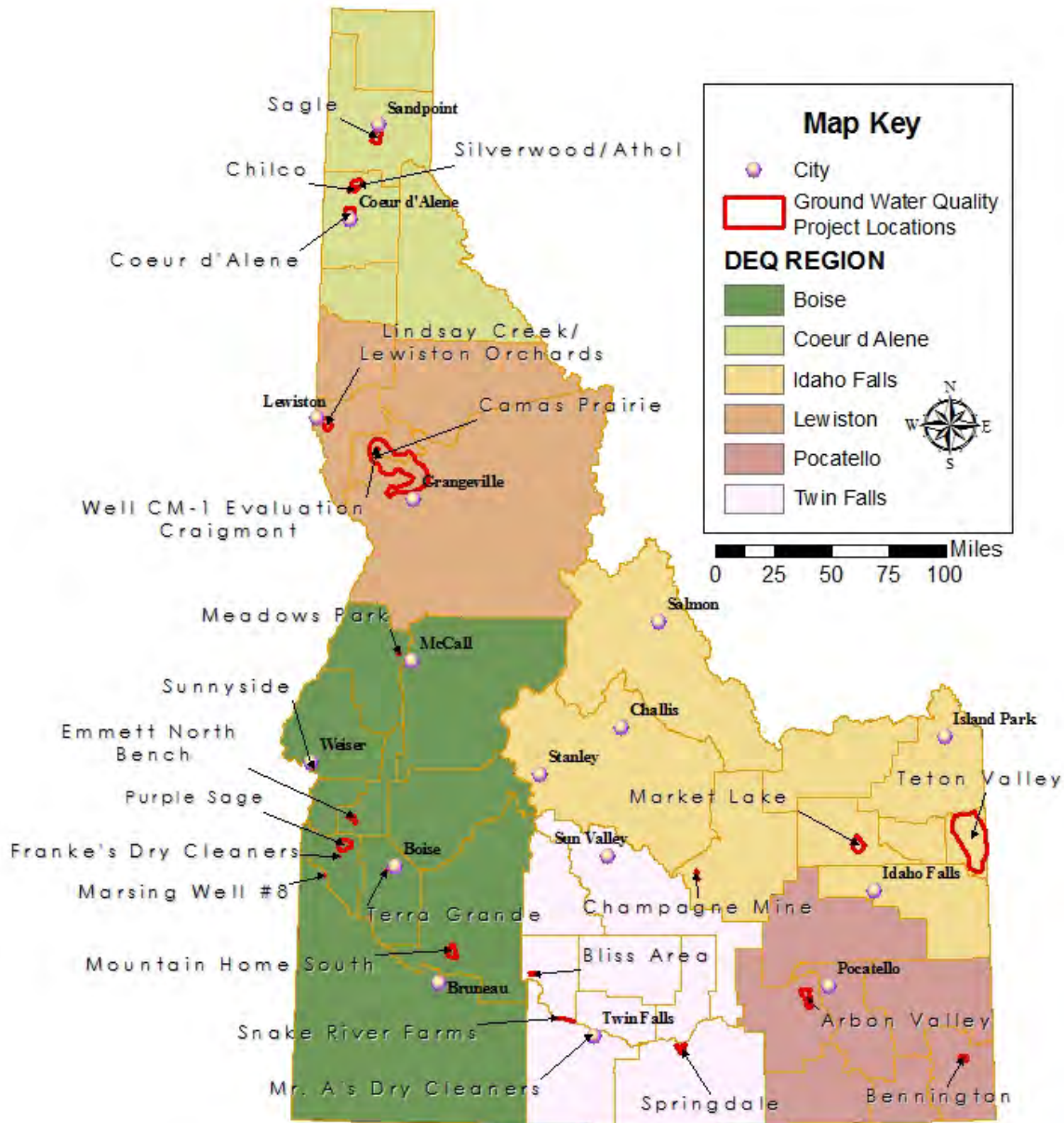


Figure 2. DEQ's 2007 and 2008 ground water quality project locations.

4.1. Boise Region

4.1.1 Meadows Park Water User Association

Meadow Park Water Users Association (PWS #3020011) is located near New Meadows in Adams County and consists of three wells: Wells 1, 2 and 3. In 2007, Well 2 had been out of service for some time due to reoccurring bacteria detections in the well. Well 2 was chlorinated several times and retested, but positive bacteria results occurred soon after chlorination. Several lots in the approximately 40-lot subdivision had not been developed as of 2007 and the water supply from Wells 1 and 3 was adequate to supply only the existing homes. Development of the remaining lots will exceed the water system capacity when only the two wells are in service.

The Meadow Park public water system is under the regulatory oversight of the Southwest District Health Department (SWDH). In 2007 SWDH requested that DEQ provide assistance to the association to help determine the source of bacteria in Well 2. Figure 3 shows the location of the three wells and also the location of Goose Creek, a small drainage that flows from west to east on the south side of the subdivision. Well 2 is located about 75 feet north of Goose Creek, on the south side of Wildwood Street. The well is located inside a concrete vault that is covered by a building. The well casing extends four to five feet above the floor of the vault.

Purpose

The proposal was to first conduct a camera survey using the DEQ downhole camera. Information from the camera survey would be used to select intervals in the well to conduct a colloidal borescope survey, to determine the ground water flow direction. Ground water flow direction would then be used to locate potential contaminant sources up-gradient of the well.

Methods and Results

A camera survey was conducted for Well 2 on September 19, 2007 after the pump was removed. Drillers' logs are not available for any of the three wells in this system. The camera survey showed the total depth of Well 2 is about 88 feet and it appears to be cased to its total depth. The casing is perforated over the interval of approximately 53 to 73 feet below the top of the casing. Perforations were created with a drilling tool known as a knife that produces vertical slots in the casing at irregular intervals. There were usually three to four knife slots arrayed around the casing at each interval, and eleven slotted intervals were identified from the camera survey. In the casing interval that was slotted there was abundant mats of dark material on the casing and suspended in the well. The casing was covered with light colored scale above the slotted interval, from 53 feet to the water table (approximately 16.6 feet below the top of the casing). The amount of suspended material above 53 feet was considerably less than in the lower section.

Above the water table, from approximately 16.6 feet to 10 feet, the casing wall was visibly moist, and water was observed flowing down the casing wall to the water table. This inflow most likely enters through a corroded section of the casing, although the

casing wall was covered with a crust of corrosion products and a specific hole or crack was not identified from the camera survey.

Colloidal Borescope Description

The colloidal borescope consists of two charged-couple device cameras, an internal compass, a 140X optical magnification lens and an illumination source, all contained in a stainless steel housing. Signals are transmitted to the surface via a cable. Software provided with the instrument tracks the movement of colloids across the field of vision and records the direction of movement, the velocity and the number of these colloids (Kearl and Roemer, 1998). Colloids are naturally occurring particles that are transported with the ambient ground water flow field. The instrument is set at a particular depth where direction and velocity information are recorded and then is raised or lowered to another target zone where additional direction and velocity information are recorded. In a screened well, only the screened interval can be surveyed. However, any favorable zone in an uncased well can be surveyed. In order to conduct a successful borescope survey of a well there must be a screened or open-hole interval in the well where the free flow of ground water can occur. The slotted intervals in Well 2 were not suitable for a borescope survey, so this part of the investigation was not conducted. From the downhole camera investigation, it was determined that water contaminated with bacteria was entering the well through a corroded or broken section of the casing.

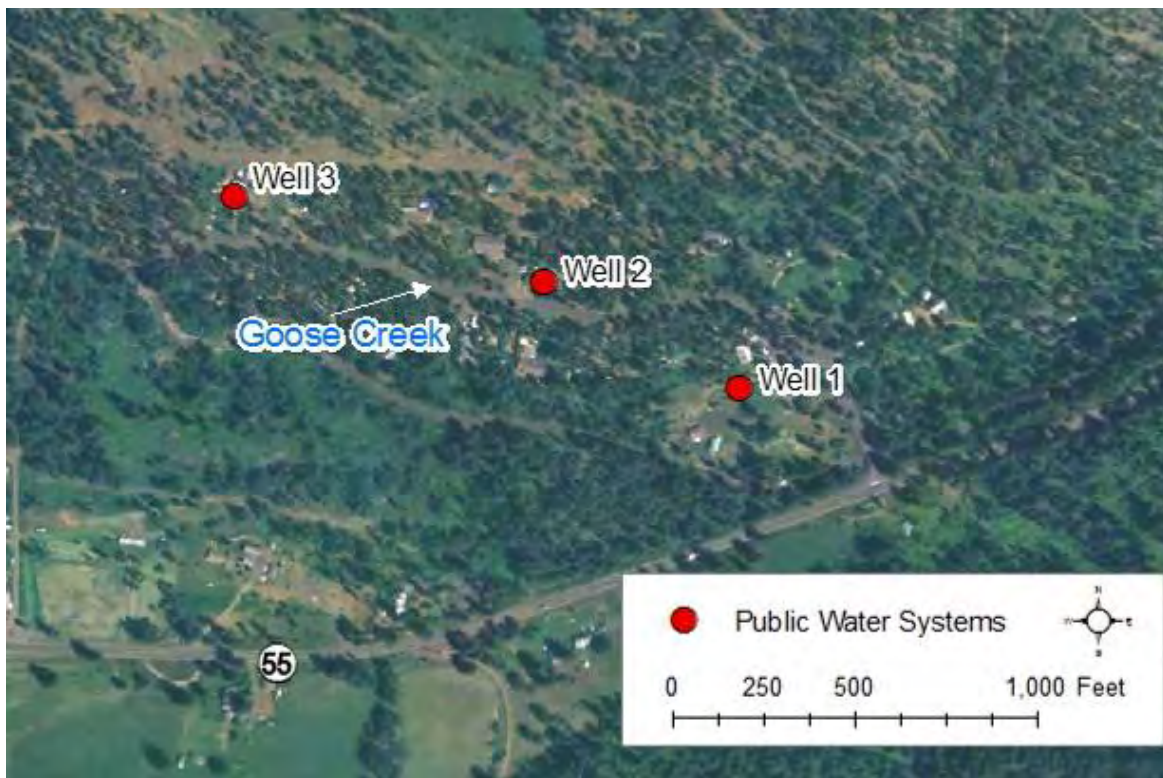


Figure 3. View of the Meadows Park area showing locations of three public water supply wells, Goose Creek and State Highway 55.

Conclusions

The inflow of water down the casing to the water table most likely represents an upper perched water table associated with Goose Creek that extends north from the drainage to the well. A failure in the casing allows this water, which is contaminated with bacteria, to enter the well. Continual drainage into the well explains why repeated chlorination efforts were unsuccessful in removing bacterial contamination from the well.

Recommendations

It was recommended to the water users association that the well be plugged and abandoned, and a replacement well with an adequate casing seal be drilled.

4.1.2 Marsing City Well #8 Colloidal Borescope Survey

The city of Marsing is located near the Snake River in Owyhee County. The Marsing City Well #8 was constructed between November 2006 and April 2007. A 13.5-inch diameter borehole was drilled to 570 feet below ground surface (bgs), following the general path of the 707 feet deep pilot hole. The pilot hole was backfilled to 570 feet bgs. Eight inch diameter steel casing was installed in the borehole from +3 to 360 feet bgs. At 360 ft bgs the casing is necked down to 6 inch diameter with 0.030 inch slot wire wrap screen from 390 to 420 feet bgs and 435 to 455 feet bgs and 0.015 inch slot wire wrap screen from 505 to 560 feet bgs. Ten feet of blank steel casing was installed below the screens from 560 to 570 feet bgs. Annular space from 360 to 570 feet bgs was filled with silica sand filter pack.

The water level in the well at the time of the survey was approximately 21 feet below the top of the casing. Borehole lithology adjacent to the three screens, based on the drillers report, is generally described as blue clay with sand, basalt with thin cracks, and fine cemented sand, respectively. The well yielded 60 gallons of water per minute with 178.4 feet of drawdown over an 8 hour pump test. Ground water flow directions and velocities in the deep aquifer beneath the site are unknown, yet believed to be towards the east-northeast, to the Snake River.

Purpose

The purpose of the colloidal borescope survey was to obtain direct measurements of ground water flow directions and velocities in Well #8 to aid in model construction and development of source water protection areas for the well.

Methods and Results

Refer to the Colloidal Borescope Description on page 8 for a description of how the colloidal borescope is used. Due to the screen lengths, depths, and time constraints DEQ targeted specific screened zones within the well to run a colloidal borescope survey. Zones were targeted based on December 8, 2006 geophysical data. The most promising zones appeared to be at 398, 412, 415, and 442 feet bgs. Initial survey measurements started at approximately 398 feet bgs and progressed to 444 feet bgs. The lowest screen was inaccessible due to the lack of sufficient cable length for the colloidal borescope. The colloidal borescope operated for a minimum of 20 minutes at each target interval to allow

any turbulence caused by the borescope placement to settle and indications of a primary flow zone to develop. If the indication of the flow zone was noted in the data the colloidal borescope was maintained in that zone for a minimum of 1 hour. The borescope was then lowered to the next target interval once sufficient data were collected. A more detailed survey of areas above and below the basalt formation at 442 feet bgs was conducted to provide a more detailed survey of the basalt formation.

Conclusions

The average ground water flow direction within the aquifer supplying water to the Marsing City Well #8 could not be determined with the colloidal borescope. Based on the survey and data found in the driller's report it is likely the upper two screens are not contributing significant amounts of water to the well. The most productive zones are likely below the 500 foot maximum depth DEQ is able survey due to limited cable length. The overall yield of the well is low, 0.34 gallons per minute per foot of drawdown, when represented as specific capacity. The lack of preferential flow zones within the depth range of the colloidal borescope supports the low yield characteristics of this well.

Recommendations

Due to the lack of preferential flow zones in Marsing City Well #8, DEQ was not able to determine ground water flow direction, velocity, or make recommendations regarding model construction and development of source water protection areas for the well.

4.1.3 Terra Grande VOC Contaminant Study

The former Terra Grande PWS is located in Boise, southwest of the intersection of Cole and Overland Roads (Figure 4). The former PWS consisted of four wells that supplied water to approximately 111 houses within the Terra Grande subdivision. Light industrial and commercial businesses are located to the north, south, and east of the PWS wells. Light industrial and residential properties are located to the west.

Purpose

Elevated concentrations of volatile organic compounds (VOCs), nitrate, or arsenic were detected in samples from one or more of the wells from 1995 through 2005. Concentrations of trichloroethylene (TCE) were detected in water samples from Wells 1, 2, and 3 during December 2004 and January 2005 at concentrations greater than 10 times the MCL of 5 micrograms per liter ($\mu\text{g/L}$) (Table 2). In response to the TCE exceedances, the owners of the PWS shut the water system down and connected into the United Water PWS in January 2005. DEQ conducted a ground water study in response to the TCE detections.

Methods and Results

During October 2007, the pumps were removed and DEQ conducted a video survey of each of the four wells. Figure 4 provides an aerial view of the well locations. Each well is located in a locked well house that also housed the pumping apparatus and hydro-pneumatic pressure tanks.

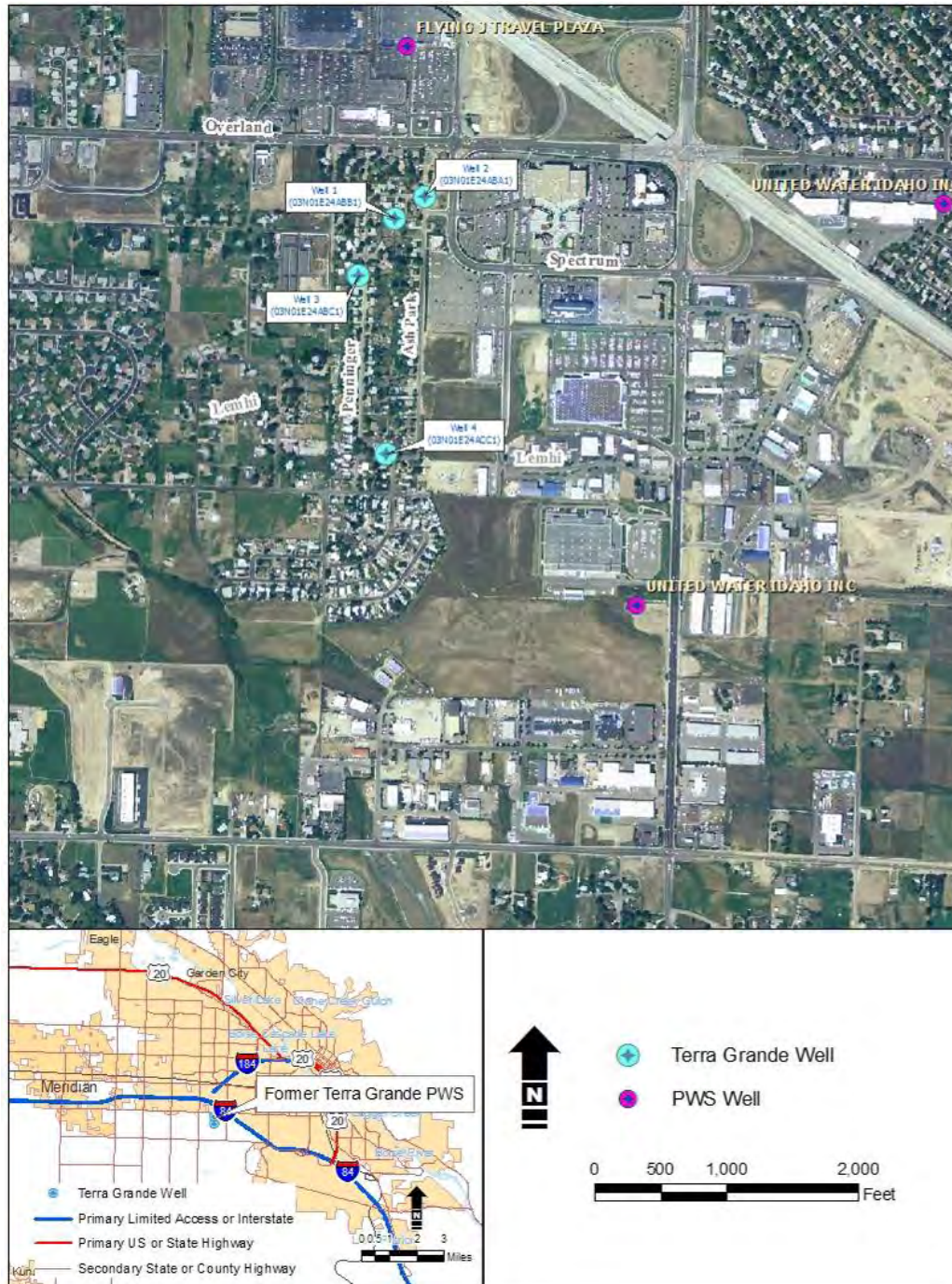


Figure 4. Terra Grande PWS Well Locations

From the video survey, it was noted that all four wells were heavily encrusted with algal growth. Cut slots were viewed in Well 1 from 93 to 150 feet below the top of the casing. The remaining three wells had blank casing to within a few feet of the bottom of the borehole.

Ground water samples were collected from each of the four wells on October 30, 2007 and March 4, 2008. Depths to water and field parameters (pH, temperature, dissolved

oxygen, and specific conductance) were measured prior to sample collection. Ground water samples were analyzed for chlorinated solvents (44 analytes), arsenic, nitrate as nitrogen, chloride, and total dissolved solids. October 2007 samples were also analyzed for oxygen ($\delta^{18}\text{O}$) and deuterium ($\delta^2\text{H}$) isotope ratios. Tetrachloroethylene (PCE) and TCE were detected in the October 2007 samples from Wells 2 and 4 at concentrations below the MCL. Analysis of the remaining samples resulted in non-detection for all chlorinated solvent analytes. Table 2 summarizes detected analytical data for the two sampling events.

Arsenic analysis results showed arsenic concentrations near the MCL in samples from three of the four wells during both sampling events. Total dissolved solids (TDS) exceeded the federal secondary drinking water standard in Wells 1 and 4 in October 2007 and Wells 1, 3, and 4 in March 2008.

Table 2. Summary of laboratory analytical results for Terra Grande VOC Study.

Notes: Table shows detected chemicals only. * = Secondary Drinking Water Standard. **BOLD** – Bolded values exceed the drinking water standards

Analyte	MCL	Well 1		Well 2		Well 3		Well 4	
		10/30/07	03/04/08	10/30/07	03/04/08	10/30/07	03/04/08	10/30/07	03/04/08
PCE ($\mu\text{g/L}$)	5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5
TCE ($\mu\text{g/L}$)	5	<0.5	<0.5	3.0	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic (mg/L)	0.01	0.0126	0.009	0.0082	0.0076	0.0014	0.0036	0.0081	0.0072
Nitrate as N (mg/L)	10	8.78	7.95	0.12	4.09	<0.1	4.17	5.01	4.88
Chloride* (mg/L)	250*	58.3	54.9	42.2	27.4	129	48.5	58.8	52.8
Total Dissolved Solids* (mg/L)	500*	625	658	293	488	305	635	640	668

Oxygen and deuterium data from the October 2007 sampling event had little variation in $\delta^{18}\text{O}$ and $\delta^2\text{H}$ ratios, with Wells 1 and 4, and Wells 2 and 3 displaying slightly closer correlations. All samples fell below the global meteoric water line indicating recharge at high elevation or under cold temperatures as would be expected throughout Idaho.

Conclusions

The TCE and PCE concentrations decreased over the sampling events. However, arsenic concentrations remained above the MCL and TDS concentrations remained above the federal secondary drinking water standard.

Recommendations

It was recommended that the Terra Grande wells be abandoned according to the Idaho well abandonment regulations.

4.1.4 Franke's Dry Cleaners Contaminant Study

Purpose

Millennium Science and Engineering (MSE) was contracted by the DEQ to perform a subsurface VOC assessment of conditions associated with historic dry cleaning operations at the former Franke's Dry Cleaning property, 406 Main Street, Caldwell, Canyon County (Figure 5). The site is currently undeveloped but surrounding property has recently been redeveloped. The following summarizes assessment activities and findings.

Methods and Results

On June 4 and 5, 2008, two shallow depth (MW-20 and MW-21) and one intermediate depth (MW-22) 2-inch diameter, polyvinyl chloride (PVC) cased monitoring wells were installed to approximately 15 feet bgs and 28 feet bgs, respectively. On June 9, 2008, Fox Land Surveys, Inc. of Boise, Idaho performed a horizontal and vertical survey of 15 monitoring wells (3 new wells and 12 existing wells) using Real Time Kinematic Global Positioning System techniques. Localized ground water flow was interpreted to be flowing toward the north-northwest.

On June 9 and June 10, 2008 the 15 monitoring wells were sampled. The ground water samples were submitted for VOC analysis according to EPA Methods 8260B. Table 3 contains a summary of all detected analytes. A full list of analytes is available in the MSE report (2008), which can be obtained by contacting the DEQ Boise Regional Office. Concentrations of the following VOCs were reported at levels exceeding the [Idaho Risk Evaluation Manual \(DEQ 2004\)](#) Idaho Default Target Levels for ground water:

- cis-1,2-dichloroethene – intermediate zone monitoring well MW-14;
- PCE – shallow zone monitoring wells MW-2, MW-7, MW-8, MW-12, MW-13, MW-20, and MW-21 and intermediate zone monitoring wells MW-16, MW-17, and MW-22; and
- TCE – shallow zone monitoring wells MW-7, MW-8, MW-12, MW-13, MW-20, and MW-21 and intermediate zone monitoring well MW-22.

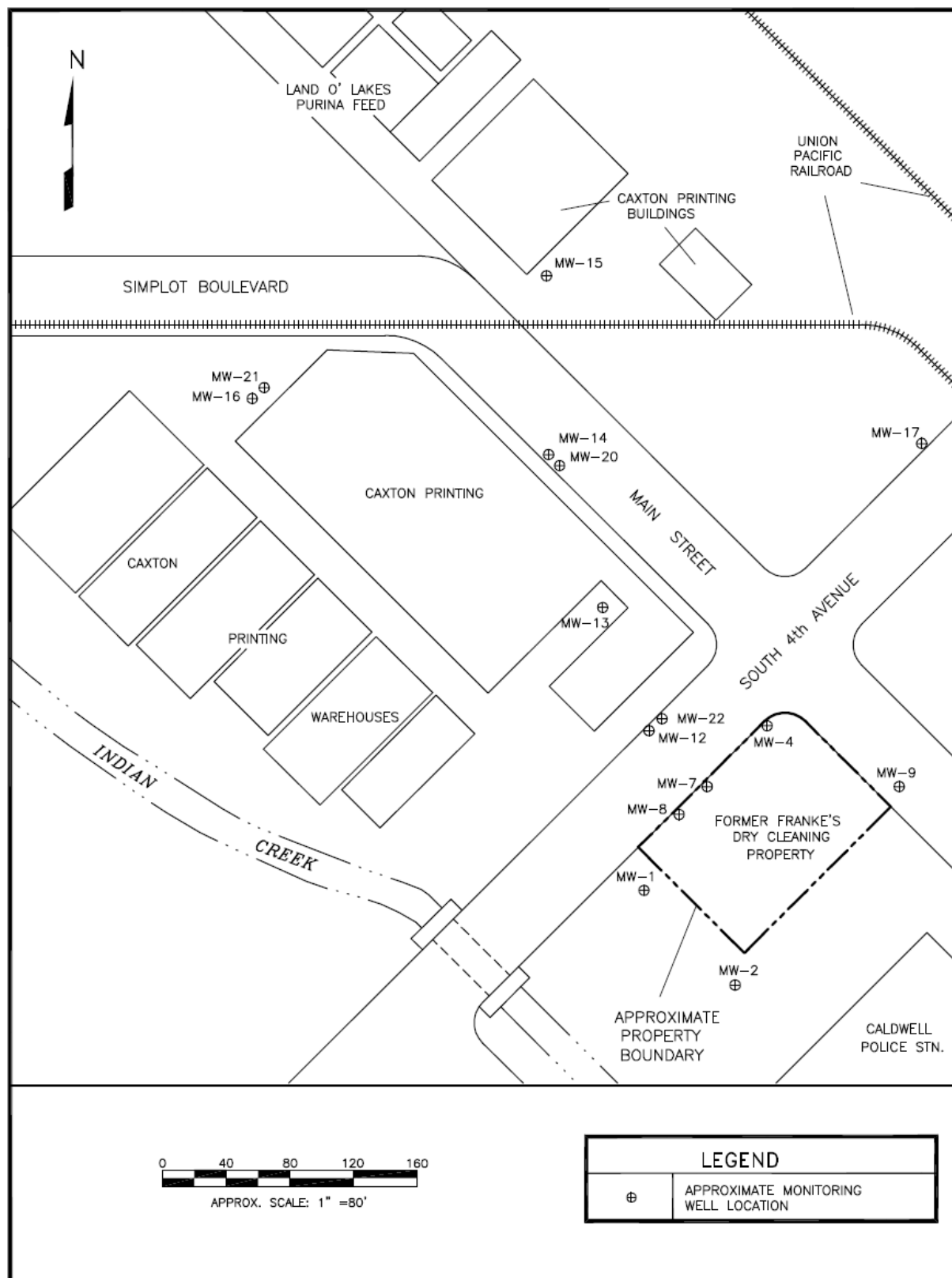


Figure 5. Franke's Dry Cleaning Monitoring Well Locations (from MSE, 2008).

Table 3. Laboratory Analytical Results for Ground Water by EPA Method 8260B, Former Franke's Dry Cleaning Property, 406 Main Street, Caldwell, Idaho

Notes: REM = Risk Evaluation Manual (DEQ, 2004); IDTLs = Idaho Default Target Levels

Sample ID	Date Collected	Sample Location	Units	Analyte						
				Acetone	Bromoform	n-Butyl-benzene	sec-Butylbenzene	tert-Butylbenzene	1,1-Dichloroethane	cis-1,2-Dichloroethene
Shallow Zone Monitoring Wells:										
GW060908-MW1	6/9/2008	MW-1	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW2	6/9/2008	MW-2	ug/L	ND (<50)	5	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW4	6/9/2008	MW-4	ug/L	270	ND (<1.0)	6	13	1.1	ND (<1.0)	ND (<1.0)
GW060908-MW7	6/9/2008	MW-7	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	33
GW060908-MW8	6/9/2008	MW-8	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	19
GW060908-MW9	6/9/2008	MW-9	ug/L	200	ND (<1.0)	2	2.2	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW12	6/9/2008	MW-12	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	1	20
GW061008-MW13	6/10/2008	MW-13	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	3.3
GW060908-MW20	6/9/2008	MW-20	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	57
GW061008-MW21	6/10/2008	MW-21	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	18
Intermediate Zone Monitoring Wells:										
GW060908-MW14	6/9/2008	MW-14	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	88
GW061008-MW16	6/10/2008	MW-16	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW17	6/9/2008	MW-17	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW22	6/9/2008	MW-22	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	2.7
Deep Zone Monitoring Wells:										
GW060908-MW15	6/9/2008	MW-15	ug/L	ND (<50)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
IDEQ REM IDTLs (Ground Water)			ug/L	9,390	7.07	NA	104	104	1,040	70

Table 3. Laboratory Analytical Results for Ground Water, Former Franke's Dry Cleaning Property, 406 Main Street, Caldwell, Idaho (continued).

Notes: REM = Risk Evaluation Manual (DEQ, 2004); IDTLs = Idaho Default Target Levels

Sample ID	Date Collected	Sample Location	Units	Analyte						
				trans-1,2-Dichloroethene	Ethyl-benzene	Isopropyl-benzene	n-Propyl-benzene	Tetrachloro-ethene	Trichloro-ethene	1,2,3-Trimethyl-benzene
Shallow Zone Monitoring Wells:										
GW060908-MW1	6/9/2008	MW-1	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	1.1	ND (<1.0)	ND (<1.0)
GW060908-MW2	6/9/2008	MW-2	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	7	ND (<1.0)	ND (<1.0)
GW060908-MW4	6/9/2008	MW-4	ug/L	ND (<1.0)	1.2	13	30	ND (<1.0)	ND (<1.0)	ND (<1.0)
GW060908-MW7	6/9/2008	MW-7	ug/L	1.9	ND (<1.0)	ND (<1.0)	ND (<1.0)	92	25	ND (<1.0)
GW060908-MW8	6/9/2008	MW-8	ug/L	1.3	ND (<1.0)	ND (<1.0)	ND (<1.0)	1,600	82	ND (<1.0)
GW060908-MW9	6/9/2008	MW-9	ug/L	ND (<1.0)	ND (<1.0)	4.8	9.6	ND (<1.0)	ND (<1.0)	1
GW060908-MW12	6/9/2008	MW-12	ug/L	1.9	ND (<1.0)	ND (<1.0)	ND (<1.0)	720	60	ND (<1.0)
GW061008-MW13	6/10/2008	MW-13	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	150	13	ND (<1.0)
GW060908-MW20	6/9/2008	MW-20	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	79	9.3	ND (<1.0)
GW061008-MW21	6/10/2008	MW-21	ug/L	7.4	ND (<1.0)	ND (<1.0)	ND (<1.0)	66	20	ND (<1.0)
Intermediate Zone Monitoring Wells:										
GW060908-MW14	6/9/2008	MW-14	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	1.9	ND (<1.0)	ND (<1.0)
GW061008-MW16	6/10/2008	MW-16	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	40	ND (<1.0)	ND (<1.0)
GW060908-MW17	6/9/2008	MW-17	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	20	ND (<1.0)	ND (<1.0)
GW060908-MW22	6/9/2008	MW-22	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	130	24	ND (<1.0)
Deep Zone Monitoring Wells:										
GW060908-MW15	6/9/2008	MW-15	ug/L	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
IDEQ REM IDTLs (Ground Water)			ug/L	100	700	1,040	NA	5	3.32	NA

Conclusions

Contamination resulting from Franke's Dry Cleaners exceeds Idaho default target levels in the ground water for cis-1,2-dichloroethene, PCE, and TCE.

Recommendations

Further characterization is needed to determine the vertical extent of contamination from Franke's Dry Cleaners. EPA is currently working with the owners of Franke's Dry Cleaners. If EPA and Franke's Dry Cleaners come to an agreement and the owners relinquish ownership of the property, DEQ recommends remediation utilizing the Brownfields program.

4.1.5 Sunnyside Ground Water Monitoring Project Report, Ground Water Quality Technical Report No. 35

Purpose

The Sunnyside Feedlot is located in the eastern portion of the Weiser NPA in Washington County. NPAs are further discussed in Section 3 of this report. The Sunnyside project resulted from an Idaho State Department of Agriculture regional monitoring project and complaints from residents near the former feedlot. The objectives of the ground water monitoring activities were to investigate the potential sources of nitrate to the ground water in the study area, to investigate other constituents potentially associated with the Confined Animal Feeding Operation (CAFO), and to monitor trends in water quality over time.

Methods and Findings

Semi-annual ground water monitoring wells (Figure 6) at and in the vicinity of the Sunnyside Feedlot to date provides water quality information during and after feedlot operations but before any significant amounts of manure have been removed.



Figure 6. Monitoring well locations for Sunnyside Project.

The highest concentrations of nitrate detected in the study area were in samples collected where CAFO wastewater may be present in ground water. The highest concentrations were in samples from wells MW-5 (located down-gradient of the small wastewater pond), MW-14 (located in an area of residual manure and down-gradient of the wastewater land application field), and MW-15 (located immediately down-gradient of

the wastewater land application field) (Figure 6). Other locations where nitrate was commonly detected at concentrations greater than the MCL of 10 mg/L were at up-gradient wells MW-2, MW-3, MW-4, and MW-7, as well as on-site and down-gradient wells MW-11 and MW-13.

The lowest concentrations of nitrate in the study area were detected in the samples from wells MW-9, MW-10, and MW-12, located adjacent to the wastewater ponds, and at well MW-6, located down-gradient of the onion dump (Table 4).

Table 4. Common anion and nitrogen isotope ratio ($\delta^{15}\text{N}$) analytical results for Sunnyside Project, 2007 through 2008.

Notes: Bold numbers indicate concentration is above the MCL; NA = Not analyzed; NS = Not sampled.

Well ID	Date Sampled	Fluoride	Chloride	Bromide	o-Phosphate-P	Sulfate	Ammonia	Nitrate-N	TKN	$\delta^{15}\text{N}$
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per mil
Drinking Water Standard		----	250	----	----	250	----	10	----	---
Up-gradient of CAFO and Onion Dump										
MW-1	5/25/2007	0.61	9.7	<0.1	0.18	89	<0.1	11	<0.7	6.7
	12/5/2007	0.68	9.2	<0.1	0.18	81	<0.1	7.8	<0.7	NS
	5/12/2008	0.67	12	0.1	0.15	94	<0.1	11	<0.7	NS
	10/7/2008	0.54	9.9	<0.1	0.12	75	<0.1	7	<0.7	NS
MW-2	5/25/2007	0.73	24	<0.1	0.2	150	<0.1	14	<0.7	5
	12/5/2007	0.74	25	<0.1	0.18	140	<0.1	16	<0.7	NS
	5/12/2008	0.82	22	0.13	0.17	160	<0.1	18	<0.7	NS
	10/7/2008	0.69	21	0.11	0.16	170	<0.1	19	<0.7	NS
MW-3	5/24/2007	0.68	15	0.13	0.11	120	<0.1	15	<0.7	NS
	12/5/2007	0.75	20	<0.1	0.17	130	<0.1	13	<0.7	NS
	5/12/2008	0.83	19	0.18	0.12	120	<0.1	15	<0.7	NS
	10/7/2008	0.70	19	0.11	<0.1	140	<0.1	15	<0.7	NS
MW-4	5/25/2007	0.84	54	0.2	<0.1	320	<0.1	14	1.1	7.7
	12/5/2007	0.91	43	0.18	0.14	270	<0.1	18	<0.7	NS
	5/12/2008	1.2	51	0.24	0.16	310	<0.1	16	0.87	NS
	10/7/2008	0.87	51	0.18	0.11	300	<0.1	24	1.1	NS
MW-7	5/25/2007	0.88	32	0.12	0.2	210	<0.1	20	<0.7	8.9
	12/5/2007	0.91	32	0.11	0.2	220	<0.1	20	<0.7	NS
	5/12/2008	Well protective casing and PVC broken. Well repaired and complete as a flush mount June 08.								
	10/8/2008	0.98	64	0.24	0.14	390	<0.1	37	1.1	NS
MW-15	8/1/2007	NA	NA	NA	0.346	NA	NA	28.4	5.8	NA
	5/13/2008	1.1	130	0.29	0.47	390	<0.1	21.0	<0.7	NS
	10/7/2008	0.96	190	0.29	0.22	530	<0.1	32.0	1.8	NS

On CAFO Site

Well ID	Date Sampled	Fluoride	Chloride	Bromide	o-Phosphate-P	Sulfate	Ammonia	Nitrate-N	TKN	$\delta^{15}\text{N}$
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per mil
Drinking Water Standard		----	250	----	----	250	----	10	----	---
<i>Adjacent to and Down-gradient of Waste Ponds</i>										
MW-9	5/24/2007	0.82	160	0.34	<0.1	140	1.8	2.4	5.5	19
	12/6/2007	0.94	71	0.2	1.2	120	1.2	4.0	2.4	NS
MW-9	5/12/2008	0.96	58	0.18	3.5	130	2.2	0.84	5.3	NS
	10/7/2008	1.3	31	0.12	4.6	130	1.4	1.20	3.9	NS
MW-10	5/24/2007	0.8	210	0.51	<0.1	130	11	0.61	15	9.7
	12/6/2007	0.93	120	0.28	0.61	130	5.9	0.77	8.4	NS
	5/12/2008	0.92	96	0.24	0.38	120	4.5	0.64	7.7	NS
	10/7/2008	0.73	22	<0.1	0.20	130	0.6	7.4	1.6	NS
MW-12	5/24/2007	0.74	190	0.38	<0.1	330	17	5.5	23	15.6
	12/6/2007	0.88	140	0.3	<0.1	340	13	5.3	16	NS
	5/13/2008	1.2	280	0.52	0.11	660	14	8.7	21	NS
	10/7/2008	1.2	300	0.37	0.38	1400	11	41	13	NS
MW-13	7/19/2007	NA	NA	NA	0.134	NA	0.049	20.2	3.4	NA
	5/13/2008	0.98	84.0	0.25	0.11	250	<0.1	19.0	<0.7	NS
	10/8/2008	0.80	130.0	0.22	<0.1	180	<0.1	16.0	0.85	NS
<i>Within former pen area and near onion dump</i>										
MW-14	7/19/2007	NA	NA	NA	0.079	NA	NA	34.7	5.9	NA
	5/13/2008	1.4	160.0	0.31	<0.1	460	<0.1	29.0	1.6	NS
	10/8/2008	NS	NS	NS	NS	NS	NS	NS	NS	NS
Down-gradient of CAFO										
MW-8	5/24/2007	0.55	200	0.38	<0.1	190	<0.1	7	2.2	15.8
	12/5/2007	0.65	130	0.25	<0.1	150	<0.1	8.7	1.2	NS
	5/12/2008	0.85	90	0.23	0.12	130	<0.1	7.9	0.94	NS
	10/7/2008	0.71	39	0.13	0.14	120	<0.1	12	<0.7	NS
MW-11	5/24/2007	0.57	100	0.23	<0.1	240	<0.1	24	0.78	13
	12/6/2007	0.76	120	0.24	<0.1	290	<0.1	27	<0.7	NS
	5/14/2008	0.94	110	0.28	<0.1	310	0.29	23	<0.7	NS
	10/8/2008	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	5/25/2007	0.73	220	0.32	<0.1	490	0.15	35	2.7	16.6
	12/6/2007	1.1	260	0.32	<0.1	480	<0.1	20	2.1	NS
	5/12/2008	1.4	210	0.38	<0.1	460	<0.1	27	2.0	NS
	10/7/2008	1.0	290	0.46	<0.1	400	<0.1	6.2	1.9	NS
Down-gradient of Onion Dump										

Well ID	Date Sampled	Fluoride	Chloride	Bromide	o-Phosphate-P	Sulfate	Ammonia	Nitrate-N	TKN	$\delta^{15}\text{N}$
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per mil
Drinking Water Standard		----	250	----	----	250	----	10	----	---
MW-6	5/25/2007	0.71	61	0.24	<0.1	480	7.6	<0.05	8.2	2.5
	12/5/2007	0.85	64	0.23	<0.1	500	6.15	0.52	7.5	NS
	5/13/2008	1.0	63	0.28	<0.1	410	6.6	<0.05	9.6	NS
	10/7/2008	0.84	67	0.22	<0.1	510	6.8	<0.05	8.9	NS

Nitrogen isotope ratio, denoted as $\delta^{15}\text{N}$, can be helpful in determining sources of nitrate in the ground water. Some nitrogen source categories, such as waste sources or fertilizer sources, have a distinguishable nitrogen isotopic ratio signature. Typical $\delta^{15}\text{N}$ values for various nitrogen sources are listed in Table 5. The $\delta^{15}\text{N}$ results for Sunnyside indicate that the nitrogen in ground water at and down-gradient of the CAFO is from a waste source ($\delta^{15}\text{N}$ values were between 9.7 and 16.6 per mil), the nitrogen down-gradient of the onion dump has a fertilizer source ($\delta^{15}\text{N}$ value was 2.5 per mil), and the nitrogen up-gradient of the CAFO has a mixed source ($\delta^{15}\text{N}$ values were between 5 and 8.9 per mil) (Table 4).

Table 5. Typical $\delta^{15}\text{N}$ values from various nitrogen sources (from Seiler, 1996).

Potential Nitrate Source	$\delta^{15}\text{N}$ (‰)
Precipitation	-3
Commercial fertilizer	-4 to +4
Organic nitrogen in soil or mixed nitrogen source	+4 to +9
Animal or human waste	Greater than +9

This review of the nitrogen data suggests the CAFO may have contributed more nitrate to the ground water than the other sources; however, fertilizers on agricultural fields, septic tank effluent, and decomposing onions are all contributors of nitrogen to ground water in the study area.

Beta-estradiol, a growth hormone, was detected at very low concentrations in samples collected from well MW-6, located adjacent to and down-gradient of the onion dump. Concentrations ranged from 0.78 to 1.8 micrograms per liter ($\mu\text{g/L}$) (Table 6).

Two sulfonamide antibiotics have been detected in one or more ground water samples collected from the study area in 2007 and 2008. Sulfamethizole was detected in the single samples collected from wells MW-14 and MW-15 at concentrations of 0.6 and 0.7 $\mu\text{g/L}$, respectively. Sulfamethazine was detected in all samples collected from wells MW-9, MW-10, and MW-12, located next to the wastewater ponds and at down-/cross-gradient well MW-8.

Table 6. Pesticide, steroid, antibiotic, and bacteria analytical results for Sunnyside Monitoring Wells, 2007 through 2008.

Notes: Bold numbers reflect detected concentration; NS = Not sampled.

Notes: Bold numbers reflect detected concentration, N/A = Not Sampled.											
		Pesticides					Steroids	Sulfa- namide Antibiotics	Bacteria		
Well ID	Date Sampled	Atrazine	Desethyl atrazine	Bromacil	Hexazinone	Prometon	Beta Estradiol	Sulfa- methazine	E. coli	Total Coliform	Additional Compounds
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mpn/ 100 ml	mpn/ 100 ml	ug/L
Drinking Water Standard		3	---	----	----	----	----	----	1	----	
Up-gradient of CAFO and Onion Dump											
MW-1	5/25/2007	<0.025	0.12	<0.05	<0.05	<0.05	<0.05	<0.1	<1	--	
MW-1	12/5/2007	<0.025	0.08	<0.05	<0.05	<0.05	<0.05	<0.1	<1	<1	
MW-2	5/25/2007	<0.025	0.096	<0.05	<0.05	1.3	<0.05	<0.1	<1	--	
	12/5/2007	<0.025	0.063	<0.05	<0.05	<0.05	<0.05	<0.1	<1	<1	
MW-3	5/24/2007	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	NA	<1	--	
	12/5/2007	<0.025	0.047	<0.05	<0.05	<0.05	<0.05		<1	165.8	
MW-4	5/25/2007	<0.025	<0.025	0.13	<0.05	0.05	<0.05	NA	<1	--	
	12/5/2007	<0.025	0.054	<0.05	<0.05	0.056	<0.05	<0.1	<1	275.5	
MW-7	5/25/2007	0.08	0.5	<0.05	<0.05	<0.05	<0.05	<0.1	<1	--	
	12/5/2007	0.044	0.25	<0.05	<0.05	<0.05	<0.05	<0.1	<1	118.7	
MW-15	7/19/2007	NA	NA	NA	NA	NA	<0.05	0.11	<1	<1	sulfamethizole 0.7
On CAFO Site											
Adjacent to and Down-gradient of Waste Ponds											
MW-9	5/24/2007	<0.025	<0.025	<0.05	<0.05	0.055	<0.05	7.6	<1	--	
	12/6/2007	<0.025	0.044	<0.05	<0.05	0.071	<0.05	0.65	<1	8.6	
MW-10	5/24/2007	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	11	<1	--	
	12/6/2007	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	1.2	<1	<1	
MW-12	5/24/2007	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	9.6	<1	--	
	12/6/2007	<0.025	0.029	<0.05	<0.05	<0.05	<0.05	0.98	<1	111.2	
MW-13	7/19/2007	NA	NA	NA	NA	NA	<0.05	<0.1	<1	<1	
Within former pen area and near onion dump											
MW-14	7/19/2007	NA	NA	NA	NA	NA	<0.05	<0.1	<1	<1	sulfamethizole 0.6
Down-gradient of CAFO											
MW-8	5/24/2007	0.057	0.13	<0.05	<0.05	0.082	<0.05	1.4	<1	--	
	12/5/2007	0.044	0.099	<0.05	<0.05	0.12	<0.05	0.55	<1	9.8	
MW-	5/24/2007	0.044	0.11	<0.05	<0.05	<0.05	<0.05	<0.1	<1	--	

		Pesticides					Steroids	Sulfa- namide Antibiotics	Bacteria		
Well ID	Date Sampled	Atrazine	Desethyl atrazine	Bromacil	Hexazinone	Prometon	Beta Estradiol	Sulfa- methazine	E. coli	Total Coliform	Additional Compounds
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mpn/ 100 ml	mpn/ 100 ml	ug/L
Drinking Water Standard		3	—	----	----	----	----	----	1	----	
11											
	12/6/2007	<0.025	0.06	<0.05	<0.05	<0.05	<0.05	<0.1	<1	2	
MW- 5	5/25/2007	0.074	0.29	<0.05	<0.05	<0.05	<0.05	<0.1	<1	--	
	12/6/2007	0.037	0.12	<0.05	<0.05	<0.05	<0.05	0.28	<1	<1	
<i>Within former pen area and near onion dump</i>											
MW- 14	8/2/2007	NA	NA	NA	NA	NA	<0.05	0.6			
	12/6/2007	0.074	0.21	<0.05	<0.05	<0.05	<0.05	<0.1			
Down-gradient of Onion Dump											
MW- 6	5/25/2007	<0.025	0.12	<0.05	<0.05	<0.05	0.78	<0.1	<1	--	
	12/5/2007	<0.025	<0.025	<0.05	<0.05	<0.05	0.98	<0.1	<1	83.6	
	5/13/2008						1.8				

Conclusions

The principal findings of this work are as follows:

- The antibiotic, sulfamethazine, was detected in the immediate vicinity of the wastewater ponds (MW9, MW10, and MW12) and at down/cross-gradient well MW-8. Sulfamethazine was detected once at low levels at the down-gradient well MW-5.
- Nitrate has been detected in shallow ground water at concentrations above the MCL of 10 mg/L in 14 of the 15 wells in the study area and consistently above the MCL in nine wells. The nine wells showing concentrations above the MCL are located both up-gradient and down-gradient of the former feedlot, indicating that the feedlot is not the only source of nitrogen to the local ground water.
- The highest concentrations of nitrate were detected at and down-gradient of the former feedlot. As the ammonia present in soil and ground water converts to nitrate in the presence of oxygen, further increases in nitrate concentration in ground water at and down-gradient of the feedlot are expected.
- Various herbicides and pesticides have been detected sporadically in ground water up-gradient, at, and down-gradient of the feedlot at concentrations that are below associated MCLs.
- The growth hormone, beta-estradiol, has been detected consistently in water collected down-gradient of the onion dump but was only detected one time in an anomalous sample from well MW-5, down-gradient of the feedlot.

Recommendations

The former Sunnyside Feedlot is for sale and ready for redevelopment. Any future development will likely include removal of a significant volume of manure and closure of the wastewater ponds. To evaluate changes in ground water chemistry resulting from redevelopment of the feedlot, DEQ recommends that monitoring for anions, ammonia, and TKN continue after remedial activities have commenced, to document the rate of change following removal of manure from the site.

For more information, please see the full technical report by Rowles (2009) at: http://www.deq.idaho.gov/water/data_reports/ground_water/sunnyside_35.pdf.

4.1.6 Purple Sage Study, Ground Water Quality Technical Report No. 37

Purpose

The Purple Sage study area is located near Middleton in Canyon County. The Purple Sage project represents the combined efforts of the Idaho State Department of Agriculture (ISDA) and DEQ. ISDA established a project area in October 2005 and tested 21 wells for nitrate. Four wells exceeded the MCL of 10 milligrams per liter (mg/L) for nitrate. DEQ began sample collection in the area in October 2006 when an additional 17 wells were sampled with nitrate concentrations ranging from 0.3 to 11.1 mg/L. ISDA and DEQ have conducted joint sampling events in the study area from 2006 through 2008. This report summarizes the 2007 and 2008 DEQ data.

Methods and Results

The DEQ sampling program began in 2006 and additional sample events were conducted in 2007 and 2008. DEQ sample locations are shown in Figure 7. Field parameters (pH, specific conductance, dissolved oxygen and temperature) were collected at each site and samples from wells were analyzed in the laboratory for chloride, sulfate, nitrate and total dissolved solids. Select samples (typically those with elevated nitrate over 4 mg/L) have also been evaluated for the stable isotope ratio of nitrogen ($\delta^{15}\text{N}$). Results are presented in Table 7.

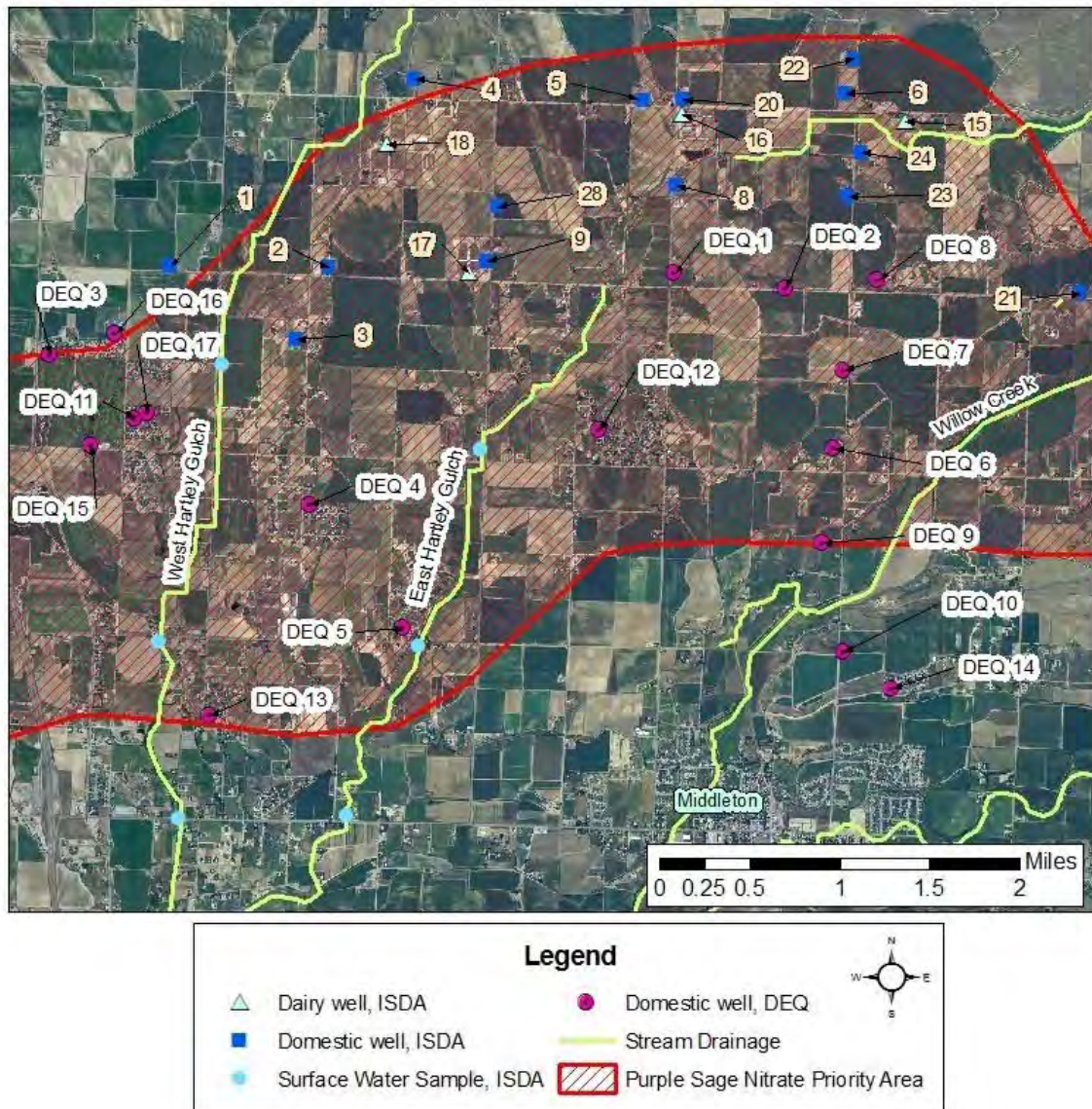


Figure 7. DEQ and ISDA well sampling locations for Purple Sage Project.

Table 7. Analytical results for the 2007 and 2008 samples in the Purple Sage study area.

Notes: Cl = chloride, SO₄ = sulfate, NO₃ = nitrate, TDS = total dissolved solids, per mil = parts per thousand. Blank cells indicate no data are available.

Well Number	Sample Date	Cl ⁻ mg/L	SO ₄ mg/L	NO ₃ mg/L	TDS mg/L	δ ¹⁵ N per mil
DEQ 1	10/23/2007			4.3		
DEQ 1	12/2/2008	5.20	33	4	270	
DEQ 2	10/25/2007			0.44		
DEQ 2	12/2/2008	31.00	89.00	3.1	440.00	
DEQ 3	10/23/2007			0.75		
DEQ 3	12/2/2008	32.00	65.00	0.85	160.00	
DEQ 4	10/25/2007			3.1		
DEQ 4	12/2/2008	10.00	52	0.5	350	
DEQ 5	10/23/2007			5		
DEQ 5	12/2/2008	8.70	42.00	5.3	340.00	5.30
DEQ 6	10/25/2007			3.4		
DEQ 6	12/2/2008	6.20	41.00	3.7	370.00	
DEQ 7	10/25/2007			3.6		
DEQ 7	12/2/2008	29.00	100.00	3.6	450.00	
DEQ 9	10/25/2007			4.5		
DEQ 9	12/2/2008	23.00	50.00	1.8	230.00	
DEQ 10	10/25/2007			1.8		
DEQ 10	12/2/2008	3.50	8.10	0.37	56.00	
DEQ 11	10/23/2007			8.3		
DEQ 12	10/23/2007			6.4		
DEQ 12	12/2/2008	5.60	35	6.1	230	5.8
DEQ 13	10/25/2007			0.32		
DEQ 14	11/1/2007			1.7		
DEQ 15	10/23/2007			3.8		
DEQ 15	102/02/2008	45.00	130	4	540	
DEQ 16	10/23/2007			0.68		
DEQ 16	12/2/2008	6.60	160.00	0.76	170.00	
DEQ 17	10/23/2007			9.6		

Four of the sixteen wells (25%) sampled by DEQ in 2007 and/or 2008 had nitrate concentrations that were greater than 5 mg/L. The criteria for the designation of a nitrate priority area (refer to Section 3 of this report) is that 25 percent of wells sampled have nitrate concentrations of 5 mg/L or greater. Parts of the Purple Sage study area are included in the Purple Sage NPA (Figure 7). When all wells sampled by DEQ and ISDA for the Purple Sage project area are analyzed, results show that 13 of the 38 sites sampled (about 34 percent) had average nitrate concentrations of 5 mg/L or greater.

Conclusions

Ground water within the shallow alluvial aquifer of the project area remains significantly impacted by nitrate. The high nitrate concentrations, large number of detections, cost of well replacement, and potential health implications are cause for concern.

Recommendations

A better understanding of ground water flow direction in the project area will assist in identifying contaminant sources.

For more information, please see the full technical report by Baldwin et al. (2009a) at http://www.deq.idaho.gov/water/data_reports/ground_water/purple_sage_37.pdf.

4.1.7 Mountain Home South Ground Water Nitrate Study, Ground Water Quality Technical Report No. 36

Purpose

The purpose of the Mountain Home South study is to evaluate elevated nitrate in ground water in an area south of Mountain Home, Idaho. In 1998, the project began after elevated pesticide and nitrate detections were found by the Idaho Department of Water Resources (IDWR) statewide program. Due to concern over elevated nitrate in domestic wells, ISDA began collecting water samples in the area. DEQ joined ISDA in collecting samples from 1998 to September 2008. Domestic wells near the Mountain Home wastewater lagoons and just east of the city's wastewater reuse land application fields showed a dramatic increase in concentrations of the contaminants nitrate, chloride, and sulfate. Because of this, DEQ carried out a study to determine whether the lagoons, the agricultural fields where wastewater is applied, or both, were responsible for the increase in concentrations of contaminants. This report summarizes the 2007 and 2008 DEQ sampling.

Methods and Results

The work performed by DEQ to evaluate the source of the increase in nitrate concentrations included the following:

- Samples from all wells were analyzed for nitrate-N, chloride, and sulfate. Some samples were analyzed for the common ions calcium, magnesium, sodium, potassium, bicarbonate, chloride, and sulfate. Samples from selected locations also were analyzed for the stable isotope ratios of oxygen ($\delta^{18}\text{O}$), deuterium ($\delta^2\text{H}$), and nitrogen ($\delta^{15}\text{N}$).
- Collection of water samples from the wastewater lagoons and irrigation ditches to compare the water quality of the surface water with the ground water.

Analytical results from the 2007 and 2008 DEQ sampling are presented in Table 8. Sample locations for DEQ and ISDA sampling is shown in Figure 8.

Table 8. Analytical results from Mountain Home project for 2007 and 2008 samples.

Monitoring Location	Sample Date	Nitrate mg/L	Chloride mg/L	Sulfate mg/L	$\delta^{18}\text{O}$ per mil	$\delta^2\text{H}$ per mil
MW-2	02/12/07	0.01	174	35	-7.3	-79
MW-2	03/12/07	0.01	174	33.4	-7.4	-81
MW-2	04/16/07	0.01	170	29.9	-7.5	-81
MW-2	05/14/07	0.01	167	28.8	-7.3	-80
MW-2	11/14/07	0.01	101	19.7	-7.6	-83
MW 3	2/12/2007	4.9	25.2	95.7	-14.3	-113
MW 3	3/12/2007	5.2	24.3	94.5	-14.4	-114
MW 3	4/16/2007	5.1	24.4	93.3	-14.4	-112
MW 3	5/14/2007	4.9	23.2	90.6	-14.4	-112
MW 3	11/14/2007	6.00	31.70	111.0	-14.5	-116
I-1	4/16/2007	1.9	32.5	23.6	-10.3	-95
I-1	5/14/2007	0.28	2.94	2	-5.4	-73
S1	5/14/2007	12	148	290	-9.3	-88
S2	5/14/2007	2.6	16.3	32.1	-7.0	-79
S7	5/14/2008	0.65	5.8	12	-15.0	-118
S8	5/14/2008	0.77	7.4	15	-16.2	-123
S11	5/14/2008	2.4	59	81	-9.0	-86
S12	5/14/2008	1.9	60	62	-4.6	-72
S13	5/14/2008	0.61	4.1	7	-15.3	-117
S14/03	3/12/2007	34	340	810	-15.8	-125
S14/03	4/16/2007	34	370	810	-12.4	-108
S14/03	5/14/2007	30	337	750	-11.2	-103
S14/03	5/14/2008	31	370	690	-16.5	-131
S14/03	5/14/2008	31	370	690	-12.4	-106
S15	11/14/2007	0.58	67.8	46.9	-12.6	-104
S15	5/14/2008	4.4	50	35	-13.0	-107
S15	9/8/2008	0.16	83	52	-11.8	-103
S16	5/14/2008	2.4	59	NA	-11.8	-103
S30	2/12/2007	0.25	55.3	44.6	-12.2	-106
S30	3/12/2007	0.52	56.1	44.8	-16.0	-124
S30	4/16/2007	1.1	57.4	45.9	-15.9	-125
S30	5/14/2007	1.3	56.1	44.2	-13.9	-116
S30	9/8/2008	0.99	73	49	-15.6	-122
S40	11/14/2007	0.27	33.5	22.7	-15.5	-124
S40	9/8/2008	0.018	42	36	-6.7	-84
S41	9/8/2008	2.3	33	25	-12.4	-109
S42	9/8/2008	2.5	16	42	-16.5	-131
S43	9/8/2008	0.11	44	44	-13.1	-106
S44	9/8/2008	0.01	6.2	4.8	-14.5	-111

Water chemistry in the perched aquifer has two distinct chemical signatures and trends, based on nitrate, chloride, and sulfate concentrations. The first distinct chemical signature occurs north of Hamilton Road, where water in the perched aquifer has low nitrate, chloride, and sulfate concentrations that are relatively stable (wells S15, S30, S42

and S44 – see Figure 8). Analysis of the available data indicates that the perched aquifer exists at background water chemistry conditions in this portion of the regional aquifer. The second distinct chemical signature is in the vicinity of Hamilton Road and South 18th Street, where water in the perched aquifer monitored by ISDA has elevated nitrate, chloride, and sulfate concentrations and time series plots show that concentrations are highly variable (Baldwin et al., 2009b). Please refer to the full technical report (Baldwin et al., 2009b) for analysis of DEQ and ISDA data.

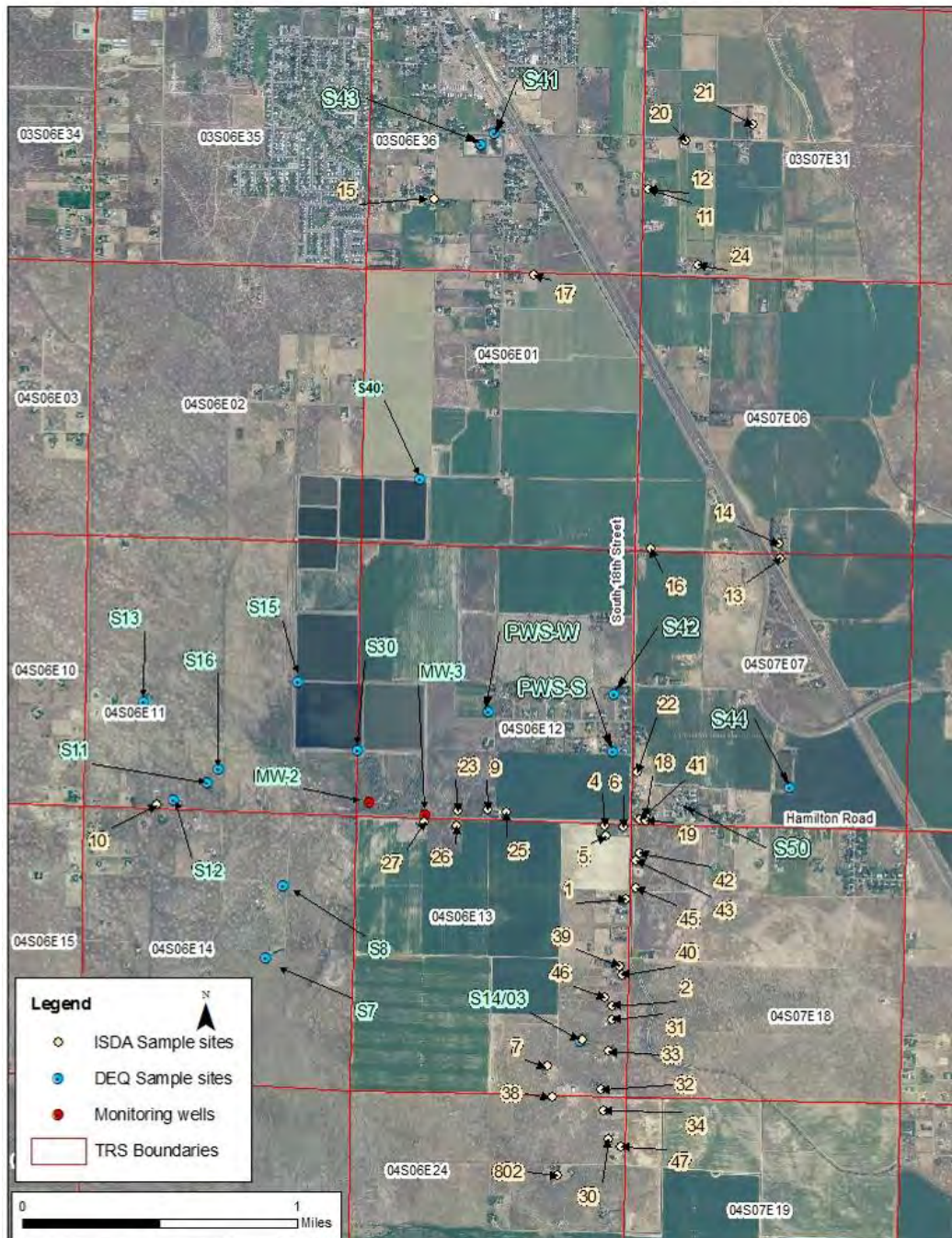


Figure 8. Sample locations and identification numbers for sites sampled by ISDA and DEQ in the Mountain Home south study area.

Oxygen and deuterium isotope ratios were used to evaluate the source of water in various wells in the study area. Figure 9, a plot of $\delta^{18}\text{O}$ versus $\delta^2\text{H}$ (including data from ISDA wells), shows that wastewater that has been in storage for the longest period (lagoon 9, sample location S30) and therefore has undergone the most evaporation, plots in the upper right part of the diagram. The variation in $\delta^{18}\text{O}$ and $\delta^2\text{H}$ for this sample location reflects the variation in evaporative conditions between summer and winter periods. Isotopic ratio evidence shows that the water in the perched aquifer at MW-2 is primarily derived from lagoon leakage and represents an average of the isotope ratios from the lagoon source. Water at MW-3 and ISDA Wells 4, 6, and 9 in the perched aquifer had a similar isotope ratio signature as the regional aquifer, and thus had no signature indicative of lagoon leakage. These isotopic ratio data indicate that the lagoon is affecting wells west of MW-2 and confirm that the ground water flow direction in the perched aquifer is northeast to southwest.

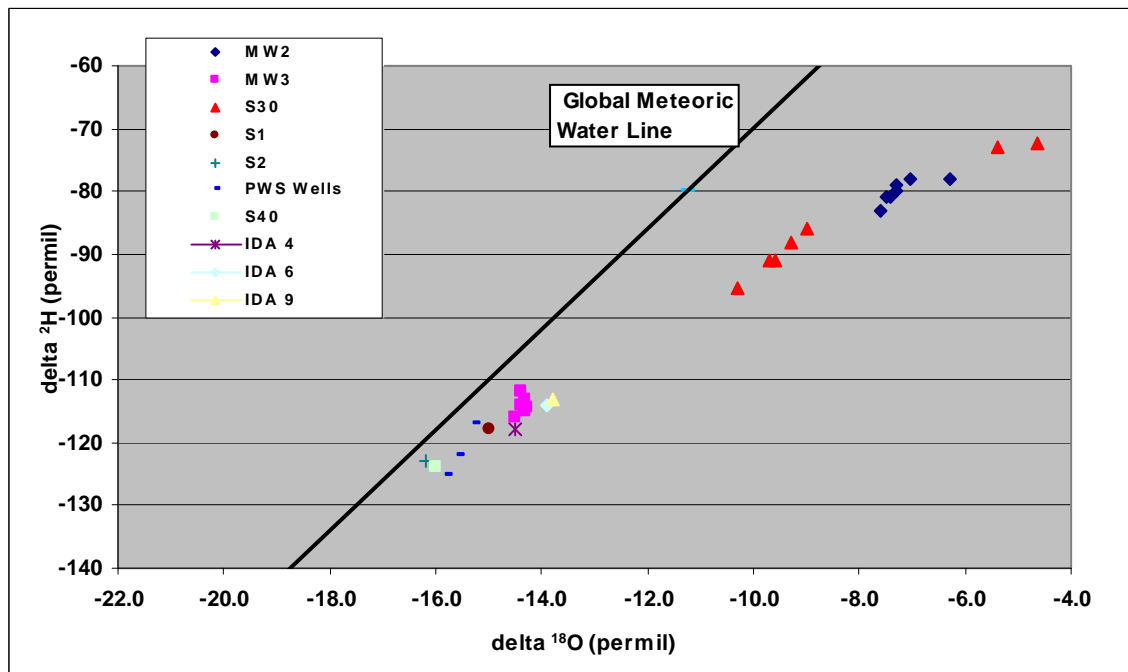


Figure 9. Plot of oxygen versus deuterium values for perched aquifer wells (MW-2, MW-3, ISDA Wells 4, 6, and 9), regional aquifer wells (S40, S1, S2 and PWS Wells), and water from the wastewater treatment lagoon (S30).

Nitrate, chloride, and sulfate concentrations are quite variable for wells completed in the regional aquifer, both with geographic location and with time. Overall, there is no consistent pattern to contaminant occurrence in wells completed in the regional aquifer. Such a wide range in water chemistry at adjacent wells indicates that an area-wide contaminant plume in the regional aquifer does not exist.

Elevated nitrate, chloride, and sulfate concentrations in regional aquifer wells can be explained by a combination of a contaminated zone in the overlying perched aquifer and leaky casing seals at the alluvium/basalt contact. Regional aquifer wells drilled through the contamination zone are at risk if the surface casing seal is not adequately seated or sealed into the basalt.

To evaluate casing seals and the depth to basalt, drillers' logs for 04S 06E Sections 12 and 13, and 04S 07E Sections 7 and 18 (Figure 8) were reviewed for construction details. The alluvium/basalt contact was identified from the drillers' logs, and the length of casing into the basalt was calculated. The highest occurrence of contaminated wells occurs in 04S 06E, Section 13 (Figure 8) which also had the corresponding highest number of wells with casing terminated at the alluvium/basalt interface. The inferred contaminated zone in the perched aquifer occurs in the area where contamination also has occurred in regional wells. No wells, perched or regional, located north or south of the perched aquifer contaminated zone are impacted.

Analytical data from lagoon influent, represented by sample S40 show that nitrate, chloride, and sulfate concentrations are similar to ambient concentrations for water in both the perched and regional aquifers. The wastewater influent represents a mixture of storm runoff and municipal wastewater that is combined with ground water pumped from the regional aquifer. The regional aquifer is the source of all municipal water for the city. The chemical input from the various waste sources does not result in significant water chemistry changes in the wastewater. The low nitrate, chloride, and sulfate concentrations in the lagoons eliminate the lagoons as the source of elevated nitrate, chloride, and sulfate in the perched aquifer.

The fate of lagoon seepage as it moves through the perched aquifer and subsequently downward to the regional aquifer can be evaluated through the use of $\delta^{18}\text{O}$ and $\delta^2\text{H}$ isotope ratio data. Deuterium values for most perched and regional aquifer wells fall within the range of -115 to -130 per mil, which establishes this water as a ground water end member. The lagoon isotopic ratio variations reflect summer and winter evaporative conditions; isotope ratio results at MW-2 represent an average of all lagoon isotopic ratio values. The wastewater isotope ratio can be used as a second end member for the study area.

Isotopic ratio results show that wells S14/03, S11, S12, and S16 are impacted by lagoon seepage, because they plot as mixed water between the two end members (Figure 10). Wells S7, S8, and S13 do not have a lagoon isotopic ratio signature. Seepage data indicate that the lagoons are leaking; however, there are insufficient data to determine the specific ground water flow in this small area and why these wells are not impacted by lagoon seepage.

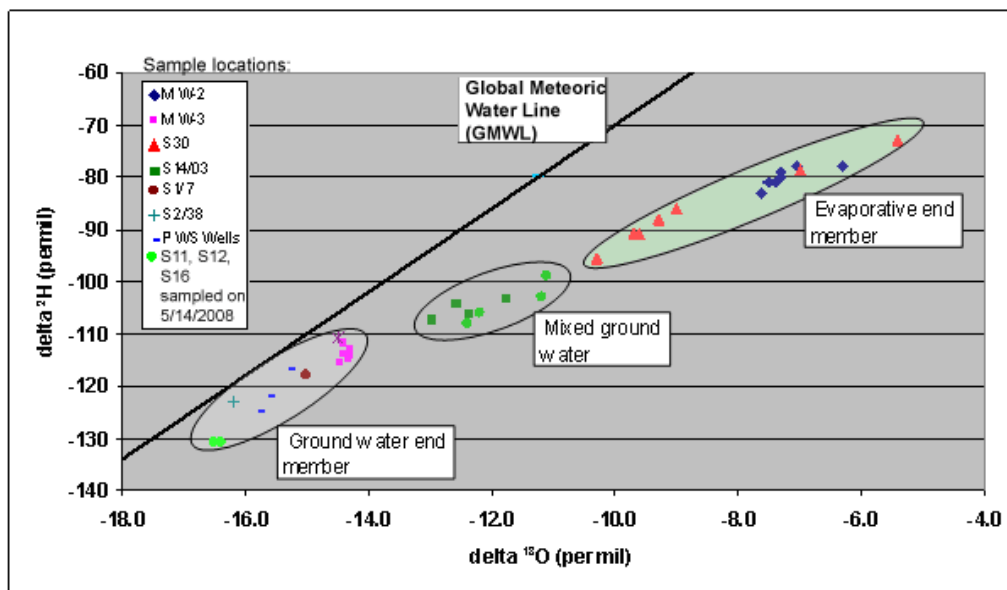


Figure 10. Plot of $\delta^{18}\text{O}$ versus $\delta^2\text{H}$ for wells in the Mountain Home South study area.

Well S14/03 is located about one mile southeast and cross-gradient of the lagoon system, yet it produces water that is a mixture of regional ground water and lagoon seepage. One explanation for the impact is as follows: a field located in the southeastern part of the wastewater land application area has shallow soils, ranging from 6 to 18 inches deep. Deep percolation of wastewater applied to the southeastern field may have occurred, and this water could migrate through the fractured basalt to the regional aquifer and to well S14/03.

Conclusions

Analysis of water quality data indicates a human-caused source of contamination from elevated levels of chloride, nitrate, sulfate, and total dissolved solids. Overall the results establish that there is a contaminated zone of elevated nitrate, chloride, and sulfate in the perched aquifer. In addition, water chemistry in the regional aquifer shows elevated nitrate, chloride, and sulfate concentrations. Contamination in regional aquifer wells is quite variable for both location and time.

This study concludes that elevated concentrations of contaminants in wells completed in the deep regional aquifer can best be explained by a combination of two factors: 1) a contaminated zone in the overlying perched aquifer, and 2) leaky well casing seals at the area where basalt and alluvium come into contact.

Analysis of data from wells and surface water indicates an unidentified anthropogenic source of contamination in the perched aquifer in the study area south of Mountain Home. This data supports that inadequate casing seals are the most likely transport mechanism from the perched aquifer to the regional aquifer.

The source of the elevated nitrate, chloride, and sulfate was investigated using water chemistry and isotope ratio tools. A point source large enough to result in the elevated nitrate, chloride and sulfate concentrations at several wells has not been identified.

Stable isotope ratios indicate that lagoon seepage is recharging the perched aquifer south and west of the wastewater treatment facility, and that this lagoon seepage has migrated to the intermediate and regional aquifer at some wells. At other regional aquifer wells down-gradient of the lagoons, there is no isotopic ratio evidence of perched aquifer leakage.

Oxygen and deuterium isotope ratios suggest that deep percolation of treated wastewater effluent applied to fields permitted for wastewater application may be migrating to domestic Well S14/03, which is completed in the regional aquifer. Deep percolation from wastewater applied to an adjacent reuse field may have migrated through the vadose zone to Well S14/03.

Overall, the investigation did not identify the source of the dramatically increasing nitrate, chloride, and sulfate concentrations observed at Well S14/03 and wells sampled by ISDA (see Baldwin et al., 2009b). The study showed that lagoon seepage water or effluent that is land applied to agricultural fields during the summer months was not the source of the elevated concentrations. A different, unknown contaminant source is indicated.

Recommendations

It is recommended that an inventory be conducted of potential contaminant sources in the area, including surface water bodies (irrigation canals and holding ponds). In addition wells with elevated nitrate, chloride, and sulfate concentrations should be resampled to evaluate trends. Bacteria analysis was not conducted as part of this study. If contaminants are migrating from the perched to the regional aquifer via leaky casing seals, pathogens also could be impacting regional aquifer wells. Bacteria sampling should be carried out for candidate wells. The water chemistry data indicate that there is a lag time between when wells were drilled and the onset of contamination, indicating that casing seal failure can occur at some time in the future. Regional aquifer wells that are not currently impacted may become impacted some time in the future. Wells in this area should be completed in accordance with the updated IDWR construction standards. If the saturated alluvium extends beyond 38 feet, then well casings should extend into the basalt.

Recommendation for future work for this area also includes a camera survey for contaminated wells completed in the regional aquifer to check for leakage from the perched to the regional aquifer. A camera survey should reveal if leakage is occurring and is moving down the open-hole portion of a well.

For more information, please see the full technical report by Baldwin et al. (2009b) at http://www.deq.idaho.gov/water/data_reports/ground_water/mountain_home_south_nitrate_36.pdf.

4.1.8 Emmett North Bench Study

Purpose

The purpose of this project was to better understand the distribution and cause of elevated nitrate in the newly identified Emmett North Bench NPA from the 2008 NPA ranking analysis.

Methods and Results

The following work was conducted for this study:

1. Nitrate data used in the original 2002 NPA Ranking (14 sample sites) were compared with the nitrate data used for the 2008 NPA Ranking (27 sample sites) that resulted in the formation of the Emmett North Bench NPA during the re-ranking process. The comparison was completed to identify data discrepancies between the two datasets.
2. Ground water samples were collected from six wells and analyzed for nitrate during August 2008. Four wells were sampled previously in 1994 or 1995 for nitrate, and the data sets were compared.

The comparison between the 2002 and 2008 data revealed that a new data set available for the 2008 ranking consisting of ground water samples from the dairies provided enough data points with concentrations of nitrate greater than 5 mg/L to result in meeting the NPA criteria (more than 25% of the wells having nitrate concentrations greater than 5 mg/L). When comparing nitrate concentrations from wells sampled prior to 2002 to the same well sampled between 2002 and 2008, no increasing trend of nitrate concentrations was indicated.

The results from the nitrate analysis for the six wells sampled in the Emmett North Bench NPA are shown in Figure 11. The nitrate concentrations ranged from 1.7 mg/L to 5.5 mg/L. When comparing nitrate concentrations between the four wells that were sampled in 1994 or 1995, and then again in 2008, all four wells showed a decrease in nitrate concentrations from 1994/1995 to 2008.

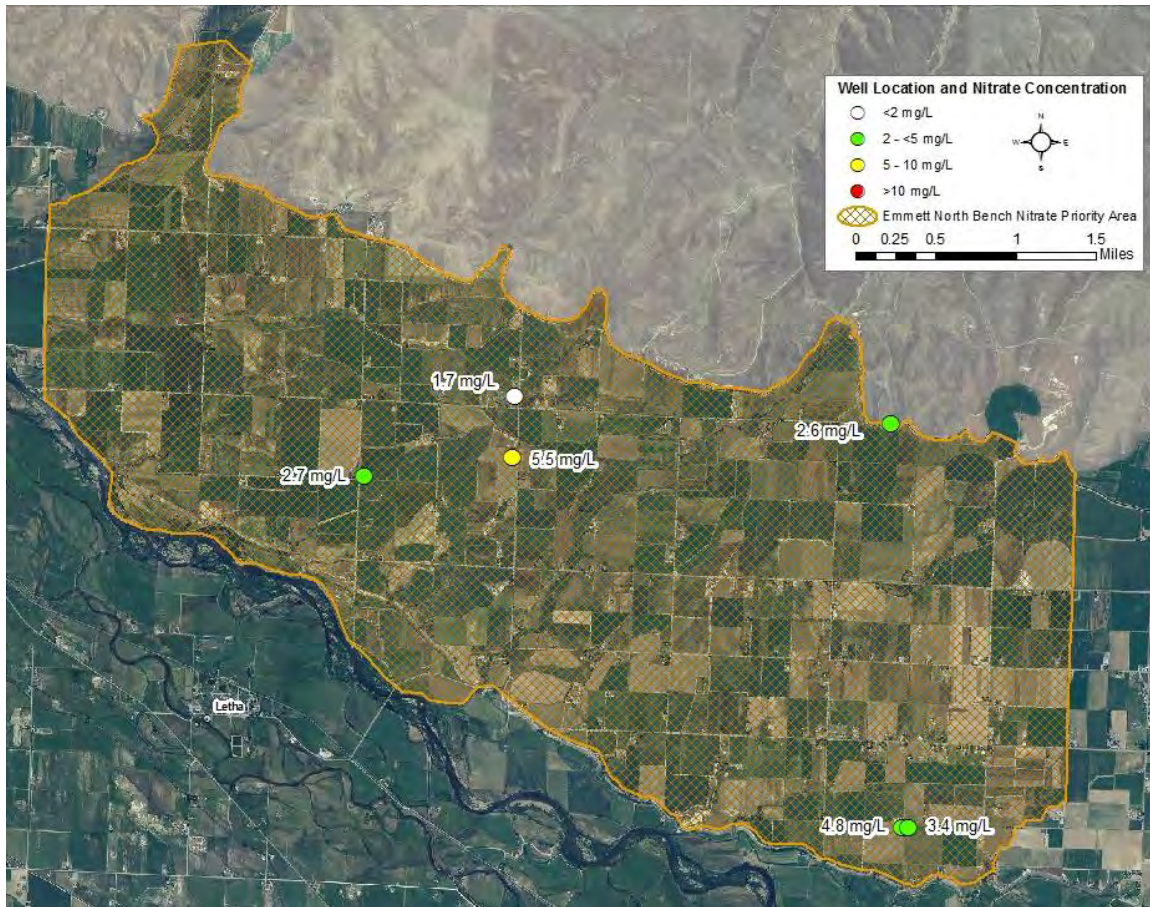


Figure 11. Well location and August 2008 nitrate results for Emmett North Bench Study.

Conclusions

The addition of the data set from ground water samples from the dairies resulted in more than 25% of the wells with nitrate concentrations over 5 mg/L, which created the new Emmett North Bench NPA. One of the six wells sampled in 2008 by DEQ had nitrate concentrations over 5 mg/L. When comparing nitrate concentrations from the four wells sampled in 1994/1995 and again in 2008, the concentrations indicated a decreasing trend.

Recommendations

For the next NPA review, it is critical to have the most recent data, as seen by the changes in nitrate concentrations in the four wells sampled in 1994/1995 and 2008. Additional wells need to be sampled in this Nitrate Priority Area.

4.2. Coeur d'Alene Region

4.2.1 Coeur d'Alene Trichloroethylene Review

Purpose

DEQ conducted a follow-up investigation to determine the status of a trichloroethylene (TCE) plume associated with Deming Industries. DEQ initiated this investigation in 2006 by compiling existing data; locating domestic and public water system wells for sampling; completing a sampling analysis and quality assurance plan; sampling the proposed wells; compiling and interpreting the analytical data; and completing a report. Additional ground water samples were collected in 2007.

In March 1990, the Sunrise Terrace Water Association public water system, consisting of two wells, was sampled by DEQ for VOC analysis. DEQ collected a water sample from the water distribution system downstream of the reservoir. Analytical results indicated a TCE concentration at 22.8 µg/L, above the MCL of 5 µg/L for TCE. A verification check sample collected the following month contained TCE at a concentration of 20.0 µg/L.

In April 1990 additional samples were collected at the wellhead for each of the supply wells. Analytical results indicated TCE concentrations of 26.5 µg/L in the north well and 19.8 µg/L in the south well. Subsequent sampling later that month indicated similar results. In 1991 the Sunrise Terrace Water Association began receiving water from the City of Coeur d'Alene.

In July 1992, at the request of DEQ, the City of Coeur d'Alene Hanley well was added to the ongoing Rathdrum Prairie monitoring program and was sampled by the Panhandle Health District (PHD) for VOC analysis. This well is located approximately 800 feet west of the Sunrise Terrace well system. Although the screened interval of the Hanley well is slightly deeper than those of the Sunrise Terrace wells, its surface elevation is proportionately higher, thus placing its screen at an elevation comparable to those of the Sunrise Terrace wells. TCE was detected in the July 1992 sample at 3.17 µg/L. Subsequent sampling yielded similar results.

Attempts to identify the source of TCE contamination found in the Sunrise Terrace and nine other area wells resulted in 26 potential sources. An extended site investigation conducted in 1995 and 1996 identified six potential TCE sources three of which, Deming Industries, a former Idaho Department of Transportation maintenance facility, and Interstate Concrete and Asphalt were investigated further. The investigation concluded that Deming Industries was a likely source for the TCE in Sunrise Terrace and City of Coeur d'Alene Hanley well which are hydraulically down gradient from the Deming site. However; other potential source could not be ruled out. Figure 12 shows the location of Deming Industries, the Sunrise Terrace well system and the Hanley well.

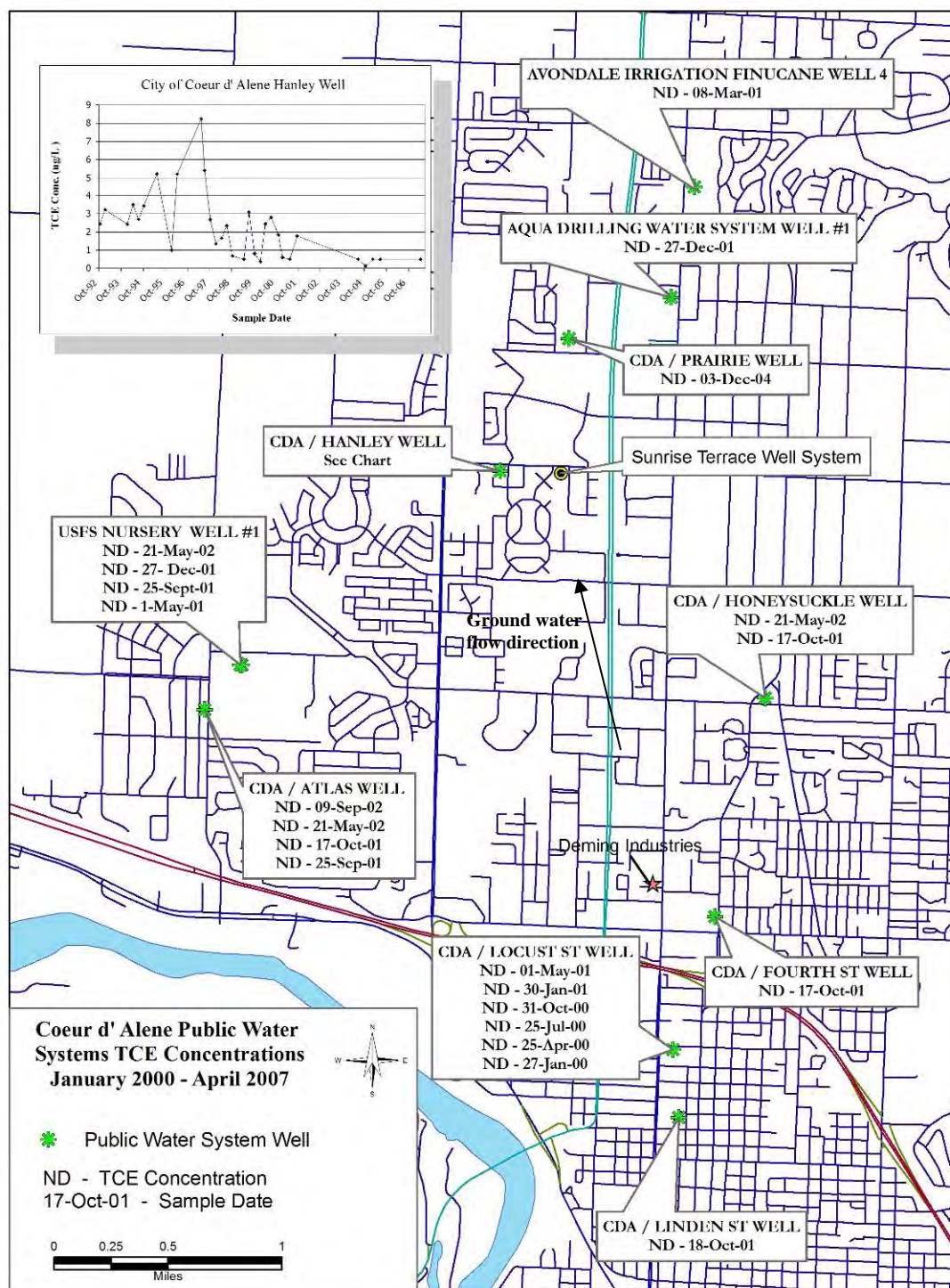


Figure 12. Summary of Historic Coeur d'Alene Area Public Water System Data from 2000 to 2007.

Methods and Results

DEQ reviewed existing reports concerning the Sunrise Terrace TCE investigations and IDWR well information database to identify and locate potential wells for sampling. Seven wells were identified hydraulically down gradient from the Deming Industries site

as potential sampling locations. No current contact information could be found for the owners of the proposed sample wells.

The DEQ PWS data base was searched for historic TCE data in the project area. Figure 12 contains the search results for January 2000 through December 2005. The only public water system well with detections for TCE during 2000 through 2005 was the Hanley well. A more thorough review of TCE data from the Hanley well showed an overall decreasing trend in TCE levels since 1992. In 1999, 2001, 2004, and 2005 TCE concentrations in samples from this well dropped to or below the MCL.

Ground water sampling was conducted on April 30, 2007. A DEQ Hydrogeologist attempted to locate the proposed wells or other domestic wells in the area for sampling and was only successful in finding one functioning well, the City of Coeur d'Alene Hanley well. Field parameters and samples were collected according to DEQ's standard operating procedures. Laboratory analysis of the ground water sample resulted in non-detection for all analytes including TCE using EPA method 8260B (Figure 12).

Conclusions

Based on the available historic data and the one ground water sample DEQ concluded TCE concentrations do not appear to be significant at public water system wells in the general area of the Sunrise Terrace Community. However, no ground water samples have been collected between the Deming Industries site and the Sunrise Terrace wells, including the Sunrise Terrace wells since the early 1990s.

Recommendations

Due to the lack of available wells down-gradient from the Deming Industries site, DEQ can not evaluate the potential presence of the TCE contamination.

4.2.2 Sagle Idaho Ground Water Quality Investigation, Ground Water Quality Technical Report No. 31

Purpose

DEQ conducted a ground water quality investigation in the Sagle, Idaho area in response to the increasing population and the reliance on individual septic systems to treat domestic wastewater. The increased number of septic systems have the potential to degrade water quality in the Sagle Aquifer, the primary drinking water source in the area.

Subsurface septic systems discharge a number of constituents including nitrate to the surrounding ground. The properties of nitrate allow it to be readily transported through permeable geologic media. Its presence in ground water can be an indicator of impacts from subsurface septic systems.

Methods and Results

To determine if nitrate concentrations in the Sagle Aquifer are increasing, DEQ compiled historic data from state databases and reports and conducted ground water sampling in the fall of 2006 and spring of 2007. This report will focus on data from 2007.

Nineteen wells were sampled during April 2007 and analyzed for chloride, nitrate, total dissolved solids, and sulfate. All analyte concentrations were below associated MCL for all samples analyzed. The maximum detection of nitrate in 2007 was 1.47 mg/L (Well 56N-2W-4bd1, see Figure 13). The median and mean nitrate concentrations were 0.352 mg/L and 0.48 mg/L, respectively.

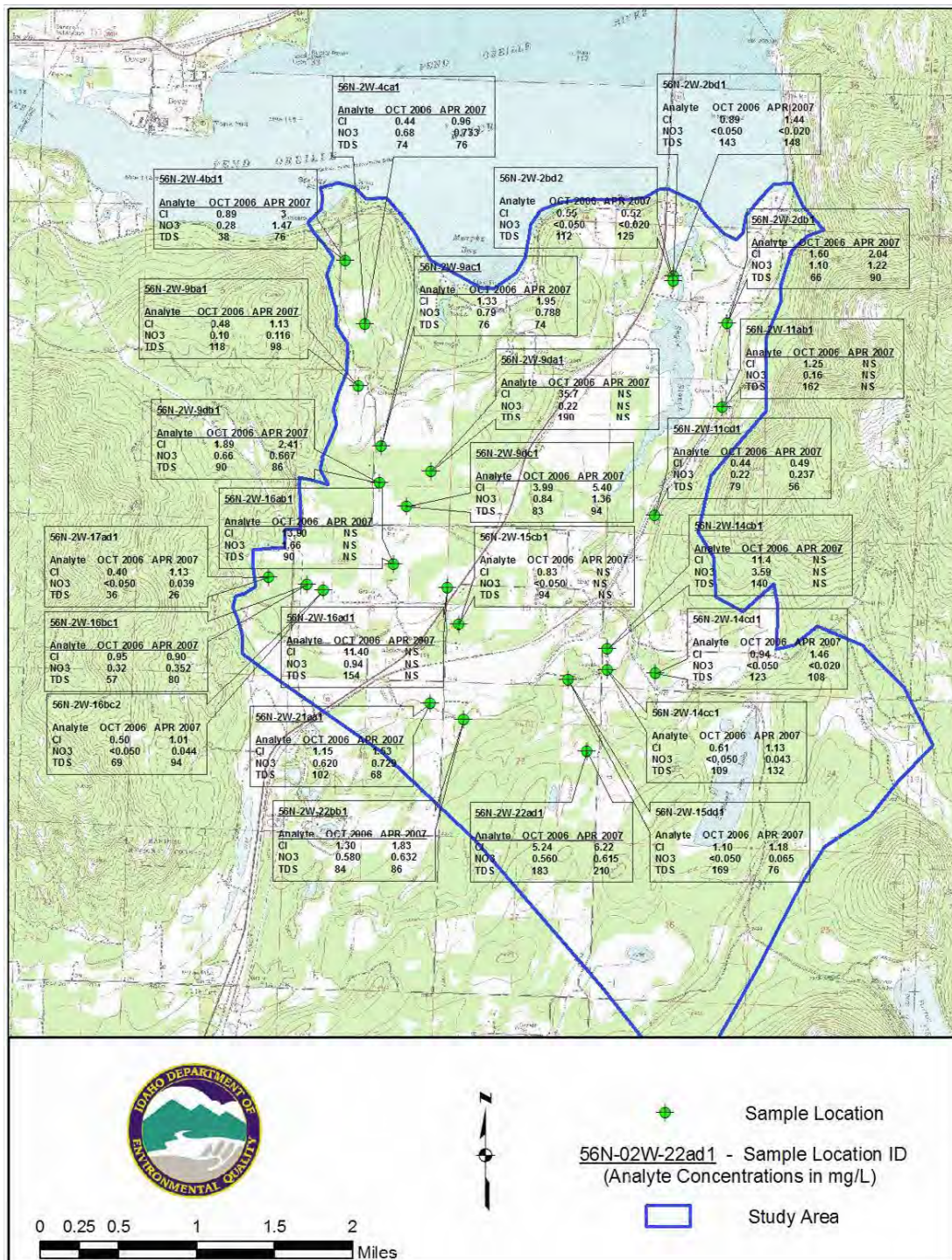


Figure 13. Sampling locations and analytical results for DEQ Sagle ground water sampling, October 2006 and April 2007.

Notes: NS = Not sampled.

Conclusions

Based on a review of all available data, it appears that ground water nitrate concentrations in the Sagle area are stable and well below the MCL. Other analytes investigated show limited evidence of any significant impact from septic systems.

Recommendations

Residents of the Sagle area are encouraged to properly maintain their septic systems to help protect ground water quality.

For more information, please see the full technical report by Miller (2008) at http://www.deq.idaho.gov/water/data_reports/ground_water/sagle_31.pdf.

4.2.3 Silverwood/Athol Ground Water Study, Ground Water Quality Technical Report No. 32

Purpose

This report presents ground water monitoring results for samples collected by DEQ during 2007 from wells in the general area of the Silverwood Theme Park, located south of the community of Athol, Idaho. During the study, water samples were collected quarterly from wells in the Silverwood area, beginning in September 2006. The theme park discharges wastewater generated during the summer operating season to a series of septic tanks and drain fields, and there is a concern that ground water in the Rathdrum Prairie Sensitive Resource Aquifer (RPSRA) may be impacted by this discharge.

Methods and Results

The initial goal of the study was to establish 15 ground water sampling locations in the area. However, following a review of well logs, and field visits to the area, nine wells were identified for the sampling network. All nine wells are public water system wells (Figure 14).

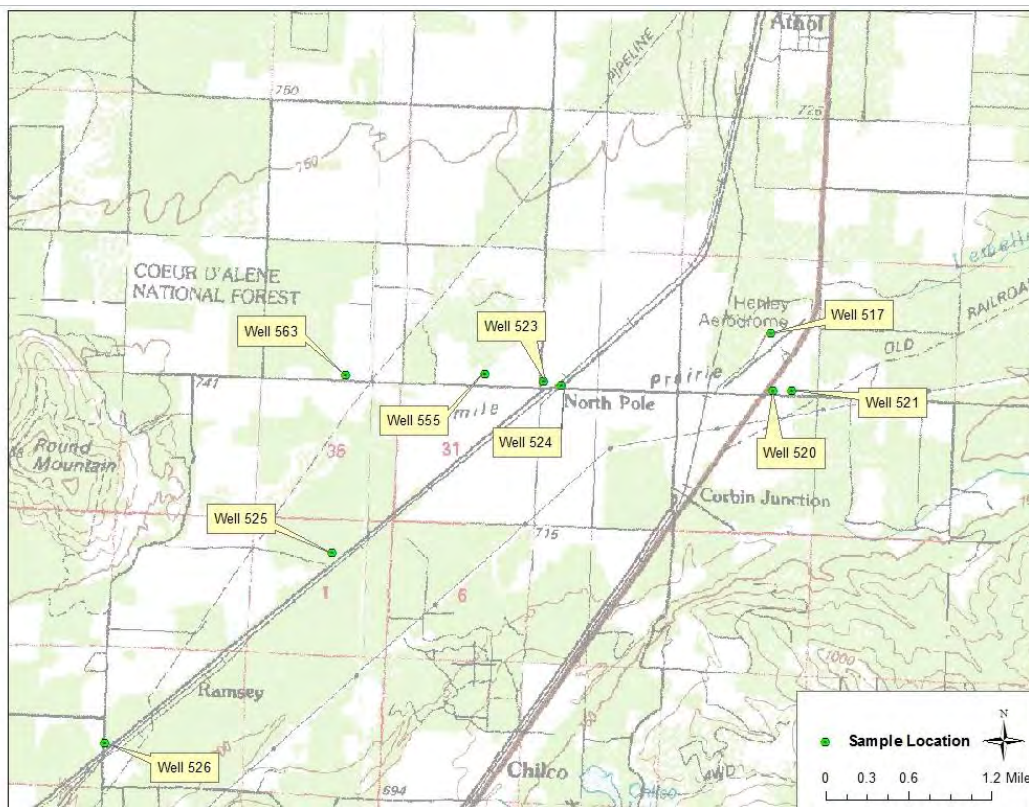


Figure 14. Sample locations for Silverwood project.

The general ground water flow direction in the RPSRA is from the northeast to the southwest, but a potentiometric map prepared by Campbell (2005) indicated that in the Silverwood area ground water moves from southeast to northwest. The potentiometric surface in this area was based on water level elevations from two wells located near the eastern margin of the aquifer. At the time, these were the only wells within a 24 square mile area where water levels were available. Two test wells completed in July 2007 at the Silverwood site provide more site-specific water level information and indicate that the direction of ground water flow in the Silverwood area is to the south-southwest. In any case, the nearest sample location for this project was approximately 1 mile west of the facility, which is believed to be cross-gradient from the theme park, and the next nearest sample location was about 3 miles to the southwest. Well samples were analyzed for major ions, nitrate as nitrogen ($\text{NO}_3\text{-N}$), total dissolved solids, the environmental isotope ratios of oxygen and hydrogen (also called deuterium) and the field parameters pH, temperature, specific conductance, and dissolved oxygen were measured.

Major ion results indicate that ground water at most sites is a calcium-magnesium bicarbonate type water. One well completed in the underlying granitic bedrock and hydrologically isolated from the overlying RPSRA is a sodium bicarbonate water. Nitrate concentrations for the 2007 sampling ranged from 0.02 mg/L to 1.54 mg/L. The stable isotope ratios indicated that oxygen and deuterium can serve as useful tracers of wastewater impacts to ground water provided suitable down-gradient monitoring locations are available.

Table 9. Analytical Results from 2007 sampling of Silverwood project.

Notes: Blank cells indicate no sample was taken.

Well ID	Sample Date	$\delta^{18}\text{O}$ (permil)	$\delta^2\text{H}$ (permil)	Cl (mg/L)	SO_4 (mg/L)	TDS (mg/L)	$\text{NO}_3\text{-N}$ (mg/L)
Well 517	7/11/2007	-10.8	-94	537	7.14	1220	1.54
Well 520	3/6/2007			1.15	5.43	138	0.589
Well 520	4/27/2007			2.07	4.99	154	0.49
Well 520	7/11/2007			1.24	4.38	74	0.433
Well 520	9/27/2007			6.73	4.99	96	1.1
Well 521	3/6/2007			1.14	5.26	144	0.531
Well 521	4/27/2007			1.9	5.02	148	0.448
Well 521	7/11/2007			0.98	4.07	204	0.345
Well 521	9/27/2007			1.45	4.35	124	0.583
Well 523	3/6/2007			1.42	5.86	164	0.707
Well 523	4/27/2007			4.18	5.89	164	0.825
Well 524	3/6/2007			1.48	5.55	158	0.642
Well 524	4/27/2007			3.67	6	154	0.755
Well 524	9/27/2007			1.53	6.02	134	1.09
Well 524	7/11/2007			1.51	5.97	124	0.626
Well 525	3/6/2007			0.48	14.2	118	0.022
Well 525	4/27/2007			0.89	14.4	116	0.02
Well 526	4/27/2007			2.73	7.48	180	1.1
Well 526	7/11/2007	-15.1	-110	1.92	8.06	174	0.62
Well 526	3/6/2007			1.86	8.25	166	0.643
Well 555	3/6/2007			1.17	7.02	160	1.02
Well 555	4/27/2007			2.05	6.04	154	0.819
Well 555	7/11/2007	-14.9	-108	2.7	5.92	52	0.759
Well 563	3/6/2007			1	4.09	120	0.78
Well 563	4/27/2007			1.71	4.28	116	0.713

Conclusions

Impacts from the Silverwood wastewater system to ground water were not documented in this study, in part because ground water sample points immediately down-gradient of the facility were not available. It also is possible that any impacts from the facility are not detectable because the contribution is small and/or there is a high degree of dilution in the aquifer.

Recommendations

An adequate evaluation of impacts from the facility would require a better definition of the local ground water flow direction. With local ground water flow direction information, sampling points that are located up-gradient and down-gradient of the facility could be chosen to better evaluate the impacts of the Silverwood wastewater system.

For more information, please see the full technical report by Baldwin and McVay (2008) at http://www.deq.idaho.gov/water/data_reports/ground_water/silverwood_32.pdf.

4.2.4 Chilco Area of the Spokane Valley-Rathdrum Prairie Aquifer

The study area is centered around the Riley Creek Lumber Mill (formerly the Louisiana-Pacific Corporation Chilco Lumber Mill), approximately 15 miles north of Coeur d'Alene, Idaho (Figure 15). Several domestic wells in the study area have had historic bacteria detections. Within the study area, the highest concentrations of bacteria have been found in Chilco Lake and the Mill Well (both used for log deck irrigation) and in samples of log deck runoff from around the mill. These water bodies seem the most likely source of domestic well impacts.

Purpose

The purpose of this study is to determine whether the Riley Creek Lumber Mill is a source of bacterial contamination in domestic wells in the area. Riley Creek Lumber Mill (Riley Creek) is currently the site of a lumberyard that includes the storage and sawing of logs on site. Stored wood consists of chip piles and log decks (large piles of logs). The stored wood is wetted almost continually to prevent drying that would reduce product quality. This irrigation of stored wood products produces runoff from the facility that collects as standing water in the Mill Pond, Mill Pit, and the Mill Runoff areas (Figure 15). At Riley Creek, irrigation runoff water and the mill well water have historically shown large concentrations of coliform bacteria, and domestic wells down gradient of the mill have tested positive for coliform bacteria. The purpose of this investigation is to determine if the persistent presence of coliform bacteria in the nearby wells is related to activities at Riley Creek.

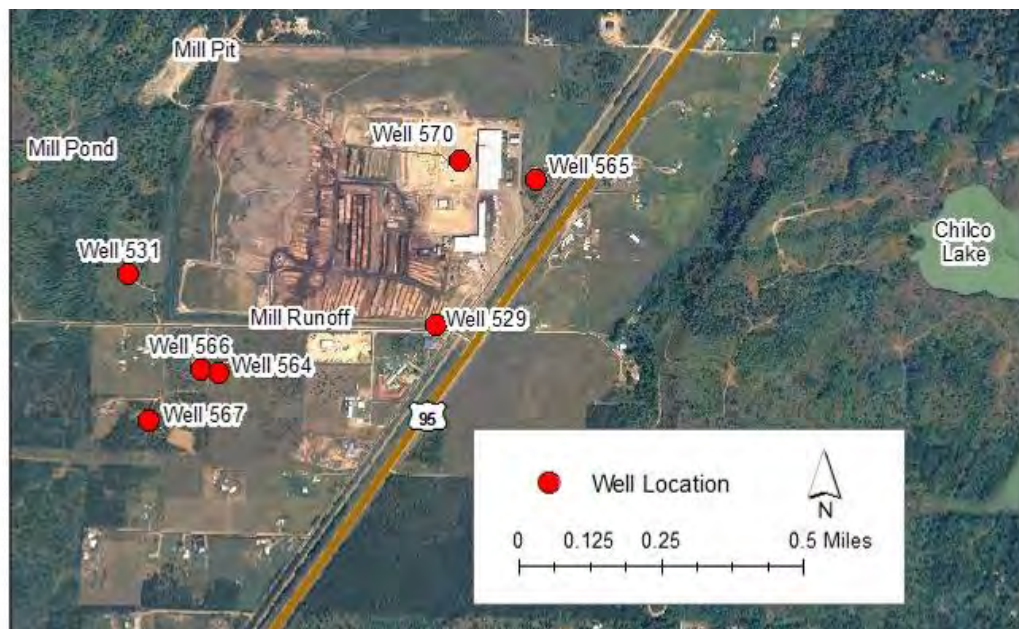


Figure 15. Well locations of Chilco project.

Methods and Results

To identify potential sampling locations, DEQ conducted a search of the IDWR well information database, spoke with domestic and public water supply well owners, and visited the study area. Well and surface water sampling locations are shown in Figure 15. Water samples were analyzed for a range of constituents including the following:

chloride, nitrate, sulfate, total dissolved solids (TDS), E. coli, total coliform, the stable isotope ratios of oxygen and deuterium, tannins, lignins, terpenes, total phenolics, alkalinity, calcium, iron, potassium, magnesium, manganese, sodium, biological oxygen demand, chemical oxygen demand, dissolved oxygen concentration, and total organic carbon. Analysis results for bacteria are found in Table 10 and nitrate results are found in Table 11. Because this project progressed as a forensic investigation with an effort to delineate source water, the analytical approach was modified throughout the investigation in an attempt to optimize project objectives. Therefore, not all constituents were analyzed for in all wells during each sampling event.

The presence of bacteria in Chilco Lake water was confirmed through sample analysis (Table 10). The highest concentrations of bacteria have been found in samples from Chilco Lake and the Mill Pond.

Table 10. Bacteria Results for Chilco project.

Notes: MPN/100ml = most probable number per 100 milliliters. Blank cells indicate no data available.

Well	Sample Date	Total Coliform (MPN/100 ml)	E. coli (MPN/100 ml)
529	March 2007		1
	7/10/2007	<1	<1
	1/24/2008	3	<1
	4/29/2008	2	<1
	July 2008	<1	<1
	11/5/2008	2	<1
531	March 2007	1	1
	April 2007	1	1
	7/10/2007	<1	<1
	9/25/2007	9.8	<1
	1/24/2008	<1	<1
	4/29/2008	<1	<1
	5/2/2008		<1
	July 2008	<1	<1
	7/31/2008	<1	
	11/5/2008	<1	<1
564	March 2007	1	1
	April 2007	1	1
	7/10/2007	<1	<1
	1/24/2008	<1	<1
	4/29/2008	<1	<1
	July 2008	<1	<1
	11/5/2008	<1	<1
565	March 2007	1	1
	April 2007	1	1
	9/25/2007	<1	<1
	4/29/2008	5	<1
	July 2008	<1	<1
	11/5/2008	<1	<1
566	March 2007	1	1
	April 2007	1	1
	7/10/2007	<1	<1

Well	Sample Date	Total Coliform (MPN/100 ml)	E. coli (MPN/100 ml)
	9/25/2007	<1	<1
	1/24/2008	<1	<1
	4/29/2008	<1	<1
	July 2008	<1	<1
	11/5/2008	1	<1
567	9/25/2007	<1	<1
	1/24/2008	<1	<1
570	7/10/2007	<1	<1
	9/25/2007	16	<1
Chilco Lake	March 2007	575	1
	April 2007	73.3	13.4
	7/10/2007	3653.5	4.1
	9/25/2007	46.1	2
	4/29/2008	150	38
	July 2008	2400	200
	11/5/2008	1700	2
Mill Pond	March 2007	331	1
	April 2007	1600	4
	7/10/2007	155310	16.9
	9/25/2007	>1600	500
	4/29/2008	16	<1
Mill Runoff	April 2007	1	1
	7/10/2007	9043	20.3

Table 11. Nitrate Results for Chilco project.

Notes: Blank cells indicate no data available.

Well ID	Nitrate Concentration (mg/L)						
	March 2007	April 2007	July 2007	September 2007	January 2008	April 2008	July 2008
565	2.03	1.81	1.54	1.74		1.72	1.65
531	0.641	0.826	0.527	0.381	0.661	1.44	0.691
566	0.974	1.18	0.989	1.42	0.971	1.27	1.29
564	0.879	1.07	0.852		0.993	1.12	1.22
529		1.16	1.27		1.32	0.805	1.37
567				1.51	1.27		
Chilco Lake	0.02	0.02	0.02	0.182		0.0432	0.0609
Mill Pond	1.26	0.759	0.157	0.172		0.02	

Conclusions

DEQ conducted a ground water quality investigation in the Chilco, Idaho area to evaluate the source of persistent bacterial contamination in domestic wells down gradient of the Riley Creek Lumber Mill. Irrigation of log decks using the Chilco Lake water source, which tested positive for bacteria, provides a pathway for delivery of bacteria to organic material within the on-site wood products. The highest concentrations of bacteria have been found in samples from Chilco Lake and Well 570 (both of which are used for log deck irrigation) and in samples of the resulting runoff from around the mill. The most likely time frame for bacterial transport from surface water features to ground water is probably during the spring recharge event, when log decks and yards are saturated.

Recommendations

A conclusive link between bacterial contamination in mill runoff water and in domestic wells has not been established. More sampling and analyses are required for any determination of the mill's impact on bacterial contamination in the area's domestic wells.

4.3. Idaho Falls Region

4.3.1 Champagne Mine Study

The Champagne mine was a precious metal mine located approximately 65 miles west of Idaho Falls, owned and operated by Idaho Gold Corporation (IGC). The project encompasses 375 unpatented mining claims and approximately 1,250 acres of fee land in Butte County, Idaho. The mine operated between 1989 and 1993 carrying out bulk mining of gold and silver ore from two open pits. Ore was processed using conventional cyanide leaching of run-of-mine material in a single heap leach pad. Waste rock was stored in a single waste rock repository or used to partially backfill the pits. The facility underwent closure in compliance with the approved closure plan proposed in the original Environmental Assessment consisting of detoxification of the heap and mine facilities and re-grading and re-vegetation of the disturbed areas. Closure was completed and approval received in 1995, with the sampling of selected monitoring sites has been conducted by IGC since that time.

Between 1989 and February 1992 approximately 3.6 million tons of ore and 3.2 million tons of waste rock were mined from two pits, the South Pit and the North Pit (Figure 16). Run-of-mine ore was delivered to a single high-density polyethylene lined leach pad constructed in three phases and processed using conventional cyanide leach. The bulk of the waste rock from both pits was either placed in a single waste rock facility lying adjacent to the South Pit or used as backfill in the North Pit with minor amounts used in the construction of the main haul road to the leach pad.

Cyanide leaching of the ore and solution processing continued after mining ceased until January 1993. The spent ore underwent detoxification beginning in May 1993 by recycling process solution through the heap to remove cyanide and dissolved metals. Hydrogen peroxide was introduced into the cycle to enhance cyanide destruction. Neutralization of the heap was completed in the second quarter of 1995. Final surface reclamation was completed by the end of 1995.

Purpose

The hydrologic relationship between the overlying North Pit and adit discharge is important as it relates to final closure of the mine site. Ponding occurs in the North Pit from spring snowmelt and precipitation events. If this water recharges to the underlying mine workings, reconfiguration of the pit to provide free drainage would reduce or eliminate this source of water to the mine workings. DEQ collected samples from the Moran Tunnel, the North Pit, a well near the mine, and locations on Champagne Creek during April 2007. The stable isotope ratios of oxygen and deuterium were analyzed and these parameters provide information regarding the pit-mine working relationships. Figure 16 shows mine features and sample locations.

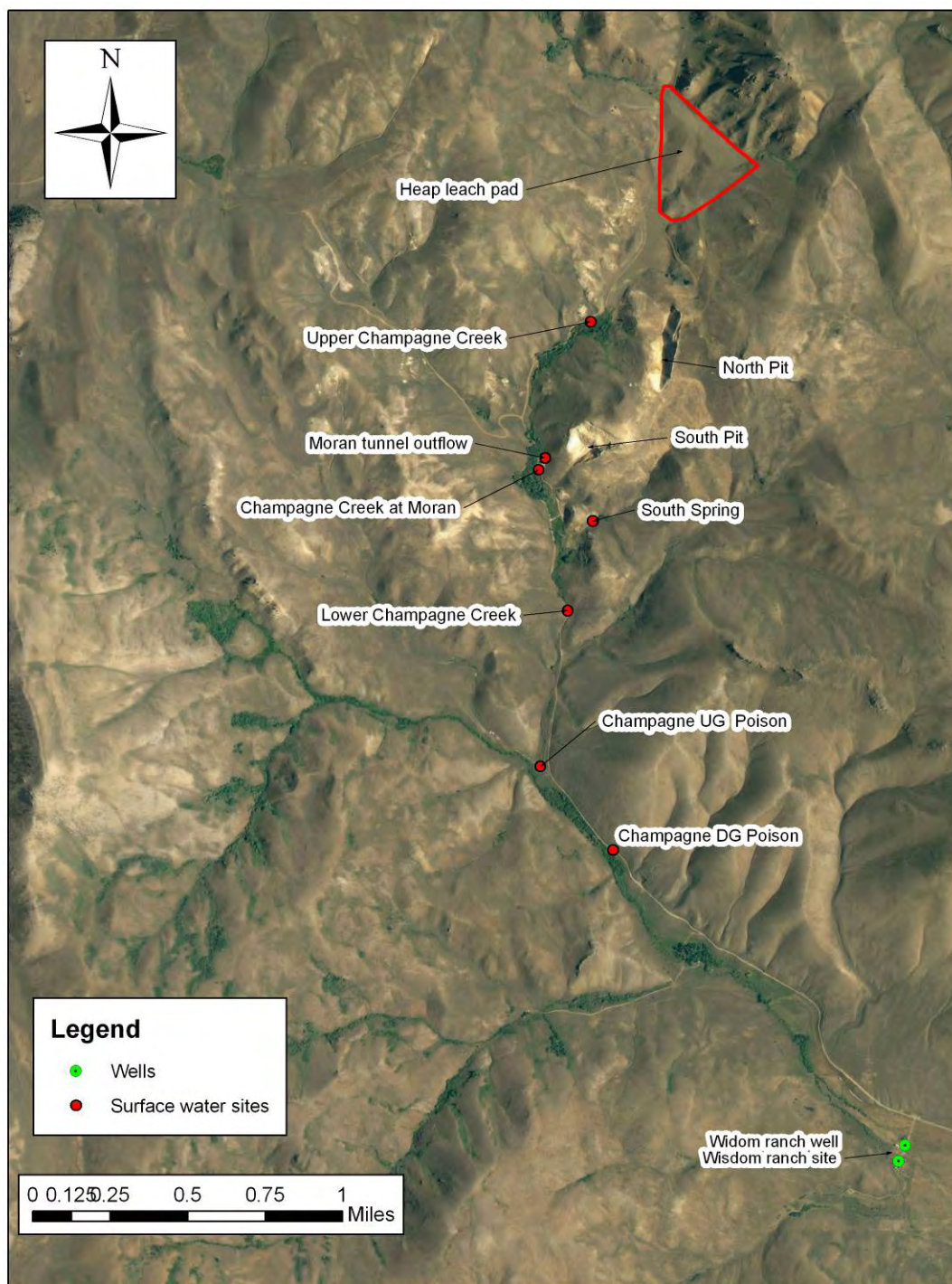


Figure 16. Champagne Mine, Butte County location map showing mine pits, heap leach pad and sample locations.

Methods and Results

Mining the oxide ore was conducted during the early part of the mine life, and it was during this period that the Moran Tunnel was constructed. This adit and mine workings above the adit are overlain by the North Pit. The adit daylights at an elevation of 20 to 30 feet above Champagne Creek and water drains continuously from the adit into a series of

ponds designed to remove metals by precipitation. Water samples show that the adit discharge has low pH values and contains elevated total dissolved solids and metals. Table 12 lists water chemistry data at the adit for a July 2008 sample event.

Table 12. Field Parameters and Laboratory Results from Moran Tunnel, July 2008 sample.

Notes: Sp Cond = specific conductance, temp = temperature in degrees Celsius, SO₄ = sulfate, TDS = total dissolved solids, As = arsenic, Al = aluminum, Fe = iron, Mn = manganese, Zn = zinc, Cu = copper, and CN = cyanide.

		Field Parameters			Laboratory Results		
Monitoring Location	Sample Date	pH (units)	Sp Cond (S/cm)	Temp (deg C)	SO4 (mg/L)	TDS (mg/L)	Total As (ug/L)
Drinking Water Standard		6.5 – 8.5	----	----	250	500	10
Moran Tunnel	7/23/2008	2.85	6100	14.2	6600	10000	2800

		Laboratory Results					
Monitoring Location	Sample Date	Total Al (mg/L)	Total Cu (mg/L)	Total Fe (mg/L)	Total Mn (mg/L)	Total Zn (mg/L)	Total CN (mg/L)
Drinking Water Standard		----	1.3 mg/L	0.3 mg/L	----	5 mg/L	0.2 mg/L
Moran Tunnel	7/23/2008	580	160	1400	40	89	0.0009

Conclusions

Figure 17 shows a plot of oxygen ($\delta^{18}\text{O}$) versus deuterium ($\delta^2\text{H}$) isotope ratios for a well, the Moran Tunnel drainage and sites along Champagne Creek for the April 2007 sampling event. The following conclusions can be made:

- 1) Stable isotope ratios that plot in the upper right area of an oxygen-deuterium plot represent water that was more highly evaporated, was recharged under warmer conditions or was recharged at lower elevations compared to points that plot in the lower left part of the plot.
- 2) Samples from upper Champagne Creek, Champagne Creek at Moran tunnel, lower Champagne Creek and Champagne Creek upstream of Poison Creek represent water from the same source. Champagne Creek downstream of Poison Creek has a different isotopic ratio signature than above Poison Creek. This most likely reflects the input of Poison Creek water that has a different isotopic ratio signature from Champagne Creek.
- 3) The isotopic ratio composition of the four Champagne Creek samples is probably typical of water from a spring snowmelt event. The isotopic ratio composition of samples collected from the same locations later in the year would probably plot in the lower left part of the figure as ground water contribution becomes the dominant source of stream flow.
- 4) Isotopic ratio results indicate the North Pit water had undergone significant evaporation prior to sample collection. Even though this sample location is at the

highest elevation of the samples collected, evaporative processes dominate, so that the ratio plots in the 'warm', upper right area of the graph.

- 5) The April 2007 results indicate there is no connection between Champagne Creek and the Moran Tunnel discharge or North Pit infiltration. The winter of 2006/2007 was drier than normal; the year-to-date precipitation in the Big Lost River basin was 73 percent of normal. A more normal water year may have resulted in seepage from the heap and areas around the heap and possibly recharge through the North Pit into the underlying mine workings.
- 6) The Moran Tunnel sample represents ground water that: i) has been in the flow system for a long period of time, ii) was recharged at either higher elevations above the tunnel, or iii) was recharged during cooler winter and spring periods.
- 7) The South Spring isotope ratio probably represents spring runoff that has undergone some evaporation so that it plots to the upper right of the Champagne Creek samples.
- 8) The Wisdom Ranch well isotope ratio is similar to Champagne Creek water, an indication that the creek and ground water are hydraulically connected.

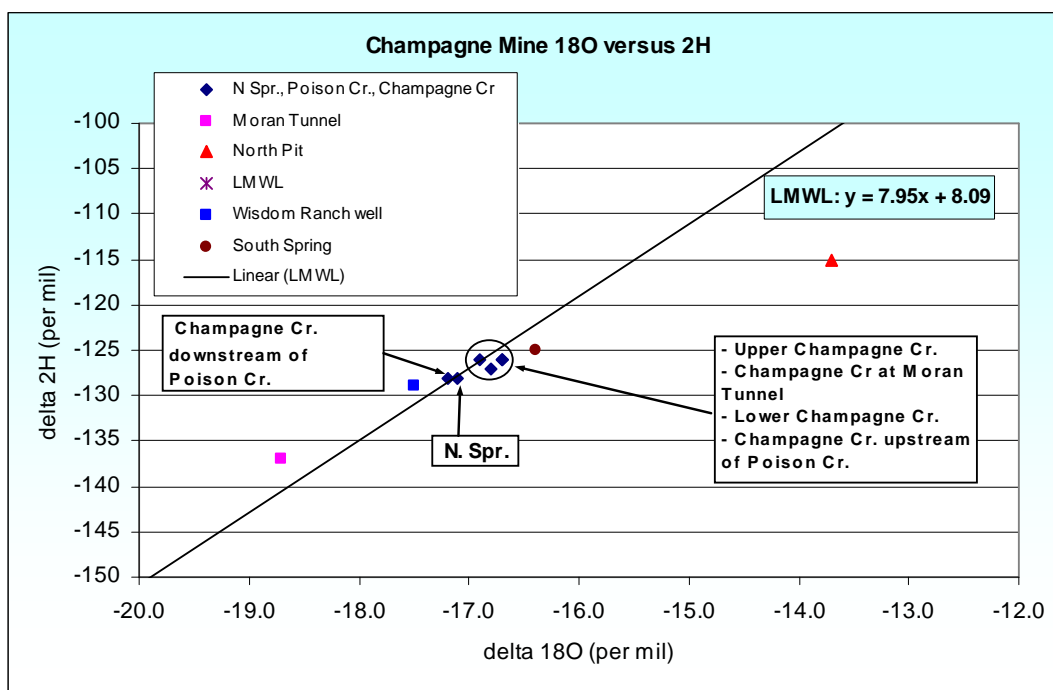


Figure 17. $\delta^{18}\text{O}$ vs. $\delta^2\text{H}$ in the Champagne Mine area for samples from one well, springs, surface water and mine drainage, collected April 2007 at the Champagne Mine. Notes: Lower Champagne Creek and Champagne Creek upstream of Poison Creek had identical $\delta^{18}\text{O}$ versus $\delta^2\text{H}$ values (-16.7 per mil and -126 per mil, respectively). LMWL = Local Meteoric Water Line (Benjamin et al., 2004).

Recommendations

Isotope ratios are a useful and inexpensive tool to evaluate water quality impacts at this site. The pit-mine relationship should be evaluated for other season time periods throughout the year. If the initial results are confirmed this would provide useful information for mine closure. Additional samples collected from the Moran Tunnel in

the fall would demonstrate whether there is seasonality in $\delta^{18}\text{O}$ to $\delta^2\text{H}$ isotope ratios. Samples should also be collected from the surface water locations that were sampled in April.

4.3.2 Teton Valley Ground Water Monitoring

Friends of the Teton River (FTR), a nonprofit organization, together with DEQ, has developed a long-term ground water monitoring network in the Teton Valley to evaluate ground water impacts from residential and commercial growth. The Teton Valley has experienced rapid residential and commercial growth over the past ten to fifteen years as residents move into the county. A GIS coverage developed by Teton County indicates that as much as 50,000 to 55,000 acres in the Teton Valley either has been developed, is platted for development or is in the planning stages for subdivisions. The total agricultural area in the valley is approximately 100,000 acres. As subdivision acreage has increased, the predominant land use has changed from agriculture and grazing to a high percentage of urbanized areas. Some of these urbanized areas feature housing densities of three to four homes per acre while in other areas lot sizes range from one to several acres. Some subdivisions are located adjacent to wetland areas and shallow ground water in these areas may limit the treatment efficiency of on-site wastewater treatment systems.

A municipal wastewater treatment plant is located at Driggs and a collection line serving Driggs and Victor runs between the two towns along Highway 33. Some housing areas adjacent to the sewer line are served by the Driggs treatment plant, including the Fox Creek, Valley Vista, Teton Reserve and Teton Springs subdivisions. Additional subdivisions may be included in the Driggs wastewater treatment system, but the extent of these hookups could not be determined at the time the report was prepared. The City of Victor is in the initial planning stages for development of a wastewater treatment system to serve the Victor area.

Housing areas not connected to the municipal wastewater treatment system utilize septic tank/drain field systems (on-site treatment systems) for wastewater treatment. Ground water impacts can occur from on-site treatment systems, including elevated chloride, nitrate-nitrogen, phosphorus and detections of bacteria.

There is no federal or state ground water standard for phosphorus. In many areas ground water discharge provides most of the flow to streams and rivers during the summer and fall months. Elevated phosphorus in ground water can result in elevated surface water phosphorus concentrations which can lead to excessive macrophyte growth, oxygen depletion and general degradation of surface water quality. In the Teton Valley, ground water discharges to the Teton River from both the east and west sides of the river, providing a direct ground water-surface water connection and the potential for ground water impacts to surface water. Recent investigations also have revealed the presence of personal care products and pharmaceuticals (PCPPs) in ground water in areas served by on-site wastewater treatment systems (Godfrey et al., 2007).

Methods and Results

The sampling network developed by FTR and DEQ includes 18 wells selected from a list of wells previously sampled. All locations are private domestic wells with the exception of one well which supplies water to the Idaho Transportation Department shop in Driggs. The first and second sample events were conducted during July and October 2008, and

quarterly samples will be collected during the life of the project. Monitoring locations are shown in Figure 18, along with the locations of 14 wells sampled as part of the IDWR statewide monitoring network. The information provided from all sample locations can be combined to develop background or ambient information about the ground water resources of the valley prior to widespread development.

Ground water sample parameters include measurement of field parameters (pH, specific conductance, dissolved oxygen and temperature), laboratory analysis of chloride, sulfate, total dissolved solids, total phosphorus, and nitrate+nitrite as nitrogen ($\text{NO}_3+\text{NO}_2\text{-N}$). Tritium ($\delta^3\text{H}$) was analyzed in all samples for the July 2008 sample event. The stable isotope ratios of deuterium ($\delta^2\text{H}$) and oxygen ($\delta^{18}\text{O}$) were analyzed for the July 2008 sample event.

Six samples were submitted for $\delta^{15}\text{N}$ analysis after nitrate sample results were evaluated. Refer to Table 5 on page 21 for typical $\delta^{15}\text{N}$ values for various nitrogen sources. Results, listed in Table 13, show that samples S-07, S-03 and S-48 have nitrogen isotope ratio values consistent with a commercial fertilizer source. Nitrogen isotope ratio values for samples S-19 and S-22 fall in the intermediate nitrogen range and indicate either an organic nitrogen from soil or nitrogen from a mixed source.

Table 13. Nitrogen isotope ratio results for six samples from the Teton Valley monitoring network.

Site ID	Sample Date	$\delta^{15}\text{N}$ (per mil)
S-07	10/22/2008	1.8
S-03	10/22/2008	2.4
S-19	10/22/2008	6.3
S-22	10/22/2008	5.7
S-48	10/22/2008	3.2

Nitrate sample results for the July and October 2008 sample events are summarized in Table 14. Twelve samples (about 35 percent of the samples) fell in the range of 0 to 1 milligram per liter (mg/L), eight samples fell in the range of 1 to 2 mg/L, and 10 samples fell in the range of 2 to 5 mg/L. Overall, about 85 percent of the samples for the two sample events were 5 mg/L or less.

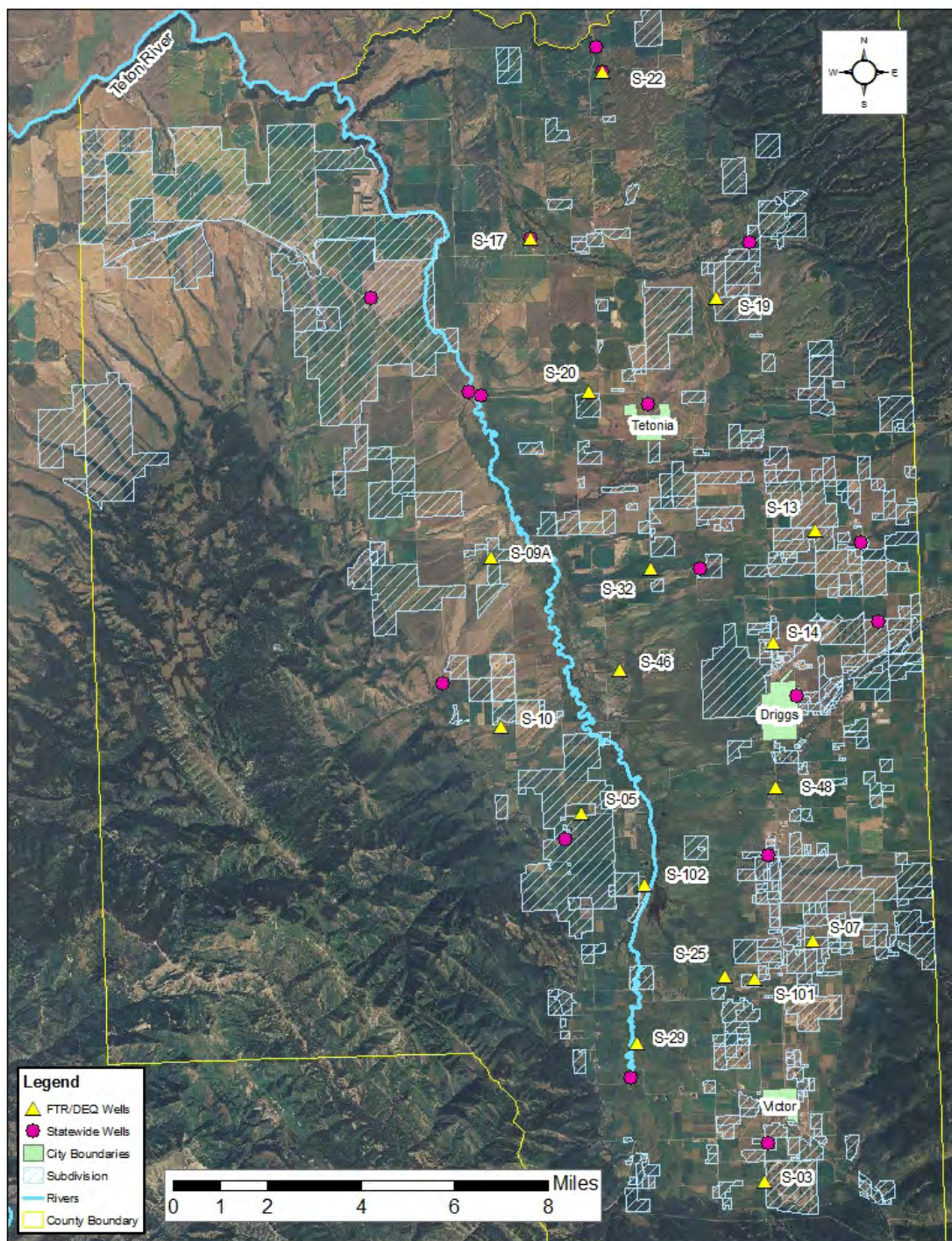


Figure 18. Location of FTR ground water sampling sites in Teton Valley. Also shown are Statewide monitoring well locations established by IDWR.

Table 14. Laboratory analytical results for Teton Valley sample events.

Notes: Blank cells indicate no data available. T.U. = Tritium Units. ‰ = per mil.

Monitoring Well	Sample Date	T Phos (mg/L)	Cl (mg/L)	SO ₄ (mg/L)	TDS (mg/L)	NO ₃ + NO ₂ -N (mg/L)	δ ³ H (T.U.)	δ ¹⁸ O (‰)	δ ² H (‰)
S-03	7/22/2008	0.06	2	12	310	4.45	7.2	-17.8	-131
S-03	10/21/2008		2	12	330	6.07			
S-05	7/22/2008	0.09	1	49	284	2.15	8.8	-17.7	-130
S-05	10/20/2008		1	45	276	2.04			
S-07	7/22/2008	0.06	1	6	260	3.78	6.9	-17.7	-163
S-07	10/21/2008		1	6	262	4.13			
S-09A	7/21/2008	0.07	3	7	236	0.9	7.8	-17.7	-130
S-09A	10/21/2008		2	6	232	0.75			
S-10	7/22/2008	0.06	5	8	204	1.36		-18.9	-139
S-10	10/20/2008		4	7	206	1.09			
S-101	7/22/2008	0.04	1	3	198	1.76		-18.1	-132
S-101	10/21/2008		1	2	172	1.26			
S-102	7/23/2008	0.58	1	3	178	0.05		-18.8	-139
S-102	10/20/2008		1	2	180	0.05			
S-13	7/22/2008	0.04	1	7	202	2.31	7.5	-18.1	-132
S-13	10/21/2008		1	7	210	2.26			
S-14	7/21/2008	0.05	1	2	140	1.39	7.5	-18.1	-131
S-14	10/20/2008		41	3	342	5.94			
S-17	7/23/2008	0.06	6	6	170	0.82	11.9	-18.3	-133
S-17	10/20/2008		3	4	132	0.56			
S-19	7/21/2008	0.11	5	9	344	9.26	9.7	-18.2	-135
S-19	10/20/2008		4	9	354	8.06			
S-20	7/21/2008	0.03	2	3	188	2.03	8.8	-17.9	-131
S-20	10/20/2008		1	2	214	1.79			
S-22	7/21/2008	0.08	11	12	298	7.87	8.1	-18.9	-140
S-22	10/20/2008		10	11	272	7.18			
S-25	7/22/2008	0.02	1	2	212	1.4	5.3	-17.9	-130
S-25	10/21/2008		1	2	214	1.05			
S-29	7/22/2008	0.03	1	9	222	0.31	6.3	-18.6	-137
S-29	10/21/2008		1	8	200	0.22			
S-32	7/21/2008	0.04	1	4	214	0.98	5.9	-18.1	-132
S-32	10/20/2008		1	3	194	0.81			
S-46	7/21/2008	0.6	1	2	144	0.54	7.2	-18.5	-135
S-46	10/20/2008		1	2	208	0.4			
S-48	7/22/2008	0.09	1	7	240	3.76		-18.0	-131
S-48	10/20/2008		1	6	210	3.46			

Conclusions

Nitrate concentrations in wells sampled for this project are below the MCL. Nitrogen isotope ratio results indicate fertilizer as a nitrogen source for three wells and mixed sources of nitrogen for two wells.

Recommendations

Quarterly sampling of this project will provide insight on the impacts of septic systems, as well as other sources of nitrogen, on the Teton Valley ground water quality.

4.3.3 Market Lake Arsenic Study, Ground Water Quality Technical Report No. 34

Purpose

The objective of the Market Lake arsenic study was to evaluate the results from a previous study by J.D. Rush (2006), which concluded that elevated arsenic concentrations reported in several domestic wells northwest of Roberts, Idaho, in the Market Lake area, are from natural sources and are not further impacted by sand and gravel operations in the area.

Methods and Results

Three sampling events were conducted from January 2008 through April 2008. Eight domestic wells, a pond from a previous sand and gravel operation, and a flowing artesian well were sampled to evaluate ambient arsenic concentrations in the study area (Figure 19). Domestic wells included shallow sandpoint wells less than 40 feet deep and wells greater than 100 feet deep that penetrated through the alluvium and into the deeper basalt bedrock.

Ground water flow direction in the study area is generally toward the southwest, which is consistent with flow directions identified in the Snake River Plain Aquifer (SRPA). However, it's likely that local flow directions vary due to stratigraphic variation. The study area is encompassed by the Mud Lake – Market Lake barrier, consisting of saturated sedimentary deposits that form a low permeability zone within the highly transmissive SRPA. As a result, ground water tends to flow comparatively slower across this zone in contrast to the surrounding basalts of the SRPA. The stratigraphic variation creates an artesian component in the area which appears to bring deeper ground water up into the lacustrine sedimentary units.

Arsenic, the primary constituent of concern, was identified in all the samples collected for this study. Sample locations and arsenic concentrations are shown in Figure 19. All but one of the eight domestic wells sampled contained arsenic at concentrations greater than the MCL of 0.01 mg/l. An unused flowing artesian well also contained arsenic at concentrations above the MCL. Analytical data indicate that most wells in the area have low dissolved oxygen, and are high in iron, manganese, sulfate, sulfide, and arsenic. Arsenic concentrations in the shallow wells vary. The old gravel pit pond, located just east of Interstate 15, had arsenic concentrations above the MCL.



Figure 19. Well locations and arsenic results for Market Lake arsenic study.

Conclusions

Major ion results show evidence that the water chemistry varies significantly among the pond, the shallow aquifer, and the deeper aquifer. The deeper wells exhibited low dissolved oxygen levels (below 1 mg/L), while the shallow wells had an average

dissolved oxygen concentration of 1.2 mg/L. The oxygen isotope ratios indicate distinct recharge histories for the deeper water (below 100 feet), the shallow water (less than 40 feet), and the pond. Despite these different recharge histories, arsenic concentrations are elevated in most of the shallow wells, all the deep wells, and the pond. The study concluded that elevated arsenic concentrations are present at all sampled depths, both up-gradient and down-gradient of the former gravel pit.

Recommendations

As a result of this study, it has become apparent that elevated concentrations of arsenic, and other constituents that have secondary drinking water standards, are present in the Roberts area, and that residents are concerned about their drinking water. It is also likely that additional residents outside of this study area have elevated concentrations of arsenic and/or secondary drinking water constituents in their ground water. Therefore, the following recommendations are made:

- Further investigation should be undertaken, to more thoroughly define the extent of this naturally occurring arsenic. The most likely area of investigation lies to the east of the Market Lake area.
- Cores obtained from wells drilled as part of a master's thesis conducted in the Market Lake area should be evaluated to determine whether the lacustrine sediments present in the Market Lake basin contain arsenic concentrations above background levels. These cores have been in storage at the Idaho State University. Selected portions of these core samples could be evaluated using the DEQ XRF instrument (X-Ray Fluorescence).
- Consideration should be given to a water testing event in which private domestic well owners from the area can submit water samples for arsenic analysis. This information could be used in an expanded sampling program to determine the areal extent of ground water with elevated arsenic.

For more information, please see the full technical report by Jeffers and Baldwin (2008) at http://www.deq.idaho.gov/water/data_reports/ground_water/market_lake_34.pdf.

4.4. Lewiston Region

4.4.1 Lindsay Creek / Lewiston Orchards Contaminant Investigation

Lindsay Creek, a tributary to the Clearwater River, is located to the east of the city of Lewiston and is bounded on the south by the Lewiston Orchards area of Lewiston. The main stem of Lindsay Creek originates from springs at the wetland just below Mann's Reservoir, and flows northwest to its confluence with the Clearwater River at Lewiston. During the late spring and summer months, ground water discharge provides most or all of the creek flow.

Ground water discharges from the uppermost aquifer, which underlies the Lewiston Orchards area, to the Lindsay Creek drainage. Water in the uppermost aquifer originates from several sources, including recharge from precipitation, deep percolation from irrigation in the Lewiston Orchards area, and deep percolation from septic tanks/drain fields in the unsewered portion of the Lewiston Orchards area that lies within the Lindsay Creek drainage. On an annual basis, ground water recharge from precipitation probably accounts for only a small percentage of the total recharge to the upper most aquifer.

Lindsay Creek elevations vary from approximately 1,800 feet above sea level at the headwaters to approximately 750 feet near the confluence. The creek flows through farmland in the upper reaches, through a canyon, and passes into a tunnel drain through the Clearwater Levee built by the Army Corps of Engineers as part of the Lower Granite Dam project. The drainage area of the Lindsay Creek watershed is approximately 22 square miles. The creek's main stem is approximately 8 miles long, and its tributaries, both intermittent and perennial, are approximately 19 miles long.

Purpose

Elevated nitrate was noted along the Lindsay Creek area based on a 1988 cooperative sampling effort between the DEQ Lewiston Regional Office and the North Central District Health Department. A second sampling project was initiated in 2007 and included some wells that were sampled in 1988. The sampling continued into 2008.

Methods and Results

DEQ sampled wells located within the Lindsay Creek drainage semi-annually. Figure 20 shows the sample locations. Samples were analyzed for nitrate and E. coli. Nitrate ground water concentrations ranged from non-detection at Wells 695 and 697 to 22.1 mg/L at Well 698. E coli ranged from non-detection to 0.5 most probable number per 100 milliliters (MPN/100 ml). A summary of analytical results is presented in Table 15.



Figure 20. Lindsay Creek Ground Water Monitoring Locations.

Table 15. Summary of 2007 & 2008 Lindsay Creek ground water analytical results.

Notes: ND = Not-detect; < = Below method detection limit. Blank cells indicate no data available.

Site ID	Sample Date	Nitrate + Nitrite as N (mg/L)	E Coli (mpn/100ml)
Well 601	3/1/2007		<1
Well 601	5/30/2007	0.146	
Spring 602	6/10/2008	4.69	488.4
Spring 602	6/24/2008	4.81	648.8
Spring 602	7/7/2008	5.06	648.8
Spring 602	7/23/2008	5.36	461.1
Spring 602	8/5/2008	4.83	461.1

Site ID	Sample Date	Nitrate + Nitrite as N (mg/L)	E Coli (mpn/100ml)
Spring 602	8/18/2008	4.69	488.4
Spring 602	9/4/2008	ND	613.1
Spring 602	9/18/2008	4.26	131.7
Spring 602	10/2/2008	4.24	123.3
Spring 602	10/16/2008	5	104.6
Spring 602	10/28/2008	5.12	31.8
Spring 602	12/2/2008	5.38	64.4
Spring 603	6/10/2008	3.85	920.8
Spring 603	6/24/2008	3.41	228.2
Spring 603	7/7/2008	3.48	648.8
Spring 603	8/5/2008	3.56	435.2
Spring 603	9/4/2008	3.66	547.5
Spring 603	9/18/2008	3.27	461.1
Spring 603	10/2/2008	3.28	248.1
Spring 603	10/16/2008	5.23	81.3
Spring 603	10/28/2008	4.25	50.4
Spring 604	5/27/2008	4.83	193.5
Spring 604	6/10/2008	3.35	88.2
Spring 604	6/24/2008	3.08	235.9
Spring 604	7/7/2008	3.47	517.2
Spring 604	8/5/2008	3.49	387.3
Spring 604	9/4/2008	3.66	261.3
Spring 604	9/18/2008	3.24	2142
Spring 604	10/2/2008	3.23	218.7
Spring 604	10/16/2008	3.88	49.5
Spring 604	10/28/2008	4.12	43.5
Well 652	8/5/2008		<1
Well 652	11/20/2008	6.39	
Well 693	3/1/2007	15.3	0.5
Well 693	5/29/2007	8.31	ND
Well 693	8/13/2008	9.06	
Well 693	11/18/2008	10.4	
Well 694	3/1/2007	11.3	0.5
Well 694	5/29/2007	12.2	ND
Well 694	8/13/2008	6.78	
Well 694	11/18/2008	8.95	
Well 695	3/2/2007	0	ND
Well 695	5/29/2007	<0.05	
Well 695	8/14/2008	<0.05	0.5
Well 695	11/18/2008	<0.05	
Well 696	5/29/2007	4.84	ND
Well 696	8/8/2008	4.52	
Well 697	3/29/2007	ND	ND
Well 697	5/29/2007	<0.05	
Well 697	8/8/2008	4.67	
Well 697	11/18/2008	3.93	
Well 698	3/2/2007	22.1	0.5

Site ID	Sample Date	Nitrate + Nitrite as N (mg/L)	E Coli (mpn/100ml)
Well 698	5/29/2007	20.8	ND
Well 698	8/13/2008	17.6	
Well 698	11/18/2008	21	
Well 699	5/29/2007	0.196	
Well 699	8/13/2008	0.149	
Well 699	11/18/2008	0.218	

Extended ground water sampling was conducted during the first half of 2007 in which 19 wells and springs were sampled for nitrate, $\delta^{18}\text{O}$, and $\delta^2\text{H}$. When plotted as $\delta^2\text{H}$ versus $\delta^{18}\text{O}$, there is a distinct separation between wells and springs in the shallow ground water system, and wells in the deep ground water system (Figure 21). When plotted points are sized based on nitrate concentration the shallow system shows distinctly higher nitrate levels. A single ground water sample that plots between the shallow and deep systems shows an intermediate concentration of nitrate, indicating some mixing may be occurring between the shallow and deep ground water systems.

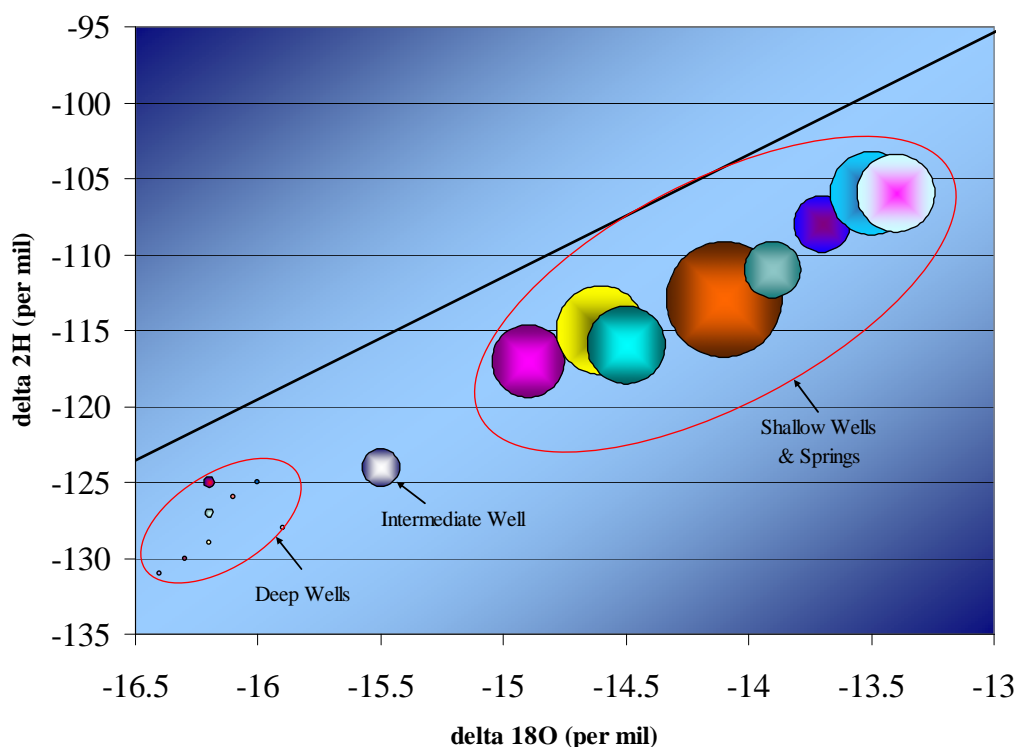


Figure 21. $\delta^{18}\text{O}$ vs. $\delta^2\text{H}$ in the Lindsay Creek Area Ground Water. Plotted points are sized based on nitrate concentration in the ground water sample from that location.

Conclusions

Feedlots, septic systems, and general agriculture within the Lindsay Creek watershed are believed, by DEQ, to be the major sources of nitrate and bacteria to the shallow ground water system and Lindsay Creek.

Recommendations

Further sampling will occur to help identify nitrogen sources. Local landowners and stakeholders will need to be involved in local implementation strategies to reduce further contamination of the ground water. Private well owners are advised to routinely sample their wells for bacteria and nitrate.

4.4.2 Camas Prairie Nitrate Priority Area Ground Water Monitoring, Ground Water Quality Technical Report No. 29

This report summarizes the 2007 and 2008 sampling results from an ongoing ground water nitrate evaluation conducted on the Camas Prairie, north of Grangeville, Idaho, that was initiated in August 2005. A 1998 investigation conducted by DEQ (Bentz, 1998) found that 40 percent of 55 wells sampled had nitrate-nitrogen (denoted as nitrate) concentrations that exceeded 5 mg/L, with a maximum concentration of 77.1 mg/L.

The Camas Prairie is included as one Idaho's 32 NPAs, based in part on the 1998 nitrate results. Refer to Section 3 of this report for more details on NPAs.

In order to address elevated nitrate concentrations in the Camas Prairie NPA, a Ground Water Quality Management Plan (GWQMP) has been developed. The plan entails implementation of voluntary best management practices (BMPs) to reduce nitrate concentrations in ground water. It is necessary to establish baseline nitrate concentrations so that as BMPs are implemented their effectiveness on improving ground water quality can be evaluated.

Results and Methods

DEQ initiated a long term ground water monitoring program in 2005 to establish baseline conditions and also to compare results with 1998 results from the same wells. Additional wells were identified for sampling by Lewis Soil Conservation District (LSCD) in November 2005. These wells were sampled by the LSCD in August 2005 and quarterly by DEQ since 2005. DEQ sampled 29 wells in the Camas Prairie project during 2007 and 2008 (Figure 22).

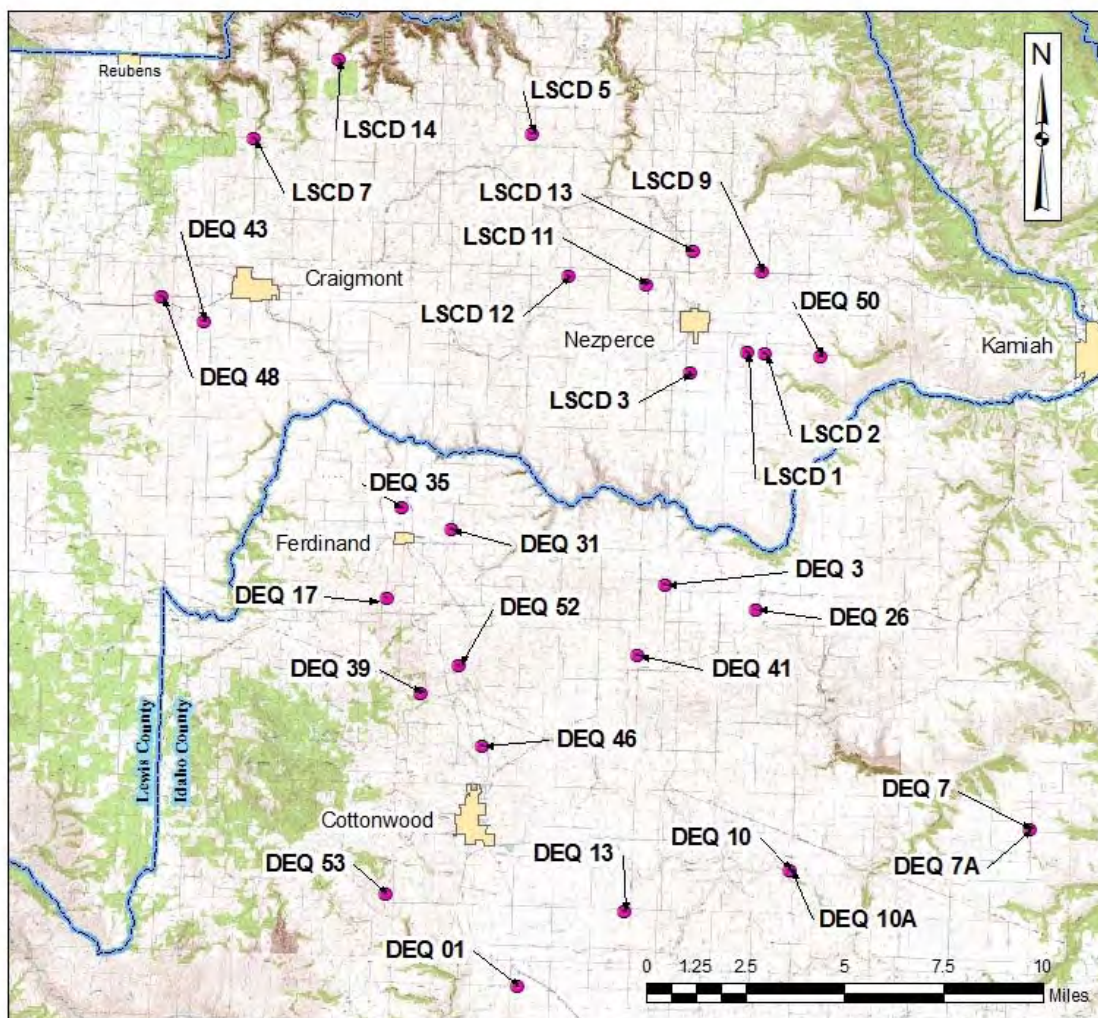


Figure 22. Well locations and IDs for Camas Prairie project.

Nitrate results are presented in Table 16. The highest nitrate concentrations detected during the February 2007 and May/June 2007 sampling events were in Well DEQ 3 (Figure 22) at concentrations of 51.6 and 47.7 mg/L, respectively. Well DEQ 3 was not sampled after the May/June 2007 sampling event. DEQ discontinued sampling Well DEQ 3 after it was determined the nitrogen source originated from on-site corrals and the nitrate concentrations were not representative of the region wide aquifer conditions. For the remaining five sampling events, Well DEQ 48 had the greatest nitrate concentrations, ranging from 16.3 mg/L (July 2008 sampling) to 21.2 mg/L (September 2007 sampling).

Table 16. Nitrate results for Camas Prairie project, 2007 through 2008.

Notes: Blank cells indicate no data available.

Well ID	Nitrate Concentration (mg/L)						
	February 2007	May/June 2007	September 2007	January 2008	April 2008	July 2008	November 2008
DEQ 01	1.10	1.04	1.05	0.84	0.94	6.57	0.95
DEQ 3	46.10	40.70					
DEQ 7		8.88	8.88		7.73	7.94	8.05
DEQ 7A					6.02	5.61	6.30
DEQ 10	17.90	16.60	18.00	14.40	14.70	13.70	14.90
DEQ 10A			0.10		0.10	0.10	
DEQ 13	12.80	11.70	16.00	10.20	10.50	10.20	10.50
DEQ 17	7.10			4.35	2.32	3.03	2.46
DEQ 26	5.00	4.50	4.64	3.85	4.13	3.83	4.21
DEQ 31		10.20	11.20			9.88	10.10
DEQ 35	10.30	10.20	8.98	8.21	8.42	8.36	9.04
DEQ 39	3.90	3.46	3.98	2.97	2.88	3.16	2.99
DEQ 41	5.10		5.06	4.04	4.38		4.58
DEQ 43	12.30	11.70	11.50	9.37	8.50	10.70	10.30
DEQ 46	4.90	4.47	4.41	3.44	3.92	3.19	3.60
DEQ 48	22.30	20.90	21.20	17.40	18.20	16.30	17.60
DEQ 50	51.60	47.70					
DEQ 52	13.30	10.80	9.96		9.10	9.54	9.92
DEQ 53	8.30	6.25	3.17	3.90	6.40	1.53	3.11
LSCD 1	6.00	5.34	5.55		4.82	4.41	4.57
LSCD 2	12.70	9.83	7.43	8.29	8.89	5.54	6.67
LSCD 3	17.60	16.90					
LSCD 5	11.60	13.10	13.00	10.70	10.90	9.95	11.00
LSCD 7	11.80	9.78	5.75				
LSCD 9	8.30	16.50	16.00	7.67	14.10	11.50	8.94
LSCD 11	4.60	4.11	4.84		4.05	4.11	4.14
LSCD 12	47.20	35.70					
LSCD 13	5.30	4.79	5.13	4.18	4.32	4.46	4.74
LSCD 14	6.40	5.96	5.90	4.45	4.90	4.75	4.97

The variation in annual ground water nitrate concentrations at various wells in the area indicates that nitrate leaching rates have not been constant over the years evaluated (see Wells DEQ 01, DEQ 43, LSCD 2, and LSCD 9 for example). This is probably due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions, and variations in leaching rates that are most likely related to the amount and timing of precipitation that is available to mobilize nitrogen below the crop root zone.

Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate. In some locations, nitrate concentrations exceed the MCL of 10 mg/L for nitrate. Based on the widespread area in which ground water nitrate concentrations occur, agricultural activities are most likely the source of nitrate contamination to the ground water.

The evaluation also reveals the large range in nitrate concentrations during the project time frame. This large variability will make it difficult to detect improvements in ground water quality in the study area as BMPs are implemented because the changes in nitrate concentrations will likely fall within the range of concentrations already measured in individual wells.

Recommendations

One method that could improve the usability of the data set would be to establish monitoring locations at surface water locations that are representative of ground water discharge. All ground water in the study area discharges to surface water. If surface water samples are collected during base flow conditions when ground water provides the only source of water to the stream, the surface water samples will be representative of ground water. Discharge and water quality samples collected during the same sampling event at several locations along the same drainage can also be used to calculate nitrate loads. This information may be useful in determining whether some areas of the drainage basin contribute more nitrogen than other areas. This information could be used to focus BMP implementation efforts.

For more information, please see the full technical report by Baldwin et al. (2008) at http://www.deq.idaho.gov/water/data_reports/ground_water/camas_prairie_29.pdf.

4.4.3 Well CM-1 Evaluation, Craigmont, Idaho, Ground Water Quality Technical Report No. 30

Purpose

The Craigmont well CM-1, which was part of the public water supply system for the City of Craigmont, was removed from service, reportedly because of water quality issues described as production of “red water.” The city removed the pump and the well has been unused for the past several years. Recently, the city expressed an interest in adding the well back onto the system, but the well condition was unknown. An investigation of the well was conducted in September 2007 to evaluate the physical condition of the well and to review the water chemistry for the occurrence of iron bacteria or other constituents that may preclude use of the well.

Methods and Results

The investigation included:

- A video survey of the well to determine completion details such as total depth, casing depth and condition, and potential production zones;
- A colloidal borescope survey of potential production zones in the well, based on the video survey, to evaluate ground water flow direction and velocity;
- Sample collection and analysis for field parameters (pH, specific conductance, dissolved oxygen, and temperature), major ions (calcium, magnesium, sodium, potassium, alkalinity, chloride, sulfate) total dissolved solids, the stable isotope ratios of oxygen ($\delta^{18}\text{O}$) and hydrogen ($\delta^2\text{H}$ or deuterium), and a depth to water measurement on September 18, 2007.

The video survey showed that a zone consisting of fractured basalt occurs from about 128 to 148 feet below land surface. The video survey also showed that the water within the casing was highly turbid, partly caused by running the video camera and colloidal borescope in the well. There is evidence of biological growth on some areas of the borehole sidewall. However, this material does not resemble an iron bacteria growth; it may be a byproduct of some of the more common soil bacteria.

The colloidal borescope survey was intended to demonstrate the site-specific ground water flow direction and flow velocity in zones identified during the video survey as being favorable for the presence of ground water flow zones. Refer to the Colloidal Borescope Description on page 8 for a description of how the colloidal borescope is used. The survey was conducted at five depths in the well: 128 feet, 144 feet, 145 feet, 146 feet and 147 feet bgs. This survey did not encounter areas of active ground water flow movement in the fractured rubble zones identified during the video survey. The high turbidity in the water column may have interfered with detection of colloids that characterize active flow zones. Although the colloidal borescope survey did not determine a ground water flow direction, information from drillers' logs in a study reviewed by the Idaho Water Resources Research Institute (Stevens et al., 2003) indicated that the general ground water flow direction in the area is to the northeast.

Sample analysis results show that the nitrate concentration was 1.71 mg/L, the total dissolved solids concentration was 194 mg/L, and the iron concentration was 8.91 mg/L. The latter concentration is considered to be very high; the Idaho Ground Water Quality Secondary Standard for iron is 0.30 mg/L. Samples from two nearby wells contained less than 0.01 mg/L of iron, indicating that elevated iron is not widespread throughout the area. The water chemistry at well CM-1 was compared to other wells in a monitoring network that has been established by DEQ. The water is a calcium bicarbonate type but contains slightly more sodium than wells in the sampling network.

Conclusions

A video survey of Craigmont well CM-1 indicated that a zone of fractured basalt occurs from 128 to 148 feet bgs. The well is cased to approximately 58 feet bgs. The water column contained high turbidity due to disturbance to the sidewall from the video camera and colloidal borescope surveys. The high turbidity in the water column may have interfered with the colloidal borescope survey. None of the surveys produced data that indicated a ground water flow direction or flow velocity.

Although the iron concentration in the water sample was 8.91 mg/L, the video survey did not indicate that iron bacteria have become established in the well. The well had a nitrate concentration of 1.71 mg/L and a total dissolved solids (TDS) concentration of 194 mg/L. With the exception of the elevated iron, these data indicate the water quality in the well is very good. There does appear to be a mat in some areas of the well that may be of bacterial origin.

Recommendations

Since the well has not been used for an extended period, it could be rehabilitated by the following steps:

1. Dose the well with a chlorine solution and allow this solution to stand in the well overnight. Household bleach (5.25 percent sodium hypochlorite) can be added; however, approximately 35 gallons of bleach would be required for an 8-inch casing with an 83-foot water column (150 foot total depth minus 67 feet to water) to achieve the recommended chlorine concentration of 1,000 mg/L. Other disinfection products may be more efficient.
2. Jet/pump the well the next day to remove accumulated sediment and clean the fracture zones. The drilling equipment should be cleaned prior to working on the well.
3. A sample should be collected after jetting and pumping, and analyzed for bacteria, iron, nitrate, chloride, sulfate, and TDS.

The well could be returned to service if the sample results are favorable and there is sufficient production during the jetting/pumping stage.

For more information, please see the full technical report by Baldwin (2007) at http://www.deq.idaho.gov/water/data_reports/ground_water/craigmont_30.pdf.

4.5. Pocatello Region

4.5.1 Arbon Valley Ambient Ground Water Characterization

Purpose

During 2008, DEQ implemented a study to collect ground water samples from domestic wells in the Arbon Valley, Power County. This study was initiated due to spatial gaps of ground water nitrate data within the Arbon Valley area.

According to the 2000 U.S. Census, Arbon Valley has a population of 627. Population density is 22 people per square mile and most of the land is used for farming or livestock. A map of the Arbon Valley well sampling study area is highlighted in Figure 23.

Methods and Results

Samples were collected in September 2008 by using standard field sampling protocol and then sent to a laboratory for nitrate and bacteria analysis. Samples that tested positive for total coliform were additionally tested for the subgroup *Escherichia coli* (E. Coli), a group within the fecal coliform family. The presence of E. Coli is an indicator of human or animal waste contamination. Field parameters were also collected including pH, temperature, and specific conductivity.

Seven of the thirty wells (23%) sampled had nitrate concentrations above 5 mg/L, with one well out the seven having a nitrate concentration of 16.4 mg/L, which exceeds the MCL of 10 mg/L for nitrate. Areas that have 25 percent of wells sampled with nitrate concentrations over 5 mg/L are designated as NPAs by DEQ. Refer to Section 3 of this report for more information about NPAs.

Four samples (13%) tested positive for total coliform; however, there were no detections of E. Coli. Well locations are shown on Figure 23 and analytical results are given in Table 17.

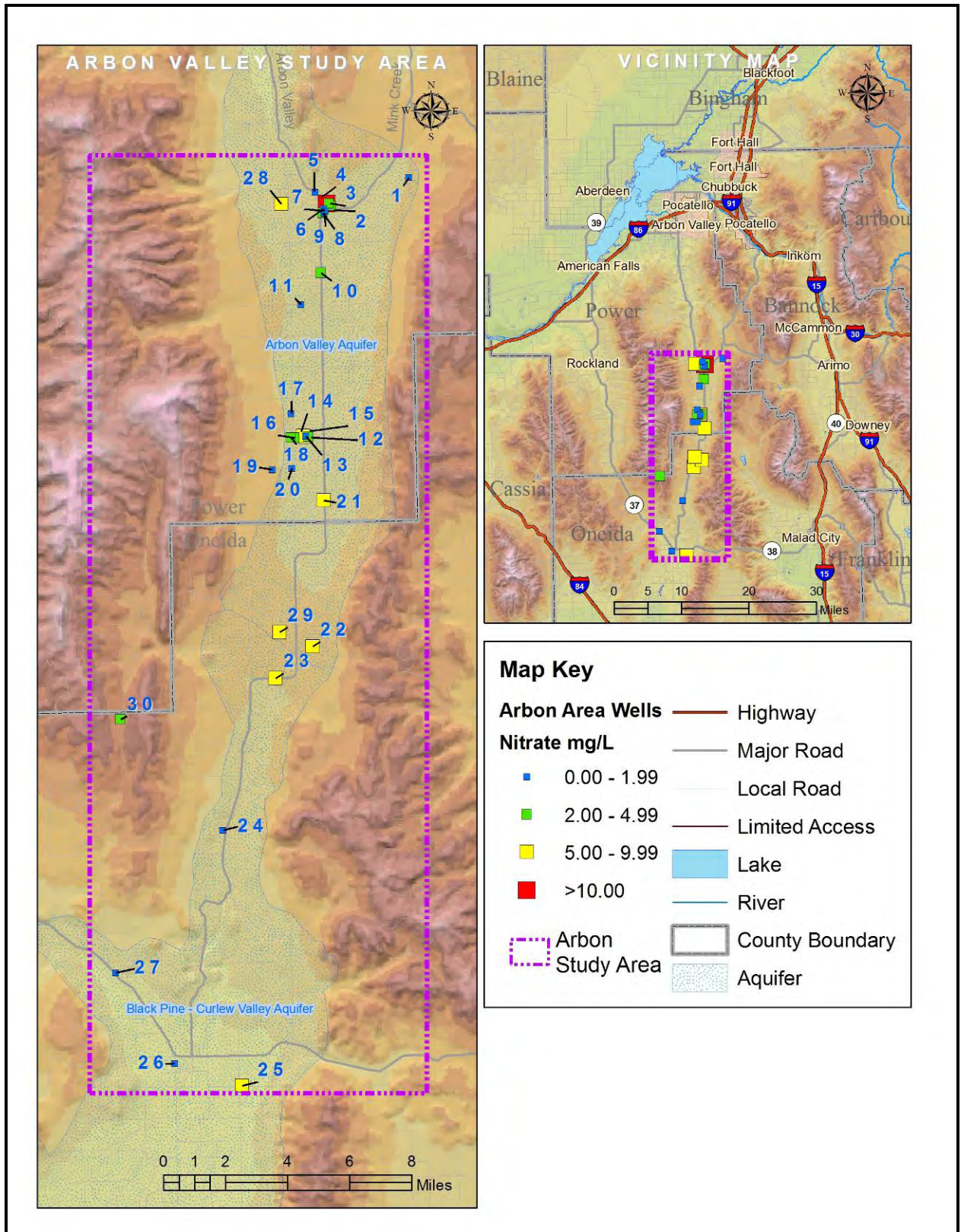


Figure 23. Arbon Valley ambient ground water study area

Table 17. Arbon Valley Laboratory and Field Data.Notes: **Bold** values indicate MCL exceedance.

Reference I.D.	Sample Date	Nitrate (mg/L)	Coliform	pH	Temp. (°C)	Electrical Conductivity (uS/cm)
1	9/25/2008	0.776	present	7.59	23.3	390
2	9/22/2008	2.62	absent	7.9	10.8	759
3	9/22/2008	2.27	present	7.79	11.3	633
4	9/25/2008	16.4	absent	7.12	12.4	1530
5	9/25/2008	0.746	absent	7.57	14.1	414
6	9/22/2008	1.21	absent	7.97	11.4	609
7	9/22/2008	0.978	absent	7.96	11.4	719
8	9/30/2008	3.01	absent	7.53	10.6	544
9	9/22/2008	1.65	present	8.08	10.1	579
10	9/22/2008	3.21	absent	8.14	9.9	448
11	9/30/2008	0.035	absent	7.25	11.1	289
12	9/22/2008	4.54	absent	8.05	9.9	628
13	9/30/2008	0.261	absent	7.63	11.5	353
14	9/30/2008	6.29	absent	7.41	10.1	583
15	9/22/2008	5.13	absent	7.97	10.1	635
16	9/22/2008	2.71	absent	7.99	10.8	570
17	9/25/2008	1.24	absent	7.33	11.2	426
18	9/22/2008	2.45	absent	8.02	10.7	482
19	9/30/2008	0.629	absent	7.47	13.6	470
20	9/30/2008	0.157	absent	6.74	11	474
21	9/25/2008	6.4	absent	7.4	10.8	1100
22	9/30/2008	6.89	absent	7.46	11.7	1180
23	9/30/2008	9.16	absent	7.36	13.6	564
24	9/25/2008	1.2	absent	7.04	12.4	1060
25	9/30/2008	5.11	present	7.38	12.6	1810
26	9/30/2008	ND	absent	7.32	12.2	1430
27	9/25/2008	0.386	absent	7.43	20.7	644
28	9/25/2008	8.08	absent	7.31	10.9	639
29	9/25/2008	5.74	absent	7.33	11.2	426
30	9/30/2008	4.35	absent	6.96	14.9	484

Conclusions

The wells sampled in this study did not meet the requirements for an NPA designation when considered as a group or with other area wells sampled by other regulatory agencies.

Recommendations

Wells within the Arbon Valley should be resampled before the 2013 ranking of NPAs to ensure any changes in the water quality is reflected in the ranking process.

4.5.2 Bennington Nitrate Study

Purpose

A ground water investigation that focused on nitrate contamination was conducted in the Bennington area in 2007. The investigation was initiated after nitrate concentrations at one of the two Bennington PWS wells exceeded 5 mg/L in 2006.

Methods and Results

Nine wells and two springs were selected for sample collection. Figure 24 shows the sample locations, surface water features, source water delineation time of travel zones for the Bennington wells and springs, and a dairy. The Bennington PWS is comprised of two wells (Wells 10 and 11 in this study – see Figure 24) and two springs (Springs 8 and 9 in this study – see Figure 24). The Bennington area is located within the southern part of the Grace/Soda Springs NPA, as shown in Figure 24.

Nine wells and two springs were sampled in December 2007. Field parameters pH, specific conductance, temperature, and dissolved oxygen were measured. Samples were collected and analyzed for major ions (calcium, magnesium, sodium, potassium, carbonate, bicarbonate, and chloride), coliform bacteria, nitrate-nitrogen, and total dissolved solids. Samples were also collected and analyzed for the stable isotope ratios of oxygen, deuterium, and nitrogen. Historic nitrate results for Spring 8, and Wells 10 and 11 are listed in Table 18. Results for samples collected for this study are listed in Table 19 (field parameters), Table 20 (analytical results), and Table 21 (isotope ratio results). None of the sample locations had a coliform detection. Historic nitrate results for the dairy well are listed in Table 22.

Table 18. Nitrate concentrations at three Bennington drinking water sources, and plot showing concentrations for the three sites.

Note: Sample locations are shown on Figure 24. Blank cells indicate no data available.

Map #	8	10	11
Date	NO ₃ -N (mg/L)	NO ₃ -N (mg/L)	NO ₃ -N (mg/L)
02/14/00			2.24
12/05/00			3.5
07/09/01			2.19
09/10/02		6.5	2.1
11/06/03	0.19	1.67	5.18
11/24/03		5.58	2.02
09/17/04	0.25		2.04
06/15/05	0.27	4.81	2.08
07/17/06	0.65	7.37	5.75
06/11/07	0.3	9.1	4.31
07/31/07		9.59	
12/03/07		7.06	
12/13/07		7.73	2.92
03/19/08		6.18	
07/15/08	0.36		2.28
12/18/08		6.85	

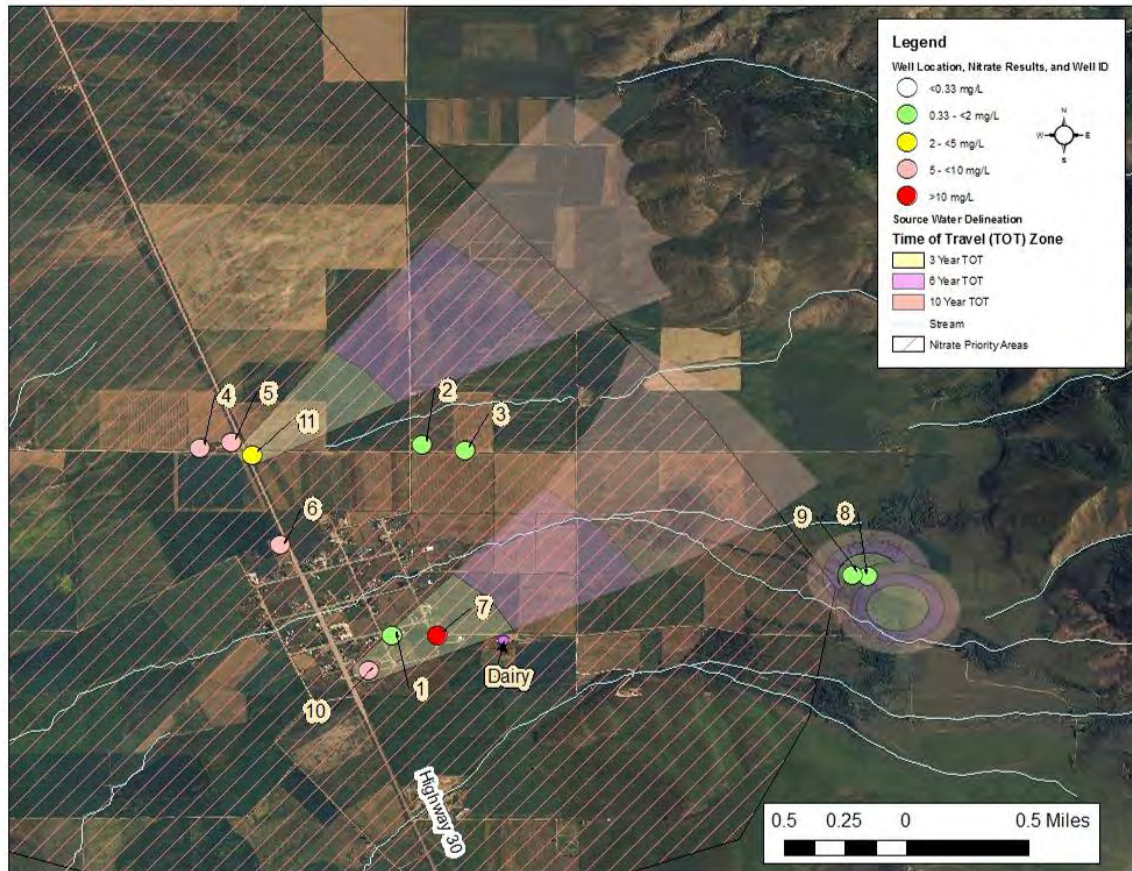


Figure 24. Location map showing sample locations, source water delineations, dairy location and surface water features for Bennington area.

Table 19. Field parameters for wells and springs sampled in the Bennington area by DEQ, December 2007.

Notes: Temp = temperature, deg C = degrees Celsius, DO = dissolved oxygen, and Sp Cond = specific conductance. Blank cells indicate no data available.

Township Range Section	Map #	Sample Date	Well Depth	Perforated interval, ft	Field Parameters			
					Temp. deg C	pH units	DO mg/L	Sp Cond μ S/cm
12S 44E 09CAD	1	12/11/2007	134	105-115	6.9	7.71	6.2	530
12S 44E 04DCC	2	12/11/2007			NA	7.84	10.5	600
12S 44E 04DCD	3	12/11/2007	136	88-96	NA	7.43	5.9	600
12S 44E 05DDC	4	12/11/2007	73	60-70	6.8	7.61	10.8	770
12S 44E 05DDD	5	12/11/2007			6.9	7.58	10.4	650
12S 44E 09BCA	6	12/11/2007			7.8	7.46	8.6	670
12S 44E 09DCB	7	12/11/2007	205	110-124, 147-165	8.6	7.57	10	650
12S 44E 10ADC1	8	12/13/2007	Spring	Spring	6.6	7.7	5.9	460
12S 44E 10ADC2	9	12/13/2007	Spring	Spring	6.8	7.12	6.5	460
12S 44E 09CDB	10	12/13/2007	180	105-112, 130-150	7.4	7.57	6.8	600
12S 44E 09BBB	11	12/13/2007	647	Cased to 448	8.6	7.52	6.5	600

Table 20. Laboratory results for samples collected from wells and springs in the Bennington area by DEQ, December, 2007.

Notes: TDS = total dissolved solids; NO3 = nitrate as nitrogen; coli. = coliform; Ca = calcium; Mg = magnesium; Na = sodium; K = potassium; CO3 = carbonate; HCO3 = bicarbonate; Cl = chloride; SO4 = sulfate; mg/L = milligrams per liter; A = absent. Blank cells indicate no information is available.

Map #	Sample Date	Well Depth	Laboratory Results										
			TDS mg/L	NO3 mg/L	Coli. cfu	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	CO3 mg/L	HCO3 mg/L	Cl mg/L	SO4 mg/L
1	12/11/2007	134	243	1.93	A	73.8	17	7.35	1.14	<1	151	3.54	49.2
2	12/11/2007		274	1.6	A	71.2	22.5	6.84	1.52	<1	230	2.74	74.4
3	12/11/2007	136	266	1.98	A	69.1	21.4	7.79	1.2	<1	168	2.84	68.6
4	12/11/2007	73	362	5.76	A	105.0	23.7	11.6	1.4	<1	153	5.13	186
5	12/11/2007		315	5.28	A	83.9	21	10.2	1.24	<1	207	4.76	98.2
6	12/11/2007		316	5.84	A	95.6	14.5	10.6	0.78	<1	239	6.87	52.9
7	12/11/2007	205	300	13.3	A	90.3	15	6.17	0.71	<1	237	5.23	35.6
8	12/13/2007	Spring	190	0.33	A	49.1	14.7	7.3	1	<1	155	2.33	43.3
9	12/13/2007	Spring	194	0.33	A	47.3	14.8	5.75	0.79	<1	152	2.31	43.8
10	12/13/2007	180	283	7.73	A	79.5	15.4	6.68	0.72	<1	231	4.53	38.4
11	12/13/2007	647	289	2.92	A	75.7	21.5	6.73	0.92	<1	219	3.07	58.3

Table 21. Isotope ratio results for samples collected in the Bennington area by DEQ, December 2007.

Notes: $\delta^{15}\text{N}$ = nitrogen isotope ratio; $\delta^{18}\text{O}$ = oxygen isotope ratio; $\delta^2\text{H}$ = hydrogen isotope ratio; Blank cells indicate no information is available.

Map #	Well Depth	Isotope Results		
		$\delta^{15}\text{N}$ (per mil)	$\delta^{18}\text{O}$ (per mil)	$\delta^2\text{H}$ (per mil)
1	134	1.5	-17.8	-130
2			-17.8	-133
3	136		-17.9	-133
4	73	4.5	-17.5	-130
5		5.5	-17.4	-131
6		6.5	-17.8	-131
7	205	7.6	-17.6	-129
8	Spring		-18.1	-133
9	Spring		-18.1	-133
10	180	10.5	-17.5	-130
11	647*	11.5	-17.7	-131

* Drillers log lists well total depth as 647 feet, but lithology from 400 to 647 was 'greenish gray clay' with no water, so water production probably comes from above 400 feet.

Table 22. Nitrate concentrations at dairy well shown on Figure 24.

Township Range Section	Sample Date	NO ₃ -N mg/L
12S 44E 09DDB	12/5/2007	13.1
12S 44E 09DDB	8/26/2008	10.4

Nitrate concentrations in the December 2007 samples ranged from 0.33 mg/L (Springs 8 and 9) to 13.3 mg/L at Well 7 (Table 20). The nitrate concentration at the two springs is considered to represent ambient or back ground conditions. Six sample locations had nitrate concentrations less than 5 mg/L, four wells had nitrate concentrations between 5 and 10 mg/L, and one well had a nitrate concentration of 13.3 mg/L, exceeding the MCL.

Well 7 is within the source water delineation zone for Bennington PWS Well #1 (Well 10 in this study), and a common nitrate source could be impacting both wells. Figure 24 shows the dairy location relative to the source water delineation zone. Nitrate concentrations at the dairy well are elevated and exceeded the nitrate MCL for sample events in 2007 and 2008 (Table 22). Nitrogen isotope ratio information can be used to evaluate nitrate sources; please refer to Table 5 on page 21 for typical $\delta^{15}\text{N}$ values for various nitrogen sources. The $\delta^{15}\text{N}$ value for Well 7 (7.6 per mil) indicates that nitrate at this well is from the decomposition of soil organic matter or is a mixture of nitrogen from various sources. The $\delta^{15}\text{N}$ value at Well 10 (10.5 per mil) indicates an animal or human waste source of nitrogen. Well 10 could be impacted by the dairy operation, depending on the site-specific ground water flow direction in the area. It is less likely that Well 7 is impacted by the dairy operation because it is located farther north and cross-gradient of the dairy. In order to determine the site-specific ground water flow direction, water levels should be measured in wells in the area. It should be noted that nitrate at Well 10 could also originate from on-site wastewater treatment systems (septic tank/drain field systems) in Bennington up-gradient of Well 10.

Based on $\delta^{15}\text{N}$ results, nitrate at Well 11 is from a waste source. However, it is unlikely that Well 11 could be impacted by the dairy since this well is located about one mile northwest and cross-gradient of the dairy. Nitrogen isotope ratio results for Wells 4, 5, 6, and 7 indicate that nitrate in these wells are from a mixture of sources.

Figure 25 is a plot of oxygen versus deuterium results from wells and springs sampled during the December 2007 sample event. Results that plot in the lower left represent water that was recharged at higher elevations and/or under cooler conditions, such as water from snowmelt or from summer storm events in the mountains. Results that plot in the upper right represent water that was recharged under warmer conditions such as summer storm events on the valley floor and/or has undergone some degree of evaporation prior to recharge.

The two springs plot in the lower left part of the diagram. These springs emerge at the base of the mountains to the east of Bennington and represent water that was recharged at some elevation above the valley floor, either from snowmelt or from summer storm events in the mountains. The well samples represent water that has undergone varying degrees of evaporation prior to recharging the alluvial aquifer. This recharge most likely occurred on the valley floor.

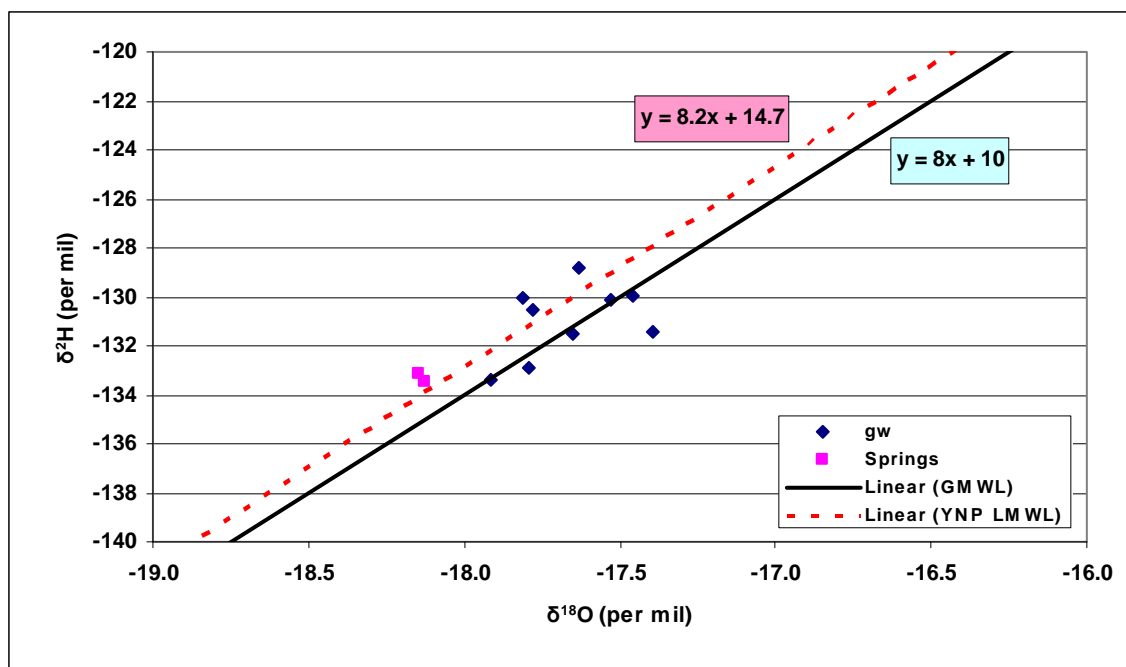


Figure 25. Oxygen and deuterium results for wells and springs sampled in the Bennington area during December 2007.

Notes: Also shown for reference is the global meteoric water line (GMWL), which represents the average isotopic ratio concentration of precipitation samples from all over the world, and the Yellowstone National Park Local Meteoric Water Line (YNP LMWL) which was developed from snow samples (Kharaka and others, 2002).

Major ion data are available from all sample locations. All sample locations have similar water chemistry with the exception of Well 4 which has less bicarbonate and more sulfate than the other locations. The reason for this difference is unknown.

A trend analysis was conducted for Wells 10 and 11 using the Mann-Kendall nonparametric statistical test, to evaluate whether trends in nitrate concentrations are occurring at these wells. The results indicate that there are no long-term nitrate trends, either increasing or decreasing, at either well.

Conclusions

The major ion chemistry at all wells and springs, with the exception of Well 4, was a calcium bicarbonate-type water. The water chemistry at Well 4 was a calcium sulfate-bicarbonate-type water. The reason for the water chemistry difference is unknown.

Oxygen and deuterium results for the two springs indicate that water from the springs originated as recharge from snowmelt or from summer storm events in the mountains. Isotope ratio samples for the wells indicate that recharge to the valley fill aquifer occurred on the valley floor, and that the contribution to the valley fill aquifer from mountainous areas is minimal.

Nitrogen isotope ratio results did not provide a definitive source for nitrate at Well 7. Nitrogen isotope ratio results indicated that nitrate at Well 10 (Bennington PWS Well 1) is from an animal or human waste source. On-site wastewater treatment systems are

located in Bennington up-gradient of Well 10, and a dairy is located cross-gradient of Well 10. Depending on the site-specific ground water flow direction, nitrate from the dairy could be migrating to Well 10. Isotope ratio results at Well 11 indicate that the source of nitrogen at this well is from a waste source; however, the well is located cross-gradient from the dairy, which indicates a waste source other than the dairy.

Recommendations

To gain a better understanding of the local ground water flow direction, it is recommended that water level measurements be collected from local wells. This will aid in determining the source of elevated nitrate concentrations in the ground water.

4.6. Twin Falls Region

4.6.1 Bliss Area Colloidal Borescope Study

Purpose

Three monitoring wells located north to northwest of the town of Bliss, Idaho, were drilled by the Gooding Soil Conservation District into the shallow perched aquifer above the regional Eastern Snake River Plain Aquifer. The purpose the monitoring wells is to analyze nitrate levels to evaluate BMP effectiveness. The monitoring wells are designated as Bliss #1, Bliss #3, and Bliss #5 (Figure 26). The shallow perched aquifer occurs on the eastern Snake River Plain within a sequence of basalt flows and sedimentary units that consist of ash, cinders, clay, or other sedimentary type deposits. The perched aquifer appears to occur on top of a clay layer located between basalt flows. Ground water flow zones in a basalt sequence often occur in the flow bottom or adjoining flow top of the underlying basalt flow or can occur in coarse-grained sedimentary interbeds. The original well depths range from 98 to 115 feet; the wells had not been completed with screens or sand pack when the colloidal borescope surveys were completed.

The purpose of the colloidal borescope surveys was to estimate the direction of ground water flow in the shallow aquifer and to estimate ground water velocity within the flow zones found using a downhole camera.

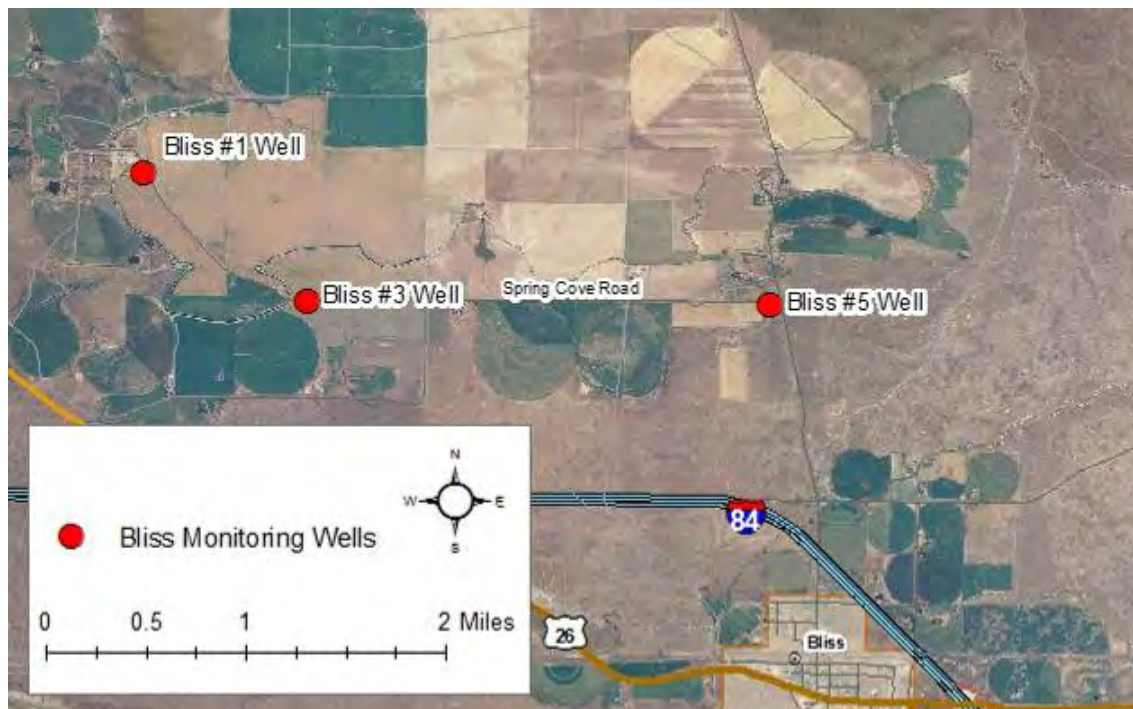


Figure 26. Bliss Area colloidal borescope well survey locations, October 3-5, 2007.

Methods and Results

In October 2007, colloidal borescope surveys were conducted in flow zones determined by reviewing downhole camera video and drilling logs of the three monitoring wells. For a description of the operation of the colloidal borescope, please refer to the Colloidal Borescope Description on page 8 of this report. For Bliss #1 flow surveys were conducted at depths of 100, 101, 101.5, 102, 103, 104, 105, 106, 110, 110.5, 111, 111.5, 112, 112.5, and 113 feet. The depth that provided the most definable flow zone was at 112.5 feet. A stable flow direction appeared to be about 340 degrees (northwest).

After edits to minimize variable flow after disturbing the water column by movement of the instrument, the resulting flow direction at 112.5 feet depth for Bliss #1 is 321° (northwest) and the average ground water velocity is estimated to be about 16 feet per day. The survey at a depth of 101 ft also appears to represent ground water flow along the same direction, between 320° and 330° (northwest), and the velocity appears to be in the range of 16 to 22 feet per day.

For Bliss #5, flow surveys were conducted at depths of 84, 84.5, 87, and 87.5 feet. All four depths provided definable flow data, but the best record is for the 84-foot depth. After edits, the resulting flow directions are 133° (southeast) at the 84-foot depth, 90° (east) at the 84.5-foot depth, 94° (east) at the 87-foot depth, and 101° (east) at the 87.5-foot depth. The record from the 84-foot depth is the best record from the standpoint of data points collected and the stability of the flow direction. This shallowest depth indicates a flow direction of 133° (southeast) with an average velocity of about 10 feet per day.

For Bliss #3, flow surveys were conducted at depths of 60, 61, 64, 77, 78, 79, 80, 82, 84, 86, 86.2, 86.5, 95, 96, 97, 98, 98.5, 99, and 100 feet. The best flow directions are at depths of 80, 86.2, 95, and 99 feet; the flow directions at these depths are 256° (southwest), 290° (northwest), 230° (southwest), and 130° (southeast), respectively. The dominant flow direction is westerly ranging from southwest to west-northwest while the deeper zone appears to be flowing to the southeast. Ground water flow velocities appear to range from about 44 to 97 feet per day.

Conclusions

The colloidal borescope indicates that the ground water flow direction is variable across the study site. The ground water velocity is also variable, ranging from 10 feet per day to 97 feet per day.

Recommendations

Due to the variability of ground water flow direction and velocity, it is recommended that all landowners and stakeholders in the study area follow recommended BMPs to reduce the potential of further nitrate ground water contamination.

4.6.2 Mr. A's Dry Cleaners Colloidal Borescope Survey

Mr. A's Dry Cleaners is located at 483 Washington St. North, Twin Falls, and overlies a shallow aquifer within a basalt matrix. Through the DEQ Brownfields Program, an environmental assessment was conducted at the site. It was determined that there was dry cleaning solvent contamination in the soil and ground water. An east-west oriented drain tunnel is located about 300 feet north of the site. In the early 1900s, the Twin Falls Canal Company excavated horizontal tunnels (called drain tunnels) that were four feet wide by seven feet high to drain areas with a high water table (Carter et al., 1973). The drain tunnels carry excess drainage water to natural surface drains (Carter et al., 1973). The drain tunnel located near Mr. A's Dry Cleaners turns to the southwest less than 1,000 feet west of the site to discharge drained ground water to Rock Creek located west of this site. Two new site monitoring wells were drilled with total depths of 60 feet and 65 feet below ground surface (bgs) at FMW-1 and FMW-2, respectively (Figure 27). The depths to ground water were 40.56 feet below the measuring point in FMW-1 (February 21, 2007) and 44.29 feet below the measuring point in FMW-2 (February 22, 2007).

Purpose

The purpose of the colloidal borescope survey was to determine the direction of ground water movement and ground water velocity in the shallow basalt aquifer beneath the site to aid with the environmental assessment.

Methods and Results

For a description of the operation of the colloidal borescope, please refer to the Colloidal Borescope Description on page 8 of this report. The colloidal borescope survey of FMW-1 and FMW-2 was characterized by low particle counts and particles too small to see on the colloidal borescope monitor, except for a few instances where visible particles were observed at monitoring well FMW-1.

Well FMW-1 has an apparent flow zone at a depth of 50 feet with a mean flow direction of 263 degrees (west) and a median flow direction of 257 degrees (west). The mean ground water flow velocity is about 13 feet per day. Well FMW-2 has an apparent flow zone at a depth of 58 feet with a flow velocity vector of 341 (northwest) degrees and a ground water flow velocity of 13 feet per day.

The driller's log indicates the presence of ground water at a depth of about 45 feet in well FMW-1 and a final water level of 41 feet at the end of drilling. The driller's log indicates the presence of ground water at a depth of about 52 feet 5 inches in well FMW-2 when drilling. After drilling, the final water level was 55 feet 10 inches. The water level information for FMW-2 indicates a lack of a ground water flow zone at the same approximate depth that a flow zone occurs in FMW-1. The difference in the depth for the occurrence of the two flow zones may account for the different flow directions observed in these two monitoring wells.

The ground water flow zones may not be continuous at this site because of heterogeneities in the basalt matrix that hosts the shallow aquifer. As a result, flow directions may vary with depth. The northerly flow direction in well FMW-2 may be

caused by ground water flow to the drain tunnel while the shallower flow zone in well FMW-1 is less impacted by the drain tunnel. Overall, the record for well FMW-2 is a more reliable record and more confidence can be placed in the flow direction determined in that well.

Conclusions

The apparent ground water flow direction in well FMW-1 is about 260 degrees (west) at a depth of 50 feet. The apparent ground water flow direction in well FMW-2 is 340 degrees (northwest) at a depth of 58 feet.

Recommendations

The most reliable record is from well FMW-2 and therefore the primary direction of ground water flow to consider for future monitoring wells is to the northwest at 340 degrees.



Figure 27. Monitoring well locations at Mr. A's Dry Cleaners used in colloidal borescope surveys.

4.6.3 Springs of Southern Gooding County Study, Ground Water Quality Technical Report No. 38

In 2007, through the National Pollution Discharge Elimination System (NPDES) monitoring program, Clear Springs Foods Inc. (Snake River Farms facility) detected elevated nitrate concentrations (greater than 5 mg/L) in springs supplying water to their facility. In an effort to identify possible increasing trends in nitrate at the springs and attempt to locate the possible source of this elevated nitrate, DEQ began monitoring the water chemistry at springs near the facility.

Purpose

The purpose of this project was to gain a better understanding of the quality of ground water-fed springs supplying water to Clear Spring Foods Snake River Farms facility. To determine if nitrate concentrations were increasing significantly at Snake River Farms, a sampling strategy was started by DEQ in 2007. Field parameters, isotopes, personal care products, pharmaceuticals, and inorganic chemicals (IOCs) including nitrate, chloride, sulfate, and metals, were analyzed. A nitrogen load was estimated using the nitrate concentration and flow data from the NPDES monitoring point at the Snake River Farms facility.

Methods and Results

This study began by measuring field parameters and IOCs at several spring sites upriver (Crystal Springs) and downriver (Banbury Springs) from Snake River Farms (Figure 28). The sample suite also included springs spanning approximately one mile encompassing the spring discharge system that supplies water to two aquaculture facilities: Idaho Trout Processors to the west and Snake River Farms to the east (Figure 29). The Hardy Spring series supplies water to Idaho Trout Processors and the R&D springs supply water to the Snake River Farms.



Figure 28. Banbury Springs, Briggs Creek Springs, and Crystal Springs sampling locations for Snake Rivers Farm project (denoted by Snake River Fish Hatchery spring).



Figure 29. Initial sampling sites in the vicinity of Snake River Farms.

After two years of ground water quality monitoring by DEQ, this suite of sample sites was focused to four sites at Snake River Farms (R&D #1, R&D #2, R&D #3, and SR-1) (Figure 30) that exhibited elevated nitrate concentrations over time (Baldwin et al., 2006). The sites R&D #3A and R&D #3B were added in the winter of 2008 after these sites showed the highest nitrate concentrations recorded at Snake River Farms to date. The NPDES compliance point SR-1 represents the combined R&D flows (Figure 30).

In 2008, these subsets of the springs were sampled for IOCs, oxygen, deuterium, and nitrate isotope ratios, and PCPPs. Two PCPP sampling events occurred; one in April of 2008 (before irrigation and the agricultural growing season) and another event in October 2008 (after the peak of the irrigation and growing season).



Figure 30. Subset of sampling sites at Snake River Farms. Also shown is location of NPDES compliance point, SR-1.

The highest nitrate concentrations occur in the fall and the lowest nitrate concentrations occur in the spring and early summer (Table 23 and Table 24). The nitrate concentration trend at the R&D #3 site is markedly higher than the other sites at Snake River Farms, some of which are less than 200 feet from R&D #3 (Figure 29 and Figure 30). The variable seasonal range in nitrate concentrations is likely controlled by the geology, ground water flow systems, and irrigation and land use practices hydraulically up-gradient of Snake River Farms.

Table 23. Nitrate results (in mg/L) for springs upriver and downriver from Snake River Farms collected in 2007.

Sample Location	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07
Banbury Springs				1.23	1.36			
Briggs Creek Spring		2.07	1.96	1.8	1.75	1.75	1.95	5.67
Crystal Springs		4.79	5	5.19	5.35	5	5.29	6
Golf Course Spring	2.2	2.07	2.18	2.17	2.25	2.13	2.21	2.23
Hardy Spring #1	2.3	2.01	2.02	1.92	1.88	1.83	1.88	ND
Hardy Spring #2	2.2							
Hardy Spring #3	2.3							
Hardy Spring #4	1.9	1.84	1.87	1.81	1.79	1.74	1.79	2.54

Sample Location	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07
Hardy Spring #5	1.5							
Hardy Spring #6	1.6	1.36	1.39	1.26	1.21	1.19	1.16	1.56
Matelana Spring	2.2	2.1	2.11	2.1	1.07	2.08	2.09	2.11

Notes: Blank cells indicate no data available; ND = Non Detect

Table 24. Nitrate results (mg/L) for springs (Snake River Farms) collected in 2007 and 2008.

Sample Location	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Apr-08	Oct-08	Dec-08
R&D #1										3.3	
R&D #2		2.47	3	2.37	2.18	3.49	2.38	4.12	2.2	4.8	
R&D #3	1.6	5.31	5	4.47	3.9	5.31	5.34	7.96	6.3	12	8.55
R&D #3A											9.14
R&D #3B											10.3
SR-1											2.83

Notes: Blank cells indicate no data available

The nitrogen isotope ratio results from Snake River Farms (Table 25) fall within the range of organic nitrogen in soil. Refer to Table 5 on page 21 for typical $\delta^{15}\text{N}$ values for various nitrogen sources. These results for the Snake River Farms nitrogen isotope analysis likely represent a mixture of nitrogen from different sources during the travel time from source to spring discharge location. The nitrogen isotope ratio signatures collected in October 2008 are inconclusive in fingerprinting a unique nitrogen source at Snake River Farms.

Table 25. $\delta^{15}\text{N}$ values from Snake River Farms collected in October 2008.

Snake River Farms sample site	$\delta^{15}\text{N}$ (‰)
SR-1	6.8
R&D #1	6.7
R&D #2	7.4
R&D #3	7.5

Table 26 presents the analytical results for the PCPP analysis. The antibiotic sulfamethoxazole was detected at each site (excluding R&D #2 in April 2008) with the highest concentration of 9.2 nanograms per liter (ng/L) or parts per trillion from R&D #3 in the fall of 2008. This antibiotic was detected in other Snake River Farms sites as well as a spring from the Crystal Springs site.

Caffeine, found in caffeinated beverages, was detected at a concentration of 17 ng/L in R&D #2 and 2.5 ng/L in R&D #3. Cholesterol detections were considered to reflect background concentrations for ground water in this area. The human anti-seizure medication carbamazepine was found in low concentrations in R&D #3 during the October 2008 sampling event.

Given that the highest nitrate concentrations occur in the fall, this time was targeted for PCPP sampling. In general, sulfamethoxazole concentrations were lower in the spring

time compared to the fall. While the detection of these constituents does not identify a point source of pollution, it does indicate that PCPPs are detectable in ESRP spring discharge and that a potential pathway exists for these constituents of concern.

Table 26. Analytical results for samples analyzed for PCPPs at Snake River Farms facility. Results are given in ng/L.

Snake River Farms Location	Sample Date	Caffeine	Sulfamethoxazole	Cholesterol	Carbamazepine
Crystal Springs	4/7/2008	ND	1.3	760	ND
SR-1	4/7/2008	ND	1.2	1700	ND
R&D #2	4/7/2008	ND	ND	860	ND
R&D #3	4/7/2008	ND	2.3	780	ND
SR-1	10/15/2008	ND	2.7	490	ND
R&D #1	10/15/2008	ND	1.4	560	ND
R&D #2	10/15/2008	17	1.6	440	ND
R&D #3	10/15/2008	2.5	9.2	540	2.5

Notes: ND = analyte was not detected at the laboratory quantification limit.

An estimate of the yearly total nitrogen load contained in the Snake River Farms springs discharge was made by using flow and nitrate concentrations at the NPDES compliance point, SR-1. The nitrogen load estimates evaluate the amount of nitrogen entering the facility from up-gradient land practices, based on daily monitoring records of flow and monthly nitrate concentrations provided by Snake River Farms. Continuous flow and nitrate data are only available for SR-1 for 2007 and 2008, so the yearly nitrogen load is an approximation from this one site over this period. This estimate was possible because there is a positive correlation between flow and nitrate concentration over the year. Equation 1 shows the calculation of nitrogen loading for SR-1 in January 2007.

Equation 1. Example of average monthly nitrogen load (pounds per month) for SR-1. This calculation uses values from January, 2007. The conversion factor converts minutes, milligrams, and liters to days, pounds and gallons.

$$\begin{aligned}
 &\text{Discharge}_{SR-1} = 41,000 \text{ gpm}_{(\text{January average})} \text{ and Nitrate}_{SR-1(\text{January})} = 3.67 \text{ mg/L} \Rightarrow \\
 &\text{Nitrogen Load}_{SR-1} = (0.012018_{\text{conversion_factor}}) \times \text{Discharge}_{SR-1} \times \text{Nitrate}_{SR-1} = 1800 \text{ lbs}_{\text{Nitrogen}} / \text{day}_{(\text{January})} \\
 &1800 \text{ lbs}_{\text{Nitrogen}} / \text{day} \times \text{number of days in month (31)} = 56,000 \text{ lbs}_{\text{Nitrogen}} / \text{month}_{\text{Average}} \\
 &\Sigma_{[\text{January Load} + \text{February Load etc.}] / \text{month}} \rightarrow \sim 630,000 \text{ lbs}_{\text{Nitrogen}} / \text{year}_{\text{Average}}
 \end{aligned}$$

Monthly nitrogen loads were calculated for SR-1 for 2007 and 2008. The monthly loads were summed to determine the yearly nitrogen load for SR-1 (Table 27). The nitrogen load calculation for the Snake River Farms NPDES site, SR-1, is representative of the flow (and nitrate concentrations in that flow) into the aquaculture system. From these nitrogen loading calculations, the total nitrogen entering the Snake River Farms facility is approximately 600,000 lbs/year (Table 27).

Table 27. Estimated yearly nitrogen load for Snake River Farms based on flows and nitrate concentration data from SR-1 (data provided by Clear Springs Foods, Inc).

Site	Year	Nitrogen Load (lbs/year)
SR-1	2007	630,600
SR-1	2008	609,000

To determine the influence of land use on ground water quality up-gradient of Snake River Farms, a zone of ground water contribution, or capture zone, was approximated for a one year time-of-travel zone (Figure 31) using the WhAEM model (as described in DEQ, 1999). Time-of-travel refers to the time necessary for a particle of water to reach a discharge point within a given ground water capture zone. The water within the calculated capture zone will likely reach Snake River Farms within one year. Calculations were performed to determine the nitrogen load expected from sources within the capture zone of ground water contribution.

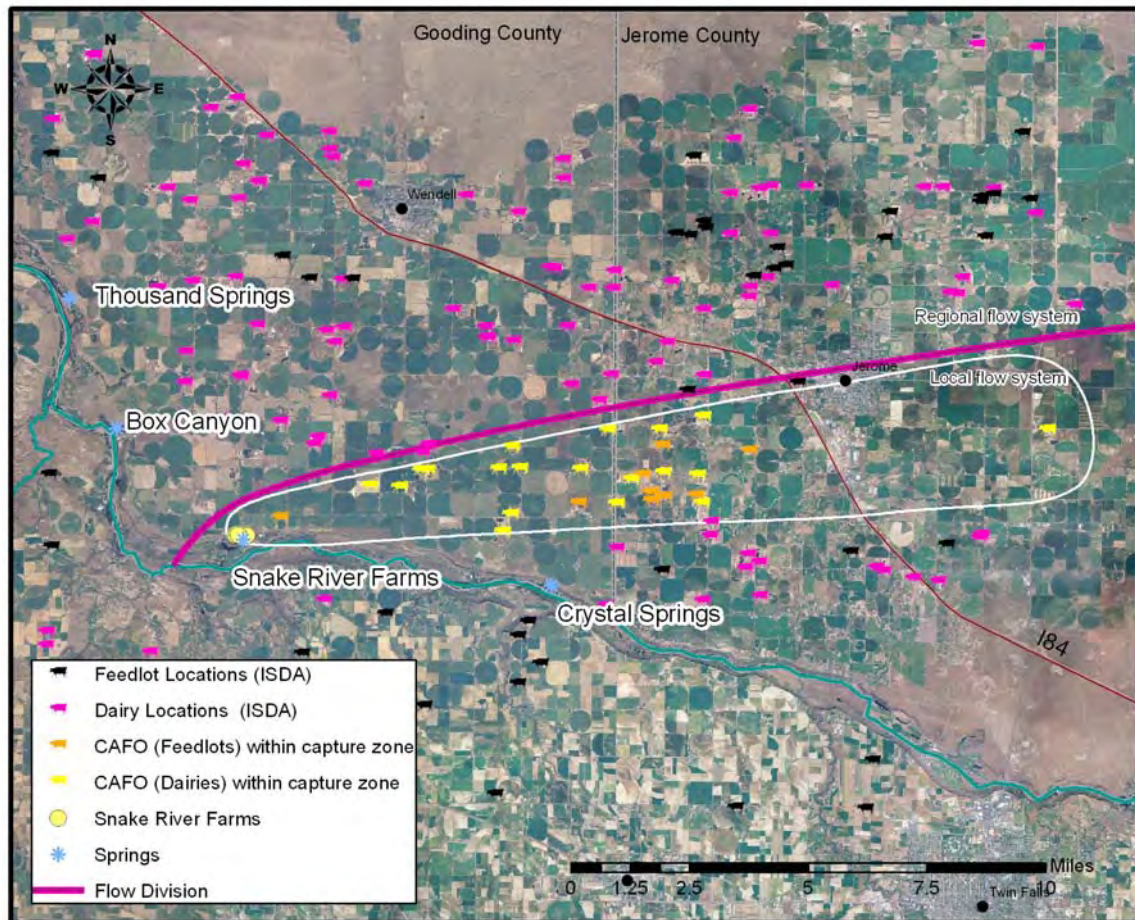


Figure 31. Ground water capture zone for Snake River Farms. White line delineates capture zone.

The population within the delineated capture zone is approximately 1,800 people, which corresponds to nitrogen loading from septic tanks of 25,200 pounds per year at 14 pounds

per person per year (Table 28). The area within the delineated capture zone, comprising approximately 23,000 irrigated acres, yields an estimated nitrogen load of 2,150,000 pounds of nitrogen per year from application of commercial fertilizer (at 94 pounds per acre). The estimated nitrogen contribution is taken from the United States Department of Agriculture census of typical crops and corresponding nitrogen fertilization rates for southern Idaho (USDA, 2002). The number of dairy and feedlot cattle within the delineated capture zone is estimated to be 18,590 and 17,875, respectively, which corresponds to the combined nitrogen loading from dairy and feedlot cattle of 3,383,000 pounds per year (USDA, 2002).

The nitrogen contribution from precipitation is a small fraction (less than 1%) of the overall nitrogen inputs to the capture zone. The total nitrogen load from precipitation falling within the capture zone was estimated at 11,000 pounds per year.

Overall, it is estimated that over 2,800 tons (~5,677,600 pounds) of nitrogen are applied each year to the land (according to published values on nitrogen input) within the capture zone up-gradient of Snake River Farms (Table 28). Of the estimated 2,800 tons of nitrogen applied to this area, approximately 315 tons of nitrogen is discharged in springs used by the Snake River Farms facility.

Table 28. Estimated nitrogen load from CAFOs (dairies and feedlots), commercial fertilizer applications, and human septic tank sources within delineated zone.

Nitrogen Source	Population	Estimated nitrogen input (lbs/animal/year)	Nitrogen load (lbs/year)
Dairy cattle	18,590	129 ^a	2,400,000
Feedlot cattle	17,875	55 ^a	983,000
Septic Tanks	1,800	14 ^b	25,200
Nitrogen Source	Acres in capture zone	Estimated nitrogen input (lbs/acre)	Nitrogen load (lbs/year)
Commercial Fertilizer	23,000	94 ^c	2,162,000
Legume crop plowdown	23,000	4.2 ^b	96,400
Precipitation	23,000	0.48 ^d	11,000
Total pounds Nitrogen/year			5,677,600

^aU.S. Department of Agriculture, National Agricultural statistics service, 2002 Census of Agriculture-County Data.

^bDEQ, 2005.

^cU.S. Department of Agriculture, National Agricultural statistics service, 2002 Census of Agriculture-County Data.
(Average nitrogen load of predicted crops in Gooding County)

^dRupert (1990) (estimated nitrogen concentration in precipitation is 0.225 mg/L).

Given the relatively small nitrogen contribution from septic tanks within the capture zone, contributions from commercial fertilizer for crop growth and CAFOs within the delineated ground water capture zone are likely the sources that produce most of the observed nitrogen loading at Snake River Farms.

Conclusions

Observations at this facility show that nitrate concentrations and flow volume increase during October through December. These increased flow and nitrate concentrations are

likely a lag in response to recharge from irrigation, and mobilization of nitrate, which begins in the spring of each year hydraulically up-gradient of Snake River Farms. The recharge from irrigation discharges as ground water and provides water to the Snake River Farms facility after a short travel distance.

Nitrate concentrations in spring discharge are highly variable within short lateral distances. The nitrate load resulting from land use within the delineated capture zone hydraulically up-gradient from Snake River Farms is the source of these areas of higher nitrate concentrations.

These nitrogen loading estimates, along with isotope ratio and PCPP results indicate that either a human or animal waste or fertilizer source is the most likely source of nitrogen at Snake River Farms. Since nitrate concentrations at Snake River Farms are much higher than at adjacent springs, the land use, nitrate loading, and geologic formations up-gradient of the facility must control the high nitrate concentrations at the facility.

The existence of PCPPs in the spring discharge at Snake River Farms is indicative of the existence of a pathway for contaminants. The constituents that were detected at Snake River Farms include an animal/human antibiotic (sulfamethoxazole), a human anti-seizure drug (carbamazepine), and an insect repellent (DEET). These results are inconclusive in providing direct evidence for a particular source of contamination to Snake River Farms. However, the presence of these PCPPs suggests that a potential pathway exists and that animal and human byproducts are present in ground water fed springs in southern Idaho.

The water chemistry, including IOCs, field parameters, isotope ratios, and PCPPs, does not provide direct evidence of a source of increasing nitrate concentrations. The amount of nitrogen (pounds) which flow through Snake River Farms is significantly higher than the amount produced by the population (septic tanks) residing up-gradient of Snake River Farms. Therefore, the source of nitrogen is likely from agricultural practices, including crop fertilization and CAFOs.

Recommendations

It is recommended that monitoring and sampling of springs for nitrate concentrations in southern Gooding County be continued. It would be useful to analyze nitrogen isotope ratios in spring discharge on a seasonal basis, to identify potential temporal variations in sources of nitrate to the springs. Continued analysis of oxygen and deuterium isotopes would also be useful because this isotopic ratio system exhibits seasonal variation and can help determine the ground water provenance.

To determine the source of elevated nitrate at the Snake River Farms facility, it is recommended that a hydrologic tracer test be conducted. Tracer tests can be used as a tool to determine hydrogeologic parameters by introducing a known volume of tracer (i.e., Rhodamine, Fluorescein, xenon) and measuring the occurrence of the tracer at the discharge point. It would be useful to use tracer tests to determine the sources of constituents of concern to springs and aquaculture facilities. Using best management practices to reduce or avoid over-application of (animal and commercial) fertilizer will become necessary to control the amount of nitrogen reaching the aquifer and springs in southern Gooding County.

For more information, please see the full technical report by Schorzman et al. (2009) at: http://www.deq.idaho.gov/water/data_reports/ground_water/southern_gooding_county_nitrate_38.pdf.

4.6.4 Springdale Study Ground Water Quality Technical Report No. 39

The Cassia County NPA was delineated using nitrate concentrations from 384 wells. The mean nitrate concentration of these wells was 6.34 mg/L. The NPA extends over approximately 300 square miles of Cassia County, and encompasses the cities of Burley and Springdale. Ground water in the eastern part of the NPA, south of the community of Springdale, has higher mean nitrate concentrations than the area as a whole. For 112 wells south of Springdale the mean nitrate concentration was 8.15 mg/L. This area is referred to as the Springdale subarea and is the focus of this study (Figure 32).

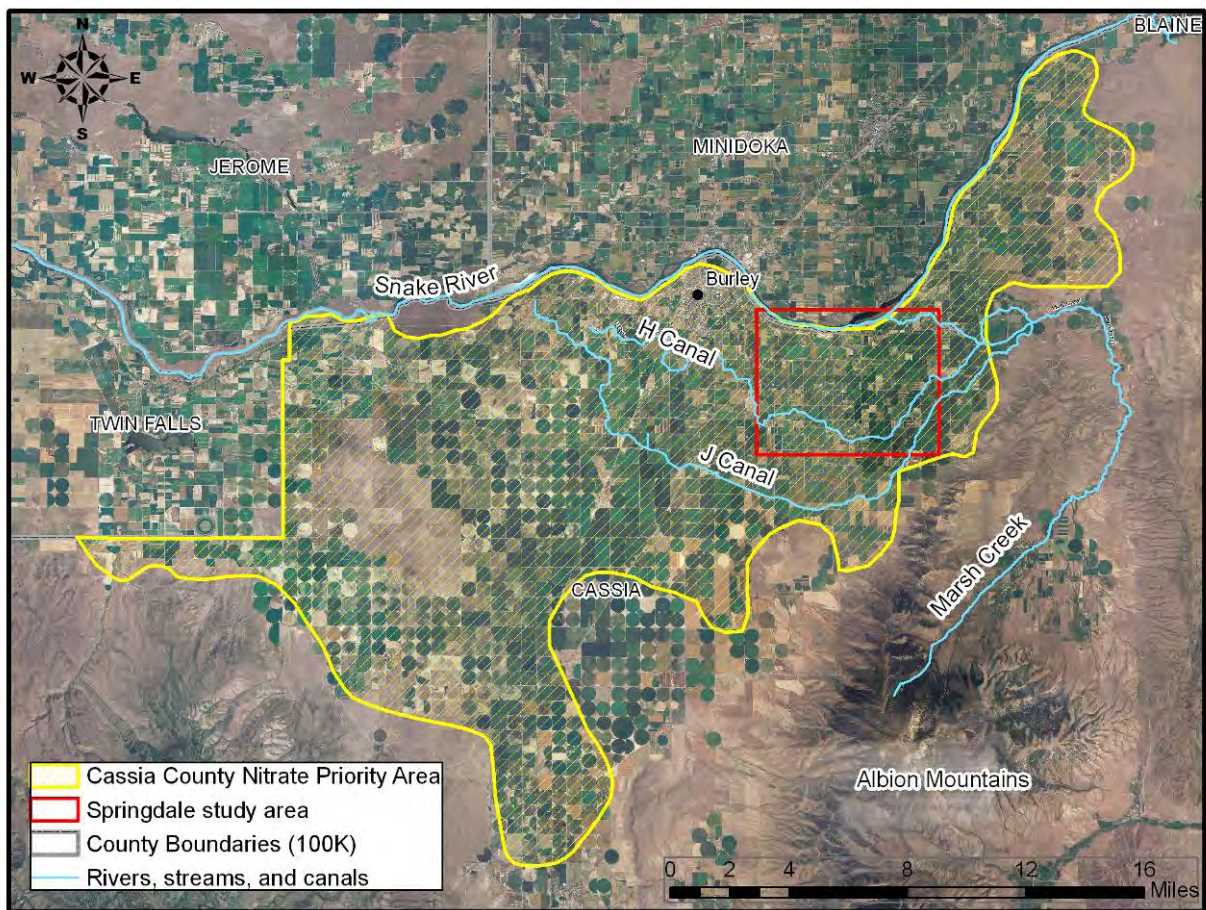


Figure 32. Springdale study area.

Purpose

A GWQMP is being developed for the Cassia County NPA. The goal of this project is to determine the sources of nitrate and the relative contribution of each source within the Springdale subarea (and also within the NPA as a whole). Possible sources of nitrate in this area include agricultural practices, confined animal feeding operations (CAFOs), and

septic tanks. Analysis of a variety of parameters and constituents can help determine the main sources of nitrate within the Springdale subarea.

Methods and Results

A sampling network consisting of 10 domestic wells was established in the Springdale area in order to evaluate nitrate impacts to ground water (Figure 33). Field parameters (pH, water temperature, dissolved oxygen and specific conductance) were collected from each site. Ground water samples were collected and analyzed for nitrate and major ions (calcium, magnesium, sodium, potassium, bicarbonate, chloride and sulfate). Nitrate results are shown in Figure 33 and Table 29. Samples were analyzed for the stable isotope ratios of oxygen ($\delta^{18}\text{O}$), deuterium ($\delta^2\text{H}$), and nitrogen ($\delta^{15}\text{N}$), and these results are also shown in Table 29. The samples also were analyzed for a suite of parameters that include antibiotics, PCPPs, steroids and hormones, all of which are referred to collectively as emerging contaminants. The results for the emerging contaminants are found in Table 30.

Nitrate concentrations exceeded the MCL of 10 mg/L in nine of 10 wells sampled (Table 29). All of the wells exceed the federal secondary drinking water standard of 500 mg/L for total dissolved solids.

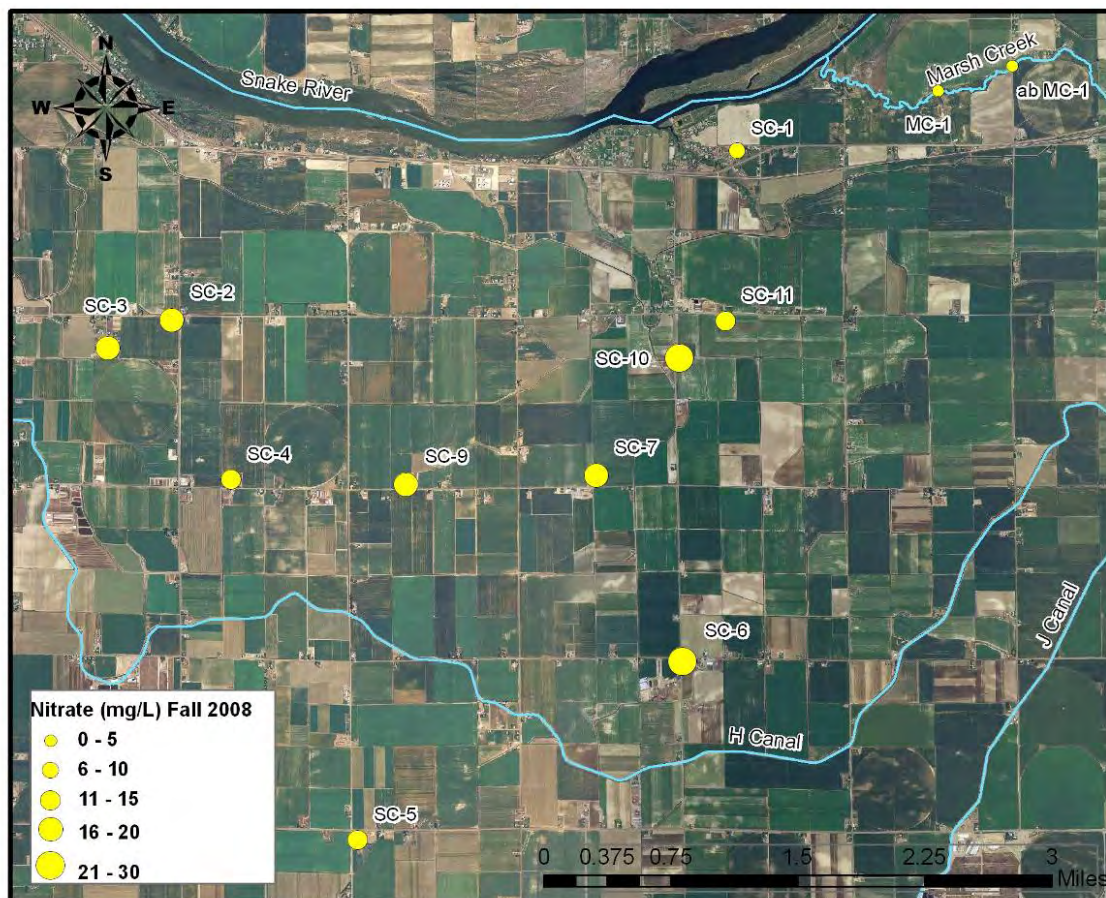


Figure 33. Well locations and nitrate concentration (mg/L) for the October 2008 sampling event.

Most of the nitrogen isotope ratio results from the Springdale area (Table 29) fall within the range of organic nitrogen in soil. Refer to Table 5 on page 21 for typical $\delta^{15}\text{N}$ values for various nitrogen sources. A majority of the wells had either a commercial fertilizer source or a mixed nitrogen source signature, which may be from mixing of water from more than one source. The nitrogen isotope ratio values for SC-3 and SC-6 appear to indicate an animal or human waste source of nitrogen. The variable nitrogen signatures across the study area suggest local land use (e.g., fertilizer loading, CAFOs) plays a significant role in resulting nitrogen signatures.

Table 29. Inorganic compound and isotope analyses for samples collected on 10/14/2008 and 10/15/2008 in the Springdale area.

Sample Site	Chloride (mg/L)	Sulfate (mg/L)	NO ₂ +NO ₃ (mg/L)	TDS (mg/L)	Phosphorus (mg/L)	$\delta^{15}\text{N}$ (‰)	$\delta^{18}\text{O}$ (‰)	$\delta^2\text{H}$ (‰)
SC-1	39.5	73.6	8.2	530	0.099	5.0	-16.1	-126
SC-2	40.2	70.5	17	590	0.061	6.7	-16.3	-129
SC-3	50.6	73	19	660	0.053	10.0	-16.2	-128
SC-4	43	64.7	14	550	0.064	8.7	-16.1	-127
SC-5	34.8	71.4	12	600	0.049	5.1	-16.1	-128
SC-6	77.3	112	22	880	0.065	9.4	-15.4	-123
SC-7	42.8	94.2	17	680	0.068	5.9	-16.0	-126
SC-9	39.4	96.5	16	610	0.052	3.4	-15.9	-124
SC-10	87.2	140	25	890	0.12	7.2	-15.8	-126
SC-11	43.4	94.6	14	630	0.084	5.6	-15.7	-123

The animal/human antibiotic sulfamethoxazole was detected in 8 of the 10 wells sampled in October 2008. Sample sites SC-6 had the highest concentration of sulfamethoxazole at 56 ng/L. The human anti-seizure drug carbamazepine was detected in site SC-7 sample at a concentration of 6.6 ng/L (7 ng/L in the duplicate (SC-8) sample). Caffeine was found in one well at 12 ng/L and the animal antibiotic sulfadimethoxine was detected in one well at 1 ng/L. Cholesterol (a plant and animal steroid) was detected in all wells, ranging from 640 to 1,100 ng/L, which is consistent with background or ambient cholesterol concentrations in ground water.

Table 30. PCPP analyses for samples collected on 10/14/2008 and 10/15/2008 in the Springdale area. The sample SC-8 is a duplicate sample of SC-7.

Sample Site	Cholesterol (ng/L)	Sitosterol (ng/L)	Caffeine (ng/L)	Sulfamethoxazole (ng/L)	Sulfadimethoxine (ng/L)	Carbamazepine (ng/L)
SC-1	910	ND	ND	3.9	ND	ND
SC-2	800	ND	ND	ND	ND	ND
SC-3	910	ND	ND	1.6	ND	ND
SC-4	1000	ND	ND	1.2	ND	ND
SC-5	840	ND	ND	1.2	ND	ND
SC-6	640	ND	ND	56	1	ND
SC-7	1100	ND	ND	1.2	ND	6.6
SC-8 (Dup)	1100	340	ND	1.5	ND	7.0
SC-9	1000	ND	ND	ND	ND	ND
SC-10	1100	ND	12	26	ND	ND
SC-11	970	ND	ND	1.1	ND	ND

Conclusions

Shallow ground water in the Springdale area is being negatively impacted from land use practices as evidenced by elevated nitrate, TDS, chloride, sulfate, and PCPP concentrations. Analytical results suggest the local land use practices in northern Cassia County influence the concentrations of these constituents of concern in domestic wells and surface water.

Oxygen and deuterium isotopic analyses suggest some wells are impacted by recharged ground water from evaporated sources (i.e. holding ponds, such as irrigation ponds or wastewater lagoons). This relationship could also be a result of distance from the H and J canal system, which recharge the shallow aquifer system through leakage.

The range of nitrogen isotope values observed in the Springdale area indicates a mixture of nitrogen from commercial fertilizer and animal or human sources, and organic nitrogen in soil. The nitrogen isotope values for SC-3 and SC-6 are indicative of animal or human waste.

The field parameters and concentrations of IOCs, isotopes, and PCPPs together suggest that an area-wide land use-related contamination problem exists independent of well depth or construction. These measurements and analysis results also suggest that well construction and on-site land use practices are important factors determining the water quality at individual well locations.

The persistence of PCPPs in analyzed wells and surface water suggests that pathways exist between human and animal waste sources, ground water, and surface water. A wide variety of PCPPs were detected in both the April and October sampling events, meaning these constituents are present in water sources year-round. The fact that PCPPs were found throughout the study area suggests there is an area-wide persistence of PCPPs in northern Cassia County.

Recommendations

Due to current data gaps, it is recommended that additional sampling events be performed to analyze ground water for the following constituents: nitrate, chloride, sulfate, total dissolved solids, nitrogen and oxygen isotopes, and PCPPs in selected wells. Measuring the isotopic signature of the oxygen that comprises the nitrate compound (NO_3), along with the nitrogen isotope signature, will be useful in further fingerprinting the wells impacted by commercial fertilizer application, and/or animal or human waste sources.

The additional data will be analyzed to identify sources of nitrogen in the area. The data will be used to help develop a ground water quality management plan for the Springdale area. Employing best management practices will ensure that the potential over-application of commercial and animal fertilizers is minimized. Public outreach would be beneficial to educate the citizens of the community of Springdale about the quality of ground water in their area and how they can protect their domestic drinking water wells.

For more information, please see the full technical report by Schorzman and Baldwin (2009) at:

http://www.deq.idaho.gov/water/data_reports/ground_water/springdale_nitrate_39.pdf.

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