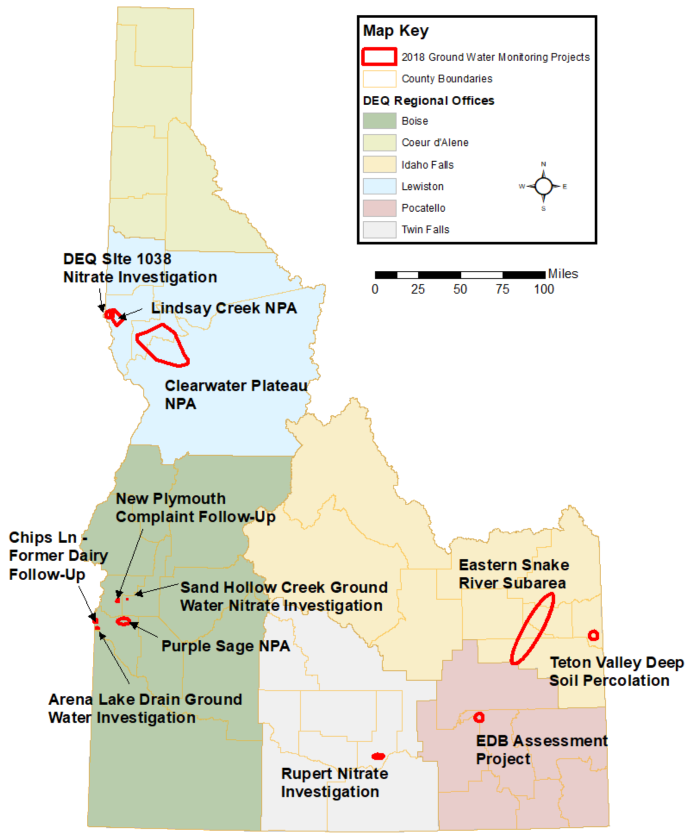
Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2018

Ground Water Quality Technical Report No. 52



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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
ESRP	Eastern Snake River Plain
FSP	field sampling plan
GWQM	ground water quality management
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	milligram

mL	milliliter
MPN	most probable number
NA	not applicable
ND	nondetect
NPA	nitrate priority area
NPDWR	National Primary Drinking Water Regulation
NSDWR	National Secondary Drinking Water Regulation
o-Xylene	orthoxylene
per mil (‰)	parts per thousand
pCi	picocuries
PWS	public water system
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
TC	total coliform
TDS	total dissolved solids
$\delta^{15}N$	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

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 almost every Idaho community depends on access to a safe and clean ground water supply.

Idaho Code §39-120 "Department of Environmental Quality Primary Administrative Agency – Agency responsibilities" 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 US Environmental Protection Agency (EPA) sets National Primary Drinking Water Regulations (NPDWRs) as legally-enforceable standards, expressed as maximum contaminant levels (MCLs), which apply to PWSs. The established levels protect public health by limiting the amount of contaminants in drinking water. EPA also sets National Secondary Drinking Water Regulations (NSDWRs) as nonmandatory standards established as guidelines to assist PWSs in managing their drinking water for aesthetic considerations (e.g., taste, color, and odor).

Although these limits only apply to PWSs, they can be used to evaluate water quality in private wells, as is done throughout this report. Total coliform (TC) and *Escherichia coli* (*E. coli*) bacteria sampling results were compared to the ground water quality standards 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 identified 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 not used for determining exceedances of Idaho's ground water quality standards. Field measurements are used to monitor well water during purging, ensure water in the wellbore is removed from the well before sampling, and 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 with elevated concentrations of nitrate (as N)[1] in ground water. These NPAs are ranked based on population, water quality, and water quality trends. The criterion for an NPA designation is met when 25% or more of the wells sampled within the area meet or exceed 5 mg/L concentration, or half of the MCL (10 mg/L). EPA established an MCL for nitrate at 10 mg/L and Idaho adopted this MCL as the ground water quality standard. The NPAs are reevaluated and reranked approximately every 5 years following the NPA delineation and ranking process (DEQ 2014a).

Prioritization effectively allocates resources for water quality improvement strategies. DEQ works with state and federal agencies and stakeholders to develop ground water quality improvement plans (i.e., ground water quality management plans) to address ground water degradation in NPAs. Ground water quality data are used to evaluate the effectiveness of plan implementation.

DEQ’s Ground Water Program implemented regional ground water monitoring using a statistically-based approach to determine the monitoring network design. Most of these regional projects focused on areas designated as NPAs. This report provides an overview of DEQ’s ground water monitoring projects and investigation activities accomplished with public funds in 2018. It does not include results from privately-funded activities, including monitoring required by permits, monitoring associated with ongoing environmental remediation projects, Kootenai County Aquifer Protection District funding, or PWS requirements.

Well owners allowing DEQ access to sample are notified of the results and informed if concentrations exceed an MCL. Well owners with concentrations above health-based standards are also provided with information on health risks and possible treatment options.

2 Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects conducted by DEQ in 2018. Projects are presented by DEQ regional offices and identified in Figure 1.

[1] Unless otherwise noted, *nitrate* refers to nitrate (as N) throughout the document.

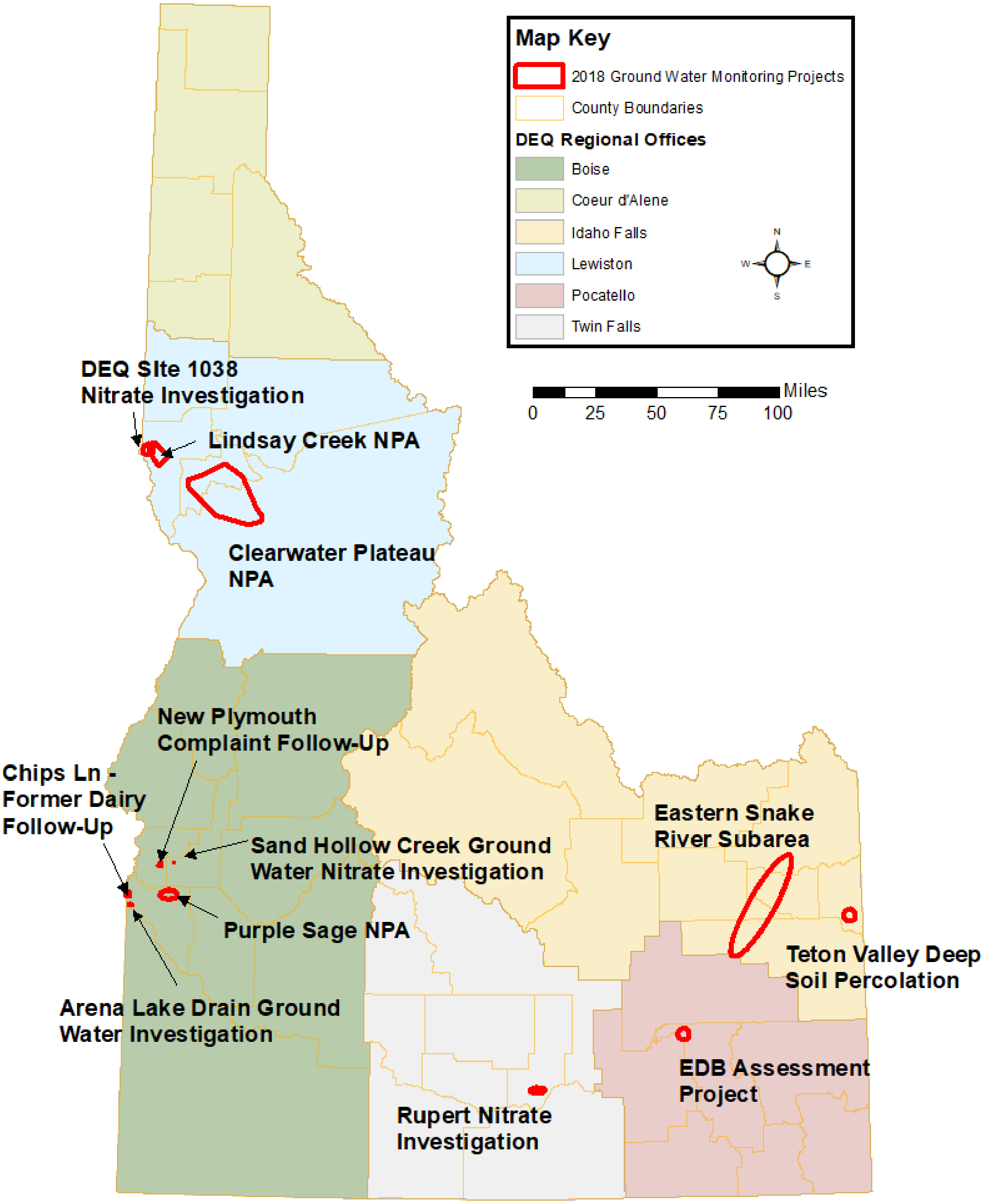


Figure 1. DEQ's 2018 ground water quality project locations by region.

All ground water quality data in this section are provided through an *interactive mapping application* available on DEQ's website. The application contains ground water quality data that

DEQ or its contractors collected from 1987 to the present. The application can be used to view and download data for over 350 contaminants, ranging from nitrate—a widespread ground water contaminant—to emerging contaminants (e.g., personal care products, 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

In 2018, five ground water quality monitoring projects were conducted in the Boise region using public funds.

2.1.1 Arena Lake Drain Ground Water Monitoring Project

2.1.1.1 Purpose and Background

The purpose of this monitoring project was to evaluate whether the deepening of a surface drain was affecting nitrate levels in a nearby private well through interconnected ground water. In 2012, DEQ sampled Well 2042 located south of the Arena Lake Drain (the Drain) and north of Howe Rd. during the 2012 Ada Canyon NPA sampling event. The nitrate concentration from that event was 6.4 mg/L. In 2017, DEQ sampled the well for the 2017 Ada Canyon NPA five-year follow up sampling event. The nitrate result from this event was 30.4 mg/L. In comparing the 2012 and 2017 field parameters, a notable difference in results was identified in specific conductance, which increased from 664 microsiemens/centimeter (μS/cm) in 2012 to 1,130 μS/cm in 2017. The 2017 results and comparison with 2012 are summarized in the 2017 annual summary report, DEQ Technical Report Number 51 (DEQ 2019). According to EPA's National Aquatic Resource Surveys:

> Significant changes (usually increases) in conductivity may indicate that a discharge or some other source of disturbance has decreased the relative condition or health of the water body and its associated biota. Generally, human disturbance tends to increase the amount of dissolved solids entering waters which results in increased conductivity. Water bodies with elevated conductivity may have other impaired or altered indicators as well (EPA 2016).

DEQ published a technical report on the ground water quality of the Arena Valley (Baldwin 2006). Arena Lake Drain is located within the Arena Valley in the western portion of Canyon County, west of Wilder. The predominant land use near Arena Lake Drain is agricultural, which includes crops such as corn, alfalfa, and small grains. The area also includes animal feeding operations and pastureland. (Baldwin 2006). Since the 2005 investigation, hops have become the dominant crop type in the area.

There are two aquifers in the Arena Valley, hydraulically separated by thick clay strata in the subsurface. The shallow aquifer extends to approximately 400 feet below ground surface and has a general water elevation of 2,365 feet (Baldwin 2006). The drains flow year round, with larger discharges during the summer irrigation months, when the shallow water table is at its highest and irrigation return flow enters the drains. Most drains continue to flow during the non-irrigation season; the flow consists of shallow water table discharge only. Discharge probably decreases in the late winter and early spring, when the water table declines to its lowest elevation (Baldwin 2006).

The Arena Lake Drain is approximately 150 feet north of Well 2042 and flows from east to west where it eventually discharges to the Snake River (Baldwin 2006). The well driller's report for Well 2042 indicates that first water was encountered at 14 feet below ground surface (bgs) in coarse gravel and continues to 46 feet bgs where the drilling stopped.

According to the well owner, the Wilder Irrigation District deepened the Arena Lake Drain sometime between the DEQ sampling events in 2012 and 2017. At the time of the 2017 sampling event, the water level in the Drain was approximately 75% of the high water level based on DEQ staff observation.

On January 23, 2018, DEQ determined that all other ditches and canals in the areas surrounding Well 2042 were dry, while Arena Lake Drain appeared to have three to four feet of running water from east of the Roswell culvert to south of Monte Rd. and was also inhabited by large catfish. DEQ staff observed the portions of the Arena Lake Drain that could be observed from public streets. It was also apparent that it had been excavated unusually deep, to at least 15 feet. Nearby canals are generally 10 – 12 feet deep. The banks were bare earth with some vegetation, while other canals in the area had concrete sides and sandy bottoms.

Although there was no apparent surface runoff, water was seeping from the banks of the Arena Lake Drain east of the Arena Valley Road culvert, indicating potential ground water discharge into the Arena Lake Drain during the first three months of 2018. During this time, all other irrigation canals and drains were dry and the depth of water in Arena Lake Drain ranged from approximately 2.5 feet to 4 feet. General ground water flow direction is shown in Figure 2. Sampling location from this project, as well as nearby locations sampled in 2003 and 2005, are also shown on Figure 2.

There is an additional ditch on the east side of the Well 2042 property that extends south to a pump for crop irrigation of a separately-owned property. The depth of this side ditch is unknown and it contained red and green algae from November 2017 to October 2018. The water level did not appear to change during the sampling project period and the pump was not in use at any time when DEQ personnel were present.

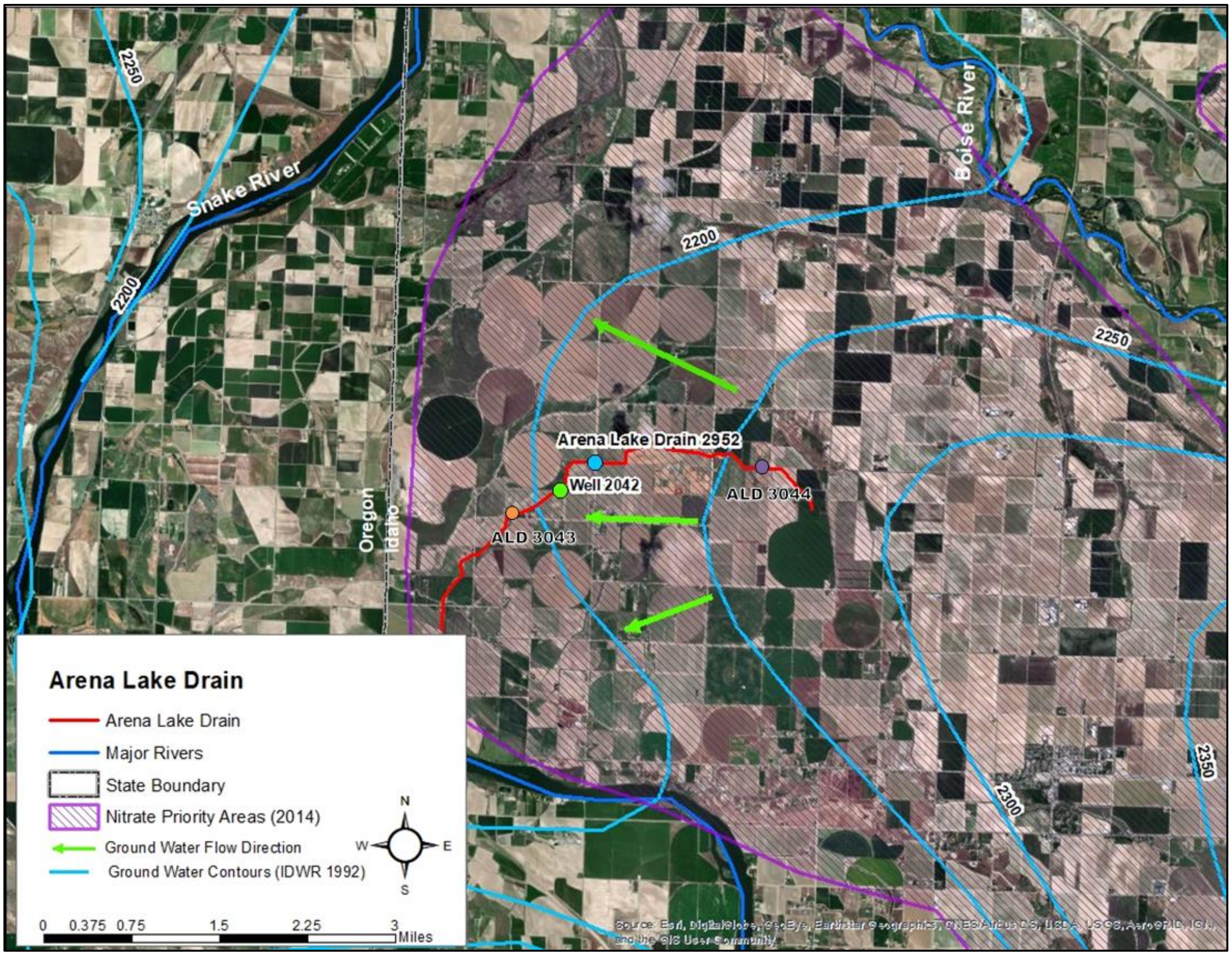


Figure 2. Sample sites and location of Arena Lake Drain—Arena Lake Drain Ground Water Monitoring Project.

2.1.1.2 Methods and Results

DEQ collected surface water samples from a location at Arena Lake Drain (DEQ site ID 2952) and ground water samples from well 2042 concurrently seven times in 2018 during a two-part sampling event. Part 1 consisted of samples collected in March and May of 2018. Part 2 consisted of samples collected in July, August, October, and November of 2018. The Arena Lake Drain sampling location was chosen due to ease of access and the least amount of vegetation growing in the water. The site is south of the corner of Arena Valley Rd. and Gopher Trail. Samples were collected in accordance with the quality assurance project plan (QAPP) (DEQ 2015a) and the field sampling plan (FSP) (DEQ 2018a). The laboratories analyzed the samples for nitrate, nitrite, ammonia, orthophosphate, total dissolved solids (TDS), and nitrogen isotopes. Water quality field parameters (i.e., pH, temperature, specific conductance, turbidity, and DO) were measured at each sample location before sample collection (Table 1) to ensure adequate purging of the well for a representative sample of the local aquifer.

During November of 2017, the Arena Lake Drain was approximately 3/4 full. When the sampling project began in February of 2018, the water level in Arena Lake Drain did not exceed four feet during Part 1 and had decreased to approximately 2.5 feet during Part 2.

Field Parameters

When well 2042 was sampled on September 19, 2017, the specific conductance was 1130 µS/cm, and dissolved oxygen (DO) was 1.80 mg/L. By February of 2018, the conductance had decreased to 718 µS/cm and the DO had increased to 3.04 mg/L. Field parameter results are listed in Table 1.

Table 1. Water quality field parameters—Arena Lake Drain Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2042	46	02/05/2018	13.12	717	6.98	3.04
		03/12/2018	13.19	717	6.94	2.36
		05/15/2018	13.83	718	7.37	3.45
		07/31/2018	13.90	653	7.34	9.01
		08/29/2018	13.85	737	6.74	3.82
		10/02/2018	13.71	745	7.37	2.71
		11/26/2018	13.48	728	6.91	2.80
2952 (ALD)	Drain	02/05/2018	12.17	887	7.00	7.92
		03/12/2018	10.76	913	7.32	6.49
		05/15/2018	19.03	296	7.81	11.41
		07/31/2018	23.75	233	7.80	8.27
		08/29/2018	19.82	267	7.14	11.21
		11/26/2018	10.52	860	7.81	24.17

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; (ALD) = Arena Lake Drain sample.
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 but can be applied to private wells to evaluate water quality.

Nutrient Results

Nitrate, nitrite, and ammonia results are contained in Table 2. Nitrate concentrations vary seasonally throughout the year at the drain site (2952), while ground water nitrate concentrations remained relatively stable at Well 2042 (Figure 3). Results from 2005 drain water samples (Baldwin 2006) from nearby locations (3043-downstream, 3044-upstream, and 2952) are included in Table 2 for comparison.

Table 2. Nutrient and nutrient-related isotope results—Arena Lake Drain Ground Water Monitoring Project and Baldwin (2006).

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{15}N$
			(mg/L)	(mg/L)	(mg/L)	(‰)
Water Quality Standard:			1	10	No Standard	No Standard
2042	46	2/5/2018	—	6.75	0.019J	—
		3/12/2018	<0.30	6.16	<0.010	—
		5/15/2018	—	4.32	<0.010	—
		7/31/2018	<0.30	7.21J	<0.010	—
		8/29/2018	<0.30	6.95	<0.010	—
		10/2/2018	<0.30	6.19	<0.010	5.3
		11/26/2018	<0.30	5.19	<0.010	4.9
2952 (ALD)	Drain	12/15/2005	—	5.05	—	—
		2/5/2018	—	**13.7**	0.034	—
		3/12/2018	<0.30	**12.5**	0.033	—
		5/15/2018	—	1.84	0.025	—
		7/31/2018	<0.30	1.29	0.02	7
		8/29/2018	<0.30	1.19	0.014	—
		10/2/2018	<0.30	1.99	0.026	—
		11/26/2018	<0.30	9.86	0.048	7.9
3043 (ALD)	NA	10/15/2003	—	7.39	—	—
		12/15/2005	—	6.1	—	—
3044 (ALD)	NA	12/15/2005	—	1.45	—	3.38

Notes: mg/L = milligrams per liter; ‰ = per mil; Unk = Unknown. Well log not found; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. J = The analyte was detected, but the value of the result is an estimate. 7.21 mg/L was reported by the laboratory as the duplicate for the surface water sample (site 2952, where the original sample = 1.29 mg/L), which resulted in an RPD of 139%. After further review, it appears there was a labeling issue between the ground water sample (reported by lab as 1.30 mg/L) and the surface water duplicate sample. Therefore, 7.21 mg/L will be reported as the ground water sample with site 2042.

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

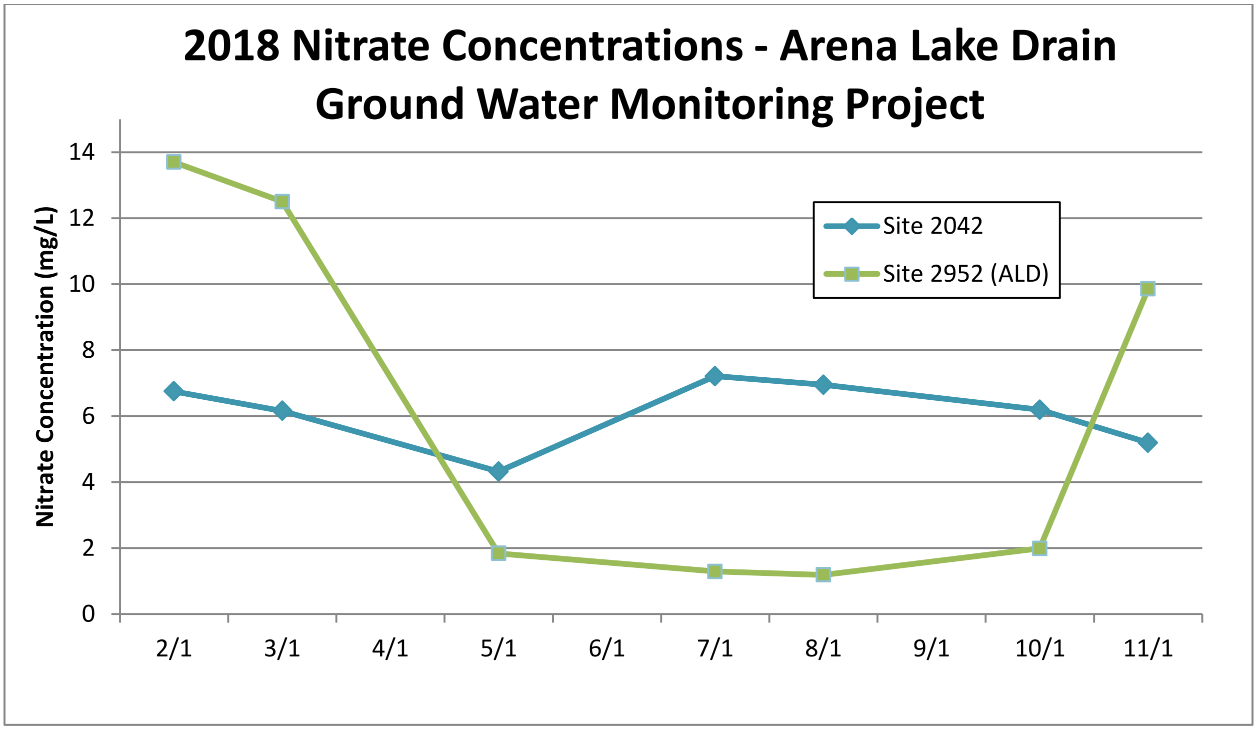


Figure 3. 2018 nitrate concentrations for sites 2042 and 2952 - Arena Lake Drain Ground Water Monitoring Project.

The reported ammonia concentration for Well 2042 was 0.019 mg/L in February (Table 2). Ammonia levels decreased to <0.010 in the remaining months of the study. The concentration of ammonia in the Arena Lake Drain was initially 0.034 mg/L in February, which gradually decreased to 0.014 mg/L in August, and later increased to 0.048 mg/L in November.

Nitrogen Isotope Results

Nitrogen isotope ratios were determined for four samples (Table 2). The result from the upgradient drain location 3044 (ALD), sampled in 2005, (Baldwin 2006) is included in Table 2 for historical comparison.

The nitrogen isotope ratio ($\delta^{15}N$) is calculated from the ratio between two stable isotopes of nitrogen ($\delta^{15}N$ and $\delta^{14}N$) in a sample and the ^{15}N and ^{14}N ratio of a reference standard. The $\delta^{15}N$ values are reported as per mil (‰; parts per thousand). The $\delta^{15}N$ value is used to assess the likely dominant source of the nitrogen in a sample, with lower $\delta^{15}N$ values generally indicating organic nitrogen in soil (+4 to +9‰) and/or fertilizer-sourced nitrogen (-4 to +4‰), with higher $\delta^{15}N$ values (greater than +9‰) indicating nitrogen from animal or human waste (Seiler 1996; Table 3).

Table 3. Typical $\delta^{15}N$ values from various nitrogen sources.

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

Source: Seiler 1996

Nitrogen isotopes can be used with other water quality data and land use information to better determine sources of nitrogen in ground water. However, nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake. Mixing sources with variable nitrogen isotope values along shallow ground water flow paths makes determining the sources and extent of denitrification very difficult for intermediate $\delta^{15}N$ values (Kendall and McDonnell 1998).

Orthophosphate and Total Dissolved Solids Results

The reported orthophosphate (OP) concentration for Well 2042 was 0.069 mg/L in February and remained fairly stable, between 0.064 mg/L and 0.074 mg/L, during the study (Table 4). The Arena Lake Drain OP concentration was 0.067 mg/L in February and 0.068 mg/L in March. During May through October, the OP concentration in samples collected from the Arena Lake Drain fluctuated between 0.016 mg/L and 0.025 mg/L, and later increased to 0.063 mg/L in November.

The reported Total Dissolved Solids (TDS) results for Well 2042 remained fairly consistent, between 450 mg/L and 480 mg/L, throughout the study (Table 4). The Arena Lake Drain TDS concentrations were 580 mg/L and 590 mg/L in February and March, respectively. In May and August, the TDS results in samples collected from the Arena Lake Drain were constant at 160 mg/L, but increased to 210 mg/L in October and to 590 mg/L in November.

Table 4. Common ion and Total Dissolved Solids results—Arena Lake Drain Ground Water Monitoring Project and Baldwin (2006).

DEQ Site ID	Well Depth (ft bgs)	Sample Date	O-Phosphate (mg/L)	Total Dissolved Solids[a] (mg/L)
Water Quality Standard:			No Standard	500
2042	46	2/5/2018	0.069	460
		3/12/2018	0.074	460
		5/15/2018	0.068	450
		7/31/2018	0.072J	480
		8/29/2018	0.071	470
		10/2/2018	0.064	470
		11/26/2018	0.065	480
2952 (ALD)	Drain	02/15/2005	0.069	526
		2/5/2018	0.067	580
		3/12/2018	0.072J	600

		5/15/2018	0.022	160
		7/31/2018	0.018	160
		8/29/2018	0.016	160
		10/2/2018	0.025	210
		11/26/2018	0.063	590
3043 (ALD)	Drain	10/15/2003	0.091	490
		12/15/2005	0.082	519
3044 (ALD)	Drain	12/15/2005	0.195	493

Notes: mg/L = milligrams per liter; Unk = Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = The analyte was detected, but the value of the result is an estimate. 0.072 mg/L was reported by the laboratory as the duplicate for the surface water sample (site 2952, original sample: 0.018 mg/L), which resulted in an RPD of 120%. After further review, it is likely there was a labeling issue between the ground water sample (reported by lab as 0.019 mg/L) and the surface water duplicate sample. Therefore, 0.072 mg/L will be reported as the ground water sample with site 2042.
a. Contaminant with a National Secondary Drinking Water Regulation standard.

Quality Assurance

Duplicate samples were collected during the March and July sampling events to evaluate the accuracy of the laboratory analysis methods. The relative percent difference (RPD) is a comparison between the original sample and the duplicate sample. The RPD helps determine the accuracy of lab analyses. The RPD for samples collected at site 2952 in July have a difference of 139% for nitrate and 120% for orthophosphate. All other RPDs calculated for these two samples are 10.5% or less.

Idaho Bureau of Laboratories (IBL) was within RPD requirements on all other samples, including ammonia and TDS in these two samples. Due to the high RPD values, DEQ requested quality assurance information for the nitrate and orthophosphate samples from the July samples collected at site 2952. Upon further review, it was determined that a labeling error occurred during sampling, sample log in, or lab labeling, which involved the ground water sample collected at site 2042. For this reason, the July sample result for nitrate at Well 2042 (Table 2), and March and July orthophosphate results at Wells 2042 and 2952 were adjusted accordingly (Table 4).

2.1.1.3 Conclusions

Deepening of the Arena Lake Drain may have had a short-term effect on the nitrate concentrations in ground water samples from nearby wells that eventually reached equilibrium. Water seeping from the drain banks indicates ground water is discharging into the drain. High nitrate concentrations occur in the drain during the winter when the shallowest ground water with the highest nitrate concentration is the source of drain water. When surface water flows during the irrigation season, the nitrate, orthophosphate, and TDS are lowest in the surface water. The concentrations of all constituents are fairly consistent in ground water, suggesting the surface water in the drain during the irrigation season does not significantly impact the ground water quality.

2.1.2 Chips Lane – Former Dairy Follow-Up Ground Water Monitoring Project

2.1.2.1 Purpose and Background

On January 2, 2018, DEQ received a complaint of “foul tasting” well water (as reported by the complainant) after the waste lagoon at a former dairy began overflowing. The former dairy is located approximately four miles southwest of the City of Parma in Canyon County. The complainant's well is located approximately 150 yards northwest of the abandoned waste lagoon.

The ISDA Dairy Bureau later collected a sample from the complainant's well. The results for this sample reported an ammonia concentration of 5.16 mg/L and a nitrate concentration <0.2 mg/L.

DEQ and ISDA employees later conducted an assessment of the waste and wastewater lagoons at the former dairy. Photographs taken during this assessment indicated that wastewater overflowed from the former dairy lagoons and drained toward established drainage ditches.

In 2018, DEQ initiated an investigation in the area of the complainant's well to determine current ammonia concentrations, and to collect samples of additional analytes. The project area is comprised of mixed residential and agricultural use served by irrigation conveyance systems (Figure 4). Domestic residences are presumed to have on-site wells for domestic water purpose, septic systems for domestic wastewater management and access to the irrigation conveyance system.

2.1.2.2 Methods and Results

DEQ received permission to sample six wells to the west and northwest of the former dairy. On June 5 and 6, 2018 each well was sampled for nitrate, nitrite, magnesium, calcium, potassium, sodium, chloride, sulfate, ammonia, orthophosphate, alkalinity, TC, and *E. coli*.

The samples were collected in accordance with the QAPP (DEQ 2017a) and FSP (DEQ 2018b). Water quality field parameters (i.e., pH, temperature, specific conductance, turbidity, DO) were measured at each sample location before sample collection (Table 5) to ensure adequate purging of the well for a representative sample of the local aquifer. All samples collected in June 2018 were submitted to the IBL for analysis. All sample results were below the primary or secondary standards for regulated analytes (Tables 5–7).

Table 5. Water Quality Field Parameters—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2055	72	06/05/2018	17.00	1030	7.06	0.53
2774	204	06/06/2018	18.06	680	7.65	0.83
2775	207	06/06/2018	16.20	765	7.69	0.97
2776	185	06/05/2018	18.21	618	6.97	0.60
2777	161	06/05/2018	17.83	688	7.25	0.80
2778	160	06/06/2018	17.30	786	7.61	0.92

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; 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 but can be applied to private wells to evaluate water quality.

Nutrients

Nutrient results are presented in Table 6. Of the six wells sampled, only the complainant's well (Well 2776) had a detectable concentration for nitrate, with a concentration of 0.329 mg/L. Well 2776 was also the only well that had a detectable concentration for nitrite, with a concentration of 0.546 mg/L. Ammonia concentrations ranged from 1.6 mg/L to 6.3 mg/L. Nitrogen isotope samples were not collected from any of the wells.

Table 6. Nutrient and nutrient-related isotope results—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration		
			Nitrite[a] (mg/L)	Nitrate[a] (mg/L)	Ammonia (mg/L)
Water Quality Standard:			1.0	10	No Standard
2055	72	06/05/2018	<0.30	<0.18	1.6
2774	204	06/06/2018	<0.30	<0.18	4.7
2775	207	06/06/2018	<0.30	<0.18	5.7
2776	185	01/03/2018	—	<0.2	5.16
2776	185	06/05/2018	0.546	0.329	4.1
2777	161	06/05/2018	<0.30	<0.18	5.6
2778	160	06/06/2018	<0.30	<0.18	6.3

Notes: mg/L = milligrams per liter; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard.

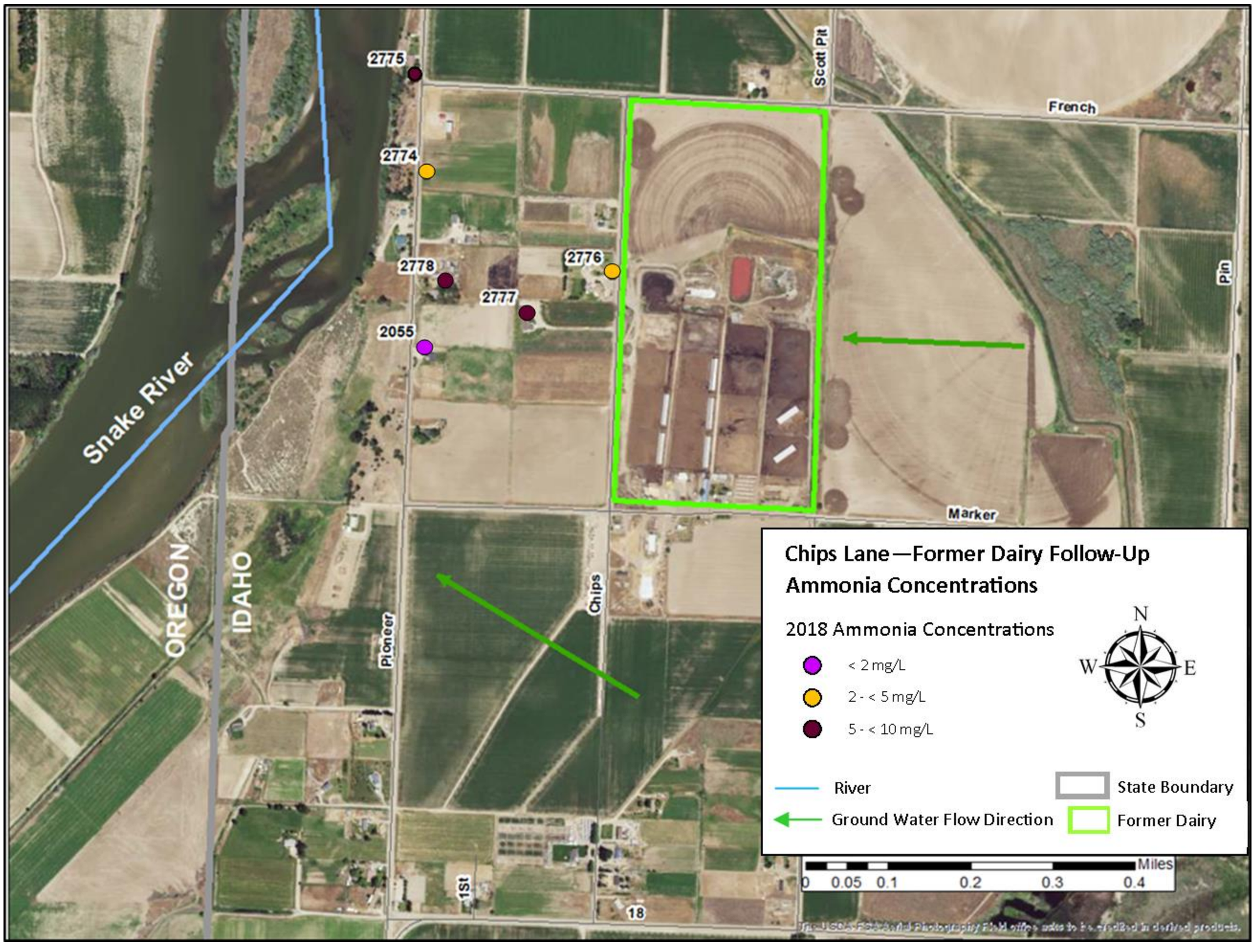


Figure 4. Sampling Sites with ammonia concentration results—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

Metals and Anions Results

Metals and common ions results are presented in Table 7. Calcium concentrations ranged from 18–80 mg/L. Magnesium concentrations ranged from 5.8–31 mg/L. Potassium concentrations ranged from 12–17 mg/L. Chloride concentrations ranged from 18.4–36.9 mg/L. Sulfate results ranged from less than the detection limit (<0.80 mg/L) to 124 mg/L. Alkalinity (measured by CaCO3) results ranged from 262–385 mg/L. Orthophosphates concentrations ranged from 0.029–0.126 mg/L. When plotted on a Piper diagram, results show distinction in water chemistry between the shallow well (Well 2055) and deeper wells (Figure 5).

Table 7. Common ion and Total Dissolved Solids results—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Calcium (mg/L)	Chloride[a] (mg/L)	Magnesium (mg/L)	O-Phosphate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Water Quality Standard:			**No Standard**	**No Standard**	**250**	**No Standard**	**No Standard**	**No Standard**	**No Standard**	**250**
2055	72	06/05/2018	385	80	36.9	31	0.029	15	98	124
2774	204	06/06/2018	309	21	30.8	6.2	0.121	12	110	<0.80
2775	207	06/06/2018	383	18	18.4	5.8	0.126	14	130	<0.80
2776	185	06/05/2018	272	18	27.7	5.8	0.094	13	100	3.33
2777	161	06/05/2018	262	34	28.1	9.3	0.086	16	86	49.2
2778	160	06/06/2018	278	40	31.9	11	0.083	17	91	73.0

Notes: mg/L = milligrams per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

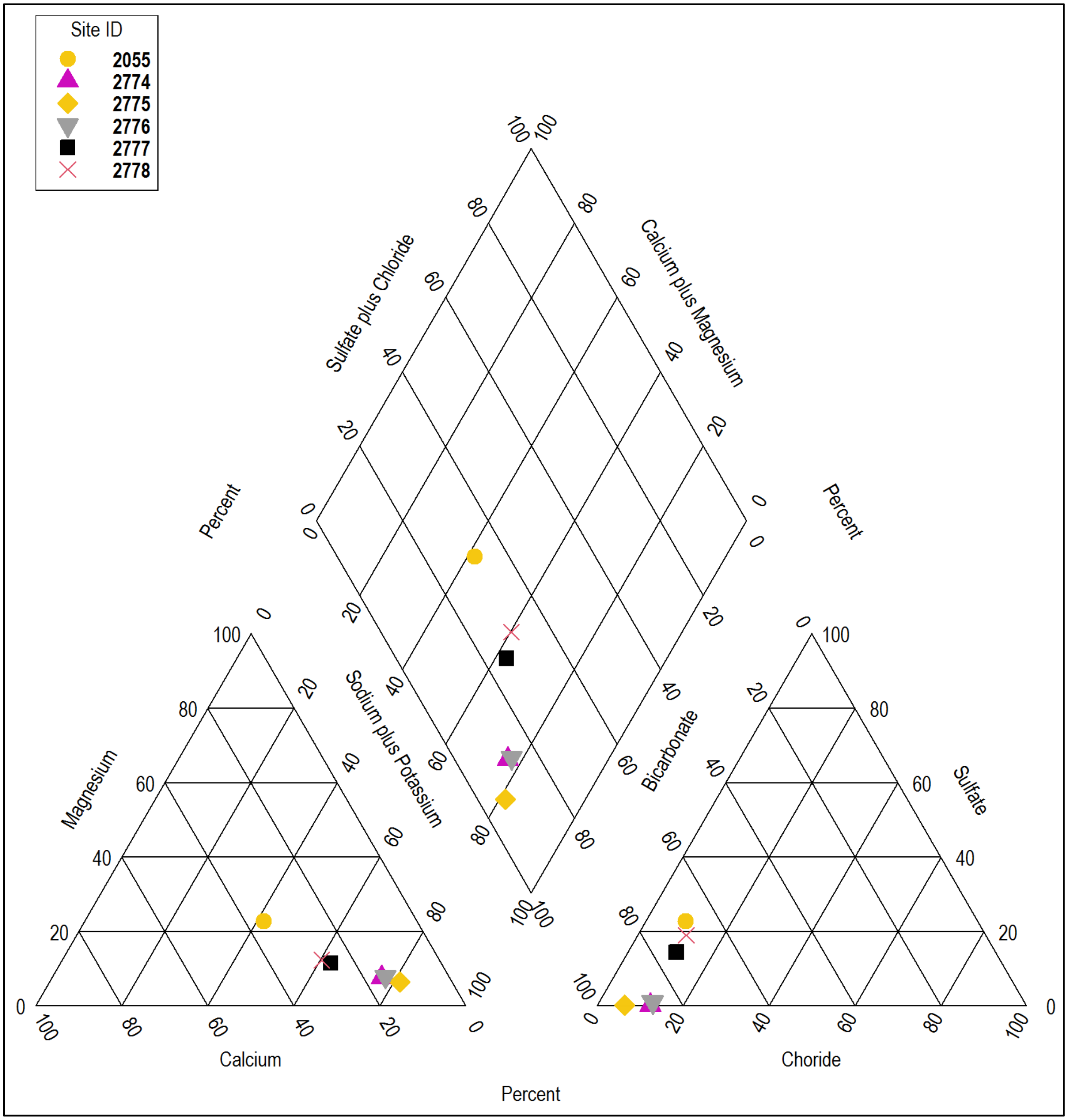


Figure 5: Piper Diagram results—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

Bacteria Results

Bacteria results are presented in Table 8. Only Well 2775 tested positive for TC with a concentration of 15.8 MPN/100 mL. None of the wells tested positive for *E. coli*.

Table 8. Bacteria Results—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	**Total Coliform** (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
2055	72	06/05/2018	<1.0	<1.0
2774	204	06/06/2018	<1.0	<1.0
2775	207	06/06/2018	<1.0	15.8
2776	185	01/03/2018	A	A
2776	185	06/05/2018	<1.0	<1.0
2777	161	06/05/2018	<1.0	<1.0
2778	160	06/06/2018	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters; A = absent of bacteria.
a. 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 numbers) 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.

Historical Results in Area

Well 2055 was the only well sampled for this project that had historical sampling data available. Project data for a nearby Parma NPA was used to compare changes in results from 2012 to 2018 (Table 9). Wells with increased concentrations of either nitrate or ammonia from 2012–2017 are also shown in Figure 6.

Table 9. Historical Nitrate and Ammonia Data—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate[a] (mg/L)	**Ammonia** (mg/L)
Water Quality Standard:			10	No Standard
2055	72	9/4/2012	<0.05	1.8
		6/5/2018	<0.18	1.6
2058	60	9/4/2012	13	<0.1
		9/18/2017	17.3	—
2061	72	9/4/2012	14	—
		9/19/2017	29	—
2062	34	9/4/2012	18	—

		9/18/2017	21.3	—
2063	41	9/4/2012	21	<0.010
		9/18/2017	23.6	—
1988	128	9/26/2012	0.13	0.49
		9/19/2017	0.18	1.4
2042	46	11/8/2012	6.4	—
		9/19/2017	30.4	<0.010
2069	155	12/6/2012	<0.05	0.93
		9/18/2017	1.1	<0.18
2072	105	12/6/2012	<0.05	2.3
		9/19/2017	<0.18	2.9
2611	83	9/19/2017	1.78	<0.010

Notes: mg/L = milligrams per liter; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard.

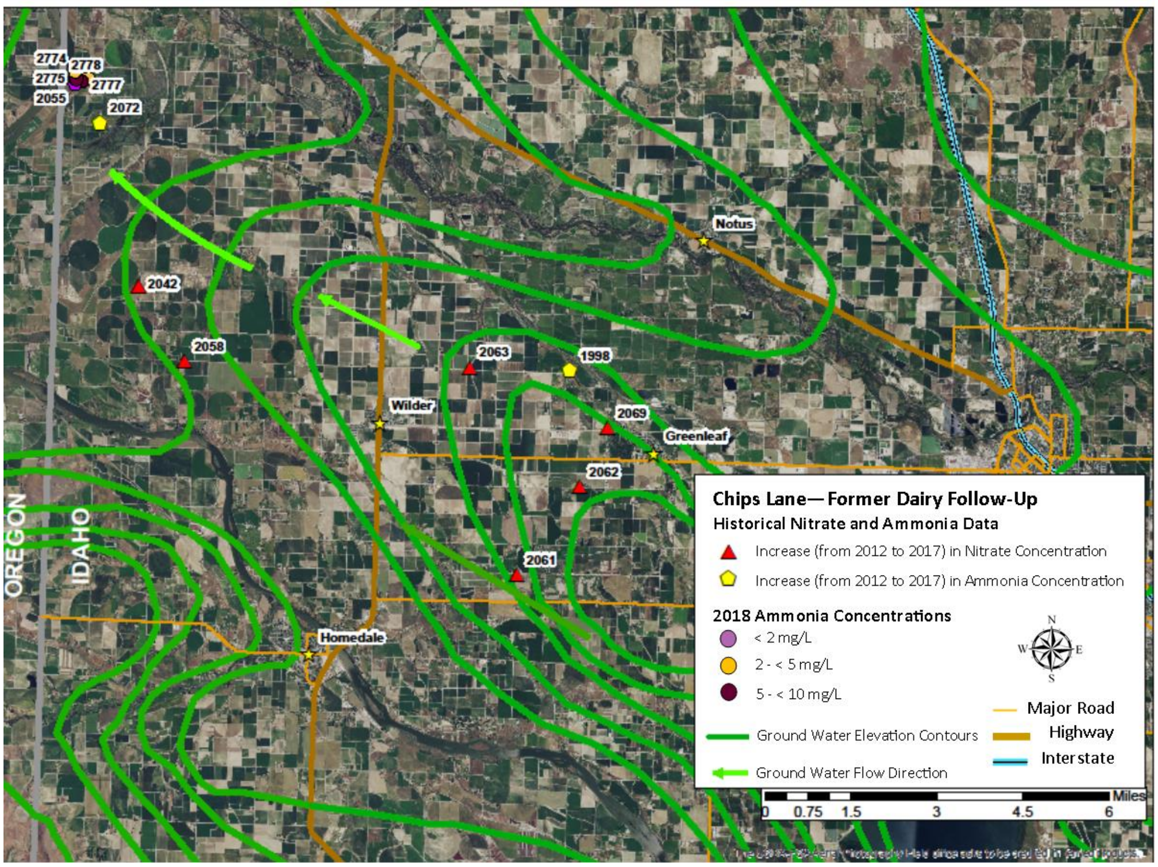


Figure 6. Comparison of nearby NPA wells with increased nitrate or ammonia between 2012 and 2017—Chips Lane-Former Dairy Follow-up Ground Water Monitoring Project.

2.1.2.3 Conclusions

The study found that the complainant's well, and all other wells sampled during this project, had nitrate, nitrite, chloride, sulfate, and bacteria concentrations below the primary and secondary drinking water quality standards. No further action is recommended.

2.1.3 New Plymouth Complaint Follow-Up Ground Water Monitoring Project

2.1.3.1 Purpose and Background

The purpose of this project was to conduct follow-up sampling in response to an elevated nitrate detection in a domestic well (Well 2871). In an attempt to identify the extent of nitrate contamination surrounding Well 2871, DEQ staff obtained permission to sample wells up-gradient, side-gradient, and down-gradient of the complainant's well.

On March 21, 2018, Southwest District Health (SWDH) informed DEQ of a resident with a qualitative nitrate result (from a nitrate test strip) from their domestic well, indicating a nitrate concentration greater than 20 mg/L. A well water sample collected by the resident, and submitted to IBL for analysis, was reported to contain a nitrate concentration of 33 mg/L. SWDH collected additional samples on March 22, 2018 to confirm the nitrate concentration as well as bacteria content. The lab again reported 33 mg/L of nitrate, and TC bacteria was negative according to SWDH.

Residences in the area rely of individual septic systems. The land use in the area surrounding Well 2871 is mostly agricultural with some dairies.

2.1.3.2 Methods and Results

DEQ collected ground water samples from 15 wells in October 2018 in accordance with the QAPP (DEQ 2017a) and the FSP (DEQ 2018c). Samples were analyzed for nitrate, nitrite, and bacteria (TC and *E. coli*). Selected samples were analyzed for ammonia and nitrogen isotopes in accordance with the FSP. Water quality field parameters (i.e., pH, temperature, specific conductance, turbidity, DO) were measured at each well before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 10). All samples were submitted to the IBL for analysis.

Table 10. Water Quality Field Parameters—2018 New Plymouth Complaint Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1342	75	10/09/2018	16.97	539	7.04	4.70
1347	80	10/01/2018	15.97	865	7.04	4.92
2023	129	10/01/2018	15.43	820	6.69	8.52
2024	145	10/01/2018	15.79	820	6.82	4.95
2784	61	10/01/2018	15.19	889	7.08	5.16
2785	91	10/01/2018	15.47	667	7.02	5.92
2786	52	10/01/2018	15.23	1060	6.56	5.95

2797	90	10/02/2018	15.27	828	7.19	6.18
2798	106.5	10/02/2018	15.91	390	7.81	5.20
2803	115	10/02/2018	15.54	565	7.34	3.26
2810	126	10/02/2018	15.49	839	7.33	4.66
2870	171	10/02/2018	15.88	768	7.06	2.79
2871	97	10/01/2018	15.47	738	6.74	10.26
2874	78	10/09/2018	15.73	757	6.68	3.78
2875	115	10/18/2018	15.25	559	7.11	9.01

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; 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 but can be applied to private wells to evaluate water quality.

Nutrients

Nutrient results are presented in Table 11 and shown in Figure 7. Samples collected from two wells (Well 2798 and Well 2870) upgradient of the complainants Well 2871, contained nitrate concentrations below 2.0 mg/L. All other samples had nitrate values above 2.0 mg/L (Figure 7). Additional samples will be taken in the spring of 2019 in an effort to determine whether the nitrate concentrations remain high, and to locate the areas at or below background nitrate levels that are side-gradient and down-gradient from Well 2871.

Table 11. Nutrient and nutrient-related isotope results—2018 New Plymouth Complaint Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration		Isotopes
			Nitrite[a] (mg/L)	Nitrate[a] (mg/L)	$\delta^{15}N$ (‰)
Water Quality Standard:			1.0	10	No Standard
1342	75	10/09/2018	<0.30	6.63	8.4
1347	80	10/01/2018	<0.30	**16.6**	8.3
2023	129	10/01/2018	<0.30	5.59	5.6
2024	145	10/01/2018	<0.30	4.64	—
2784	61	10/01/2018	<0.30	**17.4**	8.0
2785	91	10/01/2018	<0.30	6.16	4.6
2786	52	10/01/2018	<0.30	**27.8**	8.2
2797	90	10/02/2018	<0.30	**13.2**	8.3
2798	106.5	10/02/2018	<0.30	1.41	—
2803	115	10/02/2018	<0.30	4.29	—
2810	126	10/02/2018	<0.30	7.06	6.4
2870	171	10/02/2018	<0.30	1.74	—
2871	97	10/01/2018	<0.30	6.59	7.4

2874	78	10/09/2018	<0.30	**12.5**	13.9
2875	115	10/18/2018	<0.30	7.27	5.5

Notes: mg/L = milligrams per liter; ‰ = per mil; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.

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

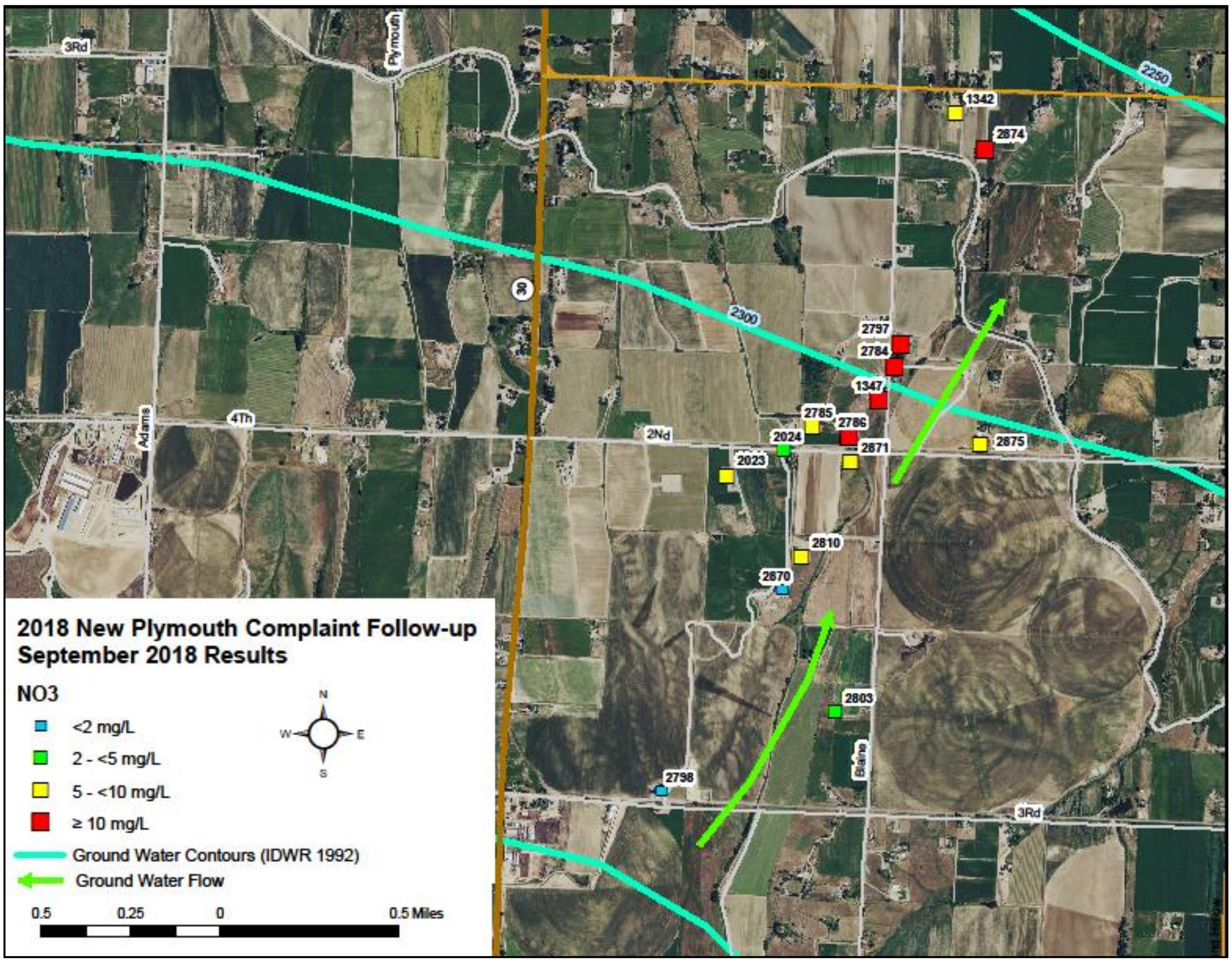


Figure 7. Sampling locations and nitrate concentration—New Plymouth Complaint Follow-Up Ground Water Monitoring Project.

From Well 2871 and continuing north along Blaine road, Wells 2786, 1347, 2784, 2797 and 2874 had the highest nitrate concentrations in the study. Samples with reported concentrations above the EPA MCL ranged from 12.5 mg/L to 27.8 mg/L (Table 11).

Nitrogen Isotope Results

Nitrogen isotope ratios were determined for four samples (Table 11). The nitrogen isotope results for all wells ranged from $\delta^{15}N$ 4.6‰ to $\delta^{15}N$ 13.9‰.Well 2874 had an isotope ratio of $\delta^{15}N$ 13.9‰, which indicates nitrate compounds in the form of human or animal waste (Seiler 1996; Table 3). Well 2874 is also one of the wells that is the farthest down gradient from well 2871 and close to the Payette River. All remaining isotope sample ratios suggested a mixture of organic wastes.

DEQ previously sampled Well 1347 on November 7, 2011 and on October 4, 2016 with reported nitrate results of 5.0 and 3.46 mg/L, respectively. The most recent sample result of 16.6 mg/L from October 1, 2018 is three times the concentration of any sample taken over the past seven years.

Ammonia and Bacteria Results

Well 2871 sampling results indicated an ammonia concentration of 0.013 mg/L and a bacteria count of 107 MPN/100 (Table 12). This well produced the only sample with positive ammonia or TC results. DEQ suggested the owner contact the well driller to check the seal on the well.

Table 12. Bacteria Results—New Plymouth Complaint Follow-up Ground Water Monitoring Project.

DEQ Site ID	Well Depth	Sample Date	Bacteria Concentrations[a] *E. coli* (MPN/100 mL)	Bacteria Concentrations[a] Total Coliform (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
1342	75	10/09/2018	<1.0	<1.0
1347	80	10/01/2018	<1.0	<1.0
2023	129	10/01/2018	<1.0	<1.0
2024	145	10/01/2018	<1.0	<1.0
2784	61	10/01/2018	<1.0	<1.0
2785	91	10/01/2018	<1.0	<1.0
2786	52	10/01/2018	<1.0	<1.0
2797	90	10/02/2018	<1.0	<1.0
2798	106.5	10/02/2018	<1.0	<1.0
2803	115	10/02/2018	<1.0	<1.0
2810	126	10/02/2018	<1.0	<1.0
2870	171	10/02/2018	<1.0	<1.0
2871	97	10/01/2018	<1.0	107
2874	78	10/09/2018	<1.0	<1.0
2875	115	10/18/2018	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters.
a. 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 numbers) 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.

2.1.3.3 Conclusions

The purpose of this study was to achieve an understanding of nitrate contamination in and around the complainant's well (Well 2871). The nitrate concentration in the complainant's well decreased from a concentration of 33 mg/L in March 2018 to 6.59 mg/L in October 2018. Nitrate concentrations were generally significantly higher to the north (downgradient) of the complainant's well and lower to the south/southwest.

All but one nitrogen isotopic signature suggest a mixed source of nitrogen from human/animal waste and inorganic fertilizer. The nitrogen source near well 2874 is likely animal or human waste, based on the high nitrogen isotope ratio 13.9‰.

2.1.3.4 Recommendations

Additional samples will be collected in the spring after neighboring farms have been tilled and fertilized. Additional samples outside this original (Part 1) sampling area will be collected in an attempt to determine the extent of nitrate contamination.

2.1.4 Purple Sage Nitrate Priority Area Ground Water Monitoring Project

2.1.4.1 Purpose and Background

This ground water monitoring project is designed to provide the data necessary for evaluating trends in ground water nitrate concentrations in and around the Purple Sage NPA in Canyon County. Ground water samples were collected from private domestic, irrigation, and livestock wells. Program objectives, design, and well selection processes are identified in the "Regional Ground Water Monitoring Network Design" developed by BRO in 2011 (DEQ 2011a).

Canyon County is located on the Snake River Plain and bounded by the Snake River to the south and the foothills of the central Idaho mountains to 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 trend 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.

For the nearby 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 a blue clay layer is located approximately 190–410 feet bgs in the area of the Ada/Canyon NPA. Wells selected for sampling for this project were completed at depths of 350 feet or less.

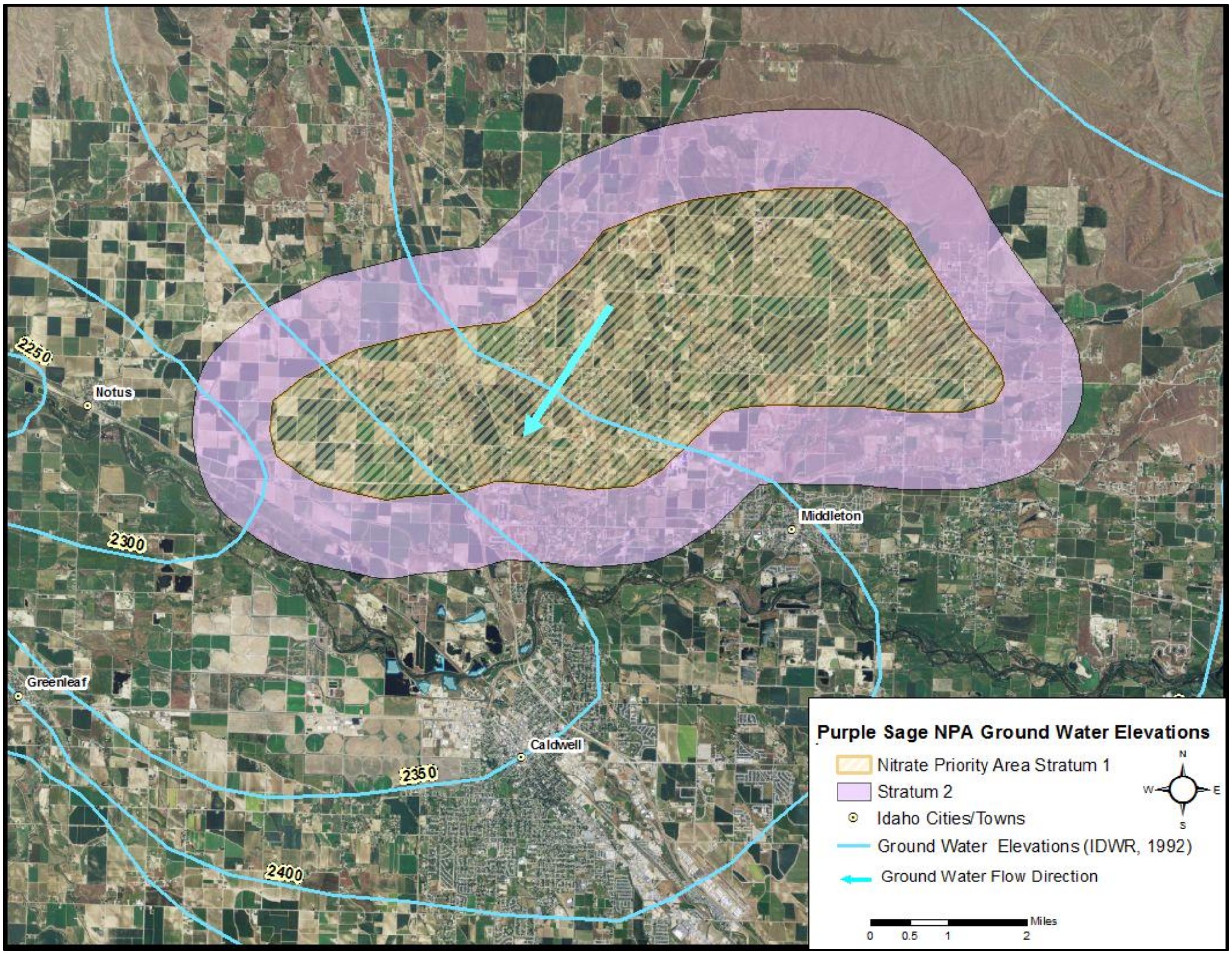


Figure 8. Ground water elevation map and flow direction—Purple Sage NPA Ground Water Monitoring Project.

2.1.4.2 Methods and Results

DEQ collected ground water samples from 84 wells from March through May 2018 in accordance with the QAPP (DEQ 2015b) and the FSP (DEQ 2018d). The wells were located inside the Purple Sage NPA Boundary (Stratum 1) and within a one-mile buffer zone around the boundary (Stratum 2). The laboratories analyzed the samples for nitrate, nitrite, and bacteria (TC and *E. coli*). Selected samples were analyzed for ammonia and nitrogen isotopes in accordance with the FSP. The wells selected for the study include 33 of the 88 wells from the 2013 Purple Sage NPA study. Water quality field parameters (i.e., pH, temperature, specific conductance, turbidity, DO) were measured at each well before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 13).

Samples from the wells were analyzed for nitrate, TC, and *E. coli.* Samples from wells with DO concentrations below 2 mg/L were analyzed for ammonia. Those samples with nitrate concentrations of 5 mg/L or higher were also analyzed for nitrogen isotopes.

Table 13. Water quality field parameters—Purple Sage NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2102	241	05/14/2018	15.15	794	7.30	10.81
2106	109	03/28/2018	14.33	1010	6.85	5.09
2109	153	03/28/2018	14.00	596	6.55	7.98
2111	313	04/23/2018	14.79	523	7.04	8.21
2112	293	04/23/2018	14.96	600	7.67	5.55
2113	138	04/02/2018	13.88	920	7.09	5.95
2114	117	04/02/2018	14.87	605	7.41	6.04
2117	118	04/23/2018	13.70	764	7.90	6.29
2118	66	04/02/2018	14.17	574	7.04	6.15
2123	98	04/09/2018	15.67	288	6.80	0.79
2124	100	03/20/2018	15.37	746	6.86	7.66
2125	115	04/09/2018	14.62	821	7.11	6.72
2126	146	03/26/2018	14.96	494	6.89	4.59
2130	80	03/28/2018	14.55	681	6.55	5.00
2135	100	04/16/2018	13.70	831	7.77	7.43
2138	138	03/28/2018	14.76	414	6.91	6.19
2139	85	03/20/2018	14.37	949	6.89	6.84
2140	100	03/20/2018	14.52	757	6.81	7.53
2147	120	04/09/2018	15.23	619	7.33	7.42
2150	100	05/14/2018	15.48	445	7.79	10.88
2151	103	03/26/2018	14.44	665	6.77	4.15
2152	83	04/16/2018	14.75	850	8.03	7.07
2155	170	04/09/2018	14.13	347	7.32	5.02
2157	153	04/02/2018	15.65	597	6.99	5.86
2159	40	04/16/2018	15.30	329	7.83	5.30
2161	44.5	05/30/2018	15.96	681	6.50	8.37
2165	173	03/20/2018	15.89	165	6.91	1.06
2170	192	05/21/2018	16.45	166	6.66	1.33
2171	165	04/23/2018	15.25	625	8.17	5.79
2177	262	04/23/2018	14.36	229	*8.81*	7.03
2179	99	05/14/2018	14.72	408	*6.37*	7.08
2182	166	04/23/2018	15.23	361	8.00	7.60

2186	95	04/16/2018	13.71	716	7.85	7.46
2528	80	03/20/2018	13.61	592	7.12	9.84
2705	220	04/02/2018	15.09	421	7.34	6.90
2706	161	03/26/2018	16.21	680	6.94	3.57
2707	184	04/09/2018	13.95	680	6.96	8.54
2708	80	03/26/2018	15.66	396	6.83	5.06
2709	132	03/26/2018	15.68	488	6.97	6.18
2710	130	04/02/2018	14.14	657	6.80	6.13
2712	135	03/20/2018	15.36	764	6.99	6.25
2713	225	04/23/2018	13.74	428	7.18	4.97
2714	219	03/28/2018	14.23	148	6.57	3.07
2715	78	03/28/2018	14.59	432	6.58	4.77
2716	97	03/26/2018	15.49	654	7.16	5.68
2717	106	03/20/2018	15.56	483	7.44	9.46
2718	129	03/26/2018	14.50	566	6.66	6.80
2719	265	04/02/2018	14.10	706	6.98	4.71
2720	98	03/26/2018	15.74	134	7.16	1.87
2721	304	04/23/2018	15.58	214	8.06	7.65
2722	192	03/26/2018	15.13	115	6.93	1.85
2723	171	04/02/2018	14.52	933	6.78	6.09
2724	112	03/20/2018	13.43	895	7.18	6.83
2725	142	04/09/2018	13.78	194	7.56	2.85
2726	70	03/26/2018	15.48	661	7.17	6.04
2727	219	04/09/2018	14.10	464	6.85	9.06
2728	156	04/02/2018	14.18	648	7.05	6.02
2729	160	03/20/2018	15.02	465	7.41	8.67
2730	180	04/23/2018	14.10	265	7.91	7.14
2731	158	03/28/2018	14.66	601	6.96	6.84
2732	170	04/23/2018	14.65	574	7.75	6.93
2733	258	04/16/2018	13.91	181	*8.61*	3.79
2734	81	04/02/2018	13.55	695	6.89	4.78
2735	277	04/09/2018	15.71	142	7.25	1.53
2736	189	04/03/2018	13.91	475	6.93	4.61
2737	180	04/03/2018	13.55	250	7.14	3.36
2738	66	04/16/2018	13.98	607	7.75	7.84
2739	77	04/16/2018	14.07	1000	7.90	6.48

2740	131	04/16/2018	14.81	775	8.02	4.79
2746	97	05/14/2018	13.30	749	7.70	8.74
2747	121	05/14/2018	14.50	430	*6.46*	10.22
2748	185	05/15/2018	14.29	553	6.87	10.95
2749	174	05/14/2018	15.34	205	7.45	7.26
2750	135	05/15/2018	14.28	750	6.98	10.28
2764	162	05/14/2018	15.32	654	6.62	11.88
2765	204	05/15/2018	14.93	496	6.87	12.00
2766	102	05/14/2018	15.70	401	6.60	8.84
2767	96	05/14/2018	16.00	489	7.66	9.18
2768	203	05/21/2018	14.89	752	7.42	8.58
2769	111	05/21/2018	15.00	260	7.05	9.71
2770	200	05/21/2018	15.13	869	7.03	9.36
2771	152	05/21/2018	14.87	338	7.57	8.96
2772	175	05/21/2018	15.97	275	7.69	9.06
2773	100	05/30/2018	16.20	510	7.20	9.81

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
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 but can be applied to private wells to evaluate water quality.

Nitrate Results

Nitrate concentrations are summarized in Table 14. The nitrate concentrations ranged from <0.18mg/L to 13.9 mg/L, and exceeded the MCL of 10 mg/L in 5 of the wells sampled. Nitrate concentrations were equal to or greater than 5 mg/L (half the MCL) in 34 of the 84 wells (40%) sampled (Table 14). Nitrate concentration results of the 2018 sampling event are shown in Figure 9.

Table 14. Nutrient and nutrient-related isotope results—Purple Sage NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a] (mg/L)	Nitrate[a] (mg/L)	Ammonia (mg/L)	$\delta^{15}N$ (‰)
Water Quality Standard:			1.0	10	No Standard	No Standard
2102	241	05/14/2018	<0.30	3.80	—	—
2106	109	03/28/2018	<0.30	**13.9**	—	6.1
2109	153	03/28/2018	<0.30	2.40	—	—
2111	313	04/23/2018	<0.30	2.97	—	—

2112	293	04/23/2018	<0.30	1.41	—	—
2113	138	04/02/2018	<0.30	8.11	—	4.8
2114	117	04/02/2018	<0.30	8.37	—	4.8
2117	118	04/23/2018	<0.30	9.06	—	3.6
2118	66	04/02/2018	<0.30	7.00	—	3.5
2123	98	04/09/2018	<0.30	0.491	<0.010	—
2124	100	03/20/2018	<0.30	5.14	—	3.8
2125	115	04/09/2018	<0.30	9.39	—	5.9
2126	146	03/26/2018	<0.30	3.50	—	—
2130	80	03/28/2018	<0.30	6.16	—	—
2135	100	04/16/2018	<0.30	6.06	—	3.9
2138	138	03/28/2018	<0.30	5.87	—	5.1
2139	85	03/20/2018	<0.30	8.16	—	3.6
2140	100	03/20/2018	<0.30	5.36	—	4.1
2147	120	04/09/2018	<0.30	6.54	—	3.7
2150	100	05/14/2018	<0.30	4.24	—	5.0
2151	103	03/26/2018	<0.30	4.16	—	—
2152	83	04/16/2018	<0.30	**10.7**	—	3.9
2155	170	04/09/2018	<0.30	0.946	—	—
2157	153	04/02/2018	<0.30	2.39	—	—
2159	40	04/16/2018	<0.30	0.731	—	—
2161	44.5	05/30/2018	<0.30	4.37	—	—
2165	173	03/20/2018	<0.30	<0.18	<0.010	—
2170	192	05/21/2018	<0.30	0.18	0.038	—
2171	165	04/23/2018	<0.30	3.10	—	—
2177	262	04/23/2018	<0.30	1.73	—	—
2179	99	05/14/2018	<0.30	6.64	—	3.9
2182	166	04/23/2018	<0.30	2.01	—	—
2186	95	04/16/2018	<0.30	5.16	—	3.6
2528	80	03/20/2018	<0.30	2.92	—	—
2705	220	04/02/2018	<0.30	1.27	—	—
2706	161	03/26/2018	<0.30	7.14	—	4.2
2707	184	04/09/2018	<0.30	2.50	—	—
2708	80	03/26/2018	<0.30	2.53	—	—
2709	132	03/26/2018	<0.30	4.10	—	—
2710	130	04/02/2018	<0.30	5.08	—	3.1

2712	135	03/20/2018	<0.30	7.14	—	3.1
2713	225	04/23/2018	<0.30	3.76	—	—
2714	219	03/28/2018	<0.30	0.494	—	—
2715	78	03/28/2018	<0.30	**11.6**	—	3.5
2716	97	03/26/2018	<0.30	6.96	—	3.7
2717	106	03/20/2018	<0.30	1.63	—	—
2718	129	03/26/2018	<0.30	2.51	—	—
2719	265	04/02/2018	<0.30	4.44	—	—
2720	98	03/26/2018	<0.30	0.184	<0.010	—
2721	304	04/23/2018	<0.30	0.879	—	—
2722	192	03/26/2018	<0.30	<0.18	<0.010	—
2723	171	04/02/2018	<0.30	9.33	—	5.7
2724	112	03/20/2018	<0.30	8.87	—	3.5
2725	142	04/09/2018	<0.30	0.442	—	—
2726	70	03/26/2018	<0.30	5.36	—	3.3
2727	219	04/09/2018	<0.30	1.54	—	—
2728	156	04/02/2018	<0.30	**11.7**	—	3.7
2729	160	03/20/2018	<0.30	1.23	—	—
2730	180	04/23/2018	<0.30	1.37	—	—
2731	158	03/28/2018	<0.30	9.40	—	3.1
2732	170	04/23/2018	<0.30	2.69	—	—
2733	258	04/16/2018	<0.30	0.622	—	—
2734	81	04/02/2018	<0.30	5.72	—	3.8
2735	277	04/09/2018	<0.30	<0.18	<0.010	—
2736	189	04/03/2018	<0.30	2.59	—	—
2737	180	04/03/2018	<0.30	0.852	—	—
2738	66	04/16/2018	<0.30	4.96	—	—
2739	77	04/16/2018	<0.30	7.80	—	2.9
2740	131	04/16/2018	<0.30	3.93	—	—
2746	97	05/14/2018	<0.30	**12.9**	—	3.4
2747	121	05/14/2018	<0.30	8.79	—	4.3
2748	185	05/15/2018	<0.30	2.26	—	—
2749	174	05/14/2018	<0.30	0.737	—	—
2750	135	05/15/2018	<0.30	3.35	—	—
2764	162	05/14/2018	<0.30	1.65	—	—
2765	204	05/15/2018	<0.30	1.97	—	—

2766	102	05/14/2018	<0.30	6.67	—	3.2
2767	96	05/14/2018	<0.30	6.53	—	4.1
2768	203	05/21/2018	<0.30	2.79	—	—
2769	111	05/21/2018	<0.30	1.98	—	—
2770	200	05/21/2018	<0.30	6.57	—	4.0
2771	152	05/21/2018	<0.30	5.70	—	7.3
2772	175	05/21/2018	<0.30	4.99	—	—
2773	100	05/30/2018	<0.30	2.71	—	—

Notes: mg/L = milligrams per liter; ‰ = per mil; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

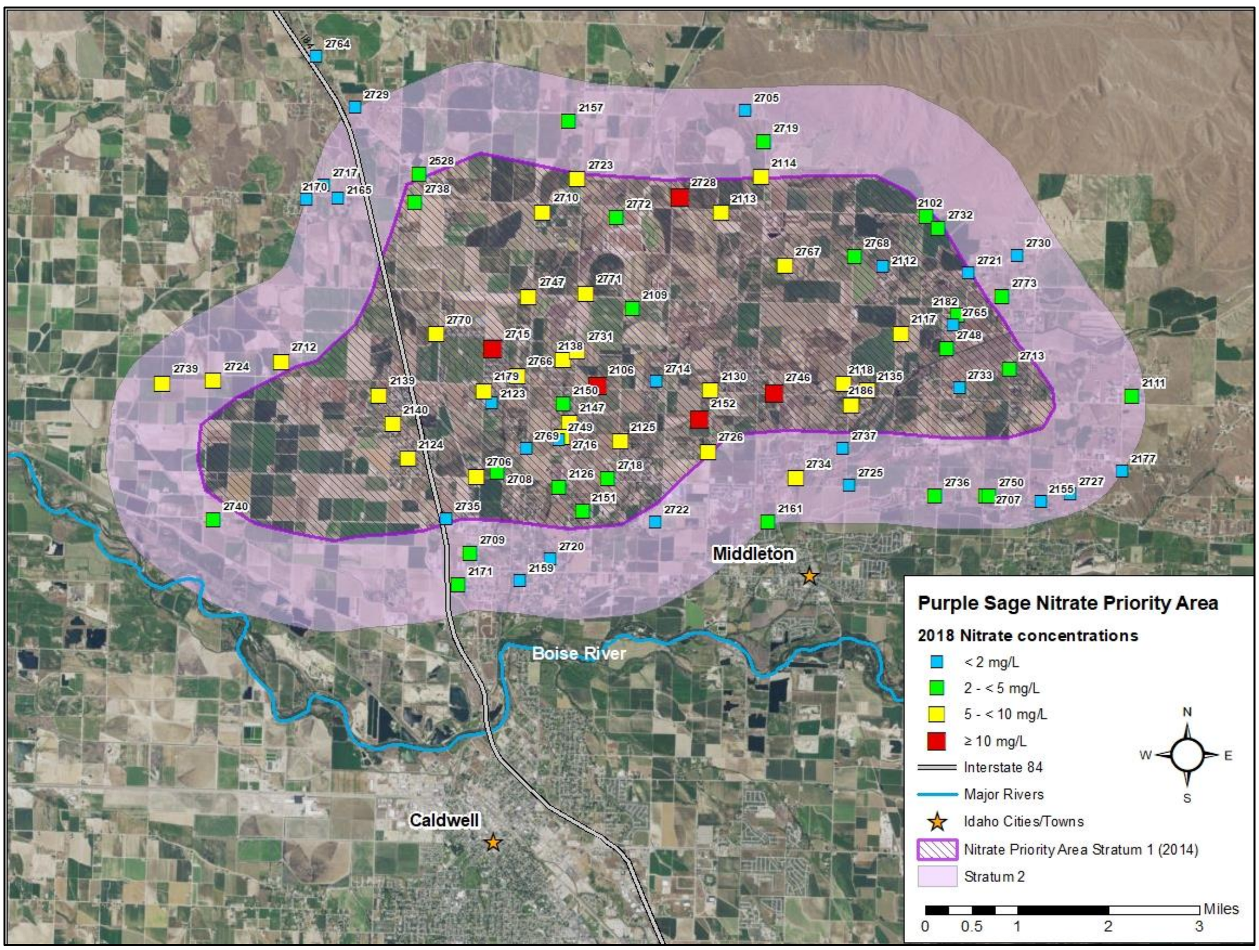


Figure 9. Nitrate concentrations—Purple Sage NPA Ground Water Monitoring Project.

When compared to the sample results from the 2013 sampling event, increased nitrate concentrations were present throughout much of the Purple Sage NPA, with most of the higher sample results located in the central region of the NPA (Figure 10). This area has seen a major increase in new residential construction over the last five years. Decreased nitrate concentrations were mostly noted in the mid to western portion of the Purple Sage NPA.

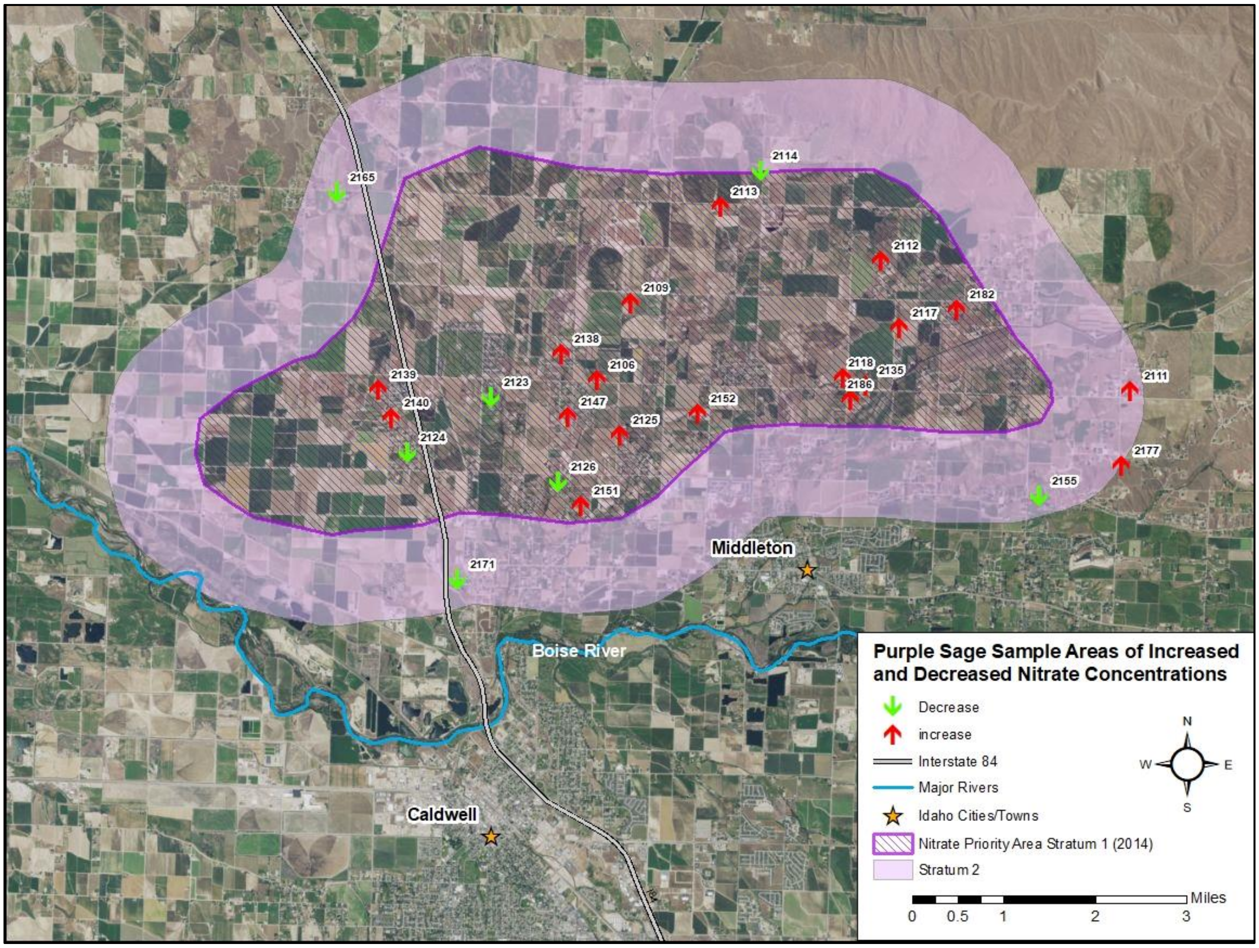


Figure 10. Increased and decreased nitrate concentrations compared to 2013—Purple Sage NPA Ground Water Monitoring Project.

Six of the 88 wells had DO concentrations below 2.0 mg/L, indicating potential anoxic conditions. The 6 wells were sample for the presence of ammonia nitrogen due to the lack of oxygen present to form nitrate. Of the six samples analyzed for ammonia, one sample (Well 2170) contained a detectable concentration of 0.038 mg/L. Ammonia in ground water is often associated with impacts from sewage systems, livestock wastes, or nitrogen fertilizers (Table 14).

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 the 34 wells which had nitrate concentrations of 5 mg/L or greater.

The $\delta^{15}N$ results from this project ranged from 2.9‰ to 7.3‰ (Table 14). A total of 21 wells had $\delta^{15}N$ values of less than 4‰, suggesting the source of nitrate in the ground water is most likely from commercial fertilizer. A total of 13 wells had $\delta^{15}N$ values between 4‰ and 9‰, suggesting the source of nitrate in the ground water is most likely from organic nitrogen in soil or a mixed nitrogen source (Table 3).

Nitrogen isotopes can be used with other water quality data and land use information to better determine sources of nitrogen in ground water. However, nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake) (Kendall and McDonnell 1998). Mixing of sources with variable nitrogen isotope values along shallow ground water flow paths makes determining the sources and extent of denitrification very difficult for intermediate $\delta^{15}N$ values (Kendall and McDonnell 1998). The land use in the project area includes agricultural (both crop fields and animal operations) and residential with individual septic systems. This land use would likely result in a mixture of commercial fertilizers or mixed nitrogen sources, which is supported by the $\delta^{15}N$ values reported.

Bacteria Results

Of the 84 wells sampled for coliform bacteria, four had positive detections of TC. The concentrations ranged from 2.0– 13.1 MPN/100 mL (Table 15). *E. coli* was not detected in any of the wells.

Table 15. Bacteria Results—Purple Sage NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth	Sample Date	Bacteria Concentrations[a] *E. coli* (MPN/100 mL)	Total Coliform (MPN/100 mL)
Primary or Secondary Standard:			**<1**	**1.0**
2102	241	05/14/2018	<1.0	<1.0
2106	109	03/28/2018	<1.0	<1.0
2109	153	03/28/2018	<1.0	<1.0
2111	313	04/23/2018	<1.0	<1.0
2112	293	04/23/2018	<1.0	<1.0
2113	138	04/02/2018	<1.0	<1.0
2114	117	04/02/2018	<1.0	<1.0
2117	118	04/23/2018	<1.0	<1.0
2118	66	04/02/2018	<1.0	<1.0
2123	98	04/09/2018	<1.0	<1.0
2124	100	03/20/2018	<1.0	<1.0
2125	115	04/09/2018	<1.0	<1.0
2126	146	03/26/2018	<1.0	<1.0
2130	80	03/28/2018	<1.0	<1.0

2135	100	04/16/2018	<1.0	<1.0
2138	138	03/28/2018	<1.0	<1.0
2139	85	03/20/2018	<1.0	<1.0
2140	100	03/20/2018	<1.0	<1.0
2147	120	04/09/2018	<1.0	<1.0
2150	100	05/14/2018	<1.0	<1.0
2151	103	03/26/2018	<1.0	<1.0
2152	83	04/16/2018	<1.0	<1.0
2155	170	04/09/2018	<1.0	<1.0
2157	153	04/02/2018	<1.0	<1.0
2159	40	04/16/2018	<1.0	<1.0
2161	44.5	05/30/2018	<1.0	3.1
2165	173	03/20/2018	<1.0	<1.0
2170	192	05/21/2018	<1.0	2.0
2171	165	04/23/2018	<1.0	<1.0
2177	262	04/23/2018	<1.0	<1.0
2179	99	05/14/2018	<1.0	<1.0
2182	166	04/23/2018	<1.0	<1.0
2186	95	04/16/2018	<1.0	<1.0
2528	80	03/20/2018	<1.0	<1.0
2705	220	04/02/2018	<1.0	<1.0
2706	161	03/26/2018	<1.0	<1.0
2707	184	04/09/2018	<1.0	<1.0
2708	80	03/26/2018	<1.0	<1.0
2709	132	03/26/2018	<1.0	<1.0
2710	130	04/02/2018	<1.0	<1.0
2712	135	03/20/2018	<1.0	<1.0
2713	225	04/23/2018	<1.0	<1.0
2714	219	03/28/2018	<1.0	<1.0
2715	78	03/28/2018	<1.0	<1.0
2716	97	03/26/2018	<1.0	<1.0
2717	106	03/20/2018	<1.0	<1.0
2718	129	03/26/2018	<1.0	<1.0
2719	265	04/02/2018	<1.0	<1.0
2720	98	03/26/2018	<1.0	<1.0
2721	304	04/23/2018	<1.0	<1.0

2722	192	03/26/2018	<1.0	<1.0
2723	171	04/02/2018	<1.0	<1.0
2724	112	03/20/2018	<1.0	<1.0
2725	142	04/09/2018	<1.0	<1.0
2726	70	03/26/2018	<1.0	<1.0
2727	219	04/09/2018	<1.0	<1.0
2728	156	04/02/2018	<1.0	<1.0
2729	160	03/20/2018	<1.0	13.1
2730	180	04/23/2018	<1.0	<1.0
2731	158	03/28/2018	<1.0	<1.0
2732	170	04/23/2018	<1.0	<1.0
2733	258	04/16/2018	<1.0	<1.0
2734	81	04/02/2018	<1.0	<1.0
2735	277	04/09/2018	<1.0	<1.0
2736	189	04/03/2018	<1.0	<1.0
2737	180	04/03/2018	<1.0	<1.0
2738	66	04/16/2018	<1.0	<1.0
2739	77	04/16/2018	<1.0	<1.0
2740	131	04/16/2018	<1.0	<1.0
2746	97	05/14/2018	<1.0	<1.0
2747	121	05/14/2018	<1.0	<1.0
2748	185	05/15/2018	<1.0	<1.0
2749	174	05/14/2018	<1.0	<1.0
2750	135	05/15/2018	<1.0	<1.0
2764	162	05/14/2018	<1.0	<1.0
2765	204	05/15/2018	<1.0	<1.0
2766	102	05/14/2018	<1.0	<1.0
2767	96	05/14/2018	<1.0	<1.0
2768	203	05/21/2018	<1.0	<1.0
2769	111	05/21/2018	<1.0	<1.0
2770	200	05/21/2018	<1.0	5.2
2771	152	05/21/2018	<1.0	<1.0
2772	175	05/21/2018	<1.0	<1.0
2773	100	05/30/2018	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters.
a. 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 numbers) 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.

2.1.4.3 Conclusions

The criterion for an NPA designation is met when 25% or more of the wells sampled within the area meet or exceed 5 mg/L concentration, or half of the MCL (10 mg/L). The Purple Sage NPA ground water monitoring project was conducted to evaluate continuing nitrate contamination concerns in the area. In this project, 34 of the 84 wells sampled had nitrate values equal to or greater than 5 mg/L. The EPA's drinking water MCL for nitrate is 10 mg/L, and was exceeded in five samples. Reported nitrate concentrations have generally increased in the area since 2013, with 18 of 25 wells sampled in 2013 showing increase in nitrate concentration by 2018.

Nitrogen isotopic signatures were evaluated for the 34 wells with nitrate concentrations at or above 5mg/L. The $\delta^{15}N$ results suggest multiple potential sources of nitrogen. 21 wells with $\delta^{15}N$ results below 4‰ suggest a commercial fertilizer source, while the 13 wells with results between 4‰ and 9‰ likely have a mixed source of nitrogen.

2.1.4.4 Recommendations

DEQ plans to resample this project again in five years to correspond with the next NPA review.

2.1.5 Sand Hollow Creek Ground Water Nitrate Investigation

2.1.5.1 Purpose and Background

The purpose of this project is to continue the evaluation of ground water quality as recommended in the 2017 annual summary report, DEQ Technical Report Number 51 (DEQ 2019). The project site is located in southwestern Gem County on the northwestern border of the Emmett North Bench NPA. The site property is located in the northern end of a hollow, which extends into the foothills on the north bench of the Payette River; Sand Hollow Creek drains the hollow. The site includes a residence, barns, and outbuildings on approximately 120 acres of farmland. Land use south and east of the site is generally agricultural, with rangeland to the west and an approximate 1,800-head dairy located adjacent to the north end of the property (Figure 11).

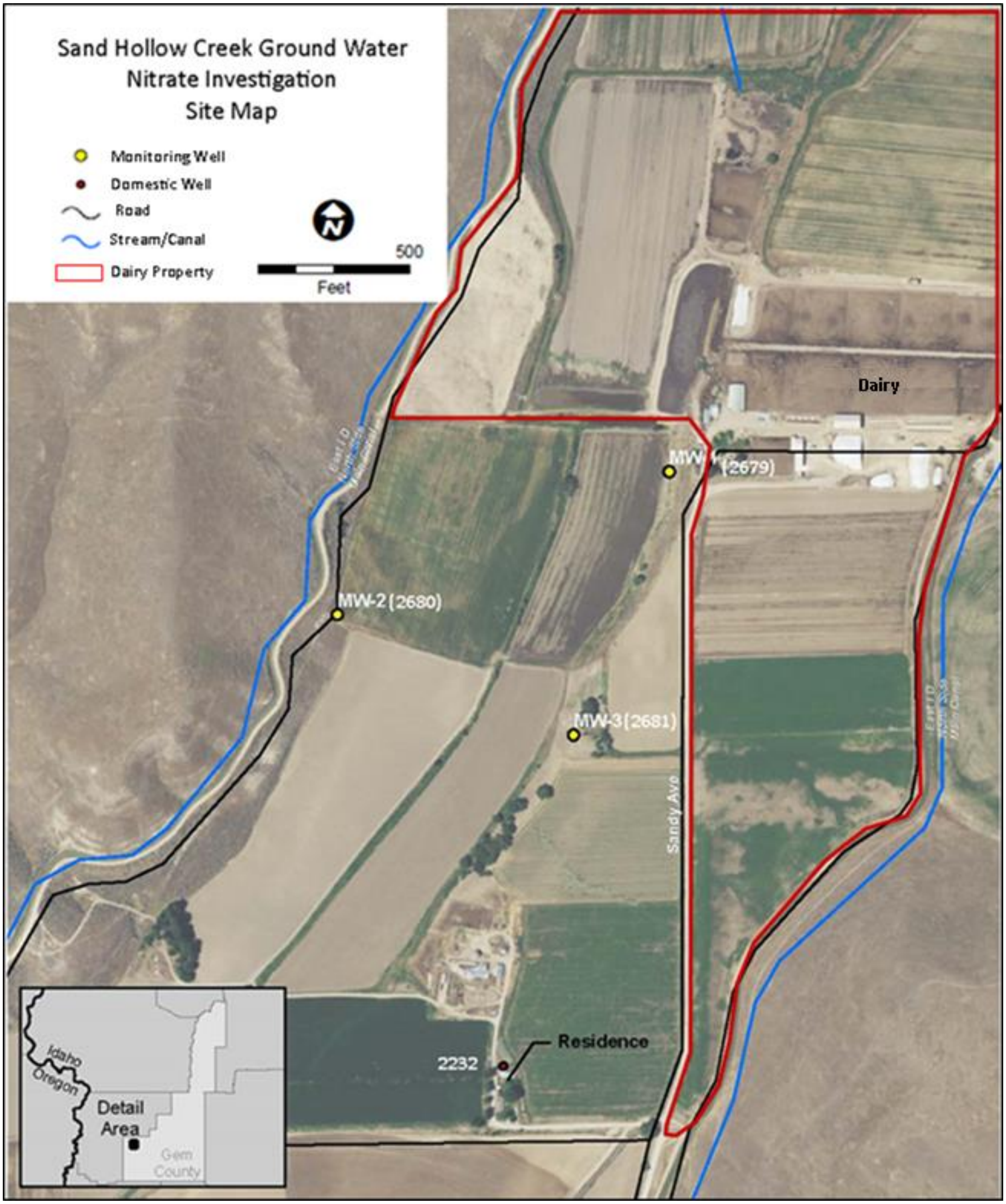


Figure 11. Project site map (modified from Tetra Tech 2018a)—Sand Hollow Creek Ground Water Nitrate Investigation.

In 2013, DEQ responded to a complaint of possible ground water contamination at the site (Well 2232) adjacent to a farm operation/dairy (Sage Dairy). Multiple sources of nitrate with the potential to impact ground water are present in the area (e.g., agricultural fertilizers, dairy waste, septic systems, stockpiled solid dairy waste, and a dairy waste lagoon). Laboratory analyses of ground water samples from the Well 2232 detected concentrations of nitrate that increased from approximately 8 mg/L in August 2012 to 21 mg/L in October 2015. The depth and construction of the site's well are not known; the owner stated that the well is approximately 68 feet deep. DEQ's assessment of the property did not identify any on-site land use changes that could account for the significant increase in nitrate concentrations in ground water at the well. DEQ conducted the Sand Hollow Creek's ground water nitrate investigation to identify potential off-site nitrate sources impacting ground water at Well 2232.

In December 2016, STRATA (DEQ's initial contractor on this project) installed three monitoring wells: Well 2679, Well 2680 2, and Well 2681 at locations estimated to be upgradient or cross gradient of Well 2232 (Figure 11). The monitoring wells were installed to identify the ground water flow direction and assess ground water quality upgradient of Well 2232 (Table 16). Subsurface lithology at all wells generally consisted of poorly graded sand, silty sand, and clay.

Table 16. DEQ Monitoring Well Construction Information—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Well ID	Well Depth (ft bgs)	Top of Casing Elevation (ft amsl)	Screened Interval (ft bgs)
2679 (MW-1)	60	2,390.51	2,331 to 2,351
2680 (MW-2)	40	2,417.8	2,378 to 2,398
2681 (MW-3)	45	2,405.65	2,361 to 2,381

In January 2017, DEQ selected Tetra Tech, Inc. as the new contractor. In April 2017, Tetra Tech prepared a QAPP outlining the organization, goals, scope of work, and quality assurance/quality control (QA/QC) criteria for investigating nitrate in ground water at the site (Tetra Tech 2018b).

2.1.5.2 Methods and Results

On May 18 and December 6, 2018, Tetra Tech measured ground water elevations and collected ground water samples from the monitoring wells and the site's domestic well, Well 2232.

Water quality field parameters (i.e., pH, temperature, specific conductance, DO, turbidity, oxygen-reduction potential) were measured during well purging and ground water sample collection at each well to ensure a representative sample of ground water (Table 17).

Table 17. Water Quality Field Parameters—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth	Sample Date	Water Temperature (°C)	Turbidity (NTU)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)
2232	Unk	05/18/2018	15.9	0	630	7.5	5.5	177
		12/06/2018	11.7	—	790	6.8	5.6	128
2679 (MW-1)	60	05/18/2018	13.8	5	620	7.2	1.2	161
		12/06/2018	12.8	—	690	6.9	3.8	109
2680	40	05/18/2018	15.9	0	180	7.8	7.5	146

(MW-2)		12/06/2018	11.4	—	140	7.2	6.1	106
2681 (MW-3)	45	05/18/2018	21.2	43	510	7.7	7.0	151
		12/06/2018	11.8	—	480	7.4	6.4	109

Notes: °C = degrees Celsius; NTU = nephelometric turbidity units; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; mV = millivolts; Unk = Unknown. Well log not found or unavailable; (-) = Not Analyzed.
a. The National Secondary Drinking Water Regulation standard for pH is 6.5-8.5. Secondary standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

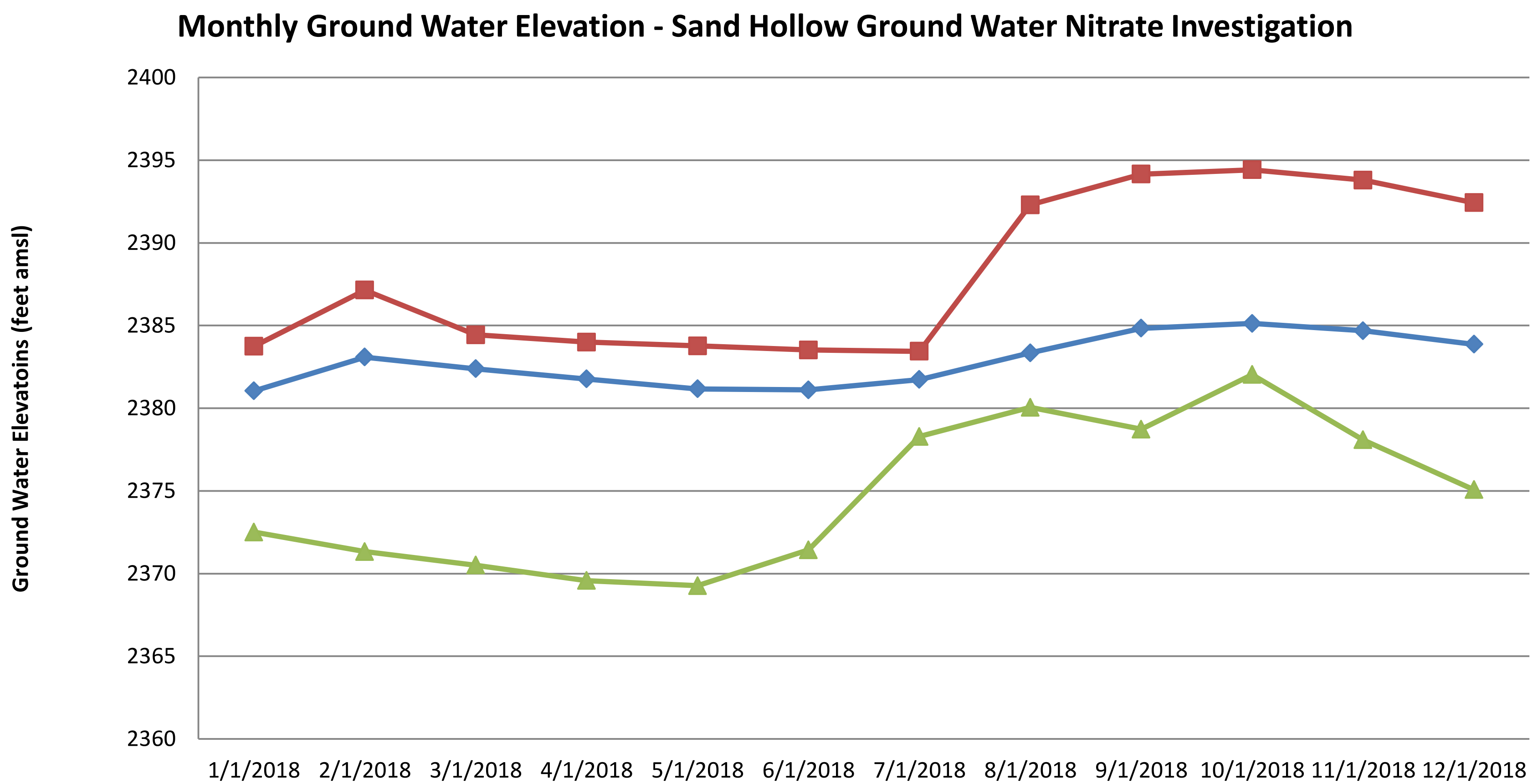
Ground water samples were shipped overnight to Eurofins Lancaster Laboratories for analyses of nutrient compounds (nitrate, nitrite, and ammonia) and general ground water chemistry constituents (common cations [barium, potassium, sodium, calcium, magnesium, iron, and manganese], common anions [bromide, chloride, fluoride, phosphate, and sulfate], bicarbonate, and TDS) (see General Ground Water Chemistry Results, Table 19 and Table 20). Filtered (0.45 micron) ground water samples were also collected, frozen, and shipped to the Environmental Isotope Laboratory at the University of Arizona for nitrogen isotope analyses (Table 21).

Ground Water Flow Direction

The general ground water flow direction calculated for both 2018 Tetra Tech monitoring events was to the southeast with a gradient of approximately 0.012 (Tetra Tech 2018a). DEQ staff also collected monthly water level measurements during 2018 to identify any notable changes in ground water flow direction throughout the year (Table 18, Figure 12). In July and December of 2018, DEQ measured spatially kriged ground water (Figure 13). In general, ground water flow is north to south when ground water is not influenced by the canal (December) and more southeast in direction when water was in the canal (July). The flow direction and gradient are similar to those calculated for two monitoring events conducted in 2017 (Tetra Tech 2017).

Table 18. DEQ Measured Ground Water Elevations—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Well ID	2679 (MW-1)		2680 (MW-2)		2681 (MW-3)	
Date	Depth to Water (ft)	Ground Water Elevation (ft amsl)	Depth to Water (ft)	Ground Water Elevation (ft amsl)	Depth to Water (ft)	Ground Water Elevation (ft amsl)
1/4/2018	9.46	2,381.05	33.36	2,384.44	33.14	2,372.51
2/6/2018	7.42	2,383.09	33.8	2,384	34.32	2,371.33
3/6/2018	8.12	2,382.39	34.03	2,383.77	35.14	2,370.51
4/5/2018	8.74	2,381.77	34.28	2,383.52	36.08	2,369.57
5/3/2018	9.34	2,381.17	34.36	2,383.44	36.38	2,369.27
6/4/2018	9.4	2,381.11	25.5	2,392.3	34.22	2,371.43
7/3/2018	8.78	2,381.73	23.64	2,394.16	27.36	2,378.29
8/7/2018	7.16	2,383.35	23.38	2,394.42	25.6	2,380.05
9/4/2018	5.67	2,384.84	24	2,393.8	26.92	2,378.73
10/2/2018	5.38	2,385.13	25.37	2,392.43	23.62	2,382.03
11/5/2018	5.82	2,384.69	27.56	2,390.24	27.56	2,378.09
12/6/2018	6.64	2,383.87	31.22	2,386.58	30.58	2,375.07



	1/4/2018	2/6/2018	3/6/2018	4/5/2018	5/3/2018	6/4/2018	07/03/18	08/07/18	09/04/18	10/02/18	11/05/18	12/6/2018
2679 (MW-1)	2381.05	2383.09	2382.39	2381.77	2381.17	2381.11	2381.73	2383.35	2384.84	2385.13	2384.69	2383.87
2680 (MW-2)	2383.74	2387.14	2384.44	2384.00	2383.77	2383.52	2383.44	2392.30	2394.16	2394.42	2393.80	2392.43
2681 (MW-3)	2372.51	2371.33	2370.51	2369.57	2369.27	2371.43	2378.29	2380.05	2378.73	2382.03	2378.09	2375.07

Figure 12. Monthly Water Level Elevations—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

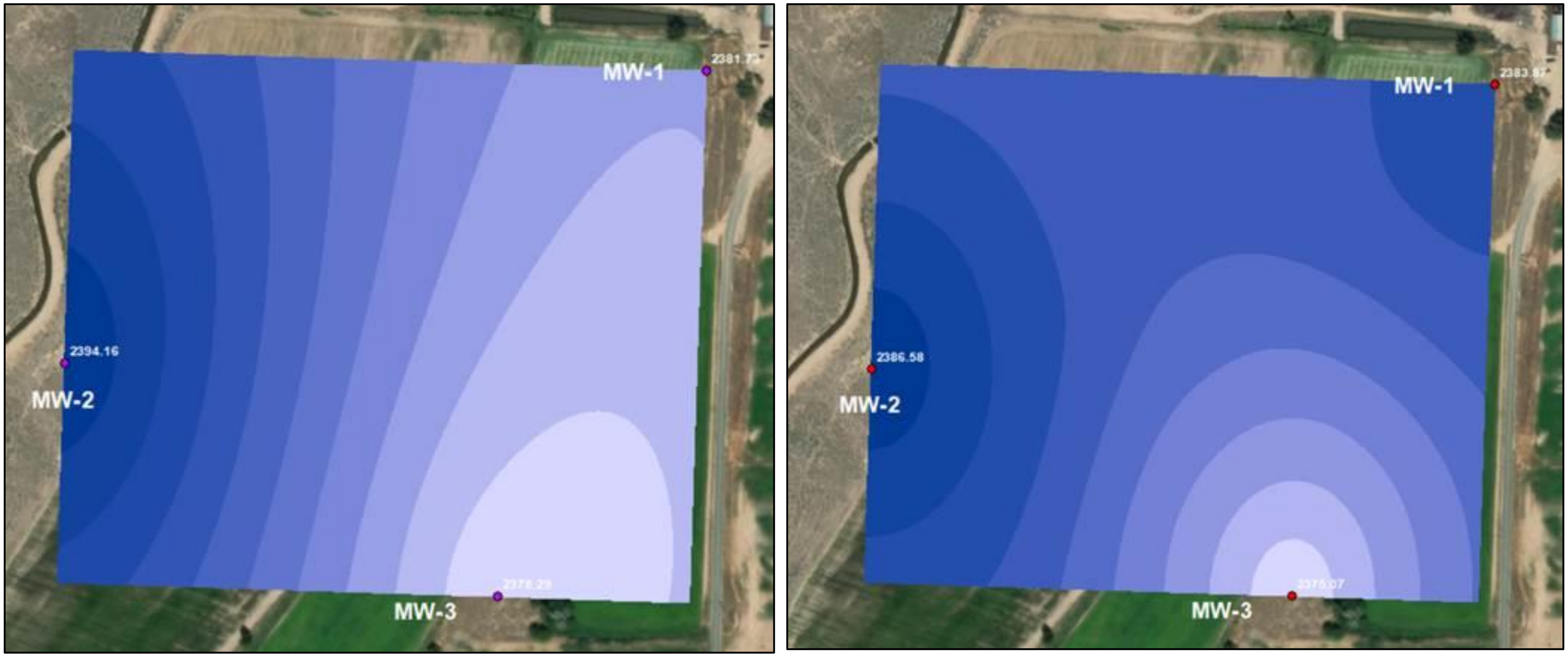


Figure 13. Kriged ground water elevations (ft above mean sea level (amsl)) for July (left) and December (right)—Sand Hollow Creek Ground Water Monitoring Project.

General Ground Water Chemistry Results

Analytical results for common ions and alkalinity are presented in Table 19. Metals results are presented in Table 20. Water chemistry at all wells was generally acceptable, with the secondary drinking water standard for TDS exceeded for the sample from Well 2232 in December 2018. Results are also shown in a trilinear (Piper) diagram (Figure 14). Well 2679 appears to be a higher sodium and chloride water whereas Well 2232 appears to be higher in calcium and bicarbonate. Well 2232 and Well 2681 have similar water chemistries. The ground water chemistry plots seem to suggest that Wells 2232 and Well 2681 are a mix of water characterized in Well 2679 and Well 2680. Based on the location of wells and land uses, Well 2680 is likely influenced by the nearby canal (Figure 11) while Well 2679 is likely influenced by the adjacent dairy lagoon.

Table 19. General Chemistry Results—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bicarbonate (as CaCO3)	Bromide	Calcium	Chloride[a]	Fluoride[ab]	Magnesium	Potassium	Sodium	Sulfate[a]	Total Dissolved Solids[a]
			(mg/L)									
Water Quality Standard:			No Standard	No Standard	No Standard	250	2.0/4	No Standard	No Standard	No Standard	250	500
2232	Unk	05/18/2018	332	<2.5	92.0	4.5	0.36	25.2	3.67	38.4	14.5	457
		12/06/2018	409	<2.5	101	4.3	<0.50	29.8	4.55	38.0	14.0	*504*
2679 (MW 1)	60	05/18/2018	247	<2.5	67.9	17.3	<0.50	15.3	2.98	65.2	31.6	426
		12/06/2018	257	<2.5	65.7	11.5	<0.50	15.0	3.08	68.2	27.0	445
2680 (MW 2)	40	05/18/2018	95.9	<2.5	28.9	1.3	<0.50	6.11	0.310	4.92	2.6	141
		12/06/2018	70.6	<2.5	19.5	1.4	<0.50	4.49	0.410	4.12	<5.0	95.0
2681 (MW 3)	45	05/18/2018	261	<2.5	67.8	3.8	0.76	22.0	2.27	28.4	18.1	393
		12/06/2018	243	<2.5	58.0	1.2	<0.50	19.9	3.82	24.9	<5.0	308

Notes: mg/L = milligrams per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Unk = Unknown. Well log not found or unavailable; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
a. Contaminant with a National Secondary Drinking Water Regulation standard.
b. Contaminant with a National Primary Drinking Water Regulation standard.

Table 20. Metals results—Sand Hollow Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Barium[a]	Iron[b]	Manganese[b]
			(mg/L)		
Water Quality Standard:			2	0.3	0.05
2232	Unk	05/18/2018	0.158	<0.100	<0.0050
		12/06/2018	0.228	<0.100	<0.0200
2679 (MW-1)	60	05/18/2018	0.239	*0.420*	0.0206
		12/06/2018	0.247	*0.665*	0.0227
2680 (MW-2)	40	05/18/2018	0.0502	0.0849	0.0040
		12/06/2018	0.0326	0.105	0.0064
2681 (MW-3)	45	05/18/2018	0.160	*3.46*	*0.0677*
		12/06/2018	0.330	*10.5*	*0.261*

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found or unavailable; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Contaminant with a National Secondary Drinking Water Regulation standard.

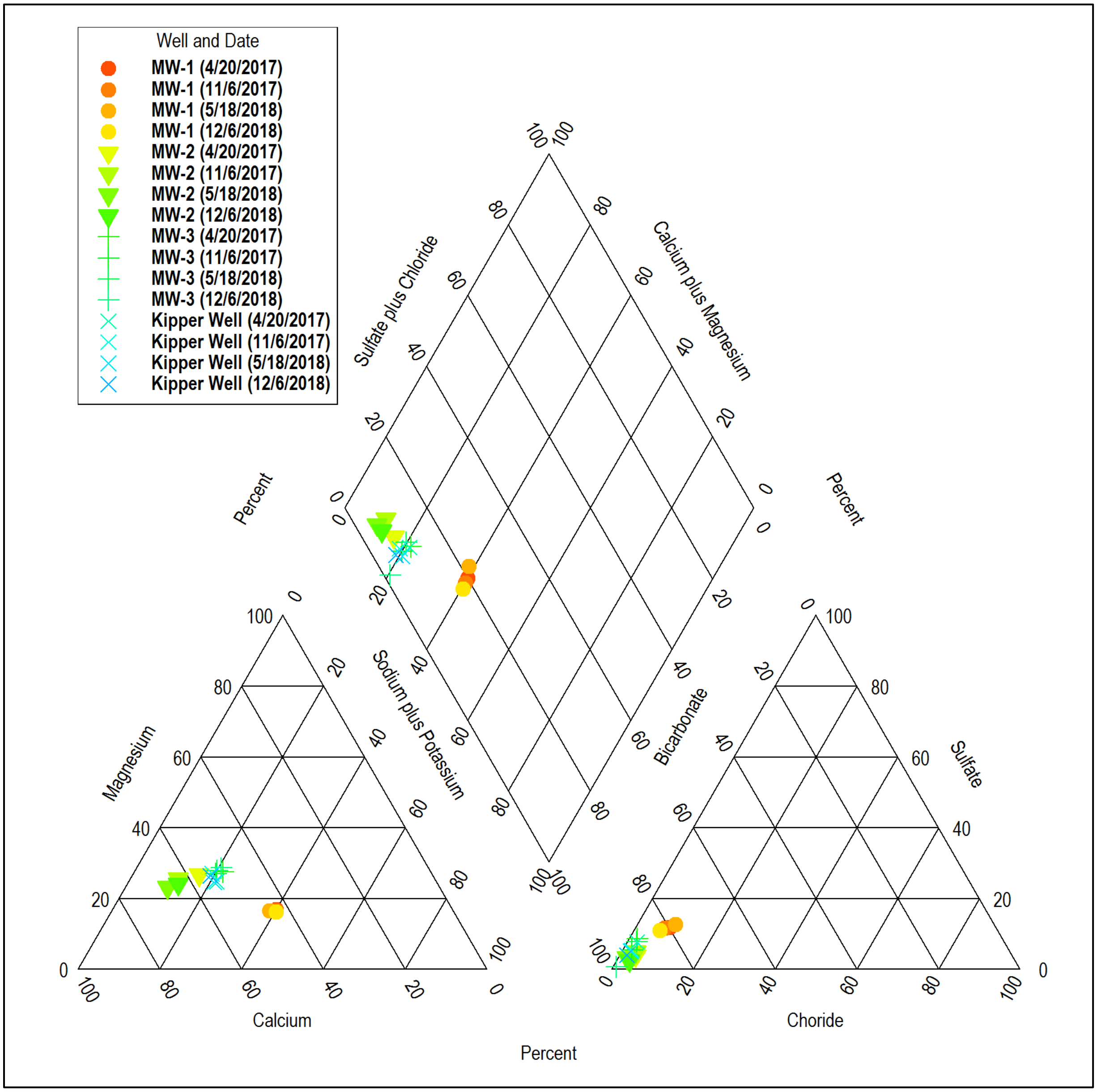


Figure 14. Trilinear (Piper) Diagram for 2017 and 2018—Sand Hollow Creek Nitrate Investigation Ground Water Monitoring Project.

Nutrient Results

Nutrient results are summarized in Table 21. Laboratory analyses of the May 2018 ground water samples indicated a nitrate concentration exceeding the MCL of 10 mg/L in Well 2679 (17.0 mg/L). Nitrate was detected at a concentration less than the MCL in the Well 2680 samples (0.25 mg/L), Well 2681 (2.9 mg/L), and the site's domestic Well 2232 (7.0 mg/L). The analyses of the December 2018 samples indicated a nitrate concentration exceeding the MCL in the Well 2679 sample (19.1 mg/L). Nitrate was detected at a concentration less than the MCL in the samples from Well 2680 (0.20 mg/L), Well 2681 (2.6 mg/L), and Well 2232 (6.6 mg/L).

Table 21. Nutrient and Nutrient-Related Isotope Results—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			
			Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{15}N$
			(mg/L)			(‰)
Water Quality Standard:			1.0	10	No Standard	No Standard
2232	Unk	05/18/2018	<0.050	7.0	<0.10	6.1
		12/06/2018	<0.050	6.6	<0.10	5.3
2679 (MW-1)	60	05/18/2018	<0.050	**17.0**	<0.10	9.6
		12/06/2018	<0.050	**19.1**	<0.10	8.4
2680 (MW-2)	40	05/18/2018	<0.050	0.25	<0.10	—
		12/06/2018	<0.050	0.20	<0.10	—
2681 (MW-3)	45	05/18/2018	<0.050	2.9	<0.10	—
		12/06/2018	<0.050	2.6	<0.10	—

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found or unavailable; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; (-) = Not Analyzed. Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

The nitrate concentration decreased in the domestic well (Well 2232) from more than 21 mg/L in 2015 to approximately 7 mg/L in 2018 (Figure 15).

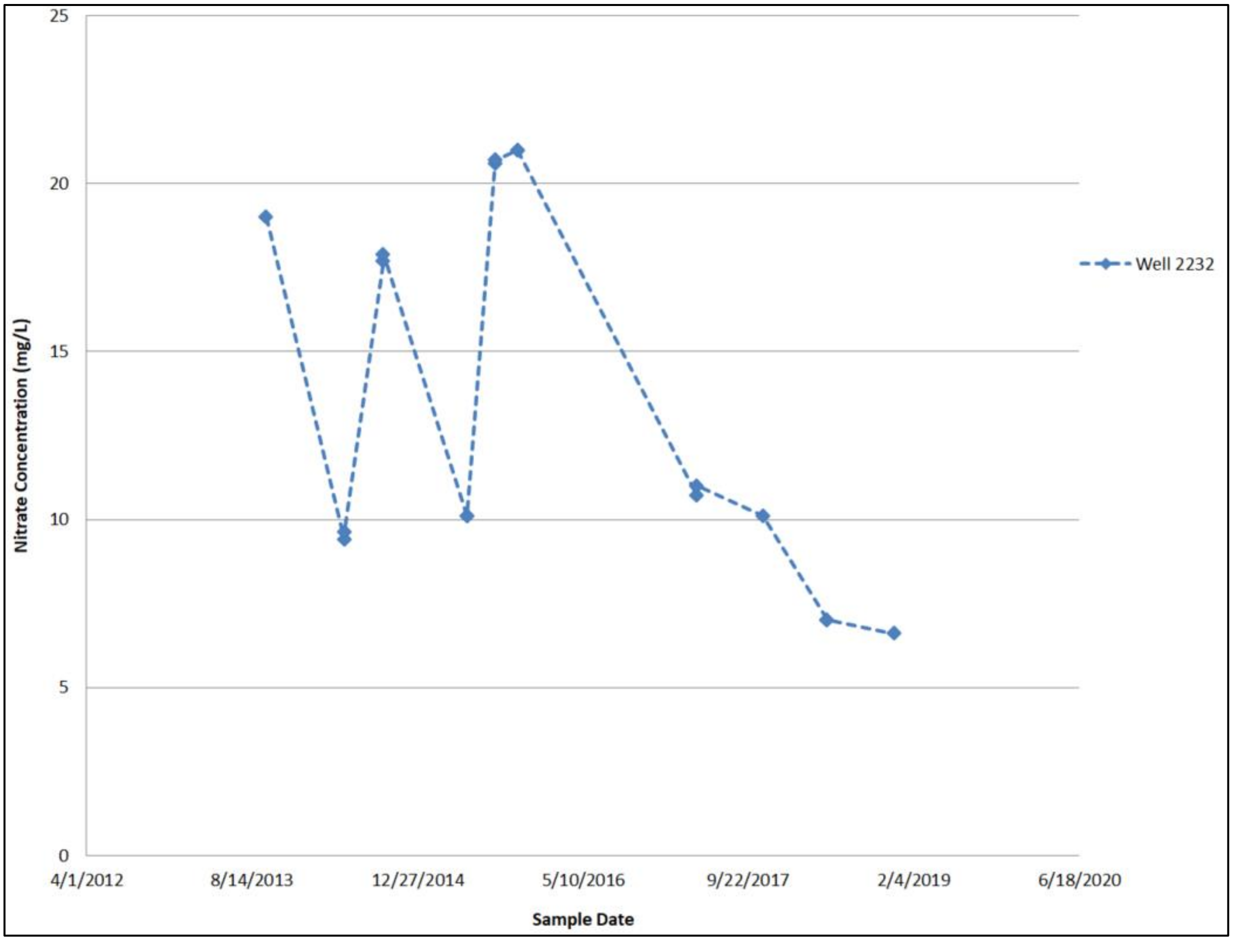


Figure 15. Nitrate concentrations over time (2013-2018) at Well 2232—Sand Hollow Creek Nitrate Investigation Ground Water Monitoring Project.

Nitrogen Isotope Results

Well 2679 and Well 2232 were sampled for nitrogen isotope, due to the higher concentrations of nitrate (Table 21). Well 2679 had $\delta^{15}N$ ratios of 9.6 per mil (‰) and 8.4‰ in May and December, respectively. These ratios are characteristic of the contribution of nitrogen from animal or human waste sources (Seiler 1996; Table 3). Well 2232 had $\delta^{15}N$ ratios of 6.1‰ and 5.3‰ in May and December, respectively, indicating a mixed nitrogen source (Table 21).

2.1.5.3 Conclusions

Tetra Tech completed two more rounds of ground water monitoring for the Sand Hollow Nitrate Investigation project in an effort to gain better understanding of the historically high nitrate concentrations at the site's domestic well, Well 2232. The nitrate concentrations in Well 2679's May (17.0 mg/L) and December (19.1 mg/L) samples exceed the MCL of 10 mg/L; whereas Well 2680, Well 2681, and Well 2232 had nitrate concentrations less than 10 mg/L. Well 2232's nitrate concentrations have decreased from a high concentration of 21 mg/L in October of 2015 to 6.6 mg/L in December of 2018. The May δ15N ratio above 9‰ for Well 2679 suggests a likely animal waste component for the nitrate. These nitrate data indicate animal waste sources of nitrate at the dairy are impacting ground water at the north end of the property. The source of the elevated nitrate concentrations in Well 2232 (7.0 mg/L and 6.6 mg/L) is undetermined. Potential sources include: fertilizer applied to agricultural fields located to the north and east of the well, fertilizer and/or liquid or solid animal waste applied to agricultural fields located north and east of Sandy Ave., or the dairy lagoon.

2.1.5.4 Recommendations

DEQ will evaluate the water quality data for the sampling completed in May of 2019 and determine the frequency of continued monitoring at the Site.

As proposed in the 2017 annual report, alternative methods for determining a hydraulic connection (e.g., conducting a dye tracer test) between Well 2232 and Sage Dairy (the lagoon) and Well 2679 were explored. It was determined that conducting a successful study with conclusive results within a reasonable timeframe and budget was not feasible due to the anticipated adsorption of the dye and prolonged travel time.

2.1.6 Exploratory Field Sampling Demonstration—Sand Hollow Creek Ground Water Nitrate Investigation

2.1.6.1 Purpose

DEQ staff conducted exploratory field sampling of the project monitoring wells ahead of Tetra Tech in December to collect screening-level nitrate and nitrite data to use for comparison with laboratory analysis. The intent was to compare field screening-level data (using nitrate test strips) to determine if it could be used to fill in gaps between analytical testing or to capture seasonal changes in nitrate levels.

Analytical samples were also collected from the monitoring wells using a bailer (with no purging) to compare with results from samples collected after the wells were purged (using low-flow techniques). The intent was to determine if bailed samples could be used in lieu of purged samples due to the limitations for collecting samples using low-flow purging methods at the monitoring wells at this site, and to determine if this method is useful in future cost-prohibitive studies.

2.1.6.2 Methods and Results

To obtain screening-level nitrate (and nitrite) comparison data, DEQ tested water collected with a bailer with nitrate test strips at the monitoring wells before Tetra Tech purging or sampling the wells. DEQ staff also collected a nitrate sample from the bailer for laboratory analysis to compare with the analytical results of water collected by Tetra Tech after the wells had been purged. Additionally, Tetra Tech also used the nitrate test strips after purging for comparison to DEQ test strips. All results from this screening-level, exploratory work is presented in Table 22. Only nitrate results are presented, as all nitrite (test strips and analytical results) were below detection.

Table 22. Screening-level nitrate results—Sand Hollow Creek Ground Water Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	DEQ Nitrate[a] Test Strip	TT Nitrate[a] Test Strip	DEQ Bailed Nitrate[a] Analytical Sample	TT Purged Nitrate[a] Analytical Sample
Water Quality Standard:			10 mg/L		10 mg/L	
2679 (MW-1)	60	12/06/2018	2-5	20	4.37	**19.1**
2680 (MW-2)	40	12/06/2018	0	2	<0.18	0.2
2681 (MW-3)	45	12/06/2018	2	2	2.66	2.6

Notes: mg/L = milligrams per liter; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Nitrate test strips are considered to be an inexpensive, simple screening-level tool that can provide a relatively accurate, rapid result. The type of strips used (Industrial Test Systems 480009 WaterWorks™ Nitrate/Nitrite Nitrogen) provide results as total nitrate (as NO3-N) or nitrite (as NO2-N). The presence and concentration of nitrate or nitrite will be indicated through a color change of the appropriate reactive pad on the strip. The range of concentrations is: 0, 0.5, 2, 5, 10, 20, 50 ppm (mg/L) for nitrate and 0.15, 0.3, 1, 1.5, 3, 10 ppm (mg/L) for nitrite. Interpretation of the pad color and its corresponding concentration is somewhat subjective between user and thus makes comparison of results interpreted by different people somewhat challenging. The images below show the product used and method of interpreting the results (Figure 16).

Figure 16. Images of WaterWorks™ Nitrate and Nitrite test strips and method of results interpretation.

The nitrate test strip results between bailed and purged samples for MW-3 were identical. MW-2 and MW-3 are screened across the water table, which allows for water to flow through the well - meaning water inside the casing is similar to the water in the aquifer and reduces the dependency on purging to obtain a representative sample. Test strip results for MW-2 showed some variation in concentration (real or through differences in interpretation) yet were similar in that they were both low concentrations and within a range of other products (e.g., 0-2 mg/L). Test strip and analytical results for MW-1 were most dissimilar. The results suggest that purging is most critical at MW-1 for obtaining accurate nitrate concentrations—using a bailer to obtain an unpurged sample is not recommended at this well as shown by both the test strip and analytical results.

2.1.6.3 Conclusions

Comparing the accuracy of the test strips with the analytical data shows that, in either scenario, the interpretations of the color change by both DEQ staff and Tetra Tech staff were consistent with concentrations determined through analytical methods. Bailed water is most representative of aquifer conditions when the water table is within the screened interval (as in the case of MW-2 and MW-3). Due to the construction of MW-1, bailed water does not accurately represent the water quality of the aquifer because stagnant water in the casing allows for denitrification of nitrate. As shown in this demonstration, MW-1 must be purged to collect a representative sample of the aquifer.

2.2 Idaho Falls Region

Two ground water quality monitoring projects were conducted in the Idaho Falls region in 2018 using public funds.

2.2.1 Eastern Snake River Plain Subarea Regional Monitoring Project

2.2.1.1 Purpose and Background

The Idaho Falls DEQ region has been divided into subareas based on land use and hydrogeologic boundaries to identify areas of vulnerable or degraded water quality, work to understand the sources of degradation to direct and prioritize protection efforts, and evaluate the effectiveness of measures taken to improve water quality (DEQ 2013a). This network prioritizes nitrate as a measure of degradation.

The ESRP subarea covers approximately 750 square miles of Eastern Idaho, consisting primarily of the relatively low lands adjacent to the Henrys Fork and South Fork of the Snake River, as well as the lower extent of the Teton River drainages along the ESRP's eastern margin (Figure 17). The regional geology for the ESRP Aquifer is dominated by basalts, interbedded sediments, and rhyolites. Basalts dominate towards the central portions of the plain where they are as much as several thousand feet thick. Towards the margins of the ESRP, sediments and permeable rhyolites can be significant. Transmissivity and aquifer thickness are also greatest towards the center of the ESRP and tend to decrease towards the margins. The general direction of ground water flow is from northeast to southwest, consistent with the flow of the South Fork and Henrys Fork of the Snake River and its major tributaries. The ESRP Aquifer tends to respond as unconfined towards the center, and as confined towards the margins, reflecting the larger proportion of sediments (Stearns and others, 1938, Whitehead, 1992). The ESRP subarea is dominated by gravels and basalts with isolated areas of finer-grained sediments. Major sources of recharge are downward percolation of precipitation and snowmelt, runoff from the surrounding uplands, stream flow losses, particularly from the Henrys Fork and South Fork of the Snake River, and direct infiltration of surface water diverted for irrigation (Graham and Campbell, 1981).

The Eastern Snake River Plain (ESRP) regional monitoring subarea was sampled in 2014 and summarized in the 2014 *Summary Report for the DEQ Ground Water Quality Monitoring Projects* (DEQ 2016) and 2018.

2.2.1.2 Methods and Results

Sites were selected from domestic wells with available well construction logs. Selection favored more recent wells in the shallowest portion of the aquifer. Potential sites were selected from randomly–identified, square-mile sections within the subarea, excluding IDWR Statewide Ambient Monitoring Program or ISDA monitoring sites (DEQ 2013b). All 26 sites sampled in 2018 were included in the initial 2014 ESRP sampling round (DEQ 2016).

Samples from 26 sites were submitted to IBL for nitrate + nitrite and ammonia analysis as part of the ESRP subarea, fall 2018 sampling. All sampling was conducted in accordance with the QAPP (DEQ 2011b) and the project FSP (DEQ 2018e). Samples were shipped weekly, in a total of five shipments during the sample campaign. The first four shipments included either a duplicate or a field blank. The field blank consisted of deionized water generated with an ultra-pure in-house system at the Idaho Falls regional office (IFRO). Each 20 L carboy was checked to confirm that the specific conductance was sufficiently low (<2.5 µS/cm).

IBL combined shipments of ESRP samples so that two consecutive shipments were analyzed together as one laboratory batch, thus analysis of samples collected 10/3/18–10/23/18 were analyzed in two batches with both a field duplicate and a field blank. Duplicates were within control criteria (± reporting limit for samples < 5 times the detection limit, or ± 20% relative percent difference for results > 5 times the reporting limit). Of the results for ammonia as N, 22 were qualified as estimates ("J") due to contamination identified in two field blanks collected on different days and analyzed in different laboratory batches. Review of results and discussion with the analyzing laboratory supervisor/staff concluded that contamination could not be attributed to the laboratory. The cause(s) of the low levels of ammonia in the samples is undetermined.

A Hach Hydrolab Quanta G with a flow through cell was used to obtain field measurements for water temperature, specific conductance, pH, and DO to ensure adequate purging of the well for a representative sample of the local aquifer. Field parameter results are provided in Table 23. Water temperature ranged from 7.76–15.95 °C with a median value of 12.49 °C. Specific conductance ranged from 173–2,030 µS/cm with a median value of 435.5 µS/cm. The highest specific conductance was recorded for Well 2403, near three times the next highest value (Well 2398). Measurements for pH ranged from 7.09 to 7.86 with a median value of 7.54. DO ranged from 0.74–10.2 mg/L with a median of 6.93 mg/L. Four sites had low (< 3.0 mg/L) DO levels (Wells 2388, 2389, 2395, 2403), with two sites yielding a field measurement at anoxic levels (<~1 mg/L DO) (Wells 2388, 2403). These anoxic sites also returned nitrate concentrations close to or below the reporting level of 0.01 mg/L (0.032, <0.01).

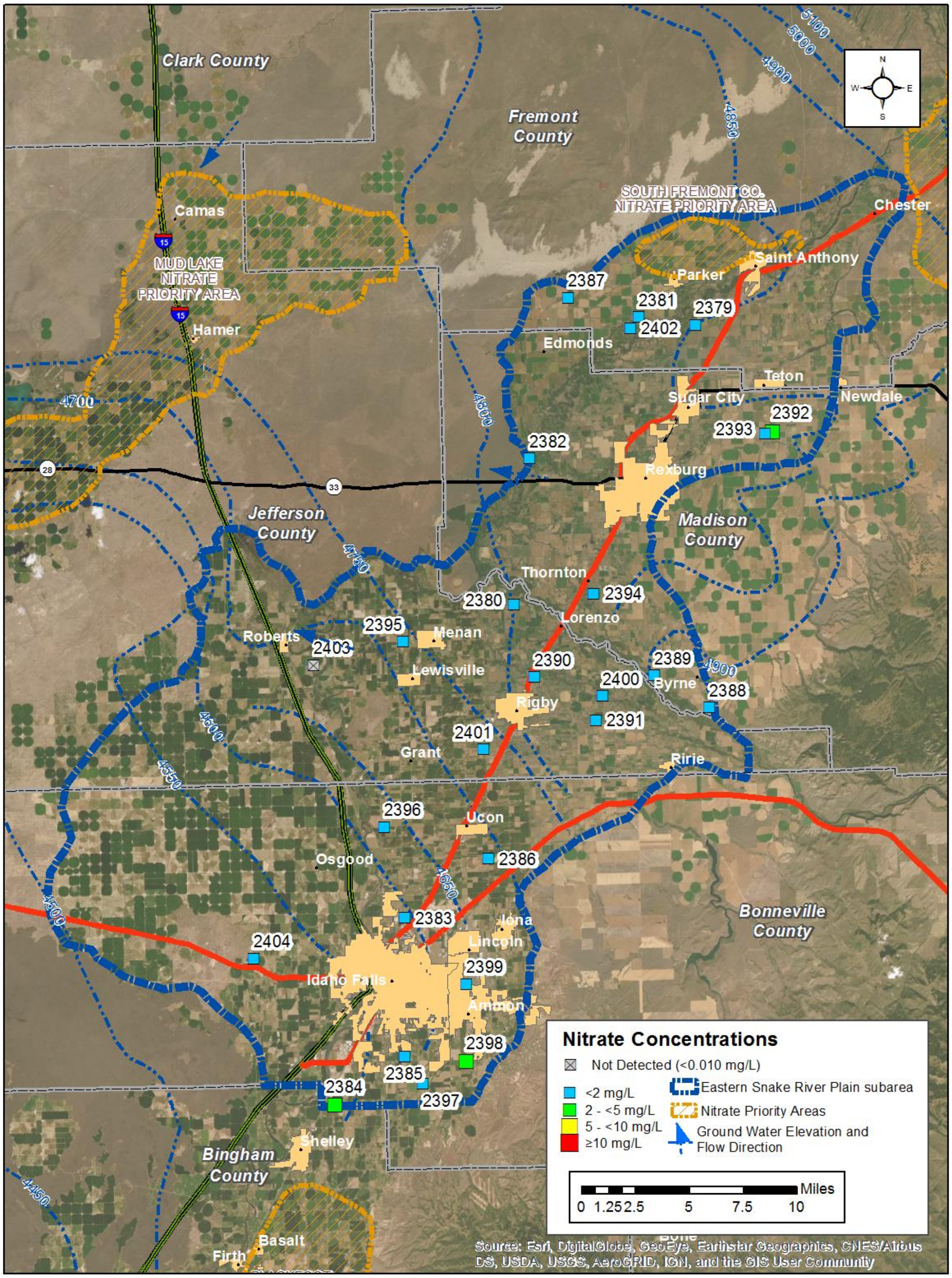


Figure 17. 2018 Monitoring sites and nitrate +nitrite concentrations—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

Table 23. Water quality field parameters—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Total Organic carbon (mg/L)	Dissolved Oxygen (mg/L)
2379	160	10/03/2018	13.60	183	6.86	<1.0	6.90
2380	48	10/25/2018	9.30	489	7.49	<1.0	3.06
2381	150	10/03/2018	12.40	173	7.67	<1.0	7.00
2382	118	10/18/2018	10.82	345	7.23	<1.0	3.50
2383	243	10/10/2018	12.16	520	7.39	<1.0	9.41
2384	195	10/23/2018	12.75	558	7.54	<1.0	6.95
2385	220	10/23/2018	13.64	558	7.41	<1.0	6.57
2386	222	10/10/2018	13.20	419	7.53	<1.0	10.20
2387	122	10/18/2018	14.56	266	7.58	<1.0	6.12
2388	142	10/16/2018	8.74	418	7.71	<1.0	0.74
2389	58	10/16/2018	7.76	452	7.77	<1.0	2.32
2390	80	10/16/2018	12.93	367	7.66	<1.0	7.00
2391	138	10/16/2018	15.82	357	7.77	<1.0	4.63
2392	280	10/03/2018	15.60	359	7.53	<1.0	8.36
2393	243	10/18/2018	13.37	276	7.54	<1.0	6.99
2394	78	11/27/2018	9.17	516	7.47	<1.0	4.65
2395	38	10/16/2018	12.03	490	7.49	<1.0	1.95
2396	200	10/10/2018	11.85	460	7.59	<1.0	9.39
2397	180	10/10/2018	12.85	578	7.32	<1.0	7.66
2398	150	10/10/2018	15.95	733	7.50	<1.0	8.19
2399	140	10/10/2018	12.55	642	7.20	1.10	8.87
2400	100	10/25/2018	12.43	389	7.59	<1.0	5.63
2401	138	10/16/2018	12.54	411	7.61	<1.0	5.30
2402	120	10/23/2018	11.27	201	7.09	<1.0	7.20
2403	35	10/18/2018	8.54	2030	7.41	3.81	1.01
2404	325	10/03/2018	11.22	502	7.86	<1.0	7.65

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; 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 but can be applied to private wells to evaluate water quality.

Nutrient Results

Nutrient concentrations are presented in Table 24. Nitrate concentrations ranged from less than the reporting level (0.01 mg/L) for one site (Well 2403) to 2.3 mg/L, with a median value of 1.1 mg/L. Three sites (Wells 2384, 2392, and 2398) exceeded the generally accepted natural background range (1–2 mg/L). A total of 19 sites had detectable ammonia; however, only Well 2403 (with a concentration of 0.32 mg/L) was not qualified as an estimate due to low level detections in field blanks. This specific site also had a nitrate concentration less than the reporting level. The locations of sites sampled in 2018, along with corresponding nitrate results, are shown in Figure 17.

Nitrogen Isotope Results

Nitrogen isotope ratios are presented in Table 24. Nitrogen from atmospheric and inorganic fertilizer sources tends to have $\delta^{15}N$ values less than 4‰, whereas waste-related sources tend to have $\delta^{15}N$ values greater than 9‰ (Seiler 1996; Table 3). Isotope ratios between that range can result from a mixture of sources and/or modification by biological and chemical processes. Review of the supporting chemistry can aid in interpreting potential sources. Results for $\delta^{15}N_{nitrate}$ ranged from 2.2–7.2‰ with a median value of 4.8‰ $\delta^{15}N_{nitrate}$. Six sites returned $\delta^{15}N_{nitrate}$ ratios of about 4‰ and lower (Wells 2379, 2383, 2386, 2394, 2400, 2402), typically indicative of an inorganic nitrogen source, while other processes can also impact this ratio. Of these six sites, four had sulfate/chloride ratios above 3.59, supporting the observation that sites with an inorganic $\delta^{15}N_{nitrate}$ signature tend to have higher sulfate concentrations relative to chloride. Another seven sites returned $\delta^{15}N_{nitrate}$ ratios between 4‰ and 5‰, transitional from the accepted range of inorganic to a mixed/organic nitrogen source. The remaining 12 sites with $\delta^{15}N_{nitrate}$ results ranged from 5‰ to 7.2‰, within the accepted range for a mixed/organic nitrogen source. One site (Well 2403) did not yield sufficient total nitrate for a $\delta^{15}N_{nitrate}$ analysis.

Table 24. Nutrient and nutrient-related isotope results—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration		Isotopes	
			Nitrate + Nitrite[a]	Ammonia	$\delta^{15}N_{nitrate}$	$\delta^{15}O_{nitrate}$
			as N (mg/L)	as N (mg/L)	(‰)	(‰)
Water Quality Standard:			10	No Standard	No Standard	No Standard
2379	160	10/3/2018	0.65	0.010J	2.2	-7.3
2380	48	10/25/2018	0.55	0.030J	6.1	-6.9
2381	150	10/3/2018	1.4	0.013J	4.4	-4.7
2382	118	10/18/2018	1.0	0.034J	7.2	-7.1
2383	243	10/10/2018	1.7	<0.010	4.0	-7.2
2384	195	10/23/2018	2.3	0.035J	4.8	-6.1
2385	220	10/23/2018	1.8	0.028J	4.6	-6.7
2386	222	10/10/2018	1.2	0.010J	3.1	-7.5
2387	122	10/18/2018	1.7	0.027J	5.8	-4.4
2388	142	10/16/2018	0.032	0.014J	6.9	-11.7
2389	58	10/16/2018	0.27	0.011J	5.2	-6.7
2390	80	10/16/2018	0.36	<0.010	6.6	-7.1
2391	138	10/16/2018	0.17	0.010J	5.2	-9.5
2392	280	10/3/2018	2.3	0.012J	4.2	-6.0
2393	243	10/18/2018	0.9	0.025J	5.3	-5.6
2394	78	11/27/2018	1.4	<0.010	3.5	-6.8
2395	38	10/16/2018	0.68	0.018J	6.8	-5.9
2396	200	10/10/2018	1.1	0.013J	4.1	-6.9
2397	180	10/10/2018	1.9	<0.010	5.2	-7.6

2398	150	10/10/2018	2.2	<0.010	5.9	-9.2
2399	140	10/10/2018	1.5	<0.010	6.7	-5.9
2400	100	10/25/2018	0.14	0.031J	4.0	-3.2
2401	138	10/16/2018	0.76	<0.010	4.4	-7.4
2402	120	10/23/2018	0.97	0.025J	3.3	-6.0
2403	35	10/18/2018	<0.010	0.32	QNS	QNS
2404	325	10/3/2018	1.4	0.010J	4.5	-5.9

Notes: ‰ = per mil; mg/L = milligrams per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. J = Analyte was detected, but the value of the result is an estimate (due to low level detection of ammonium in field blanks). QNS = (Quantity Not Sufficient) insufficient mass of N-nitrate for analysis.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Bacteria Results

TC bacteria was detected in samples from five sites (Wells 2381, 2392, 2395, 2401, 2402) with levels ranging from 2 to 122.3 MPN/100mL (Table 25), with a median of 3 MPN/100mL for sites with detections. The highest bacterial level was observed for Well 2381. Four samples were collected from outdoor frost-free hydrants nearest the well head and the fifth was collected from a hydrant within the well house. These sample ports may not have been used for a number of weeks, perhaps contributing to the levels of bacteria observed. Bacteria detections did not appear to be correlated to any other parameters. No samples contained *E. coli*.

Table 25. Bacteria Results—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
2379	160	10/03/2018	<1.0	<1.0
2380	48	10/25/2018	<1.0	<1.0
2381	150	10/03/2018	<1.0	122.3
2382	118	10/18/2018	<1.0	<1.0
2383	243	10/10/2018	<1.0	<1.0
2384	195	10/23/2018	<1.0	<1.0
2385	220	10/23/2018	<1.0	<1.0
2386	222	10/10/2018	<1.0	<1.0
2387	122	10/18/2018	<1.0	<1.0
2388	142	10/16/2018	<1.0	<1.0
2389	58	10/16/2018	<1.0	<1.0
2390	80	10/16/2018	<1.0	<1.0
2391	138	10/16/2018	<1.0	<1.0
2392	280	10/03/2018	<1.0	4.1

2393	243	10/18/2018	<1.0	<1.0
2394	78	11/27/2018	<1.0	<1.0
2395	38	10/16/2018	<1.0	3.0
2396	200	10/10/2018	<1.0	<1.0
2397	180	10/10/2018	<1.0	<1.0
2398	150	10/10/2018	<1.0	<1.0
2399	140	10/10/2018	<1.0	<1.0
2400	100	10/25/2018	<1.0	<1.0
2401	138	10/16/2018	<1.0	2.0
2402	120	10/23/2018	<1.0	2.0
2403	35	10/18/2018	<1.0	<1.0
2404	325	10/03/2018	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters.
a. 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 numbers) 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.

Ground Water Chemistry Results

Major ion chemistry results are contained in Table 26 and presented in a Piper diagram (Figure 18). The Piper diagram can aid in identifying chemical relationships beneficial to recognizing mixing of recharge waters and identifying changes resulting from disproportional inputs of major ions due to exchange with the aquifer matrix or due to anthropogenic sources at the surface. Viewing other chemical and isotopic relationships within that same recharge general water chemistry context can aid in distinguishing potential impacts related to these sources. Figure 19 presents ESRP regional monitoring sites identified by general recharge sources. Site IDs for specific ESRP locations identified in subsequent water chemistry, indicator, and stable isotope graphics figures are labeled.

A Piper diagram for sites sampled in 2018 plotted relative to the general source of recharge—Henrys Fork/Teton River Drainages (Fremont and Madison counties) or South Fork Snake River Drainage (Jefferson and Bonneville counties), with sites plotting distinctly from these regions identified is presented in Figure 18. Primary sources of recharge appear to explain general differences in overall major ion chemistry. Henrys Fork and South Fork of the Snake River sites plot with distinct combinations of major cations (magnesium (Mg), calcium (Ca), sodium (Na) + potassium (K)) and anions (bicarbonate ($HCO_{3)}$, chloride (Cl), sulfate ($SO_{4)}$). Overall there appears to be an increasing proportion of sulfate from the Henrys Fork down gradient to the South Fork-dominated portion of the ESRP subarea. Wells 2403, 2398, and 2382 plot distinctly from these groupings; Wells 2403 and 2398 with notably larger proportions of chloride and sulfate, suggesting inputs of sulfate/chloride from likely anthropogenic sources. Well 2382 plots with a greater proportion bicarbonate alkalinity (HCO_3), suggesting a distinct recharge source.

Table 26. Common ion and Total Dissolved Solids results—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as ($CaCO_3$) (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride[a] (mg/L)	Fluoride[ab] (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Water Quality Standard:			No Standard	No Standard	No Standard	250	2.0/4	No Standard	No Standard	No Standard	250
2379	160	10/03/2018	75.0	15.1	16	4.07	1.44	4.7	2.4	13	4.20
2380	48	10/25/2018	185	12.5	67	13.2	0.332	15	2.2	14	51.5
2381	150	10/03/2018	82.0	16.2	21	5.10	1.60	5.3	2.7	13	7.81
2382	118	10/18/2018	168	14.8	44	3.00	0.688	13	2.9	8.6	6.03
2383	243	10/10/2018	220	15.0	73	8.95	0.297	18	2.7	11	37.0
2384	195	10/23/2018	228	132	68	13.4	0.287	21	4.2	16	40.0
2385	220	10/23/2018	236	21.4	75	12.3	0.346	19	3.8	14	35.0
2386	222	10/10/2018	169	18.8	56	8.58	0.322	14	2.3	11	30.8
2387	122	10/18/2018	115	15.2	34	5.10	1.53	5.3	3.2	13	4.15
2388	142	10/16/2018	148	12.9	54	12.1	0.365	13	2.2	13	44.5
2389	58	10/16/2018	184	10.7	61	7.96	0.360	14	2.1	12	39.0
2390	80	10/16/2018	147	9.80	50	6.43	0.325	11	1.7	8.6	30.0
2391	138	10/16/2018	128	11.3	48	8.56	0.309	11	1.7	8.1	39.9
2392	280	10/03/2018	144	31.3	30	9.59	1.40	11	2.5	25	13.6
2393	243	10/18/2018	120	24.7	27	7.86	1.14	8.6	2.5	16	5.29
2394	78	11/27/2018	200	15.8	68	11.6	0.386	17	3.1	12	47.5
2395	38	10/16/2018	191	16.9	67	11.5	0.394	15	2.9	11	42.5
2396	200	10/10/2018	180	19.2	62	10.8	0.313	16	2.4	12	41.1

Notes: mg/L = milligrams per liter; µg/L = micrograms per liter; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. These regulations are applicable for public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

b. Contaminant with a National Primary Drinking Water Regulation standard.

Table 26. (continued)

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride[a] (mg/L)	Fluoride[ab] (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Primary or Secondary Standard:			**No Standard**	**No Standard**	**No Standard**	**250**	**2.0/4**	**No Standard**	**No Standard**	**No Standard**	**250**
2397	180	10/10/2018	245	26.1	74	13.6	0.279	20	4.6	19	34.9
2398	150	10/10/2018	168	122	68	89.4	0.223	22	7.6	41	50.7
2399	140	10/10/2018	276	28.9	93	17.5	<0.20	21	3.8	17	44.2
2400	100	10/25/2018	156	11.6	56	7.07	0.350	12	1.7	9.5	34.7
2401	138	10/16/2018	176	13.6	60	8.31	0.348	13	2.1	9.7	32.3
2402	120	10/23/2018	86.0	17.8	17	4.74	1.53	6.8	3.0	13	4.41
2403	35	10/18/2018	309	464	220	215	0.519	53	6.1	150	*476*
2404	325	10/03/2018	180	35.6	56	18.3	0.403	17	2.9	17	47.5

Notes: mg/L = milligrams per liter; µg/L = micrograms per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. These regulations are applicable for public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

b. Contaminant with a National Primary Drinking Water Regulation standard.

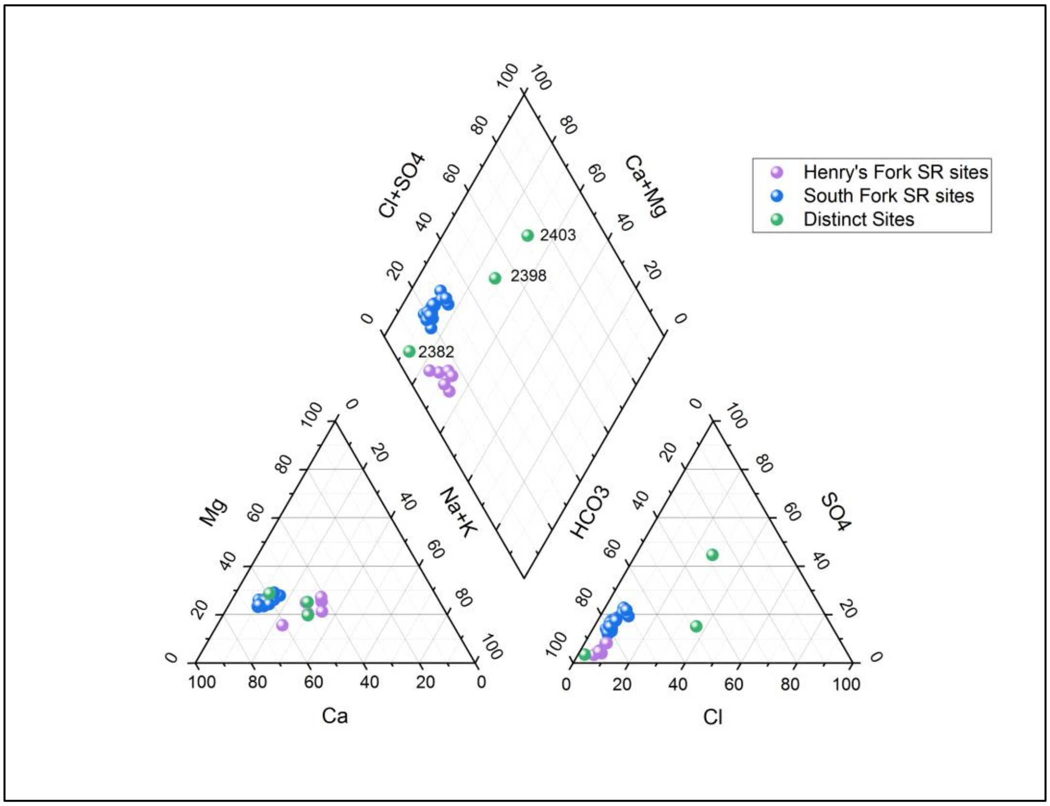


Figure 18. Piper diagram with 2018 ESRP Subarea Regional Ground Water Monitoring sites, distinguished by primary recharge sources—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

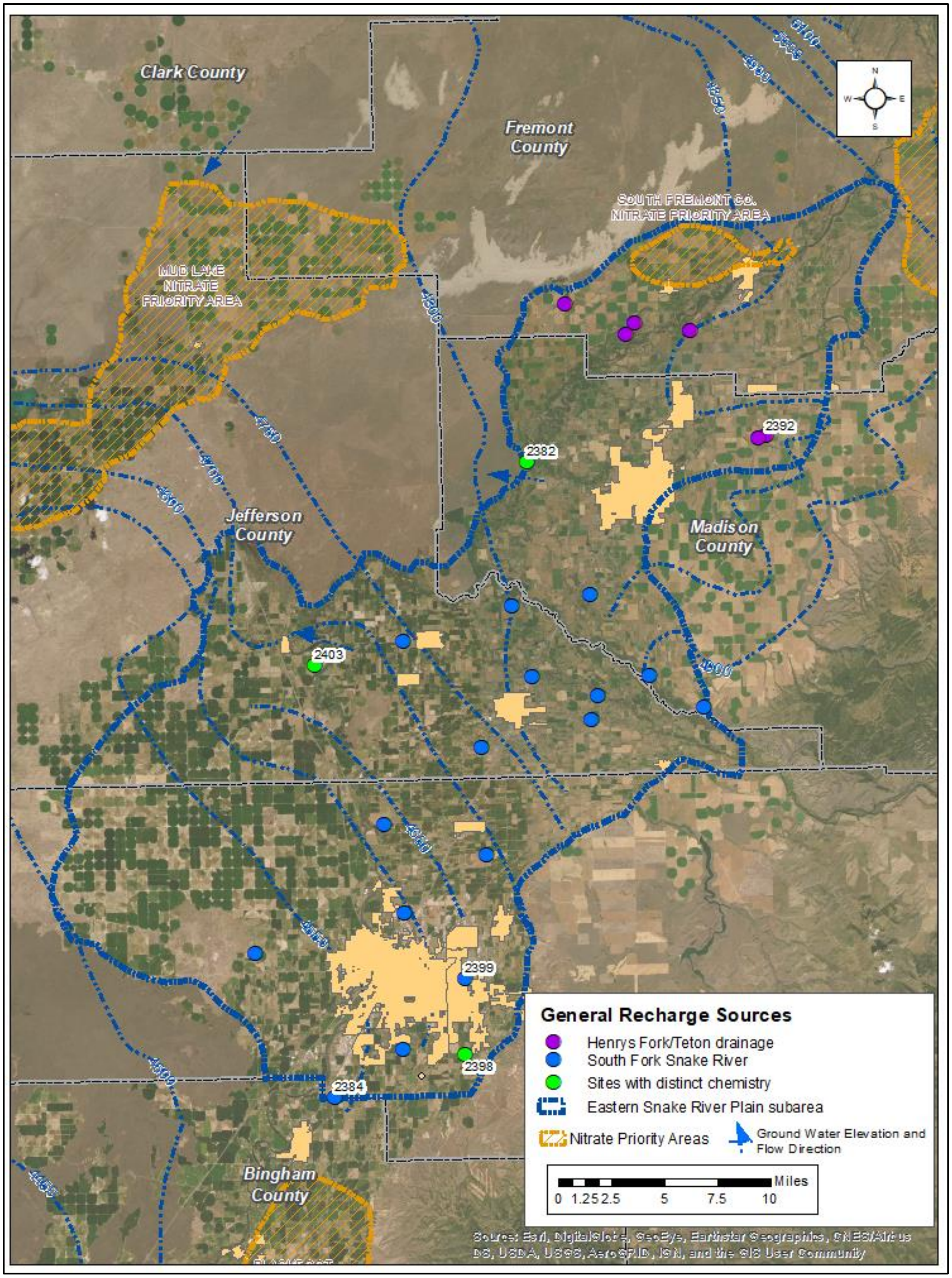


Figure 19. Map of ESRP Subarea Regional Ground Water Monitoring sites, distinguished by primary recharge sources—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

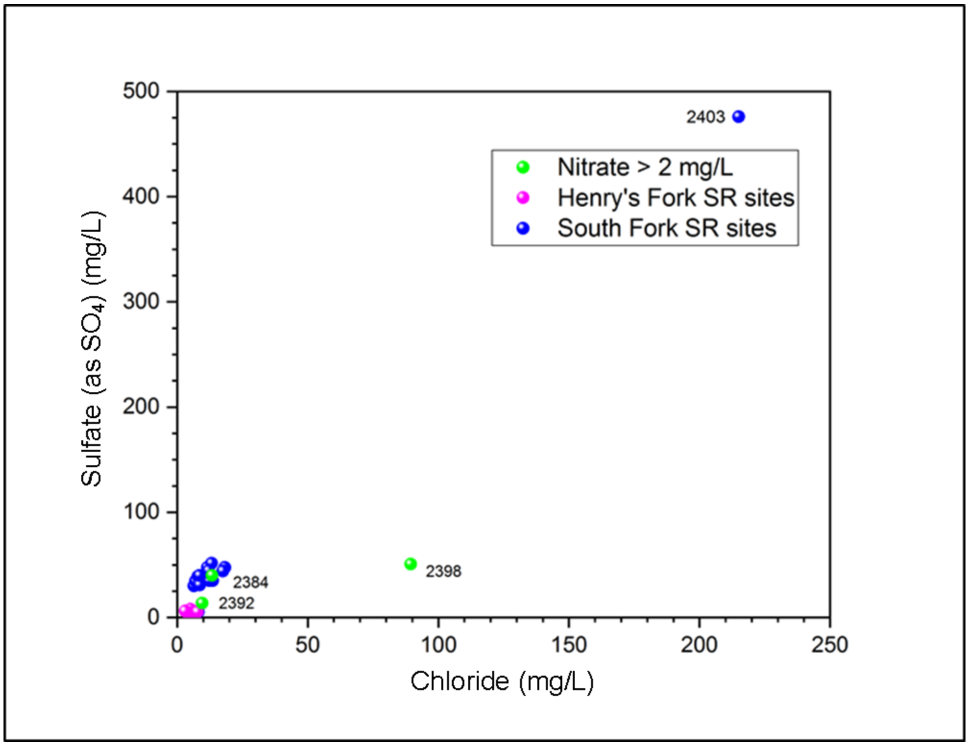


Figure 20. 2018 sulfate versus chloride comparison—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

Combinations of general chemistry and chemical and isotopic ratios for results allow distinctions to be made that can aid in identifying potential sources of nitrate to ground water.

Plotting chloride vs sulfate can help define the apparent relationships in the Piper diagram (Figure 20). Chloride and sulfate are natural constituents in ground water and will have a relative abundance determined from rock and soil from local aquifer materials. Anthropogenic impacts may result in a disproportionate addition of these major anions. Figure 20 shows chloride vs sulfate for ESRP subarea monitoring sites. There are three sites where nitrate levels exceeded the 1–2 mg/L general background range, and Well 2403 which returned significantly greater chloride and sulfate concentrations. The groupings attributed to distinctions in major ion chemistry reflecting general recharge areas (Henrys Fork and South Fork Snake River), and the proportionality greater chloride concentration for Well 2398 are apparent.

Figures 21 and 22 present sulfate/chloride ratios relative to nitrate concentrations and to $\delta^{15}N_{nitrate}$ ratios. Figure 21 shows that the general grouping based on overall source of recharge (Henrys Fork vs. South Fork Snake River) is a controlling factor in sulfate/chloride vs nitrate in ground water. An exception is Well 2398, located within the South Fork Snake River area of influence, which presents a low sulfate/chloride ratio (0.56) more often related to that observed for sites with a waste influence. The relationship of sulfate/chloride vs $\delta^{15}N_{nitrate}$ for the ESRP subarea (Figure 22) suggests that the range of $\delta^{15}N_{nitrate}$ values are not directly related to sulfate/chloride ratios, perhaps with the exception of Well 2398. This site returned a $\delta^{15}N_{nitrate}$ value reflecting a mixed N source. While most sites reflected a mixed source, about a third of sites reflected a primarily inorganic source.

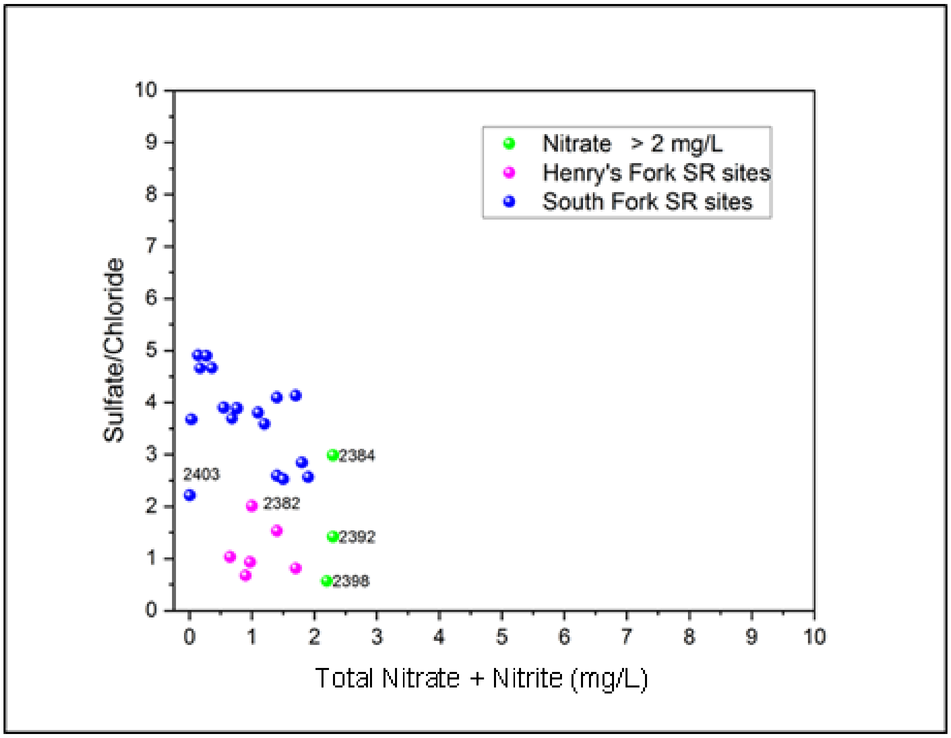


Figure 21. A plot of 2018 sulfate/chloride ratio versus total Nitrate + Nitrite—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

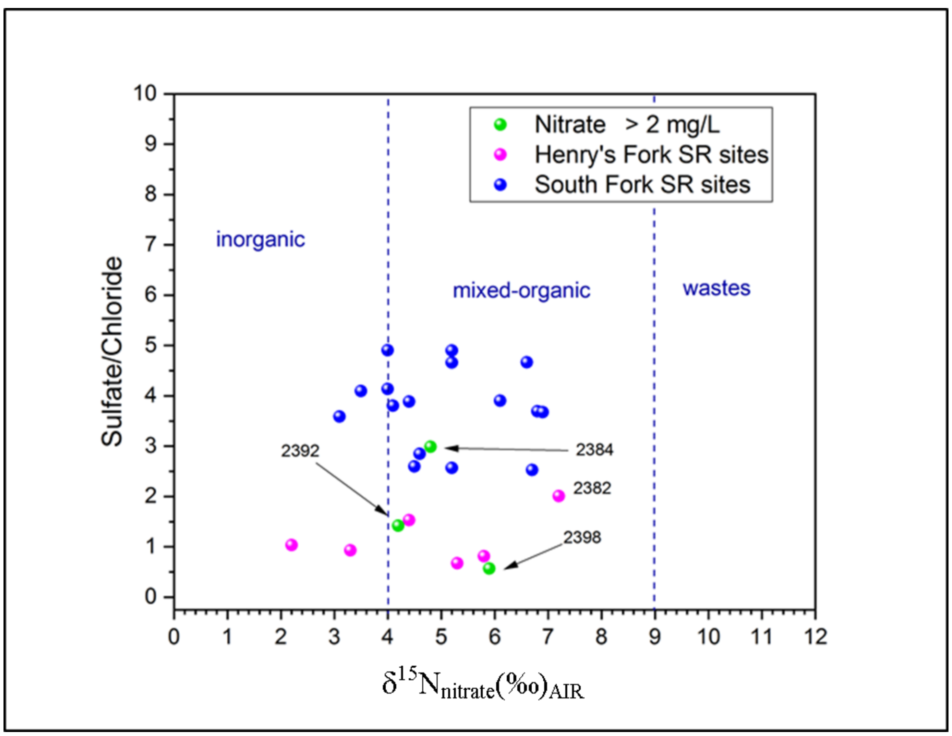


Figure 22. Comparison of 2018 $\delta^{15}N_{Nitrate}$ versus sulfate/chloride ratio—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

The ratio of chloride to bromide has been used as a means to distinguish between rain water (~50 - 150), potential septic/waste influences (~300 – 600), and impact from livestock wastes (>~600), with most ground waters overlapping somewhat with natural rain water (~100-200) ((Showers and others, 2008). Chloride concentration vs chloride/bromide ratio is presented in Figure 23. Most sites fall within ratios reflecting either primarily ground water or precipitation sources, and that distinct to primary recharge sources - Henrys Fork vs South Fork Snake River. Wells 2398 and 2403 are sufficiently distinct in Figure 23 to suggest a mixed source that may include a waste component.

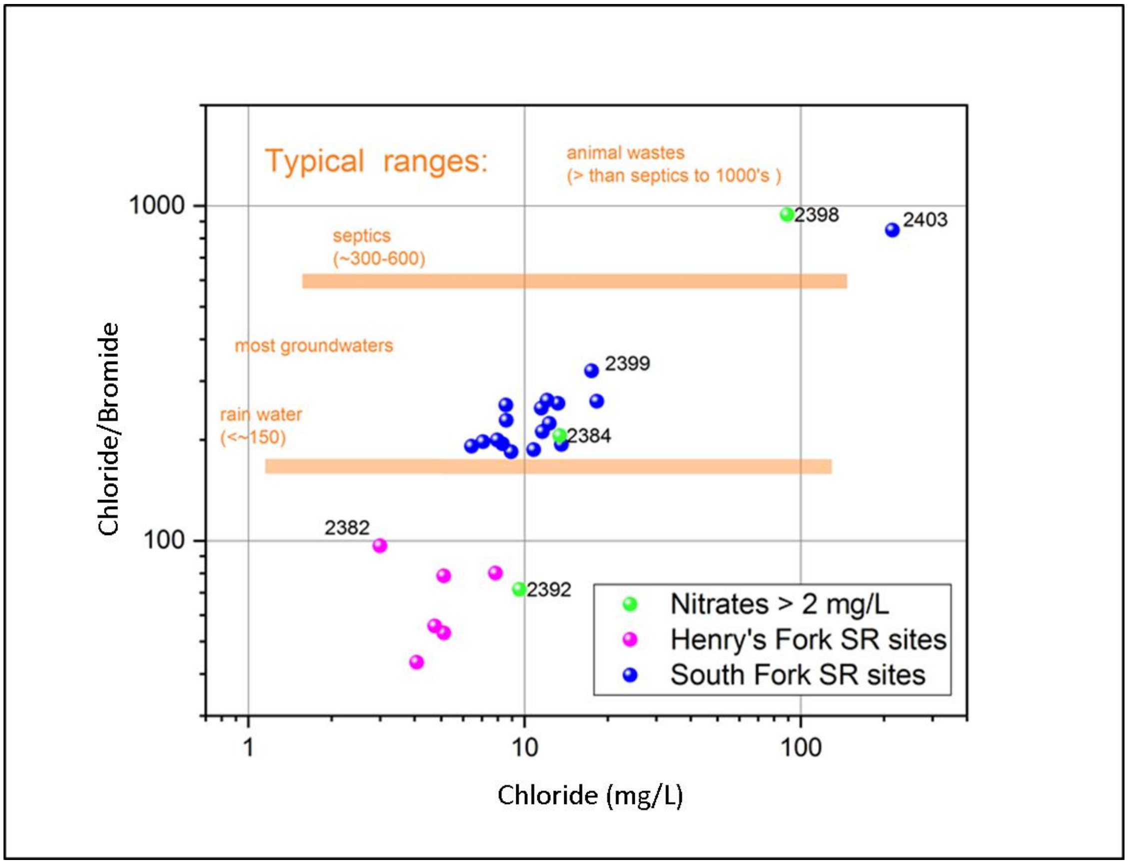


Figure 23. The 2018 Chloride/bromide versus chloride relationship—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

A dual isotope plot ($\delta^{15}N_{nitrate}$ vs $\delta^{18}O_{nitrate}$) along with the accepted ranges for typical nitrogen sources is presented in Figure 24. The sites with nitrate exceeding 2 mg/L are identified, as are sites distinguished in other plots. Sites all fall within the overlapping ranges for nitrogen from inorganic fertilizer, rain sources, and soil N or waste-related sources. Denitrification/strong waste-related sources are not indicated.

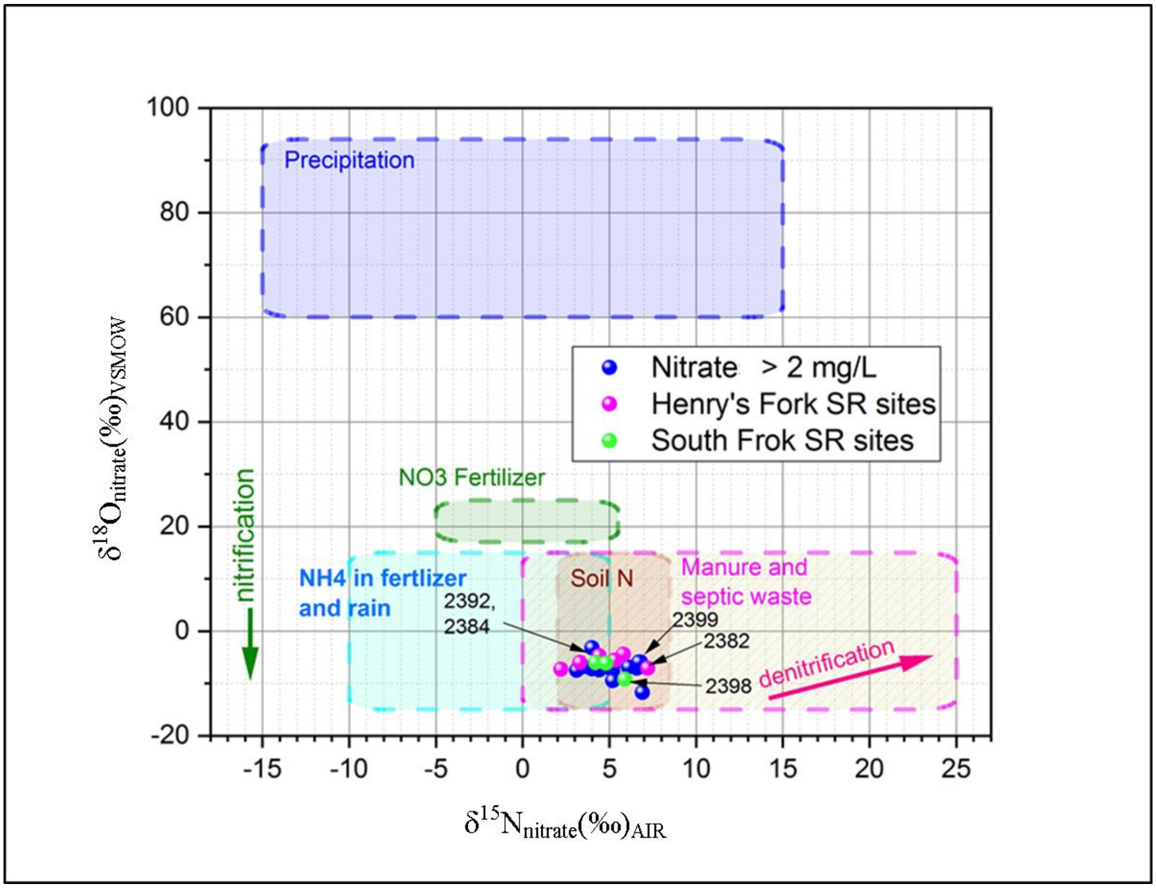


Figure 24. A plot of 2018 $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

Stable isotope results of δ^2H_{water} and $\delta^{18}O_{water}$ are presented in Table 27. A plot of δ^2H_{water} and $\delta^{18}O_{water}$ for ground water samples (Figure 25) provides an indication on the timing and potential source of recharge to ground water. Sites idenified in previous discussions are identified. Wells 2403 and 2398, previously identified in Figure 23 as having a potential waste-related or mixed source influence, are distinct from other locations, plotting along a trend that reflects ground water that has been evaporated. Well 2382 plots with heavier $\delta^{18}O_{water}$, δ^2H_{water} values, likely reflecting the isotopically heavier signature more common with snow melt/winter precipitation. The remainder of sites likely reflect an average of annual precipitation.

Table 27. Stable isotope (δ^2H_{water} and $\delta^{18}O_{water}$) results—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	δ^2H_{water} (‰)	$\delta^{18}O_{water}$ (‰)
2379	160	10/03/2018	-127.3	-17.1
2380	48	10/25/2018	-129.1	-17.4
2381	150	10/03/2018	-127.9	-17.3
2382	118	10/18/2018	-133.0	-17.8

2383	243	10/10/2018	-128.1	-17.4
2384	195	10/23/2018	-128.2	-17.1
2385	220	10/23/2018	-128.3	-17.1
2386	222	10/10/2018	-127.4	-17.1
2387	122	10/18/2018	-126.7	-17.1
2388	142	10/16/2018	-129.7	-17.6
2389	58	10/16/2018	-129.1	-17.5
2390	80	10/16/2018	-129.7	-17.6
2391	138	10/16/2018	-128.7	-17.3
2392	280	10/03/2018	-126.7	-17.1
2393	243	10/18/2018	-128.1	-17.4
2394	78	11/27/2018	-128.2	-17.3
2395	38	10/16/2018	-129.7	-17.3
2396	200	10/10/2018	-130.0	-17.4
2397	180	10/10/2018	-127.7	-17.1
2398	150	10/10/2018	-132.2	-17.3
2399	140	10/10/2018	-128.3	-17.2
2400	100	10/25/2018	-129.7	-17.4
2401	138	10/16/2018	-129.5	-17.4
2402	120	10/23/2018	-127.6	-17.0
2403	35	10/18/2018	-119.7	-14.5
2404	325	10/03/2018	-130.6	-17.3

Notes: ‰ = per mil.

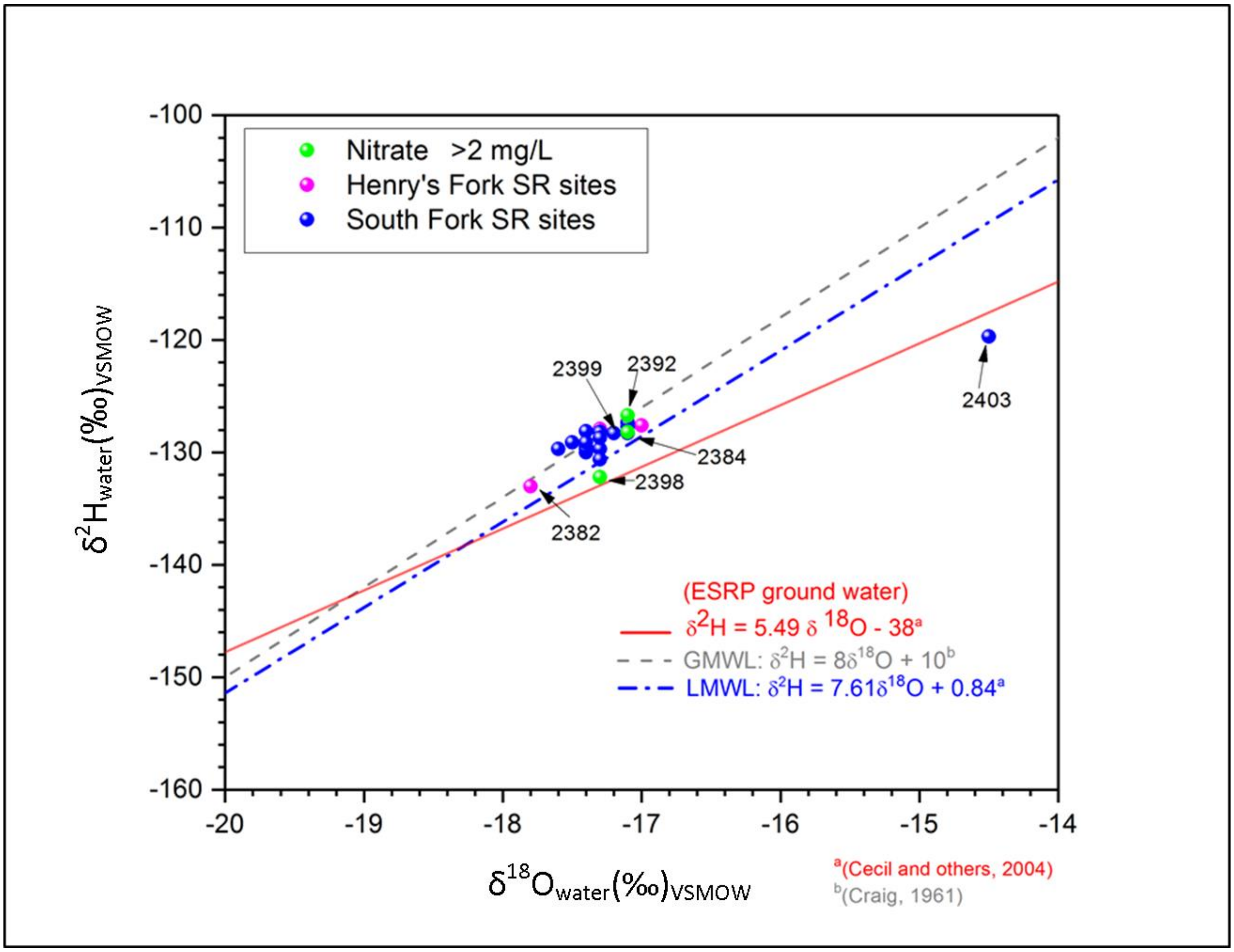


Figure 25. A plot of 2018 $\delta^{18}O_{water}$ versus $\delta^{2}H_{water}$—Eastern Snake River Plain Subarea Regional Ground Water Monitoring Project.

Comparison of 2014 and 2018 Median Nitrate Results

Regional nitrate monitoring results from 2014 and 2018 sampling were compared. For the 26 sites sampled in both time periods, the 2018 result was greater for 9 sites, and the 2014 result was greater for 14 sites, with 3 sites returning the same value for both samplings.

Results were compared to identify changes in the median nitrate value from 2014 to 2018. Box plots for nitrate values from 2014 and 2018 are presented in Figure 26. The median value for 2014 sampling was 1.10 mg/L and 1.05 mg/L for 2018. The confidence interval about the medians overlaps at the 95% confidence level. As all 2018 results have corresponding paired results from 2014, the Sign and Wilcoxon Signed-Rank tests were used to compare result pairs and medians. Both yielded test statistics concluding that the medians were not different at the 0.05 significance level (Sign Test: probability = 0.5413, Signed Rank Test: probability 0.1515).

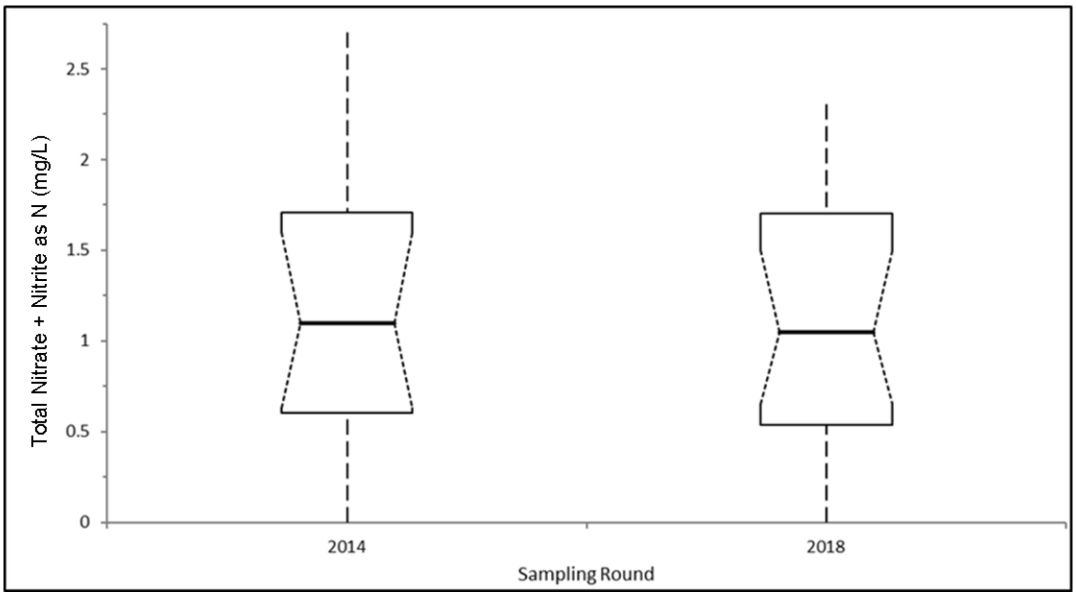


Figure 26. Box plot comparing nitrate (total nitrate + nitrite as N) values from 2014 (Round 1) and 2018 (Round 2) nitrate concentrations for ESRP regional monitoring sites—Eastern Snake River Plain Subarea Regional Ground Water Monitoring Project.

Metals and Trace Constituent Results

Arsenic was detected in 9 of 26 sites sampled with results ranging from the reporting level of 0.2 µg/L– 0.47 µg/L. The median concentration reported was 0.23 µg/L. Arsenic in ground water in Eastern Idaho has previously correlated with clays related to rhyolitic ash or ashflow tuffs in the subsurface.

Samples were analyzed for additional selected trace constituents (i.e., total organic carbon, boron, lithium, strontium, uranium) to identify possible correlations between potential nitrate sources. Results are presented in Table 28. A more complete review to identify possible correlations will be included in a technical publication to be completed at a later date.

Table 28. Metals results—Eastern Snake River Plain Subarea Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a]	Boron	Lithium	Strontium[b]
			(µg/L)			
Water Quality Standard:			10	No Standard	No Standard	1500
2379	160	10/03/2018	2.7	93.8	58.3	35.8
2380	48	10/25/2018	<2.0	51.3	29.4	370
2381	150	10/03/2018	<2.0	96.2	45.4	40.5
2382	118	10/18/2018	2.2	31.1	58.1	77.7
2383	243	10/10/2018	<2.0	48.6	33.4	444
2384	195	10/23/2018	<2.0	65.0	51.5	438
2385	220	10/23/2018	<2.0	54.9	35.3	373
2386	222	10/10/2018	2.1	37.5	12.7	253
2387	122	10/18/2018	<2.0	64.9	34.1	73.7
2388	142	10/16/2018	<2.0	46.1	31.4	333
2389	58	10/16/2018	2.3	39.8	29.4	354
2390	80	10/16/2018	<2.0	33.6	24.0	257
2391	138	10/16/2018	2.1	33.7	21.0	269
2392	280	10/03/2018	2.6	134	19.1	102
2393	243	10/18/2018	<2.0	98.3	12.7	79.3
2394	78	11/27/2018	<2.0	54.8	31.1	379
2395	38	10/16/2018	<2.0	46.2	31.2	389
2396	200	10/10/2018	<2.0	57.8	39.7	404
2397	180	10/10/2018	2.0	70.2	34.8	382
2398	150	10/10/2018	2.6	95.0	51.0	473
2399	140	10/10/2018	<2.0	54.4	31.5	472
2400	100	10/25/2018	<2.0	35.8	25.6	276
2401	138	10/16/2018	<2.0	42.7	31.3	326
2402	120	10/23/2018	<2.0	85.3	79.0	38.8
2403	35	10/18/2018	4.7	254	75.5	970
2404	325	10/03/2018	<2.0	70.1	41.1	402

Notes: µg/L = micrograms per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation (NPDWR) standard.
b. Contaminant with a "health-based reference level".

2.2.1.3 Conclusions

The 2018 ESRP regional subarea monitoring results show that regional nitrate levels remain low, with the median value slightly about 1 mg/L. The combination of potential nitrate source and general ground water source indicators; $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$, relative chloride, sulfate/chloride, chloride/bromide ratios and relationships to both nitrate and $\delta^{15}N_{nitrate}$, combined with field measurements including DO can provide some indication of potential sources. However, for the ESRP regional monitoring, given the relatively low nitrate concentrations, the power to distinguish specific sources is also limited. That given, Wells 2384 and 2392 do show a degree of impact from inorganic and mixed nitrogen sources. Wells 2398, 2399, and 2403 likely show a mixed to waste-related source of impact, based largely on the observed chloride/bromide ratio, mixed $\delta^{15}N_{nitrate}$ signature, and higher specific conductance values. Wells 2399 and 2403, with lower DO and detectable total organic carbon reported, may have a $\delta^{15}N_{nitrate}$ signature impacted by biological processes. Establishing a baseline trend for these and related indicators is valuable for recognizing potential impact sources before significant degradation.

2.2.1.4 Recommendations

DEQ will complete a technical report for this project in the future and plans to continue to monitor nitrate levels across the ESRP Subarea to improve understanding of contaminant sources.

2.2.2 Teton Valley Deep Soil Percolation and Ground Water Sampling for BMP Evaluation Project

2.2.2.1 Purpose and Background

The DEQ IFRO sampled four ground water sites in support of multi-year soil health Cover Crop Demonstration Project in cooperation with a Teton Valley-based non-profit organization *Friends of the Teton River*. Sites were selected from the nearest domestic wells to the cover crop demonstration site, approximately up gradient and down gradient of the cover crop demonstration site (Figure 27). Sites will be sampled in fall and spring through the planned three-year duration of the project, spring 2018 through spring 2021.

Sites were sampled for analytes consistent with regional nitrate monitoring and with the deep soil percolation (DSP) monitoring.

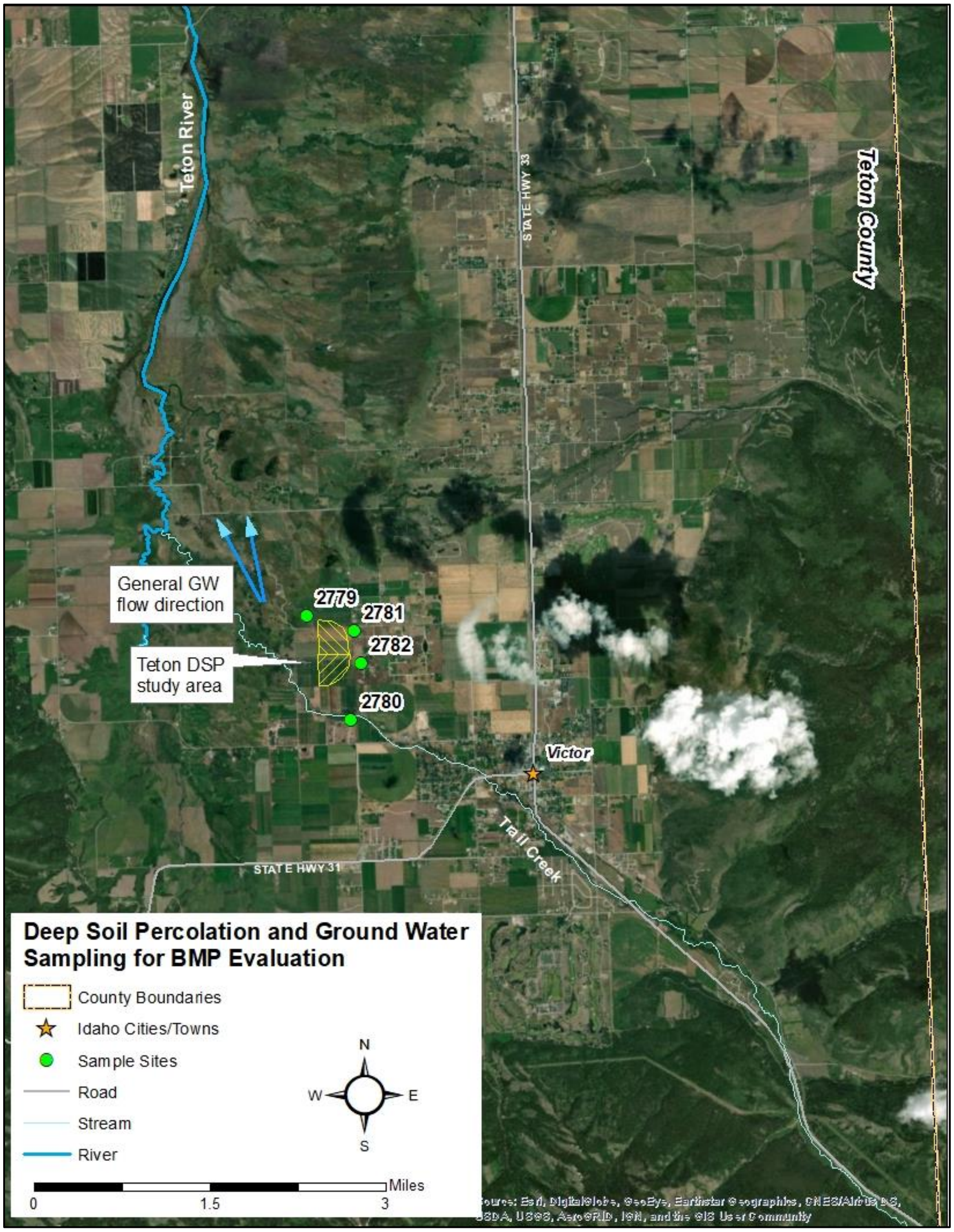


Figure 27. Sample site locations—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

Methods and Results

In October 2018, DEQ collected ground water samples from four private domestic wells located within the Teton Valley near Victor, ID. Sample locations were selected from domestic wells with available well logs. Selection favored more recent wells with complete information on well construction, well-bore seals, and lithologic descriptions, suggesting that sampled ground water would represent the shallowest aquifer zone. One of the four selected domestic wells identified as having a drilling permit on file and an issued well tag number was determined to not have a well driller's log. Permission has been obtained to video log the well and measure depth, based on well conditions encountered. Wells nearest to this location ranged in depth from 79–112 feet with open bottom-casing completions. Depth to water for these nearest wells ranges from 35–40 feet bgs.

Sites selected were the closest to the DSP study area. Well 2782 was maintained in the list of sample sites despite lack of confirmation of well depth due to proximity to the study area, similar age of construction to surrounding wells, and permission to sample. It was determined that a well permit and a tag number were issued, but a construction log was not submitted by the driller.

Samples were analyzed by IBL for common ions (i.e., Ca, Na, Mg, K, Cl, fluoride (F), SO_4), arsenic, total alkalinity, nitrite-nitrate nitrogen (nitrate), and ammonia. Samples for bacteria (TC and *E. coli*) were analyzed by IAS Environmental in Pocatello.

After receiving the major ion chemistry and nutrient results, samples for stable isotope analysis were submitted to University of Arizona for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O_{water}$ and $\delta^{2}H_{water}$). All sampling was conducted according to the regional QAPP (DEQ 2018f) and FSP (DEQ 2018g).

The University of Idaho Center for Advanced Energy Studies performed metal analysis on samples for lithium, boron strontium, and uranium, as well as total organic carbon.

Water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 29).

Table 29. Water quality field parameters—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2779	62	10/17/2018	7.40	343	7.64	8.02
2780	118	10/17/2018	7.35	383	7.60	7.92
2781	80	10/17/2018	8.03	334	7.64	8.22
2782	Unk	10/17/2018	6.79	331	7.69	8.88

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk = Unknown. Well log not found.
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 but can be applied to private wells to evaluate water quality.

Nutrient and Stable Isotope Results

The nitrate (nitrate plus nitrite) results were all below the water quality standard of 10 mg/L, ranging from 0.39 mg/L to 1.0 mg/L. Ammonia results ranged from below the reporting limit (< 0.010 mg/L) to 0.027 mg/L (Table 30). Results for $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ ranged from -131.1‰ to -132.3‰ and -17.9‰ to -18.2‰, respectively (Table 31).

Table 30. Nutrient results—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate + Nitrite[a] as N (mg/L)	Ammonia as N (mg/L)
Water Quality Standard:			10	No Standard
2779	62	10/17/2018	0.51	<0.010
2780	118	10/17/2018	1.0	0.010
2781	80	10/17/2018	0.39	<0.010
2782	Unk	10/17/2018	0.43	0.027

Notes: mg/L = milligrams per liter; Unk = Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Table 31. Stable isotope results—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	δ^2H_{water} (‰)	$\delta^{18}O_{water}$ (‰)
Water Quality Standard:			No Standard	No Standard
2779	62	10/17/2018	-131.1	-18.2
2780	118	10/17/2018	-131.6	-17.9
2781	80	10/17/2018	-132.3	-18.1
2782	Unk	10/17/2018	-132.1	-18.0

Notes: ‰ = per mil; Unk=Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

Bacteria Results

None of the four sites sampled had positive detections of *E. coli* or TC. Results are presented in Table 32.

Table 32. Bacteria Results—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water Quality Standard:			<1	1.0
2779	62	10/17/2018	<1.0	<1.0

2780	118	10/17/2018	<1.0	<1.0
2781	80	10/17/2018	<1.0	<1.0
2782	Unk	10/17/2018	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. 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 numbers) 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.

General Ground Water Chemistry Results

The four project wells were sampled for the following major ions to evaluate the general ground water chemistry: bromide, calcium, chloride, fluoride, magnesium, potassium, sodium, and sulfate. Samples were also analyzed for alkalinity (as CaCO3) and organic carbon (Table 33).

Table 33. Common ion and Total Dissolved Solids results—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Organic Carbon (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride[a] (mg/L)	Fluoride[ab] (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Water Standard:			No Standard	No Standard	No Standard	No Standard	250	2.0/4	No Standard	No Standard	No Standard	250
2779	62	10/17/2018	176	<1	<5	50	1.52	<0.20	14	0.63	1.2	7.12
2780	118	10/17/2018	192	<1	<5	57	2.37	<0.20	15	0.58	1.2	6.93
2781	80	10/17/2018	169	<1	<5	48	1.70	<0.20	14	0.56	1.1	6.99
2782	Unk	10/17/2018	165	<1	<5	48	1.67	<0.20	14	0.52	1.0	7.00

Notes: mg/L = milligrams per liter; µg/L = micrograms per liter; Unk = Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Secondary Drinking Water Regulation standard.
b. Contaminant with a National Primary Drinking Water Regulation standard.

Metals and Radionuclide Results

All sites were sampled for trace and heavy metals including: arsenic, boron, lithium, and strontium. Samples were also analyzed for the presence of uranium and were all below the detection limit. Results are provided in Table 34.

Table 34. Metals and Radionuclide results—Deep Soil Percolation and Ground Water Sampling for BMP Evaluation, Teton County SWCD, 2018 Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a]	Boron	Lithium	Strontium[a]	Uranium[a]
					(µg/L)		
Water Quality Standard:			10	No Standard	No Standard	No Standard	30
2779	62	10/17/2018	<2.0	6.62	1.55	73.2	<10
2780	118	10/17/2018	<2.0	7.37	1.53	77.7	<10
2781	80	10/17/2018	<2.0	6.43	1.54	75.1	<10
2782	Unk	10/17/2018	<2.0	11.7	1.31	69.2	<10

Notes: µg/L = micrograms per liter; Unk = Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard or a health-based reference level.

2.2.2.2 Conclusions

No conclusions have been made at this time as this is a multi-year project to evaluate nutrient flow in ground water and only initial data have been collected. Conclusions will be made when the project is complete and will be summarized in a future annual report.

2.2.2.3 Recommendations

DEQ plans to continue this multi-year project to evaluate nutrient flow in ground water. Data will be summarized in a future annual report with additional detail. Data may also be presented in a technical report to be made available at a later date.

2.3 Coeur d’Alene Region

No ground water quality projects were conducted using public funds in the Coeur d’Alene region in 2017.

2.4 Lewiston Region

Three ground water quality monitoring projects were conducted in the Lewiston region in 2018 using public funds.

2.4.1 Clearwater Plateau Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2018 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Clearwater Plateau NPA north of Grangeville, Idaho.

2.4.1.1 Purpose and Background

The objective of this project is to use an ambient ground water quality monitoring network in the Clearwater Plateau NPA to complete a multi-year trend analysis to help determine the effectiveness of the ground water quality management plan (GWQMP) in improving ground water quality in this area.

In 1998, DEQ found that 24 of 55 wells sampled (44%) had nitrate concentrations exceeding 5 mg/L, which is half the MCL of 10 mg/L (Bentz 1998). The maximum nitrate concentration reported in the 1998 study was 77.1 mg/L. The value was later determined to be caused by a point source near the wellhead and the site has not been sampled in subsequent years.

The Clearwater Plateau NPA was designated, in part, on the 1998 nitrate investigation results. In the most recent 2014 NPA ranking, the Clearwater Plateau NPA ranked as the 14th-most degraded area in the state; data used in the assessment indicated a decreasing trend in nitrate concentrations. The Clearwater Plateau NPA covers approximately 292 square miles, or 187,000 acres, of an area approximately 1,700 square miles in size north of Grangeville, known as the Clearwater Plateau. Three major rivers border the Clearwater Plateau; the Salmon River to the south, the Snake River to the west, and the Clearwater River to the north and east. Ground water beneath the plateau generally flows northeast through Miocene basalt layers that are overlain by loess ranging in thickness from tens to hundreds of feet and forms the present surface of the Palouse and occasionally in the alluvial valley aquifers and basement rocks (Hagan 2003). Well depths from ground water sampling locations ranged 12– 475 feet.

To address elevated nitrate concentrations in the Clearwater Plateau NPA, a ground water quality management (GWQM) plan was developed (DEQ and ISCC 2008). The GWQM plan encourages implementing 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 within the NPA through 2011 for implementing agricultural ground water protection BMPs (e.g., direct seed practices). Direct seed practices allow crop planting with minimal soil disturbance, which may reduce nitrogen mobility when combined with other BMPs.

DEQ initiated the Clearwater Plateau NPA ground water monitoring project (i.e., Camas Prairie project) 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 GWQM plan’s effectiveness in improving ground water quality. Nitrate concentration data are periodically evaluated to determine if ambient concentrations increase or decrease.

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 27). The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also commonly found throughout the area.

2.4.1.2 Methods and Results

In May 2018, DEQ staff sampled 12 existing project wells and 1 spring (DEQ Site ID 2677) to assess nitrate concentrations within the Clearwater Plateau NPA. Well selection was conducted with an emphasis on historically-sampled wells, well logs, homeowner permission, and spatial distribution across the project area to achieve a representative distribution.

All samples were collected according to the regional QAPP (DEQ 2017b) and FSP (DEQ 2018h). When possible, water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured at each site before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 35). Samples were collected for nitrate (nitrate-nitrite nitrogen). All samples were submitted for analysis to Anatek Labs, Moscow, Idaho. Laboratory QC checks for this project did not meet DEQ QC requirements as outlined in the QAPP, which resulted in the decision to qualify all analytical laboratory results as estimated values (as noted with a J flag) (see Tables 35–37).

Table 35. Water quality field parameters—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
199	140	05/16/2018	10.1	747	7.76	13.30
212	400	05/16/2018	9.5	454	7.86	9.01
407	475	05/09/2018	12.8	835	7.95	10.73
413	Unk	05/09/2018	11.2	430	7.19	8.97
643	145	05/09/2018	11.6	428	7.67	15.85
2587	Unk	05/16/2018	11.3	472	7.74	9.80
2669	300	05/16/2018	11.3	459	7.47	0.10
2670	300	05/09/2018	12.2	658	7.56	-
2672	Unk	05/09/2018	14.6	409	7.04	6.74
2675	12	05/16/2018	8.2	110.1	*6.10*	7.17
2677	Spring	05/09/2018	12.0	738	7.94	5.44
2678	340	05/16/2018	11.9	616	7.75	4.74

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk = Unknown. Well log not found; (-) = Not Analyzed. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
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 but can be applied to private wells to evaluate water quality.

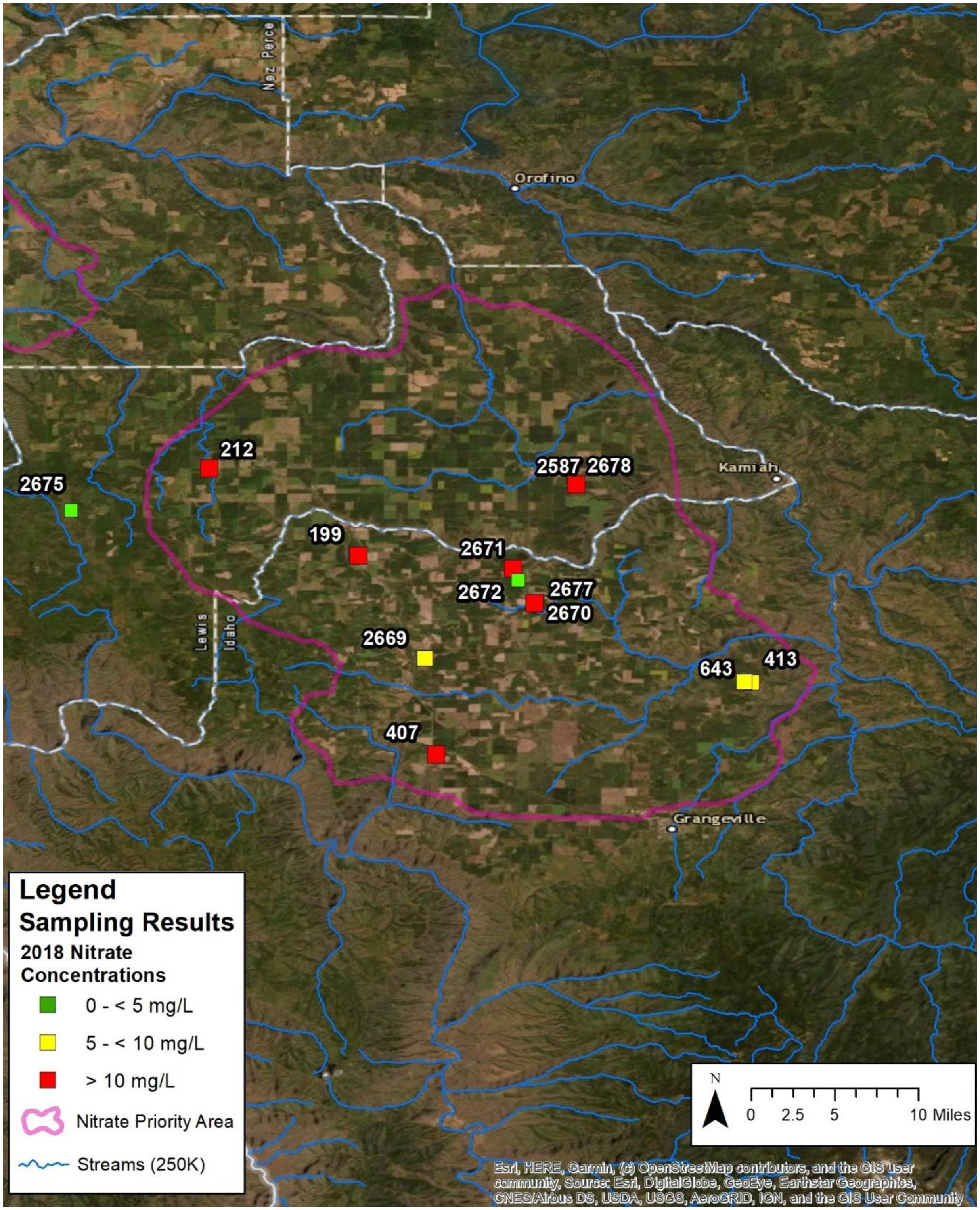


Figure 28: Sample sites and nitrate concentrations—Clearwater Plateau NPA Ground Water Monitoring Project.

Nutrient Results

Nitrate concentrations are presented in Table 36. A total of 12 wells and 1 spring were sampled as part of this project. Of 13 the sites sampled in 2018, 7 (54%) had nitrate concentrations at or above the 10 mg/L MCL and 11 (86%) had concentrations above half the MCL. All sites have been sampled as part of this project at least once previously. Eight of the 13 sites show an overall increasing trend in nitrate concentrations over their sampling history.

Well 199 experienced a significant increase in nitrate concentration from 12.7 mg/L in 2017 to 25.6 mg/L in 2018. Historically, nitrate concentrations for this site have averaged approximately 9 mg/L.

Table 36. Nutrient and nutrient-related isotope results—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration
			Nitrate + Nitrite[a] (mg/L)
Water Quality Standard:			10
199	140	05/16/2018	**25.6J**
212	400	05/16/2018	**18.5J**
407	475	05/09/2018	**32.5J**
413	Unk	05/09/2018	8.30J
643	145	05/09/2018	6.79J
2587	Unk	05/16/2018	6.05J
2669	300	05/16/2018	9.72J
2670	300	05/09/2018	**11.1J**
2671	127	05/09/2018	**23.2J**
2672	Unk	05/09/2018	3.12J
2675	12	05/16/2018	3.09J
2677	Spring	05/09/2018	**16.2J**
2678	340	05/16/2018	**12.9J**

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells. J = The analyte was detected, but the value of the result is an estimate.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Sampling at Well 407 has occurred regularly since 2008 and nitrate concentrations have varied significantly (Figure 29), ranging from 0.913 mg/L to 32.5 mg/L. The nitrate concentration in the 2018 sampling round was significantly higher at 32.5 mg/L than it has historically been. The previous maximum nitrate result was 15 mg/L in September 2011. In June 2015, this well had a 1.05 mg/L nitrate concentration, but increased significantly to 11.7 mg/L sampled in October

2017. Further investigation would be necessary to determine the cause of nitrate variability at this site.

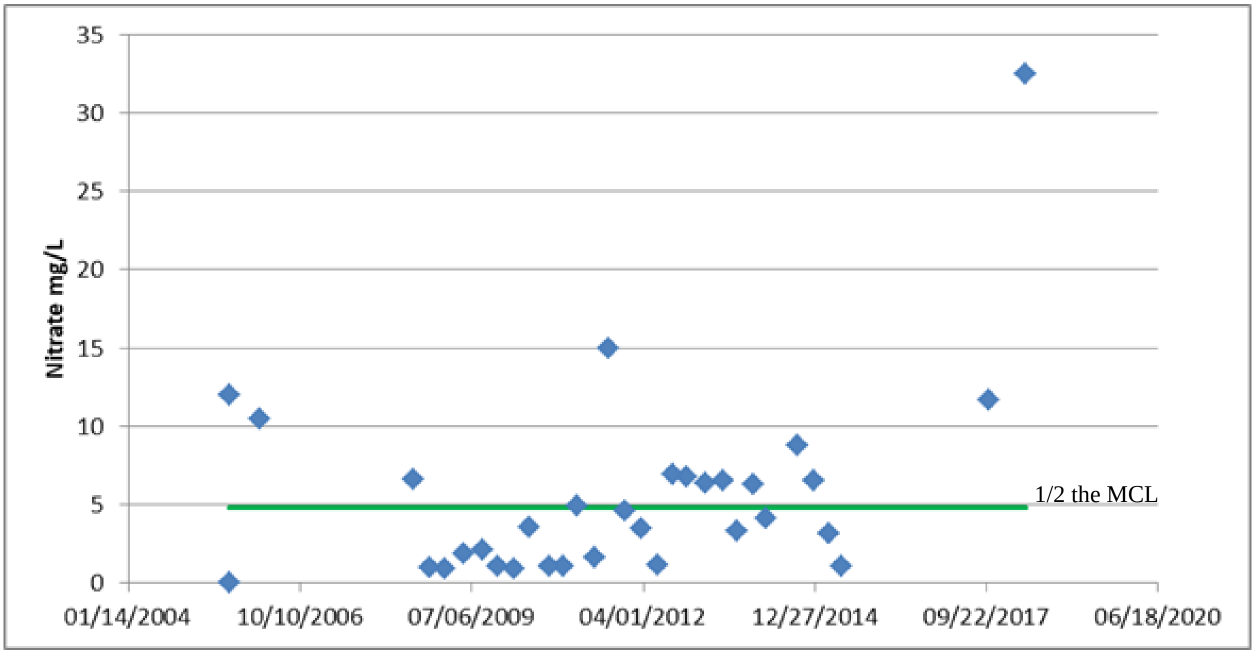


Figure 29. DEQ site 407 Nitrate Concentrations 2005–2018—Clearwater Plateau NPA Ground Water Monitoring Project.

Bacteria Results

Bacteria results are presented in Table 37. Of the 13 sites sampled, 9 had positive detections of TC bacteria. Laboratory results ranged from 2.0 to 2395.9 MPN/100 mL. *E. Coli* was detected at a concentration of 1.0 MPN/100 mL at Well 413 and the spring (DEQ Site ID 2677).

Table 37. Bacteria Results—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water Quality Standard:			<1	1.0
199	140	05/16/2018	<1	22.8J
212	400	05/16/2018	<1	18.7J
407	475	05/09/2018	<1	<1
413	Unk	05/09/2018	**1.0J**	235.9J
643	145	05/09/2018	<1	<1
2587	Unk	05/16/2018	<1	5.2J
2669	300	05/16/2018	<1	18.3J
2670	300	05/09/2018	<1	<1

2671	127	05/09/2018	<1	2.0J
2672	Unk	05/09/2018	<1	3.1J
2675	12	05/16/2018	<1	16.0J
2677	Spring	05/09/2018	**1.0J**	69.7J
2678	340	05/16/2018	<1	<1

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells. J = The analyte was detected, but the value of the result is an estimate.
a. 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 numbers) 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.

General Ground Water Chemistry Results

The project wells were sampled for the following major ions to evaluate the general ground water chemistry and to continue to build a dataset for future analysis: bromide, calcium, chloride, magnesium, potassium, sodium, and sulfate. Samples were also analyzed for alkalinity (as CaCO3) and bicarbonate. Elevated sulfate appears to correlate with elevated nitrate, as all samples with a nitrate concentration greater than 10 mg/L also had a sulfate concentration greater than 30 mg/L.

All sample results were below any set primary or secondary drinking water standard and are presented in Table 38. A Piper diagram was prepared to identify variation in water quality and ion composition of samples (Figure 30). Results suggest dominant magnesium bicarbonate composition and generally high calcium and bicarbonate.

Table 38. Common Ion and Total Dissolved Solids Results—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Chloride (mg/L)[a]	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Water Quality Standard:			No Standard	No Standard	No Standard	250	No Standard	No Standard	No Standard	250
199	140	05/16/2018	<5	182J	59.5J	36.5J	18.0J	2.59J	60.7J	40.3J
212	400	05/16/2018	<5	116J	46.8J	4.19J	15.1J	3.87J	14.6J	34.5J
407	475	05/09/2018	<5	268J	108J	6.86J	27.1J	1.56J	33.8J	50.9J
413	Unk	05/09/2018	<5	172J	47.2J	2.34J	17.4J	2.46J	19.2J	18.9J
643	145	05/09/2018	—	—	47.4J	3.84J	16.1J	2.41J	22.4J	14.1J
2587	Unk	05/16/2018	<5	212J	46.5J	2.04J	13.9J	1.56J	33.9J	12.6J
2669	300	05/16/2018	<5	172J	46.2J	7.33J	17.3J	3.94J	21.0J	17.4J
2670	300	05/09/2018	<5	230J	50.1J	8.37J	19.4J	4.97J	49.6J	34.0J
2671	127	05/09/2018	<5	264J	101J	102J	33.1J	2.14J	66.6J	70.3J
2672	Unk	05/09/2018	<5	180J	41.3J	3.58J	13.4J	1.26J	28.7J	15.4J
2675	12	05/16/2018	<5	22J	9.67J	2.30J	2.86J	1.13J	4.79J	10.1J
2677	Unk	05/09/2018	<5	258J	49.5J	14.4J	16.7J	0.580J	81.5J	52.9J
2678	340	05/16/2018	<5	242J	66.1J	4.35J	23.1J	4.39J	33.1J	32.4J

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = The analyte was detected, but the value of the result is an estimate.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

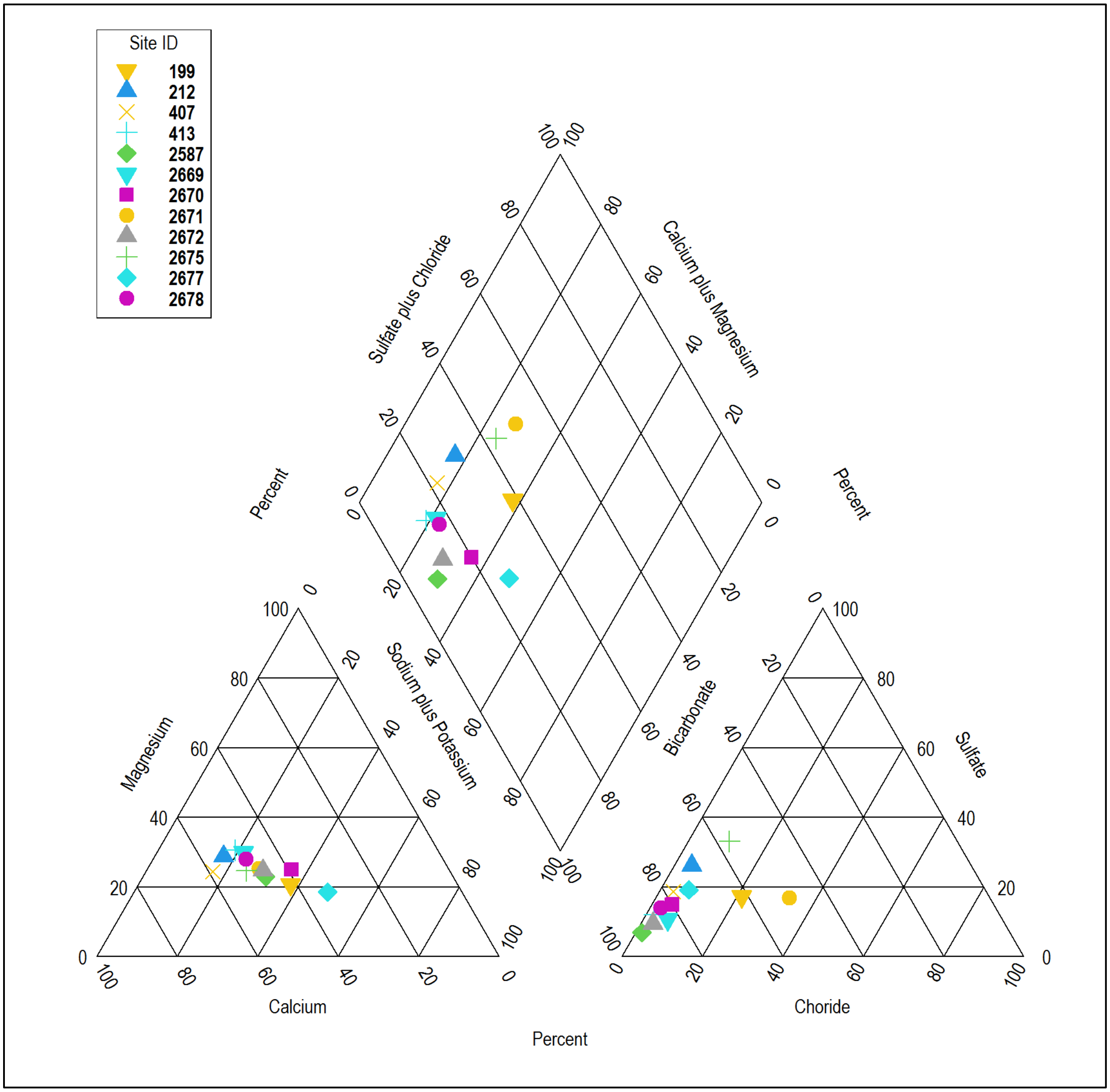


Figure 30. Piper diagram presenting variation in ground water quality—Clearwater Plateau NPA Ground Water Monitoring Project, 2018.

2.4.1.3 Conclusions

The objective of this project is to use an ambient ground water quality monitoring network in the Clearwater Plateau NPA to complete a multi-year trend analysis. This long-term monitoring will help determine the effectiveness of the GWQM plan in improving ground water quality in this area. The Clearwater Plateau NPA is identified as an area experiencing nitrate impact to ground water based on historic sampling. Analytical results of the sites sampled show that 7 of 13 sites (54%) had nitrate concentrations at or above the 10 mg/L MCL. Nitrate concentrations were equal to or above half of the MCL for 11 of 13 (85%) of samples in 2018. DEQ site 407 shows nitrate levels that are significantly higher than any that have been previously recorded for that site.

Median annual nitrate concentrations measured for the Clearwater Plateau NPA ground water monitoring project range from 5.5 mg/L to 12 mg/L. The 2018 sampling results show a significant overall increase in median nitrate levels compared to prior sampling rounds (Figure 31). The reduction in number of samples compared to previous sampling rounds, in addition to nitrate concentrations increasing by a factor of 2 or more in two of the wells (15% of samples), may have resulted in the increase in median nitrate concentration. Many of the wells that were not captured in this 2018 sampling round, but were included in the previous round, were generally lower in concentration. The exclusion of the lower concentration wells may have caused the increased the median for 2018.

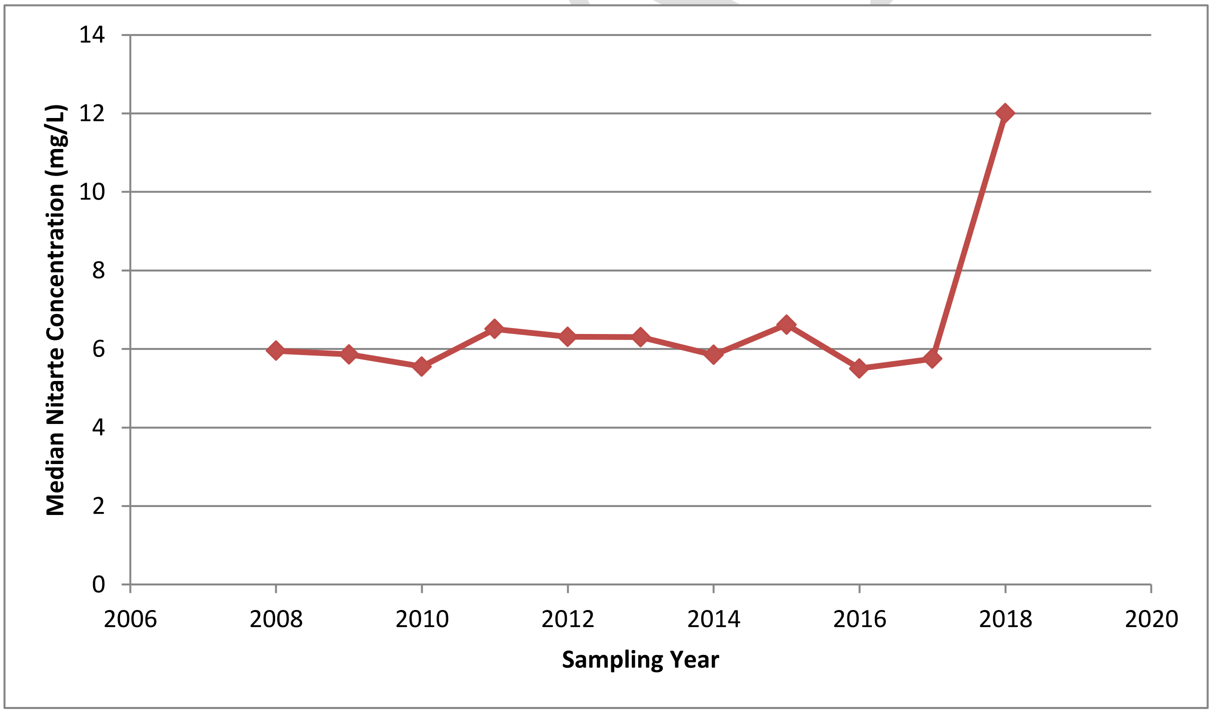


Figure 31. Median nitrate concentration by year—Clearwater Plateau NPA Ground Water Monitoring Project.

2.4.1.4 Recommendations

Continue this long-term ground water quality monitoring to determine the effectiveness of the GWQM plan in improving ground water quality in this area. Resampling will occur in 2019 to investigate the anomalously high median nitrate value.

2.4.2 Lindsay Creek Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2018 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Lindsay Creek NPA near Lewiston, Idaho.

2.4.2.1 Purpose and Background

In 2008, the Lindsay Creek NPA was first designated as an NPA based on ground water quality data from the IDWR, ISDA, United States Geological Survey, and DEQ. The NPA encompasses the Lindsay and Tammany Creek watersheds. The 2007 Lindsay Creek total maximum daily load determined that ground water base flow is a nitrogen contributor to Lindsay Creek and required a reduction in nitrogen load (DEQ 2007).

The goal of the Lindsay Creek NPA Ground Water Monitoring Project (previously referred to as the Tammany and Lindsay Creeks Ground Water Monitoring Project) is to create an ambient ground water quality monitoring network to complete a multi-year trend analysis that detects nitrate changes in ground water in the Lindsay Creek NPA and 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 (Figure 32). 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 preexisting topography during the Miocene era (Stevens et al. 2003). A thin layer of loess forms the present-day land surface of 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 locations ranged from 150feet 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 total maximum daily load (DEQ 2010).

DEQ collected ground water quality data from 14 wells and/or springs as part of an ambient ground water quality monitoring network from 2010 to 2016. Nitrate concentrations from these samples were analyzed to determine if seasonal or spatial trends exist in the monitoring network in addition to monitoring long-term regional changes. Anomalous nitrate concentrations were addressed as isolated or localized situations and dropped from the ambient network, if needed.

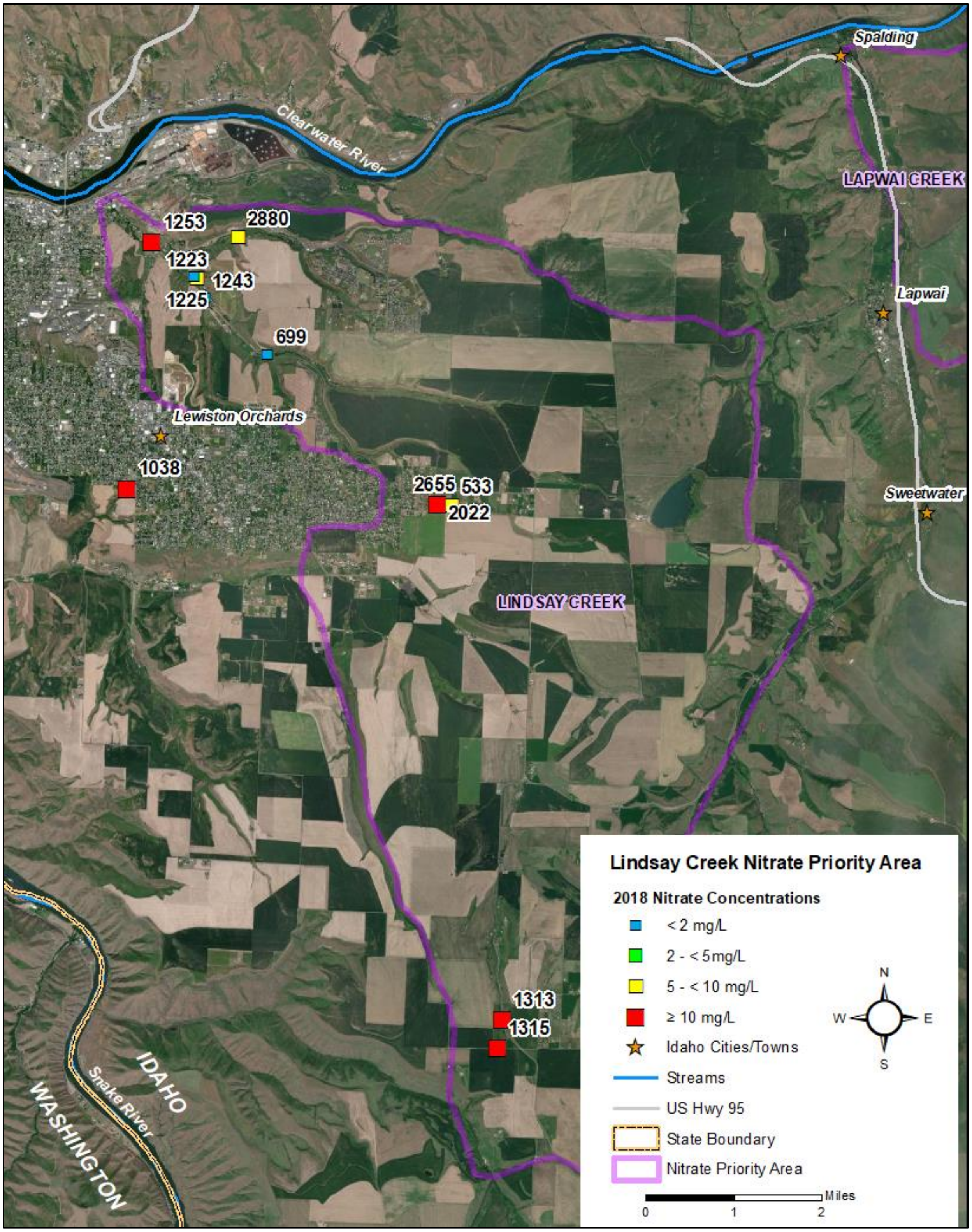


Figure 32. Sampled sites and nitrate results—Lindsay Creek NPA Ground Water Monitoring Project, 2018.

2.4.2.2 Methods and Results

In September and October of 2018, DEQ sampled 12 sites (11 wells and 1 spring) as part of the Lindsay Creek NPA project. Site selection was conducted with an emphasis on historically-sampled wells, well logs, homeowner permission, and spatial distribution across the project area to achieve a representative distribution

Samples were collected for nitrate (nitrate-nitrite nitrogen) and bacteria (TC and *E. coli*) in accordance with the QAPP (DEQ 2017b) and the FSP (DEQ 2018i). All samples were submitted for analysis to Anatek Labs, Moscow, Idaho. Laboratory QC checks for this project did not meet DEQ QC requirements as outlined in the QAPP, which resulted in the decision to qualify all analytical laboratory results as estimated values (as noted with a J flag) (see Tables 41-43). In addition to the nitrate and bacteria sampling typically included in NPA project sampling, the project also collected common ion data. These samples were included with the goal of further identifying and differentiating between aquifer sources in the future.

Water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 39).

Table 39. Water quality field parameters—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
533	225	09/10/2018	14.7	1021	7.98	13.27
699	285	09/11/2018	19.0	387	8.06	5.13
1038	150	09/11/2018	13.4	1342	7.92	12.07
1223	20	09/11/2018	17.0	582	8.32	0.11
1225	16	09/10/2018	14.7	918	7.25	8.72
1243	15	09/11/2018	19.9	580	8.33	0.26
1253	56	09/10/2018	14.0	1211	7.27	4.07
1313	Unk	09/11/2018	15.7	650	7.64	9.47
1315	589	09/11/2018	13.4	6.21	7.70	14.26
2022	950	09/10/2018	18.4	244	*8.64*	1.60
2655	203	09/10/2018	13.9	970	7.86	12.67
2880	Spring	09/10/2018	14.4	1095	8.10	10.65

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk=Unknown. Well log not found; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
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 but can be applied to private wells to evaluate water quality.

Nitrate Results

Nitrate results are presented in Table 40. Of the 11 wells and 1 spring sampled, 5 (45%) exceeded the MCL of 10 mg/L and 8 (67%) exceeded half the MCL, or 5 mg/L. Well 2880 (a spring) was the only new site added for 2018; all other sites have been sampled at least once historically. The median nitrate results for 2017 and 2018 are 6.94 and 9.32 mg/L, respectively (Figure 32), with the average nitrate concentration increasing from 6.26 mg/L in 2017 to 7.62 mg/L in 2018. While the majority of the wells that were sampled both in 2017 and 2018 showed nitrate concentrations above the MCL, most of the sites that were sampled during both years displayed a decreasing nitrate concentration However, nitrate concentrations increased in samples from Wells 1315, 1313, and 1253. Future reports will include a more detailed comparison of nitrate results by year for previous sampling rounds.

Table 40. Nutrient and nutrient-related isotope results—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration Nitrate + Nitrite[a] (mg/L)
Water Quality Standard:			10
533	225	09/10/2018	9.88J
699	285	09/11/2018	<0.05
1038	150	09/11/2018	**10.0J**
1223	20	09/11/2018	<0.05
1225	16	09/10/2018	7.15J
1243	15	09/11/2018	<0.05
1253	56	09/10/2018	**10.3J**
1313	Unk	09/11/2018	**12.1J**
1315	589	09/11/2018	**16.2J**
2022	950	09/10/2018	<0.05
2655	203	09/10/2018	**10.2J**
2880	NA	09/10/2018	9.26J

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells. J = The analyte was detected, but the value of the result is an estimate.
a. Contaminant with a National Primary Drinking Water Regulation standard.

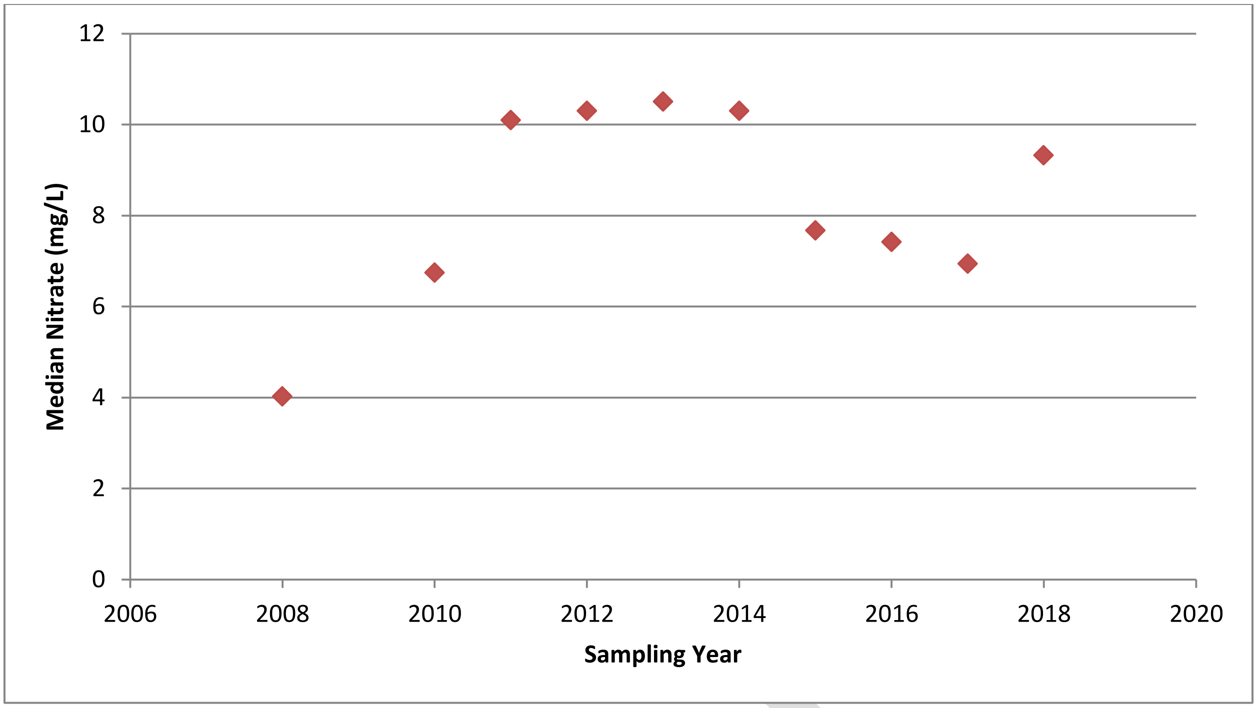


Figure 33. Comparison of median nitrate results by sampling year—Lindsay Creek NPA monitoring project.

Bacteria Results

Bacteria results are represented in Table 41. Of the 12 sites sampled, 6 (50%) had positive detections of TC bacteria. Concentrations ranged from 2.0 to 156.5 MPN/100. *E. Coli* was detected once at a concentration of 5.2 MPN/100 in Well 1313. This well also had the highest concentration of TC. The construction of this well is unknown.

Table 41. Bacteria Results—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a] *E. coli* (MPN/100 mL)	Bacteria Concentrations[a] Total Coliform (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
533	225	09/10/2018	<1	<1
699	285	09/11/2018	<1	<1
1038	150	09/11/2018	<1	<1
1223	20	09/11/2018	<1	<1
1225	16	09/10/2018	<1	33.2J
1243	15	09/11/2018	<1	2.0J
1253	56	09/10/2018	<1	<1
1313	Unk	09/11/2018	**5.2J**	156.5J
1315	589	09/11/2018	<1	3.1J

2022	950	09/10/2018	<1	2.0J
2655	203	09/10/2018	<1	<1
2880	Unk	09/10/2018	<1	5.1J

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells. J = The analyte was detected, but the value of the result is an estimate.
a. 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 numbers) 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.

General Ground Water Chemistry Results

The project wells were sampled for the following major ions to evaluate the general ground water chemistry: bromide, calcium, chloride, magnesium, potassium, sodium, and sulfate. Samples were also analyzed for alkalinity (as CaCO3) and bicarbonate. All sample results were below any set primary or secondary drinking water standard and are presented in Table 42.

The higher nitrate concentrations are associated with higher sulfate and chloride concentrations.

A Piper diagram was prepared to identify variation in water quality and ion composition of samples (Figure 34). The close proximity and similar depths of Wells 533 and 2655 likely explains their similar water chemistries. Both have mixed water chemistry with no dominant cations and ions. Water chemistry for the deepest well, Well 2022, plotted near the cusp of mixed, sodium carbonate type. Well 1225 plots with a mixed, magnesium bicarbonate type. Mixing of ground water and precipitation and/or surface water infiltration is likely due to the well’s shallow depth of 16 feet.

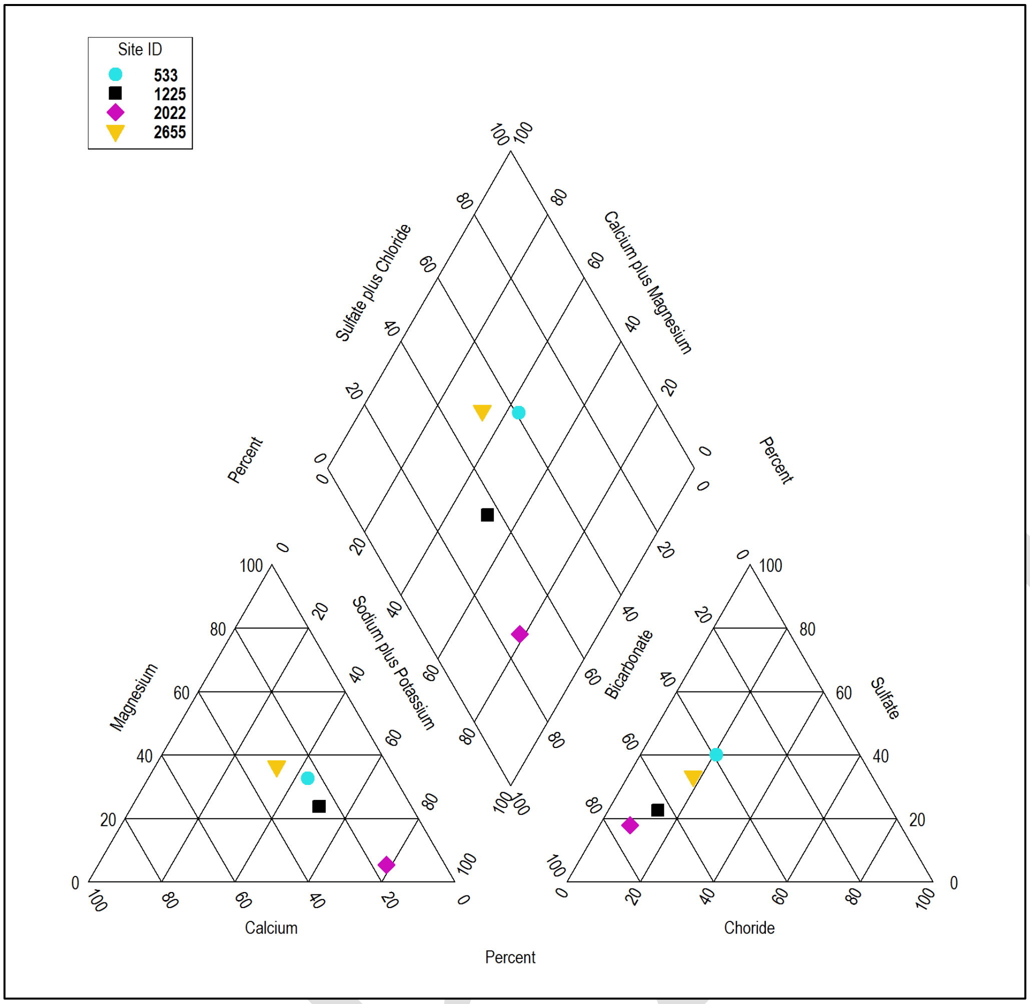


Figure 34. Piper diagram presenting variation in ground water quality—Lindsay Creek NPA Ground Water Monitoring Project.

Table 42. Common ion results—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Bicarbonate (mg/L)	Bromide (mg/L)	Calcium (mg/L)	Chloride[a] (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate[a] (mg/L)
Water Quality Standard:			No Standard	No Standard	No Standard	No Standard	250	No Standard	No Standard	No Standard	250
533	225	09/10/2018	<5	231J	<1	51.3J	71.0J	42.8J	8.45J	102J	187J
1225	16	09/10/2018	<5	316J	<1	49.5J	39.1J	28.5J	8.68J	110J	88.4J
1253	56	10/02/2018	<5	468J	0.365J	—	44.8J	—	—	—	107J
2022	950	09/10/2018	<5	92.0J	<1	8.25J	6.02J	1.72J	4.78J	43.6J	17.6J
2655	203	09/10/2018	<5	264J	<1	61.8J	56.1J	44.8J	4.90J	74.0J	142J
2880	Unk	09/10/2018	—	—	—	71.6J	—	52.7J	9.00J	82.9J	—
2880	Unk	10/02/2018	<5	240J	0.958J	—	87.0J	—	—	—	194J

Notes: mg/L = milligrams per liter; Unk=Unknown. Well log not found; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = The analyte was detected, but the value of the result is an estimate.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

2.4.2.3 Conclusions

The objective of this ongoing project is to use an ambient ground water quality monitoring network in the Lindsay Creek NPA to complete a multi-year trend analysis for nitrate.

DEQ conducted an annual sampling round in the Lindsay Creek NPA to assess nitrate concentrations and evaluate ground water quality. The Lindsay Creek NPA is identified as an area experiencing nitrate impact to ground water based on historic sampling. Of the 11 wells and 1 spring sampled, nearly half (45%) exceeded the MCL of 10 mg/L and 8 of 12 (67%) were equal to or greater than half the MCL of 5mg/L. One well had a detection of *E. Coli* bacteria.

Tracking trends in ambient nitrate ground water concentration due to changes in land uses or source controls will be accomplished by comparing Concentrations over multiple years. This comparison will assist in determining nitrate concentration variability due to changes in cropping patterns, fertilizer application, nitrogen uptake by crops due to growing season conditions, and leaching rates related to the amount and timing of precipitation available to mobilize nitrogen below the crop root zone.

2.4.2.4 Recommendations

Yearly monitoring of wells and springs in the Lindsay Creek NPA should continue to enhance the ambient ground water quality data set. Continuing to develop the ambient ground water quality data set allows DEQ to track multi-year trends, specifically for nitrate. For future annual NPA monitoring, outlier tests and common ion chemistry could be used to determine if samples represent ambient conditions and to monitor long-term trends in ground water quality. Wells yielding nitrate concentrations or other parameters inconsistent with the ambient conditions should be evaluated to determine if they represent the impacted aquifer. Nitrogen isotope analysis should be included in future sampling efforts to help determine sources of nitrate.

DEQ recommends future sampling efforts at locations with low DO concentrations include ammonia. It is also recommended that staff determine if well modifications (for example, deepening) have been made to wells sampled by DEQ over the past 30 years.

2.4.3 DEQ Site 1038 Nitrate Investigation

2.4.3.1 Purpose and Background

DEQ site 1038, located in Lewiston, ID, is a well that has been sampled as part of the Lindsay Creek NPA Ground Water Monitoring Project since 2010 (Figure 31). The site was sampled quarterly from 2010 to 2015 and annually in 2016 and 2017. Between 2010 and 2016, nitrate concentrations at this site ranged from 6.54 mg/L to 8.37 mg/L (Figure 35). During annual sampling in June 2017, the nitrate concentration at site 1038 was 13.8 mg/L, exceeding the EPA MCL of 10 mg/L as well as the site’s historical high of 8.37 mg/L. After receiving the results, the well owner contacted DEQ with concerns about the nitrate levels. The well provides the source water for individuals residing at the home, including an infant. A few weeks before the time of sampling, the City of Lewiston had informed the well owner of a sewage pump station that had been overflowing for an unknown amount of time approximately 700 ft. uphill from the well.

The well is situated behind and downhill from the residence in a basin next to a creek. The well was completed on August 22, 2000 to a depth of 150 ft bgs. The 8-inch diameter casing has a depth of 19 ft. and has a screened opening from 10 to 150 ft. below land surface. The depth to water was 60 ft. at the time of drilling. All construction information was gathered from the well driller's log.

DEQ collected quarterly follow-up samples to confirm that the fluctuation in nitrate concentrations was not due to seasonal variation or other factors and to provide the well owner with information concerning the water quality at the site.

2.4.3.2 Methods and Results

Monitoring was conducted solely at site 1038 because no other wells in the proximity were accessible.

All samples were collected according to the regional QAPP (DEQ 2017b) and FSP (DEQ 2018j). Samples were collected for nitrate (nitrate-nitrite nitrogen), TC, and *E. coli*. All samples were submitted for analysis to Anatek Labs in Moscow, Idaho. Laboratory QC checks for this project did not meet DEQ QC requirements as outlined in the QAPP, which resulted in the decision to qualify all project results as estimated values (as noted with a J flag) (see Tables 43 and 44). Water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured at each sampling event before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer. Field parameter results are presented in Table 43.

Table 43. Water quality field parameters—DEQ Site 1038 Nitrate Investigation Monitoring Project.

DEQ Site ID	Well Depth	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1038	150	03/14/2018	12.6	1530	7.95	9.61
1038	150	06/19/2018	13.1	1143	7.94	12.13
1038	150	09/11/2018	13.4	1342	7.92	12.07

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk=Unknown. Well log not found; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded.
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 but can be applied to private wells to evaluate water quality.

Nutrient Results

Nitrate results are presented in Table 44. DEQ responded to the well owner's concern about the June 2017 sampling results by collecting a follow-up sample on November 17, 2017. The resulting nitrate concentration decreased to 12.4 mg/L, but was still above the drinking water MCL. The well owner collected a sample on January 12, 2018, and DEQ collected the next two quarterly samples in March and June 2018 with nitrate concentrations of 11.1 mg/L and 10.1 mg/L, respectively.

Site 1038 was later sampled as part of the Lindsay Creek NPA annual monitoring project in September, 2018. Although minor, a decrease in nitrate concentration was again observed. The nitrate concentration in this sample was 10 mg/L, and only 0.1 mg/L less than the June 2018 sample.

Table 44. Nutrient and nutrient-related isotope results—1038 Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration
			Nitrate + Nitrite[a] (mg/L)
Water Quality Standard:			10
1038	150	03/14/2018	**11.1J**
		06/19/2018	**10.1J**
		09/11/2018	**10.0J**

Notes: mg/L = milligrams per liter. Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells. J = The analyte was detected, but the value of the result is an estimate.
a. Contaminant with a National Primary Drinking Water Regulation standard.

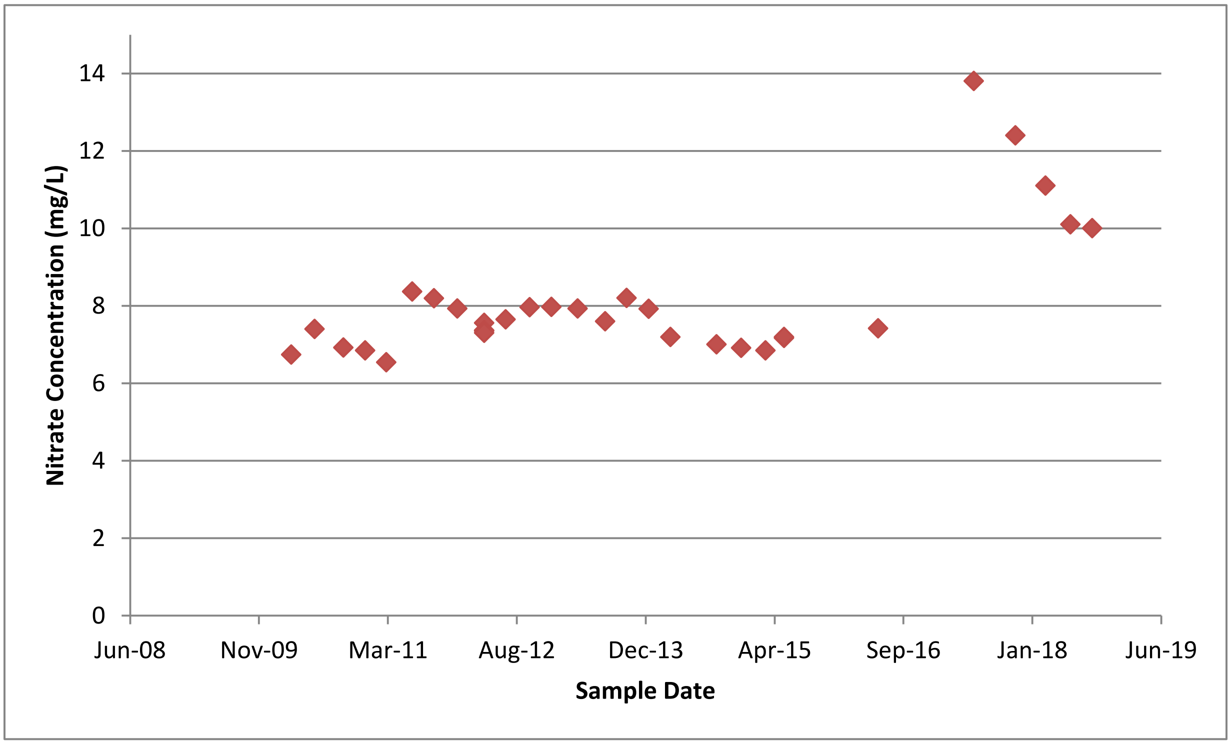


Figure 35: Nitrate (Nitrate + Nitrite) concentration results from 2010 to 2018—DEQ site 1038 Nitrate Investigation.

Bacteria Results

Bacteria results are presented in Table 45. TC results showed less than 1 MPN/100 mL in March and September, but had increased TC in June at 816.4 MPN/100 mL. There were no detections of *E. Coli* during the 2018 sampling events.

Table 45. Bacteria Results—1038 Nitrate Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
1038	150	03/14/2018	<1	<1
1038	150	06/19/2018	<1	816.4J
1038	150	09/11/2018	<1	<1

Notes: MPN/100 mL = most probable number per 100 milliliters; J = The analyte was detected, but the value of the result is an estimate.
a. 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 numbers) 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.

2.4.3.3 Conclusions

With continual decline in nitrate concentrations observed in quarterly samples, DEQ has reason to conclude that this was likely an isolated incident that did not occur due to seasonal variation. It is probable that the overflow of sewage near the well site in the weeks before the 2017 sampling contributed to the increase in nitrate levels. The apparent decrease in nitrate concentration is likely due to natural attenuation, decreasing contamination in Well 1038.

2.4.3.4 Recommendations

Continued quarterly monitoring does not appear to be necessary at this time. DEQ site 1038 will continue to be monitored annually as part of the Lindsay Creek NPA Ground Water Monitoring Project.

2.5 Pocatello Region

In 2018, the DEQ Pocatello regional office conducted a ground water quality monitoring project to monitor the extent of a historical ethylene dibromide (EDB) plume using public funds.

2.5.1 Ethylene Dibromide Assessment Project

2.5.1.1 Purpose and Background

This project is a follow up assessment of an area of known ethylene dibromide (EDB), also known as 1,2 Dibromomethane, contamination in Bannock and Power Counties, north and west of Chubbuck, Idaho (DeJongh, 1996; Safford, 2005). Dibromochloropropane (DBCP), a soil fumigant formerly used in agriculture was also included in the analyses. This sampling effort sought to assess the current state of EDB contamination, south of Reservation Road and west of Philbin Road (Figure 35). In order to maximize the return on water quality information, the 2018 sampling campaign focused on a subset of the wells sampled in 2004 and 2005, southeast of the reservation boundary where EDB was detected. These data will provide guidance for future sampling. No synoptic sampling of the wells off of the reservation has been conducted since 2005, and potentially impacted residents are generally unaware of the current state of ground water contamination in the area.

EDB is a chemical manufactured for use as a solvent, waterproofing agent, chemical intermediate in the synthesis of dyes and pharmaceuticals, and as a precursor in the synthesis of vinyl chloride. It is also used in the treatment of felled logs for bark beetle and control of wax moths in beehives. Before leaded gasoline was phased out in the United States, the primary use of EDB was as an anti-knock compound. In the 1970s and early 1980s, EDB was used as a pesticide in row crops and orchards and as a soil fumigant on golf courses. By 1984, EPA regulations had eliminated most of the use of EDB as a pesticide. However, EDB is still manufactured for other purposes (HHS, 2005).

In 1993, EDB was detected in the drinking water supply of the Fort Hall Indian Reservation at levels exceeding the MCL of 0.05 micrograms per liter (µg/L). Further ground water sampling showed that EDB was found in drinking water supplies in an area encompassing about 63 square miles, both on and off the reservation. The plume of EDB in north Bannock County is presumed to have originated on the Fort Hall Indian Reservation where EDB was applied as a pesticide in row crops. In the late 1990s, the EPA conducted a Phase I Site Assessment on the reservation in an effort to locate a point-source of EDB. No point-source was found and the site was never listed on the EPA's National Priority List. No known pesticide applications of EDB occurred outside the exterior boundaries of the reservation, but EDB contamination of private and public water supplies continues in the area south and east of the reservation boundary in northwestern Bannock County and northeastern Power County (Safford, 2005).

Apparent concentrations of this relatively insoluble compound can be affected by the length and position of the screened interval within a well and samples from adjacent wells may indicate significantly different levels of contamination, potentially interfering with characterization of the plume. The volatility of the compound makes the collection of a representative sample more difficult and the very low drinking water standard makes sampling by the well owner generally unadvisable. Residents in the impacted area are reliant on DEQ for reliable information regarding their potential exposure to this compound.

The study area is located in north Bannock County and eastern Power County in southeast Idaho (Figure 36). The American Falls Reservoir lies 2–3 miles to the northwest and the Portneuf River is within the study area. The Fort Hall Indian Reservation borders the area to the north and west.

Land use is semi-rural residential surrounded by agricultural uses; heavy industrial areas are located to the southwest.

Two primary aquifers exist in the study area. The shallower aquifer is composed of sand and gravel (Michaud Gravel), whereas the deeper aquifer is in the ESRP basalt. For wells used in the 2005 study, driller's logs indicate that sand and gravel wells are drilled to depths between 65 feet and 186 feet bgs, and basalt wells are drilled to depths between 160 feet and 204 feet bgs. Mean depth to ground water is 64.82 feet (Safford, 2005). Ground water flow in the area is generally to the southwest (Parliman and Young, 1992).

2.5.1.2 Methods and Results

A total of 21 sites were sampled in 2018 for EDB and DBCP. Samples were sent to the lab for analysis. In order to maximize the return on water quality information, the 2018 sampling campaign focused on those sites, southeast of the reservation boundary, at which EDB had previously been detected, allowing for comparisons against the previous detections. The resultant data will provide guidance for additional sampling in subsequent data collection efforts. All sampling was conducted in accordance with the project QAPP (DEQ 2011c) and the FSP (DEQ 2018k).

Water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 46).

Table 46. Water quality field parameters—Ethylene Dibromide Assessment Project Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2617	Unk	09/25/2018	14.25	573	7.39	4.97
2619	Unk	10/01/2018	13.11	632	7.36	6.01
2787	148	09/26/2018	13.79	653	7.41	4.73
2788	135	09/25/2018	14.36	890	7.34	3.70
2789	180	09/27/2018	14.51	579	7.55	6.15
2790	180	09/27/2018	13.92	588	7.52	5.62
2791	190	09/26/2018	13.36	584	7.55	5.77
2792	140	10/01/2018	14.64	585	7.44	5.61
2793	Unk	10/02/2018	13.77	678	7.26	6.76
2794	Unk	09/26/2018	13.74	723	7.38	6.10
2795	Unk	09/25/2018	14.36	569	7.47	7.29
2796	Unk	09/25/2018	15.30	773	7.29	3.01
2799	204	09/27/2018	12.16	503	7.58	4.58
2800	148	09/27/2018	14.44	584	7.44	5.98
2801	Unk	10/02/2018	13.75	651	7.32	6.25
2802	60	10/02/2018	14.03	585	7.53	5.54
2804	Unk	09/27/2018	14.47	586	7.42	5.63

2869	65	09/27/2018	13.79	564	7.41	5.79
2873	160	09/26/2018	12.86	558	7.58	4.62
2876	Spring	10/17/2018	13.33	585	7.54	5.84
2877	Unk	10/17/2018	13.07	581	7.40	3.91

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk=Unknown. Well log not found.

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 but can be applied to private wells to evaluate water quality.

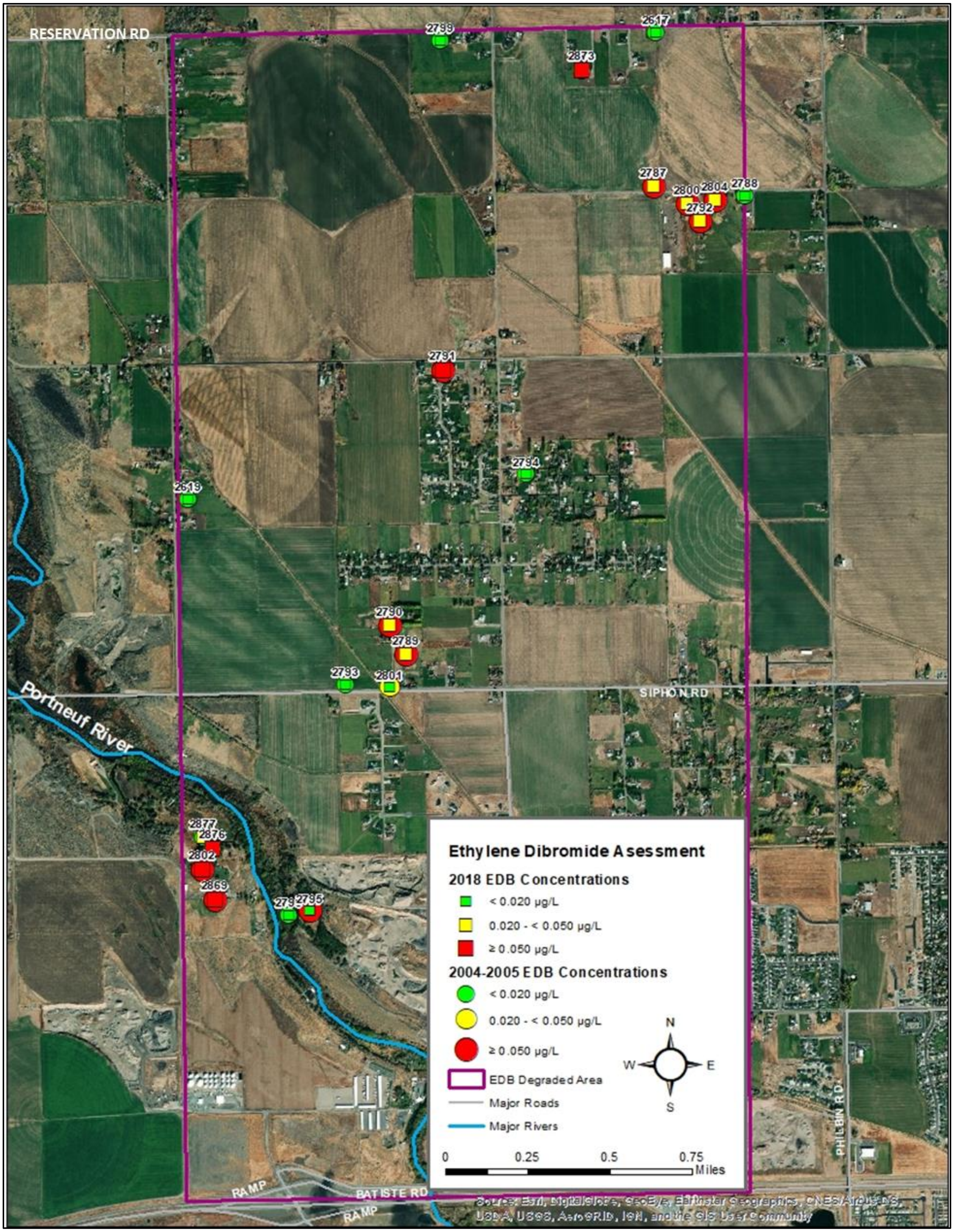


Figure 36. Ethylene Dibromide 2004-2005 and 2018 sample results—Ethylene Dibromide Assessment Project Ground Water Monitoring Project.

EDB and DBCP Results

EDB and DBCP results are presented in Table 47. The EDB concentrations varied from below the detection limit (0.020 µg/L) to 0.086 µg/L, which is over the 0.05 µg/L MCL for drinking water. All results for DBCP were below the reporting limit. Historical data from 2004 and 2005 is also included in Table 47 for comparison.

Table 47. VOC results—Ethylene Dibromide Assessment Project Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Dibromochloropropane (DBCP)[a] (µg/L)	Dibromoethane,1,2- (EDB)[a] (µg/L)
Water Quality Standard:			**0.2**	**0.05**
2617	Unk	07/26/2004	<0.003	0.006
		09/25/2018	<0.040	<0.020
2619	Unk	07/30/2004	<0.003	0.012
		10/01/2018	<0.040	<0.020
2787	148	07/19/2004	<0.003	**0.07**
		09/26/2018	<0.040	0.031
2788	135	07/19/2004	<0.003	0.005
		06/21/2005	—	0.01
		09/25/2018	<0.040	<0.020
2789	180	07/28/2004	0.011	**0.100**
		09/27/2018	<0.040	0.025
2790	180	07/28/2004	0.017	**0.139**
		09/27/2018	<0.040	0.025
2791	190	07/20/2004	<0.003	**0.16**
		09/26/2018	<0.040	**0.086**
2792	140	07/28/2004	0.007	**0.106**
		10/01/2018	<0.040	0.029
2793	Unk	08/04/2004	<0.003	0.013
		10/02/2018	<0.040	<0.020
2794	Unk	07/20/2004	<0.003	<0.003
		09/26/2018	<0.040	<0.020
2795	Unk	09/25/2018	<0.040	<0.020
2796	Unk	09/25/2018	<0.040	<0.020
2799	204	07/26/2004	<0.003	0.01
		09/27/2018	<0.040	<0.020

2800	148	07/28/2004	0.015	**0.139**
		09/27/2018	<0.040	0.034
2801	Unk	06/16/2005	—	0.02
		10/02/2018	<0.040	<0.020
2802	60	07/28/2004	0.030	**0.177**
		10/02/2018	<0.040	**0.068**
2804	Unk	07/19/2004	<0.003	**0.05**
		09/27/2018	<0.040	0.020
2869	65	06/17/2005	—	**0.16**
		09/27/2018	<0.040	**0.053**
2873	160	09/26/2018	<0.040	**0.057**
2876	Spring	10/17/2018	<0.040	**0.055**
2877	Unk	10/17/2018	<0.040	0.034

Notes: µg/L = micrograms per liter; (-) = Not Analyzed; Unk = Unknown. Well log not found. Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.

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

2.5.1.3 Conclusions

DEQ was able to assess the level of impact of EDB contamination at 21 well and spring locations. Property owners and residents were advised of the concentration of EDB in their water source. While EDB concentrations at all locations with previous data were generally lower; areas with EDB concentrations greater than 50% of the MCL remain, with several locations exhibiting concentrations over the drinking water standard (0.05 µg/L). These continuing areas of contamination appear to be concentrated along an apparent plume axis trending from northeast to southwest, but are spread along its length from the up-gradient portion of the study area to the down-gradient boundary.

2.5.1.4 Recommendations

The data collected through this project provide a reference for future sampling. Additional sampling locations will be identified to further define the extent of the EDB plume and assess the concentration of the contaminant at those locations. Residents in the impacted area will continue to be reliant on DEQ for reliable information regarding their potential exposure to this compound and continued monitoring of new and existing sampling locations will be required into the foreseeable future.

2.6 Twin Falls Region

One ground water quality monitoring project was conducted in the Twin Falls region in 2018 using public funds.

2.6.1 Rupert Well Investigation

This section summarizes the 2018 sampling results from a ground water quality investigation in Minidoka County, Idaho.

2.6.1.1 Purpose and Background

The project was conducted to confirm extremely high nitrate and nitrite concentrations detected in a water sample tested during a public water testing event as well as investigate the extent of high nitrate concentrations in ground water.

An annual Ground Water Awareness Fair was held in Heyburn on April 11, 2018. During the event, a sample from a recently-drilled domestic well south of Rupert in Minidoka County was presented with an approximate nitrate concentration greater than 50 mg/L and a nitrite concentration greater than 10 mg/L, based on a nitrate test strip. The drinking water MCL for nitrate is 10 mg/L and 1 mg/L for nitrite. Follow-up sampling confirmed the levels indicated by the nitrate test strip, but also revealed high sulfate (456 mg/L) and ammonia (150 mg/L). DEQ undertook a project to resample Well 2741 and include wells in the immediate area to determine the source and spatial distribution of the ground water contamination in the local aquifer.

The project area is in southeast Minidoka County in the southwestern part of the upper Snake River Basin, approximately two miles southwest of Rupert. Regional ground water flow in the Eastern Snake River Plain Aquifer (ESRPA) is generally to the west-southwest. The local alluvial aquifer is underlain by a clay layer that limits downward movement of water, limiting recharge to the deeper aquifer. According to local residents, this perched aquifer did not exist before the canal system was built in 1907 (Rupert et al. 1996). Based on an evaluation of seven well driller logs in the vicinity, the subsurface lithology consists of sand, gravel, and sandy clay from surface to 31 to 35 feet bgs, followed by brown and/or gray clay 31 to 40 feet bgs. Depth to ground water varied from 5 to 20 feet bgs.

Well 2741 is located on a property immediately adjacent to the southern perimeter of the agricultural chemical distribution facility near Rupert (Figure 37) where various bulk fertilizer and pesticide products have been stored, mixed, and distributed to local producers since 1978. Liquid products on the site include urea-ammonium nitrate, anhydrous ammonia, sulfuric acid, and phosphoric acid. Dry bulk products include urea, potash, ammonium sulfate, boron, manganese, iron, iron sulfate, zinc, and mono-ammonium phosphate. Land use in the populated southern region of the county is predominantly irrigated agriculture. Well 2741 was drilled in October 2017 to a depth of 34 feet. The well is cased down to 26 feet, sealed with bentonite to 22 feet, and screened from 26 to31 feet bgs. Depth to ground water was 6 feet bgs at the time of drilling. The septic system for the property was installed around the same time as the well. The three neighboring domestic wells that were sampled (Wells 2742, 2743, 2745) are located to the west and north of Well 2741. With no drilling logs available, well owners report that these wells of indeterminate age are shallow, being less than 40 feet in depth. Well 2744 to the south and the agricultural chemical distribution facility domestic Well 2783 draw water from the regional aquifer below the confining clay layer and have well driller logs on file.

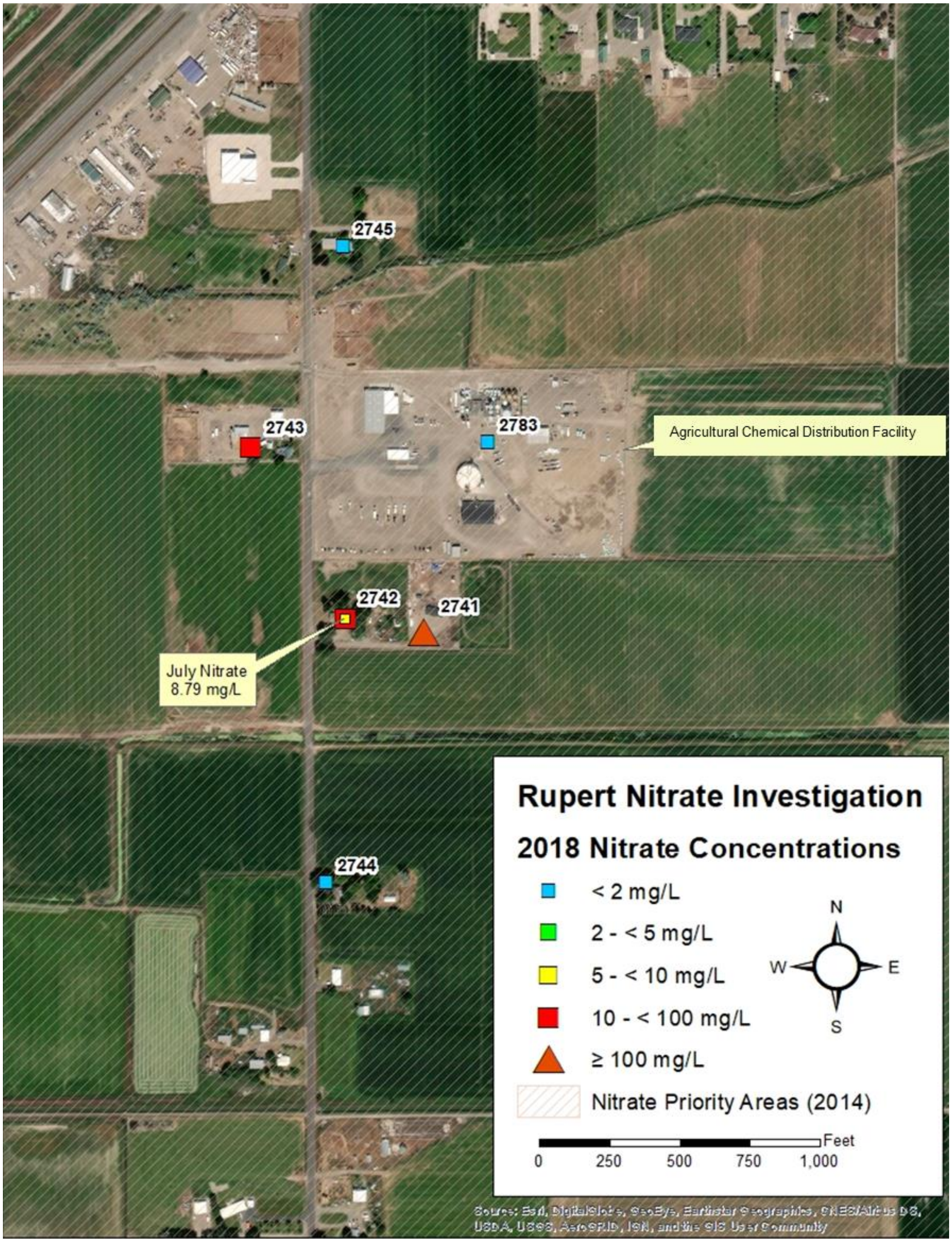


Figure 37. Site location and nitrate concentration map—Rupert Well Investigation Ground Water Monitoring Project.

The use of shallow wells for domestic water supplies in this alluvial aquifer is very common in Minidoka County. However, shallow wells are more susceptible to contamination. The Idaho State Department of Agriculture found that 19% to31% (n=36) of their samples from the alluvial aquifer had less than 2.0 mg/L of nitrate, but 6% to 70% were in the 2 to <10 mg/L range (Fox and Carlson, 2003). Few wells (0% to 5.6%) had nitrate concentrations greater than the MCL or 10 mg/L. ISDA concluded that nitrate impacts to the Minidoka County alluvial aquifer are widespread, but no extreme levels were found.

2.6.1.2 Methods and Results

On April 11, 2018, samples were collected from Well 2741 that confirmed the preliminary screening-level results of the nitrate test strip. A nitrate concentration of 130 mg/L as nitrate and 27.5 mg/L as nitrite was reported by the lab. No field measurements were collected, but water at the outside frost-free spigot adjacent to the well was allowed to flow for 15 minutes to ensure a representative sample.

Following confirmation of nitrate contamination results in Well 2741 on April 11, a total of six wells were sampled over two sampling rounds in April and July 2018. In April 2018, five wells were sampled for nitrate, nitrite, sulfate, and isotopes of nitrogen, oxygen, and hydrogen. Wells sampled were chosen based on proximity to Well 2741 which had elevated nitrate (>100 mg/L), with the goal of further understanding the extent of contamination. In July,

All samples were collected according to the regional QAPP (DEQ 2017c) and FSP (DEQ 2018l). Samples were submitted to Magic Valley Labs in Twin Falls, University of Arizona (for $\delta^{15}N$, $\delta^{18}O_{water}$, and deuterium or $\delta\,^{2}H_{water}$), and University of Washington Isolab ($\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$).

Water quality field parameters (i.e., pH, temperature, specific conductance, DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 48).

Temperature ranged from 10.93 to 14.97 degrees Celsius. The pH ranged from 7.4 to 8.32 units. Specific conductance in Well 2741 was at least double than the other wells, consistent with the highest TDS found in Well 2741. DO was below 0.5 mg/L, which is considered anoxic, in the deeper wells (Wells 2744, 2783) and three shallow wells (Wells 2742, 2743, 2745). The low DO levels are inconsistent with the presence of nitrate concentrations near 10 mg/L in Well 2742 and Well 2743 and may be due to equipment error.

On July 11, 2018 four wells, including the agricultural chemical distribution facility domestic Well 2783 (depth of 99 ft bgs), were sampled for nutrients, iron, TC bacteria, nitrogen and oxygen isotopes, TDS, and common ions.

Table 48. Water quality field parameters—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2741	34	04/11/2018	—	—	6.91	—
		04/19/2018	14.74	1440	7.4	2.68
		07/11/2018	14.97	2870	7.95	2.19
2742	Unk	04/19/2018	10.93	NR	7.4	4.55
		07/11/2018	12.11	954	8.27	0.18J

2743	Unk	04/30/2018	12.3	136	7.39	0.07J
		07/11/2018	13.30	1032	8.10	0.07J
2744	99	04/30/2018	13.08	83	7.88	0.19
2745	Unk	04/30/2018	13.2	423	7.75	0.18
2783	122	07/11/2018	14.80	433	8.32	0.09

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligrams per liter; Unk = Unknown. Well log not found; (-) = Not Analyzed; NR = No Reading; J = The analyte was detected, but the value of the result is an estimate because the values are inconsistent with Nitrate concentrations near 10 mg/L.
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 but can be applied to private wells to evaluate water quality.

General Chemistry Results

A trilinear plot is a tool for visualizing the chemistry of a water sample and the dominant ion composition. A trilinear plot of the July results (Table 49) was constructed to delineate variability in water quality among the sites (Figure 38). Three of the four samples are representative of the calcium-magnesium-bicarbonate water generally found in the ESRPA. Outlying Well 2741 does not show a specific dominant cation-anion pair but does show a higher sulfate-chloride influence.

Table 49. Common ion and Total Dissolved Solids results—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3)	Bicarbonate	Calcium	Chloride[a]	Fluoride[ab]	Magnesium	O-Phosphate	Potassium	Sodium	Sulfate[a]	TDS[a]
			(mg/L)										
Water Quality Standard:			No Standard	No Standard	No Standard	250	2.0/4	No Standard	No Standard	No Standard	No Standard	250	500
2741	34	04/11/2018	-	-	-	107	<0.80	-	0.30	-	-	*456*	-
		04/19/2018	-	-	-	-	-	-	-	-	-	*432*	-
		07/11/2018	<1	452	186	77.8	-	66.8	-	78.5	61.1	*372*	*1450*
2742	Unk	04/19/2018	-	-	-	-	-	-	-	-	-	119	-
		07/11/2018	<1	307	105	40.8	-	53.4	-	10.7	33.4	70.9	*650*
2743	Unk	04/30/2018	-	-	-	-	-	-	-	-	-	74.2	-
		07/11/2018	327	327	125	43.0	-	49.8	-	14.1	32.6	70.3	*670*
2744	99	04/30/2018	-	-	-	-	-	-	-	-	-	56.6	-
2745	Unk	04/30/2018	-	-	-	-	-	-	-	-	-	27.9	-
2783	122	07/11/2018	<1	141	59.3	17.0	-	13.9	-	8.28	21.0	31.7	310

Notes: mg/L = milligrams per liter; TDS = Total Dissolved Solids; Unk = Unknown. Well log not found; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. These regulations are applicable for public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

a. Contaminant with a National Secondary Drinking Water Regulation standard.

b. Contaminant with a National Primary Drinking Water Regulation standard.

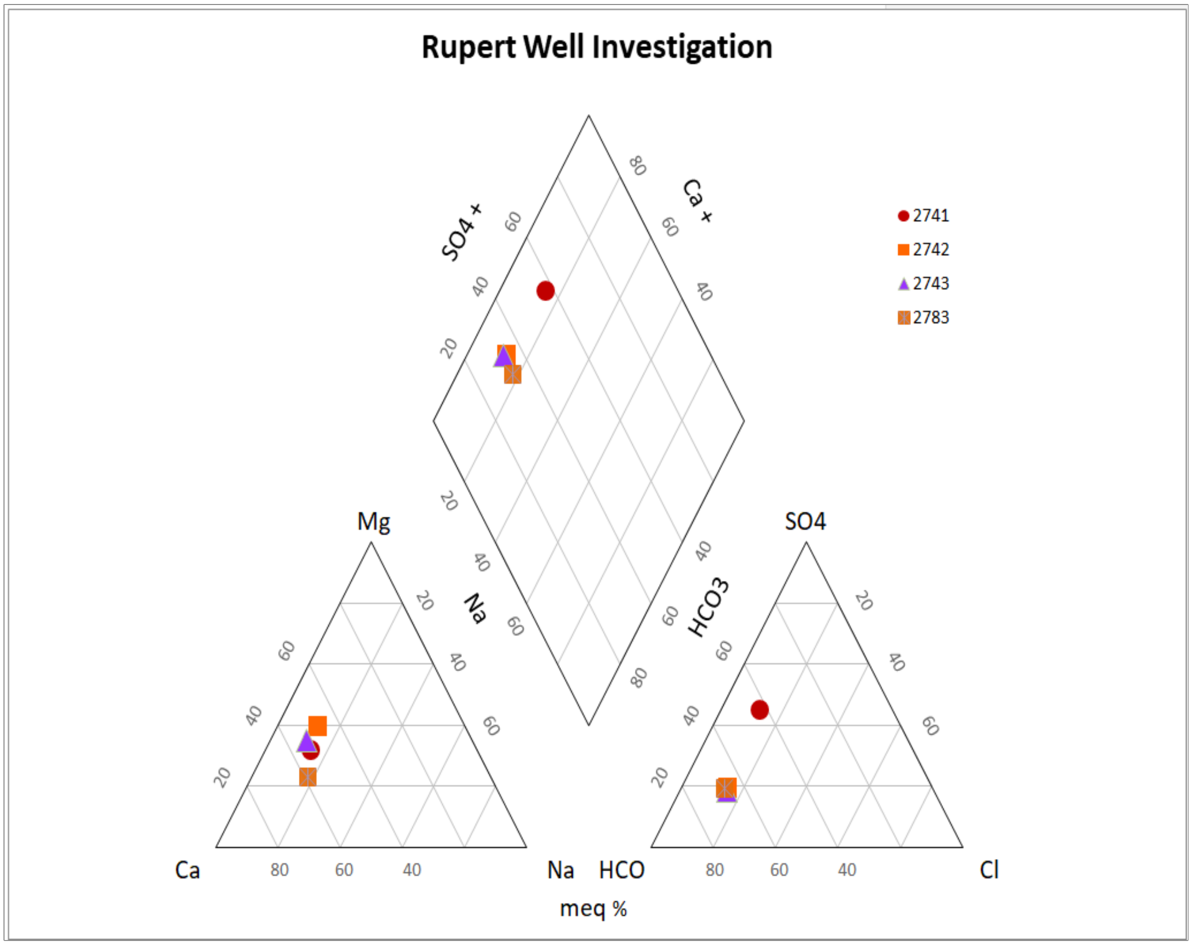


Figure 38. Trilinear plot for July 2018 water sample results—Rupert Well Investigation Ground Water Monitoring Project.

There is a strong linear relationship between nitrate, sulfate, and chloride (Figure 39). The sulfate-chloride ratio in Well 2741 is higher (4.26–4.78) than in other wells (1.63-1.86). If the source of contamination were septic or animal waste, chloride would be dominant, rather than sulfate.

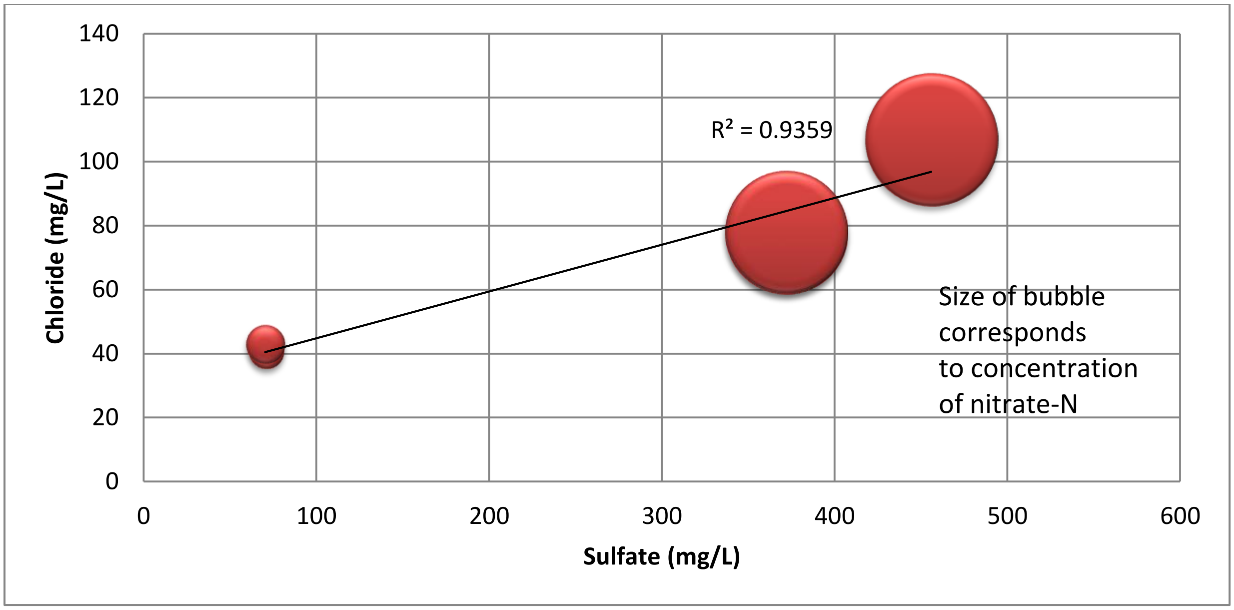


Figure 39. Sulfate-Chloride-Nitrate relationship—Rupert Well Investigation Ground Water Monitoring Project.

Nutrient Results

Three of the five wells sampled in April (Wells 2741, 2742, and 2743) had nitrate concentrations over 10 mg/L, the MCL for drinking water. Well 2744 (99 feet bgs) and the up-gradient, shallow Well 2745 had no detectable nitrate and were both removed from the July sampling round.

Nutrient results are presented in Table 50. Three wells sampled in April and July 2018, located south and west of SGS-Rupert (Wells 2741, 2742, and 2743), all exhibited nitrate levels above or approaching the drinking water MCL. Nitrate levels were higher in April than in July. Nitrate was not detected in the two deeper wells (Wells 2744, 2783), but ammonia was detected at 0.05 mg/L and 0.35 mg/L as N. Most notable and alarming are the levels of nitrate (128 mg/L and 110 mg/L), nitrite (27.5 mg/L and 2.41 mg/L), ammonia (187 mg/L and 278 mg/L), sulfate (432 mg/L and 372 mg/L), and total phosphorus (0.47 mg/L) in Well 2741. Well 2741 also had 2 to 4 times higher concentrations of potassium, sodium, chloride, and total dissolved solids than the other shallow wells (Table 50). All are constituents in the bulk fertilizers stored at the agricultural chemical distribution facility. The concentrations of nitrate and ammonia in well 2741 are several orders of magnitude higher than values found in the literature for ground water in the ESRP (Fox and Carlson 2003; Rupert 1994; Rupert 1997; Frans et.al. 2012). Nitrate levels below 2 mg/L are considered background levels. Occasionally, a well sample in the ESRP, particularly in an NPA, will contain a level above 50 mg/L, but only site 2741 has been recorded to have a level above 100 mg/L. The concentration in well 2741 is the highest nitrate concentration DEQ has recorded from more than 4000 sites located within NPAs (DEQ 2014a).

Table 50. Nutrient and nutrient-related isotope results—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration (mg/L)				Isotopes (‰)		
			Phosphorus	Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{18}O_{nitrate}$	$\delta^{15}N_{nitrate}$	$\delta^{15}N$
Water Quality Standard:			No Standard	1.0	10	No Standard	No Standard	No Standard	No Standard
2741	34	04/11/2018	—	**27.5**	**130**	150	—	—	—
		04/19/2018	—	**2.41**	**128**	187	-0.2	10.9	14.8
		07/11/2018	0.47	<0.20	**110**	278	-0.5	8.9	14.4
2742	Unk	04/19/2018	—	<0.20	**15.2**	<0.05	2.6	17.7	16.7
2742	Unk	07/11/2018	0.16	<0.20	8.79	<0.05	1.3	16.7	15.6
2742	Unk	07/11/2018	—	—	—	—	1.6	16.7	15.2
2743	Unk	04/30/2018	—	<0.20	**11.1**	<0.05	0.1	17.4	16.5
2743	Unk	07/11/2018	0.10	<0.20	**10.9**	<0.05	0.2	16.5	15.6
2744	99	04/30/2018	—	<0.20	<0.30	0.05	—	—	—
2745	Unk	04/30/2018	—	<0.20	<0.30	<0.05	—	—	—
2783	122	07/11/2018	0.21	<0.20	<0.30	0.35	—	—	—

Notes: mg/L = milligrams per liter; ‰ = per mil; Unk=Unknown. Well log not found; (-) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Bolded red numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or an Idaho Ground Water Quality Rule (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations are applicable for public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Ammonia (or ammonium when dissolved in water) is rarely found in ground water or surface water above 1 mg/L, except where industrial contamination has occurred. However, a USGS study in eastern Nebraska indicated that individual septic systems can release ammonia to ground water. The study found that well water likely derived from septic system seepage contained a maximum 1.39 mg/L ammonia-N (Verstraeten et.al. 2004). There is currently no drinking water MCL for ammonia. The lifetime health advisory for ammonia is 30 mg/L (EPA 2018). A lifetime health advisory is defined as a concentration that is not expected to cause adverse health effects over a lifetime of consistent daily exposure at that level. Ammonia concentrations found in Well 2741 (150 – 287 mg/L) greatly exceed the health advisory and are 100 times greater than levels that may be expected from septic drainfields. The concentrations of nitrate, ammonia, and sulfate found in Well 2741 indicate the presence of a significant localized contaminant source.

Nitrite was detected in Well 2741 in April but was not detected in the July sampling round. Nitrite is an intermediate product of the processes of nitrification of ammonia (the oxidation of ammonium to nitrate) and denitrification (the reduction of nitrate to nitrogen gases). Nitrite is very unstable and reactive, and rarely occurs in water above 1 mg/L, unless the ground water is also low in DO which will inhibit nitrification. DO was present in Well 2741 along with high nitrate, while the other shallow wells which were more anoxic had much lower nitrate levels. Nitrification of ammonia in Well 2741 may increase during the spring, when nitrate levels were generally greater. Denitrification may play a role in reducing nitrate levels in Wells 2742 and 2743 as compared to Well 2741.

The agricultural chemical distribution facility well (Well 2783) was only sampled in July 2018. The well draws from the deeper aquifer and had no detectable nitrate or nitrite, but had a concentration of 0.35 mg/L ammonia and 0.09 mg/L DO. The presence of ammonia is correlative to low DO.

Stable Isotope Results

Stable isotopes of hydrogen and oxygen guide our understanding of the source of recharge water in the aquifer. Samples from all sites were analyzed in April and from the agricultural chemical distribution facility well in July 2018 (Table 51). All sites plotted along the ESRP ground water line and are therefore consistent with the regional ground water chemistry (Figure 40). When irrigation water is the primary source of recharge, results generally plot in the upper right of the graph because the lighter $\delta^{16}O$ and H will evaporate, leaving the heavier isotopes $\delta^{18}O_{water}$ and $\delta^{2}H_{water}$ behind. The remaining, heavier isotopic water is then considered “enriched.” The water in Wells 2744 and 2783 is lighter and considered “depleted.” This suggests the source of recharge is not irrigation water.

Table 51. Stable isotope results—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	$\delta^{2}H_{water}$ (‰)	$\delta^{18}O_{water}$ (‰)
2741	34	04/19/2018	-125.4	-15.8
2742	Unk	04/19/2018	-126.2	-16.0
2743	Unk	04/30/2018	-125.9	-15.9
2744	99	04/30/2018	-137.6	-17.8
2745	Unk	04/30/2018	-126.7	-16.4
2783	122	07/11/2018	-134.5	-17.3

Notes: ‰ = per mil; Unk=Unknown. Well log not found.

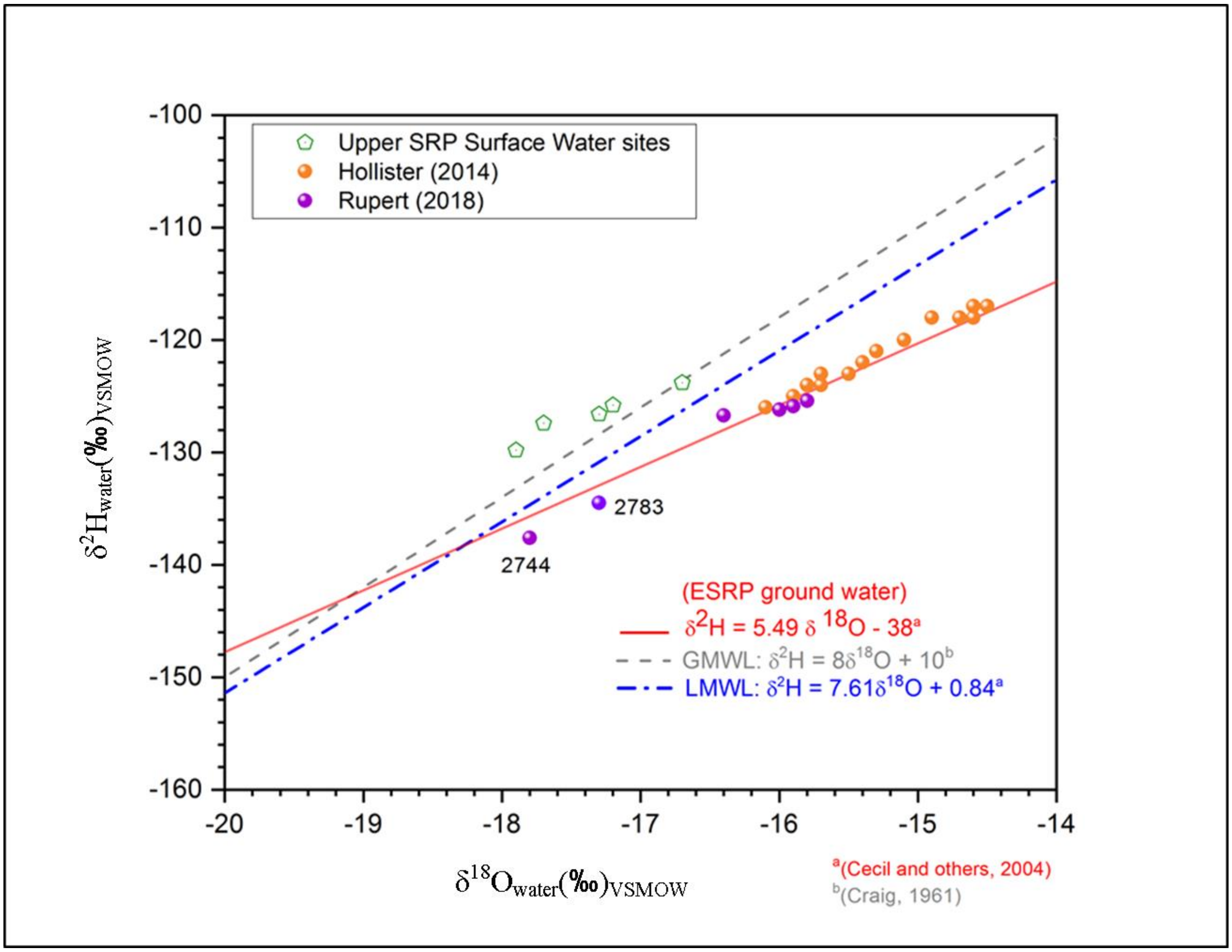


Figure 40. Local meteoric line with 2018 $\delta^{18}O_{water}$ and $\delta\,^{2}H_{water}$ isotope results—Rupert Well Investigation Ground Water Monitoring Project.

Stable isotopes of nitrogen and oxygen, $\delta\,^{15}N$, $\delta^{15}N_{nitrate,}$ and $\delta^{18}O_{nitrate}$ can be useful tools in determining sources of nitrate. Nitrogen isotope results show enrichment of $\delta^{15}N$ (heavier) (Table 50) which may indicate a waste source or denitrification. However, no significant waste source has been found in the vicinity. Plotting the $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ of nitrate also suggests a waste source or denitrification (Figure 41) with Well 2742 and 2743 plotting near the denitrification line (Kendall et al. 2007). However, several researchers suggest that isotopes should not be used as the only means to determine sources of nitrate, and a multi-tracer approach is advocated (Kendall et al. 2007; Kendall and McDonnell 1998). Other data in this project, such as a high sulfate to chloride ratio (4.3 to 4.8 in well 2741), unusually high ammonia, and high potassium, and high phosphorus, indicate a fertilizer source.

Nitrogen isotope values in ground water can be complicated by ongoing chemical reactions and isotope fractionation. For example, denitrification of fertilizer nitrate can yield residual nitrate with a much higher $\delta^{15}N$ values, such as +15 to +30 ‰ (Kendall and McDonnell 1998). DEQ found a similar example near Ashton, where the geochemistry of known liquid fertilizer spills suggested denitrification had caused a nitrogen isotopic signature commonly associated with waste sources. (DEQ 2011b).

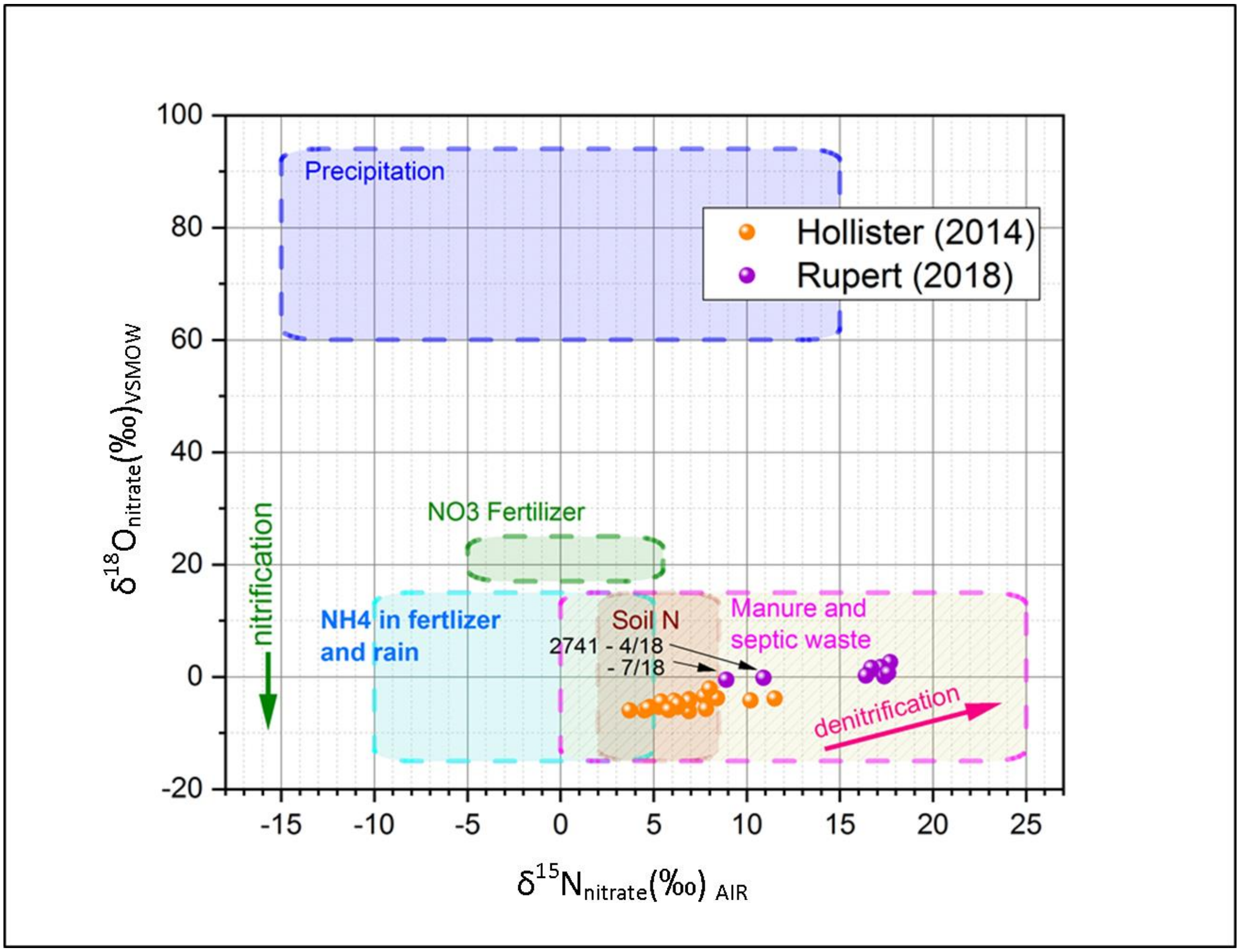


Figure 41. $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$—Rupert Well Investigation Ground Water Monitoring Project.

Bacteria Results

Bacteria samples were collected in July. TC colonies were detected in Well 2741 and 2742 (Table 52). However, *E. coli* were absent in all samples.

Table 52. Bacteria Results—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water Quality Standard:			**<1**	**1.0**
2741	34	07/11/2018	<1	1
2742	Unk	07/11/2018	<1	10
2743	Unk	07/11/2018	<1	<1
2783	122	07/11/2018	<1	<1

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. 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 numbers) 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.

Metals Results

One round of metals samples were collected in April from Well 2741. The results are presented in Table 53. Samples from Well 2741 were analyzed for iron, manganese, and zinc because these minerals may be included in fertilizers. Iron and manganese were detected above their respective drinking water standards, but relatively low amounts of zinc were detected.

Table 53. Metals results—Rupert Well Investigation Ground Water Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Iron[a] mg/L	Manganese[a] mg/L	Zinc[a] mg/L
Water Quality Standard:			0.3	0.05	5
2741	34	04/11/2018	*1.26*	*0.277*	0.282

Notes: mg/L = milligrams per liter. Italicized red numbers indicate EPA's NSDWR standard was exceeded.
a**.** Contaminant with a National Secondary Drinking Water Regulation (NSDWR) standard.

2.6.1.3 Conclusions

It is well documented that agricultural practices are a major source of nitrate in ground water of this area (Rupert et al. 1996). In the case of Well 2741, it is difficult to reasonably conclude that a potential waste-related source (e.g., a recently constructed septic drain field and a small number of goats) would lead to the concentrations of nitrate, nitrite, sulfate, and ammonia observed in Well 2741, despite the N-15 isotope results suggesting a waste source. These concentrations could be due to releases from the agricultural chemical distribution facility. Lower nitrate levels in downgradient wells and reducing conditions (low DO) provide some evidence that denitrification may be occurring (Esser et al. 2009). Clark et.al. (2008) demonstrated that ammonium and nitrate losses in ground water contaminated by a fertilizer blending plant and chemical treatment ponds were due to anaerobic oxidation reactions.

Further investigation is needed to determine the contamination source(s) and to develop a better understanding of the biological and geochemical processes occurring in and down-gradient of Well 2741. The owners of the agricultural chemical distribution facility have begun an investigation of subsurface conditions on the property.

2.6.1.4 Recommendations

The Idaho State Department of Agriculture sampled Well 2741 in August 2018, which showed detections of nine pesticides. At that time, another sampling round which included two pesticide sampling suites was planned and later conducted in the spring of 2019 at the three wells neighboring the agricultural chemical distribution facility.

Additional sampling within the shallow alluvial aquifer may also be pursued in the fall of 2019.

3 DEQ Cooperative Project

This section presents data from special ground water quality monitoring projects conducted jointly by DEQ and other state agencies in calendar year 2018.

3.1 DEQ-IDWR Ground Water Monitoring Project

This section presents data from special ground water quality monitoring and investigation projects that were conducted jointly by DEQ and IDWR in calendar year 2018.

3.1.1 Purpose

The IDWR Statewide Ambient Ground Water Quality Monitoring Network assesses ground water quality across Idaho. DEQ partnered with IDWR to collect dissolved methane and nitrogen isotope ($\delta^{15}N$) samples to help assess ground water quality in southern Idaho. The counties of interest for this project included Ada, Canyon, Gem, Payette, Owyhee, and Washington. The ground water samples were collected by IDWR staff during statewide network sampling events, while DEQ paid for the analysis—only the methane was analyzed (the $\delta^{15}N$ samples will be submitted with 2019 samples and reported in the 2019 summary report). The data will help establish baseline ground water quality for dissolved methane and identify any potential health threats associated with the gas. The addition of $\delta^{15}N$ will assist in future nitrogen source evaluation. Dissolved methane results are provided in Appendix A.

3.1.2 Methods and Results

IDWR collected 22 samples for dissolved methane from 22 domestic wells across the state following its EPA-approved QAPP (IDWR 2018). Samples were collected using the Isotech Laboratories Isoflask and were submitted to IBL in Boise, Idaho, and subcontracted to Isotech Laboratories, Inc. (a Weatherford Company) in Champaign, Illinois (Table A1). The IsoFlask was used due to its unique design that maintains (does not alter) the quantity or isotopic characteristic of any potential dissolved hydrocarbon gases in the sample (as compared to direct fill and inverted VOC sampling).

Nitrogen isotope samples were also collected from 22 wells (sites with nitrate concentrations greater than 5 mg/L; three of which were also sampled for dissolved methane). The isotope samples will be sent for analysis to the University of Arizona in Tucson, AZ with the 2019 samples. Results for the 2018 samples will be presented in the 2019 annual report along with the 2019 results.

Methane Results

Of the 22 samples submitted to Isotech Labs, 21 samples were analyzed. The submitted sample for Well 04S 01E 30BBB1 was compromised and a result could not be obtained. Dissolved methane concentrations reported for this project ranged from nondetect (< 0.2 µg/L) to 990 µg/L (Table A1; Figure A1). There is no MCL or NSDWR standard for dissolved methane in ground water. The hazard with methane in ground water occurs when dissolved methane exsolves (outgasses) from the water into the surrounding air or a confined space, where it can potentially ignite and/or explode. The suggested action level for methane is 28,000 µg/L (Eltschlager et al. 2001). All results were below the explosive risk level.

3.1.3 Conclusions

The cooperative project between IDWR and DEQ resulted in the cost-effective collection of additional dissolved methane data that helped assess ground water quality in southern Idaho. These data will be helpful in establishing a baseline dissolved methane in drinking water in areas with potential oil and gas development.

3.1.4 Recommendations

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

3.2 DEQ-ISDA Ground Water Monitoring Project

This section presents data from special ground water quality monitoring and investigation projects that were conducted jointly by DEQ and ISDA in calendar year 2018.

3.2.1 Purpose

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

3.2.2 Methods and Results

In cooperation with DEQ, ISDA submitted ground water samples from a total of 223 domestic wells across the state following its *Ambient Ground Water Quality Monitoring* QAPP (ISDA 2018a) and corresponding regional FSPs: *Ambient Ground Water Quality Monitoring: Boise Regional Office* FSP, *Ambient Ground Water Quality Monitoring: Idaho Falls Regional Office* FSP, *Ambient Ground Water Quality Monitoring: Northern Regional Office* FSP, *Ambient Ground Water Quality Monitoring: Pocatello Regional Office* FSP, and *Ambient Ground Water Quality Monitoring: Twin Falls Regional Office* FSP (ISDA 2017b-f). The analytes of interest included nitrate (nitrate-nitrite nitrogen), ammonia, arsenic, uranium, and the nitrogen ($\delta^{15}N$) isotope. All 223 wells were sampled for nitrate, while a subset of wells were also sampled for ammonia, arsenic, and/or uranium. In addition, 36 quality assurance samples (30 duplicates samples and 6 blank samples) were collected. Samples for nitrate, ammonia, arsenic, and uranium analysis were submitted to IBL in Boise, Idaho. Most samples with nitrate concentrations above 5 mg/L were sent to the University of Arizona in Tucson, AZ for $\delta^{15}N$ analysis. Water quality field parameters (pH, temperature, and specific conductance) were measured and recorded before sample collection. Field parameter, ammonia, nitrate, and $\delta^{15}N$ results are shown in Appendix B.

Nitrate (Nitrate-Nitrite Nitrogen) Results

Nitrate (nitrate-nitrite nitrogen) concentrations for this project ranged from nondetect (less than 0.010 mg/L) to 90 mg/L. Out of the 223 samples collected for nitrate analysis, 57 samples (25.6%) were between 5 mg/L (half the EPA MCL of 10 mg/L) and 10 mg/L; 56 samples (25.1%) met or exceeded the MCL. Four of the 25 ISDA projects (Projects 530 [Ada County], 710 [Washington/Payette Counties], 790 [Cassia County], and 865 [Owyhee County]) had 59% of the 10 mg/L or greater nitrate concentrations. In total, 171 samples (76.7%) were at or greater than 2 mg/L, indicating some type of nitrogen source associated with human activities; 2 mg/L is generally considered background level (DEQ 2014a).

Well locations and nitrate concentrations are shown in Table B1 and Figures B1–B25.

Ammonia Results

A total of 12 wells were sampled for ammonia in addition to nitrate. Samples were collected from wells with field-measured DO concentrations below 2 mg/L. Ammonia concentrations for this project ranged from nondetect (less than 0.010 mg/L) to 9.4 mg/L (Table B1). Median concentration was 7.2 mg/L. All wells sampled for ammonia were within Owyhee County, which is known to have wells drilled into a deeper, confined aquifer with low or depleted DO concentrations. There is currently no MCL or ground water quality rule standard for ammonia.

Arsenic Results

A total of 32 wells were sampled for arsenic in addition to nitrate. Arsenic concentrations for this project ranged from 0.0049 mg/L to 0.048 mg/L (Table B1). Median concentration was 0.0165 mg/L. All wells were below the Idaho Ground Water Quality Rule Standard for arsenic of 0.05 mg/L. Three wells (Wells 7101201, 7104101, 7104601) had a concentration equal or greater than half of the standard (0.025 mg/L) (Figure B26). All wells sampled for arsenic were within Washington and Twin Falls Counties, which are known to have naturally-occurring arsenic in ground water (Figures B26 and B27).

Uranium Results

A total of 16 wells were sampled for uranium in addition to nitrate. Uranium concentrations for this project ranged from 5.6 µg/L to 84 µg/L (Table B1; Figure B28). The median concentration was 13 µg/L. The EPA MCL for uranium is 30µg/L. Three wells in Canyon County (Wells 2203001, 2203101, and 2204801) exceeded the MCL. All wells sampled for uranium were within Ada and Canyon Counties, which are known to have naturally-occurring uranium in ground water.

Nitrogen Isotope Results

DEQ submitted a total of 112 ISDA-collected nitrogen isotope ($\delta^{15}N$) samples from 111 wells (includes 1 duplicate sample not included in this report), with nitrate concentrations of approximately 5 mg/L or greater. Due to a laboratory error, one submitted sample (Well 7804301) was not analyzed. The measurable $\delta^{15}N$ values ranged from 1.4‰ to 25.0‰. The $\delta^{15}N$ values for 25 samples (10 or 40% of which were from project 710 [Washington/Payette Counties]) ranged from +1.0‰ to +3.9‰, suggesting commercial fertilizer as the likely nitrate source; 78 samples had $\delta^{15}N$ values between +4.0‰ and +8.8‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; 8 samples had $\delta^{15}N$ values equal to or greater than +9‰, suggesting an animal or human waste source as the likely nitrate source (Seiler 1997; Tables 4 and B1).

3.2.3 Conclusions

The cooperative project between ISDA and DEQ resulted in the cost-effective collection of additional nitrate and nitrogen isotope data that helped assess ground water quality across the state. Out of the 223 samples collected for nitrate analysis, 56 samples (25.1%) met or exceeded the EPA nitrate MCL of 10 mg/L and 57 samples (25.6%) were between 5 mg/L and 10 mg/L. The nitrate results indicate degraded ground water in specific vulnerable aquifers within a few counties (Figures B1–B25). These data will be helpful in the next NPA delineation and ranking process conducted by DEQ and the Ground Water Monitoring Technical Committee. The nitrogen isotope ratios provide one line of evidence for the potential sources of nitrogen contributing to the nitrate concentrations in ground water.

Arsenic and uranium samples were collected in areas with known elevated concentrations to provide more information regarding the presence of those naturally-occurring constituents of concern and provided valuable information for those working to better understand areas with concentrations at levels that present human health risks.

3.2.4 Recommendations

This project is an 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 Idaho.

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Appendix A. Idaho Department of Water Resources Collected Data–2018

Table A1. 2018 dissolved methane results—DEQ-IDWR Joint Ground Water Monitoring Project.

Report Map ID	Site ID	County	Well Depth (ft bgs)	Sample Date	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Methane (µg/L)*
Primary or Secondary Standard:					**NA**	**6.5-8.5**	**NA**	**NA**	**NA**
M-1	02N 01E 26BBC1	Ada	300	6/27/2018	21.4	7.54	2971	5.78	<0.2
M-2	01S 02W 09CBA1	Canyon	647	7/26/2018	15.7	7.64	1247	0.05	6.9
M-3	02N 02W 23ABD1	Canyon	110	7/17/2018	15.5	7.78	571	8.35	<0.2
M-4	03N 02W 12BAB1	Canyon	35	7/03/2018	15.3	7.31	1082	0.67	<0.2
M-5	02N 04W 25CAD1	Canyon	121	7/06/2018	16.8	7.68	849.1	0.17	240
M-6	03N 02W 04ADD1	Canyon	319	7/06/2018	16.3	8	335.8	1.5	0.2
M-7	04N 02W 07ABC1	Canyon	94	6/29/2018	15.3	7.2	239.2	1.42	<0.2
M-8	04N 02W 31AAA1	Canyon	150	6/29/2018	14.7	8.12	272.4	3.77	0.49
M-9	04N 05W 23BCC1	Canyon	525	6/25/2018	18.8	7.77	896.1	0.03	15
M-10	05N 03W 27CAA1	Canyon	287	6/25/2018	16	7.4	197.4	5.79	<0.2
M-11	05N 04W 28CDC1	Canyon	145	7/03/2018	15.7	8.42	166.5	0.03	8.7
M-12	05N 04W 35BBB1	Canyon	75	6/25/2018	15.1	7.36	816.9	0.82	0.2
M-13	06N 02W 08DADA1	Gem	85	7/30/2018	17.2	9.24	257.7	0.04	990
M-14	06N 03W 22CBB1	Gem	235	7/24/2018	17.2	7.51	380.6	9.18	0.76
M-15	06N 03W 33CBA2	Gem	180	6/26/2018	16.6	7.38	348.9	7.04	<0.2
M-16	06N 04W 34DDB1	Payette	147	7/10/2018	16.8	7.87	261	7.99	0.2
M-17	03N 05W 28ACB1	Owyhee	30	7/20/2018	16.5	7.17	1392	3.88	0.64
M-18	04S 01E 30BBB1	Owyhee	300	7/20/2018	15.8	7.64	120.8	4.16	-
M-19	07S 05E 07DDC1	Owyhee	168	7/11/2018	18.2	8.62	299.1	0.03	0.8
M-20	10N 03W 18AAD1	Washington	71	7/05/2018	18.6	6.96	844.5	6.26	<0.2
M-21	12N 04W 31CAC1	Washington	75	7/05/2018	14.7	7.06	954.8	0.02	6.2
M-22	13N 01W 32CAB2	Washington	182	7/10/2018	18.4	7.9	250.7	0.04	0.72

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; ‰ = per mil. (—) = not analyzed or data are unavailable.

*Results were converted from mg/L (as reported by Isotech Labs) to µg/L for this report.

a. Contaminant with a NSDWR standard. The NSDWR standard for pH is 6.5-8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.

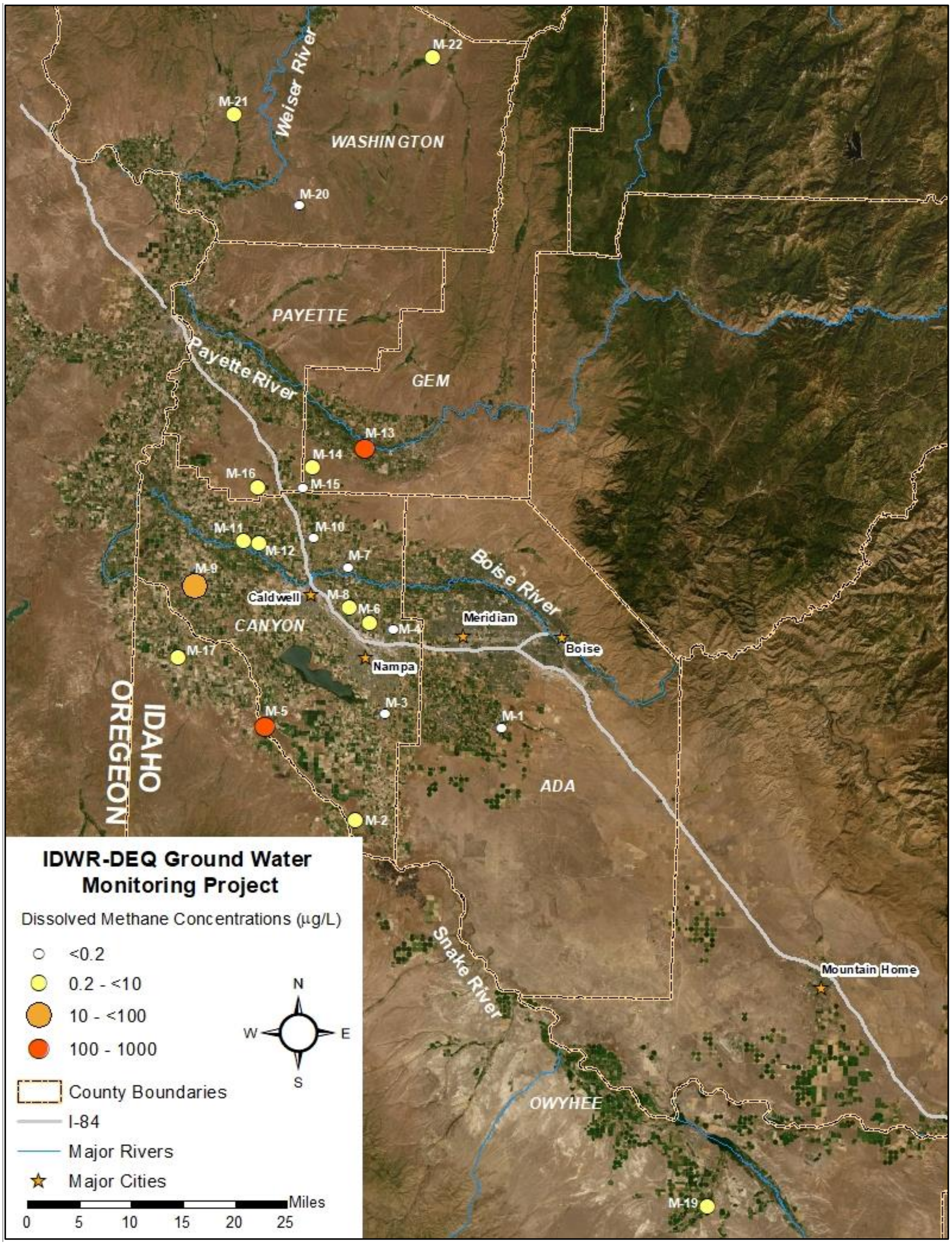

Figure A1. Dissolved methane results in southwestern Idaho—DEQ-IDWR Joint Ground Water Monitoring Project, 2018.

Table A2. Nitrogen isotope results—DEQ-IDWR Joint Ground Water Monitoring Project.

Report Map ID	IDWR Site ID	County	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	DO (mg/L)	Nitrate[b] (mg/L)	δ15N (‰)
Primary or Secondary Standard:					NA	6.5-8.5	NA	NA	10	NA
NI-1	06S 05E 26BBB1	Owyhee	205	8/14/2017	20.4	6.87	6971	0.88	27	11.4
NI-2	10S 17E 06AAD1	Twin Falls	380	6/26/2017	16.2	7.64	1726	7.71	6	5.7
NI-3	09S 15E 25BAC1	Twin Falls	100	7/13/2017	16.6	7.38	1131	4.49	6	7.1
NI-4	10S 23E 08AAA2	Minidoka	29	7/7/2017	15.8	7.22	1908	1.19	18	7.4
NI-5	10S 24E 31DDC1	Cassia	62	6/27/2017	13.9	7.36	—	2.51	5	4.1
NI-6	10S 22E 35BCB1	Cassia	235	7/12/2017	16.5	7.52	818.8	8.26	6.4	5.1
NI-7	10S 22E 29BAD1	Cassia	382	6/28/2017	15	7.69	1406	8.27	7.7	9.3
NI-8	11S 23E 05BDC1	Cassia	70	6/28/2017	13.1	7.42	1299	8.29	12	3.8
NI-9	11S 23E 16CCB1	Cassia	195	7/7/2017	16.9	7.3	931.4	8.11	4.9	5.8

Notes: °C = degrees Celsius; pH = standard pH units; µS/cm = microsiemens/centimeter; mg/L = milligram per liter; ‰ = per mil. (—) = not analyzed or data are unavailable.

a. Contaminant with a NSDWR standard. The NSDWR standard for pH is 6.5-8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.

b. Contaminant with a NPDWR standard.

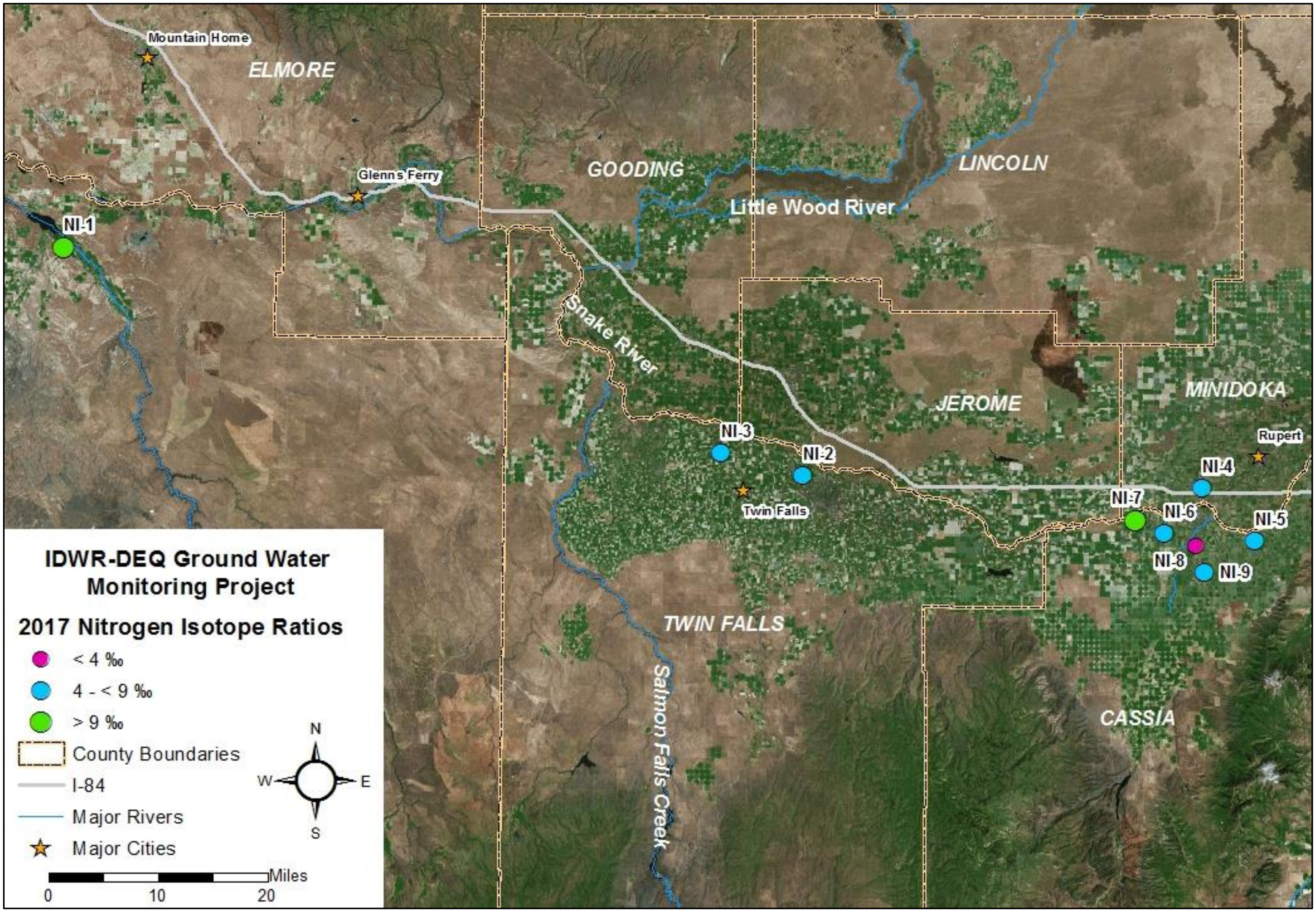

Figure A2. Nitrogen isotope ratios—DEQ-IDWR Joint Ground Water Monitoring Project.

Appendix B. Idaho State Department of Agriculture Collected Data–2018

Table B1. DEQ–ISDA Ground Water Monitoring Project data.

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temp (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Arsenic[b] (mg/L)	Uranium[b] (µg/L)	Nitrate plus Nitrite[b] (mg/L)	δ15N (‰)
Primary or Secondary Standard:				**NA**	**6.5-8.5**	**NA**	**NA**	**10**	**30**	**10**	**NA**
2200301	220	7/9/2018	Ada/Canyon	14.2	7.69	845.7	NA	NA	11	**15**	3.5
2201301	220	7/9/2018	Ada/Canyon	15.1	7.93	720.4	NA	NA	7.1	7.7	5.7
2201701	220	7/9/2018	Ada/Canyon	18	7.79	405.9	NA	NA	6	2.5	NA
2201801	220	7/10/2018	Ada/Canyon	13.8	7.56	651.1	NA	NA	13	5.5	4.5
2201901	220	7/10/2018	Ada/Canyon	15.8	7.57	674.4	NA	NA	19	5.2	6.3
2203001	220	7/10/2018	Ada/Canyon	13.8	7.15	630.6	NA	NA	**33**	5	6.2
2203101	220	7/10/2018	Ada/Canyon	13.6	7.37	870.3	NA	NA	**66**	8.4	6.6
2204701	220	7/9/2018	Ada/Canyon	15	7.42	787.1	NA	NA	13	5.3	NA
2204801	220	7/10/2018	Ada/Canyon	16.6	7.58	1157	NA	NA	**84**	**10**	5.8
2230101	223	7/9/2018	Canyon	15.9	7.53	856.8	NA	NA	22	7	4.7
3003001	300	7/18/2018	Latah	13.7	7.55	315.8	NA	NA	NA	0.013	NA
3003101	300	7/18/2018	Latah	12.3	7.03	336.7	NA	NA	NA	4.7	NA
3003701	300	7/9/2018	Latah	11.6	6.98	213.2	NA	NA	NA	2.4	NA
3100201	310	8/20/2018	Owyhee	24	7.76	2197	7	NA	NA	<0.010	NA
3100401	310	8/20/2018	Owyhee	21.1	7.74	2455	7.4	NA	NA	0.14	NA
3100601	310	8/21/2018	Owyhee	21.5	7.58	2493	6.8	NA	NA	1.4	NA
3100701	310	8/20/2018	Owyhee	16.8	7.59	1963	7	NA	NA	<0.010	NA
3101001	310	8/20/2018	Owyhee	20.5	7.5	3203	9.1	NA	NA	0.58	NA
3101601	310	8/20/2018	Owyhee	23	7.8	2533	9.1	NA	NA	0.25	NA
3200101	320	8/7/2018	Fremont	8.2	7.46	617	NA	NA	NA	9.8	5.0
3201001	320	10/2/2018	Fremont	11.6	7.84	536.6	NA	NA	NA	9.1	4.9
3300501	330	7/17/2018	Nez Perce	15.3	8.21	335.4	NA	NA	NA	0.2	NA
3400201	340	6/4/2018	Payette	15.5	7.52	841.7	NA	NA	NA	6	5.1
3400501	340	6/5/2018	Payette	15.6	7.46	977.6	NA	NA	NA	**10**	5.9
3400701	340	6/4/2018	Payette	16.3	7.59	822.1	NA	NA	NA	0.82	NA
3400801	340	6/4/2018	Payette	15.1	7.43	1061	NA	NA	NA	**11**	6.3
3401401	340	6/4/2018	Payette	14.5	7.61	863.6	NA	NA	NA	8	5.3

3401501	340	6/4/2018	Payette	14.5	7.67	970.5	NA	NA	NA	**11**	3.5
4602701	460	7/18/2018	Franklin	13	7.43	879	NA	NA	NA	2.8	NA
4602801	460	7/18/2018	Franklin	16.1	7.43	1091	NA	NA	NA	0.012	NA
4605101	460	7/18/2018	Franklin	12.2	7.36	1159	NA	NA	NA	3.4	NA
4605901	460	7/18/2018	Franklin	15.1	7.2	1135	NA	NA	NA	**13**	25.0
4900801	490	8/8/2018	Caribou	11.9	7.47	864	NA	NA	NA	5.4	5.8
4901601	490	8/8/2018	Caribou	10.2	7.63	982.3	NA	NA	NA	5.4	6.4
4902601	490	8/8/2018	Caribou	14.7	7.62	844.1	NA	NA	NA	4.7	6.1
5302001	530	8/13/2018	Ada	13.5	7.47	573.4	NA	NA	11	**13**	6.0
5302401	530	8/13/2018	Ada	13.7	7.21	741.8	NA	NA	20	**17**	7.9
5302701	530	8/13/2018	Ada	13.8	7.03	867.2	NA	NA	5.6	**41**	5.6
5303401	530	8/13/2018	Ada	13.9	7.09	978.5	NA	NA	11	**39**	6.7
5303801	530	8/13/2018	Ada	13.8	6.9	947	NA	NA	7.4	**42**	8.0
5304001	530	8/13/2018	Ada	15.1	7.34	448.4	NA	NA	29	1.1	5.7
7100201	710	9/10/2018	Washington	15.5	7.39	1382	NA	0.018	NA	**37**	2.9
7100501	710	9/10/2018	Washington	13.7	7.61	839.7	NA	0.02	NA	**13**	2.8
7100601	710	9/11/2018	Washington	14.7	7.43	876.4	NA	0.012	NA	**13**	4.6
7100701	710	9/11/2018	Washington	15.2	7.38	870.5	NA	0.011	NA	**14**	3.8
7100901	710	9/10/2018	Washington	14.4	7.28	1160	NA	0.0084	NA	**19**	6.2
7101101	710	9/10/2018	Washington	14.4	7.1	3720	NA	0.0096	NA	**74**	15.4
7101201	710	9/10/2018	Washington	13.8	7.49	749.3	NA	0.033	NA	4.7	9.1
7101701	710	9/10/2018	Washington	15	7.38	807.8	NA	0.019	NA	**10**	2.8
7102101	710	9/11/2018	Washington	13.1	7.45	640.3	NA	0.019	NA	4.8	8.8
7102301	710	9/11/2018	Washington	13.4	7.22	842.8	NA	0.014	NA	5.5	5.8
7102501	710	9/10/2018	Washington	14.7	6.98	1880	NA	0.0049	NA	**19**	7.7
7103801	710	9/10/2018	Washington	16.8	7.27	983.4	NA	0.011	NA	**12**	3.9
7103901	710	9/10/2018	Washington	16.2	7.31	742.4	NA	0.014	NA	3.7	3.0
7104001	710	9/10/2018	Washington	14.3	7.54	949.6	NA	0.018	NA	**17**	3.2
7104101	710	9/10/2018	Washington	13.5	7.42	1202	NA	0.029	NA	**15**	6.0
7104201	710	9/10/2018	Washington	14.2	7.19	744.1	NA	0.018	NA	**11**	5.7
7104401	710	9/10/2018	Washington	16.4	7.3	838.4	NA	0.01	NA	5.8	2.9

7104601	710	9/10/2018	Washington	14.2	7.21	887.6	NA	0.048	NA	**10**	1.4
7104701	710	9/10/2018	Washington	15.2	7.46	1113	NA	0.02	NA	**12**	3.2
7300201	730	7/31/2018	Minidoka (shallow)	13.2	7.26	998.4	NA	NA	NA	NA	NA
7300501	730	8/2/2018	Minidoka (shallow)	16.5	7.89	626.8	NA	NA	NA	NA	NA
7300901	730	8/1/2018	Minidoka (shallow)	12.9	7.47	1035	NA	NA	NA	NA	NA
7301101	730	8/1/2018	Minidoka (shallow)	15	7.48	663.4	NA	NA	NA	NA	NA
7301601	730	8/1/2018	Minidoka (shallow)	13	7.44	953.9	NA	NA	NA	NA	NA
7302001	730	8/1/2018	Minidoka (shallow)	15.9	7.51	634.7	NA	NA	NA	NA	NA
7302701	730	8/2/2018	Minidoka (shallow)	13.4	7.46	928.3	NA	NA	NA	NA	NA
7302801	730	8/2/2018	Minidoka (shallow)	14.7	7.43	2838	NA	NA	NA	NA	NA
7303201	730	8/1/2018	Minidoka (shallow)	14.2	7.26	2662	NA	NA	NA	NA	NA
7303401	730	7/31/2018	Minidoka (shallow)	13.7	7.5	682.6	NA	NA	NA	NA	NA
7303901	730	8/2/2018	Minidoka (shallow)	15	7.55	661.2	NA	NA	NA	NA	NA
7304101	730	8/2/2018	Minidoka (shallow)	14.4	7.6	711.7	NA	NA	NA	NA	NA
7304301	730	8/2/2018	Minidoka (shallow)	15.1	7.52	653.6	NA	NA	NA	NA	NA
7304501	730	7/31/2018	Minidoka (shallow)	12.6	7.31	1019	NA	NA	NA	NA	NA
7304701	730	8/1/2018	Minidoka (shallow)	12.1	7.75	2498	NA	NA	NA	NA	NA
7401501	740	7/31/2018	Minidoka (deep)	14.8	7.36	878	NA	NA	NA	NA	NA
7401701	740	7/31/2018	Minidoka (deep)	13.4	7.41	1011	NA	NA	NA	NA	NA
7401801	740	7/31/2018	Minidoka (deep)	14.4	7.47	946.9	NA	NA	NA	NA	NA
7403201	740	7/31/2018	Minidoka (deep)	14.4	7.5	908	NA	NA	NA	NA	NA
7404801	740	7/31/2018	Minidoka (deep)	13.6	7.37	941.3	NA	NA	NA	NA	NA
7404901	740	7/31/2018	Minidoka (deep)	20.1	7.96	466	NA	NA	NA	NA	NA
7405101	740	7/31/2018	Minidoka (deep)	14.6	7.55	822.4	NA	NA	NA	NA	NA
7502401	750	5/8/2018	Jerome/Gooding/Lincoln	14.8	7.69	767.4	NA	NA	NA	3.3	NA
7504701	750	5/8/2018	Jerome/Gooding/Lincoln	15	7.62	981.4	NA	NA	NA	5.1	11.2
7504801	750	5/8/2018	Jerome/Gooding/Lincoln	15.1	7.41	747.8	NA	NA	NA	3.4	NA
7504901	750	5/8/2018	Jerome/Gooding/Lincoln	15.2	7.37	609	NA	NA	NA	2.4	NA
7505501	750	5/7/2018	Jerome/Gooding/Lincoln	15.1	6.71	671.8	NA	NA	NA	4.8	NA
7505801	750	5/8/2018	Jerome/Gooding/Lincoln	14.8	7.24	653.2	NA	NA	NA	3.4	NA
7506701	750	5/8/2018	Jerome/Gooding/Lincoln	14.5	7.12	917.6	NA	NA	NA	2.4	NA

7507001	750	5/8/2018	Jerome/Gooding/Lincoln	14	7.47	1204	NA	NA	NA	**14**	3.2
7507401	750	5/8/2018	Jerome/Gooding/Lincoln	16	7.59	691.5	NA	NA	NA	4	NA
7700801	770	6/5/2018	Gem/Payette	15.2	7.5	662.1	NA	NA	NA	3.8	NA
7701701	770	6/5/2018	Gem/Payette	12.2	7.5	1107	NA	NA	NA	6	11.6
7702001	770	6/5/2018	Gem/Payette	15.4	7.41	1182	NA	NA	NA	**12**	11.4
7702501	770	6/4/2018	Gem/Payette	14.8	7.72	664.5	NA	NA	NA	5.2	NA
7702801	770	6/5/2018	Gem/Payette	17.7	7.14	325.6	NA	NA	NA	2.4	NA
7703201	770	6/4/2018	Gem/Payette	14.2	7.64	808.3	NA	NA	NA	5.6	8.0
7705301	770	6/5/2018	Gem/Payette	14.1	7.73	956.9	NA	NA	NA	**16**	5.5
7800201	780	6/26/2018	Twin Falls	14	7.48	876.2	NA	0.02	NA	5.4	NA
7800301	780	6/25/2018	Twin Falls	14.3	7.59	819.8	NA	0.015	NA	4.9	NA
7803601	780	6/26/2018	Twin Falls	12.7	7.8	1116	NA	0.013	NA	9.4	6.3
7804201	780	6/25/2018	Twin Falls	13.2	7.51	884.6	NA	0.018	NA	7.8	8.0
7804301	780	6/25/2018	Twin Falls	13.5	7.49	958.4	NA	0.019	NA	8.1	NA*
7804401	780	6/26/2018	Twin Falls	14.8	7.42	935.4	NA	0.011	NA	3.6	NA
7804501	780	6/26/2018	Twin Falls	18.8	7.92	574.2	NA	0.0055	NA	1.8	NA
7805501	780	6/26/2018	Twin Falls	13.6	7.52	938.1	NA	0.02	NA	**11**	6.9
7805601	780	6/26/2018	Twin Falls	13.9	7.55	893	NA	0.021	NA	6.6	7.1
7805701	780	6/25/2018	Twin Falls	13.7	7.54	922.1	NA	0.014	NA	9.2	8.7
7806401	780	6/25/2018	Twin Falls	14.6	7.52	798.3	NA	0.012	NA	4.8	NA
7806601	780	6/26/2018	Twin Falls	12.3	7.44	942.7	NA	0.024	NA	4.7	7.7
7807601	780	6/27/2018	Twin Falls	13.9	7.52	991.9	NA	0.007	NA	4.6	NA
7900101	790	5/15/2018	Cassia	17.3	7.7	950.5	NA	NA	NA	5.3	5.5
7900601	790	5/15/2018	Cassia	12.5	7.62	972.5	NA	NA	NA	9.7	5.6
7900701	790	5/14/2018	Cassia	12.7	7.15	890.4	NA	NA	NA	9	6.6
7900801	790	5/17/2018	Cassia	13.2	7.49	799.1	NA	NA	NA	**10**	6.6
7900901	790	5/15/2018	Cassia	13.4	7.39	680.1	NA	NA	NA	5	5.4
7901101	790	5/14/2018	Cassia	15.7	7.61	628.2	NA	NA	NA	3.4	NA
7901401	790	5/16/2018	Cassia	12.9	7.46	944.5	NA	NA	NA	**14**	8.8
7901501	790	5/16/2018	Cassia	14.2	7.53	869.7	NA	NA	NA	6.7	4.7
7901601	790	5/16/2018	Cassia	11.9	7.53	962.4	NA	NA	NA	**11**	3.8

7901701	790	5/16/2018	Cassia	12.5	7.62	726.6	NA	NA	NA	5.6	4.1
7901801	790	5/16/2018	Cassia	14	7.6	708.2	NA	NA	NA	5.8	NA
7901901	790	5/15/2018	Cassia	12.2	7.44	1025	NA	NA	NA	**14**	5.7
7902201	790	5/16/2018	Cassia	11.4	7.11	846.9	NA	NA	NA	2	NA
7903201	790	5/16/2018	Cassia	11.8	7.33	946.3	NA	NA	NA	**11**	5.0
7903501	790	5/15/2018	Cassia	12	7.45	1062	NA	NA	NA	**17**	6.4
7903601	790	5/17/2018	Cassia	12.9	7.54	823.8	NA	NA	NA	9.9	7.5
7903801	790	5/14/2018	Cassia	12.4	7.41	798.2	NA	NA	NA	5.8	6.0
7904001	790	5/14/2018	Cassia	13.5	7.35	845.2	NA	NA	NA	7.5	6.4
7904101	790	5/15/2018	Cassia	12.5	7.28	654.4	NA	NA	NA	5.6	5.9
7904201	790	5/15/2018	Cassia	10.8	7.15	879.9	NA	NA	NA	**11**	6.4
7907301	790	5/16/2018	Cassia	13.4	7.64	783	NA	NA	NA	**11**	7.7
8050301	805	10/2/2018	Madison/Fremont/Teton	10.5	7.65	603.4	NA	NA	NA	**10**	5.0
8050801	805	8/8/2018	Madison/Fremont/Teton	12.4	7.54	444.6	NA	NA	NA	6.2	4.1
8050901	805	8/8/2018	Madison/Fremont/Teton	12.8	7.45	444.3	NA	NA	NA	5.3	NA
8051301	805	10/2/2018	Madison/Fremont/Teton	9.9	7.55	567.5	NA	NA	NA	5	NA
8051401	805	8/8/2018	Madison/Fremont/Teton	11.6	7.42	504.1	NA	NA	NA	6.1	4.4
8053401	805	10/2/2018	Madison/Fremont/Teton	9.9	7.77	371.4	NA	NA	NA	1.2	NA
8053501	805	8/7/2018	Madison/Fremont/Teton	8.7	7.34	635.8	NA	NA	NA	**11**	8.1
8053901	805	8/8/2018	Madison/Fremont/Teton	14.4	7.58	436.3	NA	NA	NA	6.5	3.8
8055201	805	10/2/2018	Madison/Fremont/Teton	12.3	7.83	585.8	NA	NA	NA	8	5.6
8100401	810	6/18/2018	Elmore	13.8	7.68	1355	NA	NA	NA	**15**	5.9
8100601	810	6/18/2018	Elmore	13.6	7.52	1349	NA	NA	NA	**21**	3.1
8101701	810	6/18/2018	Elmore	13.5	7.09	521.9	NA	NA	NA	6.4	6.4
8102101	810	6/18/2018	Elmore	14.3	7.26	468.5	NA	NA	NA	6.8	3.5
8104801	810	6/18/2018	Elmore	18.6	8.38	350	NA	NA	NA	1.9	NA
8201201	820	7/16/2018	Kootenai/Bonner	9.3	7.98	292	NA	NA	NA	3.2	NA
8202901	820	7/11/2018	Kootenai/Bonner	16.7	7.94	339	NA	NA	NA	2.8	NA
8204501	820	7/16/2018	Kootenai/Bonner	9.3	7.93	366.6	NA	NA	NA	2.6	NA
8204601	820	7/11/2018	Kootenai/Bonner	9.6	8.12	323.4	NA	NA	NA	1.5	NA
8204701	820	7/11/2018	Kootenai/Bonner	9.5	7.78	360.7	NA	NA	NA	1.4	NA

8204801	820	7/11/2018	Kootenai/Bonner	9	8	327.8	NA	NA	NA	0.94	NA
8204901	820	7/11/2018	Kootenai/Bonner	9.5	7.81	410.6	NA	NA	NA	2	NA
8205101	820	7/16/2018	Kootenai/Bonner	8.4	7.91	343.5	NA	NA	NA	1.4	NA
8205201	820	7/16/2018	Kootenai/Bonner	9.9	7.99	301.7	NA	NA	NA	1.9	NA
8300301	830	7/24/2018	Jefferson	13.2	7.92	351.4	NA	NA	NA	4.9	NA
8300401	830	7/24/2018	Jefferson	13.4	8.06	329.9	NA	NA	NA	3.9	NA
8300501	830	7/24/2018	Jefferson	13.3	8.04	344.1	NA	NA	NA	4.2	NA
8301801	830	7/25/2018	Jefferson	16	7.59	777.2	NA	NA	NA	4.5	NA
8302001	830	7/25/2018	Jefferson	12.2	8.35	309.2	NA	NA	NA	<0.010	NA
8303001	830	7/25/2018	Jefferson	11.4	7.63	785.8	NA	NA	NA	7.3	3.5
8401601	840	6/19/2018	Bonneville/Jefferson/Madison	11.4	7.56	529	NA	NA	NA	1.2	NA
8404201	840	6/20/2018	Bonneville/Jefferson/Madison	11.9	7.58	469.4	NA	NA	NA	0.9	NA
8404301	840	6/20/2018	Bonneville/Jefferson/Madison	12.5	7.67	418.5	NA	NA	NA	0.72	NA
8404801	840	6/19/2018	Bonneville/Jefferson/Madison	12.5	7.45	585.5	NA	NA	NA	2.2	NA
8404901	840	6/19/2018	Bonneville/Jefferson/Madison	12.5	7.56	467.6	NA	NA	NA	1	NA
8405001	840	6/19/2018	Bonneville/Jefferson/Madison	11.9	7.59	497.9	NA	NA	NA	2.1	NA
8405301	840	6/18/2018	Bonneville/Jefferson/Madison	9.7	7.75	429.2	NA	NA	NA	0.27	NA
8405801	840	6/19/2018	Bonneville/Jefferson/Madison	11.8	7.56	522.8	NA	NA	NA	1.1	NA
8406101	840	6/19/2018	Bonneville/Jefferson/Madison	12.7	7.52	539.6	NA	NA	NA	1.9	NA
8406501	840	6/20/2018	Bonneville/Jefferson/Madison	12.4	7.45	307.1	NA	NA	NA	5.4	NA
8406601	840	9/19/2018	Bonneville/Jefferson/Madison	11.6	7.69	517.8	NA	NA	NA	1.6	NA
8407501	840	6/18/2018	Bonneville/Jefferson/Madison	12	7.43	571.3	NA	NA	NA	2.3	NA
8420101	842	9/19/2018	Bingham/Bonneville	13	7.42	630.2	NA	NA	NA	1.1	NA
8420201	842	9/19/2018	Bingham/Bonneville	13.3	7.51	551.1	NA	NA	NA	1.5	NA
8420301	842	9/19/2018	Bingham/Bonneville	13.5	7.56	585.6	NA	NA	NA	2	NA
8420401	842	9/18/2018	Bingham/Bonneville	15.3	7.63	754.6	NA	NA	NA	2.2	NA
8420501	842	9/18/2018	Bingham/Bonneville	13.4	7.64	599.1	NA	NA	NA	2.4	NA
8420601	842	9/18/2018	Bingham/Bonneville	12.5	7.61	603.8	NA	NA	NA	2.6	NA
8420701	842	9/18/2018	Bingham/Bonneville	13.3	7.54	579.3	NA	NA	NA	1.9	NA
8420801	842	9/17/2018	Bingham/Bonneville	14.4	7.54	430.7	NA	NA	NA	0.57	NA
8420901	842	9/17/2018	Bingham/Bonneville	13.5	7.45	566	NA	NA	NA	2.2	NA

8421001	842	9/17/2018	Bingham/Bonneville	12.9	7.51	576.1	NA	NA	NA	3.5	NA
8421101	842	9/19/2018	Bingham/Bonneville	13.2	7.52	537.2	NA	NA	NA	1.4	NA
8421201	842	9/17/2018	Bingham/Bonneville	13.3	7.43	586.7	NA	NA	NA	3.7	NA
8421301	842	9/17/2018	Bingham/Bonneville	13.3	7.45	587.9	NA	NA	NA	3.5	NA
8421401	842	9/17/2018	Bingham/Bonneville	13.9	7.25	665.5	NA	NA	NA	2.7	NA
8421501	842	9/17/2018	Bingham/Bonneville	12.9	7.49	586.8	NA	NA	NA	3.4	NA
8421601	842	9/18/2018	Bingham/Bonneville	13.3	7.54	583	NA	NA	NA	2.6	NA
8421701	842	9/18/2018	Bingham/Bonneville	13	7.59	568.6	NA	NA	NA	2.3	NA
8421801	842	9/18/2018	Bingham/Bonneville	14.5	7.68	437.2	NA	NA	NA	1.4	NA
8421901	842	9/17/2018	Bingham/Bonneville	13	7.49	584.1	NA	NA	NA	3.3	NA
8450301	845	7/17/2018	Bingham	15.3	7.37	545.9	NA	NA	NA	1	NA
8450601	845	7/16/2018	Bingham	13	7.52	459.3	NA	NA	NA	1.9	NA
8450801	845	7/17/2018	Bingham	13.4	7.59	512.7	NA	NA	NA	2.3	NA
8452101	845	8/14/2018	Bingham	14	8.17	465.4	NA	NA	NA	<0.010	NA
8452501	845	7/17/2018	Bingham	13.5	7.54	498.9	NA	NA	NA	1.6	NA
8452701	845	8/14/2018	Bingham	14.3	7.73	459.9	NA	NA	NA	0.92	NA
8452801	845	7/16/2018	Bingham	12.7	7.47	451.3	NA	NA	NA	0.85	NA
8453101	845	8/14/2018	Bingham	11.9	7.66	497.3	NA	NA	NA	1.6	NA
8453301	845	7/17/2018	Bingham	13.5	7.54	477.7	NA	NA	NA	1.9	NA
8453801	845	7/16/2018	Bingham	13	7.6	397.2	NA	NA	NA	0.83	NA
8601101	860	8/20/2018	Owyhee	14.9	7.3	2448	<0.010	NA	NA	5.3	4.1
8601401	860	8/20/2018	Owyhee	15.1	7.3	1478	<0.010	NA	NA	8.2	8.4
8602001	860	8/20/2018	Owyhee	14.9	7.09	2459	0.27	NA	NA	**11**	8.0
8602901	860	8/21/2018	Owyhee	19.1	7.64	2361	9.1	NA	NA	0.21	NA
8603001	860	8/21/2018	Owyhee	21.7	7.17	1608	9.4	NA	NA	<0.010	NA
8603101	860	8/21/2018	Owyhee	18.2	7.71	2154	7.7	NA	NA	0.12	NA
8650101	865	8/14/2018	Owyhee	15.2	7.42	1138	NA	NA	NA	**13**	5.6
8650201	865	8/15/2018	Owyhee	16	7.66	906.3	NA	NA	NA	8.6	4.8
8650301	865	8/14/2018	Owyhee	14.9	7.09	2830	NA	NA	NA	**90**	6.9
8650501	865	8/15/2018	Owyhee	17.5	7.09	2473	NA	NA	NA	**20**	8.5
8650701	865	8/15/2018	Owyhee	15.7	7.46	1573	NA	NA	NA	**38**	2.5

8651301	865	8/14/2018	Owyhee	17.6	7.7	758.6	NA	NA	NA	3.2	10.6
8653401	865	8/14/2018	Owyhee	14.1	7.34	1168	NA	NA	NA	4.1	NA
8655001	865	8/14/2018	Owyhee	14.2	7.24	1224	NA	NA	NA	**10**	6.7
8657801	865	8/14/2018	Owyhee	15.5	7.42	1330	NA	NA	NA	**21**	5.7
8700501	870	5/7/2018	Gooding	12	6.96	875.2	NA	NA	NA	8.1	4.9
8700601	870	5/7/2018	Gooding	15.3	7.01	839.2	NA	NA	NA	12	NA
8701201	870	5/7/2018	Gooding	14.6	7.04	829.7	NA	NA	NA	6.3	3.5
8701801	870	5/7/2018	Gooding	15.9	6.84	816.7	NA	NA	NA	3	NA
8706201	870	5/7/2018	Gooding	13	7.17	1260	NA	NA	NA	**19**	8.5
8706501	870	5/7/2018	Gooding	19.1	7.66	316.7	NA	NA	NA	0.015	NA
8900501	890	6/19/2018	Elmore	17.3	7.51	874.6	NA	NA	NA	3.7	NA
8900601	890	6/19/2018	Elmore	16.8	7.47	871.2	NA	NA	NA	4.1	NA
8900801	890	6/19/2018	Elmore	15.1	7.48	1494	NA	NA	NA	**39**	3.5
8901801	890	6/19/2018	Elmore	16.6	7.53	1097	NA	NA	NA	7	3.4
8902201	890	6/19/2018	Elmore	17.2	7.61	1179	NA	NA	NA	**18**	5.0
9500201	950	7/30/2018	Nez Perce/Lewis/Idaho	12.3	7.44	625.5	NA	NA	NA	8.2	4.6
9501201	950	8/1/2018	Nez Perce/Lewis/Idaho	12.5	7.77	366.6	NA	NA	NA	1.4	NA
9501401	950	7/17/2018	Nez Perce/Lewis/Idaho	12.5	7.21	1142	NA	NA	NA	**37**	13.9
9501901	950	7/11/2018	Nez Perce/Lewis/Idaho	15	7.54	514.4	NA	NA	NA	5.2	NA
9502201	950	7/24/2018	Nez Perce/Lewis/Idaho	12.3	7.65	517.7	NA	NA	NA	9.3	4.4
9502701	950	7/16/2018	Nez Perce/Lewis/Idaho	12.2	7.82	438.8	NA	NA	NA	4.4	NA
9502801	950	7/30/2018	Nez Perce/Lewis/Idaho	12.8	8.01	438	NA	NA	NA	0.38	7.7
9503701	950	7/25/2018	Nez Perce/Lewis/Idaho	18.3	7.73	356.2	NA	NA	NA	0.024	NA
9503901	950	7/16/2018	Nez Perce/Lewis/Idaho	11.1	7.49	330.9	NA	NA	NA	3.4	NA
9504301	950	7/23/2018	Nez Perce/Lewis/Idaho	11.4	7.44	1171	NA	NA	NA	**21**	4.2
9505401	950	7/11/2018	Nez Perce/Lewis/Idaho	12.5	7.67	665	NA	NA	NA	**15**	2.6
9505501	950	7/11/2018	Nez Perce/Lewis/Idaho	17.5	8.47	321.2	NA	NA	NA	0.031	NA
9505701	950	8/1/2018	Nez Perce/Lewis/Idaho	10.7	7.46	379.5	NA	NA	NA	4.5	NA
9506001	950	7/31/2018	Nez Perce/Lewis/Idaho	10.8	7.03	258.2	NA	NA	NA	7.3	NA
9506401	950	7/31/2018	Nez Perce/Lewis/Idaho	12.4	7.74	359.1	NA	NA	NA	<0.010	NA
9507601	950	7/23/2018	Nez Perce/Lewis/Idaho	11.9	7.67	545.2	NA	NA	NA	**11**	1.7

9507901	950	7/17/2018	Nez Perce/Lewis/Idaho	12.2	7.77	399.6	NA	NA	NA	6.1	NA

Notes: NA = not analyzed. Bolded red numbers indicate EPA's NPDWR standard, expressed as a maximum contaminant level (MCL), was reached or exceeded.
a. Contaminant with a NSDWR standard.
b. Contaminant with a NPDWR standard.

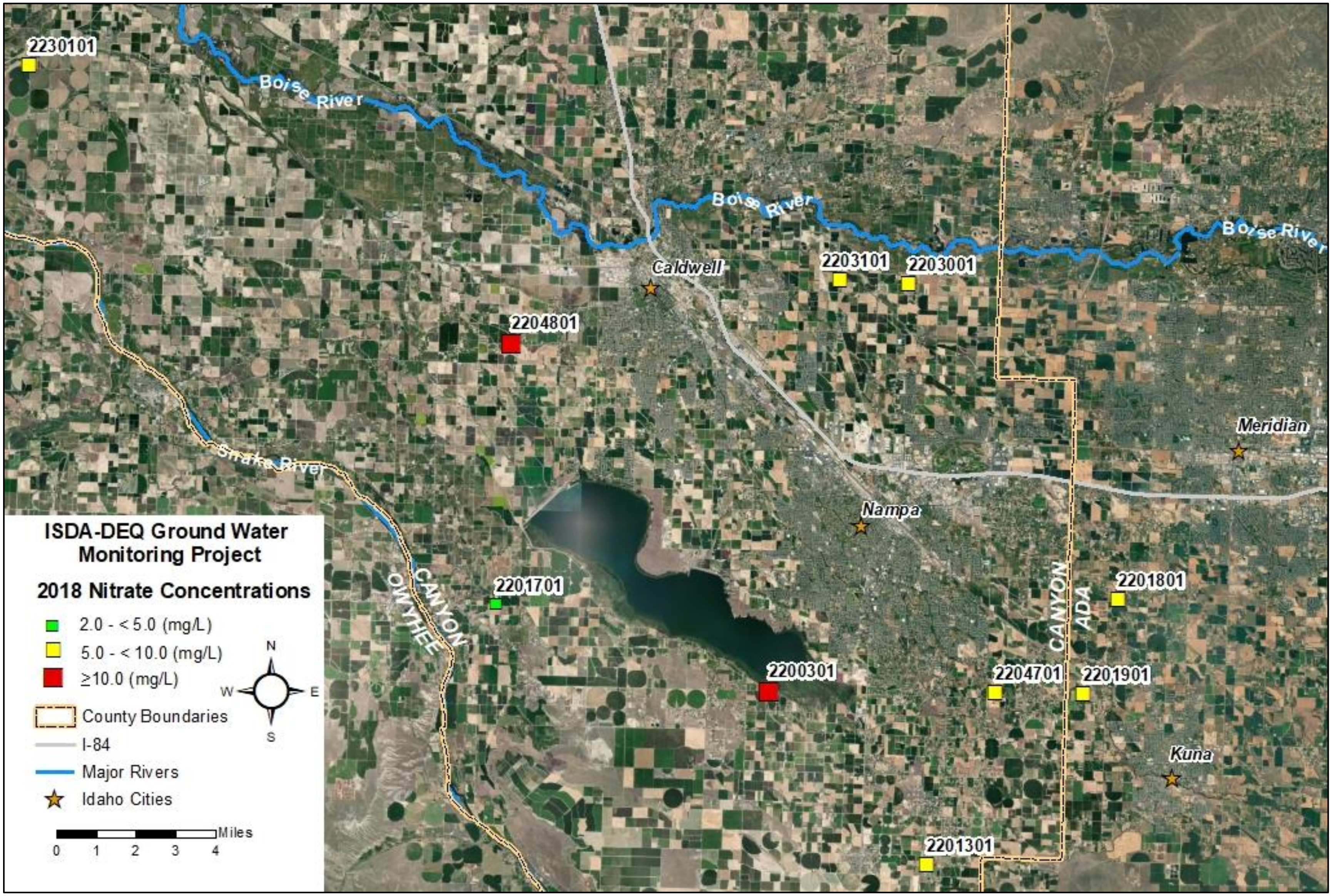

Figure B1. Project 220 (Ada and Canyon Counties) nitrate concentrations, 2018 ISDA data.

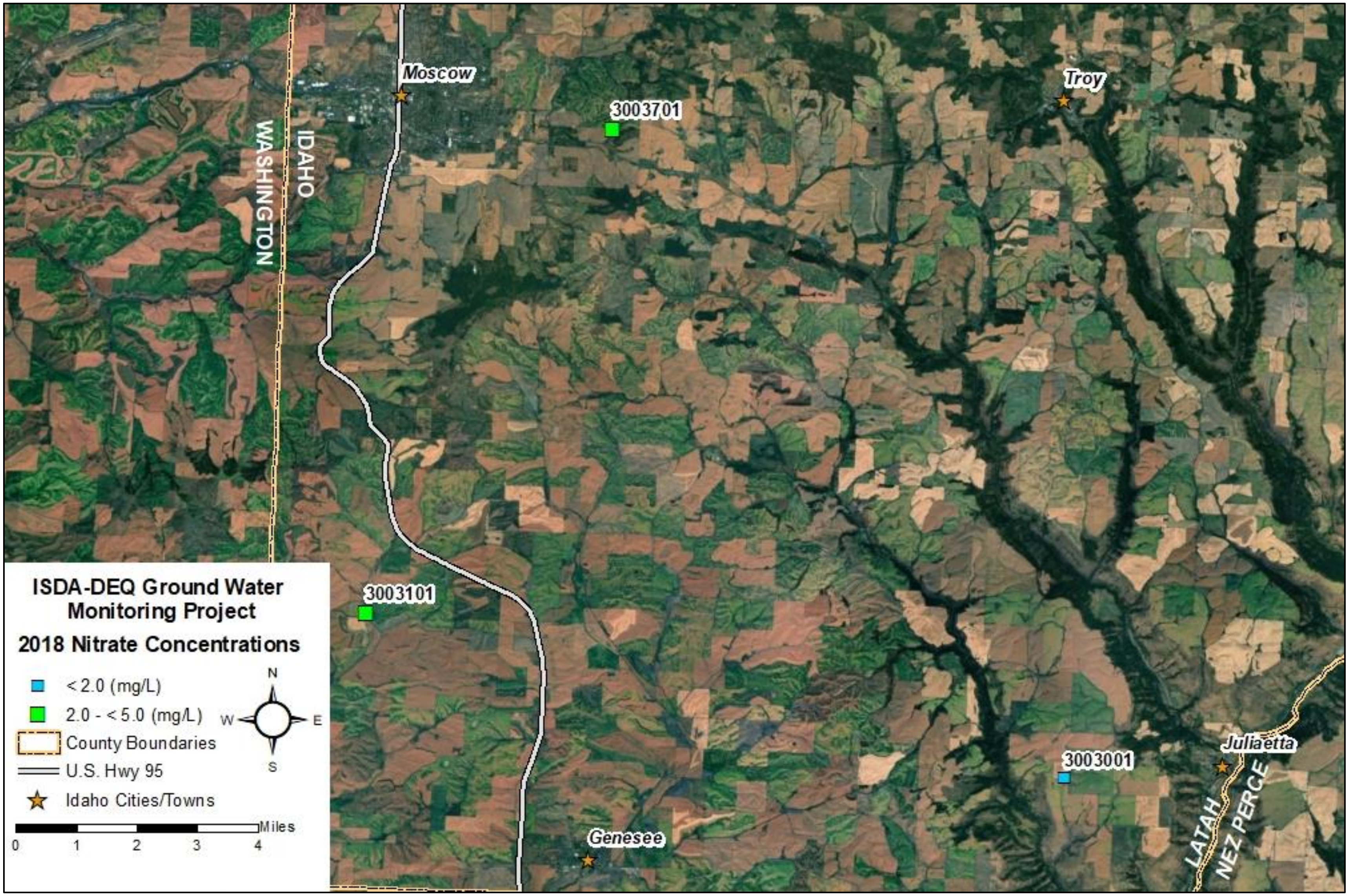

Figure B2. Project 300 (Latah County) nitrate concentrations, 2018 ISDA data.

Figure B3. Project 310 (Owyhee County) nitrate concentrations, 2018 ISDA data.

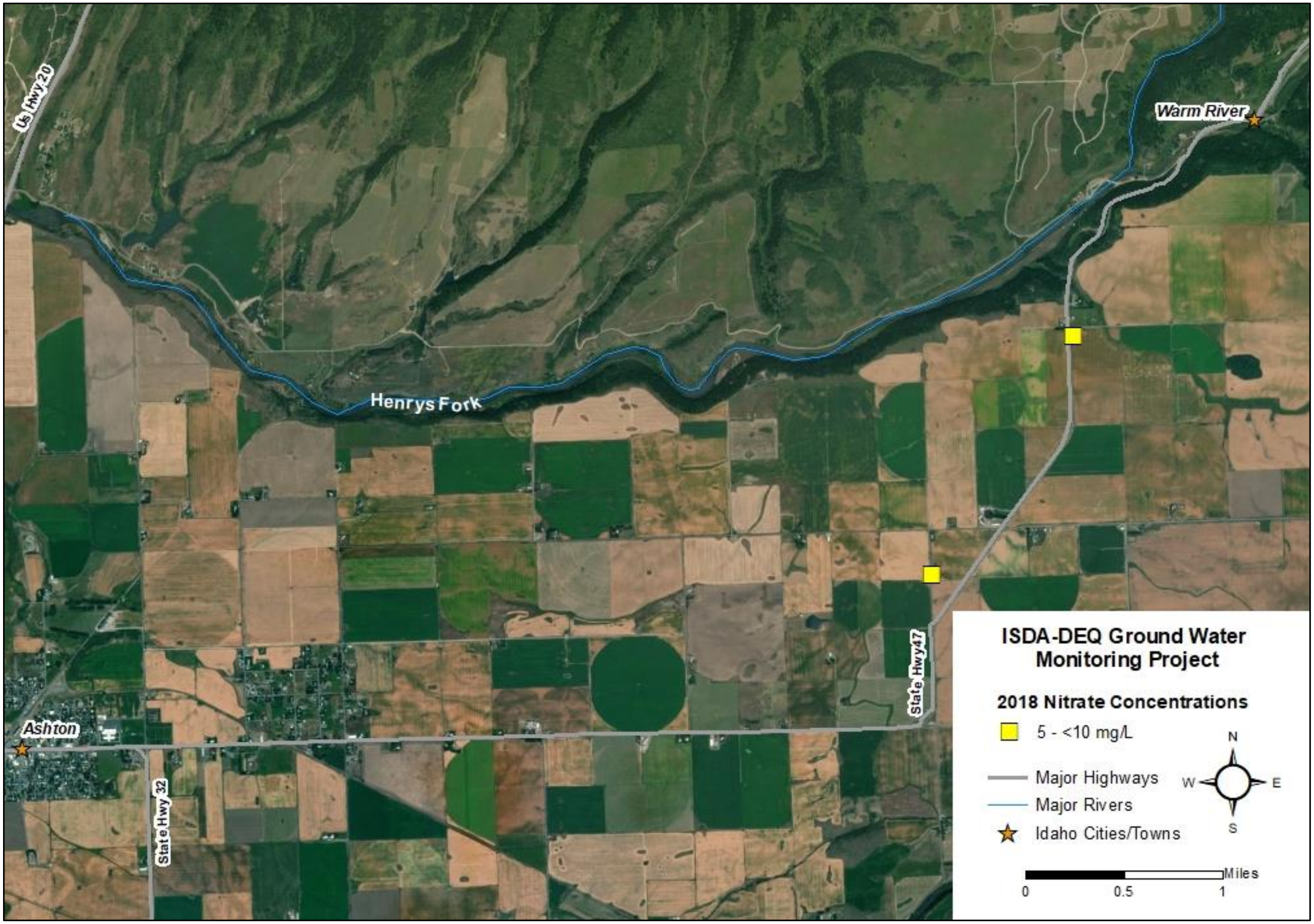

Figure B4. Project 320 (Fremont County) nitrate concentrations, 2018 ISDA data.

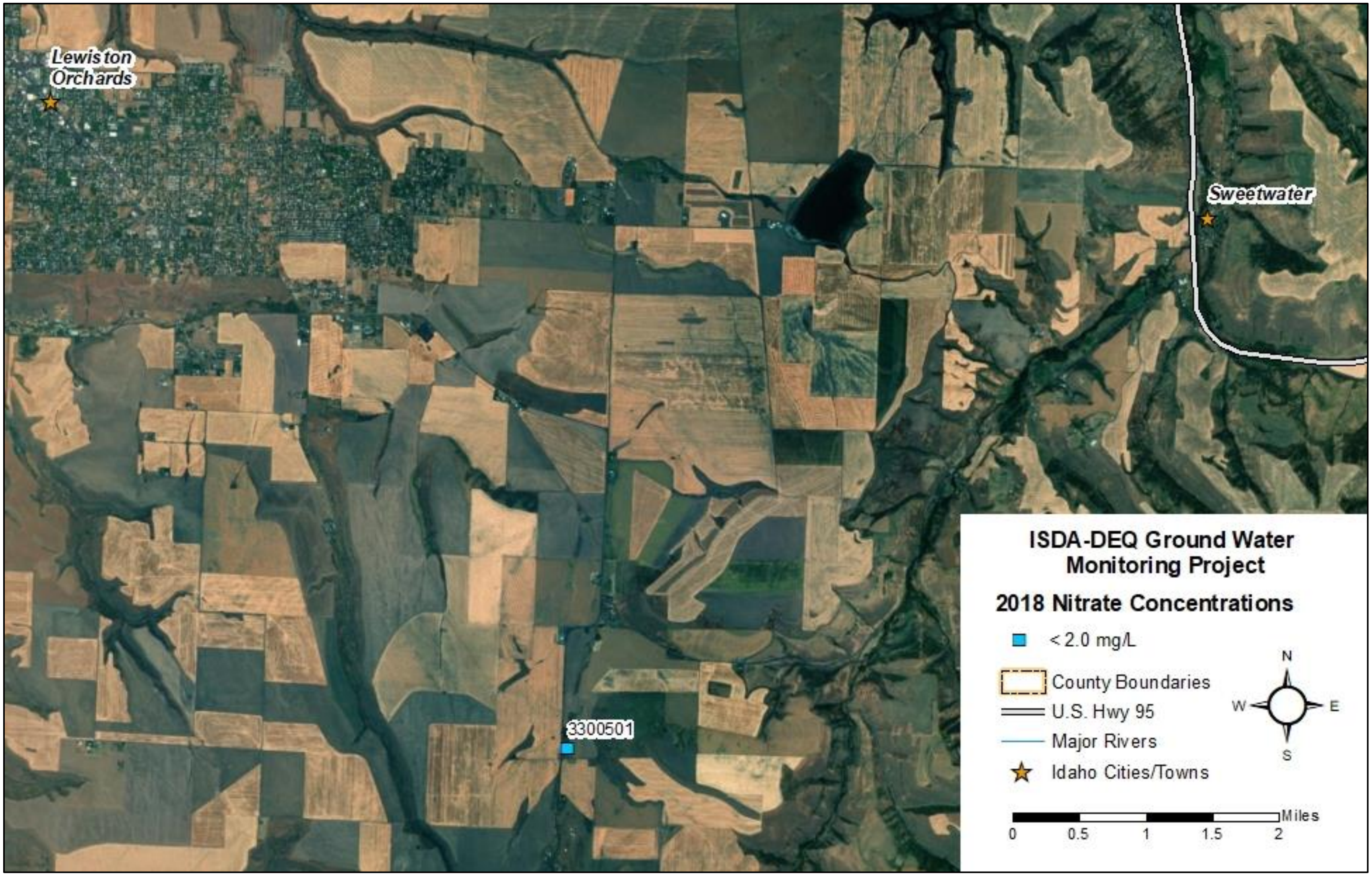

Figure B5. Project 330 (Nez Perce County) nitrate concentrations, 2018 ISDA data.

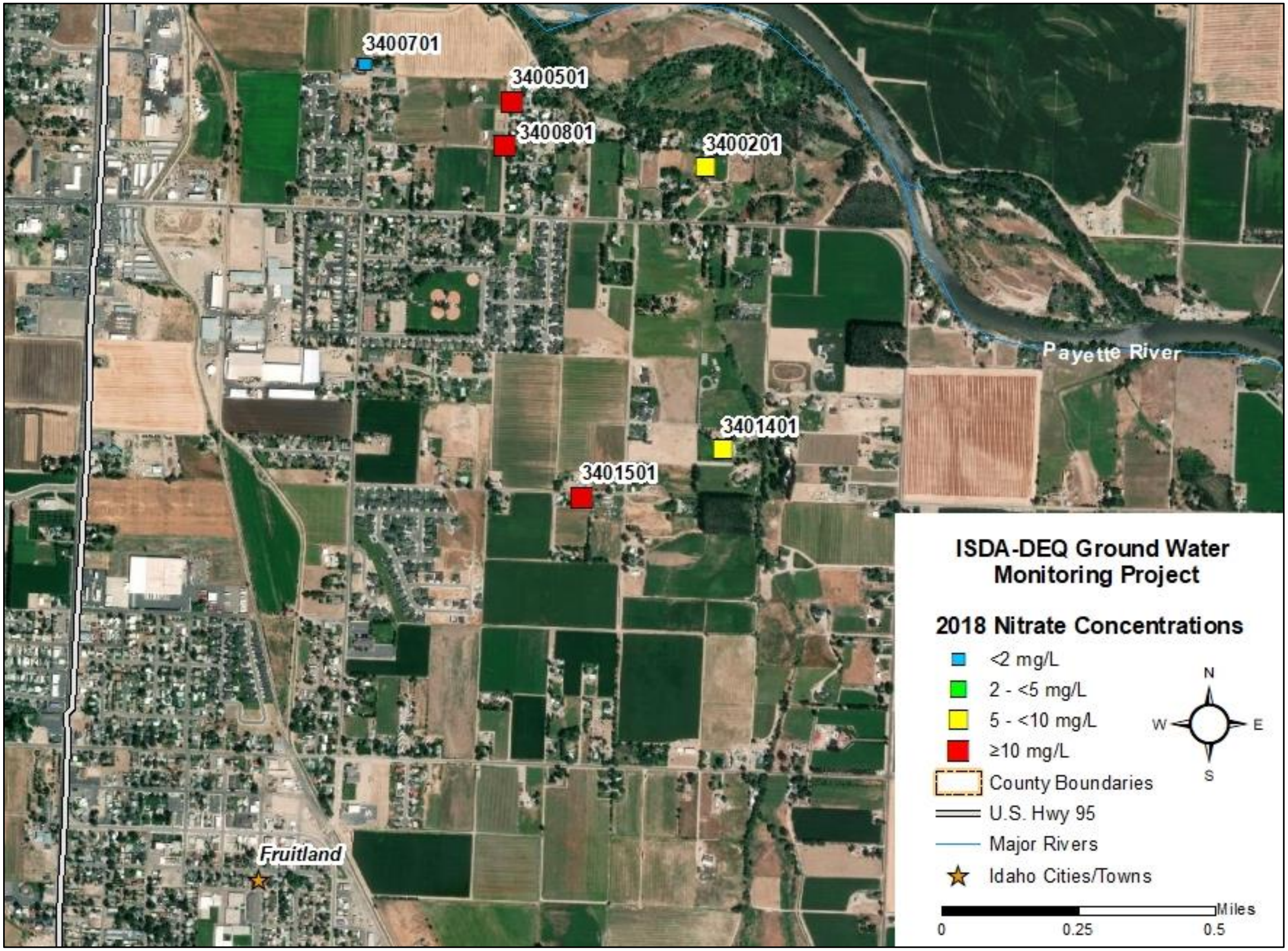

Figure B6. Project 340 (Payette County) nitrate concentrations, 2018 ISDA data.

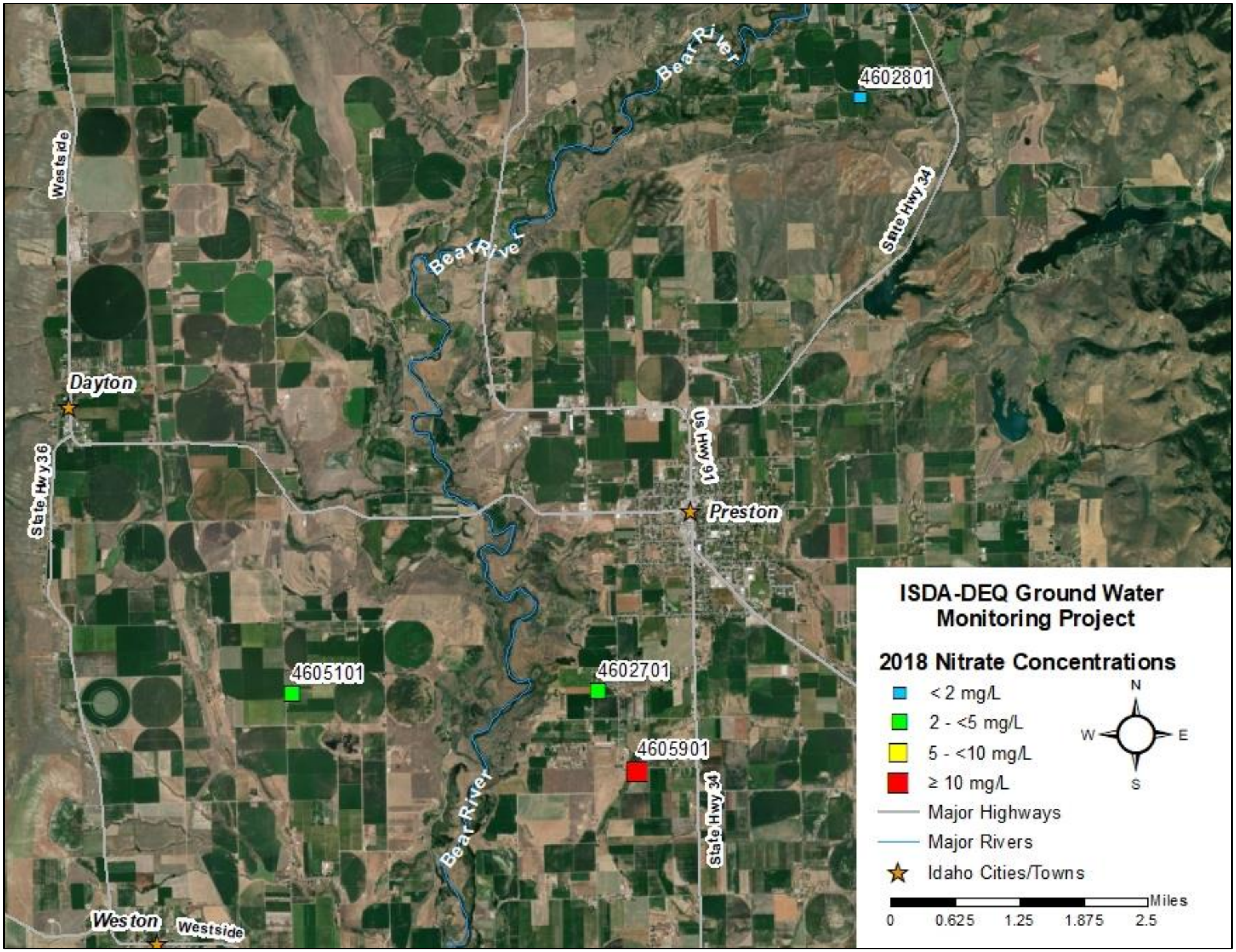

Figure B7. Project 460 (Franklin County) nitrate concentrations, 2018 ISDA data.

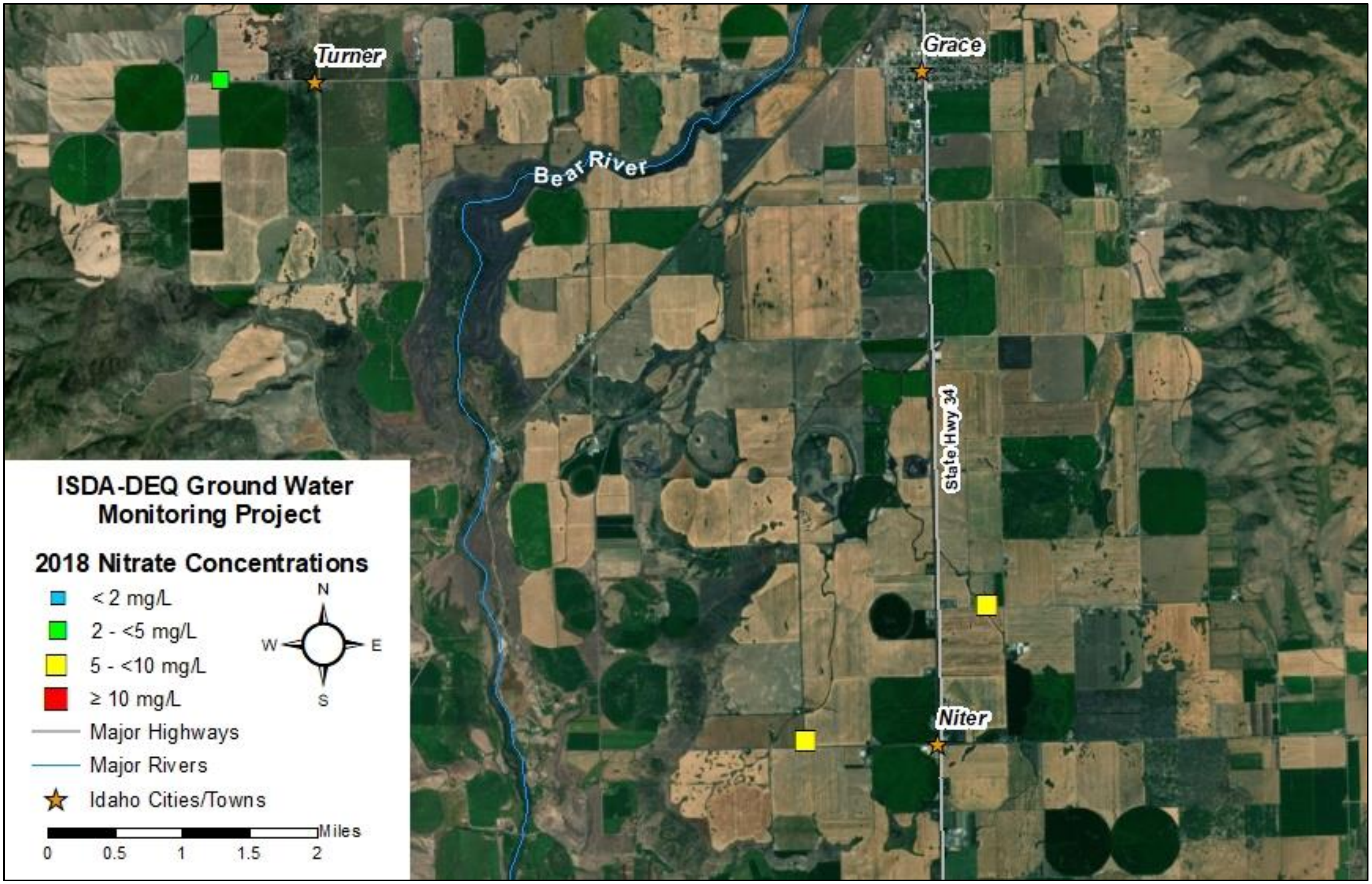

Figure B8. Project 490 (Caribou County) nitrate concentrations, 2018 ISDA data.

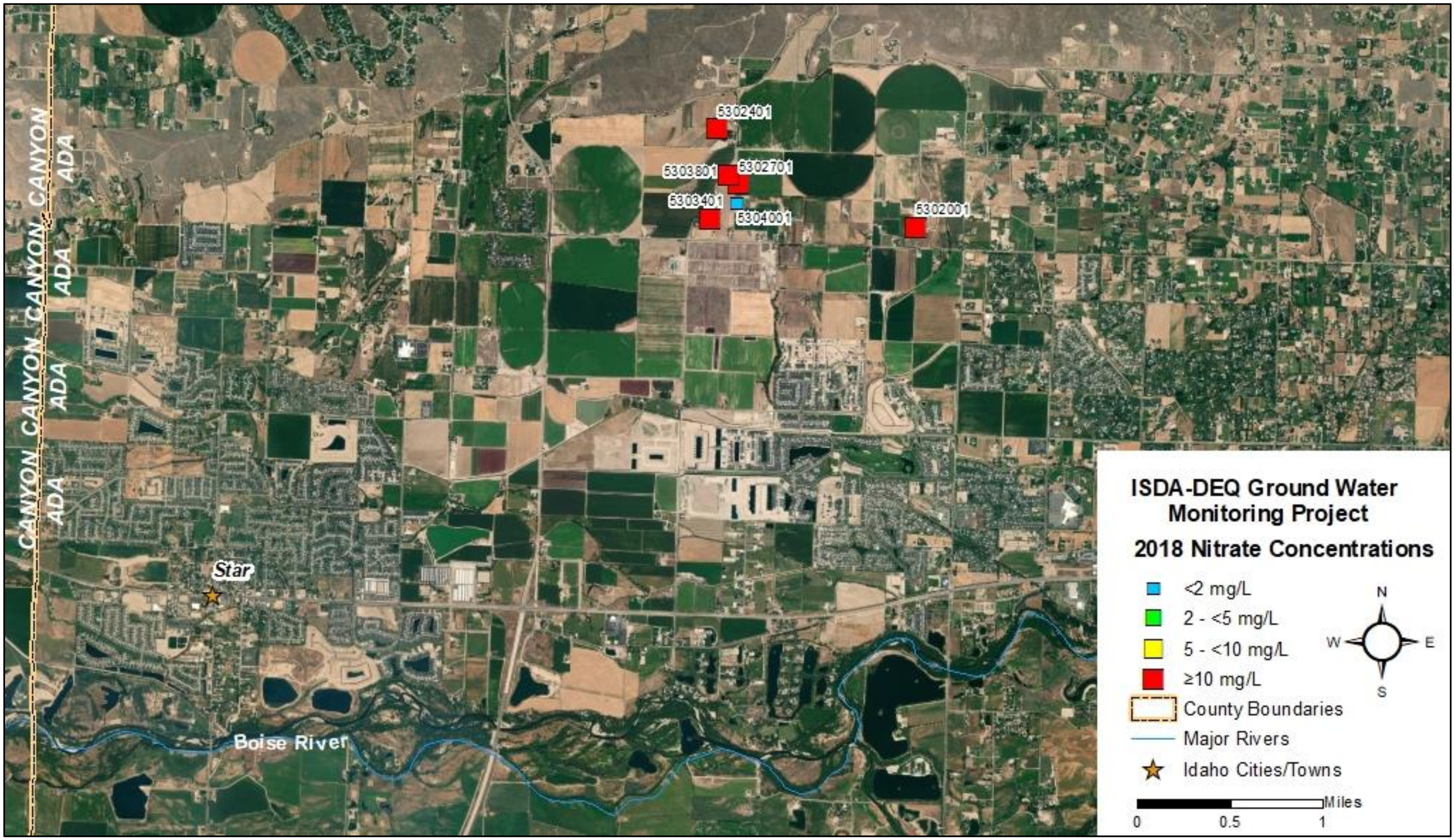

Figure B9. Project 530 (Ada County) nitrate concentrations, 2018 ISDA data.

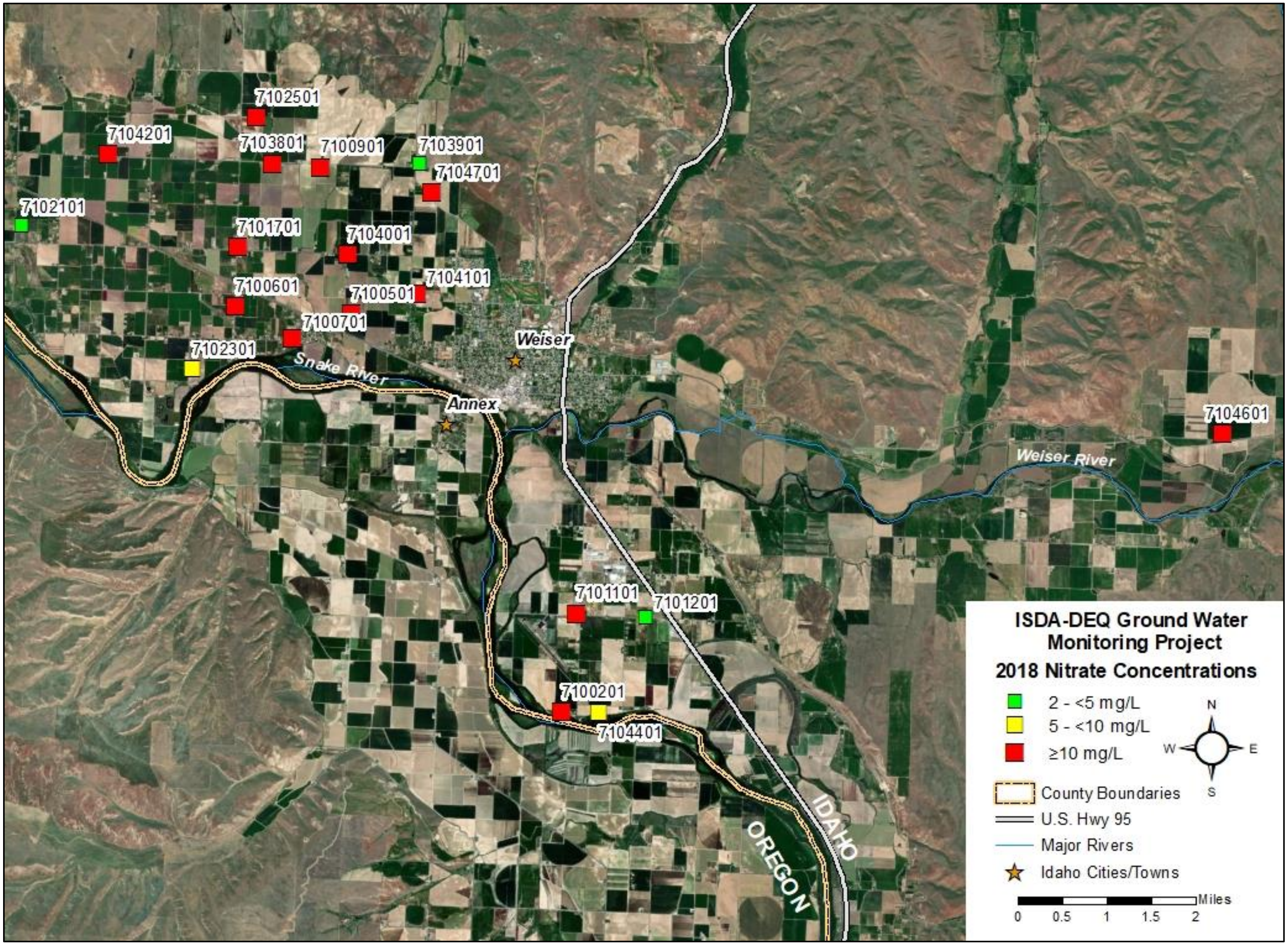

Figure B10. Project 710 (Washington County) nitrate concentrations, 2018 ISDA data.

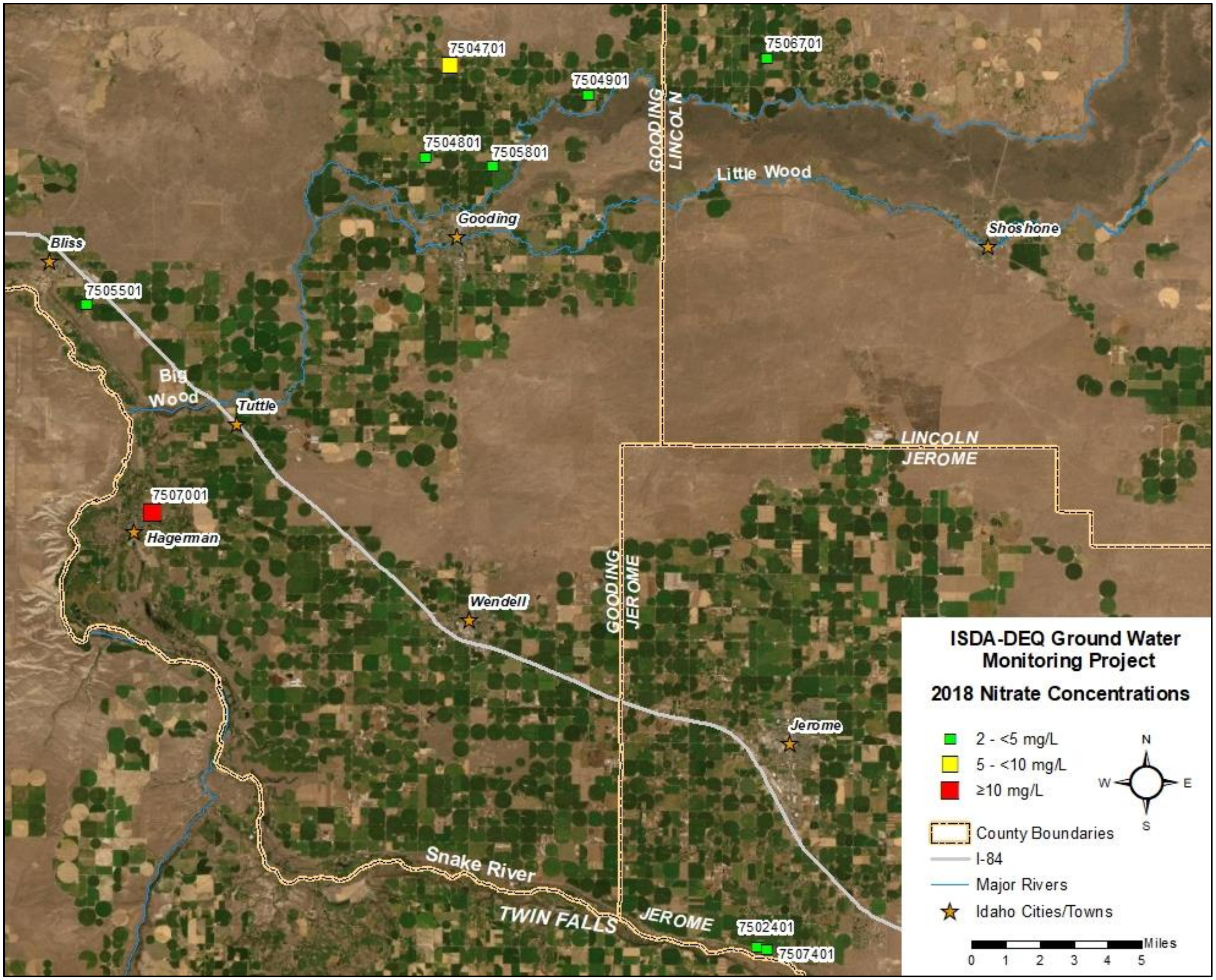

Figure B11. Project 750 (Gooding, Jerome, and Lincoln Counties) nitrate concentrations, 2018 ISDA data.

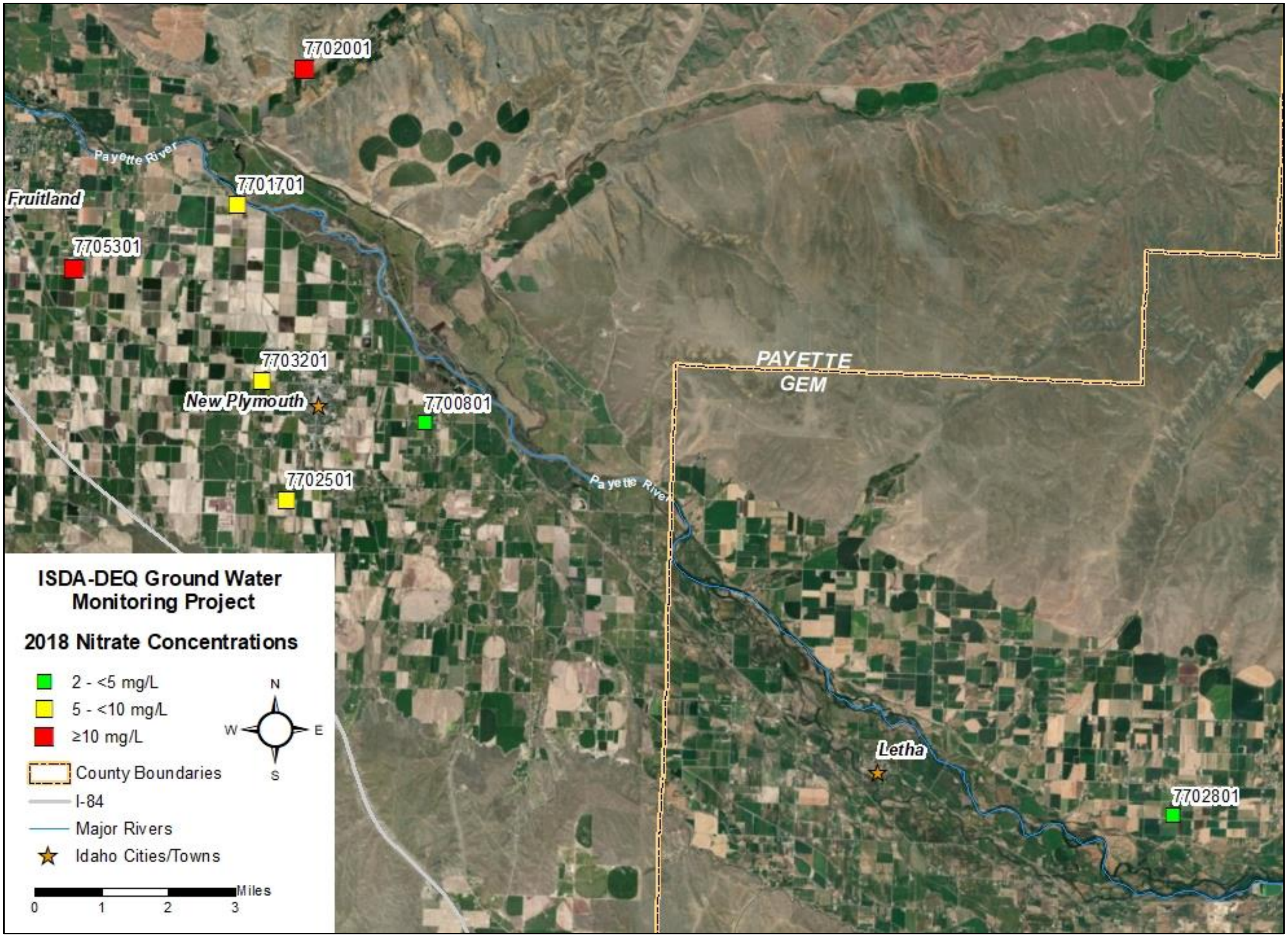

Figure B12. Project 770 (Gem and Payette Counties) nitrate concentrations, 2018 ISDA data.

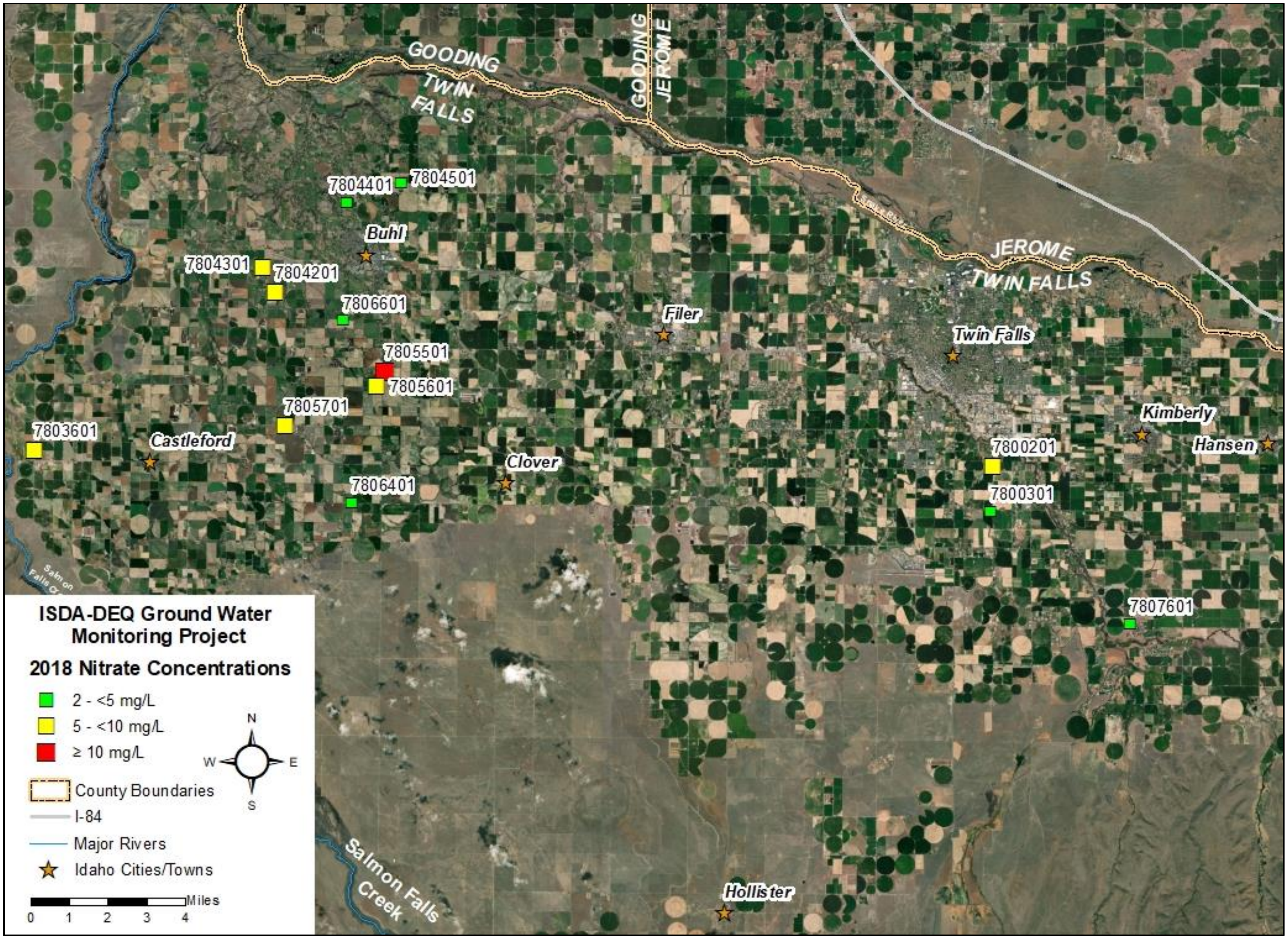

Figure B13. Project 780 (Twin Falls County) nitrate concentrations, 2018 ISDA data.

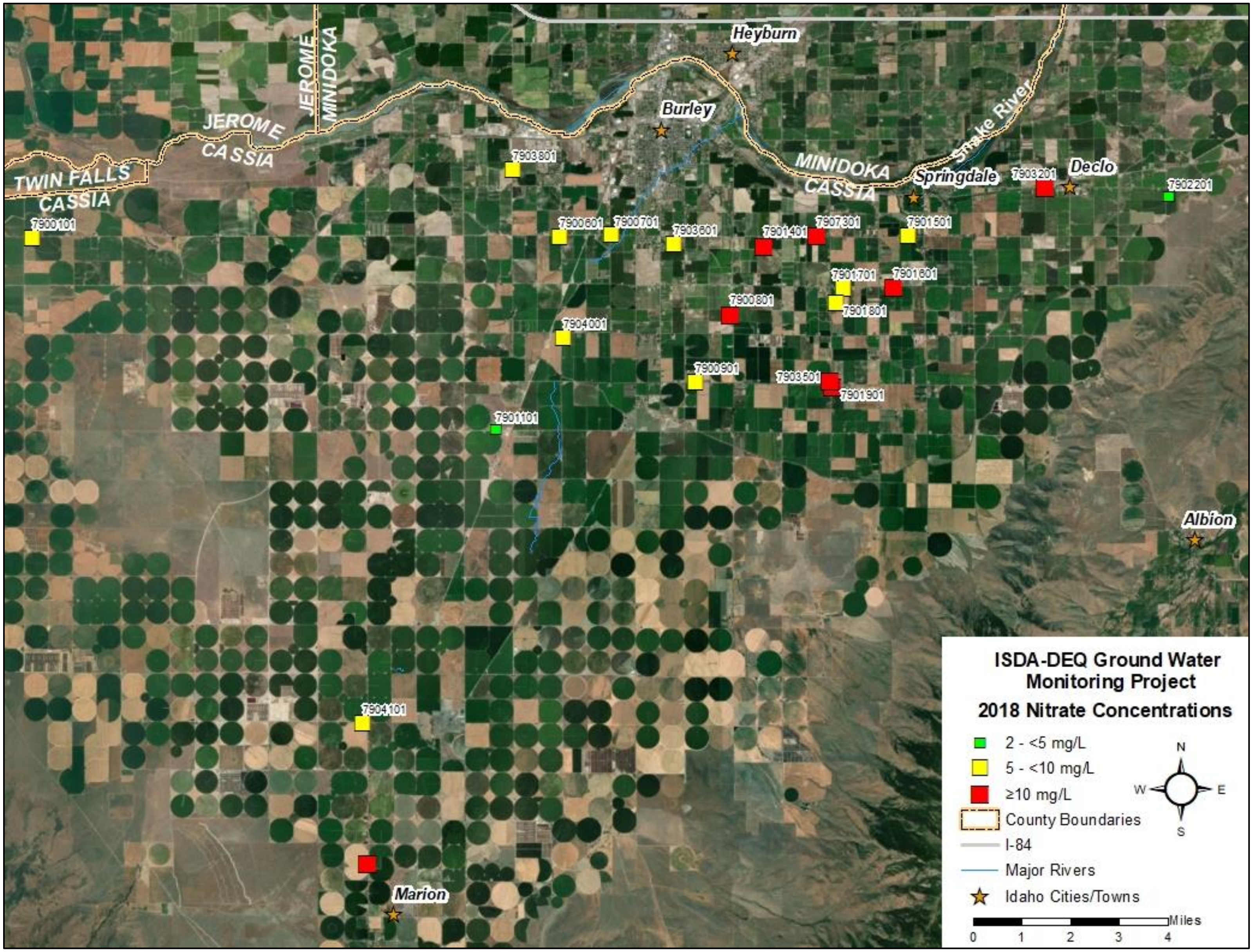

Figure B14. Project 790 (Cassia County) nitrate concentrations, 2018 ISDA data.

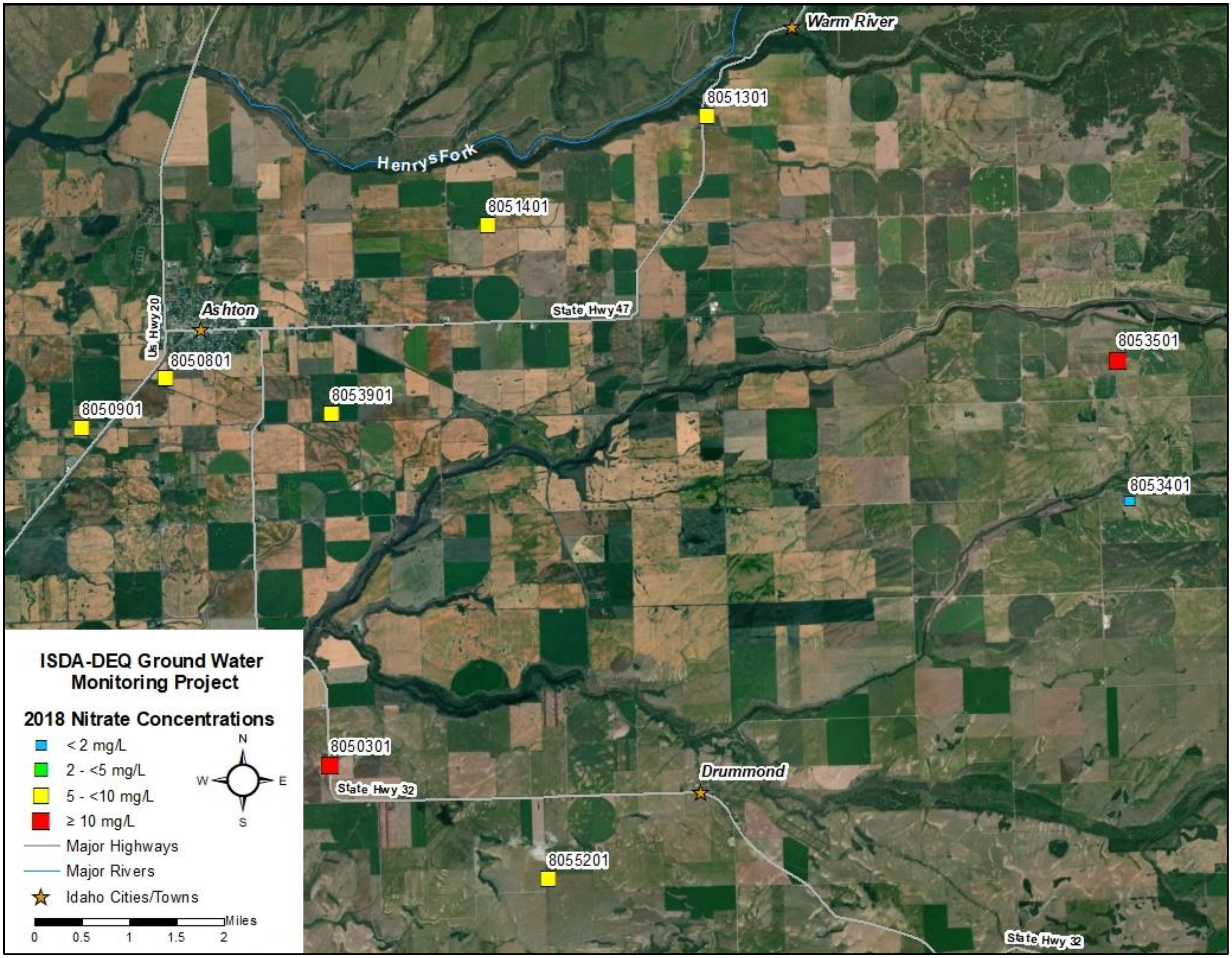

Figure B15. Project 805 (Fremont County) nitrate concentrations, 2018 ISDA data.

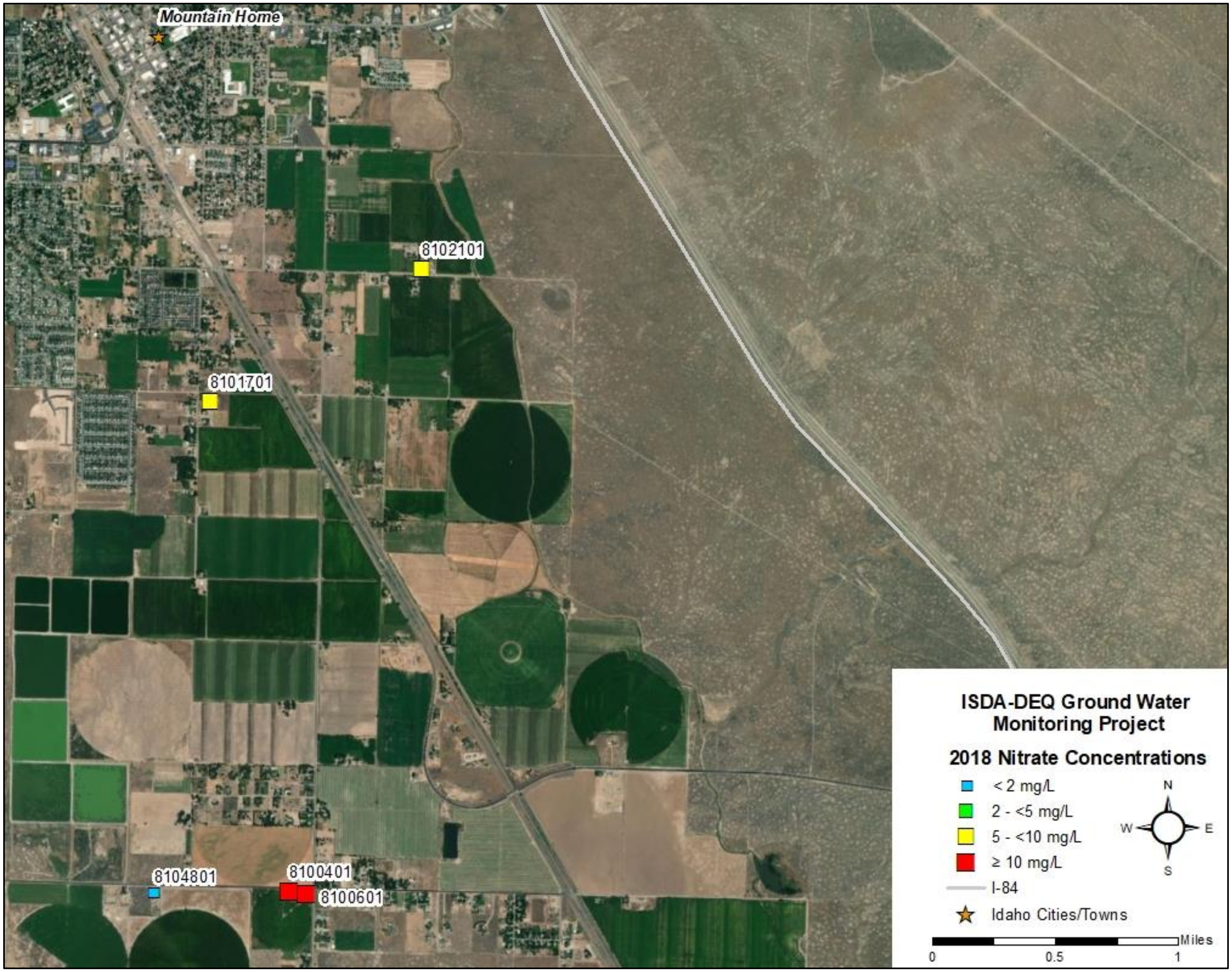

Figure B16. Project 810 (Elmore County) nitrate concentrations, 2018 ISDA data.

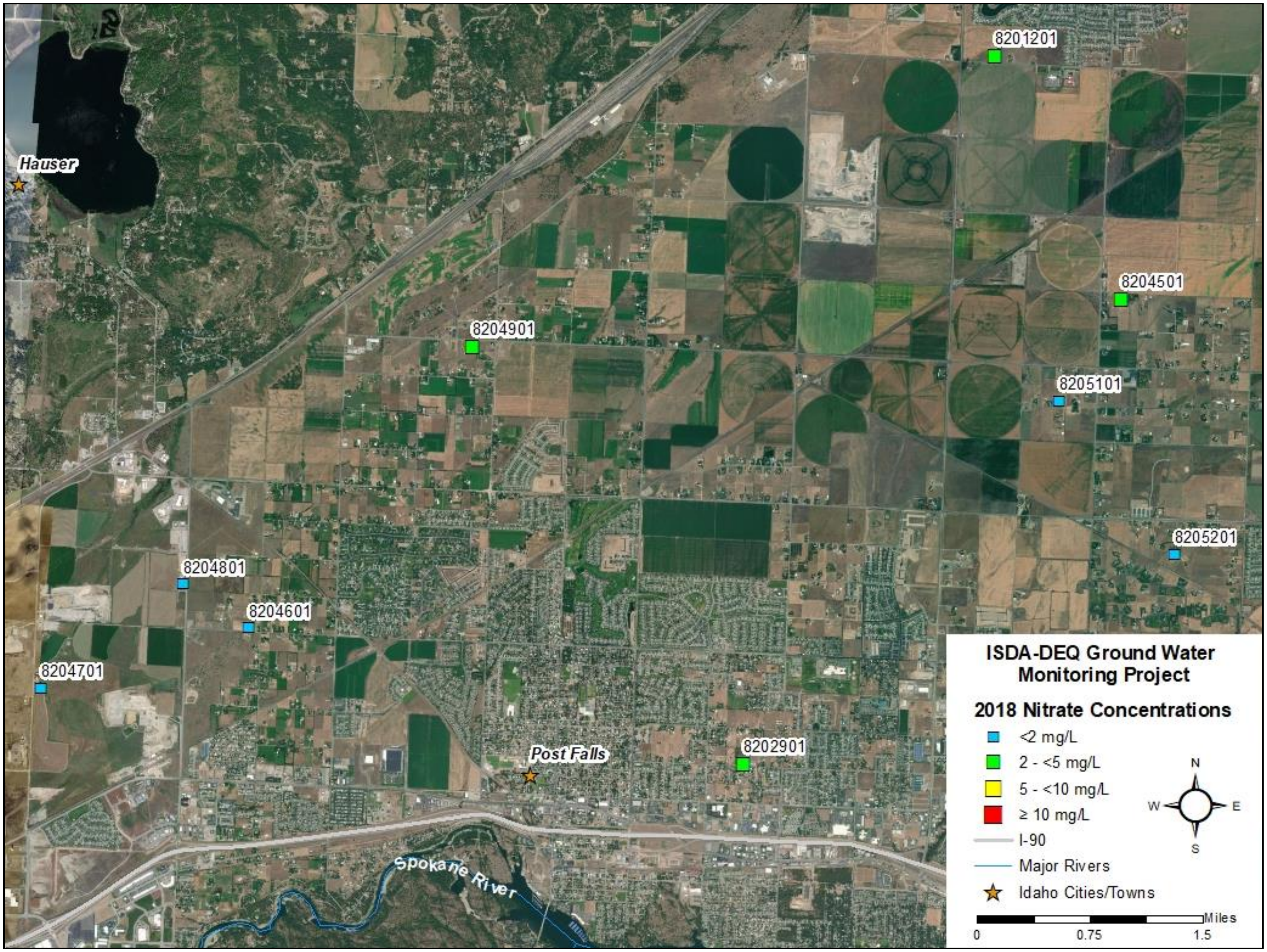

Figure B17. Project 820 (Kootenai County) nitrate concentrations, 2018 ISDA data.

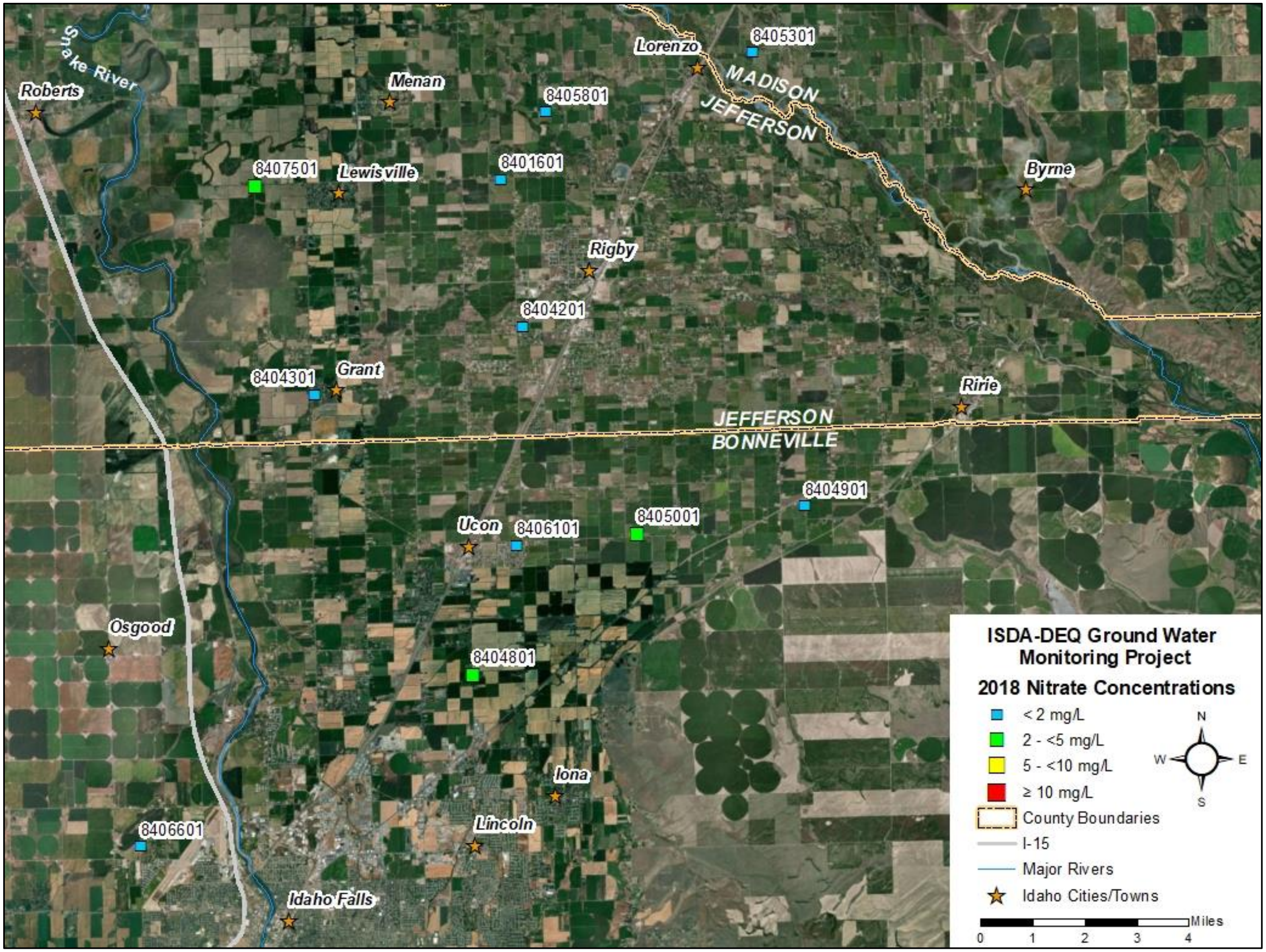

Figure B18. Project 840 (Bonneville, Jefferson, and Madison Counties) nitrate concentrations, 2018 ISDA data.

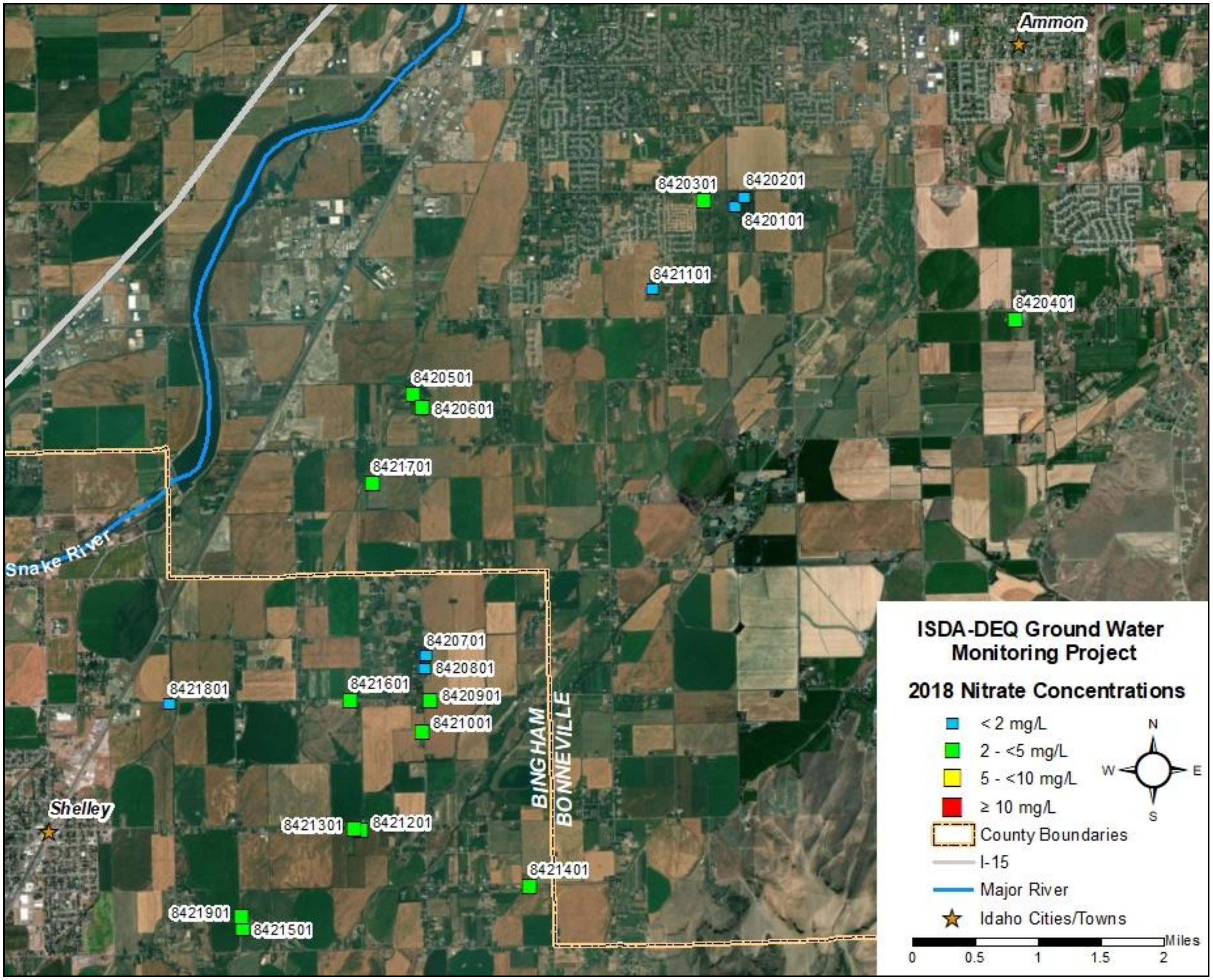

Figure B19. Project 842 (Bingham and Bonneville Counties) nitrate concentrations, 2018 ISDA data.

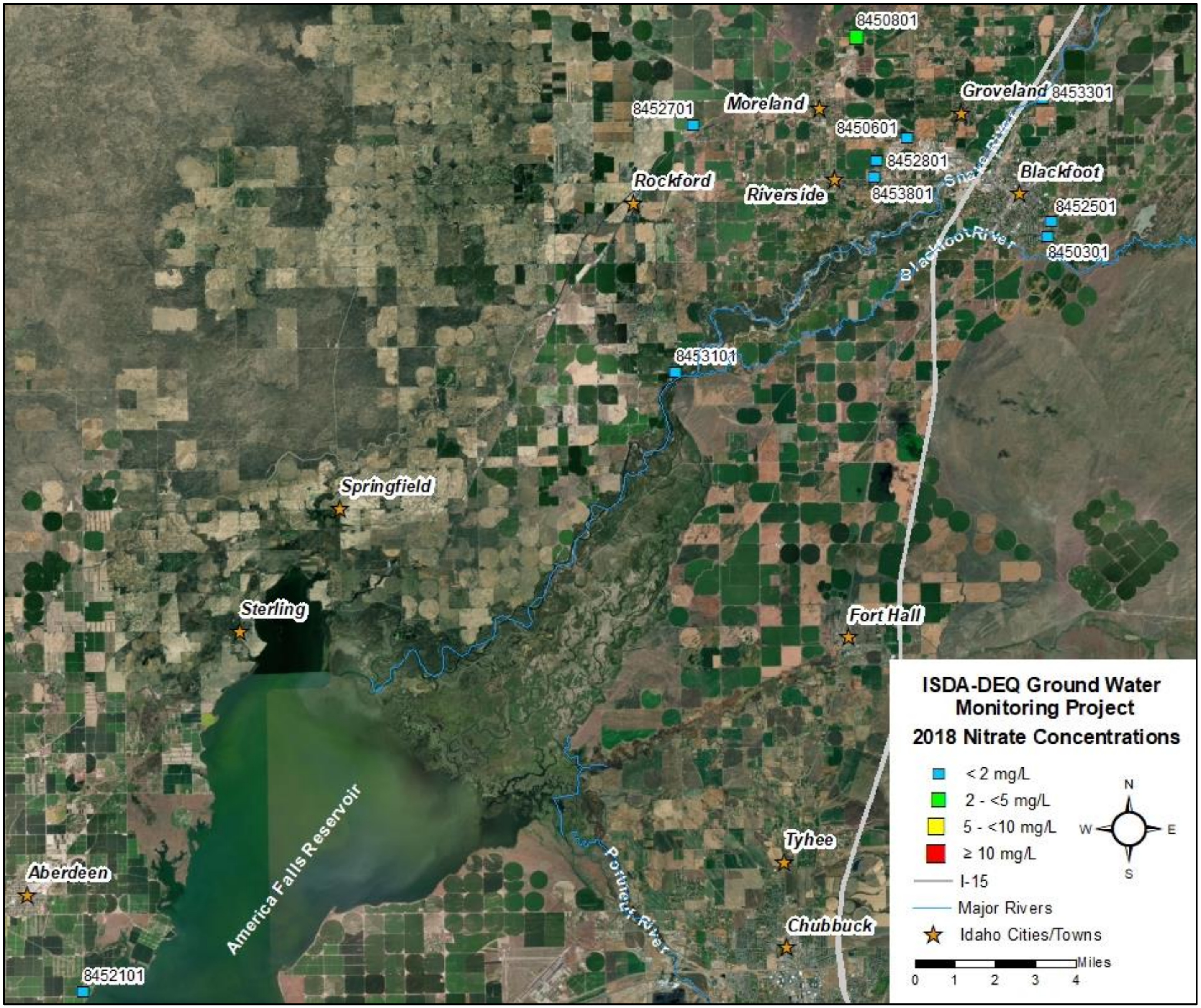

Figure B20. Project 845 (Bingham County) nitrate concentrations, 2018 ISDA data.

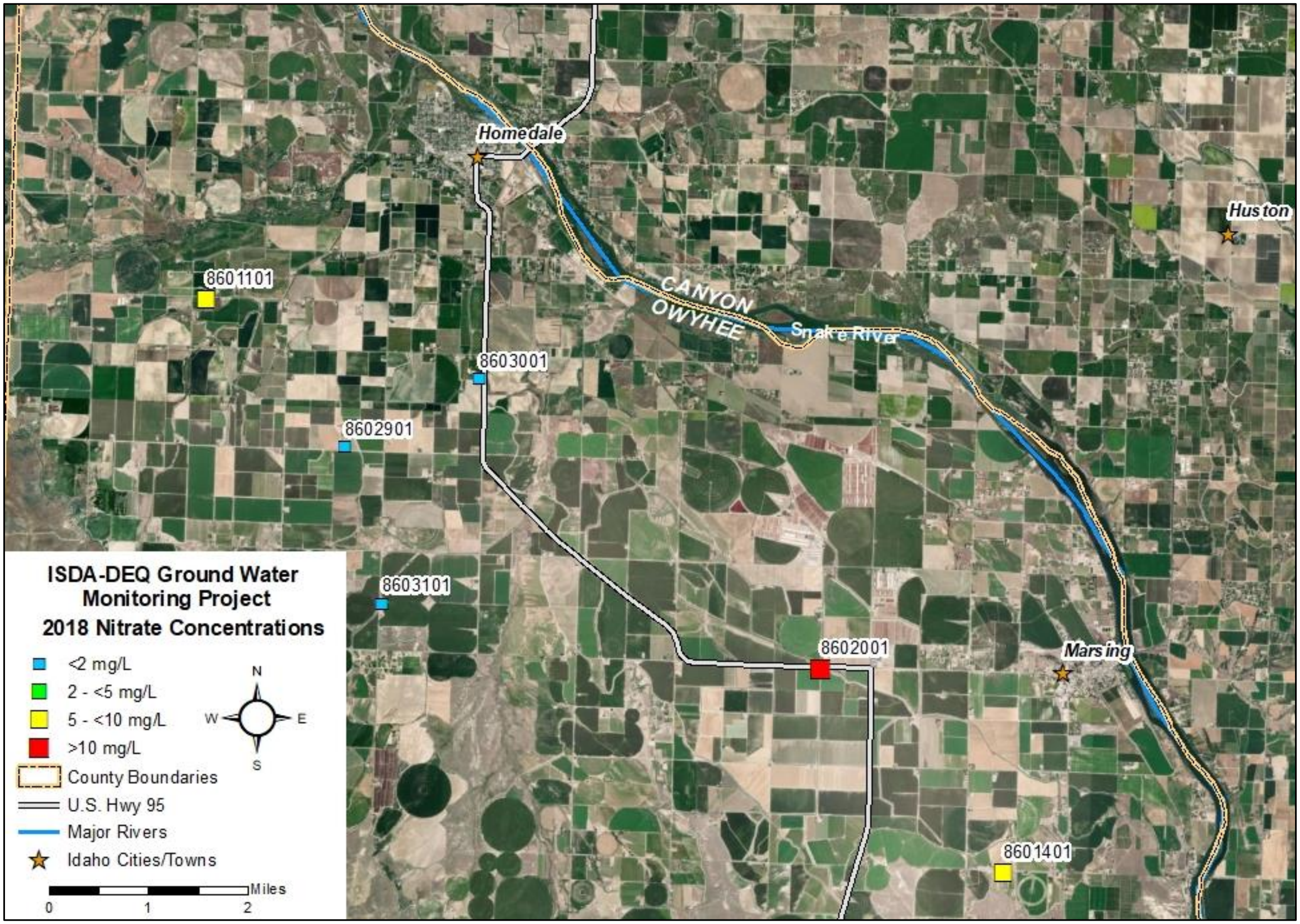

Figure B21. Project 860 (Owyhee County) nitrate concentrations, 2018 ISDA data.

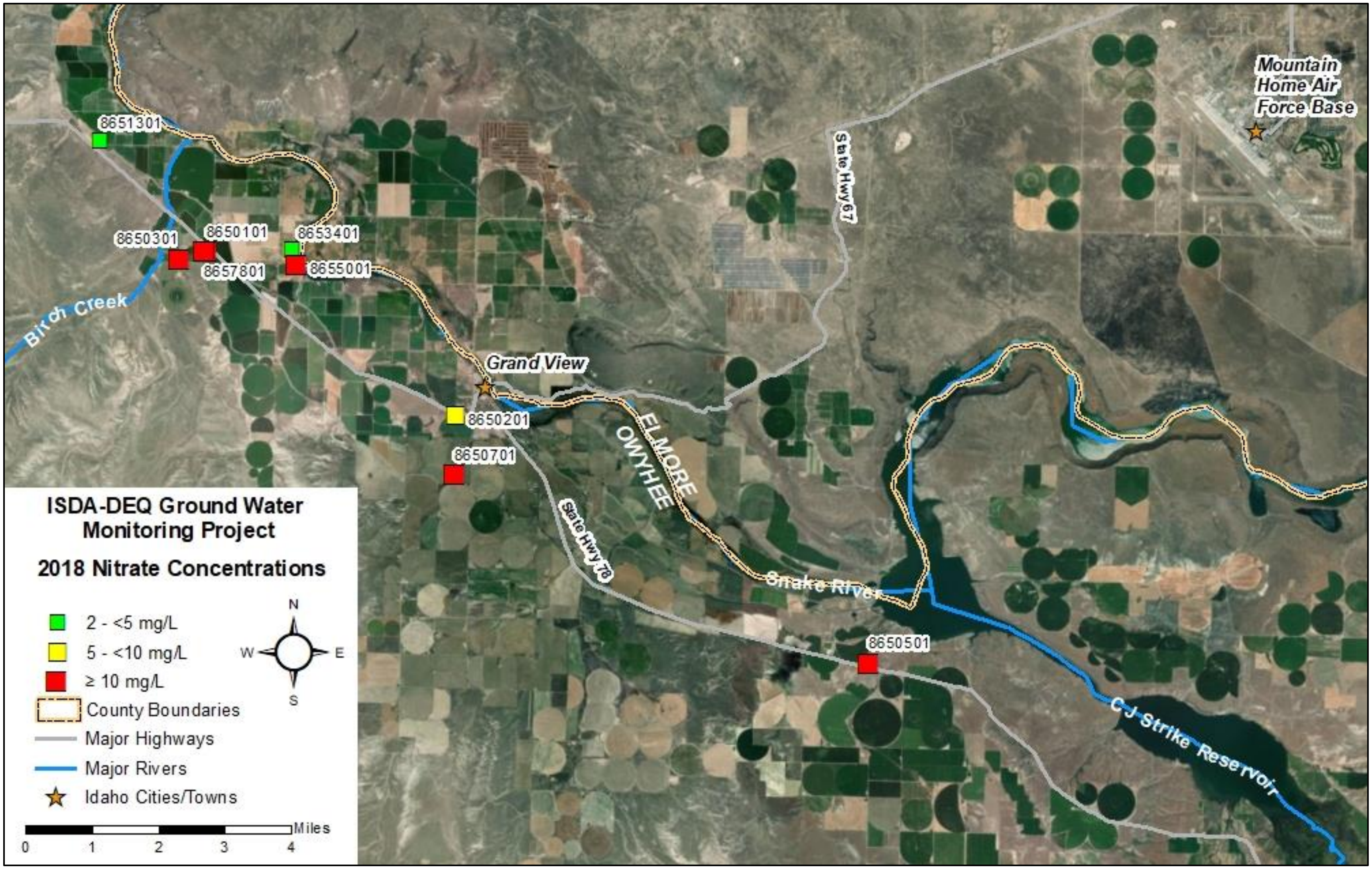

Figure B22. Project 865 (Owyhee County) nitrate concentrations, 2018 ISDA data.

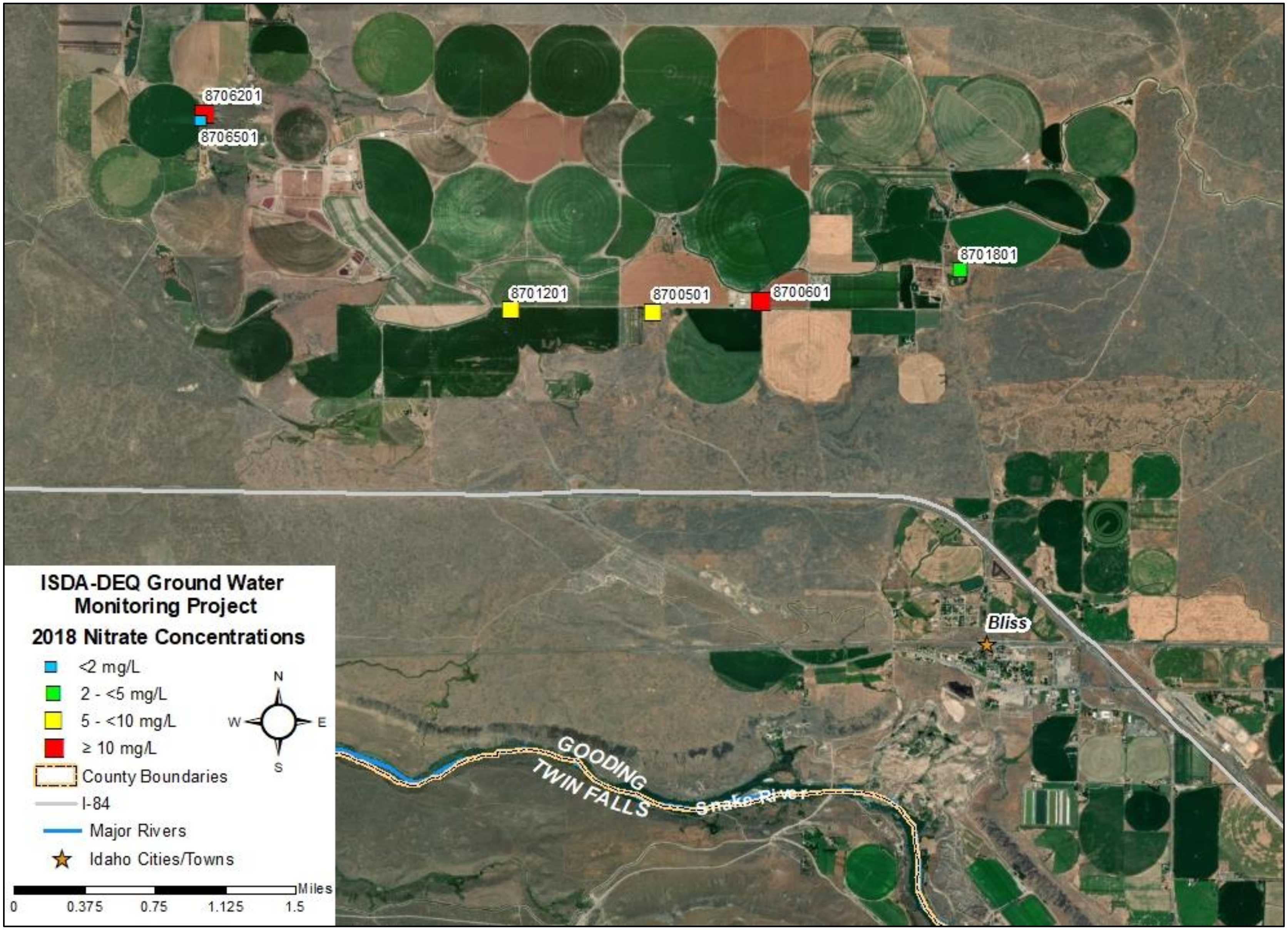

Figure B23. Project 870 (Gooding County) nitrate concentrations, 2018 ISDA data.

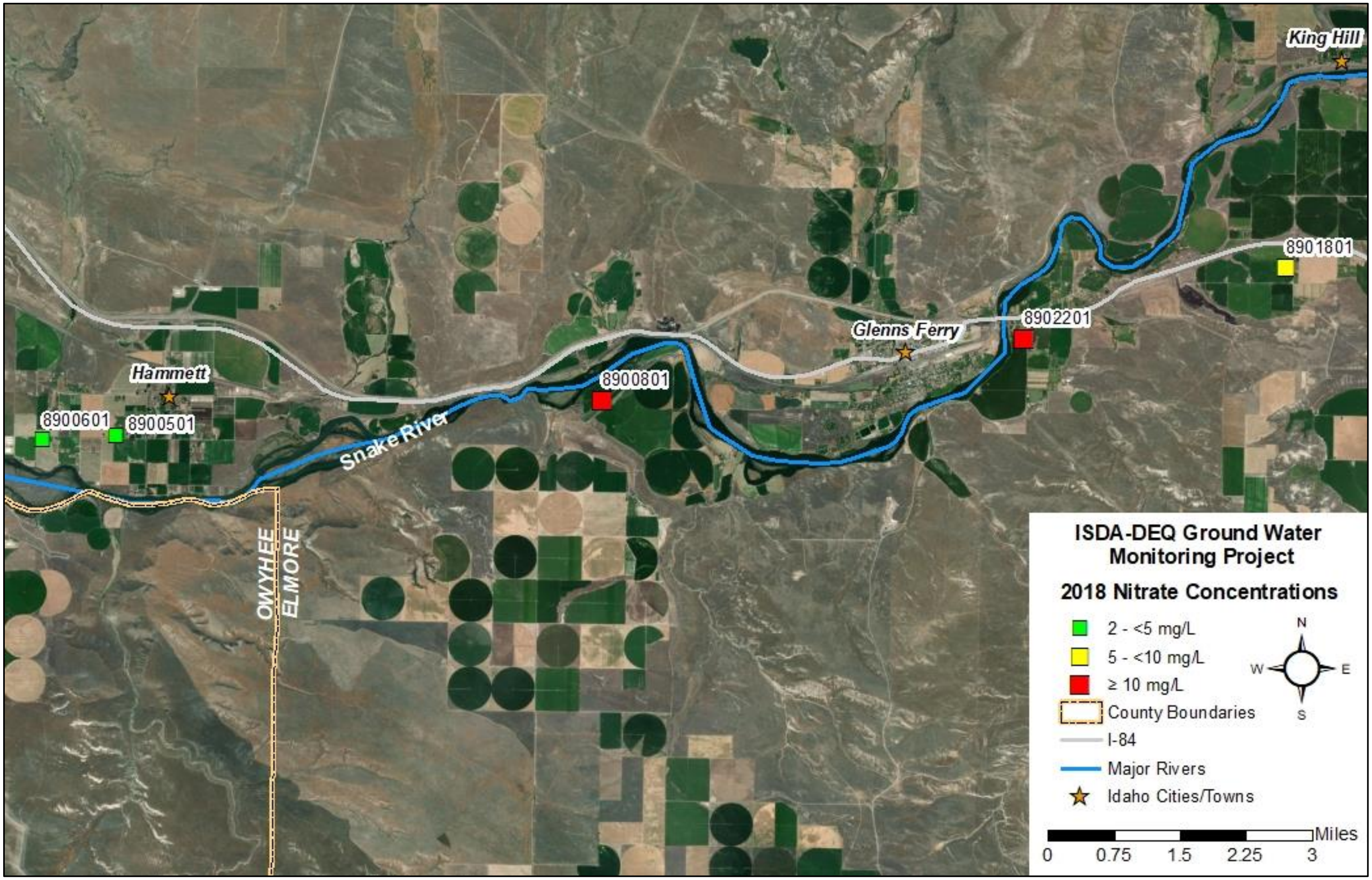

Figure B24. Project 890 (Elmore County) nitrate concentrations, 2018 ISDA data.

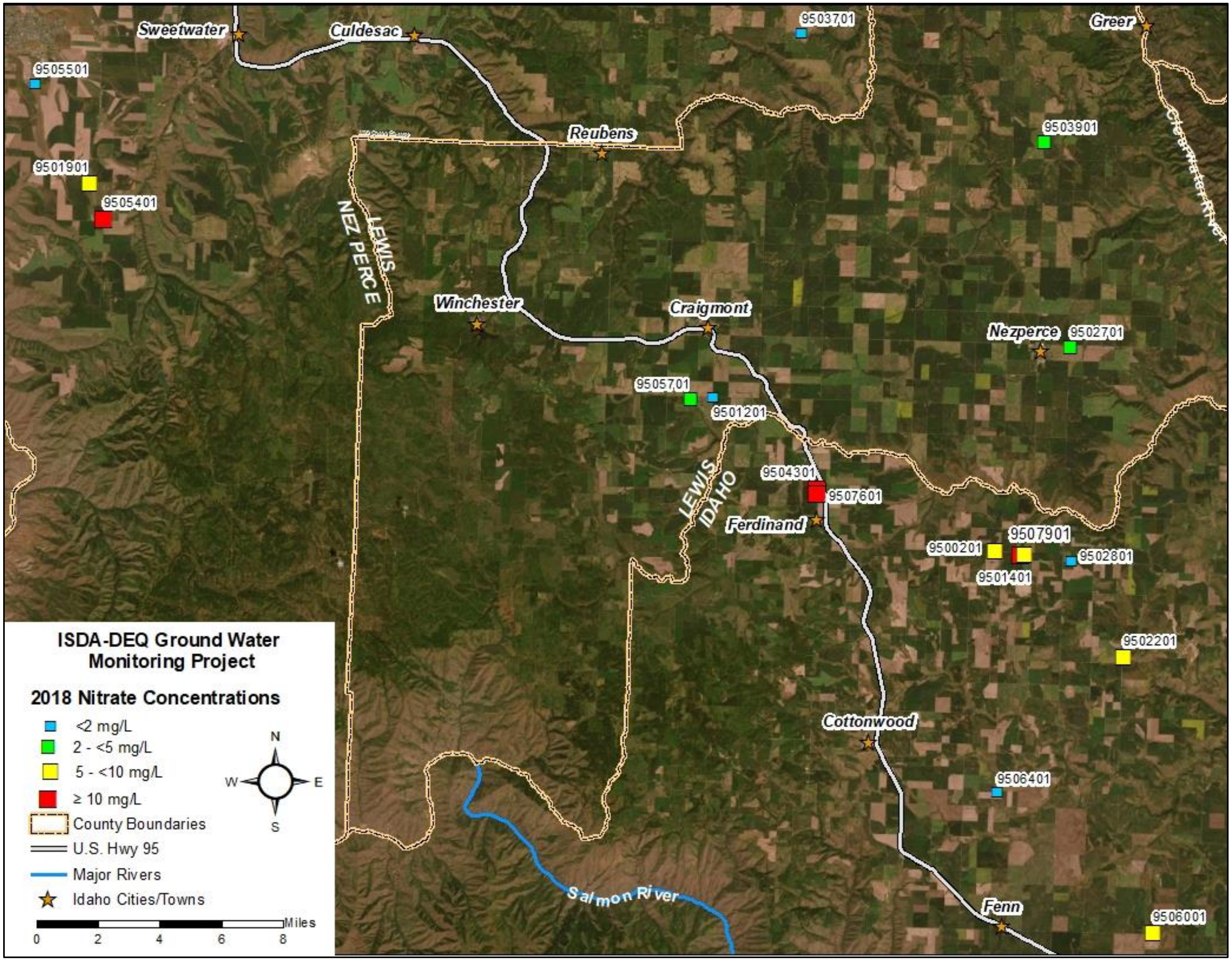

Figure B25. Project 950 (Idaho, Lewis, and Nez Perce Counties) nitrate concentrations, 2018 ISDA data.

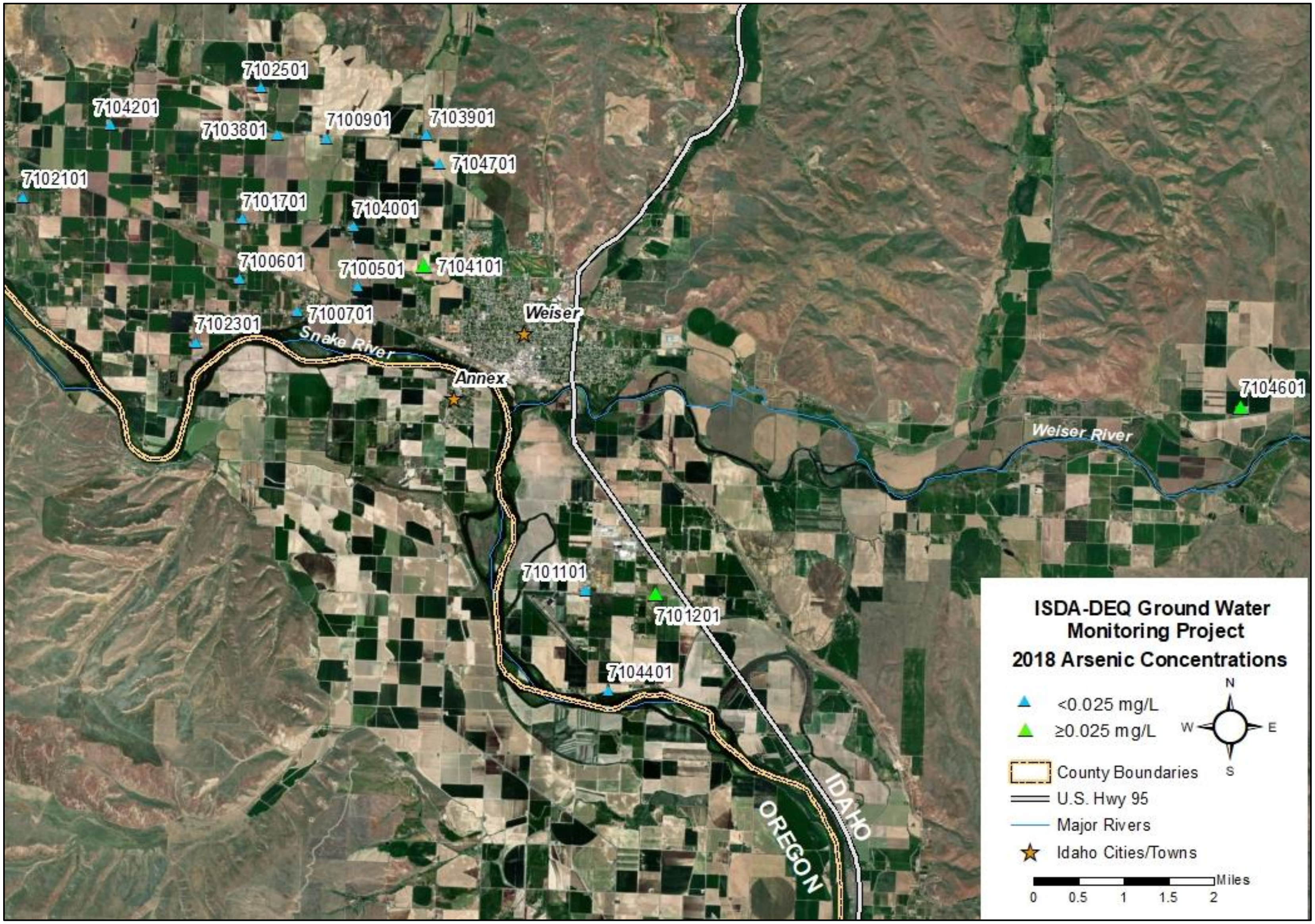

Figure B26. Project 710 (Washington County) arsenic concentrations, 2018 ISDA data.

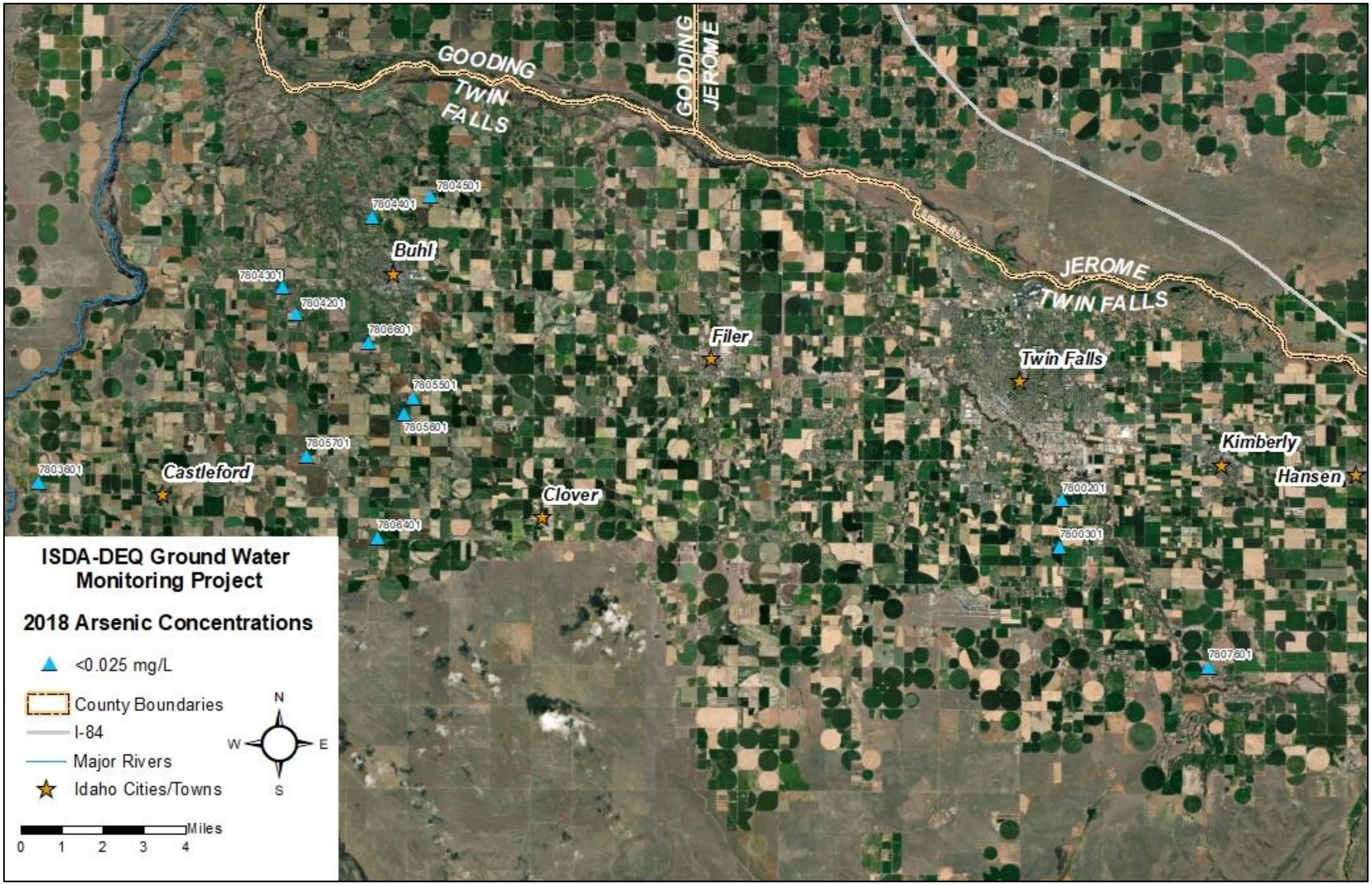

Figure B27. Project 780 (Twin Falls County) arsenic concentrations, 2018 ISDA data.

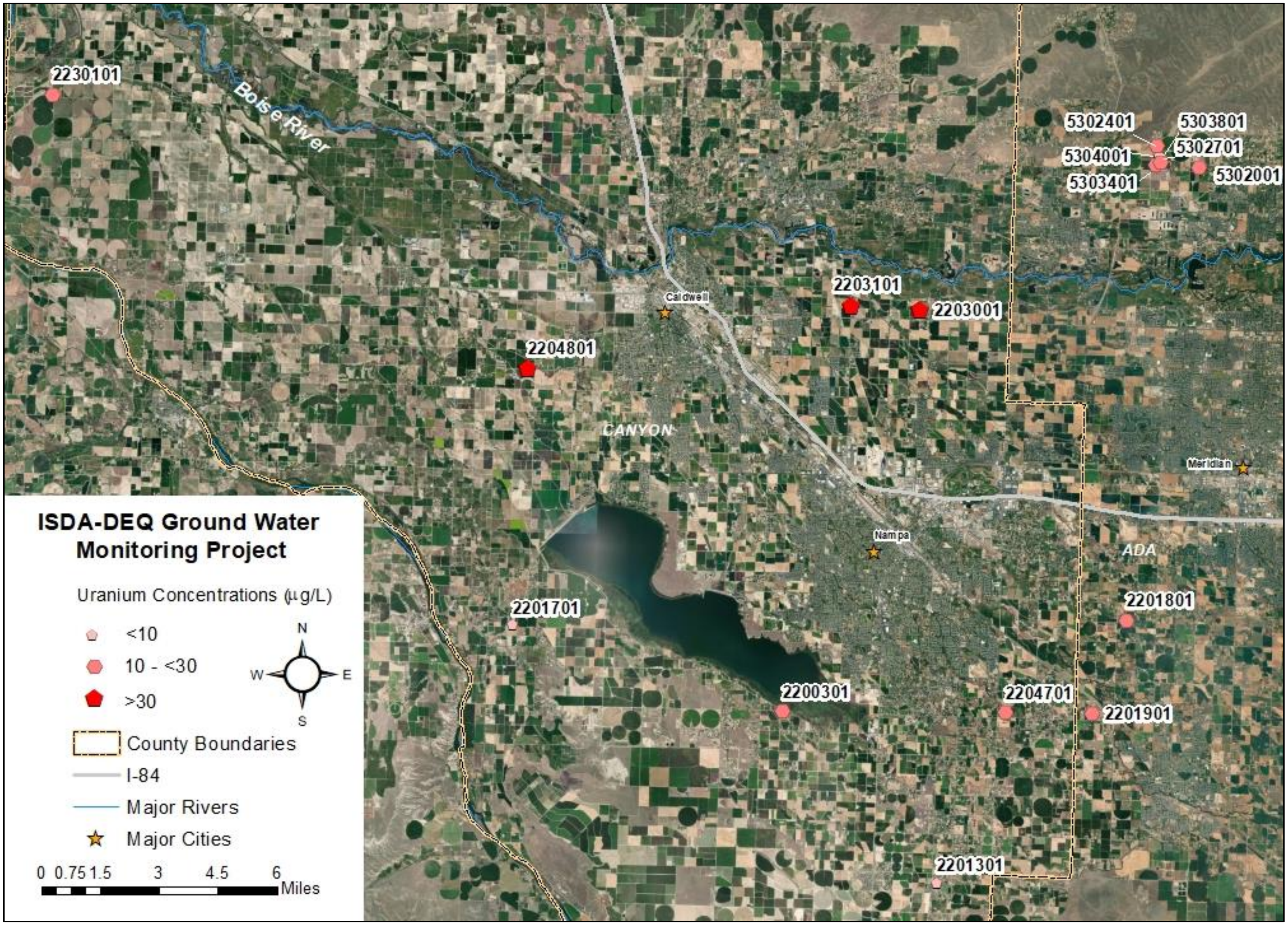

Figure B28. Uranium Concentrations (Ada and Canyon Counties), 2018 ISDA data.