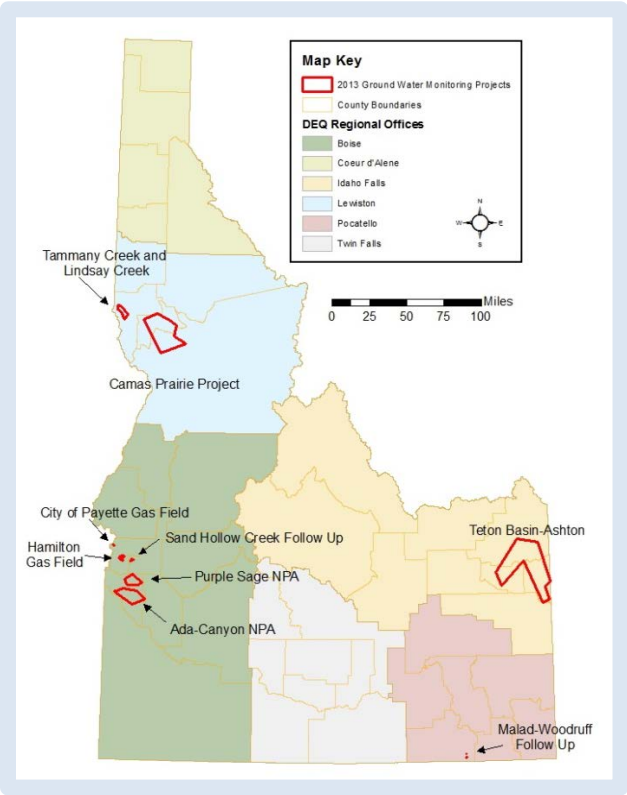
Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2013

Ground Water Quality Technical Report No. 47



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Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2013

February 2015

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Compiled and edited by Kathryn Elliott.

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- Rebecca Goehring authored and Aaron Scheff reviewed the Sand Hollow Creek Follow-Up Ground Water Monitoring Project, Purple Sage Nitrate Priority Area Ground Water Monitoring Project, Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project, City of Payette Gas Field Ground Water Monitoring Project, and Hamilton Gas Field Ground Water Monitoring Project summaries (section 2.1).
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- Joanna Hahn created the map (Figure 1) of the 2013 ground water quality project locations by region.
- Joanna Hahn created all figures in Appendix B.

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Acronyms, Abbreviations, and Symbols

°C	degrees Celsius
µg	micrograms
µS	microsiemens
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylene
$CaCO_3$	calcium carbonate
cfu	colony-forming unit
cm	centimeter
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
FSP	field sampling plan
GPS	Global Positioning System
IBL	Idaho Bureau of Laboratories
IDAPA	refers to citations of Idaho's administrative rules
IDWR	Idaho Department of Water Resources
ISDA	Idaho State Department of Agriculture
L	liter
m+p-xylene	meta-xylene plus para-xylene
MCL	maximum contaminant level
mg	milligrams
mL	milliliter
MPN	most probable number
NA	not applicable

NAU CPSIL	Northern Arizona University–Colorado Plateau Stable Isotope Laboratory
ND	nondetect
NPA	nitrate priority area
NS	not sampled
NSDWR	National Secondary Drinking Water Regulation
NTU	nephelometric turbidity unit
o-xylene	orthoxylene
per mil (‰)	parts per thousand
PWS	public water system
QAPP	quality assurance project plan
RD	rejected data
RSIL	Reston Stable Isotope Laboratory
SMCL	secondary maximum contaminant level
TDS	total dissolved solids
TMDL	total maximum daily load
TPH	total petroleum hydrocarbons
UIASL	University of Idaho Analytical Sciences Laboratory
USGS	US Geological Survey
VSMOW	Vienna Standard Mean Ocean Water
$\delta^{15}N$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{15}N_{nitrate}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N of the nitrate molecule
$\delta^{18}O$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O
$\delta^{18}O_{nitrate}$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O of the nitrate molecule
$\delta^{2}H$	ratio of the two stable hydrogen isotopes ^{1}H and ^{2}H (deuterium), also denoted as δD

1 Introduction

Ground water is a key resource in Idaho—providing drinking water to 95% of Idahoans—and a critical component of the state's economy. The economic and social vitality of every Idaho community depends on access to a safe and clean ground water supply.

Idaho Code §39-120, "Environmental Quality - Health," 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. Idaho Code §39-120 further directs DEQ, the Idaho Department of Water Resources (IDWR), and the Idaho State Department of Agriculture (ISDA) to conduct ground water quality monitoring and promote public awareness of ground water issues by making results of ground water quality investigations available to the public.

Public water systems (PWSs) are regulated by DEQ under the federal Safe Drinking Water Act and the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08). These regulations require chemical analysis of drinking water for various contaminants. DEQ ensures that follow-up monitoring is conducted when contaminants of concern are detected in PWSs. The United States Environmental Protection Agency (EPA) has set National Primary Drinking Water Regulation standards, expressed as maximum contaminant levels (MCLs), that are legally enforceable standards that apply to PWSs. These levels are set to protect public health by limiting the amount of contaminants in drinking water. EPA has also set National Secondary Drinking Water Regulations (NSDWRs), expressed as secondary maximum contaminant levels (SMCLs), which are nonmandatory standards that are established as guidelines to assist PWSs in managing their drinking water for aesthetic considerations such as taste, color, and odor. Although these limits only apply to PWSs, they can be applied to private wells to evaluate water quality, as is done throughout this report. Total coliform and *Escherichia coli* (*E. coli*) sampling results were compared to standards set forth in Idaho's Ground Water Quality Rule (IDAPA 58.01.11), rather than national regulations. The single samples collected during these projects were not appropriate for comparison to the national standards, which are based on exceedances during a month-long sampling period.

DEQ also responds to detections of contaminants of concern that are found by monitoring programs implemented by other entities, such as the Statewide Ambient Ground Water Quality Monitoring Program, administered by IDWR. Follow-up investigations may develop into a DEQ local or regional monitoring project to assess conditions and identify areas where public health may be threatened. The investigation results can facilitate management decisions that protect the resource and promote public awareness for ground water protection.

Field measurements taken during follow-up investigations and monitoring projects should be considered estimates and are not used for determining NSDWR standard violations. They are used to monitor well water during purging to ensure water in the wellbore is removed from the well prior to sampling. Field measurements are also used to qualitatively evaluate water quality variability between wells.

The ground water quality monitoring results can also be used to define and prioritize degraded ground water quality areas, such as nitrate priority areas (NPAs). In 2014, DEQ identified 34 areas in the state as having elevated concentrations of nitrate in ground water. These NPAs are ranked based on population, existing water quality, and water quality trends. The basis for an NPA is that 25% or more of the wells sampled within the designated area have nitrate concentrations that meet or exceed 5 milligrams per liter (mg/L). EPA has established an MCL for nitrate at 10 mg/L, and DEQ adopted this MCL into the Ground Water Quality Standards. The NPAs are reevaluated and re-ranked approximately every 5 years. Additional information about NPA delineation and ranking is available from the *2014 Nitrate Priority Area Delineation and Ranking Process* document (DEQ 2014a). Although the current NPAs were delineated in 2014, the 2013 monitoring projects discussed in this report refer to the 2008 NPAs since they were the most current delineation at the time these monitoring projects took place (DEQ 2008).

Prioritization is necessary to effectively allocate resources for water quality improvement strategies. DEQ has worked in coordination with state and federal agencies, as well as stakeholders, to develop ground water quality improvement plans, also known as ground water quality management plans, that address ground water degradation in NPAs. Ground water quality data are used to evaluate the effectiveness of plan implementation.

The Ground Water Program at DEQ has implemented regional ground water monitoring using a statistically based approach to determine the monitoring network design. These regional projects have focused in areas designated as NPAs. This report provides an overview of DEQ's ground water monitoring projects and investigation activities accomplished with public funds during 2013. It does not include results from privately funded activities, including monitoring required by permits, monitoring associated with ongoing environmental remediation projects, monitoring associated with Kootenai County Aquifer Protection District funding, or monitoring associated with PWS requirements.

2 Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects that were conducted by DEQ in calendar year 2013. Projects are presented by DEQ regional office and identified in Figure 1.

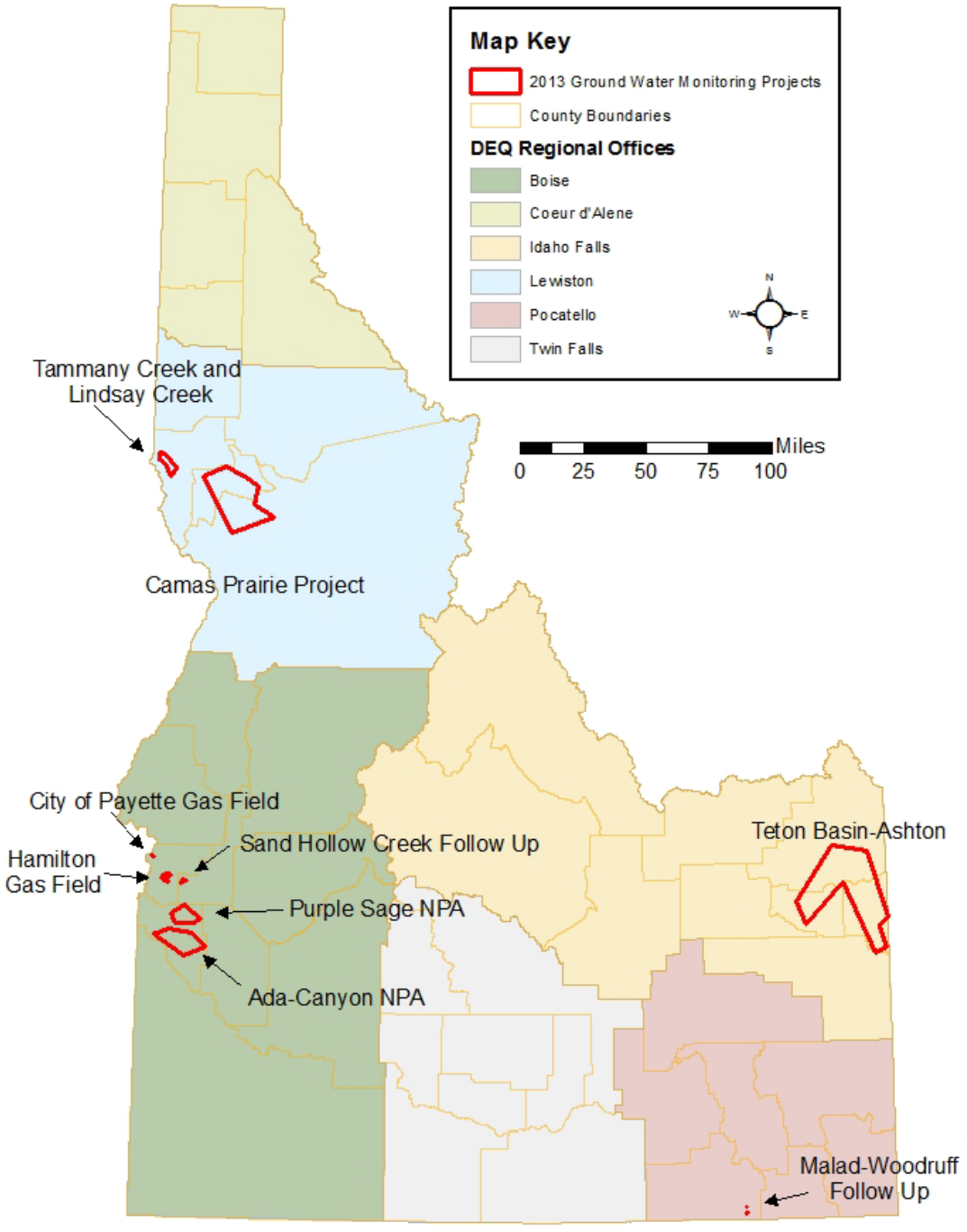


Figure 1. Idaho Department of Environmental Quality's 2013 ground water quality project locations by region.

All ground water quality data contained in this section are available through an *interactive mapping application* available on DEQ's website. The application contains ground water quality data that DEQ or its contractors have collected from 1987 to the present. The application can be used to view and download data collected for over 350 contaminants, ranging from nitrate—a widespread ground water contaminant—to emerging contaminants such as personal care products and pharmaceuticals. The application was developed to help citizens, local officials, researchers, water quality professionals, consultants, and other stakeholders make informed decisions about land-use activities. The application also provides private well owners with an indication of ground water quality conditions in an area when considering treatment options for protecting their family's health.

2.1 Boise Region

2.1.1 Sand Hollow Creek Follow-Up Ground Water Monitoring Project

2.1.1.1 Purpose and Background

The purpose of this project was to follow-up on a complaint DEQ received on September 3, 2013, about possible bacteria and nitrate contamination of wells in the vicinity of a dairy operation ("Sage Dairy") and a farming operation ("Rim Fire Ranch") that are located in the Sand Hollow Creek drainage within the Emmett North Bench NPA. In response to the complaint, DEQ conducted this project to evaluate ground water quality in eight wells ("project wells") in the project area northwest of Emmett (Figure 2).

The ISDA Dairy Bureau collects ground water samples for nitrate analysis at dairy production wells during annual facility inspections. When a sample has a nitrate concentration that exceeds the MCL of 10 mg/L for nitrate, ISDA provides the information to DEQ. The ISDA Dairy Bureau samples from the Sage Dairy site production well show nitrate concentrations above the MCL since 2000. The ISDA data show a declining nitrate trend from 17.10 mg/L in 2000 to 11.60 mg/L in 2013 (Figure 3; Table 1).

ISDA also collects isotope samples every 5 years from dairy production wells with previous nitrate concentrations greater than 5 mg/L. Nitrogen isotope ratios ($\delta^{15}N$) can be helpful in determining sources of nitrate in the ground water, as nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. The ISDA nitrogen isotope data, from samples collected in years 2000, 2005, and 2010, indicate human or animal waste is contributing nitrate to the ground water supplying the dairy production well (Table 1).

Well driller's logs from wells located within and surrounding the project area indicate the lithology consists of interbedded clay, sand, and gravel. The depth to ground water shown on well driller's logs located in the northern portion of the project area ranges from approximately 70 to110 feet below ground surface (bgs). Ground water occurs under both confined and unconfined conditions. Ground water flows in a southwesterly direction in the project area (Figure 4).

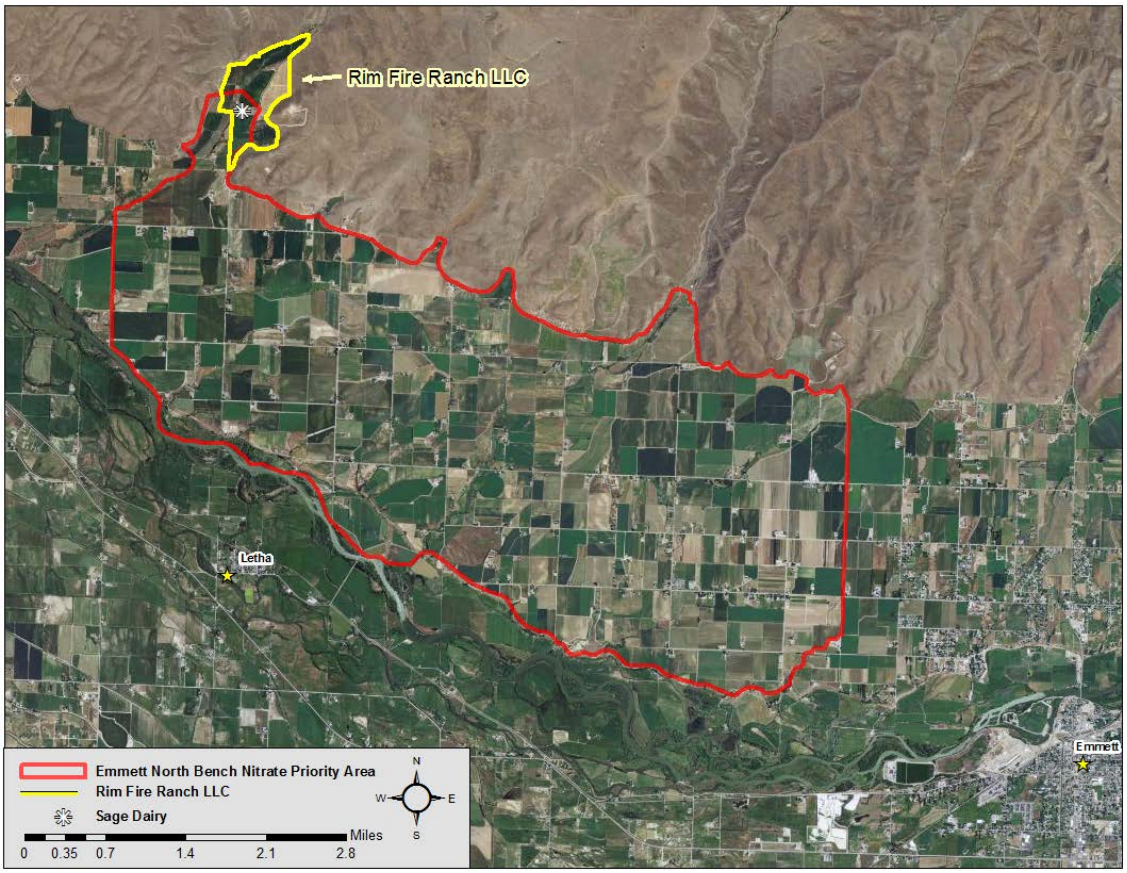


Figure 2. Location of Sage Dairy within the Emmett North Bench Nitrate Priority Area on the Rim Fire Ranch LLC property.

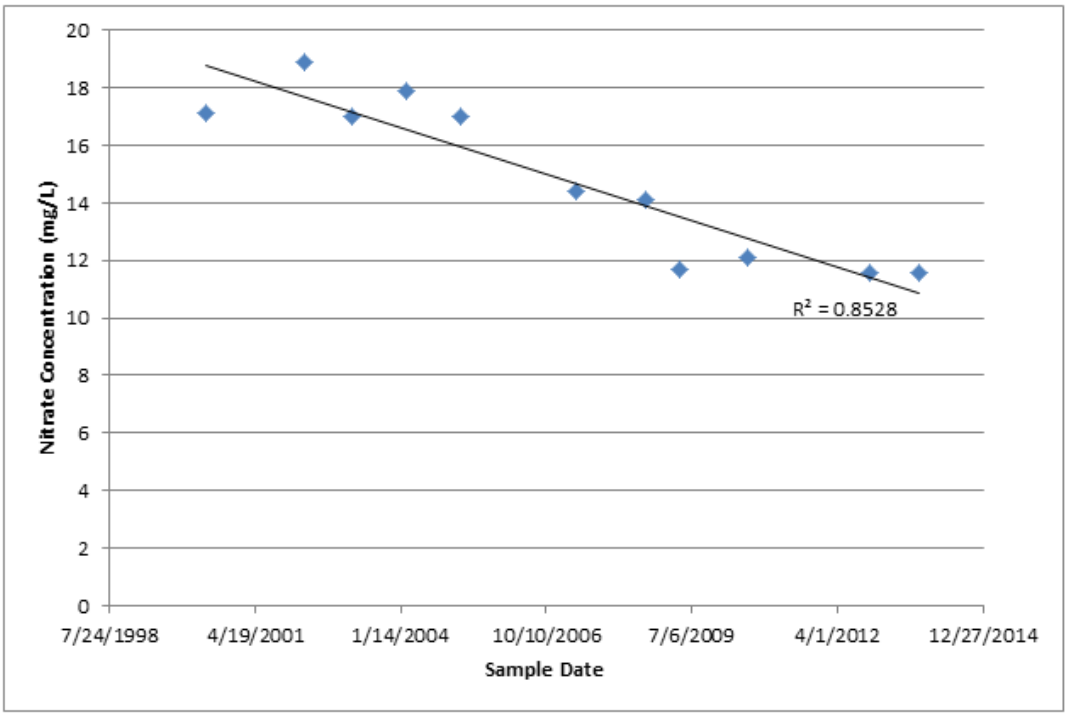


Figure 3. ISDA Dairy Bureau nitrate concentrations—Sage Dairy site production well.

Table 1. ISDA Dairy Bureau nitrate concentration and nitrogen isotope data—Sage Dairy site production well.

Sample Date	Nitrate Concentration (milligrams per liter)	$\delta^{15}N$ (‰)
05/15/2000	**17.10**	9.54
03/19/2002	**18.90**	NS
02/14/2003	**17.00**	NS
02/24/2004	**17.90**	NS
03/01/2005	**17.00**	NS
6/22/2005	NS	10.24
05/03/2007	**14.40**	NS
08/21/2008	**14.10**	NS
04/14/2009	**11.70**	NS
07/20/2010	**12.10**	NS
8/23/2010	NS	9.36
11/08/2012	**11.60**	NS
10/16/2013	**11.60**	NS

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. The MCL for nitrate is 10 milligrams per liter. NS = not sampled.

2.1.1.2 Methods and Results

On September 19, 2013, DEQ surveyed the project area and used nitrate strips on the eight project wells. DEQ also collected GPS data on each well in order to plot them on a map (Figure 2). Permission forms were collected from the owners of the project wells prior to sampling. Well logs were acquired for four of the eight wells. Well logs were not located for the remaining four wells (1264, 2229, 2230, and 2232). The well construction and depth of the wells without well logs are unknown.

On September 26, 2013, DEQ sampled the project wells. Samples were collected from each well in accordance with DEQ's quality assurance project plan (QAPP) (DEQ 2012c) and the Sand Hollow Creek follow-up field sampling plan (FSP) (DEQ 2013f). Water quality field parameters (pH, temperature, specific conductivity, dissolved oxygen [DO], and turbidity) were measured at each site prior to sample collection (Table 2).

Samples were analyzed for anions (nitrate, nitrite, chloride, sulfate, bromide, fluoride, and ortho-phosphate); ammonia (when field testing indicated a DO of less than 3.0 mg/L); arsenic; total coliform; and *E. coli*. Arsenic, total coliform, and *E. coli* samples were submitted to the Idaho Bureau of Laboratories (IBL) in Boise, Idaho, for analysis (Table 3). The anion and ammonia samples were submitted to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho, for analysis (Table 3).

Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations equal to or greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson, Arizona, for nitrogen isotope analysis. Nitrogen isotope results are shown in Table 3.

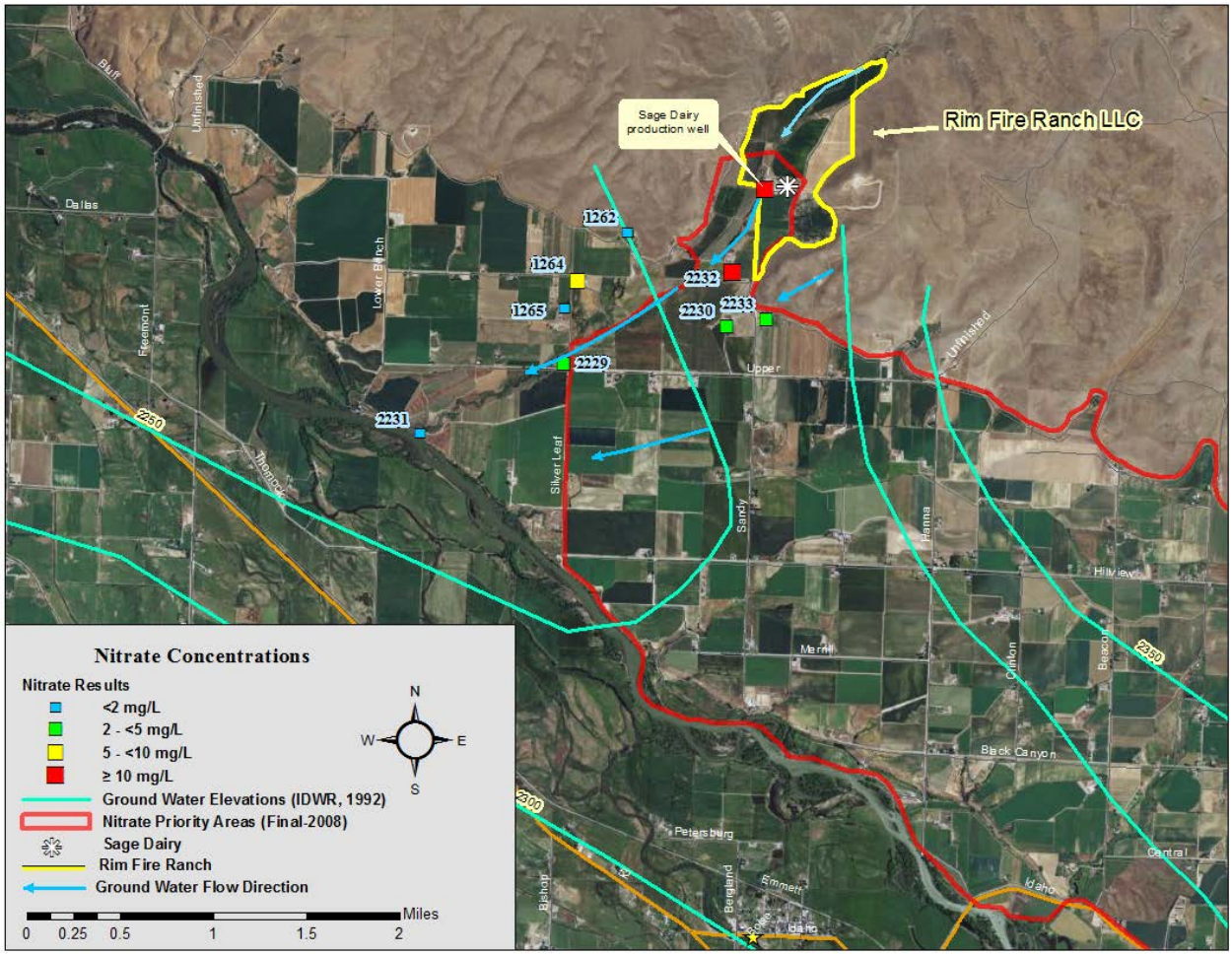


Figure 4. Sample locations, nitrate concentrations, elevations, and ground water flow directions—Sand Hollow Creek Follow-Up Ground Water Monitoring Project.

Table 2. Water quality field parameters—Sand Hollow Creek Follow-Up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
1264	—	9/26/2013	14.7	516	7.23	—	7.11
1262	188.5	9/26/2013	17.6	446	0.01	—	7.42
2229	—	9/26/2013	13.2	380	1.87	—	7.01
2230	—	9/26/2013	16.2	355	7.78	—	7.24
1265	85	9/26/2013	14.6	475	2.78	—	7.26
2231	113	9/26/2013	14.1	428	0.0	—	7.71
2232	—	9/26/2013	14.2	701	8.92	—	7.16
2233	109	9/26/2013	17.6	392	8.54	—	7.36

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; NTU = nephelometric turbidity unit; (—) = data are unavailable or were not analyzed

[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems and are used with private wells to evaluate water quality.

Table 3. Inorganic, nutrient, and bacteria results—Sand Hollow Creek Follow-Up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations										Bacteria	
			Arsenic[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Ortho-phosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	E. coli[a]
				(mg/L)									(MPN/100 mL)	
Standard:			***10***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
1264	—	9/26/2013	4.5	0.27	6.6	<0.050[d]	<0.10	0.12	16.0	—	7.3	6.8	1046.2	<1
1262	188.5	9/26/2013	<2.0	<0.15	6.8	<0.050	<0.10	<0.10	28.0	<0.10	<0.05	—	<1	<1
2229	—	9/26/2013	2.5	0.25	4.3	<0.050[d]	<0.1	0.20	16	<0.10	2.3	—	<1	<1
2230	—	9/26/2013	4.0	0.46	5.1	<0.050	<0.1	<0.1	8.5	—	3.7	—	<1	<1
1265	85	9/26/2013	<2.0	<0.15	4.7	<0.050[d]	<0.1	<0.1	24	<0.10	0.24	—	<1	<1
2231	113	9/26/2013	3.5	<0.15	7.2	<0.050[d]	<0.1	<0.1	19	0.34	<0.05	—	<1	<1
2232	—	9/26/2013	5.4	0.27	10	<0.050	<0.10	0.12	20	—	**19.0**	9.1	<1	<1
2233	109	9/26/2013	2.8	0.40	7.2	<0.050	0.40	<0.1	19	—	2.8	—	160.7	<1

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}N$ = nitrogen isotope; ‰ = per mil; NA = not applicable; cfu = colony-forming unit; (—) = data are unavailable or were not analyzed

[a] Contaminant with a National Primary Drinking Water Regulation standard.

[b] Contaminant with a National Secondary Drinking Water Regulation standard.

[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

[d] Lab sheets showed an unquantifiable detection of nitrite instead of an ND (nondetect).

Bacteria Results

Total coliform bacteria are common in the environment (such as soil) and in the intestines of animals, and are generally not harmful. *E. coli* bacteria are found in animal fecal matter. The presence *E. coli* in drinking water provides strong evidence that human or animal fecal matter is present; therefore, a greater potential for pathogenic organisms exists.

The reported total coliform concentrations were nondetect in six of the eight project wells (<1 most probable number per 100 milliliters [MPN/100 mL]). Total coliform bacteria were detected in samples collected from two of the wells (2233 and 1264). The total coliform concentrations were 160.7 MPN/100 mL in well 2233 and 1,046.2 MPN/100 mL in well 1264. *E. coli* was not detected in any of the wells.

Nitrate Results

The nitrate MCL of 10 mg/L was exceeded in one well (2232), which measured 19.0 mg/L. The nitrate values in the remaining project wells ranged from <0.05 mg/L to 7.3 mg/L. The spatial distribution of nitrate concentrations is shown in Figure 4. Based on ground water flow information from IDWR, well 2232 is located downgradient from the Rim Fire Ranch property.

Nitrite Results

No samples contained nitrites above the laboratory reportable detection limit of 0.050 mg/L.

Nitrogen Isotope Results

Nitrogen isotope analysis was completed on the samples from the two wells with nitrate concentrations greater than 5 mg/L: wells 1264 and 2232 (Table 3). Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 4. Well 1264 had $\delta^{15}N$ results of 6.8 per mil (‰), indicating the source of nitrogen is from either organic nitrogen in soil or a mixed nitrogen source. Well 2232 had a $\delta^{15}N$ value of 9.1‰, suggesting that the nitrate in the ground water originates from mixed nitrogen sources, which include an animal or human waste component.

Table 4. Typical $\delta^{15}N$ values from various nitrogen sources.

Potential Nitrate Source	$\delta^{15}N$ (‰)
Precipitation	−3
Commercial fertilizer	−4 to +4
Organic nitrogen in soil	+4 to +9
Animal or human waste	Greater than +10

Source: Seiler (1996)
Notes: $\delta^{15}N$ = nitrogen isotope; ‰ = per mil

Arsenic Results

The arsenic values ranged from nondetect (<2.0 micrograms per liter [µg/L]) to 5.4 µg/L. The EPA MCL for arsenic is 10 µg/L. All arsenic concentrations were below the MCL.

Chloride Results

Chloride values ranged from 4.3 mg/L to 10 mg/L. The EPA National Secondary Drinking Water Regulations standard for chloride is 250 mg/L, based on aesthetic effects. All chloride concentrations were below the standard.

2.1.1.3 Conclusions

In response to a complaint, DEQ conducted this project to evaluate ground water quality in the Sand Hollow Creek area southwest of the Rim Fire Ranch property. Ground water samples were collected from eight wells. Samples were analyzed for bacteria (total coliform and *E. coli*), common ions (nitrate, nitrite, chloride, sulfate, bromide, fluoride, and ortho-phosphate, ammonia (when field testing indicated a DO of less than 3.0 mg/L), arsenic, and nitrogen isotope (if sample nitrate concentrations were 5 mg/L or greater). Total coliform bacteria were detected in ground water samples collected from two of the eight project wells. No *E. coli* bacteria were detected in any samples.

Samples from seven of the eight project wells did not contain detectable concentrations of nitrate (two wells) or contained nitrate concentrations below the nitrate MCL of 10 mg/L. The sample from well 2232 exceeded the nitrate MCL with a concentration of 19.0 mg/L.

Based on the elevated nitrate concentration in a sample from well 2232, DEQ submitted this sample for nitrogen isotope analysis. The nitrogen isotope value was 9.1‰, suggesting that the nitrate in the ground water originates from mixed nitrogen sources, which include an animal or human waste component.

Ground water upgradient of well 2232, as measured in samples collected from a Sage Dairy site production well during the last 14 years, is degraded with nitrate concentrations above the MCL of 10 mg/L. The ISDA nitrate data for the production well shows a declining trend in the nitrate concentrations.

Nitrogen isotope results from the production well had $\delta^{15}N$ values greater than 9‰, indicating that animal or human waste is contributing nitrogen to the ground water. The presence of elevated nitrate concentrations, as well as a similar nitrogen isotope signature in ground water upgradient of well 2232, suggests that the source(s) of nitrate are similar. Based on this information, land use activities impacting the Sage Dairy site production well may also be impacting the ground water quality in well 2232.

2.1.1.4 Recommendations

Additional ground water sampling and analyses will be conducted to monitor changes in ground water quality and further evaluate the ground water chemistry.

2.1.2 Purple Sage Nitrate Priority Area Ground Water Monitoring Project

2.1.2.1 Purpose and Background

This ground water monitoring project was designed to evaluate the water quality and nitrate concentrations in the Purple Sage NPA in Canyon County. In 2008, the Purple Sage NPA ranked as the 21st most impacted NPA in Idaho.

In 2013, DEQ collected ground water samples from 88 domestic or irrigation wells in the Purple Sage NPA using procedures outlined in the QAPP (DEQ 2011b). Program objectives, design, and well selection processes are identified in the regional ground water monitoring network design (DEQ 2011a). DEQ analyzed the ground water samples for common water quality analytes including nitrate, bacteria, selected metals, orthophosphate, and sulfate to assess the water quality in the project area.

Canyon County is entirely on the Snake River Plain and is bounded by the Snake River on the south and the foothills of the central Idaho mountains on the north. Much of the county is underlain by Quaternary alluvium of the Boise River and Pleistocene gravel from glacial outwash. This gravel forms high benches above the Boise River. Several normal faults run northwest through the county, parallel with the northern boundary of the western Snake River Plain. Miocene lake beds make up the foothills on the northern boundary of the county. The predominant land use in the Purple Sage NPA is agricultural and residential. Most of the residences within the NPA are served by private wells (DEQ 2005b).

DEQ staff reviewed project area well logs from IDWR's database and determined a blue clay confining layer is located approximately 190 to 410 feet bgs. This confining layer can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. All wells sampled for this project had a well completion depth less than 350 feet bgs. The regional ground water flow direction is generally to the southwest (Figure 5).

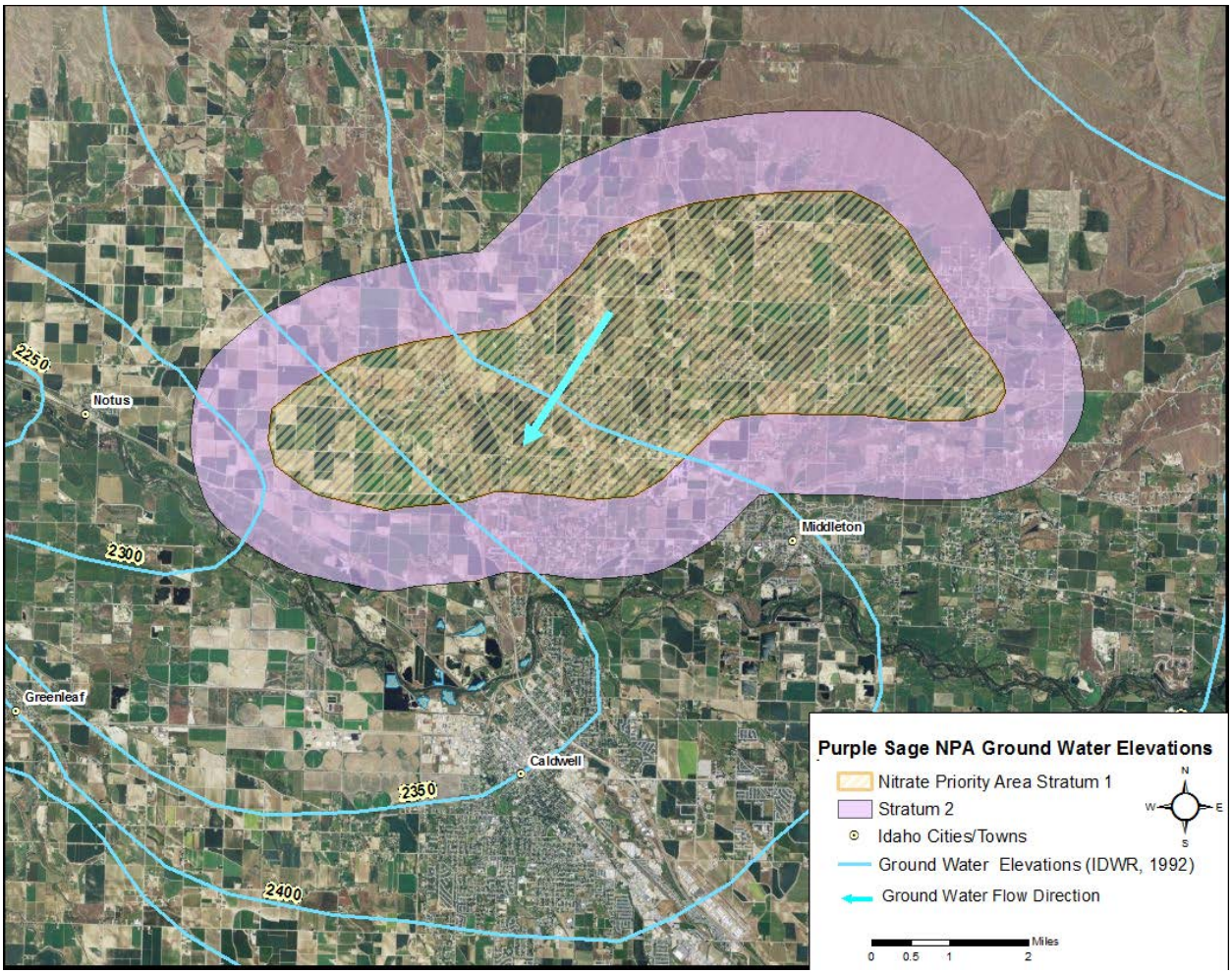


Figure 5. Ground water contours and elevations—Purple Sage Nitrate Priority Area Ground Water Monitoring Project.

2.1.2.2 Methods and Results

A statistical process, developed for DEQ by Dr. Kirk Steinhorst of the University of Idaho, was used to determine the number of samples to be collected within the Purple Sage NPA (Stratum 1) and outside the Purple Sage NPA (Stratum 2, which surrounds Stratum 1 as a 1-mile buffer) to ensure the sampling event was statistically valid (Figure 5) (Steinhorst 2011). The statistical model determined that 59 wells located in Stratum 1 and 29 wells located in Stratum 2 would be sampled to meet a 90% statistical confidence level that the estimated mean is within 15% of the true mean.

Wells were chosen in accordance with the DEQ regional network design (DEQ 2011a). Preference was given to wells screened solely within the shallow aquifer, which is above a blue lacustrine clay layer that separates the shallow and deep aquifers.

The total number of wells in Stratum 1 and the total number of wells in Stratum 2 were randomized separately to determine which wells would be sampled. Permission was obtained from the well owners for DEQ staff to access the 88 wells and collect samples for laboratory analysis.

Samples were collected in May 2013 from each well in accordance with DEQ's regional NPA ground water monitoring activities Boise region QAPP (DEQ 2011c) and the Purple Sage Nitrate Priority Area regional ground water monitoring network FSP (DEQ 2013c). Water quality field parameters (i.e., pH, temperature, specific conductivity, turbidity, and DO) were measured at each well prior to sample collection (Table 5).

Table 5. Water quality field parameters—Purple Sage Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
2102	241	5/13/2013	14.9	676	10.40	10	7.35
2103	143	5/15/2013	15.5	431	10.97	46	6.95
2186	95	5/28/2013	13.9	655	8.29	4	7.23
2014	98	5/21/2013	14.5	782	5.63	11	7.43
2113	138	5/13/2013	14.1	851	9.96	629	7.71
2106	109	5/20/2013	14.8	101	7.00	5	7.29
2180	61	5/28/2013	14.8	546	6.88	9	7.31
2107	95	5/15/2013	14.2	325	4.81	12	7.10
2108	100	5/21/2013	13.9	739	7.68	3	7.05
2109	153	5/21/2013	14.3	587	12.36	55	7.02
2185	136	5/28/2013	13.7	607	11.59	79	6.90
2110	92	5/20/2013	14.4	453	6.70	1	7.27
2111	313	5/23/2013	14.7	424	11.66	47	7.09
2112	293	5/13/2013	15.1	498	9.94	74	7.49
2105	96	5/13/2013	14.4	705	7.07	0	7.68
2182	166	5/28/2013	15.4	315	10.58	64	7.16
2114	117	5/13/2013	15.2	541	7.46	0	7.99
2115	120	5/13/2013	14.5	710	7.08	0	7.18
2116	85	5/20/2013	14.9	436	8.51	1	7.48
2117	118	5/13/2013	15.0	816	6.60	4	7.77
2118	66	5/13/2013	14.2	532	8.00	3	7.57
2119	69	5/13/2013	13.2	665	8.14	0	7.21
2120	76	5/21/2013	15.7	751	4.89	19	7.40
2121	76	5/21/2013	14.9	680	5.83	12	7.40
2122	161	5/21/2013	15.1	467	8.53	RD	7.02
2123	98	5/15/2013	15.7	391	3.25	25	6.97
2124	100	5/16/2013	15.2	663	8.37	0	7.20
2125	115	5/21/2013	14.3	838	6.46	RD	7.16
2126	146	5/21/2013	14.9	571	7.01	9	7.09
2127	93	5/15/2013	14.5	395	5.94	4	7.06
2136	100	5/20/2013	15.4	385	7.67	1	7.45
2128	93	5/15/2013	14.5	392	5.98	13	7.12
2129	160	5/20/2013	14.6	423	8.22	4	7.21

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
2130	80	5/13/2013	14.1	603	6.52	81	6.97
2183	85	5/28/2013	14.2	569	7.52	0	7.28
2131	157	5/20/2013	14.8	406	8.91	47	7.20
2132	118	5/20/2013	15.5	495	7.68	0	7.41
2133	140	5/20/2013	14.8	408	7.41	4	7.20
2134	95	5/21/2013	15.1	606	6.87	RD	7.31
2135	100	5/13/2013	14.0	611	6.73	1	7.13
2137	92	5/22/2013	14.0	1140	7.30	RD	6.71
2138	138	5/20/2013	14.6	418	8.49	2	7.19
2139	85	5/16/2013	15.2	789	7.73	4	7.21
2140	100	5/16/2013	15.0	661	7.95	0	7.24
2141	79	5/15/2013	15.7	348	7.16	66	7.10
2142	92	5/15/2013	14.1	316	7.40	20	7.03
2143	93	5/15/2013	14.8	365	6.70	19	7.08
2189	92	5/15/2013	14.6	349	4.75	3	7.21
2145	100	5/15/2013	14.7	357	4.87	2	7.21
2146	95	5/15/2013	14.0	395	6.42	7	7.03
2147	120	5/20/2013	15.2	556	7.08	0	7.42
2148	60	5/22/2013	13.9	761	7.44	0	6.92
2149	105	5/20/2013	14.7	431	11.18	14	6.82
2150	100	5/20/2013	15.1	456	9.13	10	7.46
2179	99	5/28/2013	14.8	440	4.18	1	7.02
2151	103	5/21/2013	15.0	657	7.95	RD	6.94
2184	83	5/28/2013	13.8	600	6.99	0	7.36
2152	83	5/21/2013	14.8	787	6.77	35	7.36
2153	71	5/22/2013	14.1	655	7.81	RD	7.11
2154	65	5/22/2013	13.8	821	7.05	RD	6.94
2000	90	5/28/2013	14.6	378	8.13	0	7.49
2155	170	5/23/2013	14.1	314	11.56	87	7.29
2156	61	5/15/2013	15.4	676	7.58	0	7.62
2157	153	5/22/2013	15.7	791	8.28	RD	7.22
2158	130	5/16/2013	15.9	556	13.92	23	7.07
2159	40	5/16/2013	14.9	328	12.11	17	7.03
2160	234	5/23/2013	14.5	526	8.37	RD	7.09
2161	44.5	5/21/2013	15.1	593	5.52	13	6.68
2162	240	5/23/2013	14.5	526	11.46	RD	7.05
2163	188	5/23/2013	14.2	277	13.08	96	7.01
2164	144	5/22/2013	14.2	753	9.51	RD	7.19
2165	173	5/16/2013	16.5	158	0.20	3	7.12
2166	330	5/23/2013	14.3	584	5.51	RD	6.95

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
2167	175	5/16/2013	15.5	593	6.23	5	7.15
2168	67	5/16/2013	14.0	690	7.50	2	7.30
2169	90	5/16/2013	14.3	818	5.61	0	7.08
2170	192	5/15/2013	16.5	155	0.40	0	7.49
2188	185	5/28/2013	14.3	302	12.46	57	7.03
2171	165	5/20/2013	15.5	610	8.02	36	7.00
2172	112	5/23/2013	13.4	229	6.95	0	7.25
2173	60	5/22/2013	14.4	141	1.83	RD	6.93
2174	325	5/23/2013	14.9	432	9.22	RD	7.18
2175	290	5/23/2013	15.3	377	11.90	RD	7.03
2187	194	5/28/2013	14.0	124	4.98	3	7.28
2176	84	5/23/2013	14.3	412	11.56	242	6.89
2177	262	5/23/2013	14.3	189	10.25	381	7.15
2178	115	5/28/2013	13.9	741	10.05	431	6.87
2181	322	5/28/2013	15.8	254	8.64	48	7.06

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; NTU = nephelometric turbidity unit; RD indicates rejected data due to laboratory errors or equipment errors

[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5-8.5. NSDWR standards are recommended limits for public water systems and are used with private wells to evaluate water quality.

Samples collected from each well were analyzed for arsenic; anions (bromide, chloride, fluoride, nitrate, nitrite, ortho-phosphate, and sulfate); total coliform; and *E. coli* (Table 6). Wells with DO less than 2.00 mg/L as determined by field analysis were also analyzed for ammonia as required by the FSP. Arsenic, total coliform, and *E. coli* samples were submitted to the IBL in Boise for analysis. At the time of the Purple Sage NPA project, IBL was engaged in a special project to identify other metals in ground water throughout the state. IBL analyzed all ground water samples for uranium as part of its project and informed DEQ of uranium results only if the results exceeded the MCL. Nitrate, nitrite, chloride, fluoride, bromide, orthophosphate, and sulfate samples were submitted to the UIASL in Moscow for analysis. Duplicate samples were submitted to IBL for identical analysis. Table 6 displays the results from the analysis conducted by UIASL. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson, Arizona, for nitrogen isotope analysis.

Table 6. Inorganic, nutrient, and bacteria results—Purple Sage Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations											Bacteria	
			Arsenic[a] (µg/L)	Uranium[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Orthophosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*[a]
					(mg/L)									(MPN/100 mL)	
Standard:			***10***	***30***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
2102	241	5/13/2013	2.4	—	<0.15	36	<0.05	0.27	<0.10	120	—	3.1	—	<1	<1
2103	143	5/15/2013	2.6	—	<0.15	18	<0.05	0.13	<0.10	56	—	3.6	—	<1	<1
2186	95	5/28/2013	3.4	**48**	0.23	12	<0.05	<0.10	0.18	59	—	4.9	3.7	<1	<1
2104	98	5/21/2013	4.4	—	0.55	11	<0.05	<0.10	0.19	80	—	8.4	6.4	<1	<1
2113	138	5/13/2013	6.2	**32**	0.28	33	<0.05	0.12	<0.10	140	—	7.6	5.4	<1	<1
2106	109	5/20/2013	5.3	**39**	0.42	29	<0.05	0.20	<0.10	150	—	9.6	5.9	<1	<1
2180	61	5/28/2013	4.2	—	0.37	12	<0.05	<0.10	<0.10	40	—	6.3	6.1	<1	<1
2107	95	5/15/2013	4.6	—	0.18	6.6	<0.05	<0.10	0.12	18	—	8.0	3.1	<1	<1
2108	100	5/21/2013	7.1	—	0.45	9.2	<0.05	<0.10	<0.10	46	—	5.9	5.7	<1	<1
2109	153	5/21/2013	2.9	—	<0.15	56	<0.05	0.36	<0.10	100	—	2.2	—	<1	<1
2185	136	5/28/2013	<2.0	**59**	0.17	33	<0.05	0.22	<0.10	67	—	2.8	—	<1	<1
2110	92	5/20/2013	9.1	—	0.57	16	<0.05	<0.10	0.40	30	—	6.6	7.2	<1	<1
2111	313	5/23/2013	<2.0	—	0.20	22	<0.05	0.17	<0.10	47	—	2.0	—	<1	<1
2112	293	5/13/2013	2.2	—	0.17	29	<0.05	0.26	<0.10	100	—	1.2	—	<1	<1
2105	96	5/13/2013	6.8	—	0.59	9.1	<0.05	<0.10	<0.10	61	—	**10**	4.9	<1	<1
2182	166	5/28/2013	3.6	—	0.30	17	<0.05	0.18	0.16	52	—	1.3	—	<1	<1
2114	117	5/13/2013	**13**	—	0.62	5.1	<0.05	<0.10	<0.10	26	—	8.9	5.6	<1	<1
2115	120	5/13/2013	**13**	—	0.32	12	<0.05	<0.10	<0.10	41	—	**11**	7.9	<1	<1
2116	85	5/20/2013	**11**	—	0.53	5.5	<0.05	<0.10	<0.10	19	—	3.7	—	<1	<1
2117	118	5/13/2013	4.2	**35**	0.19	8.6	<0.05	<0.10	<0.10	100	—	8.1	3.3	<1	<1
2118	66	5/13/2013	5.3	—	0.34	8.9	<0.05	<0.10	0.20	44	—	5.6	5.5	<1	<1
2119	69	5/13/2013	4.1	—	0.16	15	<0.05	0.10	0.11	64	—	9.4	2.3	<1	<1
2120	76	5/21/2013	4.7	—	0.37	13	<0.05	<0.10	0.13	65	—	6.8	5.7	<1	<1
2121	76	5/21/2013	4.7	—	0.48	7.4	<0.05	<0.10	0.14	29	—	3.1	5.6	<1	<1
2122	161	5/21/2013	2.8	—	<0.15	12	<0.05	<0.10	<0.10	27	—	2.3	—	<1	<1

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations											Bacteria	
			Arsenic[a] (µg/L)	Uranium[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Orthophosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*[a]
					(mg/L)									(MPN/100 mL)	
Standard:			***10***	***30***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
2123	98	5/15/2013	3.1	—	0.20	5.4	<0.05	<0.10	<0.10	42	—	5.1	4.4	<1	<1
2124	100	5/16/2013	**24**	—	0.66	22	<0.05	0.10	<0.10	79	—	7.2	4.6	<1	<1
2125	115	5/21/2013	8.3	—	0.44	20	<0.05	0.13	<0.10	90	—	8.0	6.0	<1	<1
2126	146	5/21/2013	3.1	—	<0.15	11	<0.05	<0.10	<0.10	33	—	4.2	—	<1	<1
2127	93	5/15/2013	2.2	—	<0.15	11	<0.05	<0.10	<0.10	23	—	**15**	3.3	<1	<1
2136	100	5/20/2013	**13**	—	0.47	4.5	<0.05	<0.10	0.10	16	—	3.0	—	<1	<1
2128	93	5/15/2013	3.3	—	0.20	10	<0.05	<0.10	<0.10	23	—	**14**	3.3	2.0	<1
2129	160	5/20/2013	6.6	—	0.40	13	<0.05	<0.10	0.15	33	—	6.3	6.3	<1	<1
2130	80	5/13/2013	5.2	—	0.46	7.9	<0.05	<0.10	0.19	43	—	6.2	6.7	<1	<1
2183	85	5/28/2013	3.7	—	0.31	10	<0.05	<0.10	0.12	57	—	7.0	2.4	<1	<1
2131	157	5/20/2013	6.6	—	0.44	12	<0.05	<0.10	0.18	32	—	6.3	5.7	<1	<1
2132	118	5/20/2013	9.7	—	0.45	10	<0.05	<0.10	0.15	29	—	4.9	—	<1	<1
2133	140	5/20/2013	6.1	—	0.34	14	<0.05	<0.10	0.15	28	—	5.6	7.0	<1	<1
2134	95	5/21/2013	8.6	—	0.46	18	<0.05	<0.10	0.19	42	—	3.4	—	<1	<1
2135	100	5/13/2013	5.2	—	0.22	12	<0.05	<0.10	0.23	35	—	3.7	—	<1	<1
2137	92	5/22/2013	4.1	—	0.17	8.8	<0.05	<0.10	0.14	63	—	7.7	2.2	<1	<1
2138	138	5/20/2013	4.6	—	0.24	14	<0.05	<0.10	<0.10	36	—	5.4	RD	<1	<1
2139	85	5/16/2013	9.3	**32**	0.41	27	<0.05	0.15	<0.10	84	—	7.7	RD	<1	<1
2140	100	5/16/2013	**15**	—	0.60	18	<0.05	<0.10	<0.10	52	—	4.1	—	<1	<1
2141	79	5/15/2013	3.6	—	0.22	6.6	<0.05	<0.10	<0.10	33	—	6.2	RD	<1	<1
2142	92	5/15/2013	4.1	—	<0.15	6.9	<0.05	<0.10	<0.10	19	—	7.2	3.3	<1	<1
2143	93	5/15/2013	2.2	—	<0.15	9.3	<0.05	<0.10	<0.10	23	—	**12**	3.4	<1	<1
2189	92	5/15/2013	4.4	—	0.31	6.5	<0.05	<0.10	<0.10	18	—	7.9	3.2	<1	<1
2145	100	5/15/2013	4.1	—	0.32	6.7	<0.05	<0.10	<0.10	19	—	8.5	3.0	<1	<1
2146	95	5/15/2013	3.8	—	<0.15	7.7	<0.05	<0.10	<0.10	24	—	9.3	3.3	<1	<1
2147	120	5/20/2013	**10**	—	0.52	9.0	<0.05	<0.10	0.11	34	—	4.3	—	<1	<1
2148	60	5/22/2013	5.5	—	0.36	4.9	<0.05	<0.10	0.27	28	—	3.1	—	4.1	<1

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations											Bacteria	
			Arsenic[a] (µg/L)	Uranium[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Orthophosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*[a]
					(mg/L)									(MPN/100 mL)	
Standard:			***10***	***30***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
2149	105	5/20/2013	2.9	—	<0.15	14	<0.05	0.11	<0.10	52	—	4.5	—	<1	<1
2150	100	5/20/2013	**13**	—	0.63	7.5	<0.05	<0.10	0.14	36	—	3.8	—	<1	<1
2179	99	5/28/2013	3.6	—	0.37	11	<0.05	<0.10	<0.10	24	—	**12**	3.6	<1	<1
2151	103	5/21/2013	2.9	**43**	<0.15	20	<0.05	0.13	<0.10	52	—	3.4	—	<1	<1
2184	83	5/28/2013	4.4	—	0.24	9.6	<0.05	<0.10	0.20	53	—	5.9	2.1	<1	<1
2152	83	5/21/2013	4.3	—	0.41	14	<0.05	<0.10	0.15	70	—	8.0	5.7	<1	<1
2153	71	5/22/2013	5.2	—	0.39	4.8	<0.05	<0.10	0.26	33	—	3.0	—	<1	<1
2154	65	5/22/2013	4.5	—	0.23	8.4	<0.05	<0.10	0.13	47	<0.10	5.6	4.4	<1	<1
2000	90	5/28/2013	**12**	—	0.50	4.2	<0.05	<0.10	0.14	16	—	3.1	—	<1	<1
2155	170	5/22/2013	<2.0	—	0.22	15	<0.05	0.14	<0.10	46	—	1.3	—	<1	<1
2156	61	5/15/2013	**15**	—	0.33	19	<0.05	0.11	<0.10	61	—	7.2	4.8	<1	<1
2157	153	5/22/2013	**15**	—	0.57	4.5	<0.05	<0.10	<0.10	45	—	1.5	—	<1	<1
2158	130	5/16/2013	5.1	—	<0.15	48	<0.05	0.34	<0.10	85	—	2.2	—	<1	<1
2159	40	5/16/2013	4.9	—	0.22	12	<0.05	<0.10	0.12	28	—	0.76	—	<1	<1
2160	234	5/23/2013	<2.0	—	0.19	6.3	<0.05	<0.10	<0.10	25	—	1.4	—	<1	<1
2161	44.5	5/21/2013	4.0	—	0.20	26	<0.05	0.17	0.18	77	—	3.2	—	1.0	<1
2162	240	5/23/2013	2.8	—	0.18	18	<0.05	0.13	<0.10	79	—	2.1	—	<1	<1
2163	188	5/23/2013	<2.0	—	0.22	12	<0.05	<0.10	<0.10	30	—	1.7	—	<1	<1
2164	144	5/22/2013	3.0	—	0.36	3.2	<0.05	<0.10	<0.10	36	—	5.0	4.7	<1	<1
2165	173	5/16/2013	**16**	—	0.27	3.5	<0.05	<0.10	<0.10	8.1	<0.10	0.061	—	<1	<1
2166	330	5/23/2013	<2.0	—	0.18	6.8	<0.05	<0.10	<0.10	32	—	2.2	—	<1	<1
2167	175	5/16/2013	2.5	—	<0.15	21	<0.05	0.16	<0.10	65	—	3.3	—	8.4	<1
2168	67	5/16/2013	6.8	—	0.55	3.7	<0.05	<0.10	<0.10	48	—	5.8	3.6	<1	<1
2169	90	5/16/2013	**17**	—	0.30	19	<0.05	0.14	<0.10	86	—	7.8	5.8	<1	<1
2170	192	5/15/2013	**14**	—	0.32	2.8	<0.05	<0.10	<0.10	7.1	<0.10	0.097	—	<1	<1
2188	185	5/28/2013	<2.0	—	0.24	20	<0.05	0.19	<0.10	43	—	2.4	—	1.0	<1
2171	165	5/20/2013	3.5	**43**	0.22	31	<0.05	0.22	<0.10	81	—	3.6	—	<1	<1

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations											Bacteria	
			Arsenic[a] (µg/L)	Uranium[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Orthophosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*[a]
					(mg/L)									(MPN/100 mL)	
Standard:			***10***	***30***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
2172	112	5/23/2013	<2.0	—	0.26	7.6	<0.05	<0.10	<0.10	24	—	1.1	—	<1	<1
2173	60	5/22/2013	2.8	—	0.34	0.55	<0.05	<0.10	0.14	2.7	<0.10	0.10	—	<1	<1
2174	325	5/23/2013	<2.0	—	0.18	21	<0.05	0.16	<0.10	44	—	1.9	—	<1	<1
2175	290	5/23/2013	<2.0	—	0.22	27	<0.05	0.16	<0.10	39	—	2.2	—	<1	<1
2187	194	5/28/2013	<2.0	—	0.32	1.6	<0.05	<0.10	<0.10	4.5	—	0.87	—	<1	<1
2176	84	5/23/2013	<2.0	—	0.22	15	<0.05	0.12	<0.10	RD	—	1.7	—	<1	<1
2177	262	5/23/2013	<2.0	—	0.27	7.6	<0.05	<0.10	<0.10	17	—	1.4	—	<1	<1
2178	115	5/28/2013	<2.0	**45**	0.26	38	<0.05	0.30	<0.10	120	—	4.2	—	<1	<1
2181	322	5/28/2013	3.8	—	0.26	13	<0.05	0.12	<0.10	35	—	0.99	—	<1	<1

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}N$ = nitrogen isotope; ‰ = per mil; NA = not applicable; (—) = data are unavailable or were not analyzed; cfu = colony-forming unit; "RD" indicates rejected data due to laboratory errors or equipment errors
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.
[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

Nitrate Results

The reported nitrate concentrations ranged from 0.061 mg/L to 15 mg/L; 41 of the 88 wells sampled had nitrate concentration of 5 mg/L or greater. The nitrate MCL of 10 mg/L was exceeded in 5 samples (2115, 2127, 2128, 2143, and 2179). The spatial distribution of nitrate concentrations is shown in Figure 6.

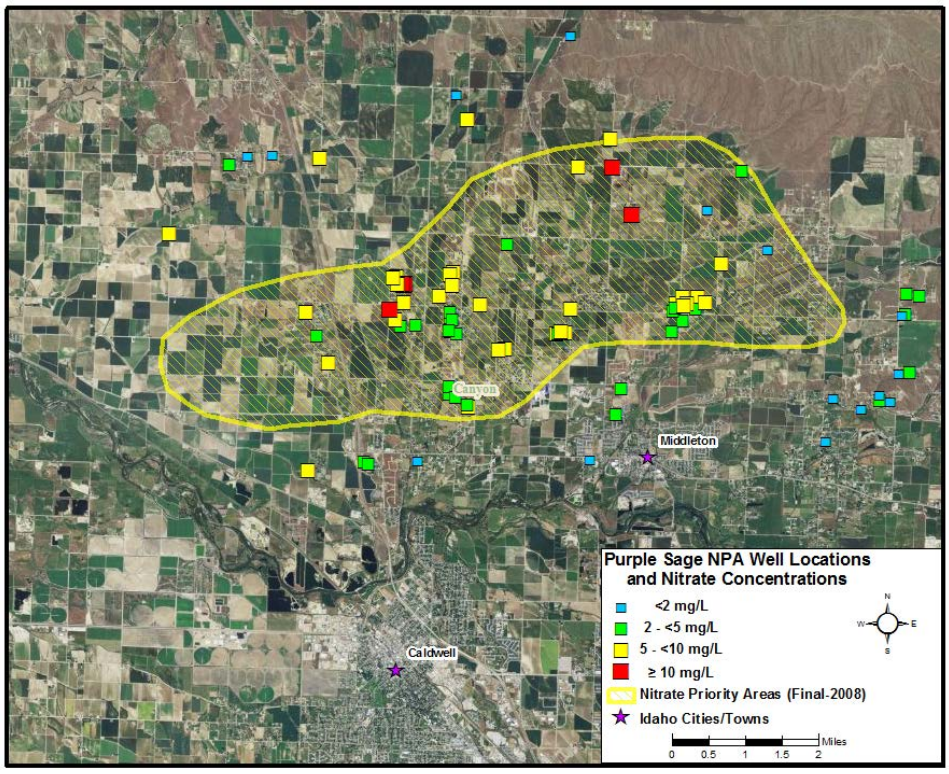


Figure 6. Private domestic drinking water well sample locations and nitrate concentrations—Purple Sage Nitrate Priority Area Ground Water Monitoring Project.

Arsenic Results

The reported arsenic concentrations ranged from <2 µg/L to 24 µg/L; 13 of the 88 wells sampled exceeded the arsenic MCL of 10 µg/L (2114, 2115, 2116, 2124, 2136, 2140, 2150, 2000, 2156, 2157, 2165, 2169, and 2170).

Chloride Results

Reported chloride concentrations ranged from 0.55 mg/L to 56.0 mg/L. EPA set the National Secondary Drinking Water Regulations standard for chloride at 250 mg/L, based on aesthetic effects. All reported chloride concentrations were below this standard.

Sulfate Results

Reported sulfate concentrations ranged from 2.7 mg/L to 150 mg/L. EPA set the National Secondary Drinking Water Regulations standard for sulfate at 250 mg/L, based on aesthetic effects. All reported sulfate concentrations were below this standard.

Uranium Results

Uranium exceedances were reported by IBL for 9 of the 88 wells sampled in 2013. The reported uranium concentrations ranged from 32 µg/L to 59 µg/L (Table 6).

Total Coliform Results

The reported total coliform bacteria concentrations ranged from <1 MPN/100 mL to 8.4 MPN/100 mL; 5 of the 88 wells sampled were positive for total coliform (2128, 2148, 2161, 2167, and 2188). All 88 wells were negative for *E. coli*.

Nitrogen Isotope Results

Nitrogen isotope ratios, denoted as $\delta^{15}N$, can be helpful in determining the potential sources of nitrate in the ground water. Nitrogen isotope ratios were determined for all samples with nitrate concentrations greater than or equal to 5 mg/L (Table 6). Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 4 (Seiler 1996).

The $\delta^{15}N$ results from this project ranged from 2.1‰ to 7.9‰. Three of the sample results had lab errors, so the results for wells 2138, 2139, and 2141 were not included in this study.

Fifteen wells (2186, 2117, 2119, 2127, 2128, 2183, 2137, 2142, 2143, 2189, 2145, 2146, 2179, 2184, and 2168) had $\delta^{15}N$ values of 2.1‰ through 4.0‰, indicating the source of nitrates in the ground water is most likely from commercial fertilizers (Seiler 1996).

Twenty-four wells (2104, 2113, 2106, 2180, 2108, 2110, 2105, 2114, 2115, 2118, 2120, 2121, 2123, 2124, 2125, 2129, 2130, 2131, 2133, 2152, 2154, 2156, 2164, and 2169) had $\delta^{15}N$ values of 4.0‰ through 7.9‰, indicating the source of nitrates in the ground water is most likely from organic nitrogen in soil or a mixed nitrogen source (Seiler 1996).

Values of greater than 10‰ indicate the source of nitrates in the ground water is most likely from animal or human waste (Seiler 1996). No wells had $\delta^{15}N$ values greater than 10‰.

The Purple Sage NPA project was also used to compare anion results between IBL and the UIASL. Split anion samples were taken from each well with an anion sample and sent to each of the two labs. The results of the lab comparison are provided in Appendix A.

2.1.2.3 Conclusions

The criterion for an NPA is at least 25% of the wells sampled within the area meet or exceed 5 mg/L nitrate. This value is half of the MCL of 10 mg/L. In this project, 41 of the 88 wells sampled had nitrate values of ≥5 mg/L. The nitrate MCL of 10 mg/L was exceeded in 5 samples (2115, 2127, 2128, 2143, and 2179).

The primary land use in the Purple Sage NPA is agricultural. The land is used as cropland, feedlots, and dairies.

The $\delta^{15}N$ results suggest a mixture of nitrate sources, including fertilizer and organic sources such as crop decay (e.g., legume crop plow down). This mixture of nitrogen sources is typical of

an agricultural area. No one point source can be considered the major contributor of nitrates to these sampling sites.

Elevated arsenic values have been identified in this area by various studies (Mitchell 2004; Neely 2002). These exceedances may be due to naturally occurring arsenic in the geology of this area, specifically the granitic sediments found in the valley and many other areas in the western Snake River Plain (Baldwin and Wicherski 1994; Neely 2002).

An analysis of the anion results received from the two labs indicated the results compared favorably.

2.1.2.4 Recommendations

Due to the many sources that contribute to the high nitrate levels in the Purple Sage NPA, an action that can be taken at this time is public education.

DEQ recommends that property owners with private domestic drinking water wells sample their well, prior to any water treatment system and as close to the well as possible, on an annual basis. DEQ suggests that well water be tested for bacteria, arsenic, and nitrate. Southwest District Health can provide Canyon County property owners with information and guidance.

In addition, property owners may benefit from education on the use of commercial fertilizers and pesticides on their lawns and gardens and education on proper maintenance of their wells and septic systems.

DEQ is in the process of assisting Canyon County in developing and implementing ground water quality improvement and drinking water source protection plans. These plans include outreach activities for private well owners and agricultural operators aimed at reducing source water contamination, including activities to reduce nitrate contamination.

2.1.3 Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project

2.1.3.1 Purpose and Background

This ground water monitoring project was designed to evaluate the water quality and nitrate concentrations in the Ada/Canyon NPA (Figure 7). In 2008, the Ada/Canyon NPA ranked as the second-most impacted NPA in Idaho (DEQ 2008). The original number of wells to be sampled in 2012 was 106 wells. Unfortunately, the temperatures dropped in December and the final six wells had to be sampled in spring (March) 2013. The same six wells were resampled in September 2013 to allow for their use in future trend analysis. This section is an addendum to the 2012 Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project evaluation in the 2012 ground water monitoring summary report (DEQ 2014b). It addresses the March and September 2013 sampling events.

In 2012, DEQ collected ground water samples from 100 domestic or irrigation wells in the Ada/Canyon NPA. In 2013, DEQ sampled the remaining 6 wells. Samples were collected using procedures outlined in the QAPP (DEQ 2011b). Program objectives, design, and well selection processes are identified in the *Regional Ground Water Monitoring Network Design* (DEQ 2011a). DEQ analyzed the ground water samples for common water quality analytes including

nitrate, bacteria, selected metals, phosphate, sulfate, and ammonia to assess the water quality in the project area.

Ada and Canyon Counties are located within the western section of the Snake River plain geologic province. The western Snake River plain is a downdropped fault-block basin, with normal (vertical) north-northwest trending faults along the margins of the basin. The basin is filled with rhyolite ash, basalt lava flows, and sediments that eroded off the surrounding hills or were deposited by streams or into lakes. Stream and lake sediments in the basin include volcanic ash, clay, silt, sand, and gravel (Newton 1991).

Many wells in the Ada/Canyon NPA produce water from relatively shallow sand and gravel aquifers. A layer of blue clay often underlies these upper aquifers; the clay acts as a barrier to downward ground water movement and separates the shallow aquifers from deeper aquifers located within and below the clay layer (Newton 1991).

For the Ada/Canyon NPA project, DEQ staff reviewed IDWR well logs of wells in the project area to assess the lithology of the subsurface. The review indicated the blue clay layer is located approximately 25–500 feet bgs in the area of the Ada/Canyon NPA. Wells selected for sampling for this project were completed at depths of 450 feet or less.

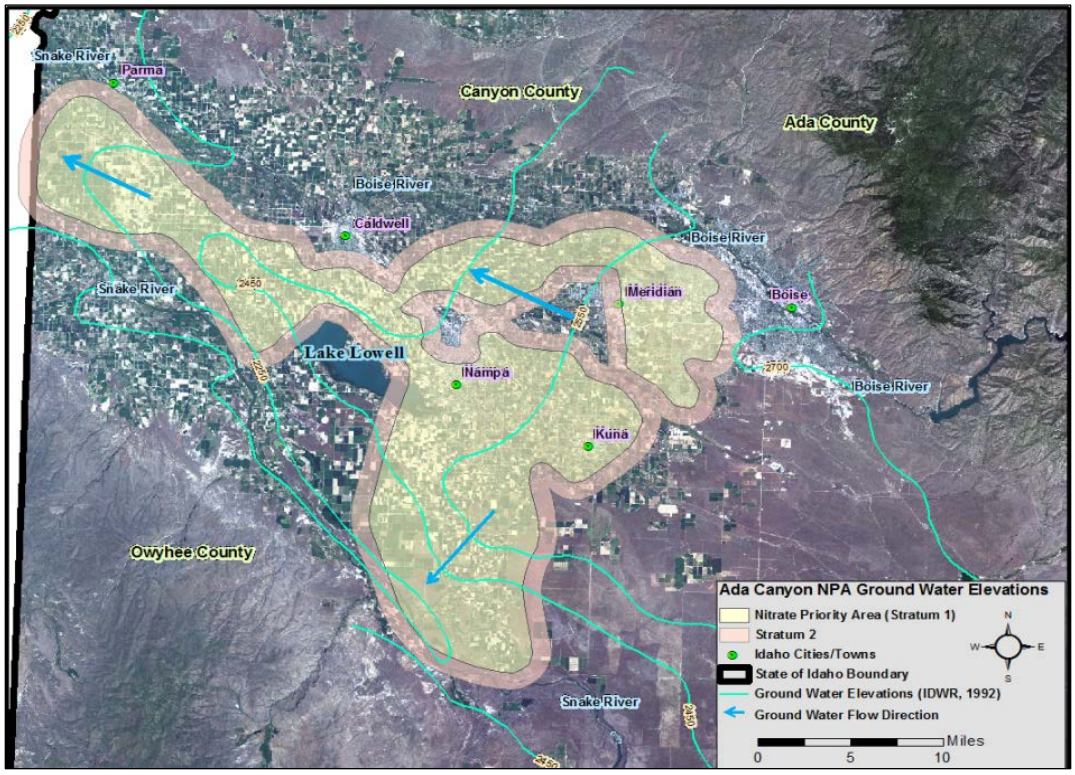


Figure 7. Ada/Canyon Nitrate Priority Area showing Stratum 1, Stratum 2, and general ground water flow directions.

2.1.3.2 Methods and Results

The regional network design (DEQ 2011a) was used to calculate a sampling unit size of one section (one square mile). A statistical process, developed for DEQ by Dr. Kirk Steinhorst of the

University of Idaho, was used to determine the number of samples needed in Stratum 1 (the area of the NPA) and Stratum 2 (a 1-mile wide buffer area surrounding Stratum 1) to ensure the sampling event was statistically valid (Figure 7) (Steinhorst 2011).

It was calculated that 54 wells located in Stratum 1 and 52 wells in Stratum 2 would need to be sampled to meet a 90% statistical confidence level that the estimated mean of nitrate is within 15% of the true mean. The total number of sections in Stratum 1 and the total number of sections in Stratum 2 were randomized separately to determine which sections would be sampled. Wells in each randomized section were chosen in accordance with the regional network design. DEQ reviewed available IDWR well logs for wells in the sections, selected wells, and requested permission from the well owners to sample. During the selection process, preference was given to wells screened within the shallow aquifer. DEQ received permission to sample 106 wells within the Ada/Canyon NPA.

DEQ collected ground water samples from 100 of the selected wells from September through December 2012 (DEQ 2014b). The remaining 6 wells were sampled in March and again in September 2013 in accordance with the QAPP (DEQ 2011b) and the FSP (DEQ 2013a). DEQ's field staff measured water quality field parameters of pH, temperature, specific conductance, turbidity, and DO prior to sample collection (Table 7).

Table 7. March and September 2013 water quality field parameters—Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
2076	75	3/14/2013	14.1	564	6.8	0	*6.3*
		9/18/2013	14.2	581	6.95	10	7.50
2077	87	3/14/2013	15.9	560	9.4	7	6.5
		9/18/2013	15.9	535	7.50	9	6.91
2078	90	3/14/2013	14.4	1110	7.1	1	6.5
		9/18/2013	15.0	116	7.07	10	7.22
2079	100	3/14/2013	14.5	450	9.1	4	*6.3*
		9/18/2013	15.1	487	8.28	10	7.72
2080	79	3/14/2013	14.2	586	3.7	0	6.5
		9/18/2013	14.5	652	3.78	10	7.46
2081	160	3/14/2014	16.9	1200	7.8	1	6.5
		9/18/2013	17.5	130	8.15	8	6.69

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; NTU = nephelometric turbidity unit
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5-8.5. NSDWR standards are recommended limits for public water systems and are used with private wells to evaluate water quality. Italicized red numbers indicate the NSDWR standard was exceeded.

The ground water samples were delivered to the analytical laboratories identified in the FSP. The laboratories analyzed the samples for arsenic; anions (bromide, chloride, fluoride, nitrate, nitrite, orthophosphate, and sulfate); and bacteria (total coliform and *E. coli*). Arsenic and bacteria

samples were submitted to IBL in Boise. Anion and ammonia samples were submitted to the UIASL in Moscow, Idaho.

During the time period of the Ada/Canyon NPA sampling, the IBL was analyzing ground water samples for uranium for an auxiliary state project and analyzed the Ada/Canyon NPA samples for uranium. The IBL reported uranium concentrations in the DEQ samples only if the concentrations exceeded the EPA MCL of 30 µg/L.

Selected samples were analyzed for nitrogen isotopes by the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson. Samples for nitrogen isotope analysis were collected from all project wells, frozen, and stored at DEQ pending nitrate analysis. If nitrate was detected at a concentration of 5 mg/L or greater in the analysis performed by the University of Idaho, the frozen sample was shipped to the University of Arizona for analysis.

Table 8 summarizes the analytical results for nitrate, nitrite, ammonia, orthophosphate, sulfate, uranium, arsenic, bromide, chloride, and fluoride. The analytical results for total coliform, *E. coli*, and nitrogen isotopes are discussed below.

Nitrate Results

Nitrate concentrations ranged from 1.9 mg/L to 21 mg/L. Nitrate concentrations were ≥5 mg/L in 4 of the 6 wells for both the March and September sampling events; nitrate concentrations at 1 well exceeded the MCL of 10 mg/L (Table 8). Figure 8 shows the nitrate concentration results from the 106 wells sampled during 2012 and 2013.

Arsenic Results

Arsenic concentrations ranged from 3.4 µg/L to 65 µg/L. The drinking water MCL for arsenic is 10 µg/L, and 5 of the 6 wells exceeded the MCL.

Chloride Results

Detections of chloride in the ground water samples ranged from 3.1 mg/L to 70 mg/L. The EPA SMCL for chloride is 250 mg/L. Chloride was not detected in the 6 wells at concentrations greater than the SMCL.

Ammonia Results

Ammonia in ground water is often associated with impacts from sewage systems, livestock wastes, or nitrogen fertilizers. None of the 6 wells had samples with DO concentrations less than 2 mg/L; therefore, none of the samples from March or September were analyzed for ammonia.

Sulfate Results

Concentrations of sulfate ranged from 17 mg/L to 190 mg/L. The SMCL for sulfate is 250 mg/L; none of the 6 wells had results exceeding the SMCL.

Uranium Results

Uranium exceedances were reported by IBL for 4 of the 6 wells sampled in 2013. The reported uranium concentrations ranged from 32 µg/L to 41 µg/L (Table 8).

Table 8. Inorganic results—Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project, September 2013 completion.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations											Bacteria	
			Arsenic[a] (µg/L)	Uranium[a] (µg/L)	Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Orthophosphate	Sulfate[b]	Ammonia	Nitrate[a]	$\delta^{15}N$ (‰)	Total Coliform	E. coli[a]
					(mg/L)									(MPN/100 mL)	
Standard:			***10***	***30***	***4***	***250***	***1***	***NA***	***NA***	***250***	***NA***	***10***	***NA***	***1 cfu/100 mL[c]***	***<1 cfu/100 mL[c]***
2076	75	3/14/2013	**19**	—	1.1	3.8	<0.050	<0.10	<0.10	18	—	3.4	—	4.1	<1
		9/18/2013	**19**	—	1.0	3.1	<0.050	<0.10	<0.10	17	—	3.1	—	3.1	<1
2077	87	3/14/2013	**30**	**33**	0.77	14	<0.050	<0.10	0.15	62	—	9.5	—	<1	<1
		9/18/2013	**29**	—	0.78	11	<0.050	<0.10	<0.10	29	—	6.2	4.5	<1	<1
2078	90	3/14/2013	**20**	**33**	0.80	70	<0.050	0.33	<0.10	180	—	7.3	—	<1	<1
		9/18/2013	**18**	—	0.42	62	<0.050	0.33	<0.10	170	—	7.2	4.5	<1	<1
2079	100	3/14/2013	**16**	—	0.62	19	<0.050	<0.10	<0.10	59	—	1.9	—	<1	<1
		9/18/2013	**21**	—	0.63	4.3	<0.050	<0.10	<0.10	31	—	2.9	—	<1	<1
2080	79	3/14/2013	3.4	**34**	0.46	13	<0.050	<0.1	<0.10	64	—	7.2	—	<1	<1
		9/18/2013	4.0	**35**	0.40	14	<0.050	<0.1	<0.10	63	—	7.8	3.6	<1	<1
2081	160	3/14/2013	**59**	**32**	0.56	51	<0.050	0.40	<0.10	190	—	**21**	—	68.3	<1
		9/18/2013	**65**	**41**	0.38	50	<0.050	0.40	<0.10	190	—	**21**	1.3	24.3	<1

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was met or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; mg/L = milligrams per liter; $\delta^{15}N$ = nitrogen isotope; ‰ = per mil; MPN/100 mL = most probable number per 100 milliliters; NA = not applicable; cfu = colony-forming unit; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.
[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

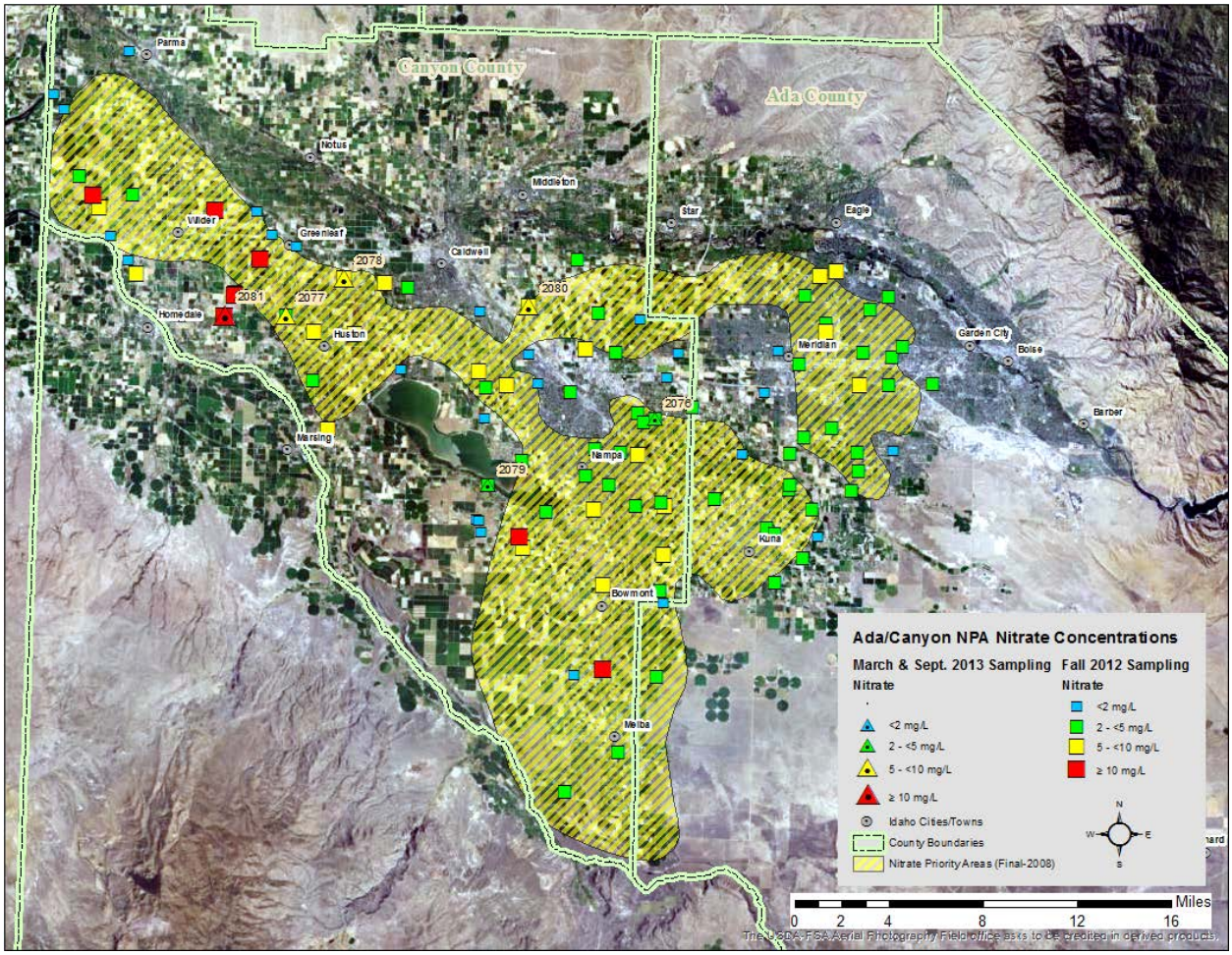


Figure 8. Well locations and nitrate concentrations—Ada/Canyon Nitrate Priority Area, 2012 and 2013 samples.

Bacteria Results

Coliform bacteria include bacteria that are common in the environment (e.g., soil and ground water affected by surface water) and in the waste of warm-blooded animals. Bacteria is used as an indicator of the sanitary conditions of a water supply and potential impacts from human or animal waste. *E. coli* is a member of the coliform group, and detections of *E. coli* in ground water are an indication of potential contamination by animal or human waste. *E. coli* numbers greater than one indicate a human or animal waste impact to ground water.

Of the 6 Ada/Canyon NPA ground water wells sampled in 2013, 2 wells reported positive results for total coliform, with values ranging from 3.1 to 68.3 MPN/100 mL. The two wells with detections had detections in both March and September. None of the 6 wells tested positive for *E. coli* (Table 8).

Nitrogen Isotope Results

Nitrogen isotope ratio analysis was performed on all September samples with nitrate detected at greater than 5 mg/L; 4 of the 6 September samples were submitted for analysis. The $\delta^{15}N$ values for the Ada/Canyon NPA ground water samples ranged from 1.3‰ to 4.5‰. Samples from 2

wells had $\delta^{15}N$ values ranging from +1.3‰ to +3.6‰, indicating commercial fertilizer as the likely nitrate source; 2 samples had $\delta^{15}N$ values of 4.5‰, indicating organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source (Table 4).

2.1.3.3 Conclusions

DEQ conducted a ground water monitoring project in the Ada/Canyon NPA to assess nitrate concentrations and evaluate ground water quality. The Ada/Canyon NPA is identified as an area of nitrate impact to ground water based on ground water sampling performed by various state agencies. The Ada/Canyon NPA ground water monitoring project included using regional network design to calculate the size of the sampling unit for the NPA; using a statistical model developed for DEQ nitrate sampling projects to determine the number of samples needed to be statistically valid; reviewing IDWR well logs to identify wells likely sourced in shallow ground water; selecting potential wells to be sampled; contacting well owners for approval to collect water samples; collecting samples using procedures outlined in the FSP; and conducting laboratory analyses of the collected samples.

Nitrate was detected at a concentration of 5 mg/L or greater in 4 of the 6 wells (for both March and September sampling events). Nitrate was detected at a concentration equal to or greater than the MCL of 10 mg/L in 1 of the wells (well 2081). The results of the nitrate isotope analyses indicated the nitrate source for the four wells with nitrate concentrations of greater than 5 mg/L in September was from fertilizer or a mixed source (organic source and/or fertilizer). The results of the nitrate isotope analyses indicated that the elevated nitrate concentrations were not from a human or animal waste source. A review of the well locations and concentrations of nitrate in the ground water samples does not indicate a point source for the nitrate.

Coliform bacteria were detected in 2 of the 6 wells sampled in March and September (Table 8). *E. coli* was not detected in any of the ground water samples, indicating ground water at the sampled wells had not been impacted by human or animal wastes.

Arsenic was detected at a concentration greater than the MCL of 10 µg/L in 5 wells for both the March and September sampling events. Previous studies (Mitchell 2004; Neely 2002) have identified elevated arsenic values in this area and in other areas of the western Snake River Plain (Baldwin and Wicherski 1994; Neely 2002). The elevated concentrations of arsenic in ground water may be due to naturally occurring arsenic in the granitic sediments found in the area of the Ada/Canyon NPA.

2.1.3.4 Recommendations

The ground water quality data for the Ada/Canyon NPA identified apparent nonpoint source nitrate impacts to ground water in the study area. The data also indicate that the source of the nitrate is likely from multiple sources of nitrate.

DEQ recommends that property owners with private domestic drinking water wells sample their wells—prior to any water treatment system and as close to the well as possible—on an annual basis for bacteria, arsenic, and nitrate. Southwest District Health and the Central District Health Department can provide property owners with information and guidance.

DEQ is currently assisting Ada and Canyon Counties in developing and implementing ground water quality improvement and drinking water source protection plans. These plans include outreach activities for private well owners and agricultural operators aimed at reducing source water contamination, including activities to reduce nitrate contamination.

2.1.4 City of Payette Gas Field Ground Water Monitoring Project

2.1.4.1 Purpose and Background

Production quantities of natural gas have been discovered in southwestern Idaho. Two gas fields have been identified in Payette County: the Hamilton Field underlies the area surrounding the city of New Plymouth, while the Willow Field underlies the foothills northeast of New Plymouth. All wells are east or southeast of the city of Payette. The effects of gas field development on the environment in Idaho are unknown, and a baseline ground water study in the Hamilton Field area was performed in November 2012 to document ground water quality information prior to proposed gas field development. Updates to this study for 2013 are presented in section 2.1.5. Gas field development includes, but is not limited to, the drilling of gas wells and drilling-related activities, treatment of gas wells to increase production (e.g., hydraulic fracturing), and gas production and other production-related activities. The City of Payette requested and funded the sampling of its municipal wells after the gas wells had been drilled but before production began and asked that the results be included in the baseline study.

The City of Payette Gas Field Ground Water Monitoring Project was designed to provide baseline ground water quality data for the City of Payette municipal wells. The City of Payette is downgradient from 13 proposed gas wells; 12 of the 13 wells have already been drilled.

Payette is located in southwest Idaho, adjacent to the Payette River and approximately 1 mile east of the Snake River. The confluence of the Payette and Snake Rivers is approximately 1 mile northwest of Payette. The town is located on the relatively flat floodplains of the Snake and Payette Rivers. Land use in the area surrounding Payette is generally agricultural.

The city wells sampled for the project are completed at depths ranging from 125 to 270 feet. The IDWR well logs indicate the subsurface in the immediate Payette area consists of interbedded layers of gravel, sand, silt, and clay from the surface to a depth of at least 270 feet. Based on the logs, aquifers consisting of coarser-grained material (sand and gravel) supply ground water to the municipal wells; the aquifers are generally at depths ranging from approximately 130 to 270 feet. The general regional ground water flow direction in Payette County is south-southwest toward the Snake River and locally toward the Payette River. Figure 9 shows ground water elevation contours (IDWR 1992) and the estimated ground water flow directions in the Payette area.

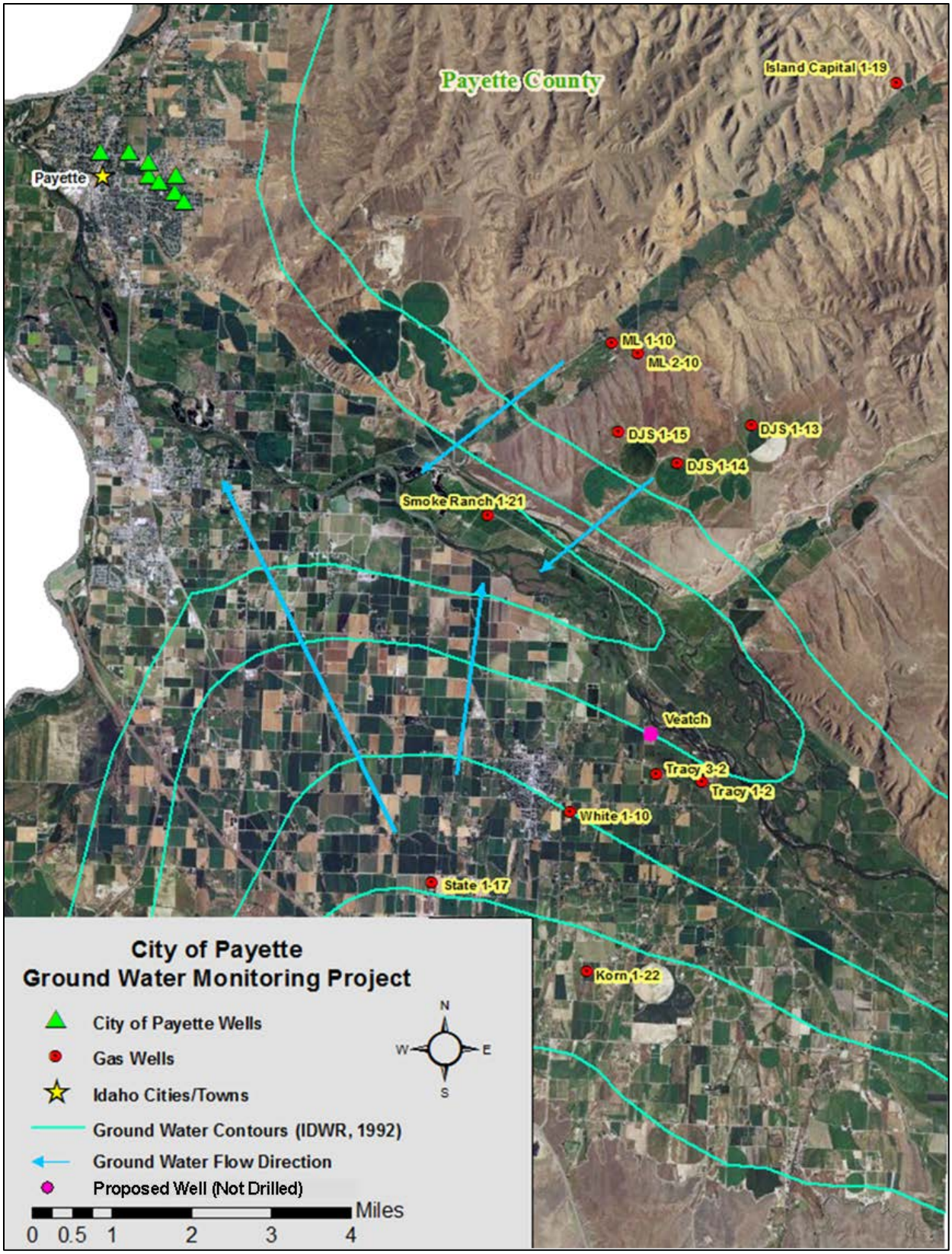


Figure 9. Location of Payette County gas fields production wells, City of Payette municipal wells, ground water contours, and ground water flow direction.

2.1.4.2 Methods and Results

Well Selection and Sampling Process

DEQ received permission to collect samples from the eight active City of Payette wells. The City of Payette provided well logs for each of the eight wells. Figure 9 shows the locations of the gas wells and City of Payette wells.

On September 25, 2013, DEQ collected water samples from the wells using procedures outlined in the QAPP (DEQ 2012b) and FSP (DEQ 2013a). Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each well prior to sample collection (Table 9). Samples were collected prior to treatment equipment.

The water samples were delivered to four analytical laboratories using procedures outlined in the FSP. The UIASL in Moscow, Idaho, analyzed the samples for common ions (fluoride, nitrite, nitrate, chloride, sulfate, bromide, and orthophosphate) (Table 10); total dissolved solids (TDS) and alkalinity (Table 11); metals (arsenic, barium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, sodium, uranium, vanadium, and zinc) (Table 12 and Table 13); dissolved methane; benzene, toluene, ethylbenzene, and xylenes (BTEX); and total petroleum hydrocarbons (TPH) (Table 14). The UIASL subcontracted the dissolved methane analysis to Accutest Laboratories in Wheat Ridge, Colorado, and the BTEX and TPH analysis to Anatek Labs, Inc., in Moscow. IBL in Boise analyzed the samples for total coliform and *E. coli* (Table 11).

Table 9. Water quality field parameters—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements			
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH[a]
2234	198	9/25/2013	15.7	781	3.46	7.60
2235	194	9/25/2013	16.5	960	0.08	7.74
2237	228	9/25/2013	16.0	1100	0.00	7.94
2236	270	9/25/2013	17.0	459	0.02	8.30
2238	213	9/25/2013	16.6	405	0.00	8.15
2239	125	9/25/2013	15.3	518	3.68	7.79
2240	230	9/25/2013	16.5	606	2.04	8.25
2241	210	9/25/2013	15.5	598	5.77	8.03

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5-8.5.

Table 10. Common ion results—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic Concentrations						
			Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Ortho-phosphate	Sulfate[b]	Nitrate[a]
			(mg/L)						
Standard:			***4***	***250***	***1***	***NA***	***NA***	***250***	***10***
2234	198	9/25/2013	0.22	18	<0.05	<0.10	<0.10	35	1.8
2235	194	9/25/2013	0.38	47	<0.05	0.30	0.30	110	0.086
2237	228	9/25/2013	0.31	70	<0.05	0.30	0.40	160	<0.10
2236	270	9/25/2013	0.24	9.0	<0.05	<0.10	0.21	35	<0.05
2238	213	9/25/2013	0.27	8.3	<0.05	<0.10	0.68	32	<0.05
2239	125	9/25/2013	0.32	9.2	<0.05	<0.10	<0.10	44	0.32
2240	230	9/25/2013	0.22	12	<0.05	<0.10	<0.10	37	<0.05
2241	210	9/25/2013	0.22	14	<0.05	<0.10	<0.10	41	<0.05

Notes: mg/L = milligrams per liter; NA = not applicable
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.

Table 11. Bacteria, total dissolved solids, and alkalinity results—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria		Other	
			Total Coliform	*E. coli*[a]	Total Dissolved Solids[b]	Alkalinity (as $CaCO_3$)
			(MPN/100 mL)		mg/L	
Standard:			***1 cfu/100 mL***[c]	***<1 cfu/100 mL***[c]	***500***	***NA***
2234	198	9/25/2013	<1	<1	*510*	390
2235	194	9/25/2013	<1	<1	*590*	340
2237	228	9/25/2013	<1	<1	*690*	370
2236	270	9/25/2013	<1	<1	300	210
2238	213	9/25/2013	<1	<1	280	190
2239	125	9/25/2013	<1	<1	340	240
2240	230	9/25/2013	<1	<1	390	290
2241	210	9/25/2013	<1	<1	390	290

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded.
mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; cfu = colony-forming unit; $CaCO_3$ = calcium carbonate; NA = not applicable
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.
[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

Table 12. Metals results—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Cadmium[a]	Chromium[a]	Lead[a]	Nickel	Selenium[a]	Uranium[a]
						(µg/L)			
Standard:			***10***	***5***	***100***	***15***	***NA***	***50***	***30***
2234	198	9/25/2013	**16**	<0.10	0.76	0.20	<2.5	0.76	8.3
2235	194	9/25/2013	**17**	<0.10	<0.50	0.34	<2.5	<0.10	1.4
2237	228	9/25/2013	4.1	<0.10	<0.50	0.20	<2.5	<0.10	<0.25
2236	270	9/25/2013	0.54	<0.10	<0.50	0.36	<2.5	<0.10	<0.25
2238	213	9/25/2013	2.9	<0.10	<0.50	0.39	<2.5	<0.10	<0.25
2239	125	9/25/2013	3.0	<0.10	<0.50	0.68	<2.5	<0.10	1.7
2240	230	9/25/2013	2.9	<0.10	<0.50	0.63	<2.5	<0.10	<0.25
2241	210	9/25/2013	2.0	<0.10	<0.50	0.61	<2.5	<0.10	<0.25

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded.
µg/L = micrograms per liter; NA = not applicable
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Table 13. Additional metals results—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Barium[a] (mg/L)	Boron (µg/L)	Calcium (mg/L)	Cobalt (µg/L)	Copper[a] (mg/L)	Iron[b] (mg/L)	Magnes-ium (mg/L)	Mangan-ese[b] (mg/L)	Molyb-denum (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Vana-dium (µg/L)	Zinc[b] (mg/L)
Standard:			***2***	***NA***	***NA***	***NA***	***1.3***	***0.3***	***NA***	***0.05***	***NA***	***NA***	***NA***	***NA***	***5***
2234	198	9/25/2013	0.037	0.23	74	<0.01	<0.02	0.10	23	0.018	<0.10	6.6	79	0.013	<0.02
2235	194	9/25/2013	0.043	0.23	78	<0.01	<0.02	*0.42*	32	*0.28*	<0.10	7.2	76	<0.01	<0.02
2237	228	9/25/2013	0.019	0.22	88	<0.01	<0.02	*0.66*	35	*0.33*	<0.10	5.4	95	<0.01	<0.02
2236	270	9/25/2013	<0.01	0.15	40	<0.01	<0.02	0.10	16	*0.082*	<0.10	3.0	38	<0.01	<0.02
2238	213	9/25/2013	<0.01	0.19	39	<0.01	<0.02	0.13	15	*0.12*	<0.10	2.6	28	<0.01	<0.02
2239	125	9/25/2013	<0.01	0.20	52	<0.01	<0.02	<0.10	20	*0.18*	<0.10	6.2	30	<0.01	<0.02
2240	230	9/25/2013	0.011	0.23	50	<0.01	<0.02	0.16	20	*0.20*	<0.10	4.5	58	<0.01	<0.02
2241	210	9/25/2013	0.023	0.24	52	<0.01	<0.02	0.22	21	*0.14*	<0.10	4.7	56	<0.01	<0.02

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded.
mg/L = milligrams per liter; NA = not applicable
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.

Table 14. BTEX, TPH, and methane results—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Benzene[a]	Toluene[a]	Ethylbenzene[a]	m+p-xylene[a]	O-xylene[a]	TPH			Methane
								Gasoline	Lube	Diesel	
			(µg/L)					(mg/L)			
Standard:			***5***	***1000***	***700***	***10,000***	***10,000***	***NA***	***NA***	***NA***	***NA***
2234	198	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.00051
2235	194	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0046
2237	228	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0034
2236	270	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0034
2238	213	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.00056
2239	125	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0017
2240	230	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0022
2241	210	9/25/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.107

Notes: µg/L = micrograms per liter; mg/L = milligrams per liter; NA = not applicable
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Total Dissolved Solids Results

Concentrations of TDS ranged from 280 mg/L to 690 mg/L. The SMCL for TDS is 500 mg/L; 3 of the 8 ground water samples had results that exceeded the SMCL (Table 11).

Arsenic Results

The reported arsenic concentrations ranged from 0.54 µg/L to 17 µg/L; two wells (2234 and 2235) exceeded the arsenic MCL of 10 µg/L (Table 12). Elevated arsenic values have been identified in this area by various studies (Baldwin and Wicherski 1994; Neely 2002; Mitchell 2004). Elevated arsenic values were also found in this area when samples were collected by DEQ for the Lower Payette NPA in 2011 (DEQ 2013h). These exceedances may be due to naturally occurring arsenic in the granitic sediments found in the lower Payette River valley (Neely 2002).

Uranium Results

The reported uranium concentrations ranged from not detected (<0.25 µg/L) to 8.3 µg/L (Table 12). No wells exceeded the uranium MCL of 30 µg/L.

Iron Results

The reported iron concentrations ranged from <0.10 to 0.66 mg/L. The SMCL for iron is 0.3 mg/L; 2 of the 8 wells had results that exceeded the SMCL (Table 13).

Manganese Results

The reported manganese concentrations ranged from 0.018 mg/L to 0.33 mg/L. The SMCL for manganese is 0.05 mg/L; 7 of the 8 wells had results that exceeded the SMCL (Table 13).

Hydrocarbon Results

Benzene, ethylbenzene, xylene, toluene, and TPH were not detected in any of the wells that were sampled. Methane was detected in all eight wells and ranged from 0.00051 mg/L to 0.107 mg/L (Table 14). An MCL for methane does not exist. The hazard with methane in water is when dissolved methane moves from ground water into the atmosphere, where it can potentially ignite, or if it accumulates in a confined space where it can explode. The US Department of the Interior, Office of Surface Mining (Eltschlager et al. 2001), advises well owners with dissolved methane levels greater than 28 mg/L to immediately remove any potential ignition sources and vent the gas away from any confined spaces. The reported concentrations of methane in samples collected from City of Payette wells were significantly below 28 mg/L.

2.1.4.3 Conclusions

The City of Payette is downgradient from 13 proposed gas; 12 of the 13 wells have already been drilled. The City of Payette Gas Field Ground Water Monitoring Project was designed to provide baseline ground water quality data for the City of Payette municipal wells. Ground water samples from some of the wells contained elements in excess of safe drinking water MCLs. However, the water samples were taken from an untreated tap, prior to the water entering a treatment system. The City of Payette has treatment in place to ensure the water served to customers does not exceed the MCLs.

Methane concentrations of 0.00051 mg/L to 0.107 mg/L were detected in samples from all of the wells sampled. The suggested action level for methane is 28 mg/L.

2.1.4.4 Recommendations

Additional ground water quality monitoring should be conducted annually to evaluate variations in ground water quality after gas production begins.

2.1.5 Hamilton Gas Field Ground Water Monitoring Project

2.1.5.1 Purpose and Background

Production quantities of gas have been discovered in southwestern Idaho. Two gas fields have been identified in Payette County: the Hamilton Field and the Willow Field. The Hamilton Field underlies the area surrounding the town of New Plymouth, while the Willow Field underlies the foothills northeast of New Plymouth. The effects of gas field development on ground water quality in this area of Idaho are unknown.

The Hamilton Gas Field Ground Water Monitoring Project was designed to provide ground water quality data in the area surrounding six proposed gas wells. In November 2012, a ground water monitoring network was created from 16 selected residential wells and municipal wells from the New Plymouth PWS to document existing ground water quality near the six proposed gas wells. It is DEQ's intent to continue to sample these sixteen wells periodically during gas production and possibly after closure of the gas wells. Two additional rounds of ground water sampling in the Hamilton Field area were conducted to document additional ground water quality information. The same network wells were sampled in August 2013 and December 2013 to evaluate seasonal and annual variations in ground water quality and to document changes in ground water conditions as the gas production activities began. Although six gas wells were originally proposed, only five had been drilled by December 2013. Production is scheduled to start once the pipeline is finished.

2.1.5.2 Methods and Results

DEQ received permission to collect samples from the same 12 residential wells and 4 City of New Plymouth wells sampled during the November 2012 baseline study. Figure 10 shows the locations of the gas wells, residential wells, and PWS wells.

DEQ reviewed the IDWR online database to identify well logs for the wells selected for the network. Additional information was gathered from the owners of the residential wells after the baseline sampling event. Well logs were located for 8 of the residential wells and the 4 PWS wells. Well logs were not available for 4 of the 12 residential wells.

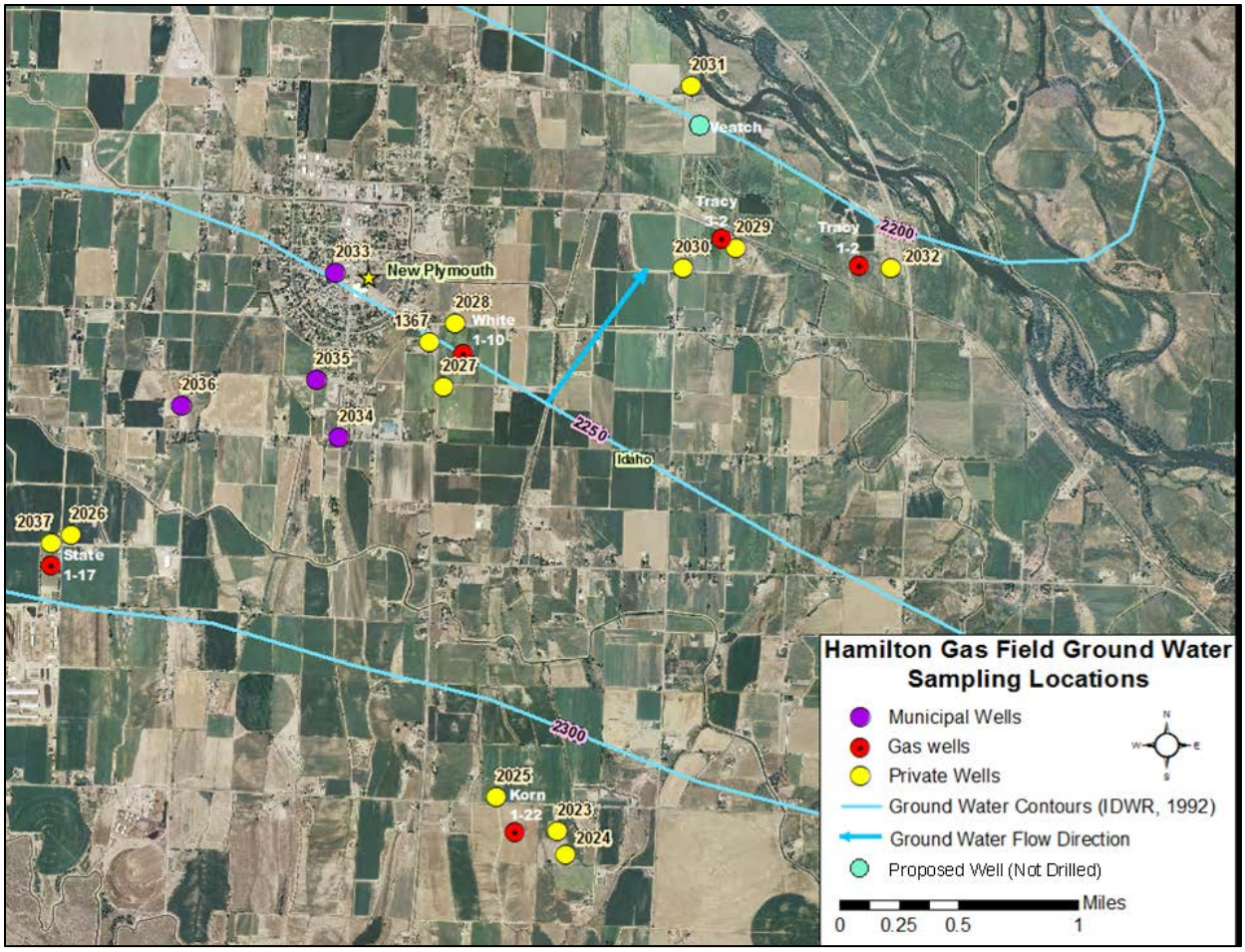


Figure 10. Location of Hamilton Gas Fields production wells, sampling network wells (private and municipal), and DEQ site IDs—Hamilton Gas Field Ground Water Monitoring Project.

On August 19 and 20 and December 2 and 3, 2013, DEQ collected water samples from the network wells using procedures outlined in the QAPP (DEQ 2012b) and FSP (DEQ 2012a). Water quality field parameters (pH, temperature, specific conductivity, turbidity, and DO) were measured at each well prior to sample collection (Table 15). Field measurements are used to monitor well water during purging to ensure water in the wellbore is removed from the well prior to sampling. When field parameters stabilize, samples are considered to be representative of ground water in the aquifer. Field measurements are also used to qualitatively evaluate water quality variability between wells.

The water samples were delivered to four analytical laboratories using procedures outlined in the FSP. The UIASL in Moscow analyzed the samples for common ions (fluoride, nitrite, nitrate, chloride, sulfate, bromide, and orthophosphate) (Table 16); TDS and alkalinity (Table 17); metals (arsenic, barium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, sodium, uranium, vanadium, and zinc) (Table 18 and Table 19); dissolved methane; BTEX; and for TPH (Table 20). The UIASL subcontracted the dissolved methane analysis to Accutest Laboratories in Wheat Ridge, Colorado, and the BTEX and TPH analysis to Anatek Labs, Inc., in Moscow. IBL in Boise, Idaho, analyzed the samples for total coliform and *E. coli* (Table 17).

Table 15. Water quality field parameters—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements				
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH[a]
August 2013 Sampling							
1367	38	08/19/2013	15.2	439	0.19	0	7.69
2023	129	08/19/2013	15.6	806	8.01	44	7.34
2024	145	08/19/2013	15.8	762	7.62	116	7.39
2025	—	08/19/2013	16.2	637	5.41	105	7.19
2026	150	08/19/2013	16.4	188	0.02	14	8.43
2027	—	08/19/2013	15.1	524	6.42	0	7.85
2028	44	08/19/2013	15.6	670	5.62	0	7.54
2029	45.5	08/19/2013	15.3	405	3.27	5	7.47
2030	—	08/19/2013	15.4	497	6.17	0	7.41
2031	204	08/20/2013	15.7	176	0.01	0	8.00
2032	—	08/20/2013	14.3	174	0.01	0	*8.90*
2033	78	08/20/2013	15.0	533	6.18	0	7.76
2034	100	08/20/2013	14.5	433	7.59	0	7.82
2035	80	08/20/2013	14.4	570	5.53	0	7.74
2036	216	08/20/2013	16.2	144	3.75	0	*8.79*
2037	101	08/20/2013	15.2	668	4.30	2	7.37
December 2013 Sampling							
1367	38	12/02/2013	14.0	370	1.10	—	—
2023	129	12/02/2013	15.4	795	7.20	44	8.49
2024	145	12/02/2013	15.5	782	7.56	116	8.48
2025	—	12/02/2013	15.0	670	6.30	10	8.3
2026	150	12/02/2013	15.0	400	0.10	—	—
2027	—	12/02/2013	14.0	340	5.20	—	—
2028	44	12/02/2013	13.0	520	5.70	—	—
2029	45.5	12/02/2013	16.0	410	5.60	—	—
2030	—	12/02/2013	16.0	390	5.30	—	—
2031	204	12/02/2013	16.0	160	—	—	—
2032	—	12/02/2013	14.0	150	—	—	—
2033	78	12/03/2013	15.0	520	5.70	—	7.8
2034	100	12/03/2013	14.0	470	4.50	—	7.8
2035	80	12/03/2013	14.0	610	5.70	—	7.8
2036	216	12/03/2013	16.0	140	3.60	—	*9.0*
2037	101	12/03/2013	15.0	680	5.00	—	7.5

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; NTU = nephelometric turbidity unit; (—) = data are unavailable or were not analyzed

[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5-8.5. Italicized red numbers indicate EPA's NSDWR standard was reached or exceeded. NSDWR standards are recommended limits for public water systems and are used with private wells to evaluate water quality.

Table 16. Common ions—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic Concentrations						
			Fluoride[a]	Chloride[b]	Nitrite[a]	Bromide	Ortho-phosphate	Sulfate[b]	Nitrate[a]
			(mg/L)						
Standard:			***4***	***250***	***1***	***NA***	***NA***	***250***	***10***
August 2013 Sampling									
1367	38	08/19/2013	0.19	27	<0.05	0.12	<0.10	51	0.49
2023	129	08/19/2013	0.19	28	<0.05	0.17	<0.10	79	4.7
2024	145	08/19/2013	0.26	22	<0.05	0.14	<0.10	65	4.4
2025	—	08/19/2013	0.17	36	<0.05	0.22	<0.10	76	2.2
2026	150	08/19/2013	0.28	20	<0.05	<0.10	<0.10	12	<0.05
2027	—	08/19/2013	0.33	7.7	<0.05	<0.10	<0.10	7.5	3.3
2028	44	08/19/2013	0.39	7.2	<0.05	<0.10	<0.10	66	8.5
2029	45.5	08/19/2013	0.61	2.6	<0.05	<0.10	0.10	6.4	1.8
2030	—	08/19/2013	0.49	5.0	<0.05	<0.10	<0.10	11	2.2
2031	204	08/20/2013	0.59	1.5	<0.05	<0.10	<0.10	<0.20	<0.05
2032	—	08/20/2013	0.33	3.3	<0.05	<0.10	<0.10	8.4	<0.05
2033	78	08/20/2013	0.34	11	<0.05	<0.10	<0.10	32	3.3
2034	100	08/20/2013	0.42	5.6	<0.05	<0.10	<0.10	18	2.3
2035	80	08/20/2013	0.15	19	<0.05	<0.10	<0.1	45	2.4
2036	216	08/20/2013	0.34	3.1	<0.05	<0.10	<0.10	5.9	<0.05
2037	101	08/20/2013	0.42	37	<0.05	0.24	<0.10	86	1.7
December 2013 Sampling									
1367	38	12/02/2013	0.22	27	<0.050	0.12	<0.10	48	0.37
2023	129	12/02/2013	0.40	26	<0.050	0.16	<0.10	72	4.6
2024	145	12/02/2013	0.42	20	<0.050	0.12	<0.10	62	4.4
2025	—	12/02/2013	0.25	36	<0.050	0.40	<0.10	74	2.2
2026	150	12/02/2013	0.19	36	<0.050	0.19	<0.10	56	<0.050
2027	—	12/02/2013	0.42	7.1	<0.050	<0.10	0.11	5.9	2.2
2028	44	12/02/2013	0.33	6.7	<0.050	<0.10	<0.10	33	6.3
2029	45.5	12/02/2013	0.56	3.1	<0.050	<0.10	0.13	7.0	2.2
2030	—	12/02/2013	0.43	4.5	<0.050	<0.10	0.12	14	2.3
2031	204	12/02/2013	0.52	1.6	<0.050	<0.10	0.11	<0.2	<0.050
2032	—	12/02/2013	0.32	3.4	<0.050	<0.10	<0.10	8.5	<0.050
2033	78	12/03/2013	0.21	13	<0.050	<0.10	<0.10	31	3.1
2034	100	12/03/2013	0.30	5.3	<0.050	<0.10	<0.10	17	2.0
2035	80	12/03/2013	0.27	21	<0.050	0.12	0.12	47	2.6
2036	216	12/03/2013	0.40	2.0	<0.050	<0.10	<0.10	5.7	<0.050
2037	101	12/03/2013	0.57	38	<0.050	0.22	<0.10	84	1.8

Notes: mg/L = milligrams per liter; NA = not applicable; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.

Table 17. Bacteria, total dissolved solids, and alkalinity results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria		Other	
			Total Coliform	*E. coli*[a]	Total Dissolved Solids[b]	Alkalinity (as $CaCO_3$)
			(MPN/100 mL)		(mg/L)	
***Standard*:**			***1 cfu/100 mL***[c]	***<1 cfu/100 mL***[c]	***500***	***NA***
August 2013 Sampling						
1367	38	08/19/2013	<1	<1	310	150
2023	129	08/19/2013	<1	<1	*570*	310
2024	145	08/19/2013	<1	<1	*540*	310
2025	—	08/19/2013	<1	<1	460	230
2026	150	08/19/2013	<1	<1	150	79
2027	—	08/19/2013	<1	<1	360	240
2028	44	08/19/2013	1	<1	490	290
2029	45.5	08/19/2013	<1	<1	300	220
2030	—	08/19/2013	15.6	<1	340	270
2031	204	08/20/2013	<1	<1	176	100
2032	—	08/20/2013	<1	<1	130	91
2033	78	08/20/2013	<1	<1	380	260
2034	100	08/20/2013	<1	<1	420	230
2035	80	08/20/2013	<1	<1	420	270
2036	216	08/20/2013	<1	<1	120	75
2037	101	08/20/2013	<1	<1	470	230
December 2013 Sampling						
1367	38	12/02/2013	<1	—	300	150
2023	129	12/02/2013	<1	—	490	340
2024	145	12/02/2013	<1	—	*520*	350
2025	—	12/02/2013	<1	—	440	240
2026	150	12/02/2013	<1	—	110	280
2027	—	12/02/2013	<1	—	270	200
2028	44	12/02/2013	<1	—	370	280
2029	45.5	12/02/2013	<1	—	290	260
2030	—	12/02/2013	<1	—	270	230
2031	204	12/02/2013	<1	—	76	100
2032	—	12/02/2013	1	<1	160	90
2033	78	12/03/2013	<1	—	360	260
2034	100	12/03/2013	<1	—	310	240
2035	80	12/03/2013	<1	—	410	260

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria		Other	
			Total Coliform	*E. coli* [a]	Total Dissolved Solids[b]	Alkalinity (as $CaCO_3$)
			(MPN/100 mL)		(mg/L)	
***Standard*:**			***1 cfu/100 mL*[c]**	***<1 cfu/100 mL*[c]**	***500***	***NA***
2036	216	12/03/2013	<1	—	130	75
2037	101	12/03/2013	1	<1	420	230

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; $CaCO_3$ = calcium carbonate; cfu = colony-forming unit; NA = not applicable; (—) = data are unavailable or were not analyzed

[a] Contaminant with a National Primary Drinking Water Regulation standard.

[b] Contaminant with a National Secondary Drinking Water Regulation standard.

[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

Table 18. Metals results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Cadmium[a]	Chromium[a]	Lead[a]	Nickel	Selenium[a]	Uranium[a]
						(µg/L)			
Standard:			***10***	***5***	***100***	***15***	***NA***	***50***	***30***
August 2013 Sampling									
1367	38	08/19/2013	7.2	<0.10	<0.50	<3.0	<2.5	0.22	6.5
2023	129	08/19/2013	8.1	0.12	0.65	<3.0	<2.5	1.3	**37**
2024	145	08/19/2013	8.6	<0.10	1.1	<3.0	<2.5	1.0	28
2025	—	08/19/2013	6.1	<0.10	1.1	<3.0	<2.5	1.7	**31**
2026	150	08/19/2013	1.2	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2027	—	08/19/2013	**16**	0.10	0.77	<3.0	<2.5	0.23	7.0
2028	44	08/19/2013	**19**	<0.10	1.3	<3.0	<2.5	0.67	13
2029	45.5	08/19/2013	**12**	<0.10	0.61	<3.0	<2.5	0.14	4.7
2030	—	08/19/2013	**11**	<0.10	0.84	<3.0	<2.5	0.23	7.3
2031	204	08/20/2013	<0.10	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2032	—	08/20/2013	0.80	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2033	78	08/20/2013	9.2	0.16	0.83	<3.0	<2.5	0.46	9.5
2034	100	08/20/2013	**13**	<0.10	0.53	<3.0	<2.5	0.34	6.7
2035	80	08/20/2013	9.3	<0.10	0.68	<3.0	<2.5	0.65	13
2036	216	08/20/2013	1.7	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2037	101	08/20/2013	7.2	<0.10	<0.50	<3.0	<2.5	2.2	16
December 2013 Sampling									
1367	38	12/02/2013	6.9	<0.1	<0.5	<3.0	<2.5	0.18	7.3
2023	129	12/02/2013	8.0	<0.1	1.0	<3.0	<2.5	1.2	**39**
2024	145	12/02/2013	7.9	<0.1	0.94	<3.0	<2.5	0.87	**31**
2025	—	12/02/2013	6.3	<0.1	1.3	<3.0	<2.5	1.6	**40**
2026	150	12/02/2013	2.6	<0.1	<0.5	<3.0	<2.5	<0.1	<0.25
2027	—	12/02/2013	**16**	<0.1	0.59	<3.0	<2.5	0.20	4.0
2028	44	12/02/2013	**18**	0.20	1.2	5.2	<2.5	0.44	12
2029	45.5	12/02/2013	**13**	<0.1	0.91	<3.0	<2.5	0.24	9.1

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Cadmium[a]	Chromium[a]	Lead[a]	Nickel	Selenium[a]	Uranium[a]
						(µg/L)			
Standard:			***10***	***5***	***100***	***15***	***NA***	***50***	***30***
2030	—	12/02/2013	**11**	0.13	0.71	3.5	<2.5	0.23	6.1
2031	204	12/02/2013	<0.10	<0.1	<0.5	<3.0	<2.5	<0.1	<0.25
2032	—	12/02/2013	0.72	0.26	<0.5	**16**	<2.5	<0.1	<0.25
2033	78	12/03/2013	7.7	<0.1	0.72	<3.0	<2.5	0.42	10
2034	100	12/03/2013	**12**	<0.1	<0.5	<3.0	<2.5	0.27	7.6
2035	80	12/03/2013	8.7	<0.1	0.64	<3.0	<2.5	0.61	14
2036	216	12/03/2013	1.7	<0.1	<0.5	<3.0	<2.5	<0.1	<0.25
2037	101	12/03/2013	7.1	<0.1	0.84	<3.0	<2.5	2.2	20

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; NA = not applicable; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Table 19. Additional metals results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Barium[a] (mg/L)	Boron (µg/L)	Calcium (mg/L)	Cobalt (µg/L)	Copper[a] (mg/L)	Iron[b] (mg/L)	Magnesium (mg/L)	Manganese[b] (mg/L)	Molyb-denum (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Vanadium (µg/L)	Zinc[b] (mg/L)
Standard:			***2***	***NA***	***NA***	***NA***	***1.3***	***0.3***	***NA***	***0.05***	***NA***	***NA***	***NA***	***NA***	***5***
August 2013 Sampling															
1367	38	08/19/2013	0.081	0.28	27	<0.01	<0.02	<0.10	8.2	*0.10*	<0.10	2.0	29	<0.010	0.056
2023	129	08/19/2013	0.070	0.34	85	<0.01	<0.02	0.19	17	<0.005	<0.10	3.1	79	0.014	0.038
2024	145	08/19/2013	0.065	0.32	74	<0.01	<0.02	<0.10	15	<0.005	<0.10	2.8	82	<0.010	0.038
2025	—	08/19/2013	0.12	0.25	80	<0.01	<0.02	<0.10	15	<0.005	<0.10	3.0	43	0.012	0.073
2026	150	08/19/2013	0.011	0.23	20	<0.01	<0.02	0.18	0.62	*0.062*	<0.10	1.3	20	<0.010	0.037
2027	—	08/19/2013	0.070	0.28	62	<0.01	<0.02	<0.10	24	<0.005	<0.10	3.0	21	0.047	0.077
2028	44	08/19/2013	0.083	0.37	80	<0.01	<0.02	<0.10	24	<0.005	<0.10	2.5	35	0.042	0.036
2029	45.5	08/19/2013	0.042	0.21	45	<0.01	<0.02	<0.10	18	<0.005	<0.10	2.0	21	0.043	0.034
2030	—	08/19/2013	0.068	0.26	58	<0.01	<0.02	<0.10	22	<0.005	<0.10	1.6	23	42	0.033
2031	204	08/20/2013	0.024	0.21	9.8	<0.01	<0.02	<0.10	2.7	*0.13*	<0.10	1.9	28	<0.010	0.044
2032	—	08/20/2013	0.014	0.20	7.1	<0.01	<0.02	<0.10	0.69	0.026	<0.10	<1.0	35	<0.010	0.040
2033	78	08/20/2013	0.051	0.30	54	<0.01	<0.02	<0.10	12	<0.005	<0.10	2.5	54	0.022	0.042
2034	100	08/20/2013	0.040	0.21	47	<0.01	<0.02	<0.10	15	<0.005	<0.10	2.7	33	0.045	0.026

DEQ Site ID	Well Depth (feet)	Sample Date	Barium[a] (mg/L)	Boron (µg/L)	Calcium (mg/L)	Cobalt (µg/L)	Copper[a] (mg/L)	Iron[b] (mg/L)	Magnesium (mg/L)	Manganese[b] (mg/L)	Molyb-denum (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Vanadium (µg/L)	Zinc[b] (mg/L)
Standard:			***2***	***NA***	***NA***	***NA***	***1.3***	***0.3***	***NA***	***0.05***	***NA***	***NA***	***NA***	***NA***	***5***
2035	80	08/20/2013	0.064	0.33	65	<0.01	<0.02	<0.10	14	<0.005	<0.10	3.9	51	0.021	0.037
2036	216	08/20/2013	<0.010	0.25	7.6	<0.01	<0.02	<0.10	0.18	0.016	<0.10	<1.0	27	<0.010	0.037
2037	101	08/20/2013	0.056	0.29	63	<0.01	<0.02	<0.10	9.8	<0.005	<0.10	2.2	75	<0.010	0.040
December 2013 Sampling															
1367	38	12/02/2013	0.081	0.21	52	<0.01	<0.02	<0.1	8.6	*0.11*	<0.1	2.0	30	<0.010	<0.020
2023	129	12/02/2013	0.070	0.25	87	<0.01	<0.02	<0.1	17	<0.005	<0.1	3.2	94	0.022	<0.020
2024	145	12/02/2013	0.064	0.27	75	<0.01	<0.02	<0.1	15	<0.005	<0.1	2.9	92	0.016	<0.020
2025	—	12/02/2013	0.130	0.23	92	<0.01	<0.02	0.14	18	<0.005	<0.1	3.5	55	0.021	0.045
2026	150	12/02/2013	0.073	0.26	57	<0.01	<0.02	*2.2*	3.1	*0.32*	<0.1	2.8	34	<0.010	<0.020
2027	—	12/02/2013	0.053	0.22	44	<0.01	<0.02	<0.1	19	<0.005	<0.1	2.7	17	0.057	<0.020
2028	44	12/02/2013	0.072	0.26	69	<0.01	<0.02	<0.1	22	<0.005	<0.1	3.1	34	0.053	<0.020
2029	45.5	12/02/2013	0.060	0.18	62	<0.01	<0.02	<0.1	25	<0.005	<0.1	2.6	35	0.060	<0.020
2030	—	12/02/2013	0.063	0.26	55	<0.01	<0.02	<0.1	20	<0.005	<0.1	1.7	26	0.052	<0.020
2031	204	12/02/2013	0.024	0.14	11	<0.01	<0.02	<0.1	2.9	*0.13*	<0.1	2.2	33	<0.010	<0.020
2032	—	12/02/2013	0.014	0.099	7.5	<0.01	<0.02	<0.1	0.72	0.028	<0.1	<1	41	<0.010	<0.020
2033	78	12/03/2013	0.050	0.21	49	<0.01	<0.02	0.12	12	<0.005	<0.1	2.6	54	0.024	<0.020
2034	100	12/03/2013	0.042	0.19	51	<0.01	<0.02	<0.1	17	<0.005	<0.1	3.4	31	0.053	<0.020
2035	80	12/03/2013	0.066	0.24	63	<0.01	<0.02	<0.1	14	<0.005	<0.1	4.3	51	0.026	<0.020
2036	216	12/03/2013	<0.01	0.20	7.3	<0.01	<0.02	<0.1	0.19	0.015	<0.1	<1	33	<0.010	<0.020
2037	101	12/03/2013	0.066	0.30	64	<0.01	<0.02	<0.1	12	0.0058	<0.1	2.8	81	0.012	<0.020

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
mg/L = milligrams per liter; NA = not applicable; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.

Table 20. BTEX, TPH, and methane results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Benzene[a]	Toluene[a]	Ethylbenzene[a]	m+p-xylene[a]	O-xylene[a]	TPH			Methane
								Gasoline	Lube	Diesel	
			(µg/L)					(mg/L)			
Standard:			***5***	***1000***	***700***	***10,000***	***10,000***	***NA***	***NA***	***NA***	***NA***
August 2013 Sampling											
1367	38	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2023	129	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2024	145	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2025	—	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2026	150	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.00061
2027	—	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2028	44	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2029	45.5	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2030	—	08/19/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2031	204	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0745
2032	—	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0038
2033	78	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2034	100	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2035	80	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2036	216	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0013
2037	101	08/20/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
December 2013 Sampling											
1367	38	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2023	129	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2024	145	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2025	—	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2026	150	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.00042
2027	—	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2028	44	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2029	45.5	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008

DEQ Site ID	Well Depth (feet)	Sample Date	Benzene[a]	Toluene[a]	Ethylbenzene[a]	m+p-xylene[a]	O-xylene[a]	TPH			Methane
								Gasoline	Lube	Diesel	
			(µg/L)					(mg/L)			
Standard:			***5***	***1000***	***700***	***10,000***	***10,000***	***NA***	***NA***	***NA***	***NA***
2030	—	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2031	204	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.173
2032	—	12/02/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0038
2033	78	12/03/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2034	100	12/03/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2035	80	12/03/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008
2036	216	12/03/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	0.0020
2037	101	12/03/2013	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.50	<0.10	<0.0008

Notes: µg/L = micrograms per liter; mg/L = milligrams per liter; NA = not applicable; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Arsenic Results

The reported arsenic concentrations ranged from not detected (<0.1 µg/L) to 19 µg/L; 5 wells exceeded the arsenic MCL of 10 µg/L, but the concentrations remained consistent with baseline sampling conducted in November 2012 (Table 18). Elevated arsenic values have been identified in this area by various studies (Baldwin and Wicherski 1994; Neely 2002; Mitchell 2004). Elevated arsenic values were also found in this area when samples were collected by DEQ for the Lower Payette NPA in 2011 (DEQ 2013h). These exceedances may be due to naturally occurring arsenic in the granitic sediments found in the lower Payette River valley (Neely 2002; Mitchell 2004).

Uranium Results

The reported uranium concentrations ranged from not detected (<0.25 µg/L) to 40 µg/L; 3 wells exceeded the uranium MCL of 30 µg/L during the December 2013 sampling event (2023, 2024, and 2025). The three highest uranium concentrations occurred in the southern portion of the project area (Figure 11).

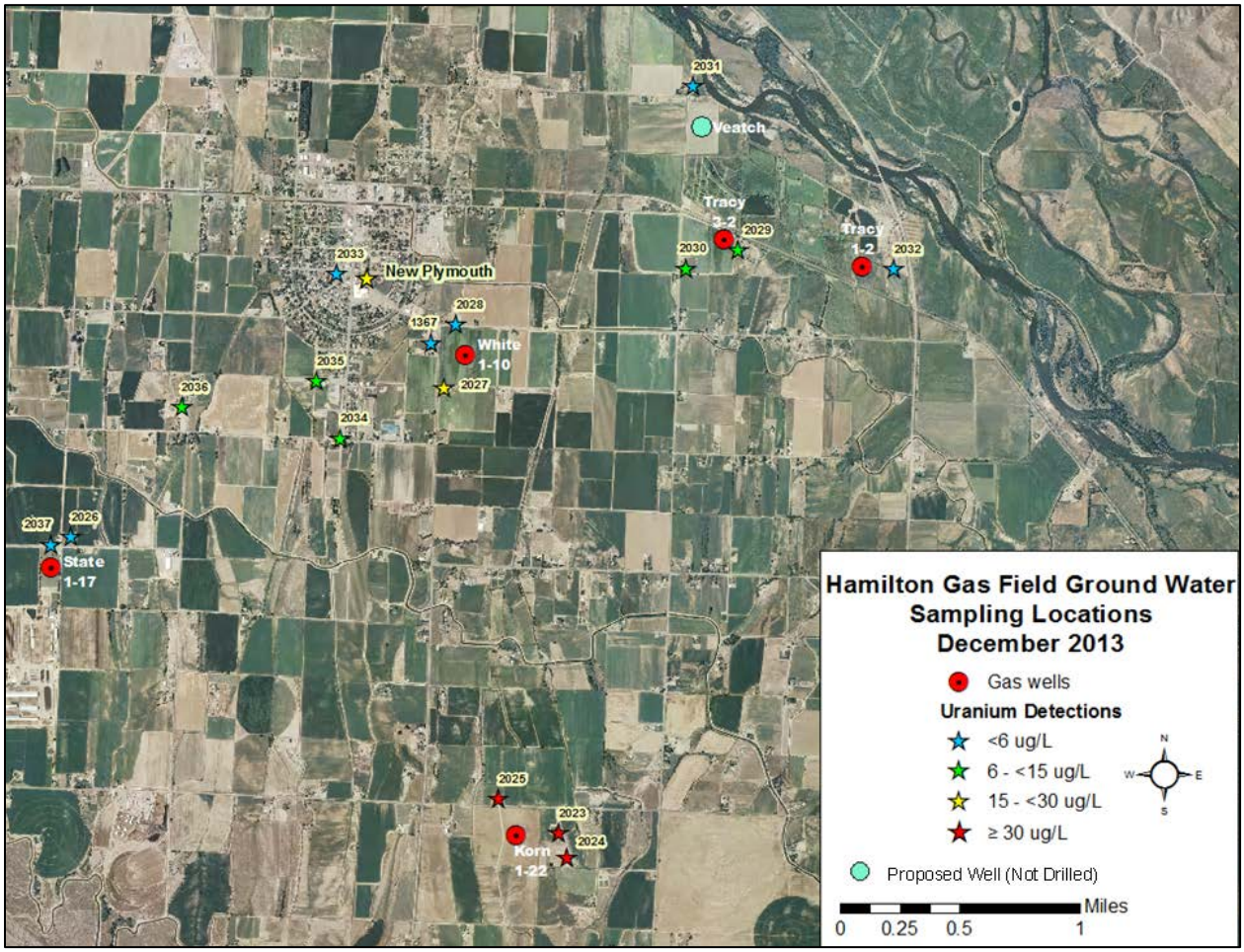


Figure 11. Uranium detections—Hamilton Gas Field Ground Water Monitoring Project, December 2013.

Uranium concentrations in wells 2023, 2024, and 2025 have shown an increasing trend since the initial baseline sampling in November 2012 (Table 21).

Table 21. Uranium sample result trend in wells 2023, 2024, and 2025.

DEQ Site ID	Well Depth (feet)	Uranium (µg/L)[a]		
		11/13/2012	8/19/2013	12/2/2013
Primary Standard:			***30 µg/L***	
2023	129	**32**	**37**	**39**
2024	145	26	28	**31**
2025	—	29	**31**	**40**

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was met or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Lead Results

During the December 2013 sampling event, lead was detected in three wells (2028, 2030, and 2032) (Figure 12). The lead concentrations in well 2032 exceeded the EPA MCL of 15 µg/L (Table 18).

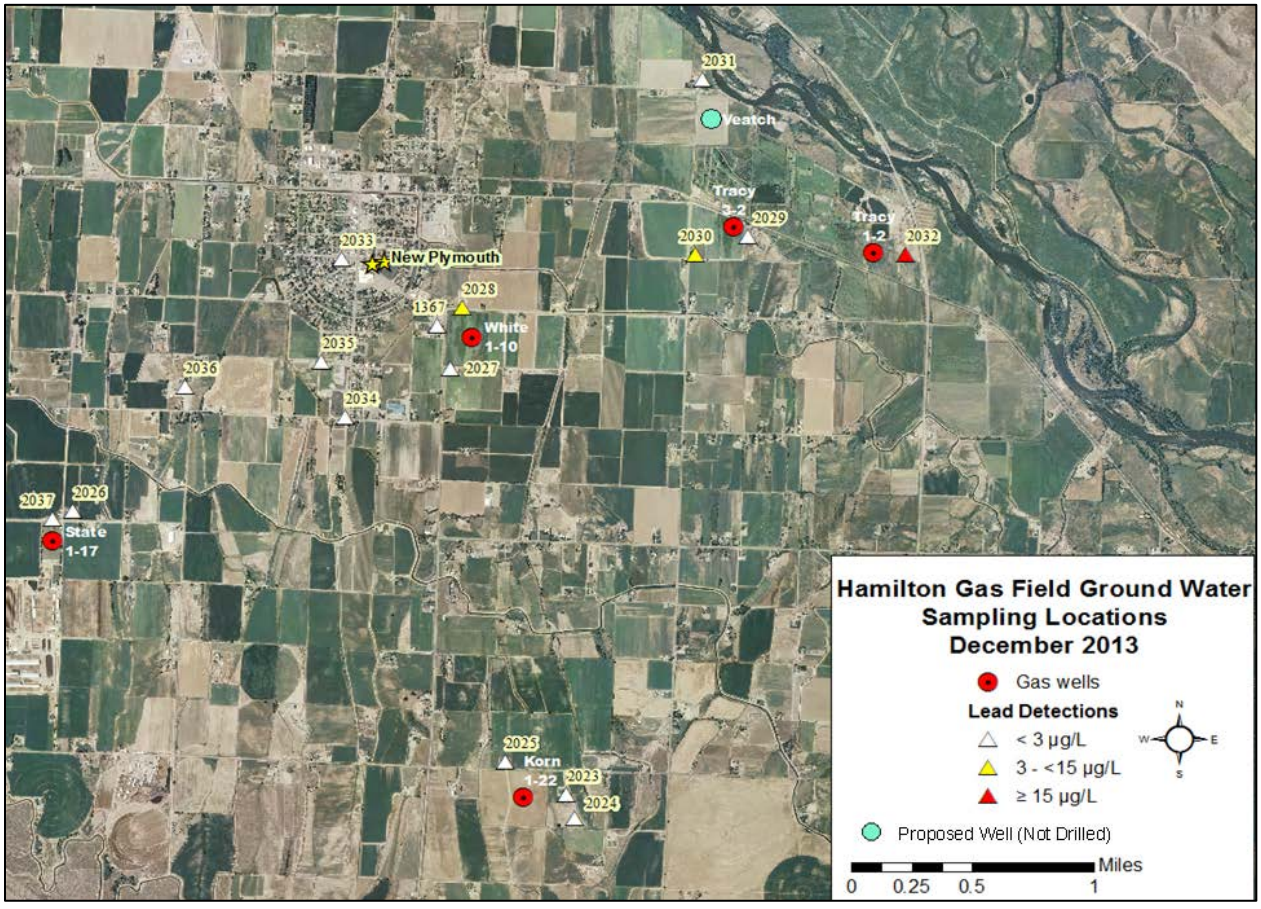


Figure 12. Lead detections—Hamilton Gas Field Ground Water Monitoring Project, December 2013.

Hydrocarbon Results

Benzene, ethylbenzene, toluene, xylene, and TPH were not detected in any wells that were sampled (Table 20). Methane was detected in wells during various sampling events:

- In 2 of 16 wells (2031 and 2036) during the November 2012 baseline sampling event (DEQ 2014b)
- In 4 of 16 wells (2031, 2036, 2026, and 2032) during the August 2013 sampling event (Table 20; Figure 13)
- In 4 of 16 wells (2031, 2036, 2026, and 2032) during the December 2013 sampling event (Table 20; Figure 13)

An MCL for methane does not exist. The hazard with methane in water is when dissolved methane moves from ground water into the atmosphere, where it can potentially ignite, or if it accumulates in a confined space where it can explode. The US Department of the Interior, Office of Surface Mining (Eltschlager et al. 2001), advises well owners with dissolved methane levels greater than 28 mg/L to immediately remove any potential ignition sources and vent the gas away from any confined spaces. Reported methane concentrations in water samples collected from wells 2031, 2036, 2026, and 2032 are significantly below 28 mg/L.

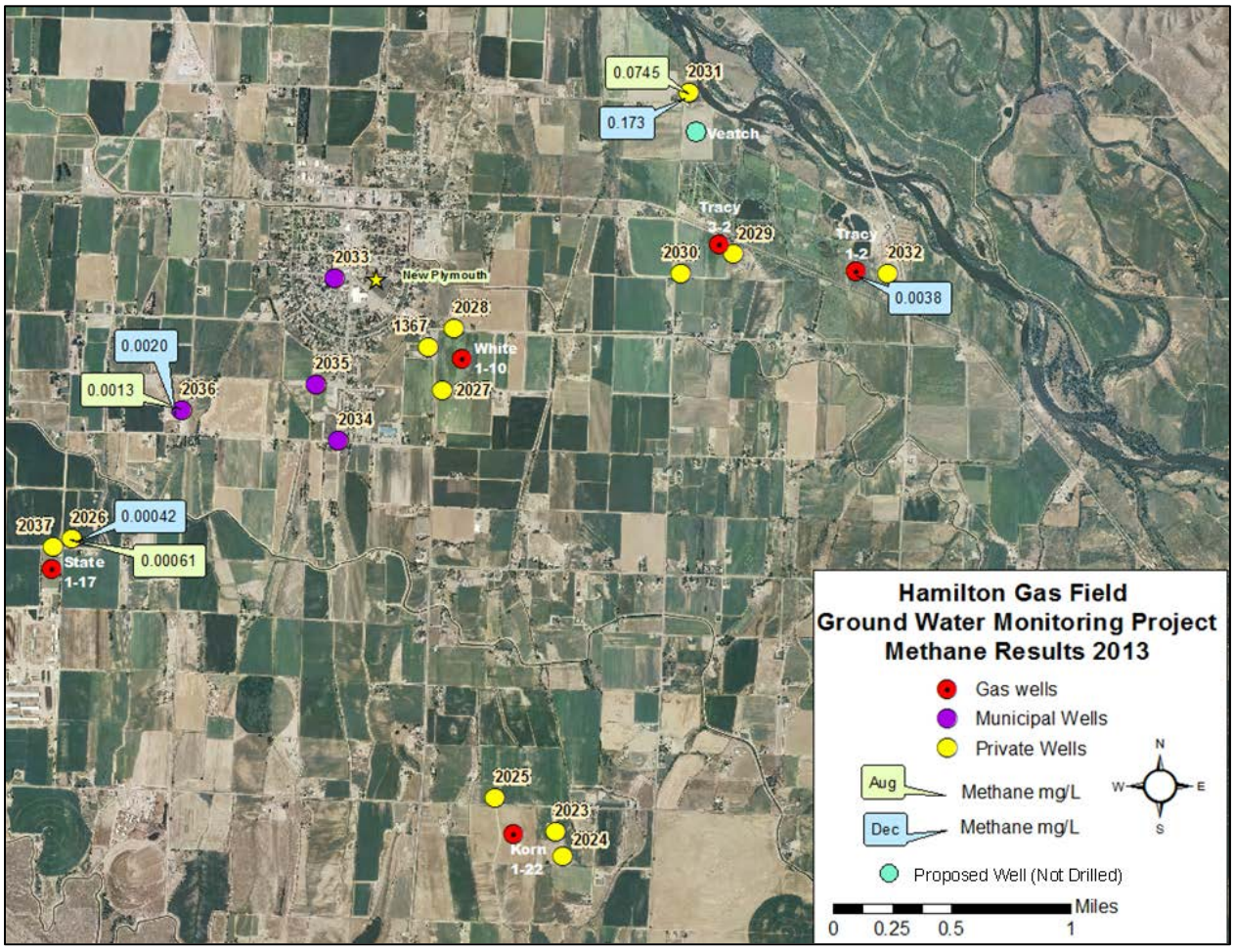


Figure 13. Methane detections—Hamilton Gas Field Ground Water Monitoring Project, 2013.

2.1.5.3 Conclusions

The Hamilton Gas Field Ground Water Monitoring Project was designed to provide background ground water quality data in the area surrounding six proposed gas wells. Additional samples will be taken on a periodic basis in an attempt to determine the effects of drilling and production on ground water.

Ground water samples from 9 of the 16 wells contained elements in excess of safe drinking water MCLs.

- Consistent with baseline sampling, water samples from 5 wells contained arsenic concentrations above the arsenic MCL of 10 µg/L. The arsenic appears to be associated with naturally occurring geologic deposits present in the aquifer.
- Water samples from 3 wells (2023, 2024, and 2025) contained uranium concentrations above the uranium MCL of 30 µg/L. These results are not consistent with the baseline sampling event in November 2012. The three wells in question are within one quarter mile of the "Korn 1-22" gas well.
- Water samples from 3 wells (2028, 2030, and 2032) contained measurable lead in December 2013. Water samples from well 2032 contained a lead concentration above the MCL. These results are not consistent with the baseline sampling event in November 2012. Each of the 3 wells is located within one quarter mile of three separate gas wells.
- Methane was detected in samples from 4 of the 16 wells sampled in August and December 2013. Methane was detected in 2 of the 16 wells during the baseline sampling event in November 2012.

2.1.5.4 Recommendations

Additional ground water quality monitoring should be conducted during different phases of natural gas production to assess potential impacts on ground water quality.

The rising uranium concentrations in the 3 wells located near the "Korn 1-22" gas well, and the appearance of lead in 3 wells as well as the lead MCL exceedance in well 2032, should be closely monitored, and additional ground water chemistry data analysis may be conducted to evaluate potential relationships with water chemistry changes.

2.2 Idaho Falls Region

2.2.1 Teton Basin-Ashton Regional Ground Water Monitoring Project

2.2.1.1 Purpose and Background

The Idaho Falls region has been divided into subareas based on land use and hydrogeologic boundaries to help identify impacts or changes to ambient ground water quality. The process for defining these subareas is described in *Regional Ground Water Monitoring Network Design, Idaho Falls Regional Office* (DEQ 2013e). Definitions for the specific subareas are summarized in *Idaho Falls Regional Office Ambient Ground Water Monitoring Plan Development: Defining Subareas* (DEQ 2013d). The Teton Basin-Ashton, Eastern Snake River Plain, and Mud Lake

subareas have been defined. Sampling for the Teton Basin-Ashton subarea was completed in calendar year 2013. Sampling is planned for the Eastern Snake River Plain subarea in calendar year 2014 and for the Mud Lake subarea in calendar year 2015. With the conclusion of the Mud Lake sampling, a more complete interpretive technical report is planned.

The Teton Basin-Ashton subarea covers 878 square miles of eastern Idaho, consisting primarily of the Teton Basin and portions of the adjacent Henrys Fork of the Snake River/Falls River drainages on the eastern and northern-most portions of the Eastern Snake River Plain, including the Ashton-Drummond NPA. Aquifer materials include alluvium and river sediments intercalated with basalts and rhyolite tuffs related to both the Yellowstone group and Heise Group volcanics. Some areas also include glacial sediments. The Teton Valley ground water system is primarily within stream and glacial deposited sediments, basalts, silicic volcanics, and pre-Tertiary sedimentary rocks (Kilburn 1964). Major sources of recharge are downward percolation of precipitation and snowmelt, runoff from the surrounding uplands, streamflow losses, and direct infiltration of surface water diverted for irrigation (Graham and Campbell 1981).

2.2.1.2 Methods and Results

Sample locations were selected from domestic wells with available well logs. Selection favored more recent wells with complete information concerning well construction, well-bore seals, and lithologic descriptions suggesting that sampled ground water would represent the shallowest aquifer zone. Existing nitrate results from IDWR's Statewide Monitoring Program and from ISDA regional monitoring projects 800 and 805 in the Middle Henrys Fork Basin were used to determine the number of samples needed to estimate the mean nitrate concentration within a 90% confidence interval with a probability value of 0.80. Potential sample sites were selected from randomly identified and ordered 1-mile sections completely within the 878-square mile study area. Sections that included Statewide Monitoring Program or ISDA sites were excluded. Suitable sites within each section were ordered by date of construction and completion depth.

Thirty sections and potential sites were identified. Efforts to identify the current well owner and obtain permission were made. Eventually, 24 sites were sampled, with duplicates for two sites and one set of field blank samples collected (Figure 14). The resulting site selection process yielded sample locations randomly distributed across the subarea. Results from these sites can be combined with results from other sampling networks based on a random site selection to make statistical inferences concerning the distribution of nitrates across the area of interest.

DEQ selected sites and obtained well owner permission during August and September 2013. Sites were sampled during October and November 2013 following the Idaho Falls Regional Office QAPP for regional nitrate monitoring (DEQ 2011c) and the FSP for Teton Basin-Ashton regional monitoring (DEQ 2013i).

For each sample site, field parameters were monitored until temperature, specific conductance, pH, and DO stabilized, indicating the well had been purged as per procedures. Samples were analyzed by IBL in Boise for calcium, sodium, magnesium, potassium, chloride, sulfate, total alkalinity, nitrite plus nitrate, and ammonia. Samples for total coliform and *E. coli* bacteria were analyzed by IAS Environmental in Pocatello. After receiving the major ion chemistry and nutrient results, samples for stable isotope analysis were submitted to Northern Arizona

University–Colorado Plateau Stable Isotope Laboratory (NAU CPSIL) for stable isotopes of nitrogen and oxygen in nitrate ($\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$) and University for Arizona for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O$ and $\delta^{2}H$). Samples were analyzed for ammonia for sites where the DO was low. For the two samples with nitrite plus nitrate less than detection level, the samples intended for $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ analysis were submitted to University of Arizona for analysis of total $\delta^{15}N$. Samples from seven sites were also sent to the US Geological Survey (USGS) Reston Stable Isotope Laboratory (RSIL) in Virginia as an interlaboratory comparison. One sample near the Newdale area was also analyzed by IBL for arsenic.

Results for field parameters are presented in Table 22. Major ion chemistry, nutrients, and bacteria results are presented in Table 23. Stable isotope results are presented in Table 24. Duplicate samples were analyzed for major ion chemistry, nutrients, and stable isotopes, and one set of field blanks was analyzed for major ion chemistry and nutrients. All duplicates and blanks met quality assurance goals.

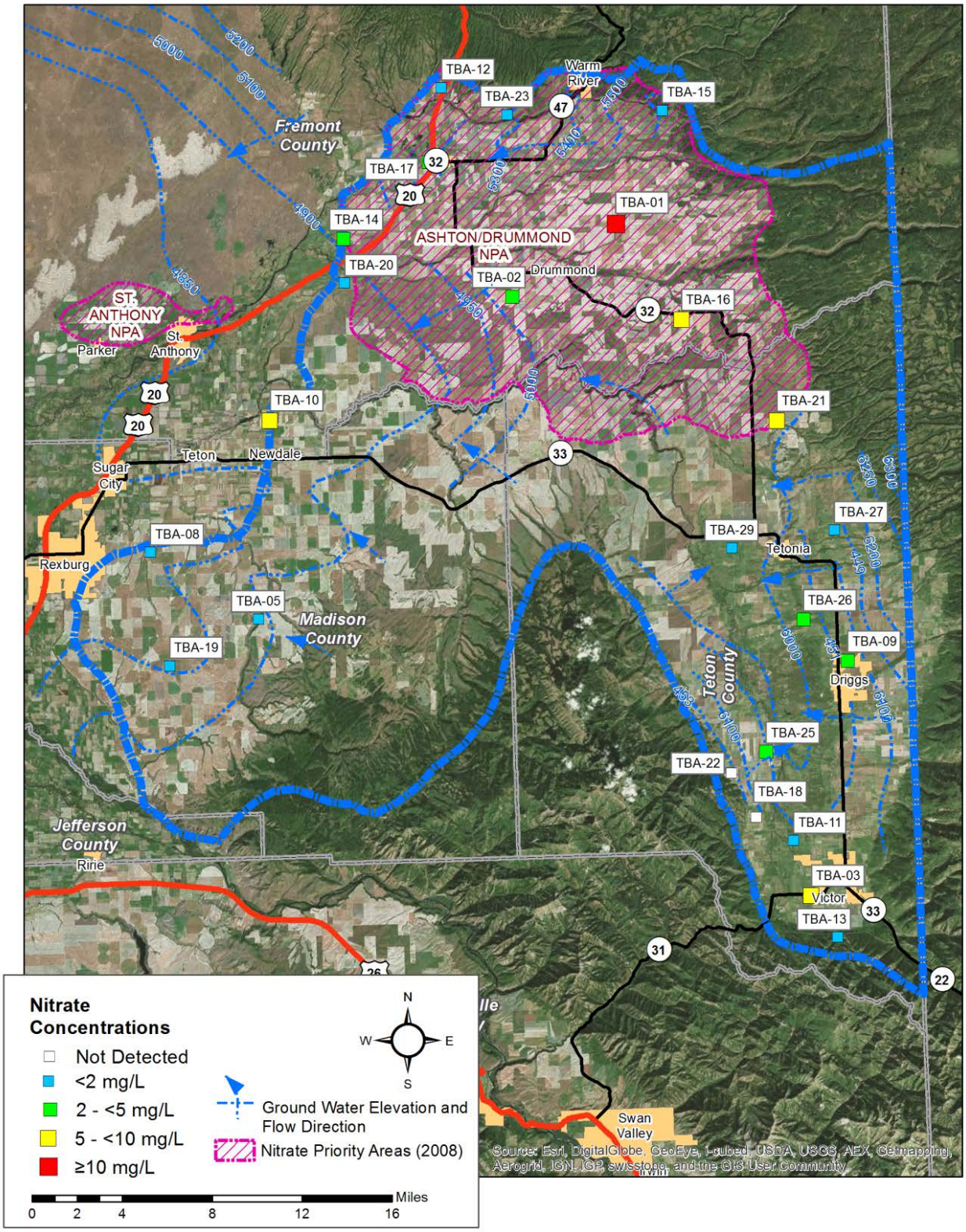


Figure 14. Nitrate concentrations and ground water flow direction—Teton Basin-Ashton Regional Ground Water Monitoring, 2013.

Table 22. Summary of water quality field parameters—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

Project Site ID	Sample Date	Field Measurements			
		Water Temperature (°C)	Specific Conductivity (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
TBA-01	10/23/2013	8.76	605	7.26	9.33
TBA-02	10/23/2013	9.90	430	7.32	8.50
TBA-03	10/24/2013	9.58	495	7.42	9.39
TBA-05	10/17/2013	9.14	249	7.34	9.14
TBA-08	10/17/2013	13.30	415	7.60	8.17
TBA-09	10/24/2013	8.37	278	7.83	9.44
TBA-10	10/17/2013	13.30	528	7.65	8.81
TBA-11	10/28/2013	7.12	349	7.50	6.85
TBA-12	10/23/2013	13.69	129	7.39	8.10
TBA-13	10/28/2013	8.02	393	7.49	7.74
TBA-14	10/17/2013	11.30	349	7.43	6.62
TBA-15	11/04/2013	7.71	504	7.44	2.97
TBA-16	11/25/2013	10.19	474	7.55	7.97
TBA-17	10/23/2013	10.80	342	7.12	5.86
TBA-18	10/28/2013	8.09	419	7.64	0.15
TBA-19	10/17/2013	12.46	282	7.53	7.18
TBA-20	10/23/2013	10.56	235	7.04	6.11
TBA-21	11/25/2013	7.80	549	7.39	8.01
TBA-22	10/28/2013	7.99	506	7.52	2.02
TBA-23	10/23/2013	12.31	221	7.53	1.57
TBA-25	10/28/2013	8.02	460	7.62	8.48
TBA-26	10/24/2013	9.89	353	7.66	8.89
TBA-27	11/04/2013	7.63	391	7.47	6.91
TBA-29	11/04/2013	7.84	343	7.63	4.98

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5-8.5. NSDWR standards are recommended limits for public water systems and are used with private wells to evaluate water quality.

Table 23. Summary of major ion results—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

Project Site ID	Well Depth (feet)	Casing Depth (feet)	Sample Date	Arsenic[a] (µg/L)	Major Ion Concentrations (mg/L)							Nutrient Concentrations		Bacteria	
					Calc-ium	Magnes-ium	Sodium	Potas-sium	Chlo-ride[b]	Sul-fate[b]	Alkalinity (as CaCO3)	Nitrite plus Nitrate[a]	Am-monia	Total Coliform	*E. coli*[a]
												(mg/L)		(MPN/100 mL)	
Standard:				***10***	***NA***	***NA***	***NA***	***NA***	***250***	***250***	***NA***	***10***	***NA***	***1 cfu/ 100 mL[c]***	***<1 cfu/ 100 mL[c]***
TBA-01	205	205	10/23/2013	—	68	34	9.4	2.3	3.77	57.4	225	11	—	<1.0	<1.0
TBA-02	220	199	10/23/2013	—	54	16	14	2.6	14.4	9.89	182	3.6	—	<1.0	<1.0
TBA-03	120	120	10/24/2013	—	81	20	1.9	0.85	3.33	13.1	238	7.4	—	<1.0	<1.0
TBA-05	600	99	10/17/2013	—	34	7.9	5.3	2.8	7.13	3.95	108	1.0	—	11	<1.0
TBA-08	320	222	10/17/2013	—	44	17	18	3.6	23.6	24.8	150	1.0	—	<1.0	<1.0
TBA-09	120	118	10/24/2013	—	44	11	0.78	0.71	0.781	4.31	136	2.3	—	<1.0	<1.0
TBA-10	245	184	10/17/2013	2.3	48	20	36	3.7	21.5	22.2	198	7.0	0.017	<1.0	<1.0
TBA-11	55	50	10/28/2013	—	53	16	1.7	0.8	1.26	7.94	183	0.91	—	4.1	<1.0
TBA-12	245	79	10/23/2013	—	13	3	11	1.2	3.25	2.84	52	0.84	—	<1.0	<1.0
TBA-13	320	160	10/28/2013	—	64	13	2.2	1.1	0.959	28.5	181	0.14	—	<1.0	<1.0
TBA-14	64	60	10/17/2013	—	37	13	18	3.1	8.47	6.2	147	2.6	—	<1.0	<1.0
TBA-15	342	328	11/04/2013	—	67	25	6.7	2.0	1.37	3.2	269	1.3	0.11	<1.0	<1.0
TBA-16	400	150	11/25/2013	—	68	26	9.6	2.8	4.08	6.94	252	7.7	—	<1.0	<1.0
TBA-17	43	29	10/23/2013	—	37	12	20	2.4	10.5	6.81	151	2.1	0.016	1.0	<1.0
TBA-18	120	72	10/28/2013	—	54	16	16	1.6	1.7	6.06	222	<0.005	1.3	<1.0	<1.0
TBA-19	635	55	10/17/2013	—	32	8.8	15	3.8	5.76	5.77	139	0.36	—	1.0	<1.0
TBA-20	105	84	10/23/2013	—	22	5.3	19	2.6	8.6	3.66	98	0.95	—	<1.0	<1.0
TBA-21	220	40	11/25/2013	—	64	32	24	1.6	26.8	33.5	237	6.6	—	<1.0	<1.0
TBA-22	260	110	10/28/2013	—	48	25	26	2.2	2.32	40.4	236	<0.005	0.14	<1.0	<1.0

Project Site ID	Well Depth (feet)	Casing Depth (feet)	Sample Date	Arsenic[a] (µg/L)	Major Ion Concentrations (mg/L)							Nutrient Concentrations		Bacteria	
					Calc-ium	Magnes-ium	Sodium	Potas-sium	Chlo-ride[b]	Sul-fate[b]	Alkalinity (as CaCO3)	Nitrite plus Nitrate[a]	Am-monia	Total Coliform	*E. coli*[a]
												(mg/L)		(MPN/100 mL)	
Standard:				***10***	***NA***	***NA***	***NA***	***NA***	***250***	***250***	***NA***	***10***	***NA***	***1 cfu/ 100 mL[c]***	***<1 cfu/ 100 mL[c]***
TBA-23	340	340	10/23/2013	—	26	8.4	10	1.0	3.05	3.34	102	1.2	0.014	<1.0	<1.0
TBA-25	107	107	10/28/2013	—	61	24	4.5	0.81	3.07	39.4	190	4.5	—	<1.0	<1.0
TBA-26	85	80	10/24/2013	—	59	14	1.6	0.75	1.65	7.05	181	2.5	—	<1.0	<1.0
TBA-27	180	158	11/04/2013	—	53	17	6.0	0.90	2.38	5.28	195	1.8	—	<1.0	<1.0
TBA-29	197	197	11/04/2013	—	53	13	3.0	1.2	1.47	2.5	181	0.72	—	<1.0	<1.0

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
µg/L = micrograms per liter; mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; $CaCO_3$ = calcium carbonate; NA = not applicable; cfu = colony-forming unit; (—) = data are unavailable or were not analyzed

[a] Contaminant with a National Primary Drinking Water Regulation standard.

[b] Contaminant with a National Secondary Drinking Water Regulation standard.

[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

Table 24. Summary of stable isotope analytical results—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

Project Site ID	Sample Date	NAU CPSIL[a]		USGS RSIL[b]		University of Arizona		
		$\delta^{15}N_{nitrate}$ (‰ AIR)	$\delta^{18}O_{nitrate}$ (‰ VSMOW)	$\delta^{15}N_{nitrate}$ (‰ AIR)	$\delta^{18}O_{nitrate}$ (‰ VSMOW)	$\delta^{15}N$ (‰ AIR)	$\delta^{18}O$ (‰ VSMOW)	$\delta^{2}H$ (‰ VSMOW)
TBA-01	10/23/2013	3.8	-5.9	3.4	-5.74	—	-17.2	-129
TBA-02	10/23/2013	5.9	-6.5	—	—	—	-18.6	-140
TBA-03	10/24/2013	3.0	-6.9	—	—	—	-17.5	-130
TBA-05	10/17/2013	13.3	-1.8	—	—	—	-17.7	-132
TBA-08	10/17/2013	4.7	-7.2	4.82	-6.75	—	-18.5	-138
TBA-09	10/24/2013	1.2	-6.3	—	—	—	-18.0	-133
TBA-10	10/17/2013	5.1	-4.5	5.05	-4.03	—	-17.5	-130
TBA-11	10/28/2013	5.5	-5.6	—	—	—	-18.4	-135
TBA-12	10/23/2013	3.3	-6.8	—	—	—	-18.2	-133
TBA-13	10/28/2013	3.3	-9.5	—	—	—	-18.2	-135
TBA-14	10/17/2013	4.8	-4.8	4.39	-5.29	—	-17.8	-134
TBA-15	11/4/2013	3.5	-5.6	—	—	—	-18.2	-133
TBA-16	11/25/2013	5.2	-6.4	4.91	-6.06	—	-18.8	-139
TBA-17	10/23/2013	5.2	-6.1	—	—	—	-17.4	-129
TBA-18	10/28/2013	—	—	—	—	1.2	-18.7	-139
TBA-19	10/17/2013	4.8	-9.4	—	—	—	-18.6	-137
TBA-20	10/23/2013	5.4	-5.8	—	—	—	-17.7	-130
TBA-21	11/25/2013	6.2	-7.1	6.24	-6.24	—	-18.3	-137
TBA-22	10/28/2013	—	—	—	—	NS	-18.3	-134
TBA-23	10/23/2013	5.5	-4.5	—	—	—	-17.9	-134
TBA-25	10/28/2013	5.9	-5.2	—	—	—	-17.9	-133
TBA-26	10/24/2013	2.4	-6.8	2.75	-6.19	—	-17.8	-132
TBA-27	11/4/2013	4.4	-7.7	—	—	—	-17.9	-134
TBA-29	11/4/2013	5.0	-7.1	—	—	—	-17.9	-134

Note: Stable isotope analytical results are presented as delta values (δ) reported as parts per thousand (identified as per mill or ‰) compared to a standard. For $\delta^{15}N$ and $\delta^{15}N_{nitrate}$, delta values represent $^{15}N/^{14}N$ of the sample compared to $^{15}N/^{14}N$ for nitrogen in air, reported as $\delta^{15}N_{air}$. Standards for $\delta^{18}O$, $\delta^{18}O_{nitrate}$, and $\delta^{2}H$ are Vienna Standard Mean Ocean Water (VSMOW).
NS = not sampled; (—) = data are unavailable or were not analyzed
[a] Northern Arizona University–Colorado Plateau Stable Isotope Laboratory
[b] US Geological Survey Reston Stable Isotope Laboratory

Nitrate Results and Ground Water Flow

Figure 14 presents sample locations and nitrate results for the Teton Basin-Ashton regional monitoring subarea. Ground water flow is generally from higher elevations in the basin toward the Eastern Snake River Plain, as shown by the ground water flow elevations (Graham and Campbell 1981). Of the 24 sample sites, 9 were within the Ashton-Drummond NPA. The highest nitrate level observed (11 mg/L) was within the Ashton-Drummond NPA.

General Ground Water Chemistry

Ground water in the Teton Basin-Ashton subarea is primarily a calcium-bicarbonate to calcium-sodium bicarbonate water with generally very low relative percentages of sulfate and chloride. A Piper trilinear water chemistry plot can help to identify major trends in ground water chemistry. Figure 15 shows that variations in major ion chemistry can be characterized by relatively consistent proportions of magnesium while proportions of calcium and sodium + potassium

change among sites. While the major portion of anion activity is expressed through carbonate + bicarbonate alkalinity, increasing proportions of chloride and sulfate are apparent.

Relative concentrations of major ions can provide clues to the potential sources of nitrates. Figure 16 and Figure 17 present the relationship of sulfate to chloride and relative sulfate/chloride to total nitrite plus nitrate. The relationship of sulfate to chloride provides a basis for distinguishing between some sites; of specific note are TBA-01, 13, 22, and 25 with high relative sulfate and TBA-21, 08, 10, and 02 with higher relative chloride. Most of these same sites are distinct when considering relative sulfate to chloride versus total nitrite plus nitrate. Sites TBA-18 and 22 both were less than detection for total nitrite plus nitrate but did return detectable ammonia concentrations, with TBA-18 returning 1.3 mg/L ammonia. Field parameter measurements for TBA-18 and 22 indicated low oxygen or anoxic conditions.

The major ion sample from TBA-10, near Newdale, was also analyzed for arsenic, with a reported value of 2.3 µg/L, less than the 10 µg/L MCL for drinking water (Table 23). Other wells in the Newdale area have showed geothermal waters and detectable concentrations of arsenic.

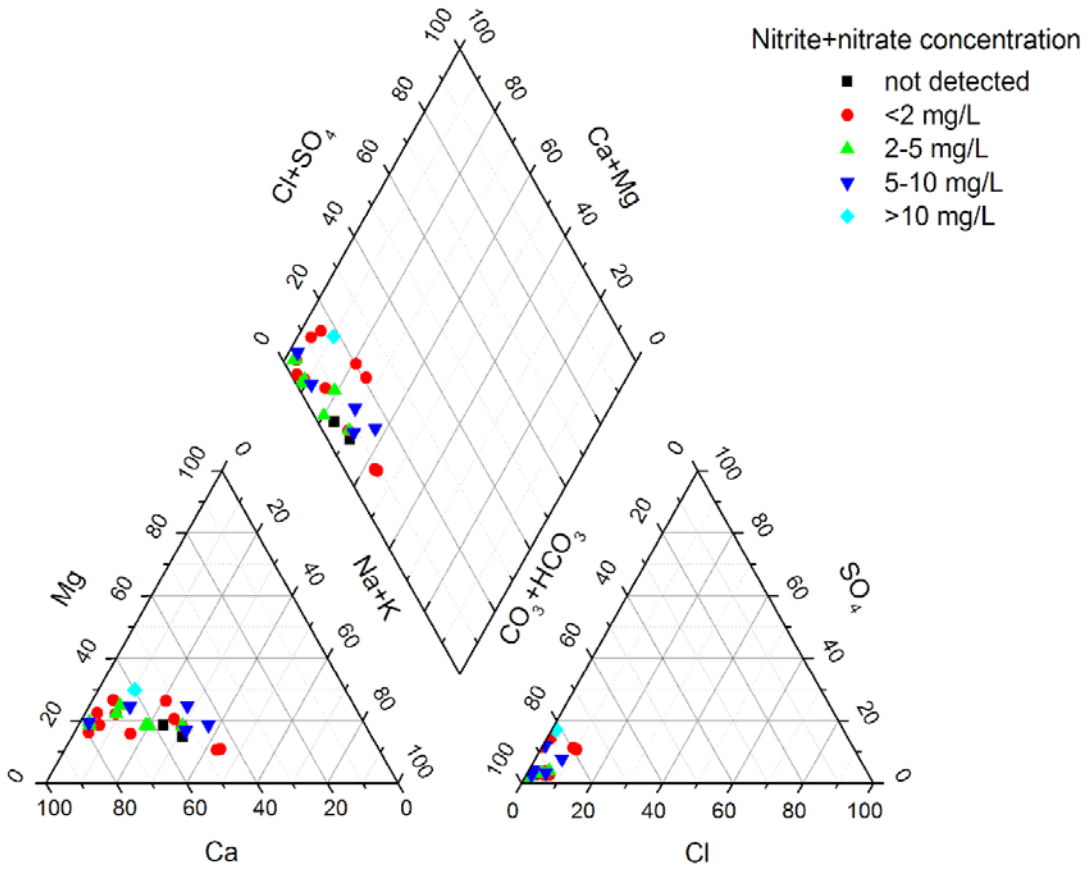


Figure 15. Piper diagram for Teton Basin-Ashton regional monitoring subarea, 2013.

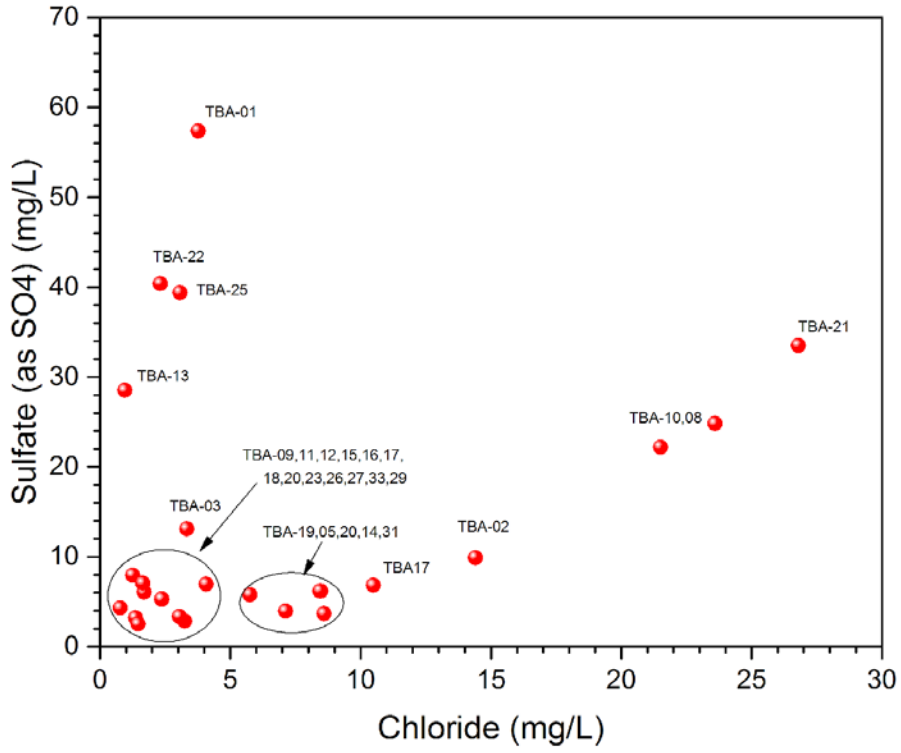


Figure 16. Comparison of chloride versus sulfate concentrations—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

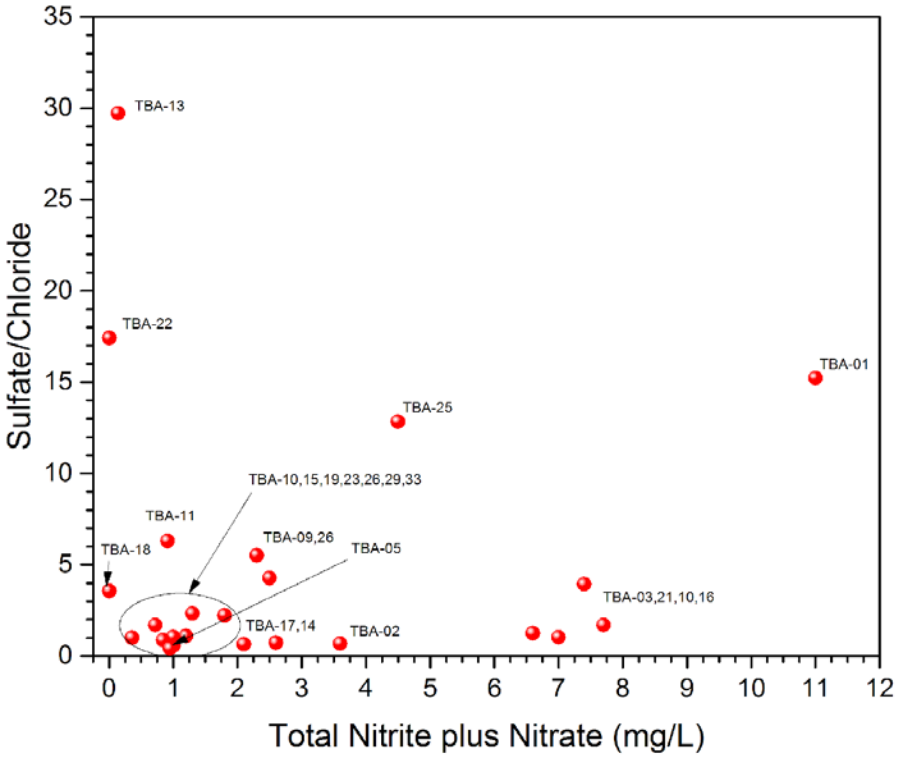


Figure 17. Total nitrite plus nitrate versus sulfate/chloride—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

Stable Isotopes

Sample results for stable isotopes can give insight to possible nitrate sources and processes influencing nitrate concentrations.

Figure 18 presents stable isotope measurements of $\delta^{15}N_{nitrate}$ compared to sulfate/chloride ratios. Most steps in the nitrogen cycle in the subsurface are facilitated by microbes and can result in isotope fractionation (changes in the observed stable isotope ratio).

The analysis method utilized by NAU CPSIL yields a result for both stable $\delta^{15}N$ and $\delta^{18}O$ for nitrate in water. To achieve this $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$, denitrifying bacteria is added to the sample, converting all nitrate to nitrous oxide. Oxygenated ground water favors nitrogen in the form of nitrate. Understanding the relationship of $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ can aid in determining the biologically driven processes that may be influencing nitrate concentrations. Samples from TBA-18 and 22 did not have sufficient nitrate concentrations (but did have nitrogen as ammonia) for the analysis method used by NAU CPSIL. These were sent to the University of Arizona for total $\delta^{15}N$ analysis. The lab did not have sufficient volume to obtain a result for TBA-22.

As presented in Figure 18, samples from 9 sites were within the general range for inorganic sources (<4‰), including TBA-01, which had the highest total nitrite plus nitrate concentration (11 mg/L). One site (TBA-05) plotted in the range expected for a waste-related source (>9‰) (Kendall 1998). This site also had the highest bacteria result (total coliform of 11 MPN/100 mL). The sites that plotted in the range for inorganic sources also tended to have high sulfate to chloride.

TBA-25 plotted in the mixed/organic nitrogen range, and TBA-22 could not be plotted. Sites identified as high relative chloride plot in the mixed/organic range. TBA-05 also plotted as low relative sulfate and was plotted in the waste range.

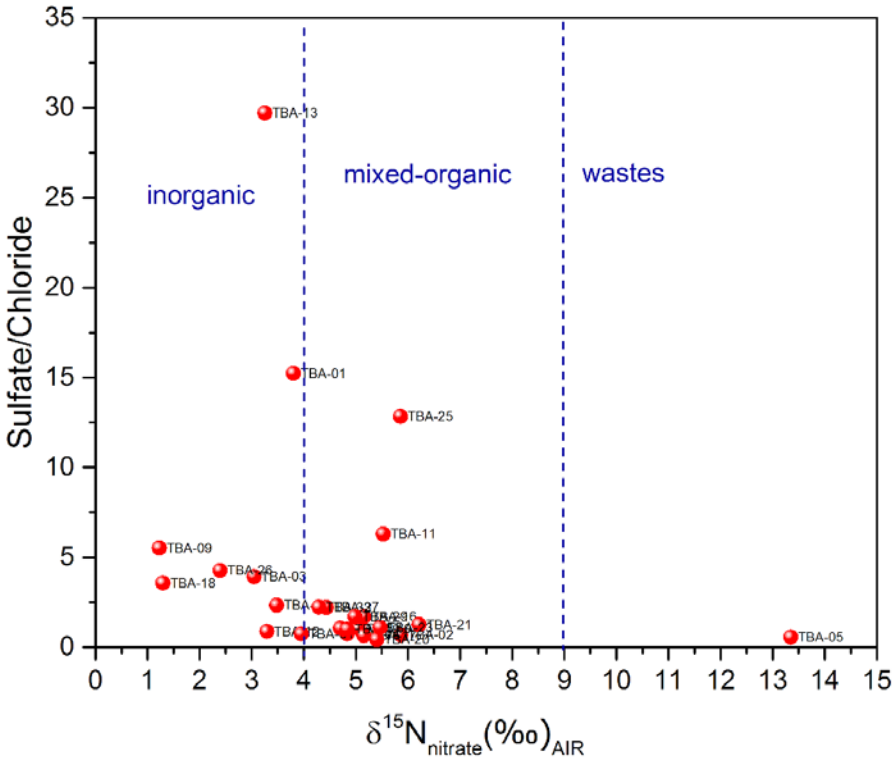


Figure 18. Sulfate/chloride nitrate versus δ^{15}Nnitrate for the Teton Basin-Ashton regional monitoring subarea, 2013. Ranges for typical nitrate sources are from Kendall 2007.

Stable isotopes of oxygen and hydrogen can help identify the likely timing and source of recharge. Results for $\delta^{18}O$ versus $\delta^{2}H$ for Teton Basin-Ashton ground water plotted along the local meteoric water line and similar to snow melt (see Figure 10 in DEQ 2011b).This suggests that recharge occurs primarily with the spring snowmelt and before the irrigation season.

Kendall (1998) discusses the use of $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ to aid in tracing sources and cycling of nitrogen in the environment. This dual-isotope method can help explain the ongoing microbial-facilitated processes and aid in understanding portions of the nitrogen cycle where $\delta^{15}N$ signatures are not sufficiently distinct. Figure 19 plots $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$ for Teton Basin-Ashton samples. Also included are typical ranges for $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$ for various sources (Kendall et al. 2007). Results for $\delta^{15}N_{nitrate}$ are reported relative to $\delta^{15}N$ in air and $\delta^{18}O_{nitrate}$ is reported relative to Vienna Standard Mean Ocean Water.

Results for most sites reflect sources that include inorganic nitrogen, likely from nitrification of ammonia-based fertilizers, or a combination of inorganic nitrogen and soil nitrogen. TBA-05 plots in a range that reflects a waste source and could be accounted for by the process of denitrification. TBA-09 plots closer to the range expected from ammonia-based inorganic fertilizer that has undergone nitrification. As nitrogen in the form of ammonia undergoes nitrification, oxygen from the air and from precipitation or irrigation water is added, typically in the ratio of one ^{18}O from air (usually $\delta^{18}O$ = 23‰) and two from the soil water (Kendall 1998); the $\delta^{18}O$ for local precipitation or irrigation water, identified from the $\delta^{18}O$/ $\delta^{2}H$ results for ground water ($\delta^{18}O \approx$ -18‰, Table 24), yield an expected $\delta^{18}O$ value of ≈ -4 or -5‰, similar to the $\delta^{18}O_{nitrate}$ results obtained.

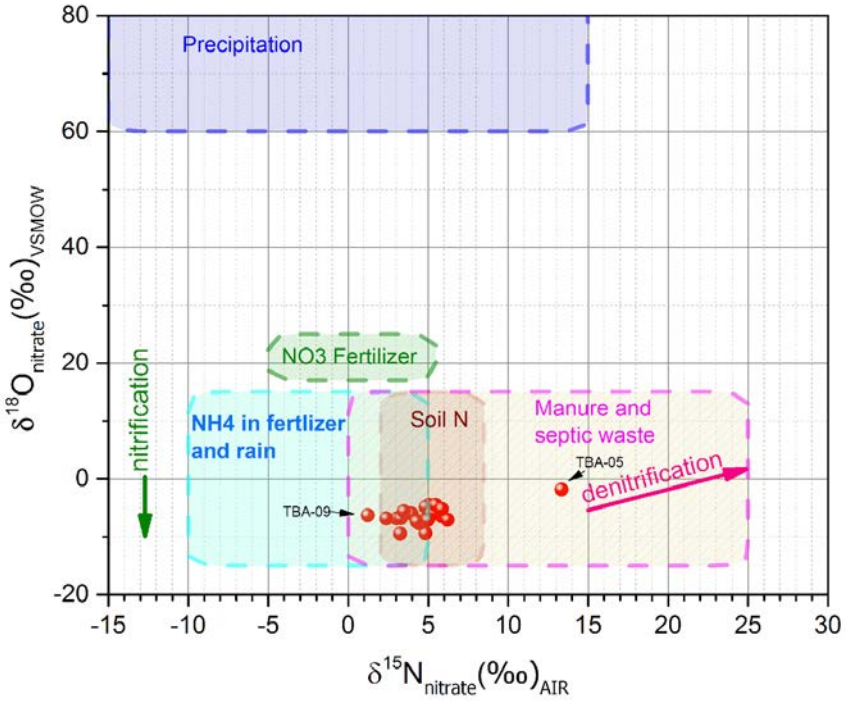


Figure 19. $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$ for the Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013. Ranges for typical nitrate sources are from Kendall 2007.

Replicate samples from seven sites were sent to the USGS RSIL for $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ analysis as an interlaboratory comparison with the NAU CPSIL. Nitrate levels for these sites ranged from 1 to 11 mg/L. Results were within 2s (or ≈95% confidence interval) for all cosample pairs. Based on this comparison, it is concluded that the results for $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ from the NAU CPSIL are reasonable and comparable with USGS RSIL.

Well Completion and Nitrate Levels

Criteria for selecting wells for regional monitoring favor those with more complete information concerning well construction, well-bore seals, and lithologic descriptions. This information can increase the likelihood that ground water samples collected will be more representative of anthropogenic impacts from the land surface. Additionally, with more recent wells and more complete information on well construction, the likelihood that water quality from that well is unduly influenced by conditions at the wellhead due to poor well construction is minimized. While ground water samples from poorly constructed wells may represent water that the specific homeowner may be drinking, it may not be representative of regional ground water quality.

Figure 20 plots well casing depth with nitrate concentrations, showing no apparent relationship between the two. A number of factors influence the depth of well casing used by the driller to complete a domestic well; these include the general IDWR rules for well construction, drilling methods used, the lithology the driller encountered, and requirements specified by the well owner. Additional factors may come into play relating well construction to potential for contamination at a specific well, including the depth, type, and method used by the driller to construct the well seal. Well owner activities and maintenance at the wellhead are also factors that may influence the vulnerability of the well to contamination.

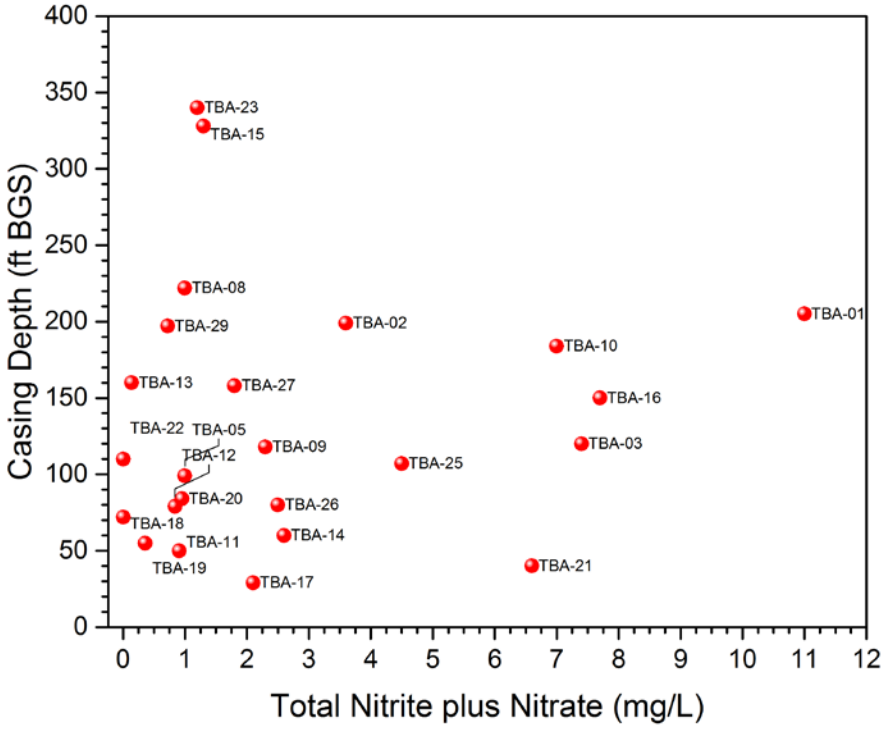


Figure 20. Casing depth compared with nitrate concentrations—Teton Basin-Ashton Regional Ground Water Monitoring Project, 2013.

2.2.1.3 Conclusions

The objectives of this regional monitoring study are to identify areas of vulnerable or degraded water quality, collect data to aid in determining potential sources of degradation, direct and prioritize protection efforts based on potential sources, and evaluate the effectiveness of protection measures to reduce nitrate impacts. This summary presents preliminary results for the first of three regional monitoring subareas for the Idaho Falls region.

- Nitrite plus nitrate concentrations exceeded 2 mg/L for 12 of 24 sites, with 1 site exceeding the 10 mg/L MCL; 2 additional sites without detectable nitrite plus nitrate yielded detections for ammonia (1.3 and 0.14 mg/L).
- The relationship of sulfate to chloride provides a basis for distinguishing between some sites; sites with higher relative sulfate tended to also plot with a lower $\delta^{15}N_{nitrate}$ value, in the range typical for inorganic nitrate. Sites with a lower relative sulfate tended to plot with a higher $\delta^{15}N_{nitrate}$ value in the mixed-organic range.
- $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ plots suggest a primarily ammonia and local precipitation source to explain the $\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$ signature for most sites, with soil nitrogen as a potential source for most other sites. The $\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$ signature for 1 site reflects a waste-related source that could be further explained by denitrification.
- Interlaboratory comparison for cosampled $\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$ results submitted to NAU CPSIL and USGS RSIL yielded comparable values within acceptable analytical variability.
- No relationship was observed between nitrate concentrations and depth of casing for wells, suggesting that other factors are needed to predict well vulnerability.

2.2.1.4 Recommendations

- Major ion chemistry, chloride, sulfate, and stable isotopes should be considered for sampling to identify potential nitrate sources. Additional analytes—including bromine, boron, and other characteristic isotopes and tracers—may add distinction between sources.
- The dual-isotope method—$\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$—provides more diagnostic information with regard to possible nitrogen sources than $\delta^{15}N$ alone.
- Regional $\delta^{18}O$ and $\delta^{2}H$ for ground water should be characterized, as the isotopic nature of ground water can provide insight to timing of recharge and potential ongoing processes in the nitrate cycle.
- Age of well, depth of seal, and drilling methods could be considered for evaluating the impact of well conditions/construction on vulnerability.

2.3 Coeur d'Alene Region

No ground water quality projects were conducted using DEQ funds in the Coeur d'Alene region in 2013.

2.4 Lewiston Region

2.4.1 Camas Prairie Ground Water Monitoring Project

This section summarizes the 2013 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Camas Prairie, north of Grangeville, Idaho. A DEQ investigation (Bentz 1998) found that 24 of 55 wells sampled (44%) had nitrate concentrations that exceeded 5 mg/L (i.e., half the MCL of 10 mg/L). The maximum nitrate concentration reported in the 1998 study was 77.1 mg/L. That value was later determined to be from a point source near the wellhead and the site has not been sampled in subsequent years. The Camas Prairie is in one of Idaho's NPAs (the Clearwater Plateau NPA), designated in part on the 1998 nitrate investigation results.

2.4.1.1 Purpose and Background

To address elevated nitrate concentrations in the Camas Prairie, a ground water quality management plan was developed (DEQ and ISCC 2008). The plan encourages implementation of voluntary best management practices (BMPs) to reduce nitrate concentrations in ground water.

As part of the plan, approximately $1 million of Clean Water Act §319 grant funds were expended on the Camas Prairie through 2011 for implementing agricultural ground water protection BMPs, such as direct seed practices. Direct seed practices allow for crop planting with minimal soil disturbance, which may contribute to reduced nitrogen mobility when combined with other BMPs.

DEQ initiated the Camas Prairie ground water monitoring program in August 2005 as part of a regional ambient ground water monitoring network. The objective of this long-term ground water monitoring is to determine the plan's effectiveness in improving ground water quality.

Nitrate concentration data will be periodically evaluated to determine if ambient concentrations increase or decrease. This evaluation will include seasonal and overall trend assessment.

The project area is located immediately north of Grangeville, Idaho, straddling Lewis and Idaho Counties and encompassing the towns of Cottonwood, Ferdinand, Craigmont, and Nezperce (Figure 21). The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also commonly found throughout the area.

The geology of the area is characterized by the Tertiary Columbia River Basalts and consists of units that formed when lava flows filled in the pre-existing basement rock topography during the Miocene era (Stevens et al. 2003). The majority of the area is capped with a thin layer of loess. Ground water in the area is most commonly found in the basalt aquifers and occasionally in the alluvial valley aquifers and basement rocks. Ground water generally flows to the north and eventually discharges into the Clearwater River (Hagan 2003). Well depths from ground water sampling ranged from 28 to 500 feet.

2.4.1.2 Methods and Results

Since 2006, DEQ has conducted routine quarterly sampling from the Camas Prairie network of 23 wells and up to 2 springs. Nitrate concentrations from sampled sites were compared seasonally for several years to identify wells with similar seasonal trends and wells with apparent anomalies. Wells with reported results that were considered to be anomalies were addressed to identify and resolve isolated or localized situations and dropped from the ambient monitoring network.

In 2013, ambient sampling was conducted in April, July, September, and December in accordance with the Camas Prairie ground water sampling QAPP (DEQ 2005a). Samples were collected from 23 wells and 1 spring. Figure 21 shows well locations and nitrate results for the September sampling event. Water quality field parameters of water temperature, specific conductance, and DO were measured prior to sample collection for nitrates (Table 25). Three wells were not consistently sampled in all four sampling rounds due to lack of water/low water or access issues.

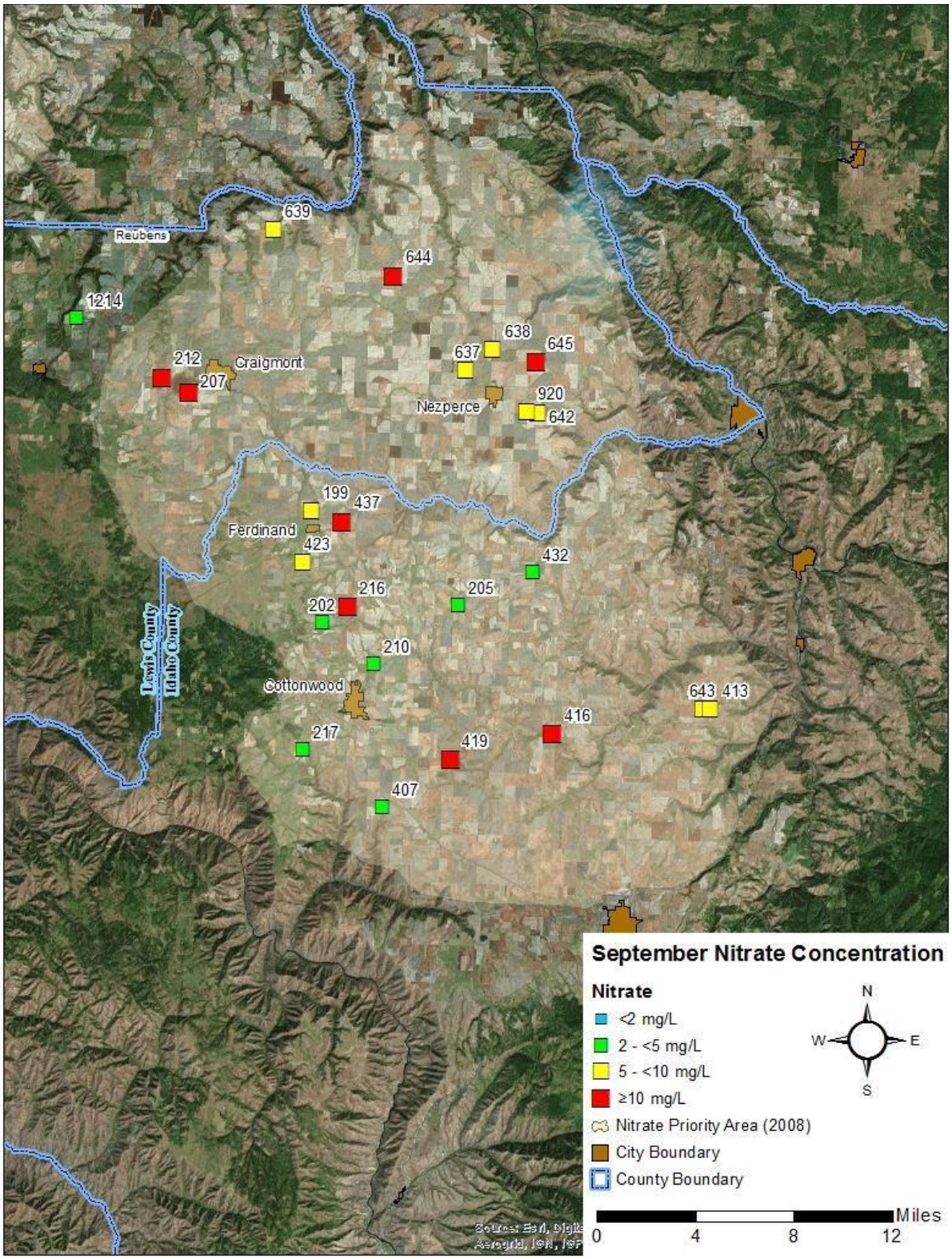


Figure 21. Well and spring locations, DEQ site IDs, and nitrate concentrations—Camas Prairie Ground Water Monitoring Project, September 2013.

Table 25. Water quality field parameters—Camas Prairie Ground Water Monitoring Project.

Site ID	Well Depth (feet)	April 2013			July 2013			September 2013			December 2013		
		Spec. Cond. (µs/cm)	Water Temp. (°C)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (°C)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (°C)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (°C)	DO (mg/L)
199	140	472	11.0	9.69	479	10.2	8.90	493	11.7	9.41	507	12.0	9.49
202	400	221	11.3	7.77	249	12.6	8.02	242	11.4	7.01	240	10.1	7.06
205	327	548	10.7	0.46	585	15.1	1.24	516	12.8	0.32	525	9.8	0.48
207	85	520	9.4	3.83	362	10.2	3.81	390	10.2	3.96	388	9.5	4.24
210	500	338	13.3	4.06	334	15.6	1.46	335	14.4	2.91	343	13.9	6.07
212	400	409	8.5	7.66	401	12.6	7.42	410	13.5	7.00	415	9.2	8.00
216	80	568	11.3	7.32	585	11.5	6.81	590	11.4	6.60	578	13.6	6.60
217	500	253	8.5	6.66	265	14.6	4.61	267	14.2	5.43	263	5.9	5.77
407	375	367	7.8	9.02	375	16.7	8.03	358	13.7	7.66	355	5.4	9.04
413	260	402	7.4	10.63	401	16.8	11.02	409	15.1	11.08	423	4.5	13.07
416	187	447	11.0	7.71	447	12.3	7.66	453	11.3	7.06	450	11.0	8.20
419	250	509	8.9	6.92	558	13.1	6.61	688	11.4	5.29	714	4.6	4.49
423	500	235	8.5	7.78	263	12.7	7.99	240	11.7	7.41	NS	NS	NS
432	135	357	11.0	3.29	353	11.7	3.22	354	11.1	3.49	358	10.8	3.21
437	28	NS	NS	NS	564	14.0	6.98	535	12.1	6.89	NS	NS	NS
637	396	405	10.7	11.50	408	11.9	13.25	404	11.5	12.91	401	9.7	14.01
638	90	410	8.5	10.26	422	11.2	9.47	426	11.7	9.30	416	10.2	10.05
639	85	620	9.4	7.44	620	12.3	7.37	614	10.8	7.30	614	7.4	7.43
642	65	554	10.7	9.80	512	11.1	9.57	489	10.9	9.78	508	10.6	9.41
643	145	382	6.8	7.95	432	16.6	7.64	438	16.0	8.30	NS	NS	NS
644	402	508	7.9	9.77	521	12.1	8.84	509	11.2	9.80	509	9.5	10.88
645	165	645	7.4	9.33	660	13.2	7.90	666	11.0	8.14	655	5.9	9.45
920	300	435	7.3	8.78	445	14.9	8.19	444	14.6	8.11	439	5.9	8.96
1214	Spring	311	8.5	4.22	314	11.9	4.78	317	8.6	5.03	323	5.9	8.21

Notes: Primary and secondary ground water quality standards do not exist for the listed parameters. Field parameters include: specific conductivity (microsiemens per centimeter), water temperature (degrees Celsius), and dissolved oxygen (milligrams per liter). NS = not sampled.

The highest reported nitrate concentration was 22.5 mg/L collected from site 419 during the December sampling event. Site 419 also had the highest reported average nitrate concentration from all four sampling events, with an annual average of 18.48 mg/L. Nearby, site 416 was similar, averaging 18.03 mg/L for the year. In all, 9 of the 24 sampled sites reported nitrate concentrations in excess of the EPA MCL (10 mg/L) at least once during the 2013 sampling year (Table 26). Overall, there was little variation in median and mean nitrate concentrations (from 0 to 12.3%) at each site between sampling events in 2013. Overall quarterly averages ranged from 8.2 mg/L to 8.6 mg/L. Project-wide, nitrate concentrations were highest in December and lowest in April.

Table 26. Nitrate results—Camas Prairie Ground Water Monitoring Project.

Site ID	Well Depth (feet)	Nitrate Concentration in milligrams per liter (mg/L)				
		April 2013	July 2013	September 2013	December 2013	Yearly Average[a]
199	140	9.0	9.2	6.7	9.7	8.7
202	400	3.6	4.0	3.8	3.6	3.8
205	327	4.1	4.5	3.7	4.0	4.1
207	85	**14.0**	**11.8**	**12.3**	**11.6**	**12.4**
210	500	4.1	3.4	3.9	4.1	3.9
212	400	**17.6**	**17.2**	**17.8**	**18.3**	**17.7**
216	80	**11.1**	**10.1**	**10.7**	**12.4**	**11.1**
217	500	3.0	2.3	2.7	2.7	2.7
407	375	6.4	6.5	3.3	6.3	5.6
413	260	5.9	5.8	5.9	6.7	6.1
416	187	**17.5**	**18.4**	**18.4**	**17.8**	**18.0**
419	250	**14.1**	**16.1**	**21.2**	**22.5**	**18.5**
423	500	3.4	7.5	7.4	3.5	5.5
432	135	4.6	4.2	4.1	4.6	4.4
437	28	NS	**12.2**	**10.8**	NS	—
637	396	5.8	5.6	5.3	5.3	5.5
638	90	5.2	5.2	5.4	5.2	5.3
639	85	5.4	5.7	5.5	5.6	5.6
642	65	**10.3**	8.1	7.3	7.9	8.4
643	145	7.2	8.2	8.3	NS	—
644	402	**11.6**	**11.8**	**11.7**	**11.4**	**11.6**
645	165	**13.9**	**15.1**	**16.3**	**15.2**	**15.1**
920	300	5.9	5.9	5.8	5.9	5.9
1214	Spring	4.1	4.2	4.4	4.3	4.3
Quarterly Average		8.2	8.5	8.4	8.6	

Notes: Bolded red numbers indicate the US Environmental Protection Agency's maximum contaminant level of 10 mg/L was reached or exceeded; NS = not sampled.
[a] Yearly averages were not calculated for wells that were not sampled during all four sampling events.

A histogram of all nitrate samples in the project area for 2013 is shown in Figure 22. Kruskal-Wallis rank sum analysis of synoptic sampling data show no significant differences ($\alpha = 0.10$) between any of the quarterly sampling events in 2013.

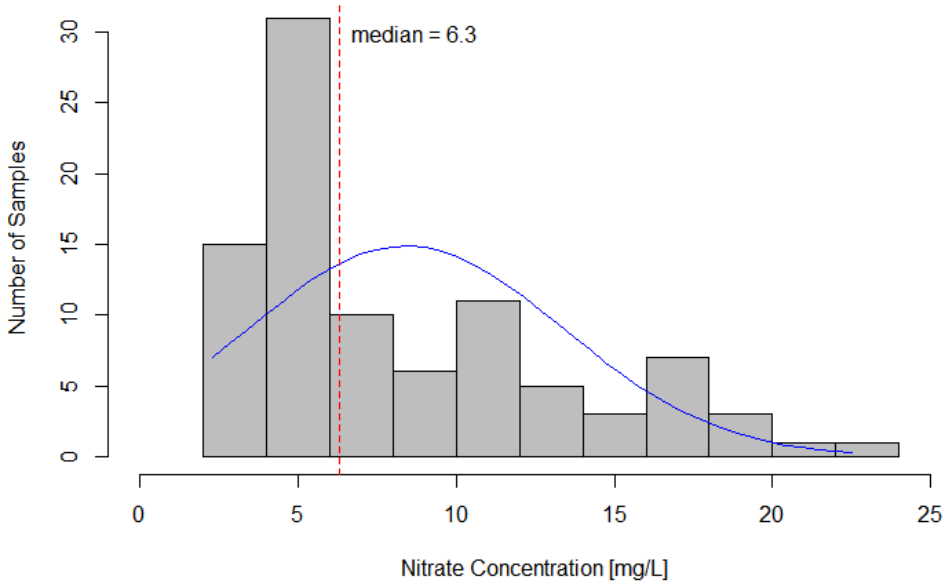


Figure 22. Histogram of nitrate concentrations and normal distribution (mean = 8.41, standard deviation = 4.98) of all nitrate samples (n = 93) from Camas Prairie project area, 2013. The median nitrate concentration value is below the MCL of 10 mg/L.

Seasonal fluctuations in nitrate concentrations in Camas Prairie wells were evaluated using scatterplots (Figure 23). No seasonality patterns could be determined from the plots.

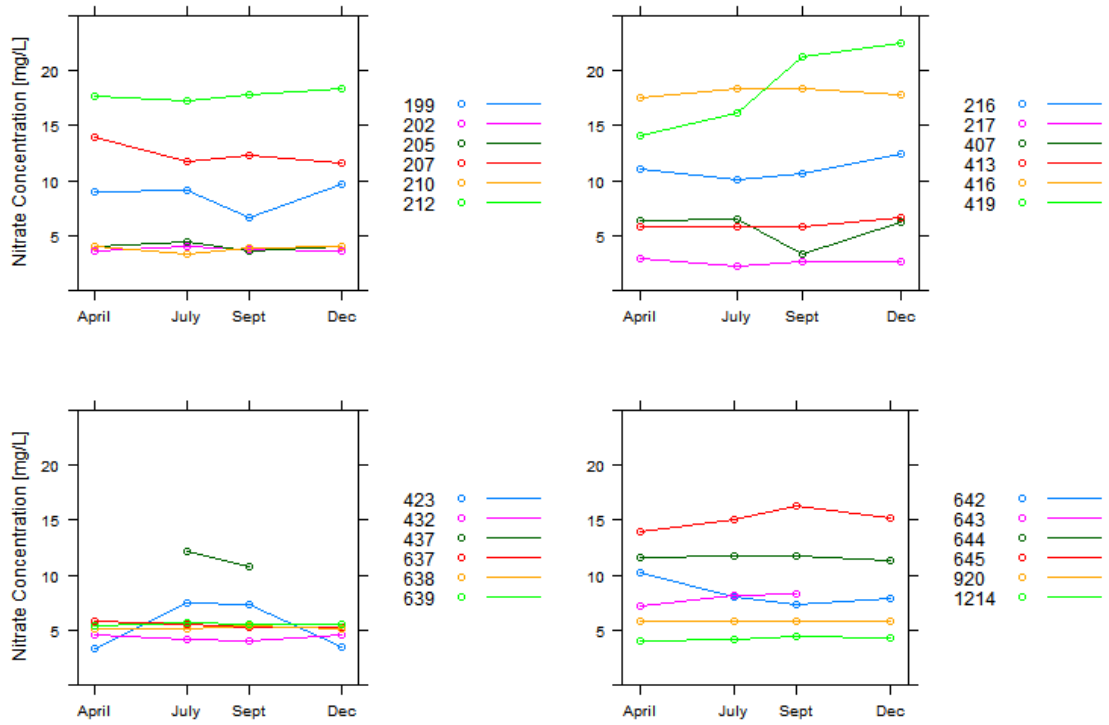


Figure 23. Scatterplots of nitrate concentrations of all nitrate samples from the Camas Prairie project area, for 2013.

2.4.1.3 Conclusions

The objective of this long-term ground water monitoring is to determine the ground water quality management plan's effectiveness on improving ground water quality. Sampling of wells and springs in the project area during 2013 will help realize this objective. Sample results show that ground water in the Camas Prairie contains elevated nitrate concentrations, with some locations exceeding the EPA MCL of 10 mg/L. Nitrogen isotope analysis from previous years indicates that both inorganic and organic nitrogen contribute to the elevated concentrations (DEQ 2013g). Based on the large aerial extent of degraded ground water, commercial fertilizer, livestock manure, and septic discharge are potential sources of elevated nitrate concentrations reported in project area ground water.

The temporal variability between ground water nitrate concentrations at various wells in the area may indicate nitrate leaching rates, sources of nitrogen, and ground water hydrology are not uniform throughout the year.

2.4.1.4 Recommendations

Annual variability reported for individual wells makes it difficult to detect improvements in ground water quality in the project area as BMPs are implemented because concentration changes may be within the range of historic concentrations reported for individual wells. Therefore, this project will attempt to compare changes in seasonal trends of the network over multiple years to identify changes in ambient conditions.

Tracking changes in ambient nitrate concentrations relative to changes in land use or source controls could be accomplished by comparing changes in seasonal trends over multiple years to minimize the effects of seasonal variability that occur under the conditions mentioned above. Multiple year seasonal trend analysis of ambient nitrate concentrations has not been conducted. Additional data and data compilation are needed prior to conducting such analyses. Data and resources are anticipated to be available for the analysis phase of the project in the future.

Ground water conditions can be represented in spring water. Monitoring spring water when ground water provides the only source of water to a spring can also be used to determine ground water nitrogen loads to surface water. This information may be useful in determining if and where ground water nitrogen contribution to surface water exists in the drainage basin and to focus BMP implementation efforts. For more information, see Baldwin et al. (2008), which summarizes data collected for this project from 2005 through 2007.

2.4.2 Tammany and Lindsay Creeks Ground Water Monitoring Project

2.4.2.1 Purpose and Background

The Lindsay Creek NPA was designated in 2008 using ground water quality data from the IDWR, ISDA, USGS, and DEQ. The NPA encompasses the Lindsay and Tammany Creek watersheds. The 2007 Lindsay Creek total maximum daily load (TMDL) determined that ground water base flow is a nitrogen contributor to Lindsay Creek and requires a reduction in nitrogen loading (DEQ 2007).

The goal of this project is to create an ambient ground water quality monitoring network to complete a multiple year seasonal trend analysis to detect changes that are a result of the Lindsay Creek NPA designation and also extend ground water quality monitoring to include the aquifer within the Tammany Creek watershed.

The project area is located east and southeast of Lewiston, Idaho. The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also common in the area. The area is underlain by the Tertiary Columbia River Basalts and consists of units that formed when lava flows filled in the pre-existing basement rock topography during the Miocene era (Stevens et al. 2003). A thin layer of loess caps a majority of the area. Ground water in the area is most commonly found in the basalt and occasionally in the alluvial valley sediments and basement rocks. Ground water generally flows to the north and eventually discharges into the Clearwater River (Hagan 2003).

Well depths from ground water sampling ranged from 134 to 1,025 feet. Limited ground water sampling has also shown elevated nitrate concentrations in the Tammany Creek area. Tammany Creek is located on the south side of the project area and the watershed has similar spring-fed nutrient load characteristics as the Lindsay Creek watershed on the north side of Lewiston. The ground water in this watershed may also be a potential source of excess nutrients to Tammany Creek. Tammany Creek is currently impaired by nutrients and has an approved nutrient TMDL (DEQ 2010).

DEQ is collecting data to develop an ambient ground water quality monitoring network of approximately 25 sites for quarterly sampling. Nitrate concentrations from sampled wells will be analyzed to determine if seasonal or spatial trends exist in the monitoring network in addition to monitoring long-term regional changes. Anomalous nitrate concentrations will be addressed as isolated or localized situations and dropped from the ambient network, if needed.

2.4.2.2 Methods and Results

DEQ sampled 11 wells and 4 springs quarterly during March, July, October, and December 2013. Water-quality field parameters—temperature, specific conductivity, and DO—were measured in the field prior to sample collection (Table 27), and samples were collected for nitrate analysis. The March samples were also analyzed for total ions. One spring and two wells were not included in all four sampling rounds due to lack of water/low water or access issues. One well owner asked to be removed from the project.

Table 27. Water quality field parameters—Tammany and Lindsay Creeks Ground Water Monitoring Project.

Well ID	Well Depth (feet)	March 2013			July 2013			October 2013			December 2013		
		Specific cond. (µS/cm)	Water temp. (°C)	DO (mg/L)	Specific cond. (µS/cm)	Water temp. (°C)	DO (mg/L)	Specific cond. (µS/cm)	Water temp. (°C)	DO (mg/L)	Specific cond. (µS/cm)	Water temp. (°C)	DO (mg/L)
533	225	849	10.6	9.79	849	14.7	9.44	866	15.1	9.76	858	10.9	9.8
538	228	1140	12.8	2.26	671	15.1	9.06	7.85	15.8	9.58	1165	12.5	2.7
696	295	1021	9.7	2.55	994	12.2	4.19	994	14.1	3.98	981	9.6	5.92
1036	134	946	15.7	7.98	NS	NS	NS	NS	NS	NS	NS	NS	NS
1038	150	1258	11.9	9.61	1177	13.6	9.62	1165	13.1	9.86	1248	11.7	9.8
1039	235	1048	12.4	9.05	828	15.3	8.4	841	15.1	8.54	916	12.2	8.97
1171	Spring	1152	11.1	9.69	1217	20	8.04	1075	13.4	9.13	1087	6.4	11.05
1254	197	1060	12.8	9.69	942	15.1	9.62	767	15.6	9.66	883	7.2	9.52
1255	200	881	12.5	8.42	877	17.9	7.87	880	14.6	8.61	888	13.4	8.36
1311	Spring	1230	11.3	8.38	1247	20.7	7.82	1250	15.6	8.12	1189	8.7	10.1
1312	1025	206.6	11.2	7.9	208.1	20.5	7.48	204.6	17	7.6	200.3	15.1	7.67
1314	Spring	518	8.1	9.79	528	20.5	8	NS	NS	NS	488	5.9	10.27
1315	476	577	7.0	9.82	544	13	9.19	NS	NS	NS	554	8.1	9.54
1317	Spring	578	11.5	9.72	554	14.5	8.49	576	11.9	9.59	582	10.2	10.45
2022	800	219.3	10.6	0.70	235	21.4	0.35	230	15.7	4.51	226	9.7	5.17

Notes: Primary and secondary ground water quality standards do not exist for the listed parameters. Field parameters include: specific conductivity (microsiemens per centimeter), water temperature (degrees Celsius), and dissolved oxygen (milligrams per liter). NS = not sampled.

Nitrate results from the 2013 quarterly sampling are presented in Table 28. The highest nitrate concentration was observed from a spring at site 1314 (18.6 mg/L) during the March 2013 sampling event (Figure 24). In the Tammany/Lindsay Creek project area, 9 of the 15 sample sites had nitrate concentrations that exceeded the MCL of 10 mg/L during at least one quarter, and these sites exhibit average nitrate concentrations over 10 mg/L for 2013. Only sites 1312 and 2022 (well depths of 1025 and 800 feet, respectively) have average concentrations less than 5 mg/L for the year. Overall quarterly averages ranged from 8.4 mg/L to 10.1 mg/L. Nitrate concentrations were highest in March and lowest in October.

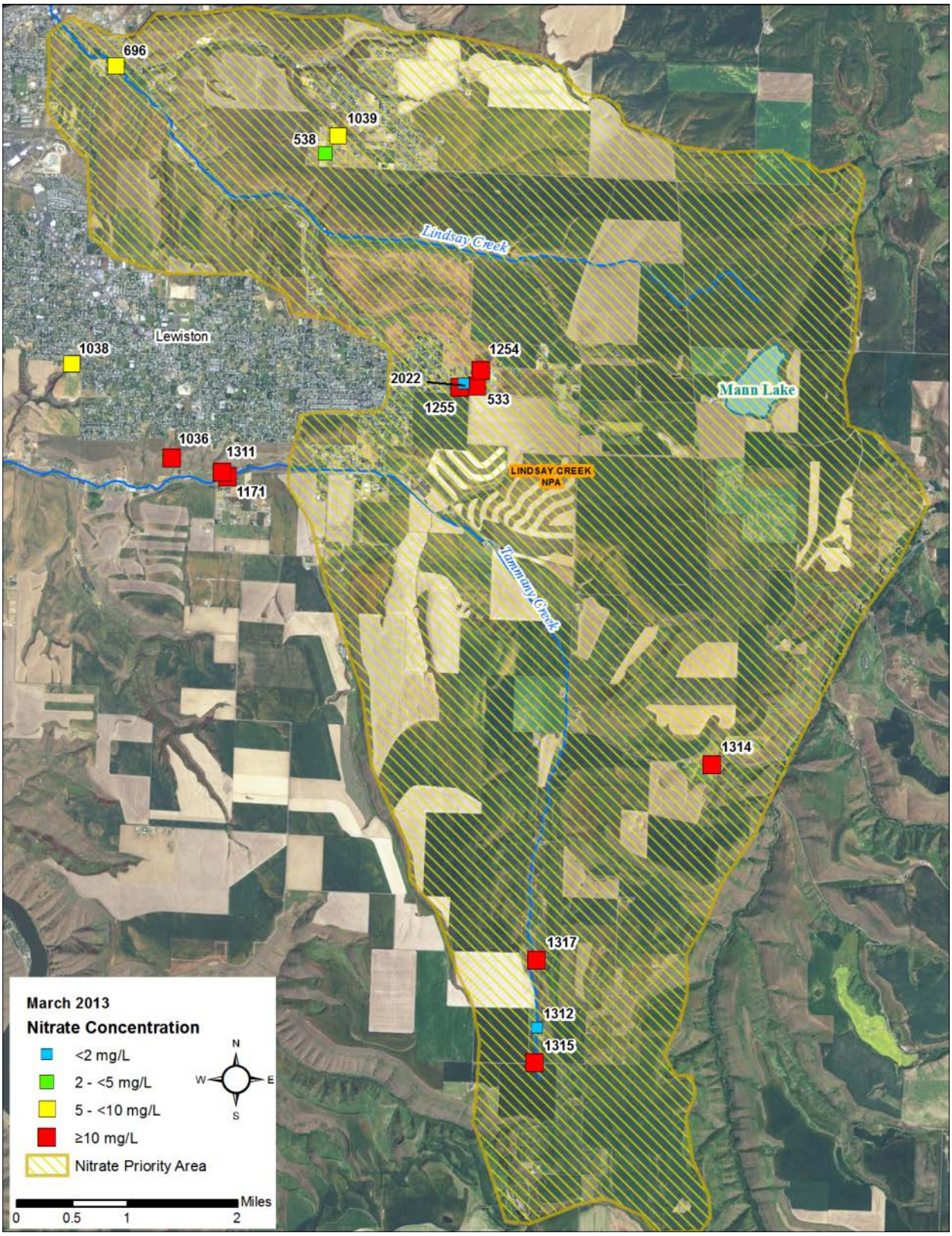


Figure 24. Well (or spring) locations with site identification numbers and nitrate concentrations—Tammany and Lindsay Creeks Ground Water Monitoring Project, March 2013.

Table 28. Nitrate results—Tammany and Lindsay Creeks Ground Water Monitoring Project.

Well ID	Well Depth (feet)	Nitrate Concentration (milligrams per liter)				
		March 2013	July 2013	October 2013	December 2013	Yearly Average[a]
533	225	**10.1**	**10.2**	**11.3**	**11.1**	**10.7**
538	228	3.6	5.8	6.9	4.6	5.2
696	295	6.2	5.3	5.6	6.1	5.8
1036	134	**10.9**	NS	NS	NS	NA
1038	150	7.9	7.6	8.2	7.9	7.9
1039	235	8.8	6.9	7.0	7.9	7.7
1171	Spring	**11.3**	**10.9**	**11.3**	**11.8**	**11.3**
1254	197	**15.3**	**12.1**	9.6	**12.5**	**12.4**
1255	200	**15.6**	**12.9**	**14.6**	**14.2**	**14.3**
1311	Spring	**11.8**	**10.5**	**10.5**	**10.9**	**10.9**
1312	1025	0.4	0.3	<0.5	0.4	0.3
1314	Spring	**18.6**	**18**	NS	**15.2**	**13.0**
1315	476	**14.8**	**12.3**	NS	**12.9**	**10.0**
1317	Spring	**15.4**	**15**	**15.7**	**15.3**	**15.4**
2022	800	<0.1	<0.1	<0.5	<0.1	0.1
Quarterly Average[a]		10.1	9.1	8.4	9.3	

Notes: Bolded red numbers indicate the US Environmental Protection Agency's maximum contaminant level for nitrate of 10.0 mg/L was reached or exceeded. NS = not sampled. NA = not analyzed.
[a] Averages were calculated using half of the detection limit for wells with sampling results below detection levels.

A histogram of all nitrate samples in the project area for 2013 is shown in Figure 25. Kruskal-Wallis rank sum analysis of synoptic sampling data show no significant differences ($\alpha = 0.10$) between any of the quarterly sampling events in 2013.

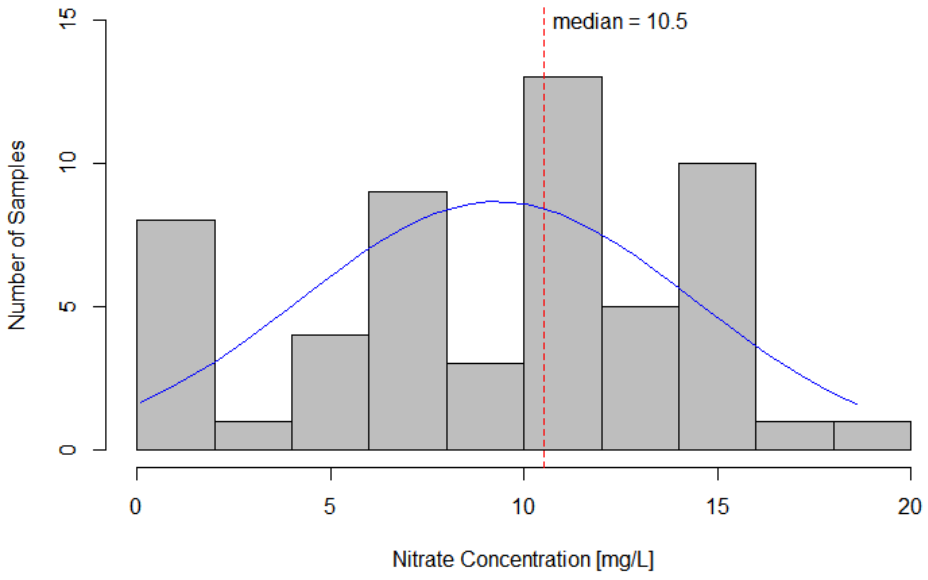


Figure 25. Histogram of nitrate concentrations and normal distribution (mean = 9.30, standard deviation = 5.07) of all nitrate samples (n = 55) from Tammany/Lindsay Creeks project area, 2013. The median nitrate concentration value exceeds the MCL of 10 mg/L.

Seasonal fluctuations in nitrate concentrations in Tammany and Lindsay Creek wells were evaluated using scatterplots (Figure 26). No seasonality patterns could be determined from the plots.

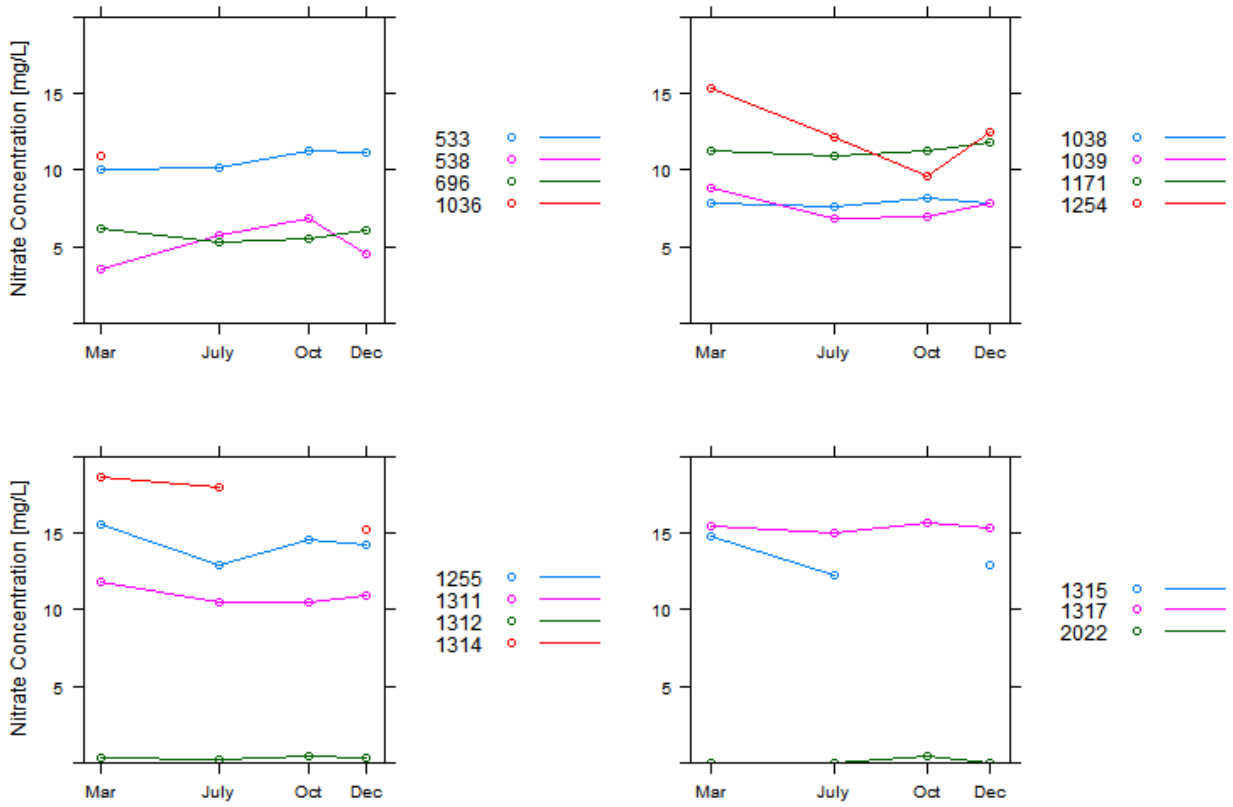


Figure 26. Scatterplots of nitrate concentrations of all nitrate samples from the Tammany-Lindsay Creeks project area, for 2013.

Samples for total ions (calcium, magnesium, sodium, potassium, bicarbonate, chloride, and sulfate) were also collected for all sites except 2022 during the March 2013 sampling event to determine what variation exists in ground water chemistry between sites and if ambient conditions are changing over time (Table 29). These data were evaluated using a Piper trilinear diagram (Figure 27) and show relatively consistent water chemistry for cations and anions in all samples. The only apparent segregation of water chemistry results is a (minor) grouping of four sites—two wells (696 and 1038) and two springs (1171 and 1311)—all located along the western side of the project area.

Table 29. Total ion results—Tammany and Lindsay Creeks Ground Water Monitoring Project, March 2013.

DEQ Site ID	Well Depth (feet)	Major Ion Concentrations						
		Calcium	Magnesium	Sodium	Potassium	Chloride[a]	Sulfate[a]	Alkalinity (as CaCO3)
		(mg/L)						
Standard:		***NA***	***NA***	***NA***	***NA***	***250***	***250***	***NA***
533	225	37	33.8	72.6	7.97	44.8	134	231
538	228	45.4	54.9	91.7	7.73	125	119	342
696	295	56	30.5	129	12.9	34.5	83.2	441
1036	134	76.3	30.8	69.7	7.82	33.3	67.3	390
1038	150	62.9	32.7	188	6.32	37.1	130	530
1039	235	51	44.4	81.4	8.44	82.9	190	244
1171	Spring	48.2	37.2	156	12.1	50.5	125	441
1254	197	72.7	38.5	78.1	7.44	58	144	321
1255	200	50.9	44.8	56	7.67	36.7	92.7	301
1311	Spring	78.2	32.4	146	7.34	52	127	474
1312	1025	17.2	7.7	11	3.46	1.55	10.3	98.6
1314	Spring	50.4	14.9	25.6	3.26	31.8	20.4	140
1315	476	60.9	21	23.7	3.34	11.7	31.2	228
1317	Spring	57.9	19.8	27.2	3.61	8.89	26	226

Notes: NS = not sampled.
mg/L = milligrams per liter; $CaCO_3$ = calcium carbonate; NA = Not Applicable; (—) = data is unavailable or was not analyzed
[a] Contaminant with a National Secondary Drinking Water Regulation standard.

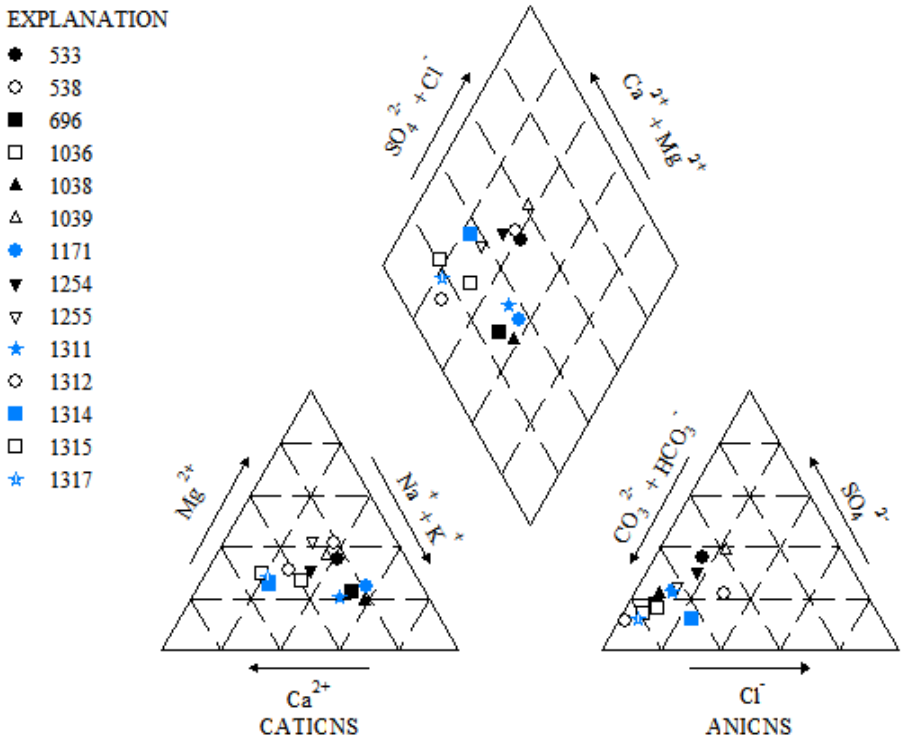


Figure 27. Piper trilinear diagram for well and spring locations (spring symbols are blue) showing percent ion composition for March 2013 sampling—Tammany and Lindsay Creeks Ground Water Monitoring Project.

2.4.2.3 Conclusions

The objective of this project is to create an ambient ground water quality monitoring network in the Tammany and Lindsay Creek areas and complete a multiple year seasonal trend analysis. Sampling of wells and springs in the project area during 2013 will help realize this objective. Results show that ground water in the Tammany and Lindsay Creeks project area has elevated nitrate concentrations, with the majority of sample locations exceeding EPA's MCL of 10 mg/L in at least one quarter of the year. Wells available to include in an ambient network are limited, and springs shown to be representative of ground water conditions may continue to be enlisted into the monitoring network to satisfy data needs.

Tracking trends in ambient nitrate ground water concentration due to changes in land uses or source controls will be accomplished by comparing seasonal trends over multiple years. This comparison will assist in determining the effects of seasonal variability that occur 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 related to the amount and timing of precipitation that is available to mobilize nitrogen below the crop root zone. Multiple year seasonal trend analysis of ambient nitrate concentrations has not yet been conducted because additional data and compilation are needed prior to conducting such analyses. Data and resources are anticipated to be available to complete the trend analysis phase of the project in the future.

2.4.2.4 Recommendations

Continued monitoring of available wells and springs is recommended to establish an ambient ground water quality network to track multiple year and seasonal trends, specifically for nitrate, in the project area. Outlier tests and common ion chemistry should be used to determine if samples are representative of ambient conditions and could be used to monitor long-term trends in ground water quality, once sufficient data are collected. Any wells yielding sample concentrations or other parameters inconsistent with the ambient conditions should be considered anomalies and dropped from the monitoring network. Multiple year trend analysis should be completed to quantify long-term trends in nitrate concentration.

DEQ is drafting an NPA management plan with the assistance of the Lindsay and Tammany Creeks Watershed Advisory Group to address the ground water degradation. The management plan will be a component of the Lindsay Creek TMDL implementation plan. The Nez Perce County Soil and Water Conservation District has proposed funding the plan through Clean Water Act §319 grant funds twice prior. The NPA management plan and applications for funding should be continued to assist with ground water protection efforts and implementing projects to reduce nitrogen loading.

2.5 Pocatello Region

2.5.1 Malad-Woodruff Follow-up Study

2.5.1.1 Purpose and Background

The purpose of this project was to investigate potential impacts to ground water quality from a feedlot near the town of Woodruff, Idaho. The investigation was prompted by a complaint from a homeowner located near the feedlot whose well was tested by DEQ in 2008 as part of the Malad Valley Study and again privately in 2013. Results from 2008 and 2013 indicated an increase in nitrate concentrations. Therefore, further investigation of the area could potentially identify the source and extent of nitrate contamination and provide useful information to residents regarding potential health effects.

The topography of the area slopes steeply to the west from the feedlot at the base of the Malad Range, flattening at the Malad River valley residences whose wells were sampled during this study (Figure 28). The feedlot extends for approximately 0.5 miles along the eastern frontage of I-15. Several culverts pass beneath the I-15 corridor carrying surface runoff from the feedlot area toward, and onto, the residential properties. In October 2013, DEQ staff observed that several of the culverts were partially filled with manure, and dried deposits of waste carried downstream to the west side of I-15 were observed up to 2-feet high on fences and 0.3 miles downstream from the feedlot boundary on residential property.

The study area is underlain by unconsolidated Quaternary lacustrine and alluvial valley fill deposits (Long et al. 2004), and ground water is presumed, based on surface topography, to flow in a westerly or southwesterly direction from the Malad Range highlands through the unconsolidated sediments toward the Malad River, 0.75 miles west of the study area.

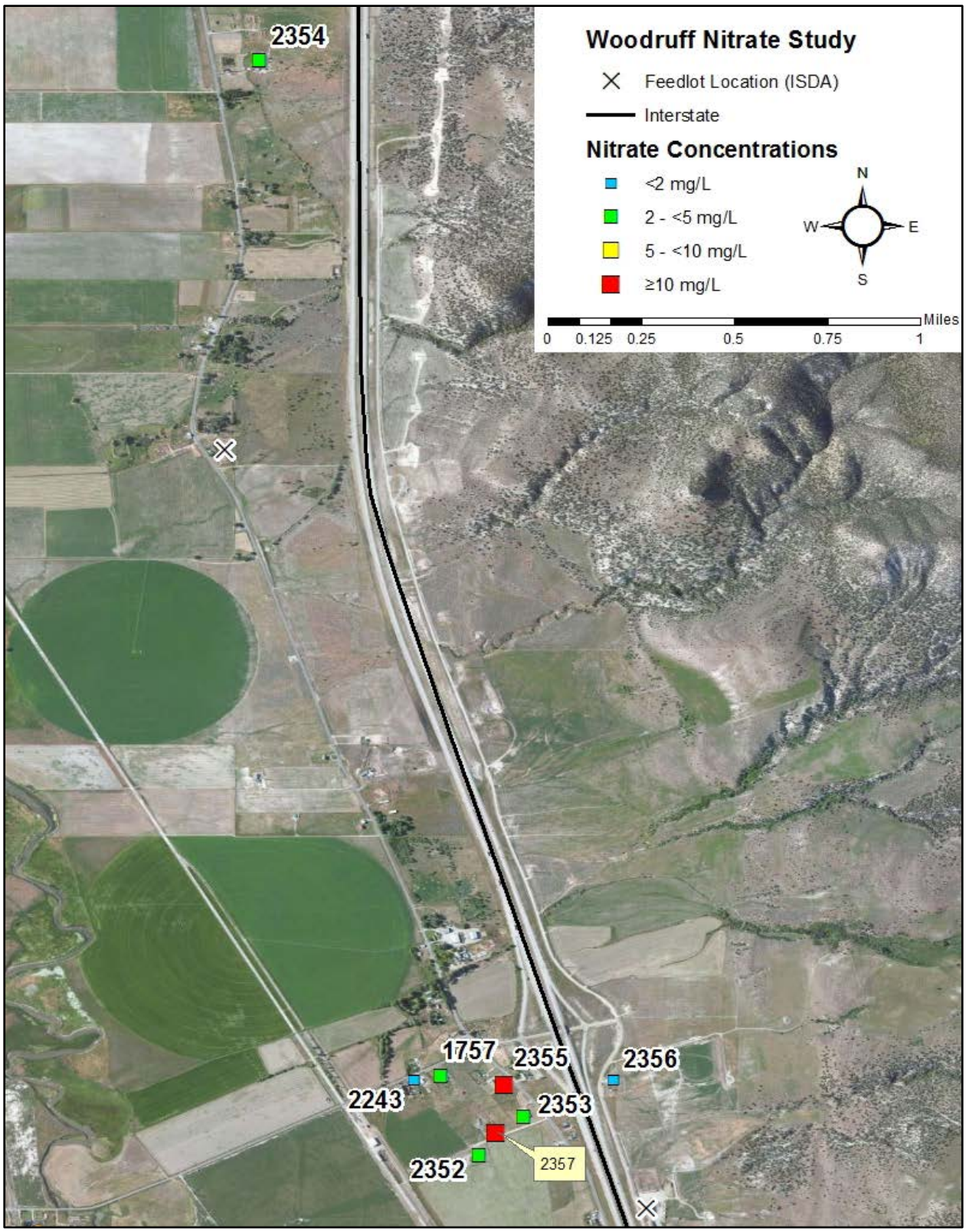


Figure 28. Location of wells sampled and nearby feedlot—Malad-Woodruff Follow-up Study.

2.5.1.2 Methods and Results

In August and October of 2013, 8 domestic wells were sampled near the Woodruff area in southeast Idaho (Figure 28). Water quality field parameters (pH, temperature, and specific conductivity) were measured at each site prior to sample collection (Table 30). All samples were submitted to IAS EnviroChem in Pocatello, Idaho, for analysis. Nutrient results can be seen in Table 30.

The 8 wells sampled had nitrate values ranging from 1.47 mg/L to 23.57 mg/L, with a median value of 3.50 mg/L; 2 wells (25%) exceeded EPA's nitrate MCL of 10 mg/L. Of the wells sampled in 2013 by DEQ, site 1757 was sampled in 2008 as part of the Malad Valley Study; this well showed a decrease in nitrate concentration from 9.56 mg/L in 2008 to 3.77 mg/L in 2013. The bacteria results for all 8 wells indicated that total coliform and *E. coli* were not present in the samples (Table 30).

Table 30. Summary of nutrient and bacteria analytical results and field parameters—Malad-Woodruff Follow-Up Study.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations		Bacteria		Field Measurements		
			Nitrite[a]	Nitrate[a]	Total Coliform	E. coli[a]	Water Temperature (°C)	Specific Conductivity (µS/cm)	pH[b]
			(mg/L)		(Presence/Absence)				
Standard:			***1***	***10***	***1 cfu/ 100 mL[c]***	***<1 cfu/ 100 mL[c]***	**NA**	**NA**	**6.5-8.5**
2243	129	10/10/2013	<0.10	1.53	A	A	13.1	776	7.12
1757	160	08/21/2013	<0.10	3.77	A	A	12.1	672	7.68
2352	—	08/21/2013	<0.10	3.33	A	A	13.6	1240	7.94
2353	—	08/21/2013	<0.10	3.66	A	A	13.7	1190	7.93
2354	220	08/21/2013	<0.10	3.02	A	A	11.13	683	7.63
2355	159	08/21/2013	<0.10	**23.57**	A	A	13.2	1130	7.92
2356	—	08/21/2013	<0.10	1.47	A	A	14.9	700	7.90
2357	160	08/21/2013	<0.10	**12.54**	A	A	14.5	569	7.98

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
mg/L = milligrams per liter; °C = degrees Celsius; µS/cm = microsiemens per centimeter; cfu = colony-forming unit; mL = milliliter; NA = not applicable; (—) = data are unavailable or were not analyzed
[a] Contaminant with a National Primary Drinking Water Regulation standard.
[b] Contaminant with a National Secondary Drinking Water Regulation standard.
[c] Total coliform and *E. coli* standards are from the Idaho Ground Water Quality Rule (IDAPA 58.01.11.200). An exceedance of the primary ground water quality standard for total coliform (indicated by gray shaded cells) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present.

2.5.1.3 Conclusions

Out of the 8 wells sampled for this project, 2 wells had nitrate levels exceeding EPA's MCL. The presence of total coliform or *E. coli* was not detected during this sampling effort.

DEQ was granted access to several private residential properties to observe the drainage culverts, animal waste run-off, and conditions surrounding the feedlot and nearby properties. Some of the

drainage culverts were observed to contain caked and dried animal waste, and the feedlot appeared to be in operation. DEQ contacted the Oneida County Commissioners and the county road and bridge supervisor to discuss the potential issues.

2.5.1.4 Recommendations

The well owners with nitrate concentrations above EPA's MCL were advised not to drink or cook with the well water until the water was treated. Property owners with private domestic drinking water wells should sample and analyze their well water for bacteria and nitrate on an annual basis.

Additional ground water quality monitoring should be conducted to better understand the source of the nitrate contamination. The nutrient management plan should be reviewed by the feedlot owner or operator annually to ensure that manure is properly managed to minimize adverse impacts to surface and ground water.

2.6 Twin Falls Region

No ground water quality projects were conducted using public funds in the Twin Falls region in 2013.

3 DEQ Cooperative Projects

This section presents data from special ground water quality monitoring and investigation projects that were conducted jointly by DEQ and other state agencies in calendar year 2013.

3.1 DEQ–ISDA Ground Water Monitoring Project

3.1.1 Purpose

The ISDA Ground Water Program has developed a ground water monitoring network across the state of Idaho to assess the impacts of pesticide use on ground water quality. DEQ partnered with ISDA and paid for analysis of common ions, nitrate, metals and $\delta^{15}N$ to help assess ground water quality across the state. The ground water samples were collected by ISDA staff in conjunction with pesticide sampling events, while DEQ paid for the analysis. The data will help identify areas of concern and potential health threats associated with degraded ground water quality. Additionally, the information will be used to augment data from PWSs, the IDWR Statewide Ambient Ground Water Quality Monitoring Program, and local-scale monitoring projects to be used in the NPA ranking process.

3.1.2 Methods and Results

ISDA collected 245 samples from domestic wells across the state following its EPA-approved QAPP. Samples were submitted to the UIASL in Moscow for analysis of anions (fluoride, chloride, nitrite, bromide, nitrate, orthophosphate, sulfate, and ammonia); cations; alkalinity; and metals. Samples collected in Owyhee County were also analyzed for ammonia due to the

anaerobic nature of the aquifer in the area. Most samples with nitrate concentrations above 5 mg/L were sent to the University of Arizona for $\delta^{15}N$ analysis. The analytical results are shown in Appendix B.

3.1.2.1 Laboratory Analysis

Nitrate Results

Nitrate concentrations for this project ranged from nondetect (<0.050 mg/L) to 97 mg/L. Out of the 245 samples collected for nitrate analysis, 60 samples (24.5%) met or exceeded the EPA MCL of 10 mg/L for nitrate. Twenty-six projects were sampled in 2013; at least 1 well exceeded the MCL in 20 of the 26 project areas sampled. In total, 190 samples (77.5%) were at or greater than 2 mg/L, indicating some type of non-naturally occurring nitrogen source; 2 mg/L is generally considered background level (DEQ 2008).

Well locations and nitrate concentrations are shown in Appendix B.

Nitrogen Isotope Results

Nitrogen isotope ratio analysis was performed on 92 samples, all of which had nitrate concentrations at or greater than 5 mg/L. The $\delta^{15}N$ values ranged from 1.0‰ to 15.6‰ (Appendix B, Table B1). Samples from 23 wells had $\delta^{15}N$ values ranging from +1.0‰ to +3.9‰, indicating commercial fertilizer as the likely nitrate source; 58 samples had $\delta^{15}N$ values between 4.1‰ and 8.7‰, indicating organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; 5 wells had $\delta^{15}N$ values greater than 10‰, indicating an animal or human waste source as the likely nitrate source (Table 4). Based on the ranges presented in Table 4, 3 samples with $\delta^{15}N$ values of 4.0‰ could be indicative of a nitrate source of commercial fertilizer or organic nitrogen soil, and 3 samples with $\delta^{15}N$ values of 9.1‰, 9.9‰, and 9.9‰ fall between the organic nitrogen soil source and animal or human waste source categories (Table 4).

Arsenic Results

Arsenic concentrations from the 3 wells (3401801, 8602701, and 7705301) sampled for arsenic ranged from <2 µg/L to 34 µg/L. Only well 7705301 had a detection that exceeded the MCL of 10 µg/L (Appendix B, Table B3).

Barium Results

Concentrations of barium ranged from <0.010 mg/L to 59 mg/L. The MCL for barium is 2 mg/L; only one sample (from well 7104801) had a detection meet or exceed the MCL (Appendix B, Table B3).

Fluoride Results

Reported fluoride concentrations ranged from <0.15 mg/L to 4.8 mg/L. One well (8650701) exceeded the MCL for fluoride of 4.0 mg/L (Appendix B, Table B1).

Chloride Results

Detections of chloride in ground water samples ranged from 0.6 mg/L to 640 mg/L. Two samples (from wells 7303201 and 8602701) exceeded the SMCL of 250 mg/L (Appendix B, Table B1).

Iron Results

Concentrations of iron ranged from <0.10 mg/L to 1.4 mg/L. The SMCL for iron is 0.3; 10 of the 245 wells had concentrations that met or exceeded the SMCL (Appendix B, Table B3).

Sulfate Results

Reported sulfate concentrations ranged from 2.6 mg/L to 1,300 mg/L. The SMCL for sulfate is 250 mg/L; 26wells had concentrations that met or exceeded the SMCL (Appendix B, Table B1).

Total Dissolved Solids Results

Concentrations of TDS ranged from 68 mg/L to 2,105 mg/L. The SMCL for TDS is 500 mg/L; 41 of the 245 ground water samples had results that exceeded the SMCL (Appendix B, Table B1).

Manganese Results

Reported manganese concentrations ranged from <0.005 mg/L to 0.55 mg/L. The SMCL for manganese is 0.05 mg/L; 23 wells had concentrations that met or exceeded the SMCL (Appendix B, Table B3).

3.1.3 Conclusions

The cooperative project between ISDA and DEQ resulted in the cost-effective collection of additional nitrate, common ion, and metals data that helped assess ground water quality across the state. Out of the 245 samples collected for nitrate analysis, 60 samples (24.5%) met or exceeded the EPA MCL of 10 mg/L for nitrate. The nitrate and other common ion results indicate the degradation of ground water in specific vulnerable aquifers. These data will be helpful in the next NPA delineation and ranking process conducted by DEQ and the Ground Water Monitoring Technical Committee.

3.1.4 Recommendations

This project was a good example of a cooperative effort between state agencies in Idaho saving time and money by using existing ground water monitoring networks and sampling schedules. ISDA and DEQ should continue these cooperative efforts to increase program efficiency and protect ground water quality in the state of Idaho.

References

Baldwin, J., X. Dai, and M. McVay. 2008. *Camas Prairie Nitrate Priority Area Ground Water Monitoring Results.* Boise, ID: Idaho Department of Environmental Quality. Ground Water Quality Technical Report No. 29.

Baldwin, J.A., and B. Wicherski. 1994. *Ground Water and Soils Reconnaissance of the Lower Payette Area, Payette County, Idaho*. Boise, ID: Idaho Department of Environmental Quality. Ground Water Quality Technical Report No. 5.

Bentz, B. 1998. *A Reconnaissance of Nitrite/Nitrate in Camas Prairie Ground Water, Volume I, Lewis and Idaho County*. Boise, ID: Idaho Department of Environmental Quality.

Cecil, L.D., L.F. Hall, L. Benjamin, L.L. Knobel, and J.R. Green. 2005. "Comparison of Local Meteoric Water Lines for Southeastern Idaho, Western Wyoming, and South-Central Montana." *Journal of the Idaho Academy of Science* 41(2):13–28.

DEQ (Idaho Department of Environmental Quality). 2005a. *Camas Prairie Ground Water Sampling Quality Assurance Project Plan.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2005b. *Lower Boise/Canyon County Ground Water Quality Management Plan*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2007. *Lindsay Creek Watershed Assessment and Total Maximum Daily Loads*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2008. *2008 Nitrate Priority Area Delineation and Ranking Process*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2010. *Tammany Creek Watershed (HUC 17060103): TMDL Addendum*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2011a. *Boise Regional Office Regional Ground Water Monitoring Network Design.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2011b. Follow-Up Sampling for Bacteria, Nitrates, Major Ions, Stable Isotopes, and Tritium 2009–2010: Ashton Drummond Nitrate Priority Area. Boise, ID: DEQ. Ground Water Quality Technical Report No. 43.

DEQ (Idaho Department of Environmental Quality). 2011c. *Quality Assurance Project Plan: Regional Nitrate Priority Area Ground Water Monitoring Activities, Boise Regional Office.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2011d. *Quality Assurance Project Plan: Regional Nitrate Priority Area Ground Water Monitoring Activities, Idaho Falls Region.* Idaho Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2012a. *Field Sampling Plan: Hamilton Gas Field Ground Water Monitoring Project*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2012b. *Quality Assurance Project Plan: Gas Field Ground Water Monitoring*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2012c. *Quality Assurance Project Plan: Local Dairy Nitrate Exceedance Follow-up Ground Water Monitoring.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013a. *Field Sampling Plan: Ada-Canyon Nitrate Priority Area Regional Ground Water Monitoring Network.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013b. *Field Sampling Plan: City of Payette, Baseline Ground Water Monitoring Project, Payette, Idaho*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013c. *Field Sampling Plan: Purple Sage Nitrate Priority Area Regional Ground Water Monitoring Network.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013d. *Idaho Falls Regional Office Ambient Ground Water Monitoring Plan Development; Defining Subareas.* Idaho Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013e. *Regional Ground Water Monitoring Network Design, Idaho Falls Regional Office.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013f. *Sand Hollow Creek Complaint Follow-Up Ground Water Monitoring Project, Emmett, Idaho*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2013g. *Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2010*. Boise, ID: DEQ. Ground Water Quality Technical Report No. 44.

DEQ (Idaho Department of Environmental Quality). 2013h. *Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2011*. Boise, ID: DEQ. Ground Water Quality Technical Report No. 45.

DEQ (Idaho Department of Environmental Quality). 2013i. *Teton Basin–Ashton Subarea Regional Ground Water Monitoring Field Sampling Plan*. Idaho Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2014a. *2014 Nitrate Priority Area Delineation and Ranking Process*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2014b. *Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2012.* Boise, ID: DEQ. Ground Water Quality Technical Report No. 46.

DEQ and ISCC (Idaho Department of Environmental Quality and Idaho Soil Conservation Commission). 2008. *Camas Prairie Nitrate Priority Area Ground Water Quality Management Plan*. Boise, ID: DEQ.

Eltschlager, K.K., J.W. Hawkins, W.C. Ehler, and F. Baldassare. 2001. *Technical Measures for the Investigation and Mitigation of Fugitive Methane Hazards in Areas of Coal Mining*. Pittsburgh, PA: US Department of the Interior, Office of Surface Mining Reclamation and Enforcement.

Graham, W.G., and L.J. Campbell. 1981. "Groundwater Resources of Idaho." Boise, ID: Idaho Department of Water Resources.

Hagan, E. 2003. "Ground Water Quality Clearwater Plateau Hydrogeologic Subarea, 1990–2002." Idaho Department of Water Resources. Water Information Bulletin No. 50, Part 6.

Heaton, T.H.E. 1986. "Isotopic Studies of Nitrogen Pollution in the Hydrosphere and Atmosphere: A Review." *Chemical Geology* 59:87–102.

Idaho Code. 2014. "Department of Environmental Quality Primary Administrative Agency—Agency Responsibilities." Idaho Code §39-120.

IDAPA. 2014. "Idaho Rules for Public Drinking Water Systems." Idaho Administrative Code. IDAPA 58.01.08.

IDWR (Idaho Department of Water Resources). 1992. *Water Table Elevation Contours in the Snake River Plain Aquifer*. SDE Feature Class GIS file.

Kendall, C. 1998. "Tracing Nitrogen Sources and Cycling in Catchments." In *Isotope Tracers in Catchment Hydrology*, C. Kendall and J.J. McDonnell, eds., 534–569. Amsterdam: Elsevier.

Kendall, C., E.M. Elliott, and S.D. Wankel. 2007. "Tracing Anthropogenic Inputs of Nitrogen to Ecosystems." In *Stable Isotopes in Ecology and Environmental Science*, R.H. Michener and K. Lajtha, eds., 375–449. Malden, MA: Blackwell Publishing.

Kilburn, C. 1964. "Ground Water in the Upper Part of the Teton Valley, Teton Counties, Idaho and Wyoming." US Geological Survey. Water-Supply Paper 1789.

Long, S.P., P.K. Link, S.U. Janecke, and D.W. Rogers. 2004. "Geologic Map of the Henderson Creek Quadrangle, Oneida County, Idaho." Idaho Geological Survey, Technical Report T-04-3.

Mitchell, T. 2004. *Preliminary Evaluations of Arsenic Detections in Ground Water: A County-Level Arsenic Review*. Boise, ID: Idaho Department of Environmental Quality. Ground Water Quality Technical Report No. 23.

Neely, K. 2002. *Arsenic Results From the Statewide Program 1999–2001*. Boise, ID: Idaho Department of Water Resources. Water Information Brochure #50, Part 5.

Newton, G.D. 1991. *Geohydrology of the Regional Aquifer System, Western Snake River Plain, Southwestern Idaho*. Washington D.C.: United States Government Printing Office, United States Geological Survey Professional Paper 1408-G.

Seiler, R.L. 1996. *Methods for Identifying Sources of Nitrogen Contamination of Ground Water in Valleys in Washoe County, Nevada*. United States Geological Survey Open-File Report 96-461

Steinhorst, K. 2011. *Designing a Sampling Plan for Nitrate Priority Areas: Step 2.* May 12, 2011.

Stevens, G., D. Garwood, and D. Ralston. 2003. "Report of Geologic/Hydrogeologic Services City of Nez Perce Lewis County, Idaho." Idaho Water Resources Research Institute. Final report for Technical Assistance for Rural Ground Water Development with Idaho Program.

Appendix A. Comparison of anion results: Idaho Bureau of Laboratories (IBL) and University of Idaho Analytical Sciences Laboratory (U of I).

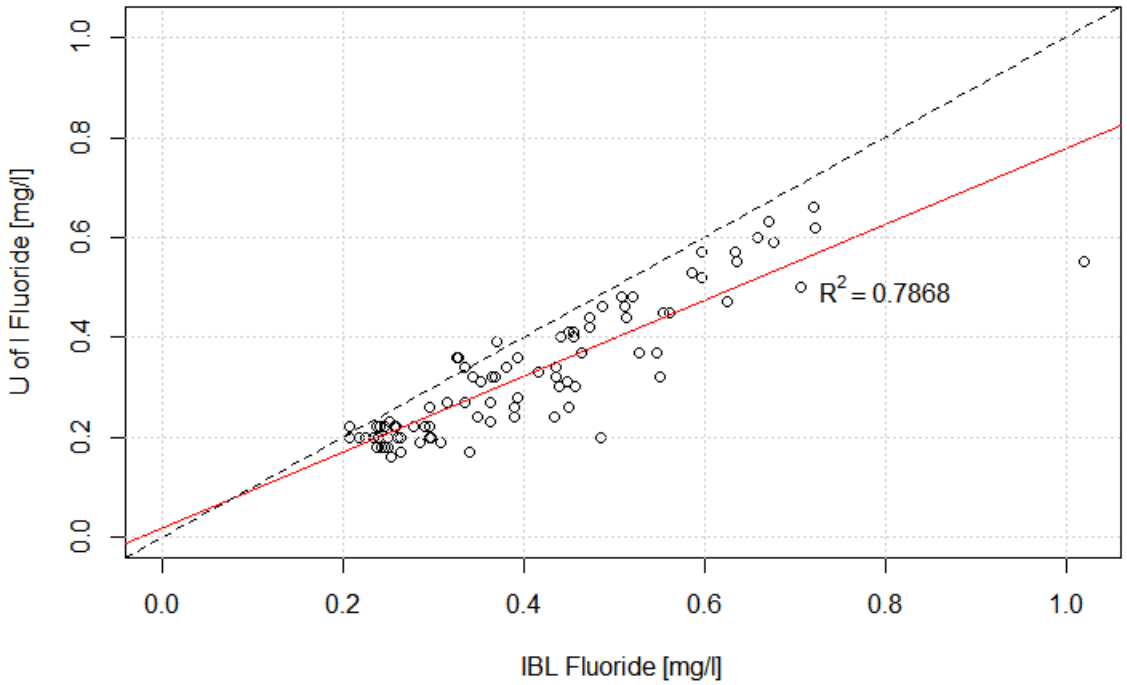


Figure A1. Fluoride comparison—IBL and U of I.

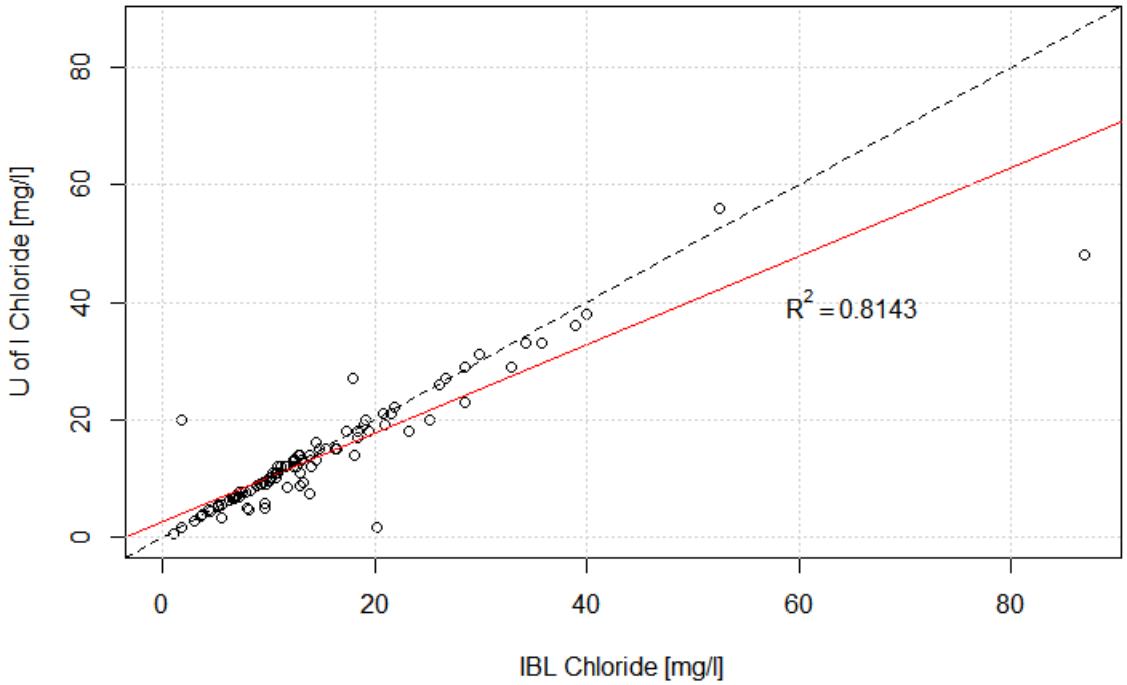


Figure A2. Chloride comparison—IBL and U of I.

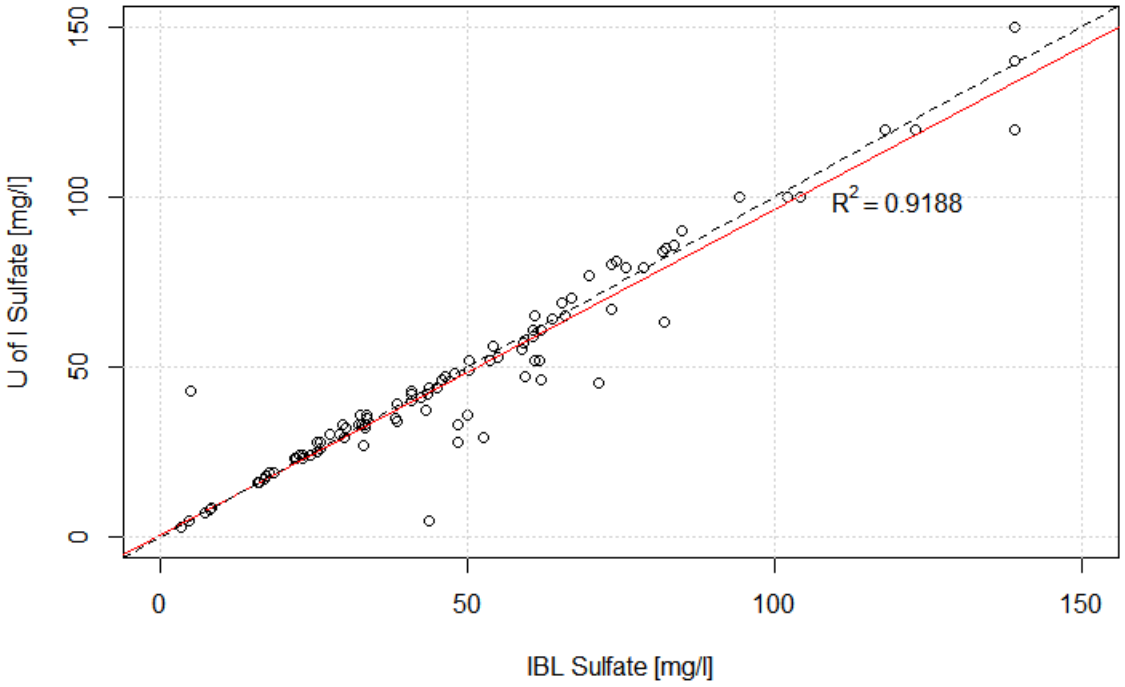


Figure A3. Sulfate comparison—IBL and U of I.

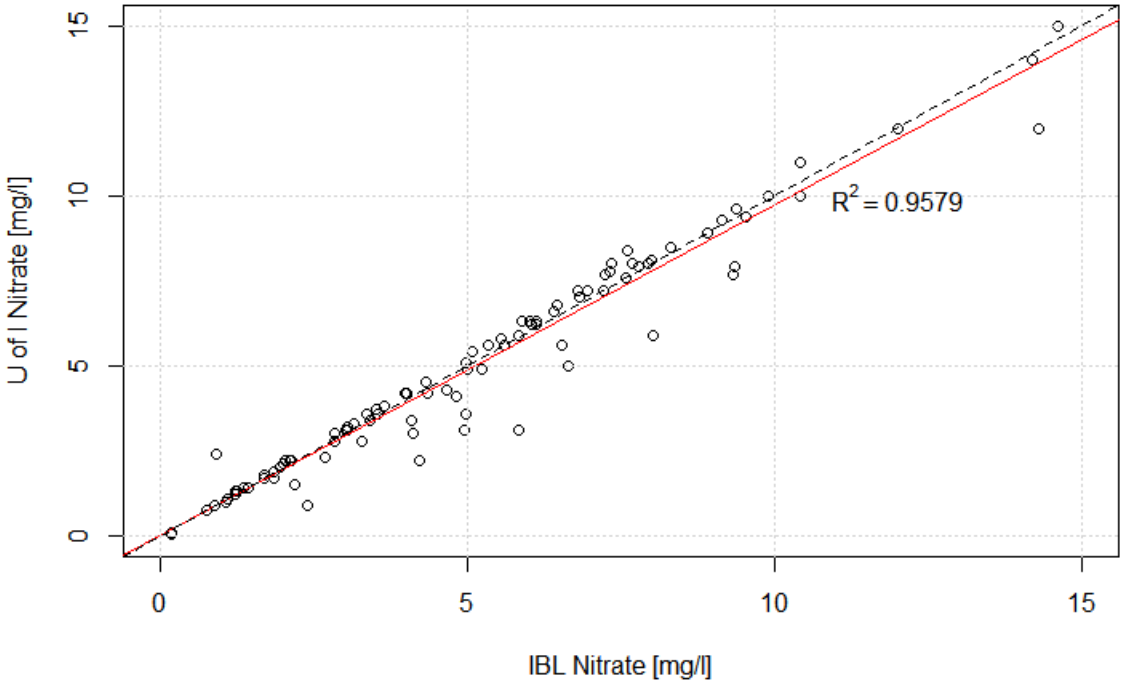


Figure A4. Nitrate comparison—IBL and U of I.

Table A1. Comparison of IBL and U of I anion results.

			Fluoride				Chloride		Nitrite				Nitrate				Sulfate	
DLS			0.2	0.15			0.8	0.2	0.3	0.05			0.18	0.05			1.6	0.2
Well No.	%DIFF		IBL	U of I	%DIFF		IBL	U of I	IBL	U of I	%DIFF		IBL	U of I	%DIFF		IBL	U of I
2102	200		0.273	0	7.743658		38.9	36	<0.30	<0.05	-1.9544		3.04	3.1	-1.68067		118	120
2103	200		0.264	0	8		19.5	18	<0.30	<0.05	-1.96353		3.53	3.6	-3.63636		54	56
2186	44.59459459		0.362	0.23	3.278689		12.4	12	<0.30	<0.05	6.515301		5.23	4.9	2.51046		60.5	59
2104	59.87261146		1.02	0.55	16.66667		13	11	<0.30	<0.05	-10		7.6	8.4	-8.74103		73.3	80
2113	33.33333333		0.392	0.28	7.860262		35.7	33	<0.30	<0.05	-0.2635		7.58	7.6	-0.71685		139	140
2106	11.65919283		0.472	0.42	-1.73913		28.5	29	<0.30	<0.05	-2.31823		9.38	9.6	-7.61246		139	150
dup	9.523809524		0.44	0.4	21.35922		28.5	23	<0.30	<0.05	16.81159		9.35	7.9	14.67181		139	120
		RPD	7.017544	4.878049		RPD	0	23.07692				RPD	0.320342	19.42857		RPD	0	22.22222
2180	35.18930958		0.528	0.37	5.668016		12.7	12	<0.30	<0.05	-2.89855		6.12	6.3	1.980198		40.8	40
2107	26.92307692		0.236	0.18	0.754717		6.65	6.6	<0.30	<0.05	-0.87884		7.93	8	-5.12821		17.1	18
2108	21.95845697		0.561	0.45	35.71429		13.2	9.2	<0.30	<0.05	30.45977		8.02	5.9	29.62963		62	46
2109	200		0.213	0	-6.64207		52.4	56	<0.30	<0.05	-8.03783		2.03	2.2	-5.97322		94.2	100
2185	66.40471513		0.339	0.17	3.571429		34.2	33	<0.30	<0.05	0.711744		2.82	2.8	9.116809		73.4	67
2110	10.63122924		0.634	0.57	-10.5263		14.4	16	<0.30	<0.05	-3.23326		6.39	6.6	-8.33333		27.6	30
2111	21.82628062		0.249	0.2	-0.45558		21.9	22	<0.30	<0.05	-2.53165		1.95	2	-1.71674		46.2	47
2112	43.31797235		0.264	0.17	12.29773		32.8	29	<0.30	<0.05	1.652893		1.22	1.2	1.980198		102	100
2105	13.58609795		0.676	0.59	3.030303		9.38	9.1	<0.30	<0.05	3.921569		10.4	10	1.464605		61.9	61
2182	41.47952444		0.457	0.3	7.365439		18.3	17	<0.30	<0.05	-3.92157		1.25	1.3	3.216651		53.7	52
2114	15.33879375		0.723	0.62	4.034582		5.31	5.1	<0.30	<0.05	-0.11242		8.89	8.9	-0.38536		25.9	26
2115	52.87356322		0.55	0.32	3.278689		12.4	12	<0.30	<0.05	-5.60748		10.4	11	3.121248		42.3	41
2116	9.865470852		0.585	0.53	-3.7037		5.3	5.5	<0.30	<0.05	-5.55556		3.5	3.7	-3.20856		18.4	19
2117	47.08249497		0.307	0.19	2.185164		8.79	8.6	<0.30	<0.05	-1.49254		7.98	8.1	3.921569		104	100
2118	11.11111111		0.38	0.34	2.441731		9.12	8.9	<0.30	<0.05	0		5.6	5.6	2.024747		44.9	44
2119	44.66019417		0.252	0.16	1.980198		15.3	15	<0.30	<0.05	1.268499		9.52	9.4	-0.31299		63.8	64
dup	47.71573604		0.244	0.15	8.917197		16.4	15	<0.30	<0.05	-1.10608		9.89	10	-5.35714		65.4	69
		RPD	3.225806	6.451613		RPD	-6.94006	0				RPD	-3.81247	-6.18557		RPD	-2.47678	-7.5188
2120	22.54196643		0.464	0.37	-3.92157		12.5	13	<0.30	<0.05	-5.43807		6.44	6.8	-6.51311		60.9	65
2121	8		0.52	0.48	61.03286		13.9	7.4	<0.30	<0.05	60.98655		5.82	3.1	57.66871		52.5	29
2122	200		0.255	0	15.38462		14	12	<0.30	<0.05	15.26104		2.68	2.3	20.2995		33.1	27
2123	26.08695652		0.26	0.2	2.739726		5.55	5.4	<0.30	<0.05	-2.38095		4.98	5.1	-3.14389		40.7	42
2124	8.834178132		0.721	0.66	-0.91324		21.8	22	<0.30	<0.05	-6.00858		6.78	7.2	-4.13437		75.8	79
2125	15.32004197		0.513	0.44	-4.08163		19.2	20	<0.30	<0.05	-4.08163		7.68	8	-5.94966		84.8	90
2126	200		0.246	0	-5.60748		10.4	11	<0.30	<0.05	-5.12821		3.99	4.2	-0.91324		32.7	33
2127	200		0.2	0	-3.7037		10.6	11	<0.30	<0.05	-2.7027		14.6	15	-3.53982		22.2	23
2136	28.31050228		0.625	0.47	-2.47469		4.39	4.5	<0.30	<0.05	-6.18557		2.82	3	-0.62696		15.9	16
2128	39.03420523		0.297	0.2	1.980198		10.2	10	<0.30	<0.05	1.41844		14.2	14	0		23	23
dup	27.5862069		0.264	0.2	1.980198		10.2	10	<0.30	<0.05	17.49049		14.3	12	0.433839		23.1	23
		RPD	11.76471	0		RPD	0	0				RPD	-0.70175	15.38462		RPD	-0.43384	0
2129	12.86549708		0.455	0.4	-5.5336		12.3	13	<0.30	<0.05	-4.87805		6	6.3	-10.5263		29.7	33
2130	10.5046344		0.511	0.46	3.604723		8.19	7.9	<0.30	<0.05	-1.2987		6.12	6.2	-5.00596		40.9	43
2183	36.19550859		0.447	0.31	6.763285		10.7	10	<0.30	<0.05	-2.75163		6.81	7	3.617571		59.1	57
2131	-195.7546321		0.472	44	-9.60699		10.9	12	<0.30	<0.05	-7.06656		5.87	6.3	-5.78778		30.2	32
2132	20.71713147		0.554	0.45	0		10	10	<0.30	<0.05	2.020202		5	4.9	3.389831		30	29
2133	24.74226804		0.436	0.34	-8.17844		12.9	14	<0.30	<0.05	-4.7532		5.34	5.6	-9.73783		25.4	28
2134	5.702217529		0.487	0.46	1.652893		18.3	18	<0.30	<0.05	0.293686		3.41	3.4	3.508772		43.5	42
dup	5.668016194		0.508	0.48	25.54517		18.1	14	<0.30	<0.05	15.78947		3.28	2.8	15.46135		43.2	37
		RPD	-4.22111	-4.25532		RPD	1.098901	25				RPD	3.886398	19.35484		RPD	0.692042	12.65823

			Fluoride				Chloride		Nitrite				Nitrate				Sulfate	
DLS			0.2	0.15			0.8	0.2	0.3	0.05			0.18	0.05			1.6	0.2
Well No.	%DIFF		IBL	U of I	%DIFF		IBL	U of I	IBL	U of I	%DIFF		IBL	U of I	%DIFF		IBL	U of I
2135	27.45098039		0.29	0.22	2.469136		12.3	12	<0.30	<0.05	-4.98615		3.52	3.7	-4.08163		33.6	35
2137	-200		0	0.17	37.78802		12.9	8.8	<0.30	<0.05	19.03643		9.32	7.7	26.08696		81.9	63
2138	37.01188455		0.349	0.24	-8.95522		12.8	14	<0.30	<0.05	-6.30372		5.07	5.4	-10.5263		32.4	36
2139	9.302325581		0.45	0.41	-1.49254		26.6	27	<0.30	<0.05	-6.29605		7.23	7.7	-2.7761		81.7	84
2140	9.372517871		0.659	0.6	25.24272		23.2	18	<0.30	<0.05	15.73034		4.8	4.1	17.06245		61.7	52
2141	23.29317269		0.278	0.22	1.950488		6.73	6.6	<0.30	<0.05	-2.61438		6.04	6.2	-2.45399		32.2	33
2142	200		0.217	0	3.418803		7.14	6.9	<0.30	<0.05	0.277393		7.22	7.2	-3.75335		18.3	19
2143	200		0.224	0	1.069519		9.4	9.3	<0.30	<0.05	0		12	12	-4.89978		21.9	23
2189	12.68882175		0.352	0.31	0.766284		6.55	6.5	<0.30	<0.05	-1.53061		7.78	7.9	-4.54545		17.2	18
2145	12.86549708		0.364	0.32	1.481481		6.8	6.7	<0.30	<0.05	-2.38095		8.3	8.5	-7.08447		17.7	19
2146	200		0.233	0	1.546392		7.82	7.7	<0.30	<0.05	-1.84482		9.13	9.3	-5.56745		22.7	24
2147	13.62007168		0.596	0.52	8.102345		9.76	9	<0.30	<0.05	7.821229		4.65	4.3	12.67218		38.6	34
2148	-10.2189781		0.325	0.36	65.56927		9.68	4.9	<0.30	<0.05	45.96273		4.95	3.1	53.59477		48.5	28
dup	-9.6069869		0.327	0.36	51.75553		9.68	5.7	<0.30	<0.05	31.7757		4.96	3.6	38.03681		48.5	33
		RPD	-0.6135	0		RPD	0	-15.0943				RPD	-0.20182	-14.9254		RPD	0	-16.3934
2149	200		0.207	0	-7.40741		13	14	<0.30	<0.05	-3.85051		4.33	4.5	-3.5225		50.2	52
dup	200		0.225	0	0.766284		13.1	13	<0.30	<0.05	3.278689		4.34	4.2	2.618328		50.3	49
		RPD	-8.33333	0		RPD	-0.76628	7.407407				RPD	-0.23068	6.896552		RPD	-0.199	5.940594
2150	6.153846154		0.67	0.63	-4.35967		7.18	7.5	<0.30	<0.05	-4.30108		3.64	3.8	-6.89655		33.6	36
2179	38.4279476		0.546	0.37	-1.83486		10.8	11	<0.30	<0.05	0		12	12	2.061856		24.5	24.0
2151	200		0.249	0	22.61641		25.1	20	<0.30	<0.05	17.93842		4.07	3.4	15.76616		60.9	52
2184	47.61904762		0.39	0.24	5.076142		10.1	9.6	<0.30	<0.05	-1.36519		5.82	5.9	3.521779		54.9	53
2152	10.40462428		0.455	0.41	-0.71685		13.9	14	<0.30	<0.05	-8.46906		7.35	8	-4.67836		66.8	70
2153	-5.533596838		0.369	0.39	50.23401		8.02	4.8	<0.30	<0.05	30.98592		4.1	3	37.63838		48.3	33
2165	21.19205298		0.334	0.27	3.921569		3.64	3.5	<0.30	<0.05	-200		0	0.061	0.369686		8.13	8.1
dup	29.38388626		0.363	0.27	-3.75335		3.66	3.8	<0.30	<0.05	-200		0	0.071	-5.00596		8.18	8.6
		RPD	-8.32138	0		RPD	-0.54795	-8.21918				RPD	0	-15.1515		RPD	-0.61312	-5.98802
2154	8.731808732		0.251	0.23	32.83582		11.7	8.4	<0.30	<0.05	15.486		6.54	5.6	22.97552		59.2	47
2000	34.16252073		0.706	0.5	6.228374		4.47	4.2	<0.30	<0.05	-2.61438		3.02	3.1	0		16	16
2187	13.95348837		0.368	0.32	170.6422		20.2	1.6	<0.30	<0.05	92.92308		2.38	0.87	162.578		43.6	4.5
dup	30.46357616		0.435	0.32	2.898551		1.75	1.7	<0.30	<0.05	1.935117		0.887	0.87	0.865801		4.64	4.6
		RPD	-16.6874	0		RPD	168.1093	-6.06061				RPD	91.39884	0		RPD	161.5257	-2.1978
2166	32.55813953		0.25	0.18	2.325581		6.96	6.8	<0.30	<0.05	-4.65116		2.1	2.2	3.981623		33.3	32
dup	17.35159817		0.238	0.2	0.433839		6.93	6.9	<0.30	<0.05	-4.65116		2.1	2.2	1.204819		33.4	33
		RPD	4.918033	-10.5263		RPD	0.431965	-1.45985				RPD	0	0		RPD	-0.29985	-3.07692
2176	8.695652174		0.24	0.22	7.692308		16.2	15	<0.30	<0.05	7.909605		1.84	1.7	6.508355		58.7	55
dup	7.439824945		0.237	0.22	-3.38983		11.6	12	<0.30	<0.05	-6.30372		1.69	1.8	-3.38983		29	30
		RPD	1.257862	0		RPD	33.09353	22.22222				RPD	8.498584	-5.71429		RPD	67.7309	58.82353
2155	16.28392484		0.259	0.22	-2.0202		14.7	15	<0.30	<0.05	-6.34921		1.22	1.3	-0.43573		45.8	46
2156	23.05630027		0.416	0.33	10		21	19	<0.30	<0.05	-3.67751		6.94	7.2	-0.49302		60.7	61
2157	4.627249357		0.597	0.57	57.93212		8.17	4.5	<0.60	<0.05	37.39837		2.19	1.5	45.09466		71.2	45
2158	200		0.484	0	57.67235		86.9	48	<0.60	<0.05	62.71451		4.21	2.2	-3.22773		82.3	85
2159	29.12621359		0.295	0.22	-7.79221		11.1	12	<0.30	<0.05	-2.3968		0.742	0.76	-7.79221		25.9	28
2160	39.66244726		0.284	0.19	0.475059		6.33	6.3	<0.30	<0.05	-4.37956		1.34	1.4	1.980198		25.5	25
2161	38.70967742		0.296	0.2	0.383877		26.1	26	<0.30	<0.05	-5.45746		3.03	3.2	-9.95228		69.7	77
2162	29.38388626		0.242	0.18	-3.96601		17.3	18	<0.30	<0.05	-4.87805		2	2.1	-0.50761		78.6	79
2163	10.75268817		0.245	0.22	-3.38983		11.6	12	<0.30	<0.05	-0.58997		1.69	1.7	-3.38983		29	30

			Fluoride				Chloride		Nitrite				Nitrate				Sulfate	
DLS			0.2	0.15			0.8	0.2	0.3	0.05			0.18	0.05			1.6	0.2
Well No.	%DIFF		IBL	U of I	%DIFF		IBL	U of I	IBL	U of I	%DIFF		IBL	U of I	%DIFF		IBL	U of I
2164	8.764940239		0.393	0.36	53.88128		5.56	3.2	<0.30	<0.05	28.03095		6.63	5	32.36321		49.9	36
2167	0		0	0	2.352941		21.5	21	<0.30	<0.05	-4.96894		3.14	3.3	1.223242		65.8	65
2168	14.34599156		0.635	0.55	0		3.7	3.7	<0.30	<0.05	-4.76611		5.53	5.8	-0.41754		47.8	48
2169	37.39837398		0.438	0.3	0		19	19	<0.30	<0.05	-6.34921		7.32	7.8	-2.83019		83.6	86
2170	7.228915663		0.344	0.32	7.228916		3.01	2.8	<0.30	<0.05	-200		0	0.097	0.421644		7.13	7.1
2188	57.3551263		0.433	0.24	-167.647		1.76	20	<0.30	<0.05	-90.0302		0.91	2.4	-160.134		4.76	43
2171	-6.088992974		0.207	0.22	-3.94737		29.8	31	<0.30	<0.05	-6.89655		3.36	3.6	-8.76289		74.2	81
2172	12.94964029		0.296	0.26	-1.45792		7.49	7.6	<0.30	<0.05	-0.91324		1.09	1.1	-3.82166		23.1	24
2173	-1.481481481		0.335	0.34	52.64568		0.943	0.55	<0.30	<0.05	-200		0	0.1	19.39799		3.28	2.7
2174	30.58823529		0.245	0.18	-0.95694		20.8	21	<0.30	<0.05	-3.20856		1.84	1.9	-0.68415		43.7	44
2175	15.51362683		0.257	0.22	-40.5345		17.9	27	<0.30	<0.05	-3.7037		2.12	2.2	10		38.4	39
2177	15.06849315		0.314	0.27	-1.72528		7.47	7.6	<0.30	<0.05	1.41844		1.42	1.4	-1.18343		16.8	17
2178	39.75346687		0.389	0.26	4.878049		39.9	38	<0.30	<0.05	-4.87805		4	4.2	2.469136		123	120
2181	53.52112676		0.45	0.26	10.21898		14.4	13	<0.30	<0.05	5.882353		1.05	0.99	8.743169		38.2	35
98																		
		RPD	7.017544	4.878049		RPD	0	23.07692				RPD	0.320342	19.42857		RPD	0	22.2222
			3.225806	6.451613			6.94006	0					3.81247	6.18557			2.47678	7.5188
			11.76471	0			0	0					0.70175	15.38462			0.43384	0
			4.22111	4.25532			1.098901	25					3.886398	19.35484			0.692042	12.65823
			0.6135	0			0	15.0943					0.20182	14.9254			0	16.3934
			8.33333	0			0.76628	7.407407					0.23068	6.896552			0.199	5.940594
			8.32138	0			0.54795	8.21918					0	15.1515			0.61312	5.98802
			16.6874	0			168.1093	6.06061					91.39884	0			161.5257	2.1978
			4.918033	10.5263			0.431965	1.45985					0	0			0.29985	3.07692
			1.257862	0			33.09353	22.22222					8.498584	5.71429			67.7309	58.82353
		avg.	6.636068	2.611128		avg.	21.0988	10.85405				avg.	10.90509	10.30413		avg.	23.39712	13.48195

FLUORIDE		**CHLORIDE**		**NITRATE**		**SULFATE**	
% DIFF	% Samples	% DIFF	% Samples	% DIFF	% Samples	% DIFF	% Samples
≥ 50	20%	≥ 50% diff	10%	≥ 50% diff	8%	≥ 50% diff	4%
26 - 50	31%	26 - 50	6%	26 - 50	6%	26 - 50	6%
≤ 25	49%	≤ 25	84%	≤ 25	86%	≤ 25	90%

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Appendix B. Idaho State Department of Agriculture (ISDA) 2013 data.

Table B1. Field parameters and anions—ISDA 2013 data.

ISDA Well ID	Sample Date	Temp (°C)	pH	SpecCond (µS/cm)	TDS (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrite (mg/L)	Bromide (mg/L)	Nitrate (mg/L)	OrthoP (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
2200201	5/7/2013	15.6	7.22	1296	*641*	0.78	160	ND	1.1	6.8	<0.10	*360*	NS	6.2
2200301	5/7/2013	14.1	6.90	719	353	0.6	14	ND	ND	**14**	<0.10	98	NS	2.9
2201001	5/8/2013	16.7	6.84	367	180	0.63	4.9	ND	ND	3.4	ND	18	NS	NA
2201201	5/8/2013	16.7	*6.47*	644	316	0.69	10	ND	ND	1.4	<0.10	58	NS	NA
2201301	5/7/2013	14.7	6.91	636	312	0.73	14	ND	<0.10	7	<0.10	48	NS	6.4
2201701	5/8/2013	17.7	6.94	375	184	0.51	2.9	ND	ND	1.7	<0.10	9.6	NS	NA
2201801	5/8/2013	13.7	6.70	597	292	0.9	3.6	ND	ND	7.8	<0.10	36	NS	3.3
2201901	5/7/2013	15.9	6.64	635	311	0.4	9.1	ND	0.13	5.2	ND	66	NS	5.9
2202001	5/7/2013	14.7	6.68	197	97	0.55	1.3	ND	ND	0.41	<0.10	8.4	NS	NA
2202601	5/9/2013	15.7	7.40	165	81	0.46	3.2	ND	ND	1.6	0.12	5.4	<0.10	NA
2203001	5/9/2013	14.2	6.68	545	267	<0.15	12	ND	ND	4.9	<0.10	45	NS	NA
2203101	5/9/2013	13.8	6.78	802	392	0.15	29	ND	0.12	7.7	<0.10	110	NS	6.8
2203801	5/9/2013	13.9	6.76	138	68	0.28	5.2	ND	ND	0.32	<0.10	14	NS	NA
2204601	5/8/2013	16.2	7.02	826	405	0.36	62	ND	0.3	4.5	ND	130	NS	NA
2204701	5/8/2013	15.2	6.71	692	339	0.66	18	ND	ND	6.4	<0.10	71	NS	6.0
2205701	5/13/2013	14.4	7.02	593	290	0.6	6.9	ND	ND	6.6	<0.10	51	NS	4.9
2206201	5/9/2013	14.4	6.96	1195	*584*	1	34	ND	0.17	9.7	<0.10	190	NS	4.2
2230101	5/13/2013	16.3	6.77	679	333	0.45	23	ND	0.11	4.4	<0.10	85	NS	NA
3004601	6/12/2013	17.2	6.86	973	478	0.41	53	ND	<0.10	**15**	<0.10	100	NS	3.6
3100201	5/28/2013	19.3	7.02	2077	*1017*	0.97	130	ND	0.38	0.15	0.13	*410*	11	NA
3100401	5/28/2013	20.8	7.05	2334	*1144*	0.77	240	ND	0.8	ND	<0.10	*300*	7	NA
3100601	5/28/2013	21.1	6.96	2343	*1148*	1	130	ND	0.42	0.78	0.13	*590*	5.6	NA
3101001	5/29/2013	18.6	7.10	3120	*1527*	0.59	210	ND	0.57	0.18	0.11	*880*	9.3	NA
3101201	5/28/2013	19.5	6.93	1822	*893*	0.68	160	ND	0.65	<0.050	0.19	85	7	NA
3201001	6/20/2013	11.1	6.82	517	253	0.25	4.1	ND	ND	**12**	<0.10	13	NS	4.6
3300401	8/21/2013	21.7	7.14	229.3	112	0.27	1.9	ND	ND	1	ND	7.7	NS	NA
3300801	8/21/2013	17.2	7.03	397	194	0.33	7.1	ND	<0.10	3.1	ND	17	NS	NA
3400501	5/14/2013	15.6	6.86	919	450	0.59	21	ND	ND	**11**	0.18	37	NS	6.2
3400701	5/14/2013	15.7	6.96	703	344	0.4	24	ND	0.17	1.2	0.13	83	NS	NA
3400801	5/18/2013	14.8	6.77	805	395	0.49	11	ND	ND	8.7	0.11	32	NS	6.5
3401501	5/14/2013	14.4	6.77	702	343	0.64	14	ND	ND	8.5	0.15	34	NS	5.3
3401801	5/14/2013	15.1	6.82	852	417	0.49	27	ND	ND	**11**	0.14	32	NS	5.6
5302001	5/6/2013	13.1	*6.20*	664	325	0.31	20	ND	ND	**16**	0.11	28	NS	6.9
5302401	5/6/2013	13.4	*6.41*	744	365	0.31	37	ND	ND	**16**	0.18	33	NS	7.4
5302501	5/6/2013	13.3	*6.12*	842	413	0.29	51	ND	<0.10	**24**	0.18	42	NS	8.7
5303401	5/6/2013	13.6	*6.25*	1096	*537*	0.24	59	ND	ND	**41**	0.16	74	NS	8.2
5303701	5/6/2013	13.4	*6.36*	781	383	0.22	32	ND	ND	**28**	0.2	47	NS	7.2
7100101	5/20/2013	16.5	6.63	911	447	0.22	70	ND	0.41	5.4	0.56	120	NS	8.7
7100201	5/20/2013	14.0	6.60	1411	*692*	1.2	73	ND	0.11	**53**	0.21	140	NS	2.8
7100501	5/23/2013	14.0	6.70	837	410	0.24	6.6	ND	ND	**14**	0.17	75	NS	2.0
7100601	5/22/2013	14.9	6.59	852	417	0.23	13	ND	<0.10	**12**	0.19	110	NS	3.9
7100901	5/21/2013	14.4	*6.47*	989	485	0.2	27	ND	0.1	**13**	<0.10	180	NS	4.7
7101201	5/21/2013	12.7	6.69	1291	*632*	0.95	21	ND	ND	**11**	0.25	170	NS	7.0
7101701	5/23/2013	14.7	6.65	760	373	0.19	9.1	ND	ND	**10**	0.22	88	NS	3.0
7102101	5/22/2013	13.0	6.75	703	345	0.42	9.8	ND	ND	7.6	0.32	75	NS	6.8
7102301	5/23/2013	14.7	6.52	1012	496	0.69	25	ND	ND	7	0.19	95	NS	2.6
7102501	5/22/2013	13.9	*6.45*	1403	*688*	0.26	66	ND	0.17	**17**	<0.10	*330*	NS	9.9
7102701	5/23/2013	13.0	*6.35*	806	394	0.28	12	ND	ND	9.9	0.21	100	NS	5.8
7103801	5/21/2013	16.6	6.82	913	447	0.26	19	ND	ND	**11**	0.17	180	NS	4.5

ISDA Well ID	Sample Date	Temp (°C)	pH	SpecCond (µS/cm)	TDS (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrite (mg/L)	Bromide (mg/L)	Nitrate (mg/L)	OrthoP (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
7103901	5/21/2013	14.5	*6.47*	760	372	0.26	7.1	ND	ND	9.7	0.12	55	NS	1.2
7104001	5/23/2013	14.3	6.74	984	482	0.18	11	ND	<0.10	**21**	0.14	100	NS	1.0
7104101	5/21/2013	13.5	6.64	1449	*712*	0.61	24	ND	ND	**29**	0.12	220	NS	2.9
7104201	5/22/2013	14.7	*6.41*	873	428	0.66	16	ND	0.13	**19**	0.4	130	NS	5.2
7104601	5/23/2013	14.1	*6.42*	730	358	0.46	38	ND	0.23	7	0.27	110	NS	4.3
7104801	5/23/2013	13.3	6.73	941	461	0.27	8.2	ND	ND	**15**	0.18	85	NS	1.2
7105101	5/22/2013	14.0	6.58	721	353	0.19	9.5	ND	ND	8.6	0.26	100	NS	4.5
7300201	7/25/2013	13.8	6.64	834	409	0.29	44	ND	0.11	7.7	<0.10	77	NS	NA
7300501	7/24/2013	16.6	6.68	611	299	0.2	30	ND	ND	2.2	<0.10	45	NS	NA
7300801	7/25/2013	12.1	6.73	1056	*518*	0.76	59	ND	ND	**12**	<0.10	140	NS	NA
7300901	7/25/2013	14.5	6.72	958	469	0.84	43	ND	ND	9.7	<0.10	120	NS	NA
7301101	7/30/2013	15.4	6.76	611	299	<0.15	26	ND	ND	6	<0.10	53	NS	NA
7301501	7/30/2013	14.8	6.99	592	290	0.38	43	ND	ND	ND	<0.10	35	NS	NA
7301601	7/25/2013	12.9	6.72	844	414	0.29	45	ND	ND	8.8	<0.10	84	NS	NA
7301801	7/24/2013	15.7	6.88	805	394	0.37	82	ND	0.11	6.6	<0.10	67	NS	NA
7301901	7/29/2013	15.4	6.62	993	486	0.94	62	ND	ND	**15**	0.14	67	NS	12.1
7302001	7/24/2013	16.6	6.69	602	295	0.18	26	ND	ND	3.4	ND	47	NS	NA
7303001	7/24/2013	15.2	6.76	582	284	0.43	29	ND	ND	2.7	<0.10	49	NS	NA
7303101	7/30/2013	14.2	6.83	661	324	0.46	37	ND	ND	4.8	<0.10	59	NS	NA
7303201	7/25/2013	13.5	6.78	2334	*1148*	0.54	*340*	ND	0.48	**29**	ND	*310*	NS	11.3
7303401	7/29/2013	13.7	6.85	605	297	0.7	28	ND	ND	0.22	<0.10	74	NS	NA
7303901	7/24/2013	16.2	6.60	653	320	0.52	30	ND	ND	9.5	<0.10	59	NS	NA
7304101	7/30/2013	14.7	6.92	682	334	0.21	34	ND	ND	**11**	<0.10	65	NS	3.6
7304301	7/24/2013	15.1	6.77	651	319	0.5	25	ND	ND	5.5	<0.10	52	NS	NA
7304501	7/25/2013	13.2	6.72	927	454	0.37	50	ND	ND	9.8	<0.10	120	NS	6.1
7400401	7/23/2013	14.7	6.65	554	272	0.51	48	ND	ND	2.1	<0.10	59	NS	NA
7401501	7/23/2013	15.2	6.73	822	403	0.22	47	ND	ND	7.1	<0.10	90	NS	NA
7401801	7/23/2013	14.6	6.80	822	403	0.15	60	ND	0.14	5.6	ND	91	NS	NA
7402001	7/23/2013	14.1	6.92	956	468	0.28	100	ND	0.18	6.4	<0.10	96	NS	NA
7402701	7/24/2013	15.8	6.75	711	349	0.43	53	ND	ND	6	<0.10	59	NS	NA
7403201	7/22/2013	15.4	6.76	871	427	0.18	80	ND	0.14	5.3	ND	100	NS	NA
7404101	7/23/2013	15.1	6.82	779	381	0.37	65	ND	0.11	5.8	<0.10	74	NS	NA
7404801	7/22/2013	13.9	6.62	872	427	0.18	56	ND	<0.10	8.7	<0.10	81	NS	NA
7404901	7/22/2013	19.6	6.82	434	212	0.45	44	ND	ND	0.85	<0.10	42	NS	NA
7405101	7/23/2013	15.3	6.92	740	362	0.29	55	ND	0.12	5.7	<0.10	72	NS	NA
7502201	7/17/2013	15.1	6.79	475	233	0.44	28	ND	ND	1.1	<0.10	45	NS	NA
7502401	7/16/2013	15.6	6.92	671	329	0.38	44	ND	ND	3.6	ND	62	NS	NA
7503401	7/17/2013	15.8	7.05	363	178	0.49	22	ND	ND	0.73	<0.10	35	NS	NA
7504701	7/16/2013	15.8	6.74	665	326	0.53	31	ND	ND	2.7	<0.10	66	NS	NA
7505501	7/16/2013	15.3	6.65	576	282	0.44	27	ND	ND	3.4	<0.10	55	NS	NA
7507001	7/16/2013	14.7	6.86	1101	*540*	0.45	31	ND	ND	**11**	<0.10	84	NS	3.7
7507401	7/16/2013	16.0	6.92	634	311	0.41	59	ND	<0.10	3.2	<0.10	58	NS	NA
7600601	5/6/2013	13.1	*6.37*	814	399	0.22	37	ND	ND	**29**	0.17	49	NS	6.7
7700801	5/16/2013	15.3	6.61	565	277	0.31	2.9	ND	ND	2.8	<0.10	6.6	NS	NA
7701101	5/16/2013	14.6	6.62	563	276	0.27	18	ND	ND	5.3	0.13	46	NS	4.7
7701401	5/15/2013	15.7	6.86	653	320	0.19	12	ND	ND	ND	<0.10	48	NS	NA
7701701	5/15/2013	11.6	6.90	1044	*512*	1.3	25	ND	0.12	3.5	0.17	140	NS	NA
7702501	5/16/2013	14.6	6.82	571	280	0.52	12	ND	ND	4.2	0.12	40	NS	NA
7703001	5/16/2013	14.0	6.65	473	232	0.38	5.2	ND	ND	3.8	<0.10	18	NS	NA
7703201	5/14/2013	14.3	6.78	703	344	0.4	12	ND	ND	3.1	<0.10	32	NS	NA
7703501	5/16/2013	15.1	7.98	188	92	0.26	4.1	ND	ND	ND	<0.10	10	NS	NA
7703601	5/15/2013	13.7	7.02	822	402	0.53	8	ND	ND	**14**	0.14	58	NS	3.5
7703701	5/15/2013	14.6	7.03	383	188	0.37	20	ND	ND	ND	<0.10	40	NS	NA
7705201	5/14/2013	15.0	6.77	756	371	0.47	10	ND	ND	5.8	0.23	23	NS	5.3
7705301	5/15/2013	14.0	6.98	864	424	0.62	11	ND	ND	**11**	0.13	32	NS	4.1

ISDA Well ID	Sample Date	Temp (°C)	pH	SpecCond (µS/cm)	TDS (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrite (mg/L)	Bromide (mg/L)	Nitrate (mg/L)	OrthoP (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
7800201	7/17/2013	14.5	6.72	841	412	0.83	35	ND	<0.10	4.6	<0.10	130	NS	NA
7801701	7/17/2013	15.5	6.97	898	440	0.24	44	ND	<0.10	8	<0.10	100	NS	NA
7803601	7/18/2013	13.1	7.15	1254	*615*	0.82	55	ND	0.11	**11**	<0.10	180	NS	6.3
7804101	7/18/2013	14.3	6.72	783	385	0.98	32	ND	ND	4.1	ND	68	NS	NA
7804201	7/18/2013	13.1	6.80	831	406	0.86	37	ND	ND	5.4	ND	74	NS	NA
7804301	7/18/2013	13.2	6.68	899	440	0.92	44	ND	<0.10	6.6	<0.10	94	NS	NA
7804401	7/18/2013	15.7	6.72	845	414	0.77	40	ND	<0.10	2.9	ND	78	NS	NA
7805501	7/17/2013	15.4	6.68	905	444	0.95	38	ND	<0.10	9.4	<0.10	91	NS	NA
7805601	7/18/2013	16.1	6.86	829	407	0.9	43	ND	0.1	7.1	<0.10	100	NS	NA
7805701	7/18/2013	13.9	6.85	827	405	0.89	54	ND	<0.10	7.2	<0.10	91	NS	NA
7806401	7/17/2013	15.7	6.73	703	345	0.8	31	ND	ND	4	<0.10	67	NS	NA
7806601	7/18/2013	13.0	6.65	860	422	1.3	40	ND	ND	6.2	<0.10	100	NS	NA
7900101	8/5/2013	17.9	6.92	838	411	0.36	85	ND	0.3	4.5	ND	120	NS	NA
7900601	7/30/2013	13.0	6.71	887	435	<0.15	43	ND	ND	9.5	<0.10	80	NS	NA
7900701	7/30/2013	13.5	*6.50*	780	382	<0.15	49	ND	ND	**13**	<0.10	85	NS	7.5
7900801	7/31/2013	13.8	13.80	758	370	<0.15	34	ND	ND	9.3	ND	61	NS	NA
7900901	8/1/2013	14.2	6.56	633	310	0.16	31	ND	ND	5.2	ND	59	NS	NA
7901001	8/1/2013	14.2	6.83	825	405	<0.15	38	ND	<0.10	**10**	ND	70	NS	3.5
7901101	8/5/2013	16.8	6.80	611	298	<0.15	53	ND	<0.10	3.8	ND	47	NS	NA
7901301	7/30/2013	16.2	6.62	514	252	0.21	33	ND	ND	3.2	0.14	45	NS	NA
7901401	7/31/2013	13.0	6.82	913	446	<0.15	46	ND	<0.10	**15**	ND	70	NS	9.4
7901501	7/31/2013	14.2	6.80	886	434	0.29	34	ND	ND	**10**	ND	80	NS	3.5
7901601	7/31/2013	12.1	6.62	855	419	0.15	32	ND	<0.10	**11**	ND	78	NS	4.6
7901701	7/31/2013	12.7	6.83	688	338	0.23	25	ND	ND	6.3	ND	61	NS	NA
7901801	7/31/2013	14.2	6.68	590	289	0.39	23	ND	ND	5.6	ND	46	NS	NA
7901901	7/31/2013	14.0	6.72	920	451	<0.15	36	ND	ND	**12**	ND	68	NS	5.9
7902001	8/1/2013	13.9	6.75	710	347	<0.15	38	ND	ND	6.8	ND	76	NS	NA
7902101	8/1/2013	16.6	6.82	745	365	<0.15	41	ND	<0.10	**13**	ND	70	NS	4.6
7902201	8/1/2013	12.0	*6.38*	593	291	1.6	30	ND	ND	1.4	0.15	60	NS	NA
7902401	8/1/2013	12.5	6.52	826	404	0.74	39	ND	ND	6.3	ND	73	NS	NA
7903201	8/1/2013	12.2	6.67	781	382	0.42	45	ND	ND	9.1	ND	74	NS	NA
7903501	7/31/2013	12.9	6.68	892	440	<0.15	33	ND	ND	**11**	ND	64	NS	6.2
7903601	7/31/2013	13.9	6.78	763	374	0.15	43	ND	<0.10	**10**	ND	65	NS	6.7
7903801	8/5/2013	15.6	6.68	794	389	0.32	47	ND	ND	**13**	ND	94	NS	9.9
7904001	8/5/2013	14.0	6.56	625	306	0.37	36	ND	<0.10	4.4	ND	70	NS	NA
7904101	8/5/2013	12.7	6.64	606	297	<0.15	36	ND	0.12	5.4	ND	35	NS	NA
8050301	6/20/2013	10.5	6.72	497	244	0.54	5.5	ND	ND	9.5	<0.10	16	NS	4.0
8050801	6/18/2013	12.4	6.68	425	208	1	7.3	ND	ND	5.9	<0.10	17	NS	3.3
8050901	6/18/2013	11.6	*6.34*	398	195	1.1	8.8	ND	ND	4.6	<0.10	16	NS	NA
8051301	6/19/2013	10.0	6.68	467	229	0.25	4.3	ND	ND	4.7	<0.10	4.7	NS	NA
8051401	6/19/2013	11.5	6.52	411	202	0.31	7.5	ND	ND	8.9	<0.10	20	NS	NA
8051501	6/19/2013	11.7	6.82	330	162	0.54	6.9	ND	ND	3.7	0.11	5.2	NS	NA
8052801	6/19/2013	8.9	6.58	474	232	0.23	4.1	ND	ND	8.5	<0.10	20	NS	4.0
8053401	6/19/2013	10.1	6.52	317	155	1.2	2.8	ND	ND	1.5	<0.10	2.6	NS	NA
8053501	6/19/2013	8.7	*6.35*	489	238	0.27	2.4	ND	ND	**12**	<0.10	23	NS	5.5
8053901	6/18/2013	14.6	6.85	402	197	0.96	7	ND	ND	5.5	<0.10	15	NS	5.1
8054601	6/19/2013	10.7	6.73	803	393	0.41	10	ND	ND	**29**	<0.10	38	NS	7.8
8055201	6/20/2013	12.3	6.82	533	261	0.53	4.5	ND	ND	7.8	<0.10	7.4	NS	4.7
8100401	6/3/2013	13.7	6.95	1080	*530*	0.25	80	ND	0.51	**13**	ND	240	NS	NA
8100601	6/3/2013	13.3	6.83	1407	*689*	0.52	36	ND	0.22	**26**	<0.10	*360*	NS	2.8
8101601	6/13/2013	12.9	*6.10*	219.8	108	0.47	7	ND	ND	0.51	0.28	27	NS	NA
8101701	6/4/2013	14.2	*6.50*	478	234	0.22	11	ND	ND	5.2	0.22	27	NS	7.1
8101901	6/13/2013	11.8	6.62	698	342	0.4	20	ND	0.11	**11**	0.24	130	NS	5.1
8102101	6/3/2013	13.5	*6.22*	500	245	0.19	7.1	ND	ND	7.6	0.17	30	NS	3.7
8102601	6/3/2013	11.1	*6.32*	1152	*565*	0.53	60	ND	0.36	**11**	0.12	210	NS	15.6

ISDA Well ID	Sample Date	Temp (°C)	pH	SpecCond (µS/cm)	TDS (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrite (mg/L)	Bromide (mg/L)	Nitrate (mg/L)	OrthoP (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
8201201	8/27/2013	10.2	6.83	292.5	143	<0.15	1.4	ND	ND	2.1	ND	11	NS	NA
8202901	8/28/2013	17.2	7.06	201.5	99	<0.15	7.7	ND	ND	2.1	ND	11	NS	NA
8204501	8/27/2013	9.9	6.88	349	171	<0.15	1.8	ND	ND	1.8	ND	19	NS	NA
8204601	8/28/2013	10.2	6.98	268	131	<0.15	3.1	ND	ND	1.5	ND	13	NS	NA
8204701	8/28/2013	10.9	6.92	302	148	<0.15	1.9	ND	ND	1.2	ND	16	NS	NA
8204801	8/28/2013	9.6	6.92	272.1	133	<0.15	1.6	ND	ND	0.74	ND	16	NS	NA
8205001	8/28/2013	9.1	7.06	288.2	141	<0.15	1.1	ND	ND	0.92	ND	17	NS	NA
8205101	8/27/2013	8.8	7.02	364	178	<0.15	1.4	ND	ND	2.3	ND	20	NS	NA
8205201	8/27/2013	15.1	7.04	310	152	<0.15	3.8	ND	ND	3.1	ND	9	NS	NA
8300201	6/18/2013	12.6	6.90	335	164	0.84	8.3	ND	ND	4.2	<0.10	18	NS	NA
8300301	6/17/2013	13.1	6.85	302	148	0.87	8.5	ND	ND	4.4	<0.10	19	NS	NA
8300401	6/18/2013	13.1	6.98	322	158	0.83	7.6	ND	ND	3.5	<0.10	16	NS	NA
8300501	6/18/2013	13.7	6.79	342	168	0.99	8.5	ND	ND	4	<0.10	17	NS	NA
8301101	6/17/2013	13.7	6.62	290	142	0.39	9.6	ND	ND	1	<0.10	10	NS	NA
8301401	6/17/2013	12.2	6.60	693	340	<0.15	52	ND	0.11	6.6	0.29	36	NS	NA
8301801	6/17/2013	13.1	6.61	728	357	0.16	52	ND	<0.10	5.2	<0.10	37	NS	NA
8302001	6/17/2013	12.2	6.95	281	138	0.64	9.6	ND	ND	ND	<0.10	5	NS	NA
8302701	6/17/2013	10.7	6.66	1006	493	0.2	61	ND	0.12	8.6	<0.10	76	NS	5.2
8303001	6/17/2013	11.3	6.76	727	356	<0.15	27	ND	ND	7.8	<0.10	24	NS	6.8
8401501	6/24/2013	11.9	6.53	545	267	0.35	14	ND	ND	4.6	<0.10	52	NS	NA
8401601	6/24/2013	11.8	6.63	482	236	0.39	13	ND	ND	1.4	<0.10	53	NS	NA
8404201	6/25/2013	12.1	6.56	476	233	0.37	12	ND	ND	1.1	<0.10	48	NS	NA
8404301	6/25/2013	12.4	6.76	417	204	0.35	9.7	ND	ND	0.87	<0.10	44	NS	NA
8404401	6/25/2013	12.8	6.54	486	238	0.35	9.5	ND	ND	2.4	<0.10	40	NS	NA
8404801	6/25/2013	12.5	6.58	533	261	0.23	12	ND	ND	2.2	<0.10	39	NS	NA
8404901	6/24/2013	11.9	6.67	509	250	0.32	8.9	ND	ND	2.9	ND	41	NS	NA
8405001	6/24/2013	12.0	6.77	444	218	0.35	8.5	ND	ND	1.9	<0.10	40	NS	NA
8405301	6/25/2013	9.8	6.63	488	239	0.32	20	ND	ND	0.29	<0.10	64	NS	NA
8405801	6/24/2013	11.8	6.71	475	232	0.35	10	ND	ND	1.1	<0.10	42	NS	NA
8406101	6/24/2013	12.4	6.62	500	245	0.32	9.1	ND	ND	1.7	<0.10	42	NS	NA
8600801	5/29/2013	15.8	6.95	1077	*528*	0.41	54	ND	0.3	ND	ND	170	2.4	NA
8600901	5/29/2013	15.8	7.01	1296	*635*	0.44	76	ND	0.32	ND	<0.10	*320*	6.2	NA
8601101	10/1/2013	14.3	6.80	2540	*1245*	2.4	38	ND	0.2	4	<0.10	*990*	<0.10	5.7
8601101	5/28/2013	14.4	6.84	2686	*1316*	2.5	47	ND	0.24	5.5	ND	*990*	<0.10	NA
8601401	5/30/2013	15.1	6.53	1479	*725*	0.39	120	ND	0.51	7.9	<0.10	*320*	<0.10	7.6
8601401	10/1/2013	15.1	6.72	1488	*729*	0.4	120	ND	0.53	7.9	<0.10	*330*	<0.10	NA
8601801	5/30/2013	16.0	7.25	983	481	1.7	33	ND	0.13	ND	<0.10	6.2	4.9	8.3
8601801	10/1/2013	16.4	7.31	980	480	1.8	27	0.078	0.13	ND	<0.10	17	4.7	NA
8602001	10/1/2013	15.2	6.78	1042	*512*	0.56	18	ND	ND	0.36	<0.10	*320*	1.3	NA
8602001	5/30/2013	14.5	6.54	1320	*646*	0.67	36	ND	0.11	1.9	<0.10	*390*	0.91	NA
8602701	5/29/2013	17.8	6.92	4300	*2105*	1	*640*	ND	1.8	**13**	ND	*1300*	<0.10	NA
8602901	5/30/2013	17.5	7.01	2226	*1091*	0.65	72	ND	0.32	ND	0.12	*540*	9.1	NA
8603001	5/30/2013	20.7	6.52	1360	*668*	0.52	36	ND	0.17	ND	<0.10	*270*	8.2	NA
8603001	10/1/2013	22.1	6.71	1424	*698*	0.56	38	ND	0.18	ND	<0.10	*300*	8.2	NA
8603101	5/30/2013	18.9	6.98	2001	*981*	0.62	63	ND	0.21	0.64	0.12	*590*	6.8	NA
8603201	5/29/2013	19.1	6.98	2167	*1062*	0.68	63	ND	0.29	ND	0.23	*370*	8.8	NA
8604601	5/29/2013	15.4	6.95	2145	*1051*	1.5	110	ND	0.57	**14**	ND	*680*	<0.10	5.2
8604801	10/1/2013	18.8	6.96	2466	*1208*	1	130	ND	0.42	0.37	0.11	*740*	5.5	NA
8650101	6/5/2013	15.0	6.67	973	477	0.67	49	ND	0.14	**12**	ND	140	NS	5.5
8650201	6/4/2013	16.1	6.80	764	374	0.7	39	ND	0.11	7.8	ND	100	NS	4.6
8650301	6/5/2013	15.4	*6.50*	2433	*1191*	0.99	150	ND	0.63	**97**	ND	*490*	NS	6.7
8650501	6/6/2013	17.5	6.51	1974	*967*	1.1	120	ND	0.39	**21**	<0.10	*690*	NS	5.2
8650601	6/5/2013	13.5	*6.42*	1291	*633*	0.59	46	ND	0.15	5.1	ND	170	NS	8.4
8650701	6/5/2013	15.9	6.54	1151	*564*	**4.8**	74	ND	0.18	**24**	ND	170	NS	NA
8653401	6/5/2013	13.7	*6.48*	923	452	1	39	ND	<0.10	3.3	ND	99	NS	NA

ISDA Well ID	Sample Date	Temp (°C)	pH	SpecCond (µS/cm)	TDS (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrite (mg/L)	Bromide (mg/L)	Nitrate (mg/L)	OrthoP (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
8655001	6/6/2013	16.3	16.30	994	487	1.1	41	ND	0.1	5.3	<0.10	110	NS	5.2
8700501	6/11/2013	12.2	6.76	970	475	0.62	64	ND	0.11	**19**	<0.10	110	NS	NA
8700601	6/11/2013	18.0	6.97	483	237	0.52	15	ND	ND	2.5	<0.10	41	NS	NA
8700801	6/11/2013	14.1	6.63	813	398	0.54	36	ND	<0.10	8	<0.10	75	NS	NA
8701201	6/11/2013	15.1	6.94	1007	493	0.69	69	ND	0.28	**12**	<0.10	170	NS	NA
8701401	6/12/2013	14.3	6.68	897	439	0.48	62	ND	0.33	6.6	<0.10	120	NS	4.6
8701601	6/12/2013	16.9	6.88	708	347	0.62	53	ND	0.17	6.7	<0.10	94	NS	6.7
8701801	6/11/2013	16.1	6.62	716	351	0.34	52	ND	0.3	2.7	<0.10	120	NS	NA
8900401	6/10/2013	18.0	*6.46*	952	466	0.76	53	ND	0.14	8.1	<0.10	110	NS	3.2
8900501	6/10/2013	17.7	6.52	750	368	0.75	51	ND	0.23	3.5	<0.10	82	NS	NA
8900601	6/10/2013	16.4	6.75	746	365	0.66	40	ND	<0.10	3.4	<0.10	89	NS	NA
8900801	6/10/2013	16.3	6.68	1551	*760*	0.71	110	ND	0.23	**42**	<0.10	*250*	NS	4.0
8901801	6/10/2013	16.6	6.68	991	485	0.44	51	ND	0.12	**12**	<0.10	160	NS	2.3
9501001	8/19/2013	17.0	6.52	340	167	0.51	1.5	ND	ND	0.7	ND	32	NS	NA
9501201	8/26/2013	12.2	6.68	295.3	145	0.56	2	ND	ND	2	0.13	7.2	NS	NA
9501401	8/26/2013	12.2	6.59	953	467	0.58	42	ND	0.23	**39**	<0.10	48	NS	13.4
9501901	8/21/2013	15.8	6.78	482	236	0.4	26	ND	0.36	3.7	ND	18	NS	NA
9502001	8/21/2013	16.2	7.31	317	155	0.34	6.1	ND	<0.10	0.28	ND	19	NS	NA
9502701	8/26/2013	12.5	6.91	375	183	0.73	2.5	ND	<0.10	4	ND	15	NS	NA
9502801	8/20/2013	13.2	7.03	387	190	0.69	3.4	ND	ND	0.12	ND	18	NS	NA
9503701	8/22/2013	17.9	6.80	305	150	0.47	1.2	ND	ND	ND	ND	7.6	NS	NA
9504301	8/20/2013	11.3	6.83	828	406	0.81	16	ND	0.15	**19**	ND	46	NS	3.3
9504501	8/20/2013	11.8	*6.21*	260.4	128	0.38	0.6	ND	ND	1.4	ND	6.6	NS	NA
9505101	8/22/2013	18.1	*6.07*	350	172	0.35	8.7	ND	0.12	7.9	0.12	16	NS	NA
9505301	8/21/2013	16.0	6.98	779	382	0.43	45	ND	0.47	6.7	ND	110	NS	NA
9505701	8/20/2013	11.2	6.55	412	203	0.59	3.2	ND	ND	3.2	ND	13	NS	NA
9506001	8/19/2013	12.0	*6.10*	194	95	0.42	0.9	ND	ND	5.1	ND	5.7	NS	NA
9506401	8/19/2013	12.5	6.96	312	153	0.66	2.3	ND	ND	ND	ND	14	NS	NA
9507901	8/26/2013	12.1	6.81	372	182	0.69	2.7	ND	<0.10	5.7	ND	14	NS	NA
9550301	8/20/2013	11.9	6.82	595	292	0.44	13	ND	<0.10	**12**	ND	16	NS	10.1
9551101	8/26/2013	12.6	6.92	386	189	0.53	4.1	ND	<0.10	6.2	ND	14	NS	NA

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
Nondetect (ND); not sampled (NS).

Table B2. Cations and alkalinity—ISDA 2013 data.

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
2200201	5/7/2013	120	45	5.9	92	<3.0	<3.0	120	120
2200301	5/7/2013	55	26	3.4	68	<3.0	<3.0	250	250
2201001	5/8/2013	34	13	5.1	30	<3.0	<3.0	170	170
2201201	5/8/2013	54	20	14	59	<3.0	<3.0	300	300
2201301	5/7/2013	24	17	4.6	98	<3.0	<3.0	280	280
2201701	5/8/2013	30	15	4.8	30	<3.0	<3.0	180	180
2201801	5/8/2013	52	22	2.2	53	<3.0	<3.0	280	280
2201901	5/7/2013	75	17	4.4	46	<3.0	<3.0	290	290
2202001	5/7/2013	20	6	1.3	15	<3.0	<3.0	100	100
2202601	5/9/2013	16	NS	1.6	13	<3.0	<3.0	81	81
2203001	5/9/2013	65	15	2.4	35	<3.0	<3.0	240	240
2203101	5/9/2013	81	19	2.6	72	<3.0	<3.0	290	290
2203801	5/9/2013	17	3.8	<1.0	10	<3.0	<3.0	60	60
2204601	5/8/2013	78	17	5.6	79	<3.0	<3.0	250	250
2204701	5/8/2013	72	31	3.6	39	<3.0	<3.0	300	300

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
2205701	5/13/2013	37	27	2.5	74	<3.0	<3.0	300	300
2206201	5/9/2013	45	29	5.8	190	<3.0	<3.0	420	420
2230101	5/13/2013	61	20	16	70	<3.0	<3.0	310	310
3004601	6/12/2013	88	60	4	43	<3.0	<3.0	350	350
3100201	5/28/2013	48	12	31	400	<3.0	<3.0	540	540
3100401	5/28/2013	49	19	37	450	<3.0	<3.0	660	660
3100601	5/28/2013	37	11	34	470	<3.0	<3.0	490	490
3101001	5/29/2013	46	16	48	660	<3.0	<3.0	490	490
3101201	5/28/2013	2.4	1.6	26	420	<3.0	<3.0	720	720
3201001	6/20/2013	63	25	1.6	8.1	<3.0	<3.0	230	230
3300401	8/21/2013	21	12	5.3	13	<3.0	<3.0	110	110
3300801	8/21/2013	41	18	4.7	18	<3.0	<3.0	180	180
3400501	5/14/2013	94	57	12	45	<3.0	<3.0	490	490
3400701	5/14/2013	79	28	9.8	45	<3.0	<3.0	320	320
3400801	5/18/2013	90	44	9.2	42	<3.0	<3.0	440	440
3401501	5/14/2013	57	32	6.4	87	<3.0	<3.0	400	400
3401801	5/14/2013	89	52	12	38	<3.0	<3.0	430	430
5302001	5/6/2013	70	15	3.2	41	<3.0	<3.0	230	230
5302401	5/6/2013	75	17	3.8	48	<3.0	<3.0	240	240
5302501	5/6/2013	87	19	3.9	50	<3.0	<3.0	230	230
5303401	5/6/2013	110	25	5.5	68	<3.0	<3.0	260	260
5303701	5/6/2013	74	20	5	49	<3.0	<3.0	200	200
7100101	5/20/2013	95	24	2.9	70	<3.0	<3.0	260	260
7100201	5/20/2013	110	46	9.2	120	<3.0	<3.0	310	310
7100501	5/23/2013	83	36	4.2	37	<3.0	<3.0	350	350
7100601	5/22/2013	83	31	5.1	45	<3.0	<3.0	320	320
7100901	5/21/2013	100	36	4.4	48	<3.0	<3.0	290	290
7101201	5/21/2013	83	32	13	150	<3.0	<3.0	510	510
7101701	5/23/2013	79	28	4.3	38	<3.0	<3.0	290	290
7102101	5/22/2013	58	21	5.4	54	<3.0	<3.0	280	280
7102301	5/23/2013	100	38	10	70	<3.0	<3.0	430	430
7102501	5/22/2013	130	40	5.7	98	<3.0	<3.0	320	320
7102701	5/23/2013	82	31	4.6	38	<3.0	<3.0	300	300
7103801	5/21/2013	90	29	6.1	60	<3.0	<3.0	260	260
7103901	5/21/2013	60	21	3.4	68	<3.0	<3.0	340	340
7104001	5/23/2013	94	33	5.7	65	<3.0	<3.0	360	360
7104101	5/21/2013	110	45	8.2	140	<3.0	<3.0	470	470
7104201	5/22/2013	15	39	19	93	<3.0	<3.0	250	250
7104601	5/23/2013	48	13	16	67	<3.0	<3.0	190	190
7104801	5/23/2013	<0.10	23	4	110	<3.0	<3.0	370	370
7105101	5/22/2013	71	26	4.8	38	<3.0	<3.0	260	260
7300201	7/25/2013	98	33	7	44	<3.0	<3.0	300	300
7300501	7/24/2013	<0.10	21	6.1	26	<3.0	<3.0	240	240
7300801	7/25/2013	110	54	11	46	<3.0	<3.0	350	350
7300901	7/25/2013	85	58	12	49	<3.0	<3.0	340	340
7301101	7/30/2013	70	25	6.3	24	<3.0	<3.0	230	230
7301501	7/30/2013	70	19	6.4	30	<3.0	<3.0	240	240
7301601	7/25/2013	93	36	7.7	42	<3.0	<3.0	290	290
7301801	7/24/2013	77	23	6.2	53	<3.0	<3.0	210	210
7301901	7/29/2013	91	23	110	33	<3.0	<3.0	330	330
7302001	7/24/2013	72	21	5.7	26	<3.0	<3.0	230	230
7303001	7/24/2013	67	22	6.5	27	<3.0	<3.0	210	210
7303101	7/30/2013	72	23	6.6	39	<3.0	<3.0	230	230
7303201	7/25/2013	140	65	14	290	<3.0	<3.0	350	350

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
7303401	7/29/2013	79	20	7.9	28	<3.0	<3.0	230	230
7303901	7/24/2013	79	19	6.8	24	<3.0	<3.0	210	210
7304101	7/30/2013	77	21	6.8	38	<3.0	<3.0	220	220
7304301	7/24/2013	84	23	5.1	25	<3.0	<3.0	250	250
7304501	7/25/2013	100	38	11	50	<3.0	<3.0	290	290
7400401	7/23/2013	52	21	4.5	34	<3.0	<3.0	160	160
7401501	7/23/2013	86	31	7.7	52	<3.0	<3.0	280	280
7401801	7/23/2013	90	29	7.1	46	<3.0	<3.0	260	260
7402001	7/23/2013	90	30	8.7	66	<3.0	<3.0	250	250
7402701	7/24/2013	73	24	6.6	41	<3.0	<3.0	220	220
7403201	7/22/2013	79	30	8.1	68	<3.0	<3.0	260	260
7404101	7/23/2013	69	28	7.7	56	<3.0	<3.0	230	230
7404801	7/22/2013	80	30	7.8	67	<3.0	<3.0	310	310
7404901	7/22/2013	28	14	8.9	39	<3.0	<3.0	130	130
7405101	7/23/2013	74	28	7.3	42	<3.0	<3.0	230	230
7502201	7/17/2013	47	20	4.4	24	<3.0	<3.0	170	170
7502401	7/16/2013	60	25	5.7	49	<3.0	<3.0	230	230
7503401	7/17/2013	36	16	4.1	22	<3.0	<3.0	130	130
7504701	7/16/2013	64	24	3.6	54	<3.0	<3.0	270	270
7505501	7/16/2013	57	26	4.3	34	<3.0	<3.0	220	220
7507001	7/16/2013	96	62	11	69	<3.0	<3.0	490	490
7507401	7/16/2013	59	26	5.6	33	<3.0	<3.0	230	230
7600601	5/6/2013	81	20	4.4	50	<3.0	<3.0	200	200
7700801	5/16/2013	68	21	3.3	28	<3.0	<3.0	300	300
7701101	5/16/2013	49	12	3	60	<3.0	<3.0	220	220
7701401	5/15/2013	60	9.3	6.5	81	<3.0	<3.0	320	320
7701701	5/15/2013	50	17	8.1	170	<3.0	<3.0	390	390
7702501	5/16/2013	<0.10	9.1	2.5	80	<3.0	<3.0	230	230
7703001	5/16/2013	56	18	2	22	<3.0	<3.0	220	220
7703201	5/14/2013	70	16	2.6	72	<3.0	<3.0	340	340
7703501	5/16/2013	13	0.27	<1.0	31	<3.0	<3.0	81	81
7703601	5/15/2013	58	30	6.3	85	<3.0	<3.0	340	340
7703701	5/15/2013	42	6.7	4.1	29	<3.0	<3.0	140	140
7705201	5/14/2013	83	48	10	28	<3.0	<3.0	430	430
7705301	5/15/2013	52	18	4.2	120	<3.0	<3.0	400	400
7800201	7/17/2013	88	37	4.1	46	<3.0	<3.0	290	290
7801701	7/17/2013	<0.10	30	8.5	110	<3.0	<3.0	320	320
7803601	7/18/2013	100	47	12	120	<3.0	<3.0	440	440
7804101	7/18/2013	90	37	4	48	<3.0	<3.0	330	330
7804201	7/18/2013	90	37	3.7	46	<3.0	<3.0	340	340
7804301	7/18/2013	97	43	4.1	58	<3.0	<3.0	350	350
7804401	7/18/2013	93	31	5.7	68	<3.0	<3.0	350	350
7805501	7/17/2013	86	42	3.8	55	<3.0	<3.0	350	350
7805601	7/18/2013	77	41	5.3	67	NS	NS	290	290
7805701	7/18/2013	91	27	5.1	54	<3.0	<3.0	280	280
7806401	7/17/2013	67	30	3.9	48	<3.0	<3.0	270	270
7806601	7/18/2013	100	40	4.4	54	<3.0	<3.0	330	330
7900101	8/5/2013	67	36	7.3	67	<3.0	<3.0	200	200
7900601	7/30/2013	93	18	9	76	<3.0	<3.0	320	320
7900701	7/30/2013	110	19	9.1	30	<3.0	<3.0	220	220
7900801	7/31/2013	88	15	8.8	50	<3.0	<3.0	260	260
7900901	8/1/2013	73	13	7.8	54	<3.0	<3.0	220	220
7901001	8/1/2013	86	16	11	68	<3.0	<3.0	290	290
7901101	8/5/2013	82	16	7.6	23	<3.0	<3.0	190	190

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
7901301	7/30/2013	64	13	7.7	26	<3.0	<3.0	170	170
7901401	7/31/2013	110	17	9.7	60	<3.0	<3.0	310	310
7901501	7/31/2013	92	29	9.2	63	<3.0	<3.0	320	320
7901601	7/31/2013	64	21	10	92	<3.0	<3.0	300	300
7901701	7/31/2013	75	21	9.6	44	<3.0	<3.0	250	250
7901801	7/31/2013	70	21	11	23	<3.0	<3.0	220	220
7901901	7/31/2013	100	29	12	55	<3.0	<3.0	360	360
7902001	8/1/2013	83	22	9.4	40	<3.0	<3.0	240	240
7902101	8/1/2013	77	22	7.8	60	<3.0	<3.0	240	240
7902201	8/1/2013	58	17	5	62	<3.0	<3.0	220	220
7902401	8/1/2013	90	38	8.4	45	<3.0	<3.0	260	260
7903201	8/1/2013	83	35	8.2	44	<3.0	<3.0	320	320
7903501	7/31/2013	100	26	11	52	<3.0	<3.0	350	350
7903601	7/31/2013	89	17	9.2	51	<3.0	<3.0	250	250
7903801	8/5/2013	97	22	7	47	<3.0	<3.0	230	230
7904001	8/5/2013	75	18	7.7	36	<3.0	<3.0	200	200
7904101	8/5/2013	91	13	6.8	19	<3.0	<3.0	230	230
8050301	6/20/2013	54	28	1.6	12	<3.0	<3.0	210	210
8050801	6/18/2013	46	14	2.1	17	<3.0	<3.0	160	160
8050901	6/18/2013	41	14	3.3	20	<3.0	<3.0	160	160
8051301	6/19/2013	69	24	1.7	6.6	<3.0	<3.0	250	250
8051401	6/19/2013	60	15	1.4	12	<3.0	<3.0	180	180
8051501	6/19/2013	37	20	1.8	9.3	<3.0	<3.0	170	170
8052801	6/19/2013	66	25	1.8	6.1	<3.0	<3.0	230	230
8053401	6/19/2013	49	13	1.4	8.4	<3.0	<3.0	180	180
8053501	6/19/2013	84	18	1.1	5.3	<3.0	<3.0	220	220
8053901	6/18/2013	46	14	2.3	19	<3.0	<3.0	160	160
8054601	6/19/2013	73	52	2.6	16	<3.0	<3.0	290	290
8055201	6/20/2013	70	22	2.4	15	<3.0	<3.0	250	250
8100401	6/3/2013	130	45	6.2	65	<3.0	<3.0	270	270
8100601	6/3/2013	120	37	4.6	180	<3.0	<3.0	390	390
8101601	6/13/2013	18	4.7	4.9	28	<3.0	<3.0	87	87
8101701	6/4/2013	70	16	4.6	30	<3.0	<3.0	250	250
8101901	6/13/2013	75	27	3	81	<3.0	<3.0	220	220
8102101	6/3/2013	70	18	4.8	29	<3.0	<3.0	250	250
8102601	6/3/2013	84	22	2.3	180	<3.0	<3.0	300	300
8201201	8/27/2013	37	14	1.6	<5.0	<3.0	<3.0	140	140
8202901	8/28/2013	26	9.7	2.6	5.5	<3.0	<3.0	88	88
8204501	8/27/2013	<0.10	20	2.2	<5.0	<3.0	<3.0	160	160
8204601	8/28/2013	35	16	2.3	<5.0	<3.0	<3.0	140	140
8204701	8/28/2013	40	19	2.2	<5.0	<3.0	<3.0	180	180
8204801	8/28/2013	36	17	2	<5.0	<3.0	<3.0	140	140
8205001	8/28/2013	37	18	2	<5.0	<3.0	<3.0	150	150
8205101	8/27/2013	39	22	2.3	<5.0	<3.0	<3.0	170	170
8205201	8/27/2013	33	18	2	<5.0	<3.0	<3.0	140	140
8300201	6/18/2013	34	11	2.8	15	<3.0	<3.0	120	120
8300301	6/17/2013	36	11	3.2	15	<3.0	<3.0	130	130
8300401	6/18/2013	32	10	2.6	15	<3.0	<3.0	120	120
8300501	6/18/2013	35	11	2.8	16	<3.0	<3.0	130	130
8301101	6/17/2013	35	10	3.2	14	<3.0	<3.0	140	140
8301401	6/17/2013	83	23	4.2	38	<3.0	<3.0	270	270
8301801	6/17/2013	72	26	5.4	50	<3.0	<3.0	290	290
8302001	6/17/2013	18	8.7	5.6	36	<3.0	<3.0	89	89
8302701	6/17/2013	80	25	5.7	110	<3.0	<3.0	380	380

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
8303001	6/17/2013	80	20	4.4	49	<3.0	<3.0	330	330
8401501	6/24/2013	79	17	2.5	10	NS	NS	220	220
8401601	6/24/2013	69	15	2.1	12	<3.0	<3.0	200	200
8404201	6/25/2013	75	15	2	9.8	<3.0	<3.0	190	190
8404301	6/25/2013	62	14	2.1	9.4	<3.0	<3.0	160	160
8404401	6/25/2013	73	19	2.6	10	<3.0	<3.0	210	210
8404801	6/25/2013	80	17	3	11	<3.0	<3.0	230	230
8404901	6/24/2013	75	16	3.4	9.1	<3.0	<3.0	220	220
8405001	6/24/2013	60	17	2.3	8.3	<3.0	<3.0	190	190
8405301	6/25/2013	68	16	2	12	<3.0	<3.0	170	170
8405801	6/24/2013	68	15	2.1	9.4	<3.0	<3.0	200	200
8406101	6/24/2013	69	18	2.6	9.2	<3.0	<3.0	220	220
8600801	5/29/2013	79	19	20	120	<3.0	<3.0	330	330
8600901	5/29/2013	91	30	22	140	<3.0	<3.0	290	290
8601101	5/28/2013	130	25	20	460	<3.0	<3.0	380	380
8601101	10/1/2013	150	28	20	460	<3.0	<3.0	390	390
8601401	5/30/2013	130	61	9.7	120	<3.0	<3.0	330	330
8601401	10/1/2013	130	62	9.4	130	<3.0	<3.0	340	340
8601801	5/30/2013	20	5.1	18	210	<3.0	<3.0	520	520
8601801	10/1/2013	20	5.3	17	230	<3.0	<3.0	510	510
8602001	10/1/2013	100	39	21	87	<3.0	<3.0	280	280
8602001	5/30/2013	120	46	19	110	<3.0	<3.0	320	320
8602701	5/29/2013	290	110	58	540	<3.0	<3.0	320	320
8602901	5/30/2013	39	12	45	490	<3.0	<3.0	610	610
8603001	5/30/2013	55	23	26	230	<3.0	<3.0	460	460
8603001	10/1/2013	57	24	25	240	<3.0	<3.0	460	460
8603101	5/30/2013	26	7.2	36	450	<3.0	<3.0	410	410
8603201	5/29/2013	20	7.2	42	480	<3.0	<3.0	780	780
8604601	5/29/2013	180	51	24	240	<3.0	<3.0	330	330
8604801	10/1/2013	92	24	36	460	<3.0	<3.0	450	450
8650101	6/5/2013	88	32	5.7	110	<3.0	<3.0	320	320
8650201	6/4/2013	60	37	13	79	<3.0	<3.0	290	290
8650301	6/5/2013	300	78	6.2	260	<3.0	<3.0	390	390
8650501	6/6/2013	260	77	25	150	<3.0	<3.0	320	320
8650601	6/5/2013	97	53	14	140	<3.0	<3.0	540	540
8650701	6/5/2013	85	39	11	130	<3.0	<3.0	290	290
8653401	6/5/2013	90	26	6.6	100	<3.0	<3.0	390	390
8655001	6/6/2013	100	32	11	120	<3.0	<3.0	430	430
8700501	6/11/2013	87	44	2.8	53	<3.0	<3.0	260	260
8700601	6/11/2013	49	25	2.3	22	<3.0	<3.0	200	200
8700801	6/11/2013	75	43	2	50	<3.0	<3.0	340	340
8701201	6/11/2013	57	76	5	53	<3.0	<3.0	260	260
8701401	6/12/2013	94	44	3.3	42	<3.0	<3.0	290	290
8701601	6/12/2013	78	19	4.3	57	<3.0	<3.0	200	200
8701801	6/11/2013	90	33	4.5	23	<3.0	<3.0	220	220
8900401	6/10/2013	110	48	13	65	<3.0	<3.0	370	370
8900501	6/10/2013	91	32	16	53	<3.0	<3.0	280	280
8900601	6/10/2013	93	36	13	44	<3.0	<3.0	300	300
8900801	6/10/2013	160	85	14	70	<3.0	<3.0	390	390
8901801	6/10/2013	87	36	18	98	<3.0	<3.0	340	340
9501001	8/19/2013	35	14	3.9	24	<3.0	<3.0	160	160
9501201	8/26/2013	33	11	3.4	26	<3.0	<3.0	160	160
9501401	8/26/2013	110	34	2	58	<3.0	<3.0	310	310
9501901	8/21/2013	39	24	6.2	23	<3.0	<3.0	170	170

ISDA Well ID	Sample Date	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Total Alkalinity (mg/L)
9502001	8/21/2013	19	18	5.9	20	<3.0	<3.0	93	93
9502701	8/26/2013	36	16	4.7	34	<3.0	<3.0	200	200
9502801	8/20/2013	34	15	3.5	31	<3.0	<3.0	200	200
9503701	8/22/2013	29	15	4	27	<3.0	<3.0	180	180
9504301	8/20/2013	78	24	1.8	72	<3.0	<3.0	320	320
9504501	8/20/2013	30	8.7	1.7	15	<3.0	<3.0	130	130
9505101	8/22/2013	42	14	3	20	<3.0	<3.0	140	140
9505301	8/21/2013	57	41	7.2	62	<3.0	<3.0	260	260
9505701	8/20/2013	38	14	2.8	27	<3.0	<3.0	180	180
9506001	8/19/2013	20	7.2	<1.0	12	<3.0	<3.0	80	80
9506401	8/19/2013	29	12	4.3	27	<3.0	<3.0	170	170
9507901	8/26/2013	36	9.8	1.3	40	<3.0	<3.0	180	180
9550301	8/20/2013	56	22	4.6	40	<3.0	<3.0	240	240
9551101	8/26/2013	46	14	1.7	29	<3.0	<3.0	190	190

Notes: not sampled (NS).

Table B3. Metals—ISDA 2013 data.

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
2200201	5/7/2013	NS	0.034	<0.010	<0.050	<0.010	<0.020	*0.4*	<0.0050	<0.10	<0.050	0.04	0.22
2200301	5/7/2013	NS	0.023	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.078	0.026
2201001	5/8/2013	NS	0.035	<0.010	<0.050	<0.010	0.021	0.21	<0.0050	<0.10	<0.050	0.043	0.08
2201201	5/8/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	*0.051*	<0.10	<0.050	0.019	<0.020
2201301	5/7/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.12	0.027
2201701	5/8/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.039	0.032
2201801	5/8/2013	NS	0.073	<0.010	<0.050	<0.010	0.02	0.1	<0.0050	<0.10	<0.050	0.04	0.24
2201901	5/7/2013	NS	0.054	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.026	<0.020
2202001	5/7/2013	NS	0.018	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.025
2202601	5/9/2013	NS	0.022	<0.010	<0.050	<0.010	<0.020	*0.86*	0.0055	<0.10	<0.050	0.016	0.43
2203001	5/9/2013	NS	0.12	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.06
2203101	5/9/2013	NS	0.066	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.034
2203801	5/9/2013	NS	0.022	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.051
2204601	5/8/2013	NS	0.072	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.024	0.026
2204701	5/8/2013	NS	0.031	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.088	0.022
2205701	5/13/2013	NS	0.055	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.093	<0.020
2206201	5/9/2013	NS	0.051	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.07	0.022
2230101	5/13/2013	NS	0.052	<0.010	<0.050	<0.010	<0.020	<0.10	0.041	<0.10	<0.050	0.035	0.032
3004601	6/12/2013	NS	0.015	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.1	0.057
3100201	5/28/2013	NS	0.016	<0.010	<0.050	<0.010	<0.020	<0.10	*0.093*	<0.10	<0.050	<0.010	0.14
3100401	5/28/2013	NS	0.21	<0.010	<0.050	<0.010	<0.020	*0.32*	*0.12*	<0.10	<0.050	<0.010	0.04
3100601	5/28/2013	NS	0.011	<0.010	<0.050	<0.010	<0.020	<0.10	*0.13*	<0.10	<0.050	<0.010	0.038
3101001	5/29/2013	NS	<0.010	<0.010	<0.050	<0.010	0.1	<0.10	*0.17*	<0.10	<0.050	<0.010	0.059
3101201	5/28/2013	NS	0.036	<0.010	<0.050	<0.010	<0.020	<0.10	*0.55*	<0.10	<0.050	<0.010	0.039
3201001	6/20/2013	NS	0.016	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.38
3300401	8/21/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.04	0.088
3300801	8/21/2013	NS	0.02	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.039	0.032
3400501	5/14/2013	NS	0.12	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.06	<0.020
3400701	5/14/2013	NS	0.24	<0.010	<0.050	<0.010	<0.020	<0.10	*0.44*	<0.10	<0.050	0.019	0.041
3400801	5/18/2013	NS	0.076	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.048	0.097
3401501	5/14/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.073	0.024
3401801	5/14/2013	8.2	0.2	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.054	0.044
5302001	5/6/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.024	0.027
5302401	5/6/2013	NS	0.19	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.023	0.037
5302501	5/6/2013	NS	0.19	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.026	0.058
5303401	5/6/2013	NS	0.24	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.028	0.03
5303701	5/6/2013	NS	0.18	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.026	0.052

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
7100101	5/20/2013	NS	0.027	<0.010	<0.050	<0.010	<0.020	<0.10	0.049	<0.10	<0.050	0.024	0.021
7100201	5/20/2013	NS	0.24	<0.010	<0.050	<0.010	0.03	<0.10	<0.0050	<0.10	<0.050	0.05	0.022
7100501	5/23/2013	NS	0.036	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.077	0.034
7100601	5/22/2013	NS	0.14	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.056	<0.020
7100901	5/21/2013	NS	0.047	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.041	<0.020
7101201	5/21/2013	NS	0.16	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.032	<0.020
7101701	5/23/2013	NS	0.049	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.076	0.042
7102101	5/22/2013	NS	0.097	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.038	0.036
7102301	5/23/2013	NS	0.25	<0.010	<0.050	<0.010	0.091	<0.10	<0.0050	<0.10	<0.050	0.036	<0.020
7102501	5/22/2013	NS	0.053	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.038	<0.020
7102701	5/23/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.05	0.026
7103801	5/21/2013	NS	0.044	<0.010	<0.050	<0.010	0.037	<0.10	<0.0050	<0.10	<0.050	0.035	0.053
7103901	5/21/2013	NS	0.032	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.047	0.031
7104001	5/23/2013	NS	0.12	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.061	0.025
7104101	5/21/2013	NS	0.18	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.081	0.021
7104201	5/22/2013	NS	0.021	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.056	0.051
7104601	5/23/2013	NS	0.068	<0.010	<0.050	<0.010	0.023	<0.10	0.01	<0.10	<0.050	0.023	0.022
7104801	5/23/2013	NS	**59**	<0.010	<0.050	<0.010	0.025	<0.10	<0.0050	<0.10	<0.050	0.065	<0.020
7105101	5/22/2013	NS	0.091	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.05	0.043
7300201	7/25/2013	NS	0.085	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.027	0.05
7300501	7/24/2013	NS	0.16	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.026
7300801	7/25/2013	NS	0.11	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.049	0.021
7300901	7/25/2013	NS	0.049	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.051	0.052
7301101	7/30/2013	NS	0.16	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.045
7301501	7/30/2013	NS	0.17	<0.010	<0.050	<0.010	<0.020	*0.43*	*0.22*	<0.10	<0.050	0.013	0.039
7301601	7/25/2013	NS	0.068	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.03	0.023
7301801	7/24/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.019	0.038
7301901	7/29/2013	NS	0.78	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.02	0.033
7302001	7/24/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.019	0.054
7303001	7/24/2013	NS	0.098	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.021	0.073
7303101	7/30/2013	NS	0.088	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.022
7303201	7/25/2013	NS	0.022	<0.011	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.048	<0.020
7303401	7/29/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.029
7303901	7/24/2013	NS	0.2	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.019	0.041
7304101	7/30/2013	NS	0.14	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.036
7304301	7/24/2013	NS	0.14	<0.010	<0.050	<0.010	0.05	<0.10	<0.0050	<0.10	<0.050	0.021	0.042
7304501	7/25/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.03	0.035
7400401	7/23/2013	NS	0.04	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.04
7401501	7/23/2013	NS	0.56	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.025	0.11

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
7401801	7/23/2013	NS	0.17	<0.010	<0.050	<0.010	<0.020	0.14	<0.0050	<0.10	<0.050	0.027	0.1
7402001	7/23/2013	NS	0.18	<0.010	<0.050	<0.010	<0.020	*1.2*	0.026	<0.10	<0.050	0.029	0.21
7402701	7/24/2013	NS	0.096	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.021	0.056
7403201	7/22/2013	NS	0.06	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.025	0.026
7404101	7/23/2013	NS	0.09	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.025	0.054
7404801	7/22/2013	NS	0.095	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.028	0.043
7404901	7/22/2013	NS	0.049	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.021	0.13
7405101	7/23/2013	NS	0.13	<0.010	<0.050	<0.010	<0.020	0.24	<0.0050	<0.10	<0.050	0.023	0.097
7502201	7/17/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.025	0.063
7502401	7/16/2013	NS	0.072	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.03	0.038
7503401	7/17/2013	NS	0.023	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.056
7504701	7/16/2013	NS	0.043	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.031	0.044
7505501	7/16/2013	NS	0.042	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.028	0.066
7507001	7/16/2013	NS	0.4	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.061	0.037
7507401	7/16/2013	NS	0.072	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.03	0.05
7600601	5/6/2013	NS	0.17	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.031
7700801	5/16/2013	NS	0.087	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.036	0.043
7701101	5/16/2013	NS	0.11	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.029	0.023
7701401	5/15/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	*0.46*	<0.10	<0.050	<0.010	0.02
7701701	5/15/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	*0.23*	<0.10	<0.050	0.018	<0.020
7702501	5/16/2013	NS	0.06	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.042	0.03
7703001	5/16/2013	NS	0.063	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.034	0.021
7703201	5/14/2013	NS	0.08	<0.010	<0.050	<0.010	0.073	<0.10	<0.0050	<0.10	<0.050	0.03	0.051
7703501	5/16/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	0.027	<0.10	<0.050	<0.010	0.022
7703601	5/15/2013	NS	0.098	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.041	0.064
7703701	5/15/2013	NS	0.087	<0.010	<0.050	<0.010	<0.020	<0.10	*0.28*	<0.10	<0.050	<0.010	<0.020
7705201	5/14/2013	NS	0.09	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.05	<0.020
7705301	5/15/2013	**34**	0.059	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.075	0.02
7800201	7/17/2013	NS	0.017	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.079	0.028
7801701	7/17/2013	NS	0.039	<0.010	<0.050	<0.010	<0.020	0.16	<0.0050	<0.10	<0.050	0.03	0.12
7803601	7/18/2013	NS	0.014	<0.010	<0.050	<0.010	<0.020	0.24	<0.0050	<0.10	<0.050	0.07	0.076
7804101	7/18/2013	NS	0.034	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.077	0.11
7804201	7/18/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.072	0.022
7804301	7/18/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.085	0.02
7804401	7/18/2013	NS	0.021	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.051	0.052
7805501	7/17/2013	NS	0.018	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.082	0.022
7805601	7/18/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.093	0.046
7805701	7/18/2013	NS	0.017	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.05	0.082
7806401	7/17/2013	NS	0.031	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.057	0.13

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
7806601	7/18/2013	NS	0.032	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.1	0.027
7900101	8/5/2013	NS	0.071	<0.010	<0.050	<0.010	0.029	<0.10	<0.0050	<0.10	<0.050	0.031	0.13
7900601	7/30/2013	NS	0.058	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.056
7900701	7/30/2013	NS	0.2	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.13
7900801	7/31/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.081
7900901	8/1/2013	NS	0.13	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.01	0.038
7901001	8/1/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.013	0.077
7901101	8/5/2013	NS	0.17	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.067
7901301	7/30/2013	NS	0.13	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.023
7901401	7/31/2013	NS	0.097	<0.010	<0.050	<0.010	0.13	<0.10	<0.0050	<0.10	<0.050	0.013	0.023
7901501	7/31/2013	NS	0.087	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.029	0.029
7901601	7/31/2013	NS	0.038	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.023	0.024
7901701	7/31/2013	NS	0.056	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.024	0.023
7901801	7/31/2013	NS	0.084	<0.010	<0.050	<0.010	0.44	<0.10	<0.0050	<0.10	<0.050	0.023	0.23
7901901	7/31/2013	NS	0.081	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.024	0.022
7902001	8/1/2013	NS	0.082	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.023	0.033
7902101	8/1/2013	NS	0.084	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.04
7902201	8/1/2013	NS	0.078	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.028
7902401	8/1/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.03	0.046
7903201	8/1/2013	NS	0.07	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.031	0.045
7903501	7/31/2013	NS	0.081	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.023	0.096
7903601	7/31/2013	NS	0.15	<0.010	<0.050	<0.010	0.11	<0.10	<0.0050	<0.10	<0.050	0.014	0.056
7903801	8/5/2013	NS	0.079	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.039
7904001	8/5/2013	NS	0.13	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.032
7904101	8/5/2013	NS	0.17	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.011	0.031
8050301	6/20/2013	NS	0.076	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.021	0.077
8050801	6/18/2013	NS	0.024	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.027
8050901	6/18/2013	NS	0.034	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.048
8051301	6/19/2013	NS	0.034	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.075
8051401	6/19/2013	NS	0.033	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.18
8051501	6/19/2013	NS	0.03	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.11
8052801	6/19/2013	NS	0.019	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.22
8053401	6/19/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.01	0.072
8053501	6/19/2013	NS	0.035	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.2
8053901	6/18/2013	NS	0.033	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.059
8054601	6/19/2013	NS	0.069	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.039	0.74
8055201	6/20/2013	NS	0.078	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.1
8100401	6/3/2013	NS	0.072	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.036	0.04
8100601	6/3/2013	NS	0.023	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.039	0.021

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
8101601	6/13/2013	NS	0.092	<0.010	<0.050	<0.010	0.021	*1.4*	0.0093	<0.10	<0.050	0.013	0.083
8101701	6/4/2013	NS	0.25	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.032
8101901	6/13/2013	NS	0.16	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.068	0.026
8102101	6/3/2013	NS	0.22	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.02	0.066
8102601	6/3/2013	NS	0.036	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.089
8201201	8/27/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.017	0.067
8202901	8/28/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.046
8204501	8/27/2013	NS	0.023	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.017	0.068
8204601	8/28/2013	NS	0.026	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.057
8204701	8/28/2013	NS	0.03	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.019	0.043
8204801	8/28/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.05
8205001	8/28/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.017	0.045
8205101	8/27/2013	NS	0.031	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.021	0.12
8205201	8/27/2013	NS	0.033	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.016	0.078
8300201	6/18/2013	NS	0.01	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.043
8300301	6/17/2013	NS	0.014	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.011	0.065
8300401	6/18/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.032
8300501	6/18/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.031
8301101	6/17/2013	NS	0.03	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.068
8301401	6/17/2013	NS	0.18	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.022
8301801	6/17/2013	NS	0.19	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.28
8302001	6/17/2013	NS	0.036	<0.010	<0.050	<0.010	<0.020	<0.10	0.041	<0.10	<0.050	0.011	0.031
8302701	6/17/2013	NS	0.049	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.027
8303001	6/17/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.019	0.035
8401501	6/24/2013	NS	0.07	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.013	0.068
8401601	6/24/2013	NS	0.075	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.01	0.12
8404201	6/25/2013	NS	0.097	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.024
8404301	6/25/2013	NS	0.069	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.037
8404401	6/25/2013	NS	0.081	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.075
8404801	6/25/2013	NS	0.15	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.051
8404901	6/24/2013	NS	0.26	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.011	0.038
8405001	6/24/2013	NS	0.08	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.012	0.073
8405301	6/25/2013	NS	0.059	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.01	0.036
8405801	6/24/2013	NS	0.07	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	<0.010	0.022
8406101	6/24/2013	NS	0.089	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.014	0.046
8600801	5/29/2013	NS	0.12	<0.010	<0.050	<0.010	<0.020	0.28	*0.3*	<0.10	<0.050	130	0.044
8600901	5/29/2013	NS	0.066	<0.010	<0.050	<0.010	<0.020	0.28	*0.48*	<0.10	<0.050	0.019	0.053
8601101	5/28/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	0.23	<0.0050	<0.10	<0.050	0.1	0.043
8601101	10/1/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	0.28	<0.0050	<0.10	<0.050	0.1	<0.020

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
8601401	5/30/2013	NS	0.017	<0.010	<0.050	<0.010	<0.020	<0.10	0.0052	<0.10	<0.050	0.063	0.037
8601401	10/1/2013	NS	0.021	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.061	<0.020
8601801	5/30/2013	NS	0.18	<0.010	<0.050	<0.010	<0.020	0.29	*0.056*	<0.10	<0.050	<0.010	0.03
8601801	10/1/2013	NS	0.19	<0.010	<0.050	<0.010	<0.020	<0.10	0.047	<0.10	<0.050	<0.010	<0.020
8602001	10/1/2013	NS	0.018	<0.010	<0.050	<0.010	<0.020	<0.10	*0.26*	<0.10	<0.050	0.03	0.043
8602001	5/30/2013	NS	0.02	<0.010	<0.050	<0.010	<0.020	<0.10	*0.18*	<0.10	<0.050	0.036	0.064
8602701	5/29/2013	<2.0	0.031	<0.010	<0.050	<0.010	0.034	<0.10	<0.0050	<0.10	<0.050	0.1	0.039
8602901	5/30/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	0.15	*0.17*	<0.10	<0.050	<0.010	0.032
8603001	10/1/2013	NS	0.088	<0.010	<0.050	<0.010	<0.020	0.13	*0.22*	<0.10	<0.050	0.015	0.021
8603001	5/30/2013	NS	0.091	<0.010	<0.050	<0.010	<0.020	*0.47*	*0.2*	<0.10	<0.050	0.011	<0.020
8603101	5/30/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	0.12	*0.15*	<0.10	<0.050	<0.010	0.037
8603201	5/29/2013	NS	0.015	<0.010	<0.050	<0.010	<0.020	0.18	*0.083*	<0.10	<0.050	<0.010	0.06
8604601	5/29/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.1	0.039
8604801	10/1/2013	NS	0.028	<0.010	<0.050	<0.010	<0.020	<0.10	*0.18*	<0.10	<0.050	0.019	0.28
8650101	6/5/2013	NS	0.042	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.038	0.045
8650201	6/4/2013	NS	0.068	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.052	0.038
8650301	6/5/2013	NS	0.047	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.068	0.028
8650501	6/6/2013	NS	0.014	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.057	0.033
8650601	6/5/2013	NS	0.05	<0.010	<0.050	<0.010	<0.020	<0.10	*0.055*	<0.10	<0.050	0.047	0.041
8650701	6/5/2013	NS	0.066	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.042	0.051
8653401	6/5/2013	NS	0.058	<0.010	<0.050	<0.010	0.03	<0.10	<0.0050	<0.10	<0.050	0.029	0.037
8655001	6/6/2013	NS	0.068	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.029	0.031
8700501	6/11/2013	NS	0.022	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.04	0.029
8700601	6/11/2013	NS	0.11	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.028	0.055
8700801	6/11/2013	NS	0.017	<0.010	<0.050	<0.010	0.021	<0.10	<0.0050	<0.10	<0.050	0.051	<0.020
8701201	6/11/2013	NS	0.019	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.064	0.075
8701401	6/12/2013	NS	0.078	<0.010	<0.050	<0.010	<0.020	0.12	<0.0050	<0.10	<0.050	0.061	0.048
8701601	6/12/2013	NS	0.1	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.042	0.026
8701801	6/11/2013	NS	0.081	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.034	0.035
8900401	6/10/2013	NS	0.054	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.046	0.038
8900501	6/10/2013	NS	0.083	<0.010	<0.050	<0.010	<0.020	<0.10	0.013	<0.10	<0.050	0.022	0.043
8900601	6/10/2013	NS	0.076	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.033	0.072
8900801	6/10/2013	NS	0.2	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.077	0.033
8901801	6/10/2013	NS	0.064	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.064	0.051
9501001	8/19/2013	NS	0.053	<0.010	<0.050	<0.010	<0.020	<0.10	0.017	<0.10	<0.050	<0.010	0.022
9501201	8/26/2013	NS	0.014	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.022	0.16
9501401	8/26/2013	NS	0.21	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.036	0.043
9501901	8/21/2013	NS	0.042	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.036	0.04
9502001	8/21/2013	NS	0.022	<0.010	<0.050	<0.010	<0.020	<0.10	0.0064	<0.10	<0.050	0.011	0.036

ISDA Well ID	Sample Date	Arsenic (µg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Vanadium (mg/L)	Zinc (mg/L)
9502701	8/26/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.033	0.022
9502801	8/20/2013	NS	0.046	<0.010	<0.050	<0.010	<0.020	*0.43*	0.033	<0.10	<0.050	<0.010	0.11
9503701	8/22/2013	NS	0.057	<0.010	<0.050	<0.010	<0.020	*0.5*	0.037	<0.10	<0.050	0.01	0.22
9504301	8/20/2013	NS	0.056	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.036	0.036
9504501	8/20/2013	NS	0.01	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.018	0.038
9505101	8/22/2013	NS	0.059	<0.010	<0.050	<0.010	0.11	0.2	<0.0050	<0.10	<0.050	0.028	0.035
9505301	8/21/2013	NS	0.096	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.058	0.03
9505701	8/20/2013	NS	0.013	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.024	0.051
9506001	8/19/2013	NS	0.016	<0.010	<0.050	<0.010	0.044	<0.10	<0.0050	<0.10	<0.050	<0.010	0.076
9506401	8/19/2013	NS	0.021	<0.010	<0.050	<0.010	<0.020	*0.44*	0.014	<0.10	<0.050	<0.010	0.026
9507901	8/26/2013	NS	0.066	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.015	0.62
9550301	8/20/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.033	0.027
9551101	8/26/2013	NS	<0.010	<0.010	<0.050	<0.010	<0.020	<0.10	<0.0050	<0.10	<0.050	0.032	0.1

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded. These regulations are applicable for public water systems only and are used with private wells to evaluate water quality.
Not sampled (NS).

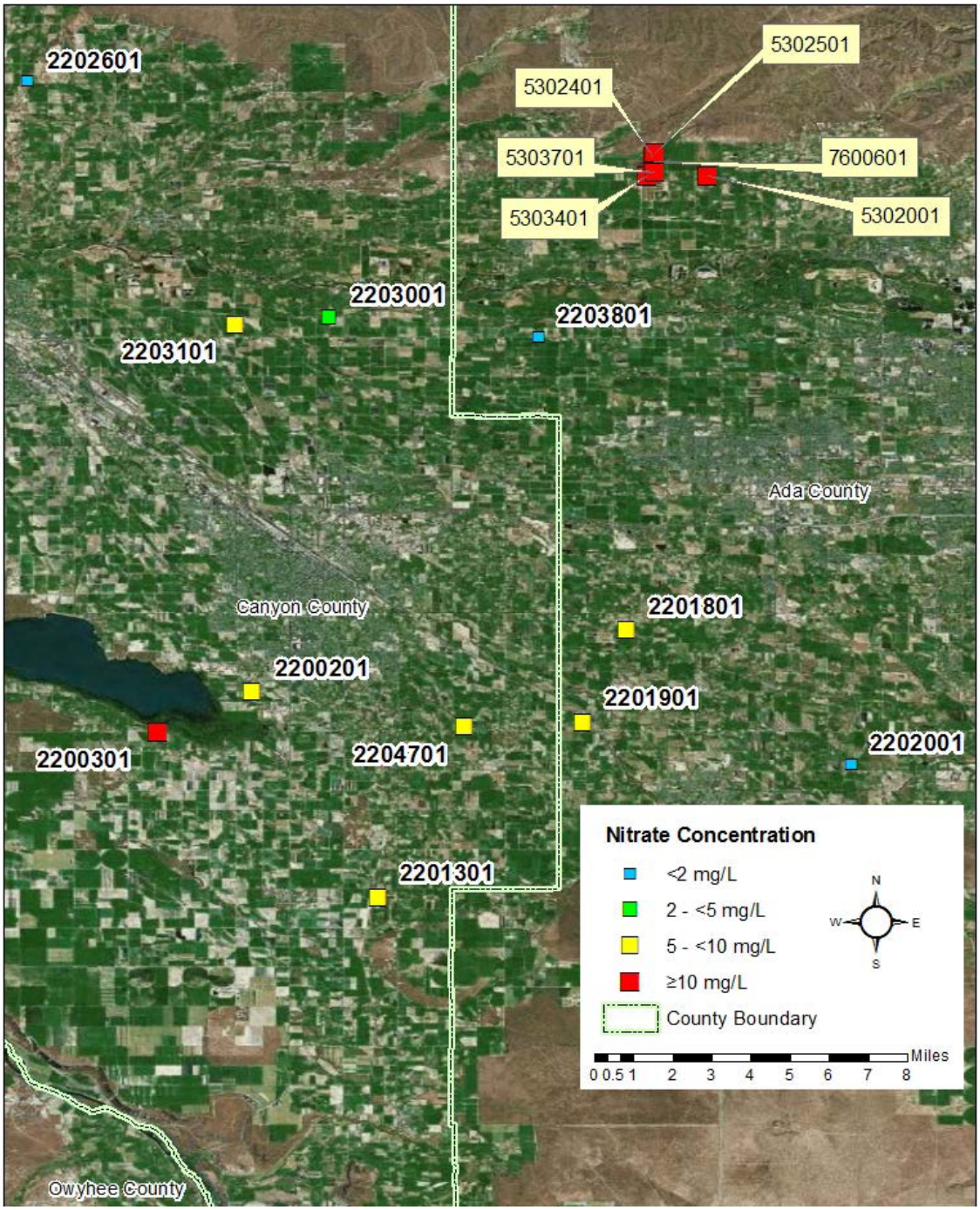


Figure B1. East Canyon and Ada Counties nitrate concentrations—ISDA 2013 data.

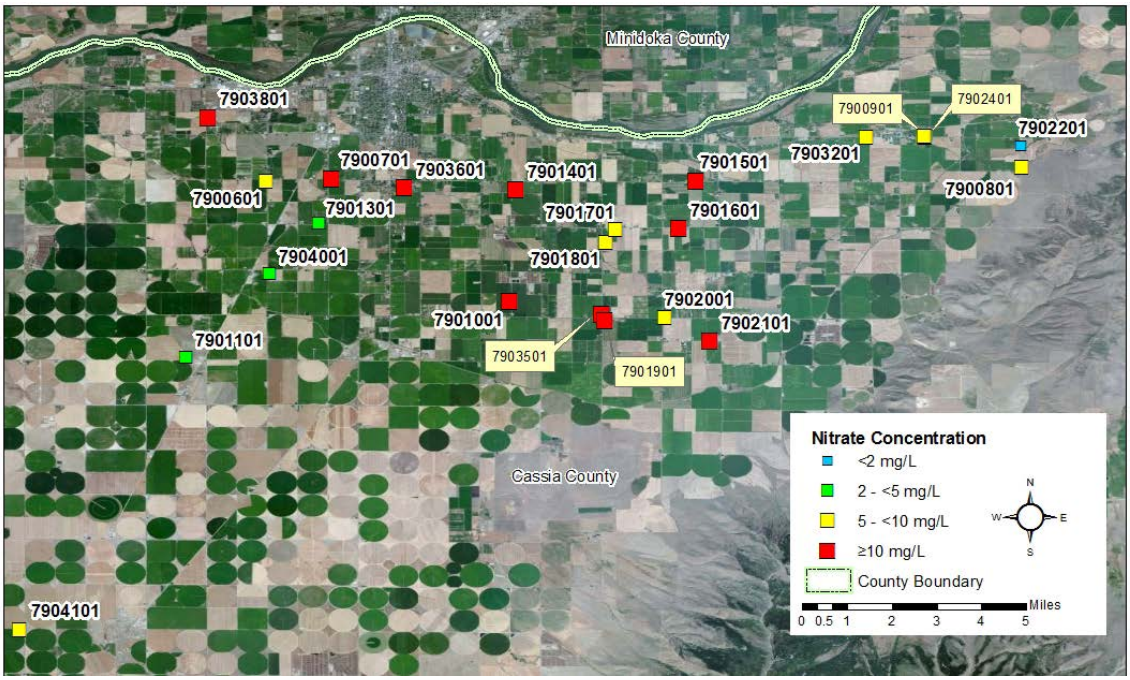


Figure B2. East Cassia County nitrate concentrations—ISDA 2013 data.

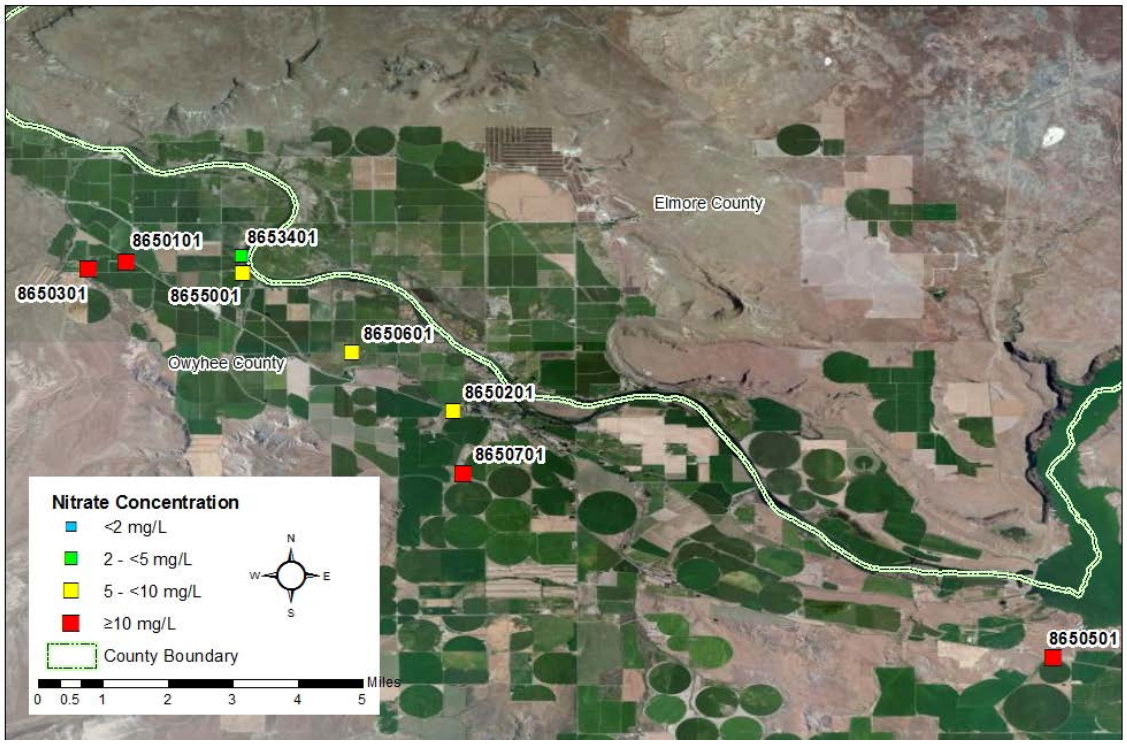


Figure B3. Eastern Owyhee County nitrate concentrations—ISDA 2013 data.

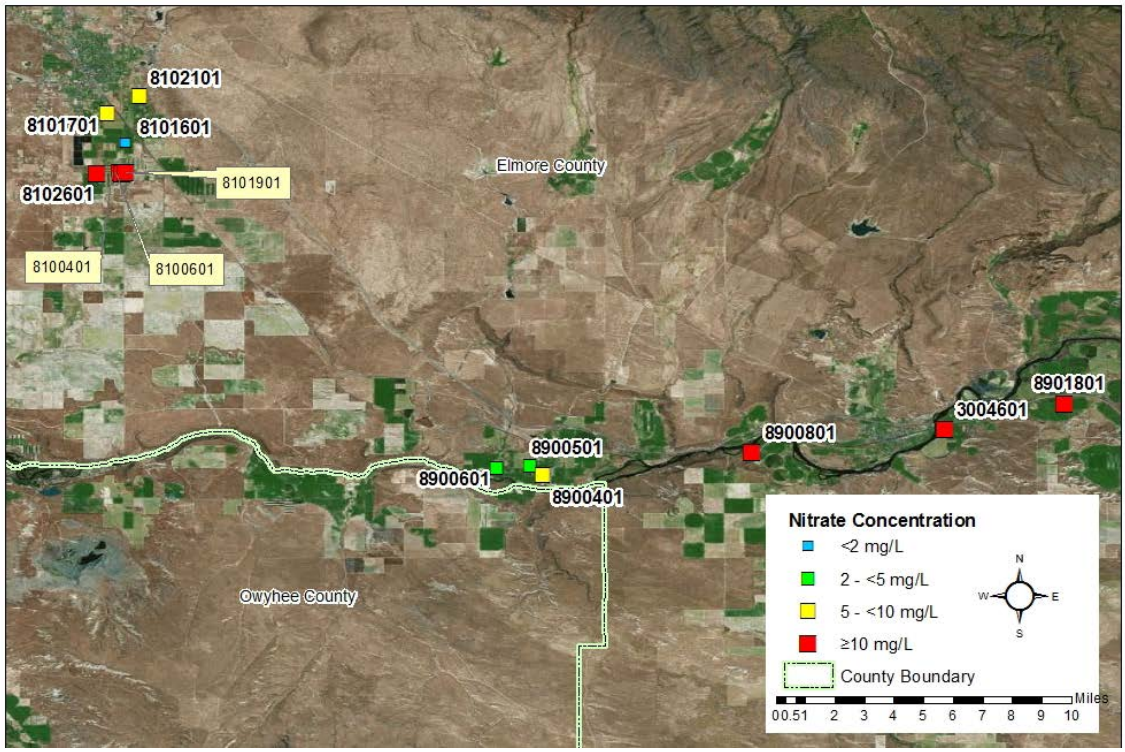


Figure B4. Elmore County nitrate concentrations—ISDA 2013 data.

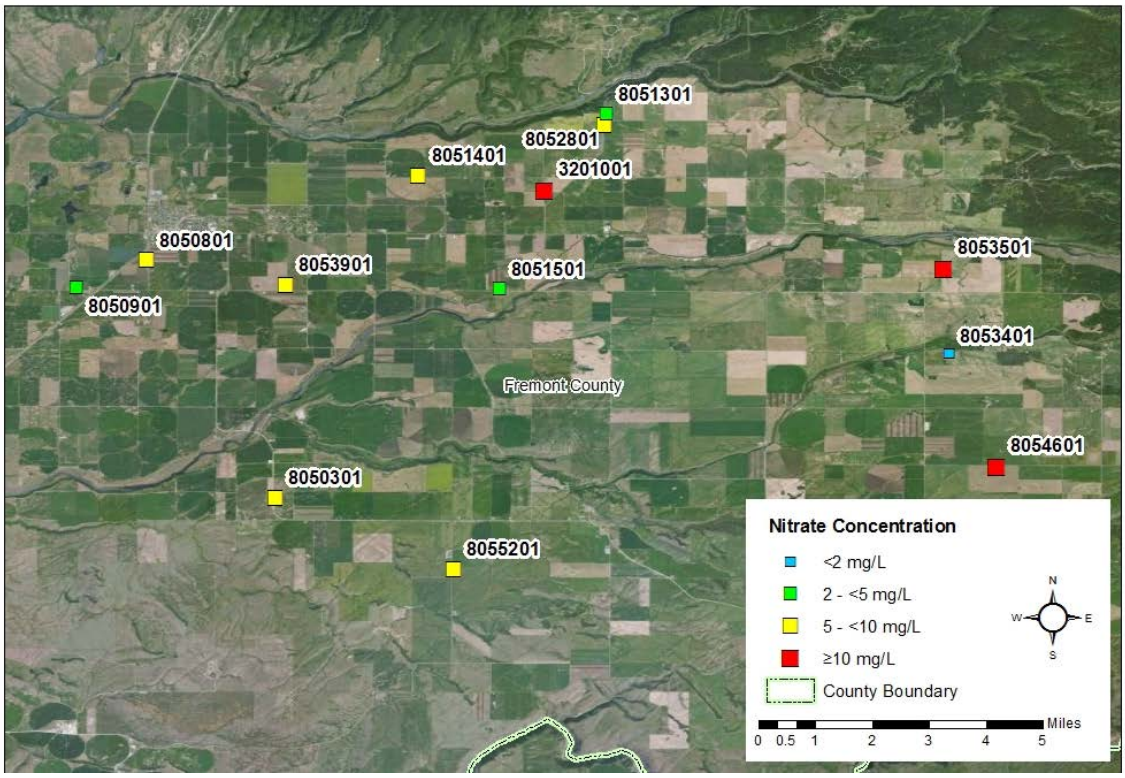


Figure B5. Fremont County nitrate concentrations—ISDA 2013 data.

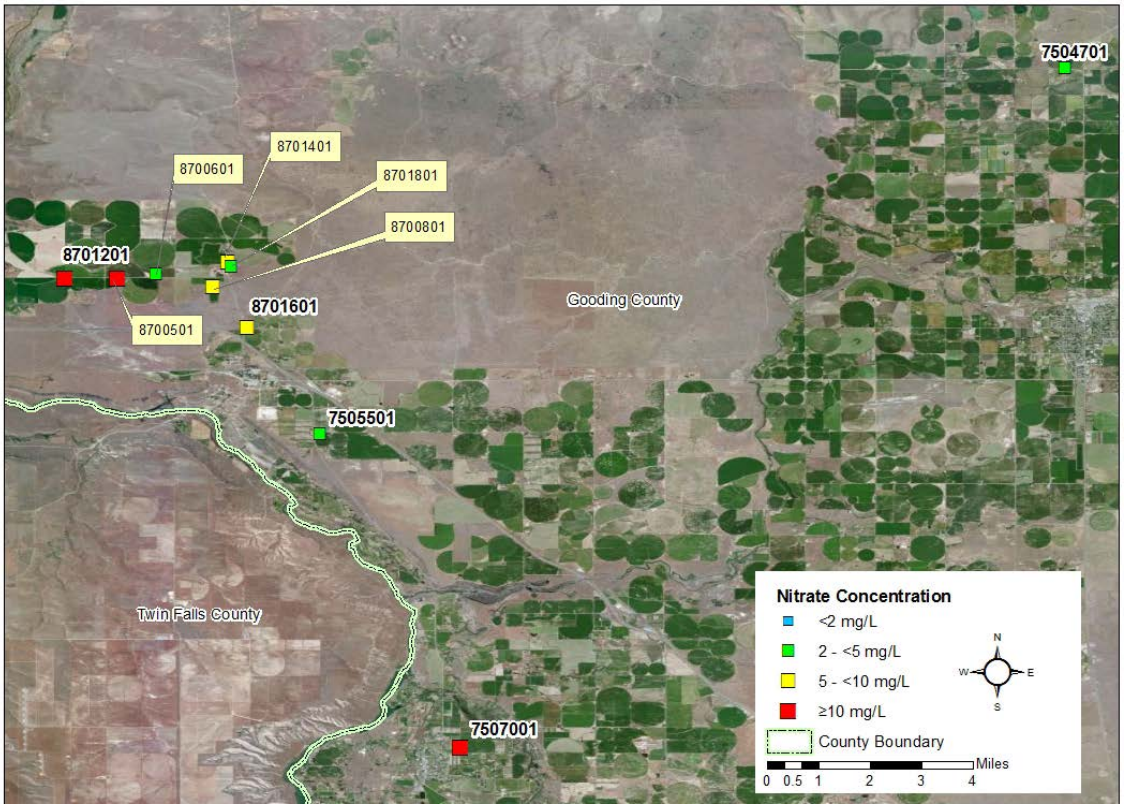


Figure B6. Gooding County nitrate concentrations—ISDA 2013 data.

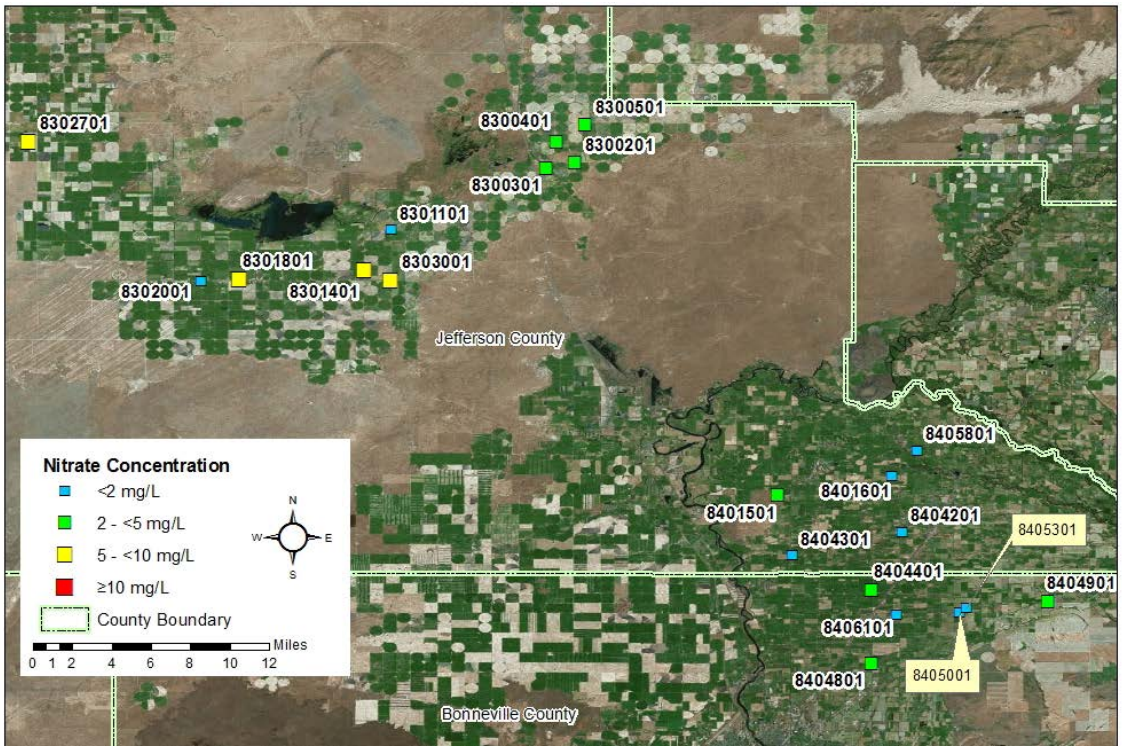


Figure B7. Jefferson and Bonneville Counties nitrate concentrations—ISDA 2013 data.

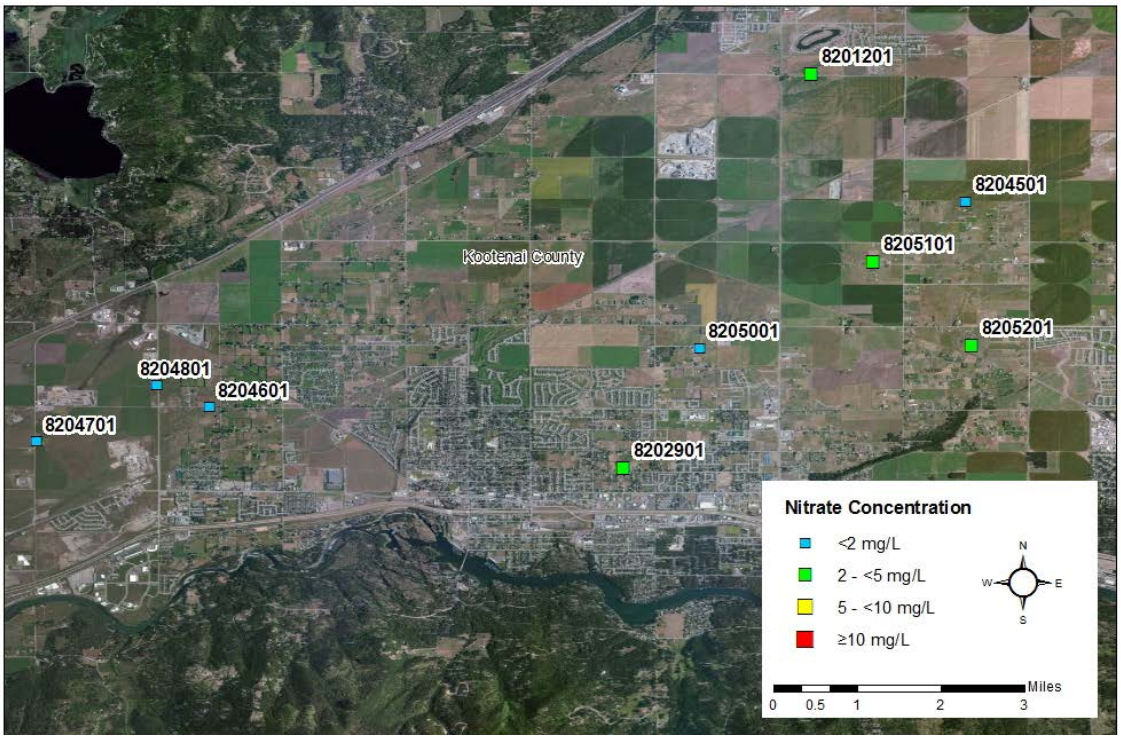


Figure B8. Kootenai County nitrate concentrations—ISDA 2013 data.

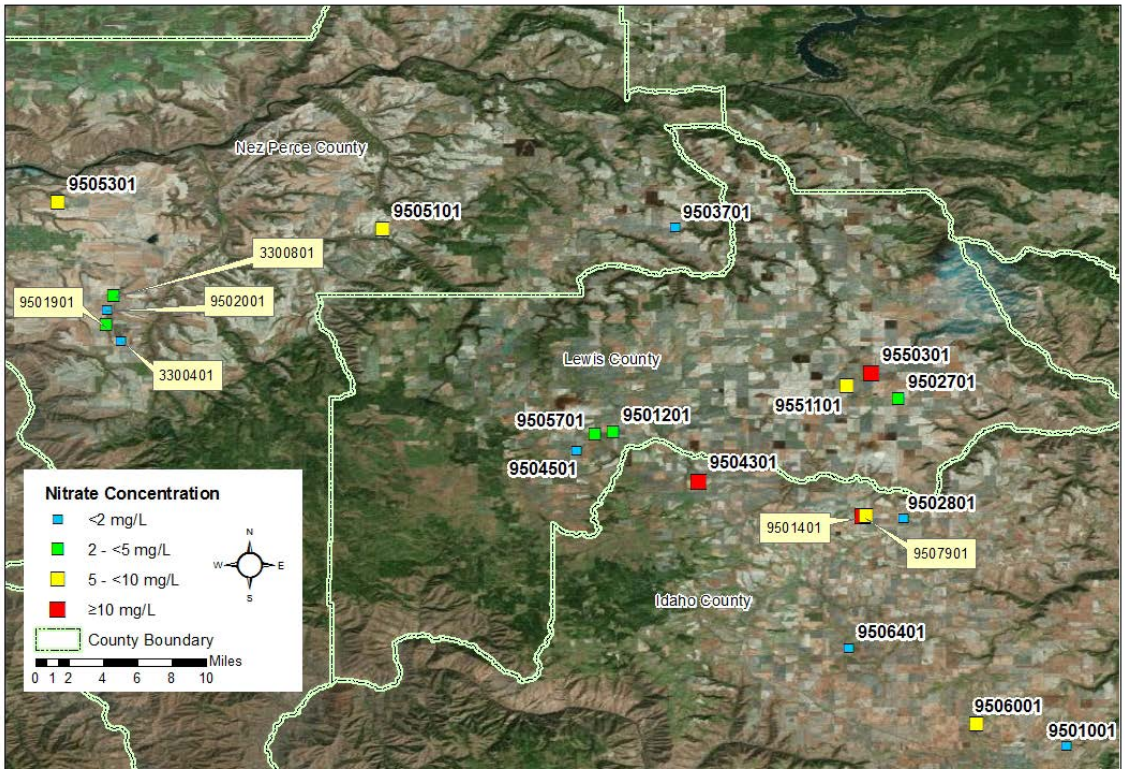


Figure B9. Lewis, Nez Perce, and Idaho Counties nitrate concentrations—ISDA 2013 data.

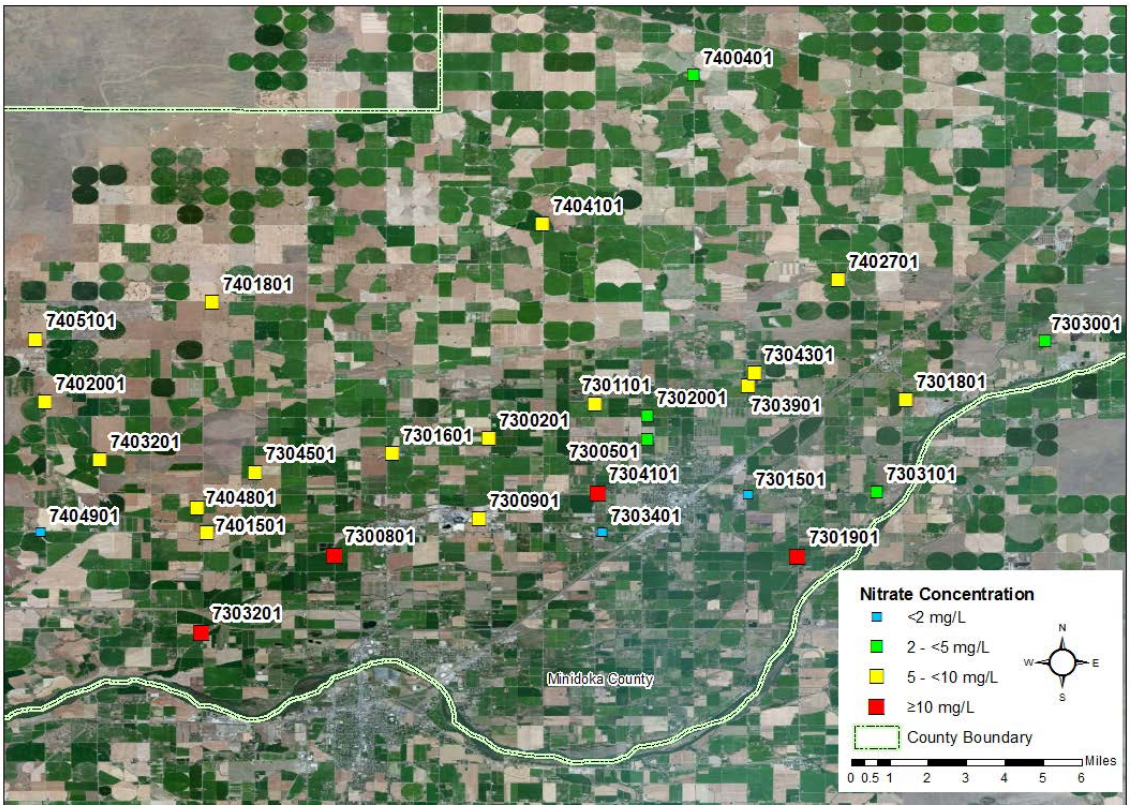


Figure B10. Minidoka County nitrate concentrations—ISDA 2013 data.

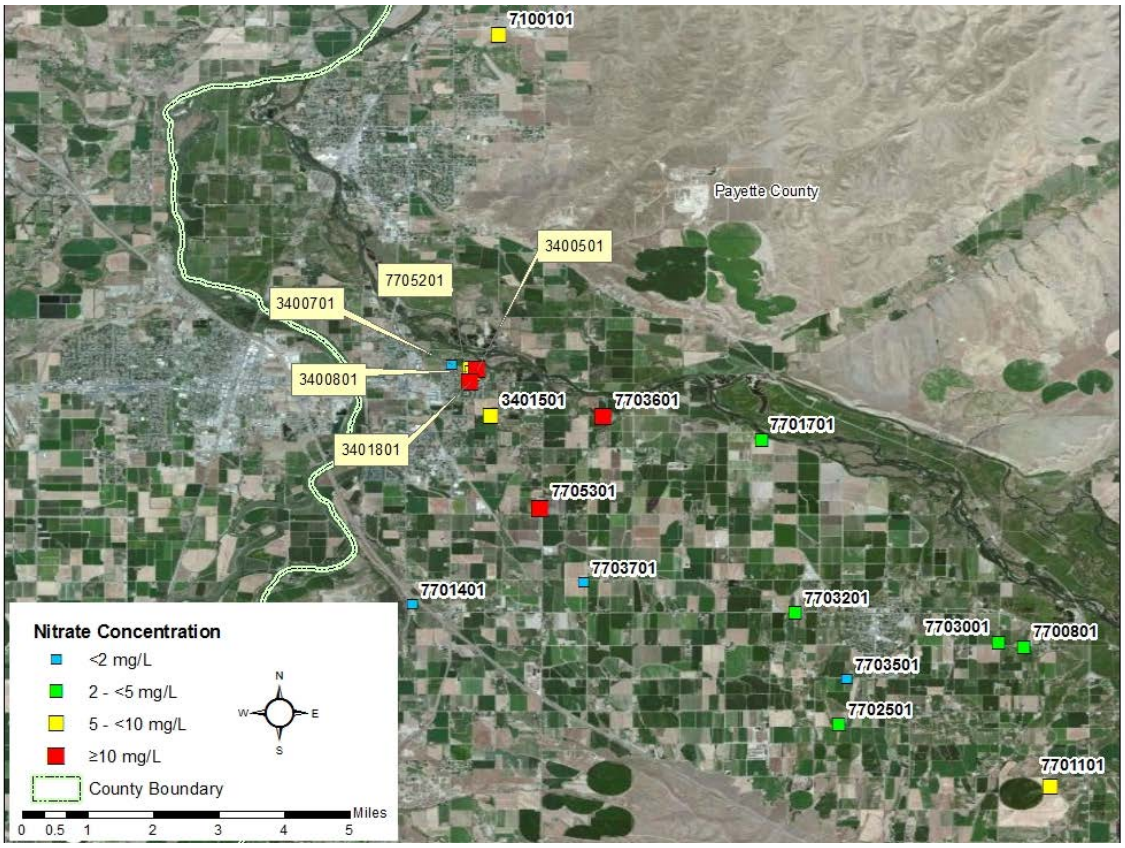


Figure B11. Payette County nitrate concentrations—ISDA 2013 data.

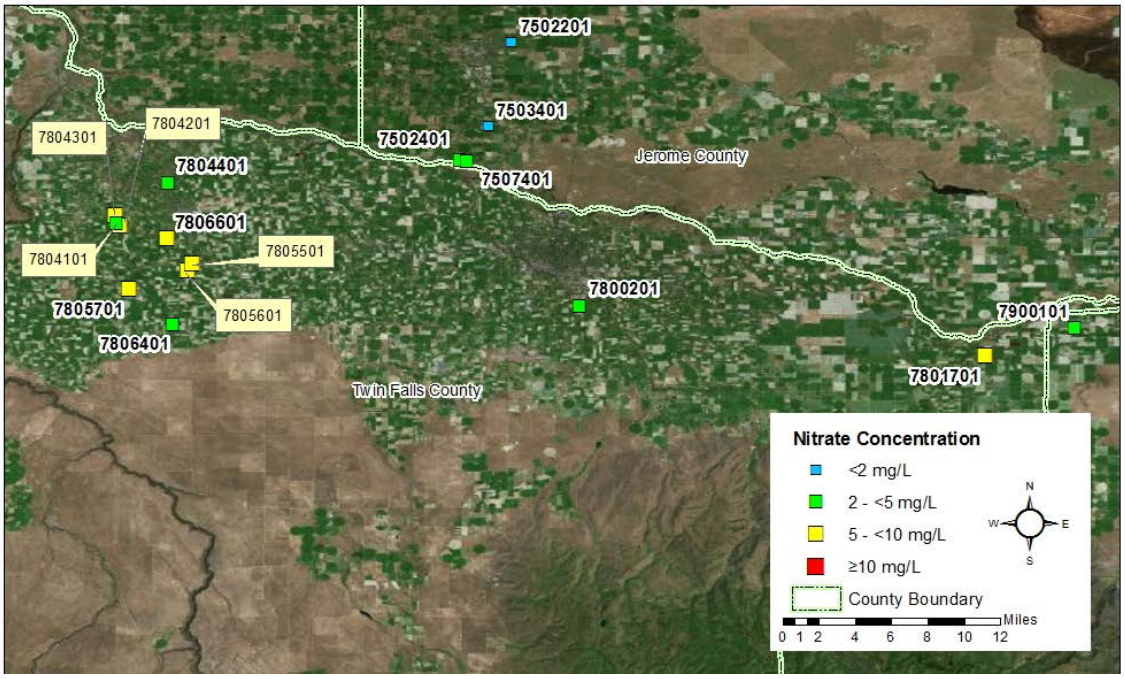


Figure B12. Twin Falls, Jerome, and West Bonneville Counties nitrate concentrations—ISDA 2013 data.

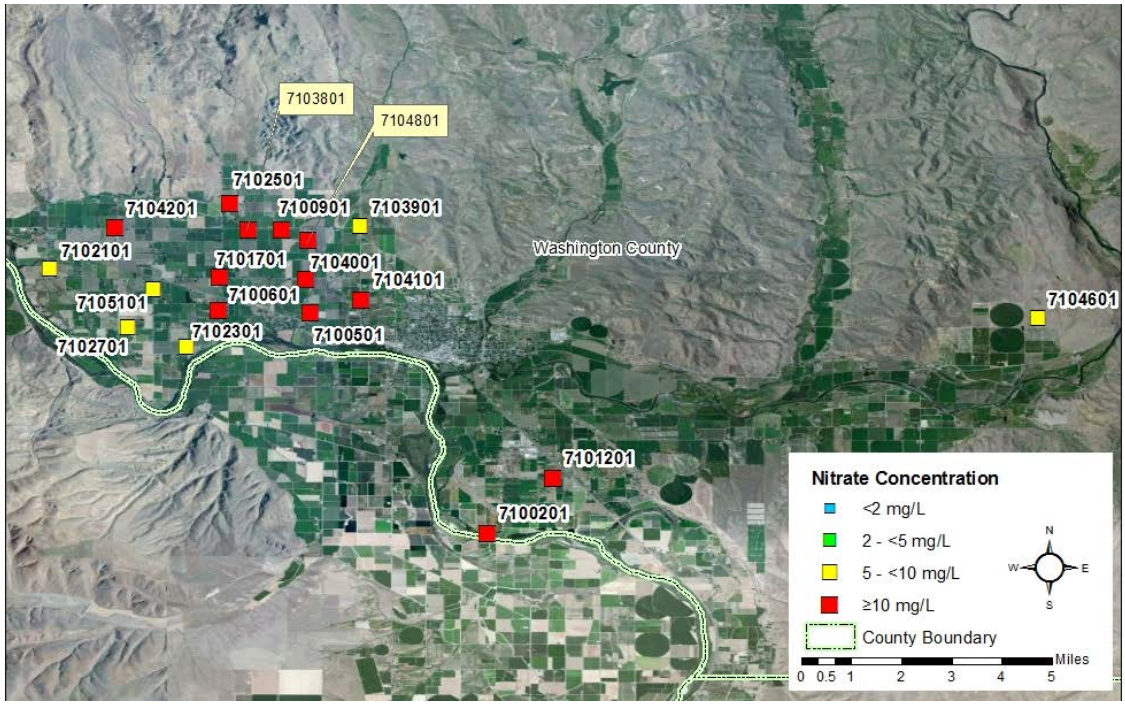


Figure B13. Washington County nitrate concentrations—ISDA 2013 data.

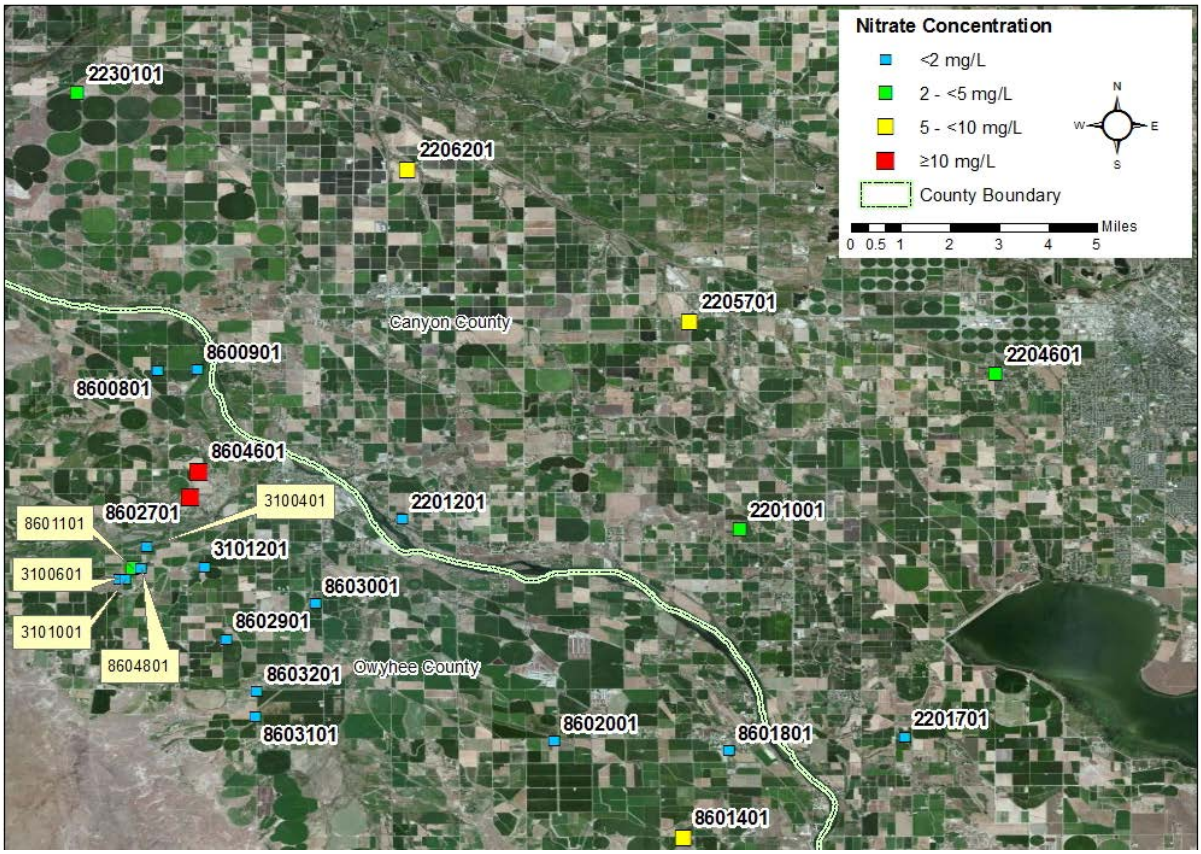


Figure B14. West Canyon and West Owyhee Counties nitrate concentrations—ISDA 2013 data.