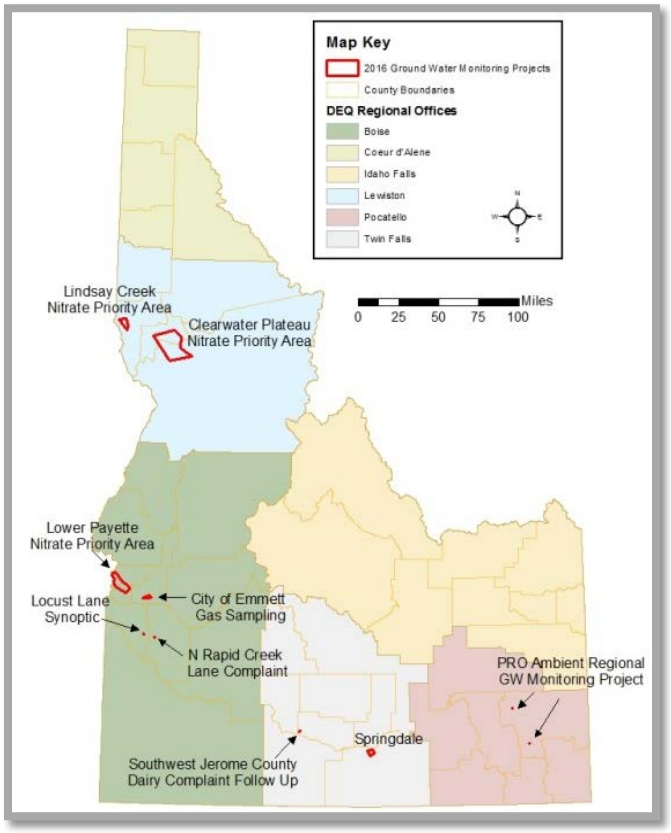
Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2016

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Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2016

April 2018

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Compiled and edited by Kathryn Elliott.

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Acronyms, Abbreviations, and Symbols

°C	degrees Celsius
µg	micrograms
µS	microsiemens
bgs	below ground surface
BMP	best management practice
BPA	bisphenol A
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
ESC	ESC Lab Sciences
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
MBAS	methylene blue active substances
MCL	maximum contaminant level
mg	milligram
mL	milliliter
MPN	most probable number
NA	not applicable
ND	nondetect
ng	nanogram
NPA	nitrate priority area
NPDWR	National Primary Drinking Water Regulation

NSDWR	National Secondary Drinking Water Regulation
o-xylene	orthoxylene
per mil (‰)	parts per thousand
PRO	Pocatello Regional Office
PWS	public water system
QAPP	quality assurance project plan
SLAP	Standard Light Antarctic Precipitation
SWDH	Southwest District Health Department
TC	total coliform
TDS	total dissolved solids
TMDL	total maximum daily load
TPH	total petroleum hydrocarbons
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VSMOW	Vienna Standard Mean Ocean Water
$\delta^{15}N$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{15}N_{nitrate}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N of the nitrate molecule
$\delta^{18}O$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O
$\delta^{18}O_{nitrate}$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O of the nitrate molecule
$\delta^{2}H$	ratio of the two stable hydrogen isotopes ^{1}H and ^{2}H (deuterium), also denoted as δD

1 Introduction

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

Idaho Code §39-120, "Environmental Quality - Health," designates the Idaho Department of Environmental Quality (DEQ) as the primary agency to coordinate and administer ground water quality protection programs for the state. DEQ is also responsible for collecting and analyzing data for ground water quality management purposes. Idaho Code §39-120 further directs DEQ, the Idaho Department of Water Resources (IDWR), and the Idaho State Department of Agriculture (ISDA) to conduct ground water quality monitoring and promote public awareness of ground water issues by making results of ground water quality investigations available to the public.

Public water systems (PWSs) are regulated by DEQ under the federal Safe Drinking Water Act and the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08). These regulations require chemical analysis of drinking water for various contaminants. DEQ ensures that follow-up monitoring is conducted when contaminants of concern are detected in PWSs. The United States Environmental Protection Agency (EPA) set National Primary Drinking Water Regulations (NPDWRs) as legally enforceable standards, expressed as maximum contaminant levels (MCLs), that apply to PWSs. The established levels protect public health by limiting the amount of contaminants in drinking water. EPA also set National Secondary Drinking Water Regulations (NSDWRs) as nonmandatory standards established as guidelines to assist PWSs in managing their drinking water for aesthetic considerations such as taste, color, and odor.

Although these limits only apply to PWSs, they can be used to evaluate water quality in private wells, as is done throughout this report. Total coliform (TC) and *Escherichia coli* (*E. coli*) sampling results were compared to the Idaho Ground Water Quality Standards set forth in Idaho's Ground Water Quality Rule (IDAPA 58.01.11), rather than national regulations. The single samples collected during these projects were not appropriate for comparison to the national standards, which are based on exceedances during a month-long sampling period.

DEQ also responds to detections of contaminants of concern that are 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 are not used for determining exceedances at PWS wells. They are used to monitor well water during purging to ensure water in the wellbore is removed from the well before sampling. Field measurements are also used to qualitatively evaluate water quality variability between wells.

The ground water quality monitoring results can also be used to define and prioritize degraded ground water quality areas, such as nitrate priority areas (NPAs). In 2014, DEQ identified

34 areas in the state as having elevated concentrations of nitrate in ground water. These NPAs are ranked based on population, water quality, and water quality trends. The basis for an NPA is that 25% or more of the wells sampled within the designated area have nitrate concentrations that meet or exceed 5 milligrams per liter (mg/L). EPA has established an MCL for nitrate at 10 mg/L, and Idaho adopted this MCL as the Ground Water Quality Standard. The NPAs are reevaluated and reranked approximately every 5 years. Additional information about NPA delineation and ranking is available in the *2014 Nitrate Priority Area Delineation and Ranking Process* document (DEQ 2014a).

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

The Ground Water Program at DEQ has implemented regional ground water monitoring using a statistically based approach to determine the monitoring network design. Most of these regional projects have focused in areas designated as NPAs. This report provides an overview of DEQ's ground water monitoring projects and investigation activities accomplished with public funds during 2016. It does not include results from privately funded activities, including monitoring required by permits and monitoring associated with ongoing environmental remediation projects, Kootenai County Aquifer Protection District funding, or PWS requirements.

2 Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects that were conducted by DEQ in calendar year 2016. Projects are presented by DEQ regional office and identified in Figure 1.

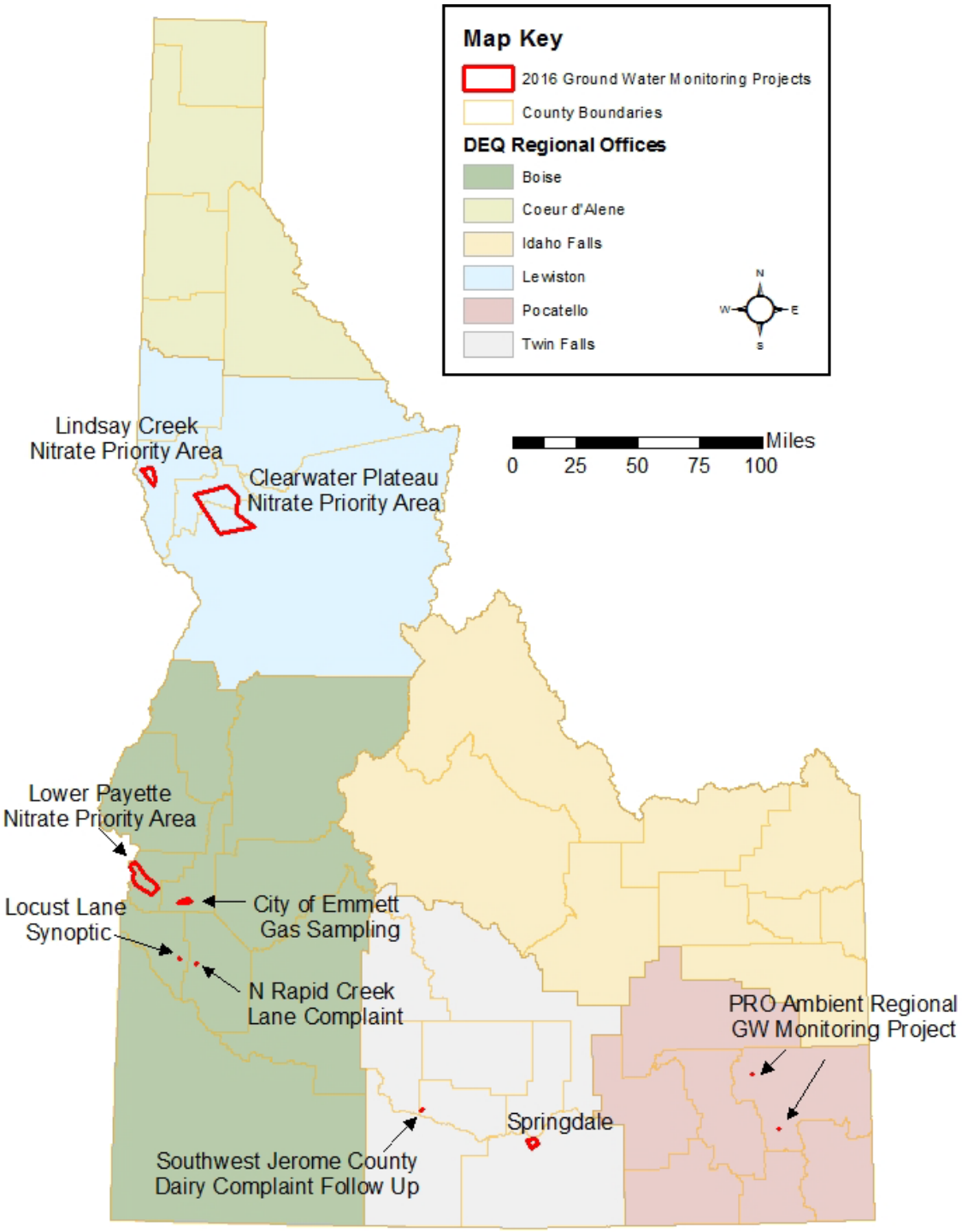


Figure 1. Idaho Department of Environmental Quality 2016 ground water quality project locations by region.

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

2.1 Boise Region

Four ground water quality monitoring projects were conducted in the Boise region in 2016 using public funds.

2.1.1 City of Emmett Baseline Ground Water Monitoring Project

2.1.1.1 Purpose and Background

Southwestern Idaho is an area of interest for natural gas development since the discovery of production quantities of natural gas in Payette County. Establishing and developing natural gas fields generally includes, but is not limited to, well drilling and drilling-related activities, gas and oil/condensate production, treatment of wells to increase production, pipeline construction, and other production-related activities. In July 2017, the Idaho Department of Lands reported seven producing oil and gas wells in Idaho; all producing wells are in Payette County, located west of Gem County.

In spring 2015, the City of Emmett (the county seat of Gem County) and DEQ discussed initiating ground water quality monitoring of the city's public water system (PWS) wells before the potential development of oil and gas fields in Gem County. In August 2015, DEQ and the city signed an agreement to mutually conduct a project to assess the quality of ground water at four PWS wells owned by the city. The agreement stated that DEQ would sample the wells, review sample analytical data, and provide the city with a summary and interpretation of the sample analyses. The city would provide access to the wells and be responsible for the costs of sample analyses.

The City of Emmett Baseline Ground Water Monitoring Project was designed to provide baseline water quality data at four city-owned PWS wells. Constituents chosen for laboratory analysis were selected based on identifying changes in aquifer chemistry potentially resulting from natural gas field development. Initial sampling of the wells was performed in November 2015.

Gem County is located in southwestern Idaho to the east of Payette County and in the western Snake River Plain. The majority of agricultural and other development is along the Payette River, which flows from east to west in southern Gem County.

The general ground water aquifer system in the western Snake River Plain includes three units: an upper and middle unit in sedimentary deposits and volcanic rock, and a lower unit in volcanic rock. Wells completed in the upper unit generally produce water from sand or gravel layers. A layer of blue-colored clay is often found within the upper unit, which limits or retards downward ground water movement and separates shallow, upper unit aquifers from deeper aquifers (Newton 1991). The project wells range in depth from 133 to 535 feet and are screened across sand and gravel aquifers. Wells 2580, 2581, and 2582 are located within or directly adjacent to the Emmett city limits and are screened below one or more layers of blue clay or sandy blue clay. Well 2583 is located approximately 2.5 miles west of Emmett and is screened above and below sandy blue clay layers (Figure 2).

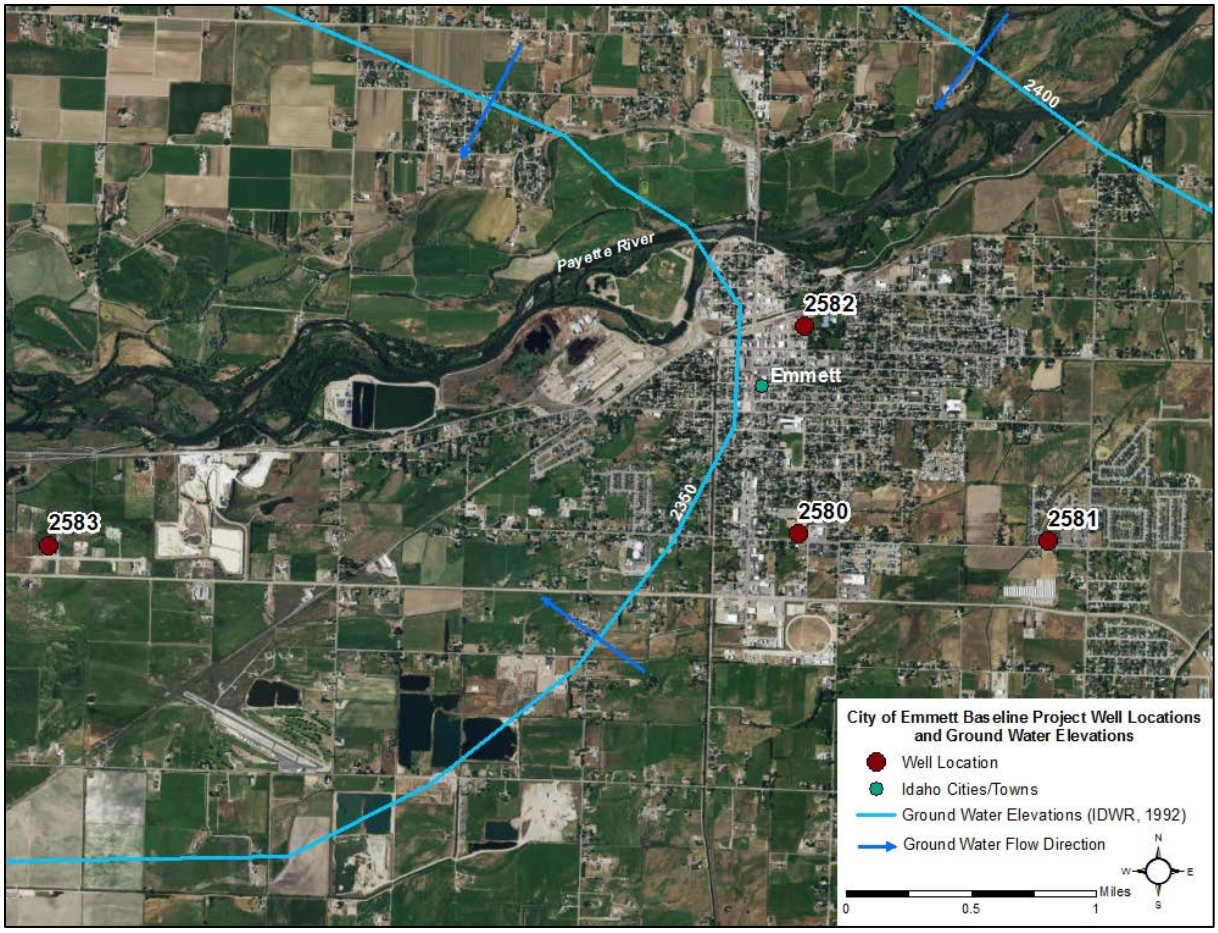


Figure 2. Locations of project wells—City of Emmett Baseline Ground Water Monitoring Project.

2.1.1.2 Methods and Results

On December 15, 2016, DEQ collected water samples from the four PWS wells using procedures outlined in the quality assurance project plan (QAPP) (DEQ 2015a) and field sampling plan (FSP) (DEQ 2016a). Water samples were collected from sampling points located prior to any water treatment processes. Water quality field parameters (pH, temperature, specific conductivity, and dissolved oxygen [DO]) were measured and recorded before sample collection (Table 1). A duplicate sample was collected from Well 2583. A field blank sample was also collected.

Table 1. Water quality field parameters—City of Emmett Baseline Ground Water Monitoring Project.

DEQ Well ID	Project Well Name	Well Depth[a] (feet)	Sample Date	Water Temperature (°C)	pH[b]	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)
2580	No. 8	319	11/17/2015	18.50	8.10	290	4.13
			12/15/2016	18.47	7.79	266	3.14
2581	No. 9	485	11/17/2015	19.5	7.90	359	5.09
			12/15/2016	19.76	6.99	339	4.58
2582	No. 6	202	11/17/2015	16.1	6.90	455	3.34
			12/15/2016	16.17	6.72	425	5.79
2583	No. 1	123	11/17/2015	11.70	8.10	280	8.63
			12/15/2016	6.42	7.32	256	0.166

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter.
[a] Two wells (2581 and 2583) have different depths than what were reported in 2015. This was due to a difference in well log interpretation and a possible typo.
[b] 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.

The water samples were submitted to ESC Lab Sciences (ESC) in Mount Juliet, Tennessee, using procedures outlined in the QAPP and FSP. ESC analyzed the samples for major ions (cations and anions) that included bromide, chloride, sulfate, calcium, magnesium, potassium, and sodium; metals (arsenic, barium, boron, chromium, iron, manganese, selenium, and uranium); total dissolved solids (TDS); alkalinity (reported as calcium carbonate [$CaCO_3$]); hydrocarbons (methane, ethane, ethene, benzene, toluene, ethylbenzene, and total xylenes (m+p-xylene and o-xylene); and total petroleum hydrocarbons (TPH) (high fraction/diesel range organics). Table 1 presents the field parameters measured during sample collection. Table 2 presents the laboratory analytical results for major ions, TDS, and alkalinity. Table 3 presents the laboratory analytical results for metals and Table 4 presents the laboratory analytical results for hydrocarbons.

Table 2. Major ions, total dissolved solids, and alkalinity results—City of Emmett Baseline Ground Water Monitoring Project.

DEQ Well ID	Project Well Name	Well Depth (feet)	Sample Date	Major Ions (mg/L)							Total Dissolved Solids[a] (mg/L)	Alkalinity (as $CaCO_3$) (mg/L)
				Bromide	Chloride[a]	Sulfate[a]	Calcium	Potassium[b]	Sodium	Magnesium		
Primary or Secondary Standard:				***No Stand.***	***250***	***250***	***No Stand.***	***No Stand.***	***No Stand.***	***No Stand.***	***500***	***No Stand.***
2580	No. 8	319	11/17/2015	<1.00	8.27	6.98	18.8	<1.00	—	—	234	110
			12/15/2016	<1.00	8.4	6.2	19.6	1.74	41.2	<1.00	256	107
2581	No. 9	485	11/17/2015	<1.00	10.8	37.0	33.2	1.65	—	—	197	109
			12/15/2016	<1.00	10.9	35.2	30.7	2.60	37.8	1.59	220	98.1
2582	No. 6	202	11/17/2015	<1.00	12.6	45.5	40.8	3.43	—	—	234	141
			12/15/2016	<1.00	13.1	44.8	39.9	4.48	39.5	6.89	209	138
2583	No. 1	123	11/17/2015	<1.00	5.46	<5.00	10.3	<1.00	—	—	154	119
			12/15/2016	<1.00	4.85	<5.00	10.2	1.47	50.4	<1.00	178	111

Notes: mg/L = milligrams per liter; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; (—) = data unavailable or not analyzed.

[a] Contaminant with a National Secondary Drinking Water Regulation standard. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

[b] Potassium detected in the laboratory blank at a concentration of 0.432 mg/L; actual potassium concentration may be less than reported.

Table 3. Metals results—City of Emmett Baseline Ground Water Monitoring Project.

DEQ Well ID	Project Well Name	Well Depth (feet)	Sample Date	Metals (mg/L)							Uranium[a] (µg/L)
				Arsenic[a]	Barium[a]	Boron	Chromium[a]	Iron[b]	Manganese[b]	Selenium[a]	
Primary or Secondary Standard:				***10***	***2***	***No Stand.***	***100***	***0.3***	***0.05***	***50***	***30***
2580	No. 8	319	11/17/2015	<0.00200	<0.00500	<0.200	<0.00200	0.136	0.0394	<0.00200	<0.0100
			12/15/2016	<0.00200	<0.00500	0.201	<0.00200	<0.100	0.0415	<0.00200	<0.0100
2581	No. 9	485	11/17/2015	<0.00200	<0.00500	<0.200	<0.00200	<0.100	*0.164*	<0.00200	<0.0100
			12/15/2016	<0.00200	<0.00500	<0.200	<0.00200	<0.100	*0.170*	<0.00200	<0.0100
2582	No. 6	202	11/17/2015	0.00372	0.00709	<0.200	<0.00200	*0.313*	*0.0947*	<0.00200	<0.0100
			12/15/2016	0.00373	0.00762	<0.200	<0.00200	*0.380*	*0.109*	<0.00200	<0.0100
2583	No. 1	123	11/17/2015	<0.00200	0.00549	<0.200	<0.00200	<0.100	0.0200	<0.00200	<0.0100
			12/15/2016	<0.00200	<0.00500	<0.200	<0.00200	<0.100	0.0105	<0.00200	<0.0100

Notes: mg/L = milligrams per liter; µg/L = micrograms per liter; No Stand. = 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 standard was exceeded. These regulations apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

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

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

Table 4. Hydrocarbons results—City of Emmett Baseline Ground Water Monitoring Project.

DEQ Well ID	Project Well Name	Well Depth (feet)	Sample Date	Methane[a]	Ethane	Ethene	Benzene[b]	Toluene[b]	Ethylbenzene[b]	Total Xylenes[b]	Total Petroleum Hydrocarbons—High Fraction/ Diesel Range Organics
				(µg/L)							(mg/L)
Primary Standard:				***No Stand.***			***5***	***1,000***	***700***	***10,000***	***No Stand.***
2580	No. 8	319	11/17/2015	4,510	<13.0	<13.0	<1.00	<5.00	<1.00	<1.00	0.225
			12/15/2016	3,790	<13.0	<13.0	<1.00	<1.00	<1.00	<3.00	<0.100
2581	No. 9	485	11/17/2015	610	<13.0	<13.0	<1.00	<5.00	<1.00	<1.00	0.115
			12/15/2016	577	<13.0	<13.0	<1.00	<1.00	<1.00	<3.00	<0.100
2582	No. 6	202	11/17/2015	396	<13.0	<13.0	<1.00	<5.00	<1.00	<1.00	0.156
			12/15/2016	285	<13.0	<13.0	<1.00	<1.00	<1.00	<3.00	<0.100
2583	No. 1	123	11/17/2015	31.1	<13.0	<13.0	<1.00	<5.00	<1.00	<1.00	<0.100
			12/15/2016	153	<13.0	<13.0	<1.00	<1.00	<1.00	<3.00	<0.100

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

[a] The United States Department of the Interior Office of Surface Mining advises well owners with dissolved methane levels greater than 28 mg/L (28,000 µg/L) to immediately remove any potential ignition sources and vent the gas away from any confined spaces (Eltschlager et al. 2001).

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

General Ground Water Chemistry (Major Ions, TDS, and Alkalinity) Results

The four project wells were sampled for the following major ions to evaluate the general ground water chemistry: bromide, chloride, sulfate, calcium, and potassium. Samples were also analyzed for TDS and alkalinity (as $CaCO_3$). Concentrations of chloride and TDS did not exceed EPA's NSDWR standards of 250 and 500 mg/L, respectively (Table 2).

Metals Results

Iron was detected in one of the four wells (Well 2582); the concentration of 0.380 mg/L exceeded the NSDWR standard of 0.3 mg/L (Table 3).

Manganese was detected in all four wells. Exceedance of the NSDWR standard for manganese of 0.05 mg/L were reported for Wells 2581 and 2582 with concentrations of 0.170 mg/L and 0.109 mg/L, respectively.

Arsenic and barium were detected at low concentrations in Well 2582 (Table 3). Boron was detected in Well 2580. Chromium, selenium, and uranium were not detected above the laboratory reporting limit.

Hydrocarbon Results

Methane was detected in all four samples at concentrations ranging from 0.153 mg/L (Well 2583) to 3.79 mg/L (Well 2580) (Table 4). All detections were less than the concentrations detected in 2015, with the exception of Well 2583. There is no MCL or NSDWR standard for dissolved methane in ground water. The hazard with methane in ground water results 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 mg/L (Eltschlager et al. 2001).

No benzene, toluene, ethylbenzene, and xylene (BTEX) or TPH (high fraction/diesel range organics) were detected in any of the samples. There is currently no MCL or NSDWR standard for TPHs in ground water.

2.1.1.3 Conclusions

The City of Emmett and DEQ are cooperating on a ground water project to assess baseline ground water quality at four of the city's PWS wells. In November 2015 and December 2016, DEQ collected samples from the wells. The samples were analyzed for major ions, alkalinity, TDS, metals, and hydrocarbons. These analytical data will be used to identify background water quality before any future oil and gas well development in Gem County.

Except for TPH, laboratory analytical results of the samples collected in 2016 were similar to the samples collected in 2015. Methane was detected in all PWS samples at concentrations ranging from 0.153 mg/L (Well 2583) to 3.79 mg/L (Well 2580). No BTEX or TPH compounds were detected in any of the samples in 2016. In the 2015, TPH were detected in samples collected from Wells 2580, 2581, and 2582 at concentrations ranging from 0.115 mg/L to 0.180 mg/L.

2.1.1.4 Recommendations

Annual sampling should be continued to monitor background ground water quality at the four wells.

2.1.2 Locust Lane Local Synoptic Ground Water Monitoring Project

2.1.2.1 Purpose and Background

In response to a complaint from a community member, the Southwest District Health Department (SWDH) collected ground water well samples from 13 private domestic wells in Canyon County during summer 2016. The presence of TC or *E. coli* was confirmed in samples from 8 of the 13 SWDH sampled wells. Due to the reported presence of *E. coli*, SWDH requested assistance from DEQ with identifying constituents helpful in confirming a source of the bacteria. Additional data collection and analysis were conducted for nine wells (seven of which were among the 13 wells sampled by SWDH) and the canal to determine the potential contaminant sources affecting the shallow aquifer underlying the residential neighborhoods near the southern boundary of Nampa. The DEQ sample locations are shown in Figure 3.

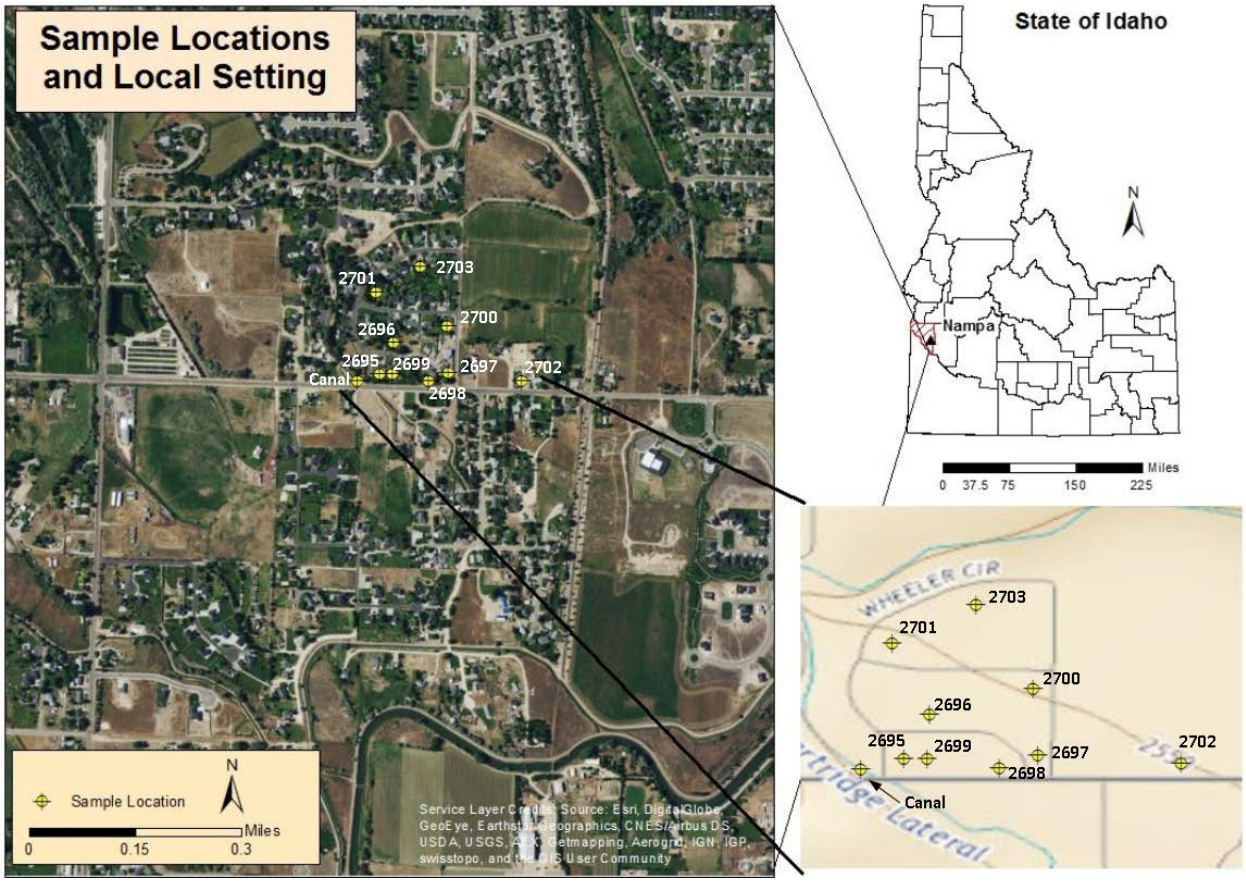


Figure 3. Sample locations and project location—Locust Lane Local Synoptic Ground Water Monitoring Project.

The project area is a residential area within a few hundred feet of the southernmost residential area of Nampa, which connected to the city sewer system. The surrounding area is dominated by irrigated agricultural use. Each home within the project area has an individual septic system and receives water for domestic uses from wells completed in and producing from a fractured basalt aquifer; which is the first saturated zone below ground surface (bgs).

DEQ reviewed well driller's reports for 11 ground water wells in the immediate proximity to the sample locations. Most wells in the project area and surrounding area indicate that the depth to bedrock ranges from approximately 2 to 22 feet. The well depths are between 68 to 130 feet bgs and have annular seals that range from 18 to 57 feet bgs. The well casing lengths range from 18 to 90 feet and are open to the saturated zone a minimum of 20 to a maximum of 63 feet below the casing. Static water levels reported at the time of well completions range from 15 to 38 feet bgs or from 2,539 to 2,517 feet above mean sea level.

The soil conditions are generally described as topsoil (sandy silt or silty sandy clay) over weathered basalt. This weathered and fractured bedrock forms the local shallow aquifer, which has an average depth to water of approximately 25 feet. These hydrogeologic conditions result in limited opportunity for filtration and/or degradation of contaminants due to the base of the septic system being only a few feet above the bedrock aquifer. Similarly, thin layers of topsoil between the base of the local canal system and the top of the bedrock can also provide a pathway for contaminants to infiltrate and enter the shallow aquifer or seep into the canal system. Shallow bedrock can also provide a direct transport pathway for contaminants in surface-applied wastewater, irrigation water, or contaminated surface runoff to enter the fractured bedrock aquifer.

Individual subsurface sewage disposal applications/permits for the sample locations were reviewed and the estimated base elevation of the septic systems in the local area range from 2,550 to 2,542 feet above mean sea level. The difference between the static water level of the aquifer, reported at the time of well completion, and the estimated elevation of the septic systems range from 9 to 23 feet. The septic system density within the neighborhood is approximately one system for every 0.8 acre.

Ground water flow direction of the shallow basalt aquifer appears to be northwest with localized changes in gradients and elevations during summer months when irrigation and canals provide additional recharge through leakage (Figure 4).

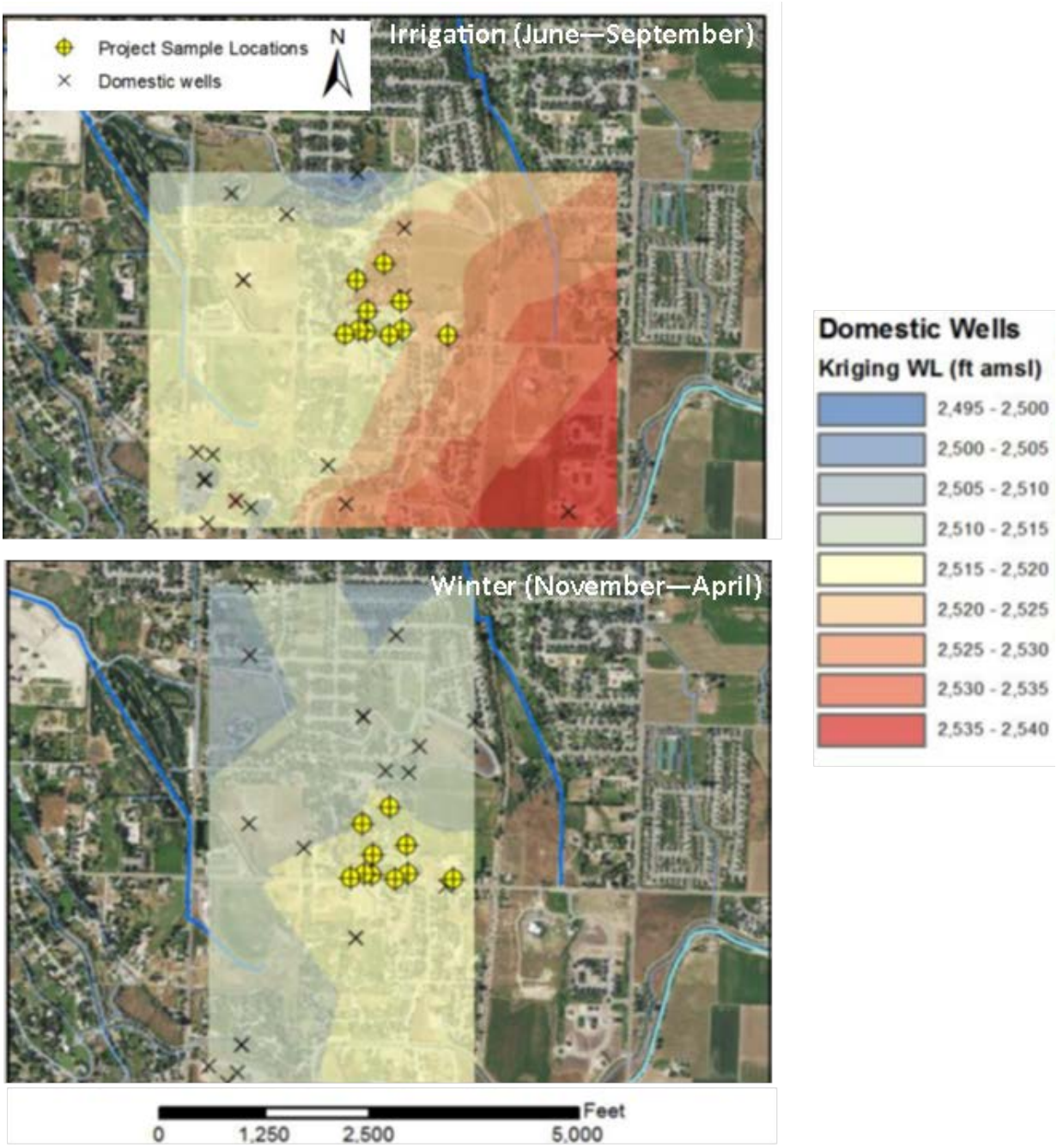


Figure 4. Local ground water elevations in the Locust Lane project area. Ground water elevations from local domestic wells (IDWR 2016a) at the time of installation were incorporated into a kriging routine to create the surfaces. Seasonal ground water maps show general ground water flow to the northwest with seasonal changes in both relative elevation and gradient due to localized recharge.

2.1.2.2 Methods and Results

In September 2016, DEQ collected ground water samples from nine private domestic wells located near Locust Lane and Powerline Road. Of the nine wells sampled by DEQ, seven were part of the initial SWDH sampling; five of which were positive for the presence of TC or *E. coli*.

Two wells not previously sampled by SWDH were included in the project (Wells 2702 and 2703). An additional sample was collected from the Partridge Lateral, a canal that flows through the neighborhood during the irrigation season (Figure 3).

Samples were collected for several common constituents found in human wastewater, including: chloride, sulfate, ammonia, nitrate plus nitrite as nitrogen, *E. coli*, male-specific coliphage (F+ coliphage, a type of bacteriovirus); boron; methylene blue active substances (MBAS) (anionic surfactants such as a detergent or foaming agent); triclosan (antibacterial and antifungal agent found in some consumer products, including toothpaste, soaps, detergents, toys, and surgical cleaning treatments); 17-beta estradiol (the 17β-isomer of estradiol, an estrogen steroid hormone); bisphenol A (BPA) (organic synthetic compound); and caffeine. All samples were submitted for analysis to the Idaho Bureau of Laboratories (IBL), Boise, Idaho.

All sampling was conducted according to the project QAPP (DEQ 2015b) and the FSP (DEQ 2016b).

Water quality field parameters (pH, temperature, specific conductivity, and 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 5).

Table 5. Water quality field parameters—Locust Lane Local Synoptic Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Field Measurements			
			Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH[a]
2695	98	09/12/2016	15.9	381	6.86	6.61
2696	Unk	09/12/2016	15.0	417	6.72	6.72
2697	Unk	09/12/2016	14.8	413	7.76	*6.00*
2698	Unk	09/12/2016	15.3	438	6.98	*6.20*
2699	83	09/12/2016	15.2	404	7.04	6.50
2700	130	09/12/2016	15.0	465	6.32	6.78
2701	85	09/12/2016	14.7	712	6.98	6.76
2702	Unk	09/12/2016	14.8	950	6.51	6.68
2703	105	09/12/2016	14.8	506	6.76	6.79
Canal	NA	09/12/2016	15.2	190	9.21	6.72

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; Unk = Unknown. Well log not found; NA = not applicable. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. These regulations apply to 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. 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

The reported nitrate concentrations ranged from 2.5 mg/L to 7.4 mg/L; all nine sampled wells had nitrate concentrations greater than 2.0 mg/L, which is generally considered background for nitrate. Concentrations greater than 2.0 mg/L often suggest human influences on ground water in the area. None of the wells exceeded the nitrate MCL (Table 6). The spatial distribution of nitrate concentrations is shown in Figure 5.

Table 6. Inorganic results—Locust Lane Synoptic Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Ammonia	Nitrate plus Nitrite[a]
			(mg/L)	
Primary or Secondary Standard:			***No Stand.***	***10***
2695	98	09/12/2016	<0.010	3.7
2696	Unk	09/12/2016	<0.010	4.2
2697	Unk	09/12/2016	<0.010	4.0
2698	Unk	09/12/2016	<0.010	4.5
2699	83	09/12/2016	<0.010	4.1
2700	130	09/12/2016	<0.010	4.4
2701	85	09/12/2016	<0.010	6.9
2702	Unk	09/12/2016	<0.010	7.4
2703	105	09/12/2016	0.01	2.5
Canal	NA	09/12/2016	0.013	1.4

Notes: mg/L = milligrams per liter; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Unk = Unknown. Well log not found; NA = Not Applicable.

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

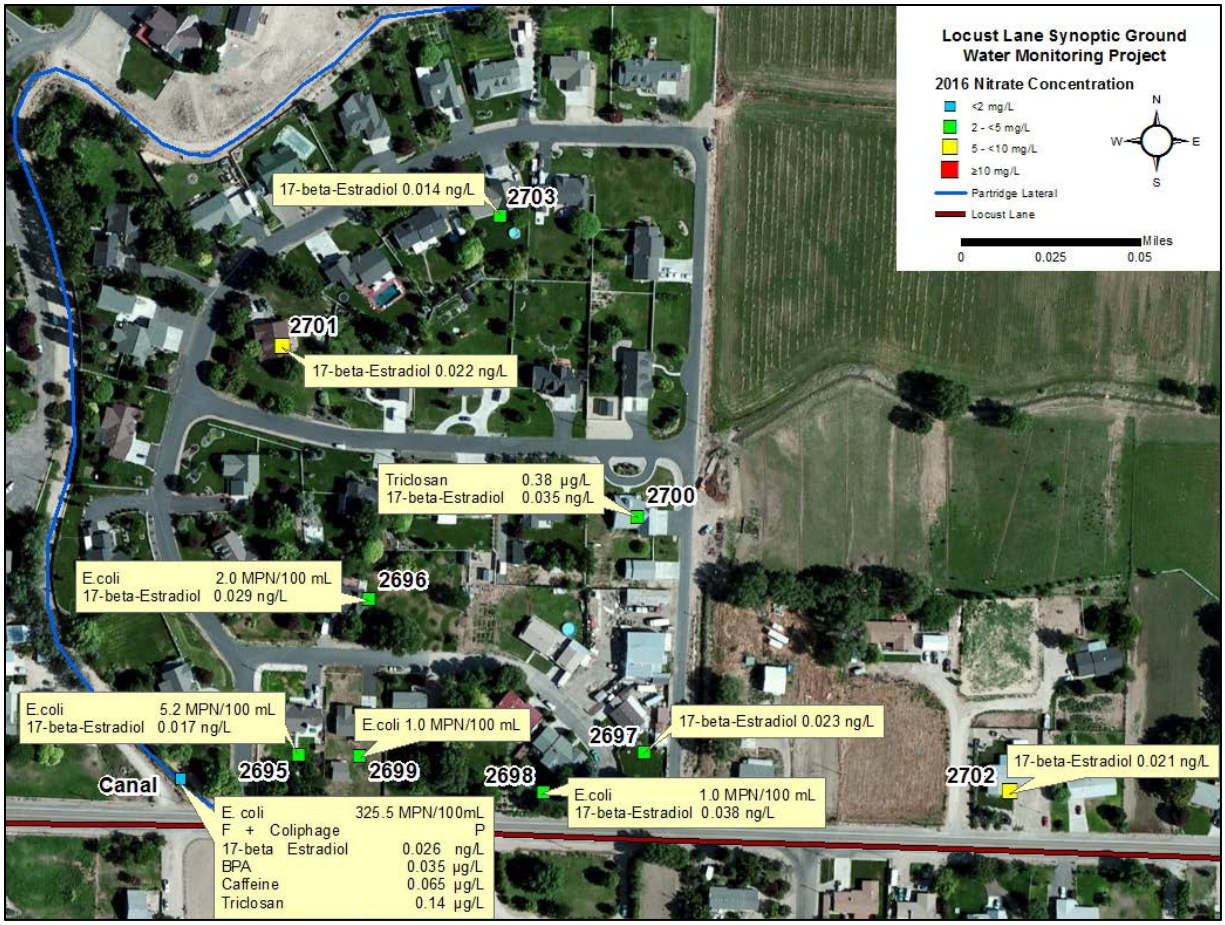


Figure 5. Nitrate, bacteria, and common wastewater constituent concentrations—Locust Lane Synoptic Ground Water Monitoring Project.

Bacteria Results

Of the nine wells sampled, eight wells had positive detections of TC bacteria; the concentrations ranged from 4.1 and 461.1 most probable number per 100 milliliters (MPN/100 mL) (Table 7). Of the eight wells with positive TC detections, five wells were also positive for E. coli. The E. coli concentrations ranged from 1.0 to 6.3 MPN/100 mL (Table 7; Figure 5). All nine sampled wells were absent for F+ coliphage (male-specific coliphage). The canal sample was positive for all three bacteria constituents. The canal TC and E. coli concentrations reported are consistent with surface water sources.

Table 7. Bacteria results—Locust Lane Synoptic Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Total Coliform[a] (MPN/100 mL)	*E. coli*[b] (MPN/100 mL)	F+ coliphage (Present/Absent)
Primary or Secondary Standard:			***1 cfu/100 mL***	***<1 cfu/100 mL***	***No Stand.***
2695	98	09/12/2016	461.1	**5.2**	A
2696	Unk	09/12/2016	50.4	**2.0**	A
2697	Unk	09/12/2016	11.9	<1.0	A
2698	Unk	09/12/2016	24.6	**1.0**	A
2699	83	09/12/2016	275.5	**1.0**	A
2700	130	09/12/2016	290.9	**6.3**	A
2701	85	09/12/2016	<1.0	<1.0	A
2702	Unk	09/12/2016	4.1	<1.0	A
2703	105	09/12/2016	2	<1.0	A
Canal	NA	09/12/2016	>2419.6	**325.5**	P

Notes: MPN/100 mL = most probable number per 100 milliliters; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Unk = Unknown. Well log not found; NA = Not Applicable. Bolded red numbers indicate EPA's National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

[a] TC 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 TC (indicated by gray shaded numbers) is not a violation of these rules. TC 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 colony forming units per 100 milliliters (cfu/100 mL), analytical results provided in most probable number per 100 milliliters (MPN/100 mL) are acceptable for comparison to the standard.

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

Human-Influenced Constituent Results

Boron, chloride, and sulfate were detected in all nine wells and the canal (Table 8). The highest concentrations of all three constituents were found in Wells 2701 and 2702. Eight of the nine wells and the canal had detections of 17-beta estradiol, a human hormone. The concentrations of 17-beta estradiol ranged from 0.014 nanograms per liter (ng/L) to 0.038 ng/L. Well 2697 had a BPA detection, Well 2701 had triclosan detection, and both wells had hormone detections. The canal sample had positive detections of BPA, caffeine, and triclosan. MBASs (a measure of surfactants) were not detected in any of the samples.

Table 8. Common human wastewater constituents results—Locust Lane Synoptic Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Boron	Chloride[a]	Sulfate[a]	17-Beta Estradiol	Bisphenol A	Caffeine	Methyl Blue Active Substance (MBAS)	Triclosan
			(µg/L)	(mg/L)		(ng/L)	(µg/L)		(mg/L)	(µg/L)
Primary or Secondary Standard:			***No Stand.***	***250***	***250***	***No Stand.***	***No Stand.***	***No Stand.***	***No Stand.***	***No Stand.***
2695	98	09/12/2016	75	7.38	37.3	0.017	<0.05	<0.175	<0.05	<0.1
2696	Unk	09/12/2016	81	8.18	40.5	0.029	<0.05	<0.175	<0.05	<0.1
2697	Unk	09/12/2016	84	8.43	43.7	0.023	0.17	<0.175	<0.05	<0.1
2698	Unk	09/12/2016	90	8.96	43.8	0.038	<0.05	<0.175	<0.05	<0.1
2699	83	09/12/2016	80	7.77	39.9	<0.00000005	<0.05	<0.175	<0.05	<0.1
2700	130	09/12/2016	110	9.58	54.2	0.035	<0.05	<0.175	<0.05	<0.1
2701	85	09/12/2016	140	29.8	80.7	0.022	<0.05	<0.175	<0.05	0.38
2702	Unk	09/12/2016	240	28.5	113	0.021	<0.05	<0.175	<0.05	<0.1
2703	105	09/12/2016	90	9.32	35.7	0.014	<0.05	<0.175	<0.05	<0.1
Canal	NA	09/12/2016	0.3	3.24	17.9	0.026	0.035	0.065	<0.05	0.14

Notes: µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanogram per liter; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; Unk = Unknown. Well log not found; NA = Not Applicable.

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

2.1.2.3 Conclusions

In September 2016, DEQ assisted SWDH with a contamination source identification effort for wells near Nampa, Idaho. While natural background for the local basalt aquifer is poorly defined, historical data (USGS 2016) from nearby wells was evaluated for comparison. Based on the information from the United States Geological Survey (USGS), all nine wells sampled appear to be enriched in chloride, boron, sulfate, and nitrate and impacted by bacteria or a pharmaceutical compound, indicating human impact to the underlying aquifer.

The contaminants identified in the wells and canal (bacteria, nitrate, BPA, 17-beta estradiol, and triclosan) are components indicative of human or animal waste. The potential sources of these types of waste include on-site septic systems, the canal, and livestock/agricultural activities.

Based on the observed contaminants in the wells, their close association with human waste, and the lateral distribution of contaminants; DEQ believes that the most likely source of contamination is either from local domestic septic systems or canal water impacted by human wastewater.

2.1.2.4 Recommendations

If connecting to the city of Nampa's sewage system is not a feasible option for residential developments south of the existing city boundary, domestic septic systems may still prove to be a viable alternative. Recognizing the benefits and drawbacks of these systems resulted in guidance (EPA 1977) that may be helpful to local land-use planning and development, or permitting authorities. In particular, considering local geology, hydrology, and septic system density are factors identified in existing guidance that appear to be applicable to the area south of Nampa. Thin soil horizons in direct contact with fractured lithology are conditions that facilitate transmission of contaminants to ground water. In regions where the soil horizon is periodically saturated, either by meteoric events or irrigation practices, contaminants may be further mobilized and rapidly transported to aquifers. To prevent further degradation of the basalt aquifer south of Nampa, the following engineering controls should be considered:

- Septic systems—Newly constructed or replaced septic systems should be designed to account for the thin soil horizons to minimize contaminant transport through the thin soil layers.
- Water wells—Most of the local water wells are vulnerable to contamination in the shallow subsurface due to the geology and well construction. Thin soil horizons provide limited opportunity for contaminants to degrade before entering the shallow aquifer. Fractured rock provides little additional filtration or contaminant degradation as contaminated water moves down to the water table and is drawn into domestic supply wells. New wells should be constructed having a minimum well seal depth into a deeper aquifer in competent bedrock, which would reduce the risk of drawing in contaminants that exist in the upper fractured bedrock aquifer.
- Canal—The irrigation canal adjacent to and upgradient of Locust Lane does not appear to be lined. As such, the canal may be impacting the shallow aquifer during the irrigation season. Sections of the canal should be identified and lined to prevent loss of water in the area within and upgradient of Locust Lane. The lining will likely reduce the contaminant load or mobilization of contaminants from the canal and improve water quality in local domestic wells.

2.1.3 Lower Payette Nitrate Priority Area Ground Water Monitoring Project

2.1.3.1 Purpose and Background

This regional monitoring project was designed to provide the data necessary for evaluating water quality in the Lower Payette NPA. Among the state's 34 NPAs, the Lower Payette NPA is ranked 31, with 1 being the most degraded and 34 the least. Ground water samples were collected from individual private domestic or irrigation wells. Program objectives, design, and well selection processes were identified in the Boise Regional Office's Regional Ground Water Monitoring Network Design (DEQ 2011a). The monitoring results will be used by DEQ in future NPA delineation and ranking activities. Data may also be used to identify a local monitoring project to determine potential sources and the extent of constituents exceeding a health standard. To accurately evaluate water quality and determine trends in an area, it is important that data are collected over time from the same wells, the wells monitor the same aquifer zone, and wells are distributed across the area and located in a manner that accurately represents the ground water quality of the area.

Payette County is located on the western boundary of the state and is bounded by Washington County on the north, Gem County on the east, Canyon County on the south, and the Snake River and the state of Oregon on the west. Payette County contains the mouth of the Payette River where it empties into the Snake River, and forms the western border of Idaho. The Payette River crosses the central portion of the county from southeast to northwest and separates the foothills on the northeast from the farmland in Payette Valley on the southwest. The Snake River bounds the western edge of the county and the southern portion of the county is comprised of low rolling hills. The majority of the county is irrigated agricultural land, with agriculture occurring on Miocene lake beds and Quaternary stream deposits. A small area of Columbia River basalt is found in the northeast corner of the county, where it is cut by north-striking normal faults (Alt and Hyndman 1995).

Ground water occurs within the unconsolidated deposits of gravel, sand, and silt that overly the basement rocks. The flow system is recharged primarily by leakage from the Snake and Payette Rivers, drainage from the hills to the north of the valley, precipitation, and infiltration from agricultural water (Alt and Hyndman 1995).

Regional ground water elevations obtained from IDWR show that shallow ground water flows northwesterly toward the Snake River in the southernmost part of the NPA area, and northerly toward the Payette River in the central part of the NPA area (Figure 6). Data in the northernmost hills are not available to document ground water flow, but ground water likely flows southwesterly toward the Snake and Payette Rivers in a manner consistent with the topography.

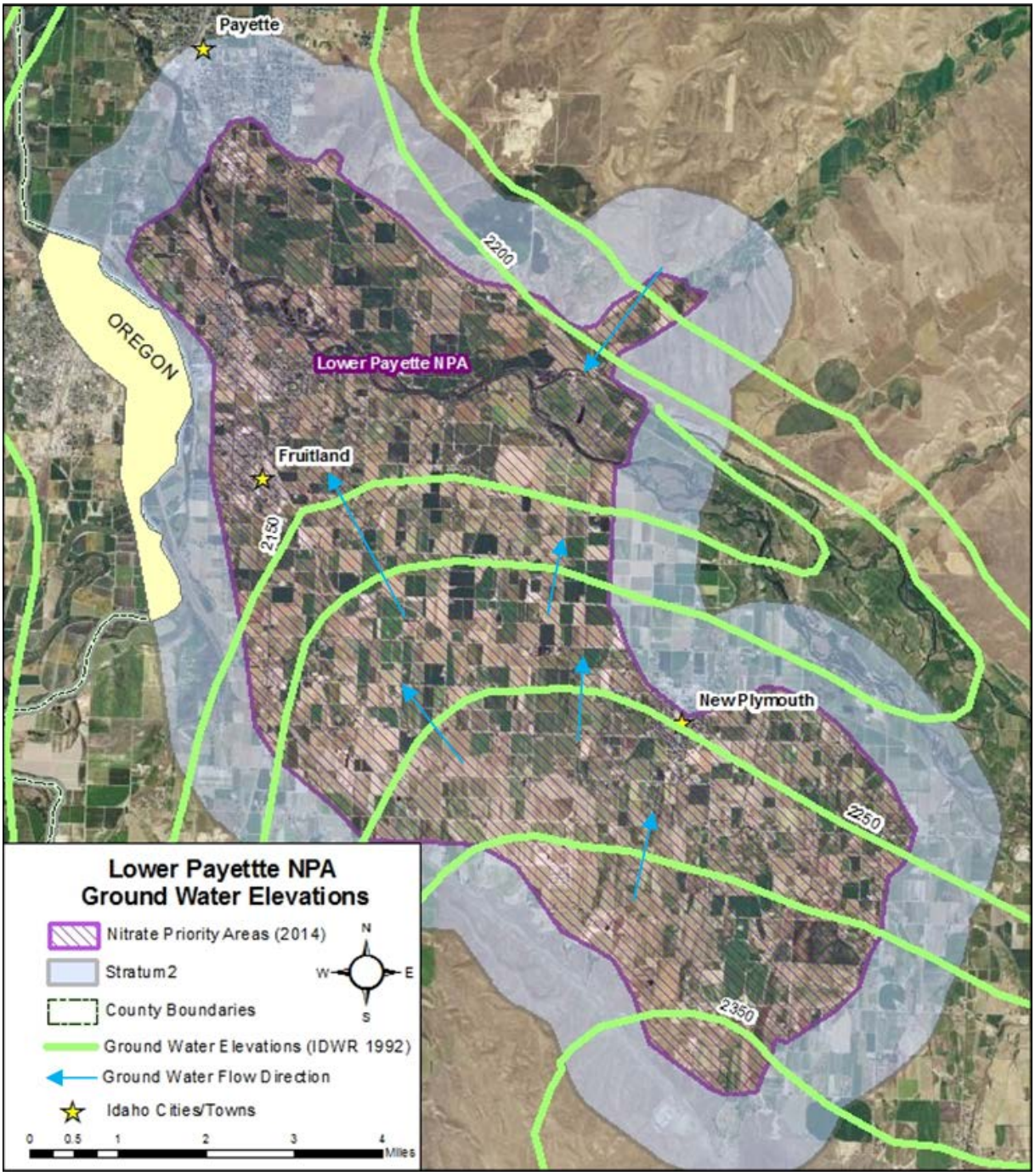


Figure 6. Ground water contours and elevations—Lower Payette Nitrate Priority Area Ground Water Monitoring Project.

2.1.3.2 Methods and Results

In 2016, 78 wells were sampled as part of the Lower Payette NPA ground water quality monitoring project. The number of wells sampled was chosen according to the statistical process specified in the Regional Network Design (DEQ 2011a). The process determined that for the Lower Payette NPA, 77 wells would need to be sampled to meet a 90% statistical confidence level that the estimated mean is within 15% of the true mean. The Regional Network Design

protocol also determined that the size of each sampling unit would be a quarter section of a Township/Range/Section within the project area.

The total number of quarter sections located within Stratum 1 and Stratum 2 were randomized separately to determine which quarter sections would be sampled. Well depths of sampled wells (with known depths) ranged from 15 to 123 feet bgs, with a median depth of 59 feet bgs.

All samples were collected according to the QAPP (DEQ 2014b) and FSP (DEQ 2016c). Water quality field parameters (pH, temperature, specific conductivity, and 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 9).

Table 9. Water quality field parameters—Lower Payette Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
750	77	10/12/2016	15.52	7.55	492	2.65
979	45	09/12/2016	14.13	7.28	718	1.07
982	60	09/13/2016	15.13	7.44	653	4.06
984	45	09/13/2016	14.30	7.40	839	4.05
990	65	09/26/2016	14.97	7.68	664	6.53
997	56	09/13/2016	14.86	7.19	960	6.53
1322	68	10/03/2016	15.43	7.63	804	3.14
1325	78	10/03/2016	15.88	7.52	526	6.31
1326	53	10/04/2016	15.12	7.51	786	4.88
1327	58	10/03/2016	15.51	7.80	747	4.32
1332	68	09/14/2016	14.56	7.51	590	6.01
1333	57	09/14/2016	14.65	7.32	1,050	6.99
1334	30	09/06/2016	18.28	7.07	719	2.42
1336	69	09/26/2016	13.97	7.73	695	0.88
1340	58	10/03/2016	16.10	8.01	501	3.71
1341	61	09/14/2016	15.39	7.40	781	6.83
1342	75	10/04/2016	17.11	7.35	588	3.85
1344	45	10/11/2016	15.00	7.27	333	0.91
1345	63	10/11/2016	16.09	7.50	488	6.04
1346	60	10/12/2016	14.88	7.37	569	6.10
1347	80	10/04/2016	15.70	7.44	790	6.33
1348	58	10/04/2016	15.70	7.38	569	6.32
1356	80	09/26/2016	14.54	7.76	586	8.38
1357	40	09/19/2016	16.38	7.78	276	0.59
1359	40	10/03/2016	16.18	7.71	292	1.05
1360	60	09/12/2016	16.40	*8.51*	160	0.36
1362	57	09/13/2016	14.33	7.55	661	4.06
1363	50	09/19/2016	14.58	7.53	527	4.35
1364	38	10/03/2016	15.72	7.88	550	3.11

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
1368	75	10/11/2016	15.76	*6.43*	333	5.30
1369	60	10/04/2016	15.25	7.48	457	5.62
1370	40	11/03/2016	14.80	6.97	1,120	5.49
1379	72	09/14/2016	14.95	8.10	272	1.18
1380	59	09/06/2016	17.51	7.40	377	4.34
1381	15	09/06/2016	16.80	7.19	470	1.42
1382	29	09/07/2016	15.09	7.13	954	6.68
1383	45	09/06/2016	15.09	7.15	887	4.48
1385	25	09/09/2016	14.16	7.62	317	1.14
1393	40	09/14/2016	14.81	7.01	897	5.45
1395	38.5	09/13/2016	15.51	7.53	730	2.56
1396	25	09/06/2016	17.48	7.15	720	4.11
1397	37	09/07/2016	13.69	7.44	676	6.91
1399	36	09/12/2016	13.58	7.10	797	1.93
1402	53	09/07/2016	15.27	7.35	858	4.55
2521	60	11/03/2016	15.37	7.28	569	4.54
2523	90	10/11/2016	15.30	7.51	536	7.41
2524	54.5	09/26/2016	13.96	7.58	809	5.40
2526	50	09/12/2016	15.19	7.13	869	1.92
2532	62	10/11/2016	15.88	7.33	486	3.01
2552	102	09/26/2016	15.68	7.64	1,210	7.32
2553	49	09/14/2016	14.14	7.43	856	4.65
2554	71	09/12/2016	14.57	8.25	230	0.38
2556	75	09/13/2016	15.02	7.55	761	1.19
2557	100	09/26/2016	14.46	7.74	583	8.46
2558	37	09/07/2016	16.51	7.33	582	5.72
2559	36	09/26/2016	16.64	*5.43*	868	10.3
2560	41	09/07/2016	14.91	7.16	800	5.51
2561	45	09/06/2016	17.57	7.16	836	6.33
2562	37	09/14/2016	13.57	7.43	1,070	3.20
2563	47	09/19/2016	15.38	7.39	617	3.33
2564	80	09/12/2016	14.94	7.33	915	1.08
2565	123	09/14/2016	16.47	7.35	628	1.05
2567	27	09/07/2016	15.70	6.75	819	1.03
2568	103	09/06/2016	14.73	6.81	338	1.74
2569	59	10/04/2016	14.82	7.33	762	6.48
2570	75	10/03/2016	14.91	8.16	170	0.89
2571	104	10/12/2016	16.47	8.02	165	0.75
2572	70	09/19/2016	14.92	7.06	624	2.62
2573	71	10/04/2016	15.17	7.53	483	5.83
2574	78	10/11/2016	14.88	7.24	621	6.80
2576	112	09/13/2016	14.95	7.45	1,010	6.34

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
2577	50	09/12/2016	14.50	6.98	575	0.29
2578	78	10/04/2016	15.31	7.27	529	2.75
2579	77	10/03/2016	16.72	6.74	464	2.20
2584	71	09/26/2016	14.03	7.53	813	1.72
2585	65	10/12/2016	15.69	7.14	500	3.13
2646	Unk	09/13/2016	14.60	7.44	871	6.58
2647	Unk	11/03/2016	15.74	7.14	573	0.80

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; 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. These regulations apply to 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. 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.

Samples were analyzed for nitrate, nitrite, TC, and *E. coli* (Table 10). Wells with a DO less than 2.00 mg/L, as determined by field analysis, were also analyzed for ammonia as required by the FSP (DEQ 2016c). Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson for nitrogen isotope analysis (Table 10).

Table 10. Nutrient and bacteria results—Lower Payette Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations				Bacteria[a]	
			Ammonia	Nitrate[b]	Nitrite[b]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*
			(mg/L)				(MPN/100 mL)	
Primary or Secondary Standard:			***No Stand.***	***10***	***1***	***No Stand.***	***1 cfu/100 mL***	***<1 cfu/100 mL***
750	77	10/12/2016	—	4.17	<0.30	—	<1.0	<1.0
979	45	09/12/2016	0.012	9.41	<0.30	4.2	<1.0	<1.0
982	60	09/13/2016	—	6.38	<0.30	4.6	<1.0	<1.0
984	45	09/13/2016	—	8.48	<0.30	4.8	<1.0	<1.0
990	65	09/26/2016	—	4.86	<0.30	—	1.0	<1.0
997	56	09/13/2016	—	4.22	<0.30	—	<1.0	<1.0
1322	68	10/03/2016	—	3.46	<0.30	QNS	<1.0	<1.0
1325	78	10/03/2016	—	5.52	<0.30	7.6	<1.0	<1.0
1326	53	10/04/2016	—	5.84	<0.30	5.3	<1.0	<1.0
1327	58	10/03/2016	—	5.12	<0.30	6.7	<1.0	<1.0
1332	68	09/14/2016	—	1.92	<0.30	8.4	<1.0	<1.0
1333	57	09/14/2016	—	**19.4**	<0.30	4.4	1.0	<1.0
1334	30	09/06/2016	—	3.25	<0.30	—	<1.0	<1.0
1336	69	09/26/2016	<0.050	3.8	<0.30	—	<1.0	<1.0
1340	58	10/03/2016	—	4.32	<0.30	—	<1.0	<1.0

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations				Bacteria[a]	
			Ammonia	Nitrate[b]	Nitrite[b]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*
			(mg/L)				(MPN/100 mL)	
Primary or Secondary Standard:			***No Stand.***	***10***	***1***	***No Stand.***	***1 cfu/100 mL***	***<1 cfu/100 mL***
1341	61	09/14/2016	—	6.34	<0.30	4.2	<1.0	<1.0
1342	75	10/04/2016	—	9.41	<0.30	8.2	<1.0	<1.0
1344	45	10/11/2016	<0.010	<0.18	<0.30	—	<1.0	<1.0
1345	63	10/11/2016	—	4.34	<0.30	—	<1.0	<1.0
1346	60	10/12/2016	—	0.891	<0.30	—	4.1	<1.0
1347	80	10/04/2016	—	9.45	<0.30	7.1	<1.0	<1.0
1348	58	10/04/2016	—	5.82	<0.30	4.2	<1.0	<1.0
1356	80	09/26/2016	—	3.87	<0.30	—	2.0	<1.0
1357	40	09/19/2016	0.03	0.724	<0.30	—	1.0	<1.0
1359	40	10/03/2016	<0.010	1.31	<0.30	—	<1.0	<1.0
1360	60	09/12/2016	0.13	<0.18	<0.30	—	<1.0	<1.0
1362	57	09/13/2016	—	3.15	<0.30	—	<1.0	<1.0
1363	50	09/19/2016	—	3.27	<0.30	3.4	<1.0	<1.0
1364	38	10/03/2016	—	2.33	<0.30	—	<1.0	<1.0
1368	75	10/11/2016	—	5.56	<0.30	5.9	2.0	<1.0
1369	60	10/04/2016	—	2.6	<0.30	—	<1.0	<1.0
1370	40	11/03/2016	—	**18.2**	<0.30	4.4	<1.0	<1.0
1379	72	09/14/2016	2.6	0.197	<0.30	—	<1.0	<1.0
1380	59	09/06/2016	—	2.51	<0.30	—	<1.0	<1.0
1381	15	09/06/2016	<0.020	1.36	<0.30	—	31.7	<1.0
1382	29	09/07/2016	—	**29.8**	<0.30	5.6	<1.0	<1.0
1383	45	09/06/2016	—	8.01	<0.30	7.4	<1.0	<1.0
1385	25	09/09/2016	0.095	<0.18	<0.30	QNS	<1.0	<1.0
1393	40	09/14/2016	—	6.67	<0.30	4.5	4.1	<1.0
1395	38.5	09/13/2016	—	3.64	<0.30	—	<1.0	<1.0
1396	25	09/06/2016	—	2.53	<0.30	11.5	224.7	**8.6**
1397	37	09/07/2016	—	7.09	<0.30	6.1	<1.0	<1.0
1399	36	09/12/2016	<0.020	8.93	<0.30	2.7	<1.0	<1.0
1402	53	09/07/2016	—	6.48	<0.30	4	2.0	<1.0
2521	60	11/03/2016	—	3.37	<0.30	—	<1.0	<1.0
2523	90	10/11/2016	—	**10.8**	<0.30	8.5	<1.0	<1.0
2524	54.5	09/26/2016	—	**11.0**	<0.30	3	9.8	<1.0
2526	50	09/12/2016	<0.050	**11.1**	<0.30	4.1	<1.0	<1.0
2532	62	10/11/2016	—	0.64	<0.30	6.5	1.0	<1.0
2552	102	09/26/2016	—	**31.2**	<0.30	8.6	<1.0	<1.0
2553	49	09/14/2016	—	**12.0**	<0.30	3.8	<1.0	<1.0
2554	71	09/12/2016	0.16	<0.18	<0.30	QNS	<1.0	<1.0
2556	75	09/13/2016	3.7	0.447	<0.30	QNS	<1.0	<1.0
2557	100	09/26/2016	—	4.12	<0.30	4.2	<1.0	<1.0
2558	37	09/07/2016	—	3.44	<0.30	—	<1.0	<1.0

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations				Bacteria[a]	
			Ammonia	Nitrate[b]	Nitrite[b]	$\delta^{15}N$ (‰)	Total Coliform	*E. coli*
			(mg/L)				(MPN/100 mL)	
Primary or Secondary Standard:			***No Stand.***	***10***	***1***	***No Stand.***	***1 cfu/100 mL***	***<1 cfu/100 mL***
2559	36	09/26/2016	—	8.5	<0.30	4.8	2.0	<1.0
2560	41	09/07/2016	—	**15.3**	<0.30	7.3	<1.0	<1.0
2561	45	09/06/2016	—	7.28	<0.30	4.6	<1.0	<1.0
2562	37	09/14/2016	—	**17.9**	<0.30	4.9	2.0	<1.0
2563	47	09/19/2016	—	4.92	<0.30	—	<1.0	<1.0
2564	80	09/12/2016	<0.010	7.16	<0.30	4.4	<1.0	<1.0
2565	123	09/14/2016	0.96	0.232	<0.30	—	<1.0	<1.0
2567	27	09/07/2016	<0.010	2.52	<0.30	—	12.1	<1.0
2568	103	09/06/2016	0.9	<0.18	<0.30	—	<1.0	<1.0
2569	59	10/04/2016	—	**10.2**	<0.30	7.6	<1.0	<1.0
2570	75	10/03/2016	0.5	<0.18	<0.30	—	41.4	<1.0
2571	104	10/12/2016	0.028	<0.18	<0.30	—	<1.0	<1.0
2572	70	09/19/2016	—	3.16	<0.30	—	8.6	<1.0
2573	71	10/04/2016	—	3.06	<0.30	—	<1.0	<1.0
2574	78	10/11/2016	—	7.4	<0.30	4.1	<1.0	<1.0
2576	112	09/13/2016	—	9.46	<0.30	4.4	<1.0	<1.0
2577	50	09/12/2016	5	<0.18	<0.30	—	<1.0	<1.0
2578	78	10/04/2016	—	1.48	<0.30	—	1.0	<1.0
2579	77	10/03/2016	—	0.778	<0.30	—	1.0	<1.0
2584	71	09/26/2016	<0.050	9.21	<0.30	3.6	<1.0	<1.0
2585	65	10/12/2016	—	2.55	<0.30	—	<1.0	<1.0
2646	Unk	09/13/2016	—	**12.9**	<0.30	—	<1.0	<1.0
2647	Unk	11/03/2016	1.2	<0.18	<0.30	—	<1.0	<1.0

Notes: mg/L = milligrams per liter; ‰ = per mil; MPN/100 mL = most probable number per 100 milliliters; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; (—) = data unavailable or not analyzed; QNS = Quantity not sufficient; Unk = Unknown. Well log not found. Bolded red numbers indicate EPA's National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

[a] TC 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 TC (indicated by gray-shaded numbers) is not a violation of these rules. TC 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 colony forming units per 100 milliliters (cfu/100 mL), analytical results provided in most probable number per 100 milliliters (MPN/100 mL) are acceptable for comparison to the standard.

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

Nitrate and Nitrite Results

The nitrate values ranged from <0.18 mg/L to 31.2 mg/L. Samples from 34 of the 78 wells contained nitrate concentrations of 5 mg/L or greater; with 12 or the 34 samples exceeding the nitrate MCL of 10 mg/L (Table 10). The spatial distribution of nitrate concentrations is shown in Figure 7.

All samples had reported nitrite concentrations less than the reporting limit of 0.3 mg/L.

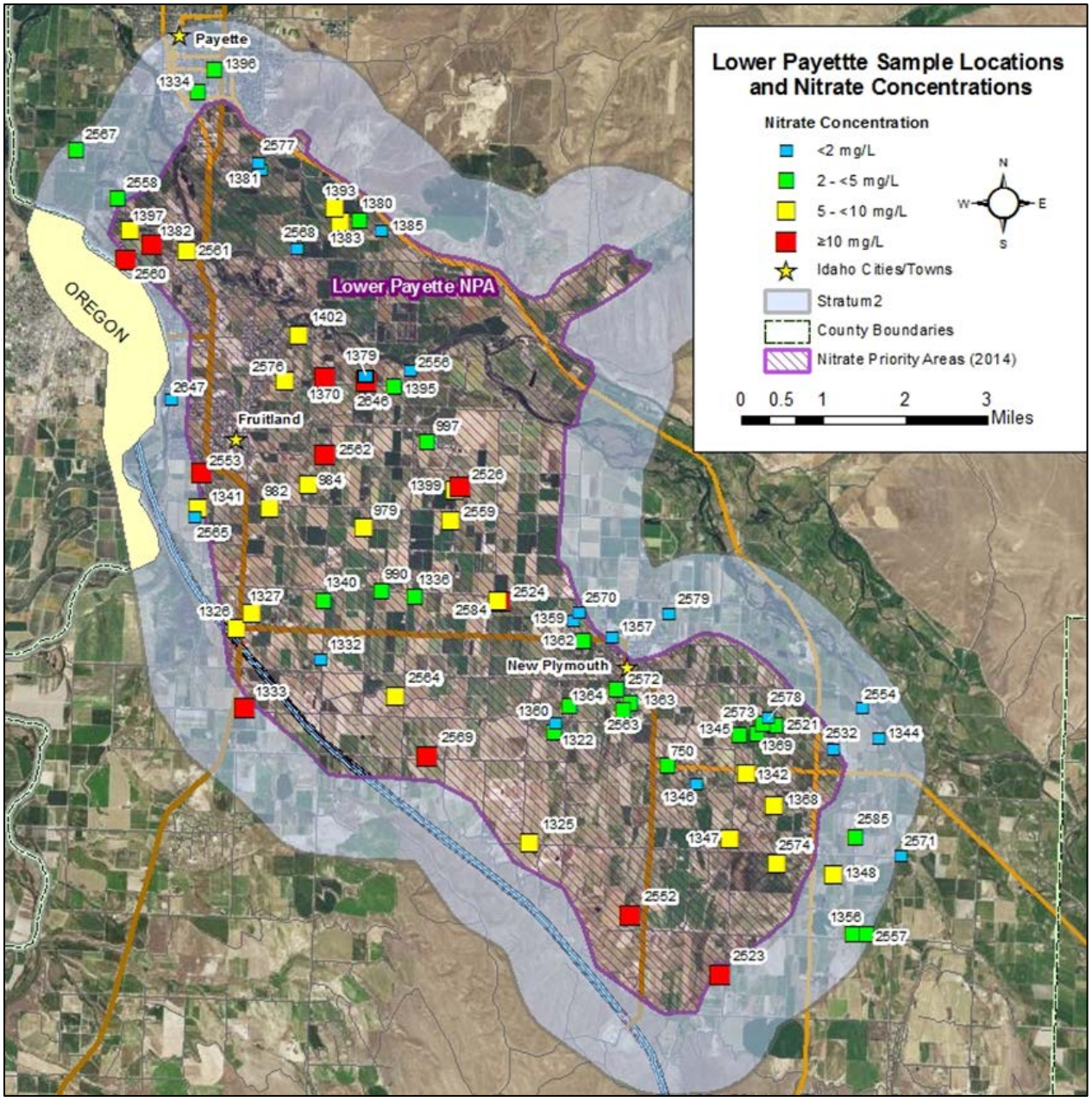


Figure 7. Private domestic drinking water well sample locations and nitrate concentrations—Lower Payette Nitrate Priority Area Ground Water Monitoring Project.

Comparing the 2011 and 2016 nitrate sample results showed the majority of the project wells changed (increased or decreased) over the 5-year period, with only three wells showing no change in nitrate concentration (DEQ 2013a). A total of18 wells showed a decrease and 22 wells showed an increase in nitrate concentration, while one well showed no change. The median nitrate concentration decreased from 4.40 mg/L to 4.22 mg/L. The largest increase in nitrate concentration (an increase of 25.4 mg/L) was at Well 1382 (Table 11). The spatial distribution of changes in nitrate concentration is shown in Figure 8.

Table 11. Comparison of nitrate concentrations from 2011 to 2016—Lower Payette NPA Ground Water Monitoring Project.

Site ID	Well Depth (feet)	2011 Nitrate	2016 Nitrate	Change in Nitrate
		(mg/L)		
979	45	8.8	9.41	0.61
982	60	9.7	6.38	-3.32
997	56	3.8	4.22	0.42
1322	68	2.3	3.46	1.16
1325	78	8.4	5.52	-2.88
1326	53	7.3	5.84	-1.46
1327	58	3.8	5.12	1.32
1332	68	2.9	1.92	-0.98
1333	57	9.1	19.4	10.3
1334	30	2.3	3.25	0.95
1336	69	2.9	3.8	0.9
1340	58	2.8	4.32	1.52
1341	61	6.1	6.34	0.24
1342	75	9.5	9.41	-0.09
1344	45	<0.05	<0.18	0[a]
1345	63	2.5	4.34	1.84
1346	60	1.8	0.891	-0.909
1347	80	5.0	9.45	4.45
1348	58	1.7	5.82	4.12
1356	80	2.9	3.87	0.97
1357	40	0.91	0.724	-0.186
1359	40	1.2	1.31	0.11
1360	60	5.4	0.01	-5.39
1362	57	4.9	3.15	-1.75
1363	50	4.8	3.27	-1.53
1364	38	0.57	2.33	1.76
1368	75	4.6	5.56	0.96
1369	60	3.2	2.6	-0.6
1370	40	20	18.2	-1.8
1379	72	<0.05	0.197	0.147[a]
1380	59	3.1	2.51	-0.59
1381	15	0.18	1.36	1.18
1382	29	4.4	29.8	25.4
1383	45	10	8.01	-1.99
1385	25	0.53	<0.18	-0.35[a]
1393	40	7.4	6.67	-0.73
1395	38.5	2.5	3.64	1.14
1396	25	2.1	2.53	0.43
1397	37	6.7	7.09	0.39
1399	36	17	8.93	-8.07
1402	53	9.2	6.48	-2.72

[a] An estimate. One of (or both) the concentrations was below the detection limit so an exact change in concentration could not be calculated.

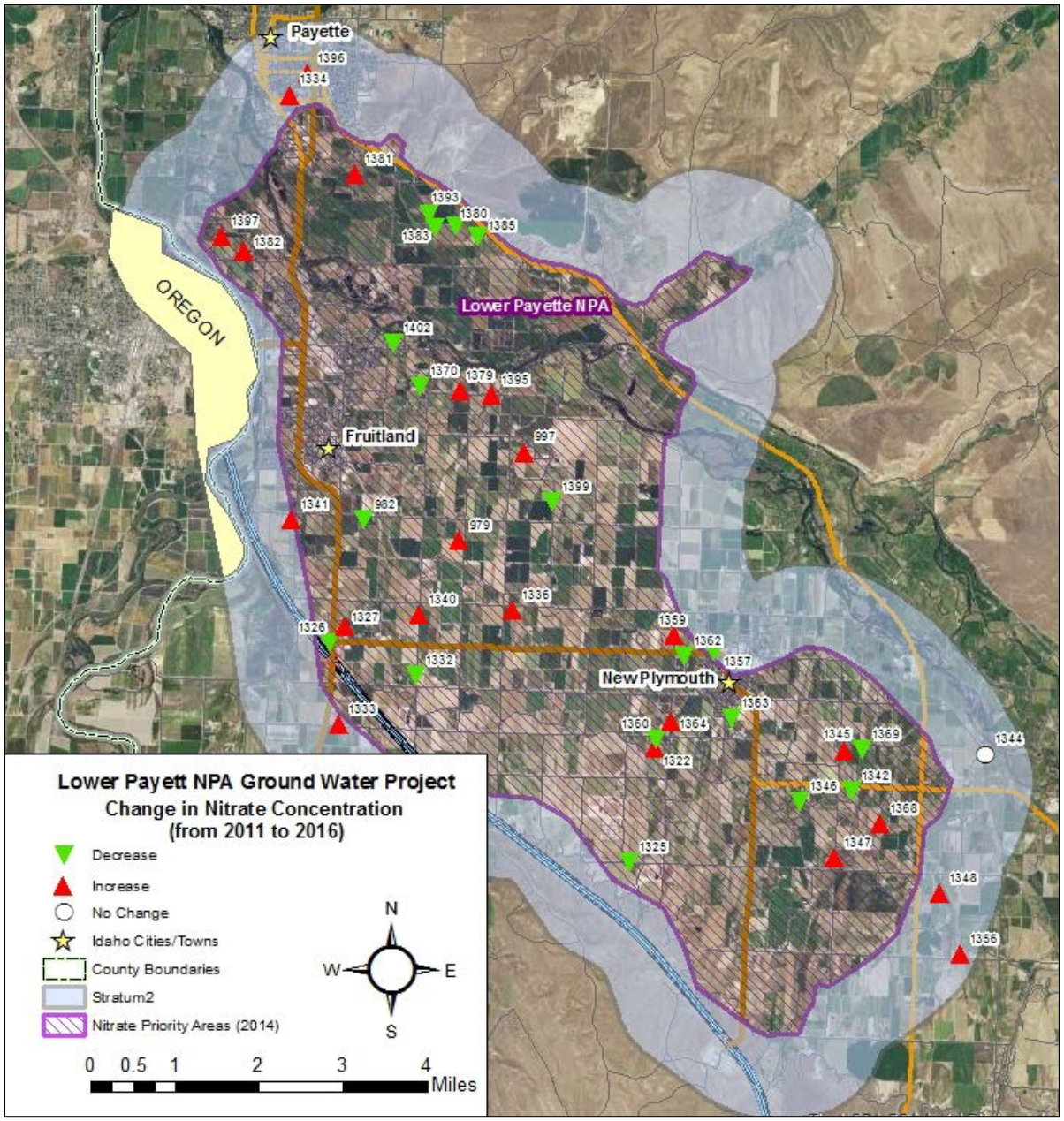


Figure 8. Changes in nitrate concentration—Lower Payette NPA Ground Water Monitoring Project.

Bacteria Results

Of the 78 wells, 19 had positive detections of TC bacteria; the concentrations ranged from 1.0 and 224.7 MPN/100 mL. Well 1396 was positive for *E. coli* (Table 10).

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 42 samples, most of which had nitrate concentrations greater than or equal to 5 mg/L (Table 10). Nitrogen from

human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 12.

Table 12. 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

The $\delta^{15}N$ results from this project ranged from 2.7‰ to 11.5‰. A total of 5 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 32 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. Well 1396 had a $\delta^{15}N$ ratio of 11.5‰ (and was positive for *E. coli),* which is typical nitrogen waste sources (Table 10; Table 12).

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, and 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 is predominately agricultural, including both crop fields and animal operations. This type of land use would likely result in a mixture of nitrogen sources, which is supported by the $\delta^{15}N$ values detected.

2.1.3.3 Conclusions

NPAs are designated when at least 25% of the wells sampled contain nitrate concentrations equal to or greater than 5 mg/L. In this project, 34 of the 78 wells sampled (44%) had nitrate values of 5 mg/L or greater.

The nitrate MCL of 10 mg/L was exceeded in 12 wells. The highest nitrate concentration detected during the monitoring event (31.2 mg/L) was at Well 2552. Well 2552 had a nitrogen isotope value that is consistent with organic nitrogen in soil or a mixed nitrogen source. The second highest nitrate concentration detected (29.8 mg/L) was at Well 1382. Well 1382 had a nitrogen isotope value that is consistent with organic nitrogen in soil or a mixed nitrogen source.

Bacteria detections were not widespread throughout the project area; however, there were several TC detections. There does not appear to be a strong correlation between elevated nitrate and bacteria detections. The most northern project well, Well 1396, was positive for both TC and *E. coli* and had a nitrogen isotope ration of 11.5‰ suggesting a waste source although the nitrate concentration was not elevated. Well 1396 is a shallow irrigation well screened at 15 feet bgs, with a total completion depth of 25 feet bgs. The depth to water at this well is 6 feet bgs. The nitrogen isotope value and presence of *E. coli* bacteria suggests there is a waste source

(potentially a septic system drainfield or leaking sewer line or pet waste) nearby that is impacting this well.

Overall the wells sampled in 2011 and 2016 showed minor increases or decreases in nitrate concentrations. The greatest change in nitrate concentration over the last 5 years occurred at Well 1382, with an increase of 25.4 mg/L, resulting in a concentration almost three times the MCL of 10 mg/L. The nitrogen isotope value at Well 1382 was consistent with a mixed nitrogen source. Well 1333 also showed a significant increase in nitrate concentration, changing from 9.10 mg/L to 19.4 mg/L, which is almost double the MCL of 10 mg/L. The nitrogen isotope value at Well 1333 was consistent with a mixed nitrogen source.

The median depth of wells with nitrate concentration greater than 10 mg/L (of those with a known depth) was 50 feet bgs. This is less than the median depth of all project wells (59 feet bgs), which is consistent with the rationale that well depth is an indicator of vulnerability to nitrate contamination.

2.1.3.4 Recommendations

Land-use activities near the sites with elevated nitrate concentrations should be evaluated by the appropriate agency to determine if best management practices (BMPs) should be implemented or improved to protect ground water quality from further degradation.

The *Payette County Ground Water Quality Improvement and Drinking Water Source Protection Plan* is available at *http://www.deq.idaho.gov/media/856951-payette-county-ground-wq-improvement-dw-source-protection-plan-0612.pdf*. This plan includes implementation activities for private well owners and agricultural operators designed to reduce ground water contamination from nitrate and other contaminants.

2.1.4 N. Rapid Creek Lane Complaint Follow Up Monitoring Project

2.1.4.1 Purpose and Background

This ground water monitoring project was designed to respond to a complaint regarding suspected ground water contamination from animal waste (manure) from a nearby dairy. The complaint response monitoring area was limited to private domestic wells of homes along N. Rapid Creek Lane, Kuna, Idaho. N. Rapid Creek Lane is near the intersection of Meridian Road and E. Deer Flat Road (Figure 9).

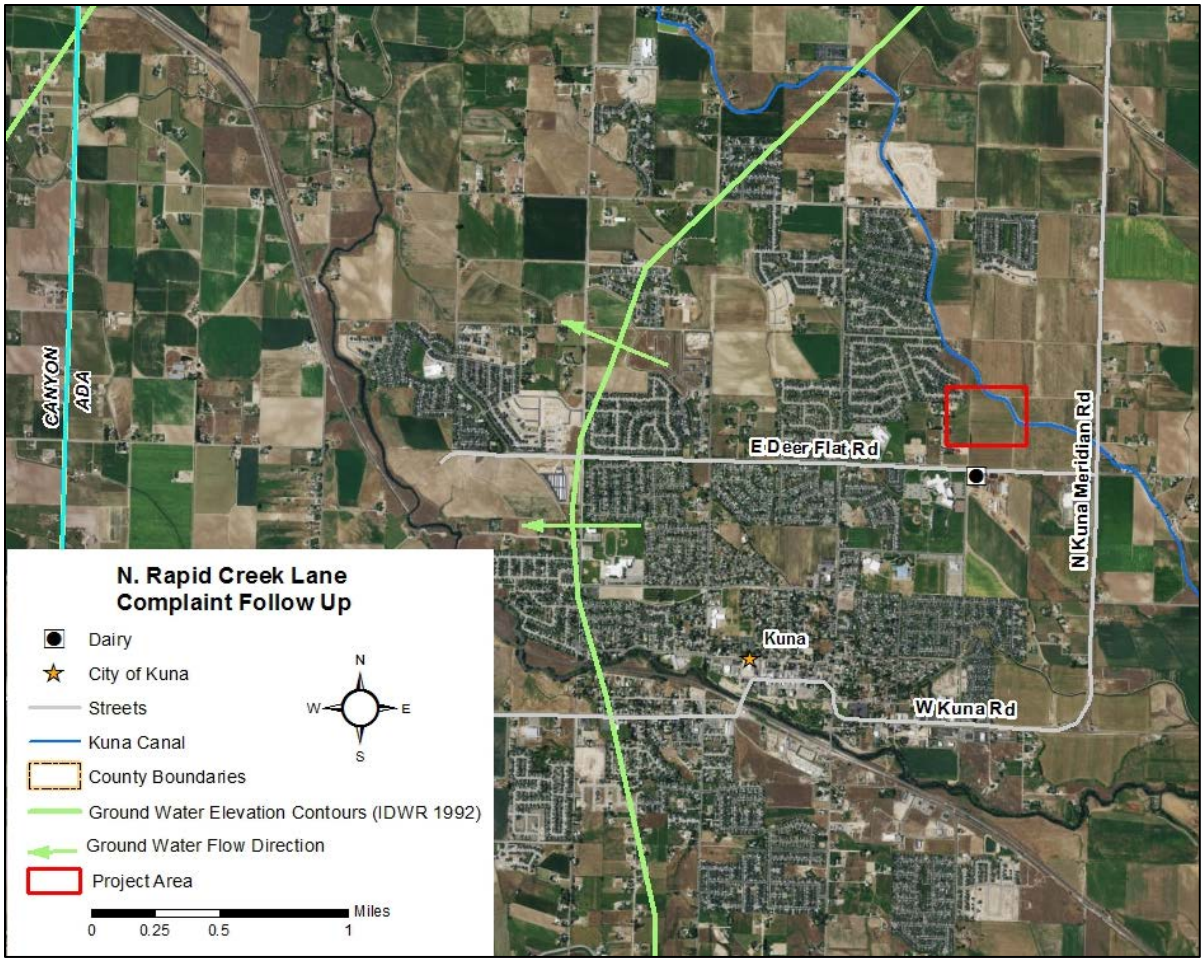


Figure 9. Project area, ground water elevations and flow direction—N. Rapid Creek Lane Complaint Follow Up Ground Water Monitoring Project.

2.1.4.2 Methods and Results

DEQ obtained permission from five of the six well owners on N. Rapid Creek Lane to access wells and collect samples for laboratory analysis in response to suspected ground water contamination.

Samples were collected on June 13, 2016, from the five wells according to the appropriate QAPP (DEQ 2015b) and FSP (DEQ 2016d). Additionally, a surface water sample was collected from a cistern on a well owner's property.

Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each well before sample collection (Table 13).

Table 13. Water quality field parameters—N. Rapid Creek Lane Complaint Follow Up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
2015	80	06/13/2016	13.96	7.93	466	10.52
2017	105	06/13/2016	13.84	7.53	471	10.40
2527	160	06/13/2016	13.80	7.89	530	10.15
2529	162	06/13/2016	14.42	8.10	489	7.66
2531	126	06/13/2016	13.78	6.96	489	10.05
Cistern/surface water	NA	06/13/2016	—	—	—	—

Note: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; NA = Not Applicable; (—) = data unavailable or not analyzed.
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

Samples were analyzed for nitrate and bacteria (TC and *E. coli*) (Table 14). The samples were submitted to the IBL for analysis.

Nitrate and Nitrite Results

The reported nitrate concentrations ranged from 4.16 mg/L to 5.69 mg/L; one well of the five wells sampled (Well 2527) had a nitrate concentration of 5 mg/L or greater (Table 14). The nitrate MCL of 10 mg/L was not exceeded in any of the samples. The spatial distribution of nitrate concentrations is shown in Figure 10.

Table 14. Nitrate results—N. Rapid Creek Lane Complaint Follow Up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate[a] (mg/L)	Nitrite[a] (mg/L)
Primary or Secondary Standard:			***10***	***1***
2015	80	06/13/2016	4.16	<0.30
2017	105	06/13/2016	4.87	<0.30
2527	160	06/13/2016	5.69	<0.30
2529	162	06/13/2016	4.31	<0.30
2531	126	06/13/2016	4.86	<0.30
Cistern/surface water	NA	06/13/2016	0.498	<0.30

Note: NA = Not Applicable.
[a] Contaminant with a National Primary Drinking Water Regulation standard.

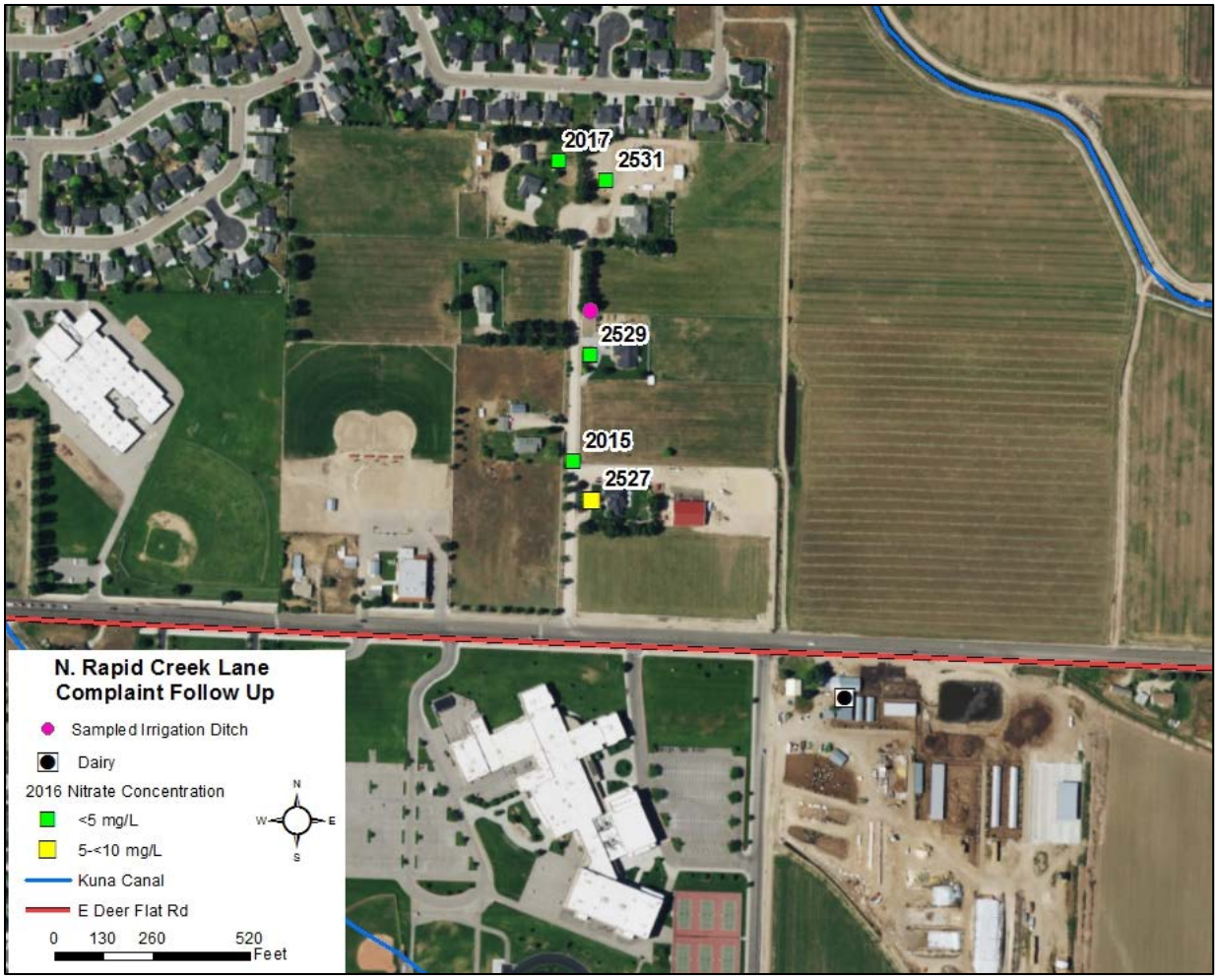


Figure 10. Private domestic drinking water wells and irrigation ditch sample locations and nitrate concentrations—N. Rapid Creek Lane Complaint Follow Up Ground Water Monitoring Project.

Bacteria Results

The reported TC bacteria concentrations ranged from <1 MPN/100 mL to 25.9 MPN/100 mL; three of the five wells were positive for TC (Table 15). All five wells were negative for *E. coli*. The irrigation ditch had an *E. coli* concentration of 886.4 MPN/100 mL, which is within a typical range for surface water.

Table 15. Bacteria results—N. Rapid Creek Lane Complaint Follow Up Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	*E. coli*[a]	Total Coliform[b]
Primary or Secondary Standard:			***<1 cfu/100 mL***	***1 cfu/100 mL***
2015	80	06/13/2016	<1.0	25.9
2017	105	06/13/2016	<1.0	2.0
2527	160	06/13/2016	<1.0	1.0
2529	162	06/13/2016	<1.0	<1.0
2531	126	06/13/2016	<1.0	<1.0
Cistern/surface water	NA	06/13/2016	**866.4**	>2419.6

Notes: MPN/100 mL = most probable number per 100 milliliters; NA = Not Applicable. Bolded red numbers indicate EPA's National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. These regulations apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

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

[b] TC 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 TC (indicated by gray shaded numbers) is not a violation of these rules. TC 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 colony forming units per 100 milliliters (cfu/100 mL), analytical results provided in most probable number per 100 milliliters (MPN/100 mL) are acceptable for comparison to the standard.

2.1.4.3 Conclusions

As a response to a compliant regarding potential impact to ground water from animal waste, five wells along N. Rapid Creek Lane in Kuna, Idaho were sampled for nitrate and bacteria (TC and *E. coli*). All five wells had nitrate concentrations below the MCL and all wells were negative for *E. coli*; however, TC was detected in three of the five samples. The southernmost well (Well 2527) has the highest nitrate concentration of 5.69 mg/L and was positive for TC.

The nitrate and bacteria results for the five wells did not indicate ground water had been significantly impacted at the time of sampling.

2.1.4.4 Recommendations

For this project, no further sampling is recommended at this time.

In general, DEQ recommends that property owners with private domestic drinking water wells sample their well, prior to any water treatment system and as close to the well as possible, on an annual basis. The Central District Health Department can provide Ada County property owners with information and guidance.

2.2 Idaho Falls Region

No ground water quality projects were conducted using DEQ funds in the Idaho Falls region in 2016.

2.3 Coeur d'Alene Region

No ground water quality projects were conducted using DEQ funds in the Coeur d'Alene region in 2016.

2.4 Lewiston Region

Two ground water quality monitoring projects were conducted in the Lewiston region in 2016 using public funds.

2.4.1 Clearwater Plateau NPA Ground Water Monitoring Project

This section summarizes the 2016 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Clearwater Plateau NPA, north of Grangeville, Idaho. A DEQ investigation by Bentz (1998) found that 24 of 55 wells sampled (44%) had nitrate concentrations exceeding 5 mg/L, which is half the MCL of 10 mg/L. The maximum nitrate concentration reported in the 1998 study was 77.1 mg/L. That value was later determined to be 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 NPA ranking, completed in 2014, 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.

2.4.1.1 Purpose and Background

To address elevated nitrate concentrations in the Clearwater Plateau NPA, a ground water quality management plan (GWQM plan) was developed (DEQ and ISCC 2008). The GWQM plan encourages implementation of voluntary 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, such as direct seed practices. Direct seed practices allow for crop planting with minimal soil disturbance, which may contribute to reduced nitrogen mobility when combined with other BMPs.

DEQ initiated the Clearwater Plateau NPA ground water monitoring project (also known as the 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 will be 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 11). The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also commonly found throughout the area.

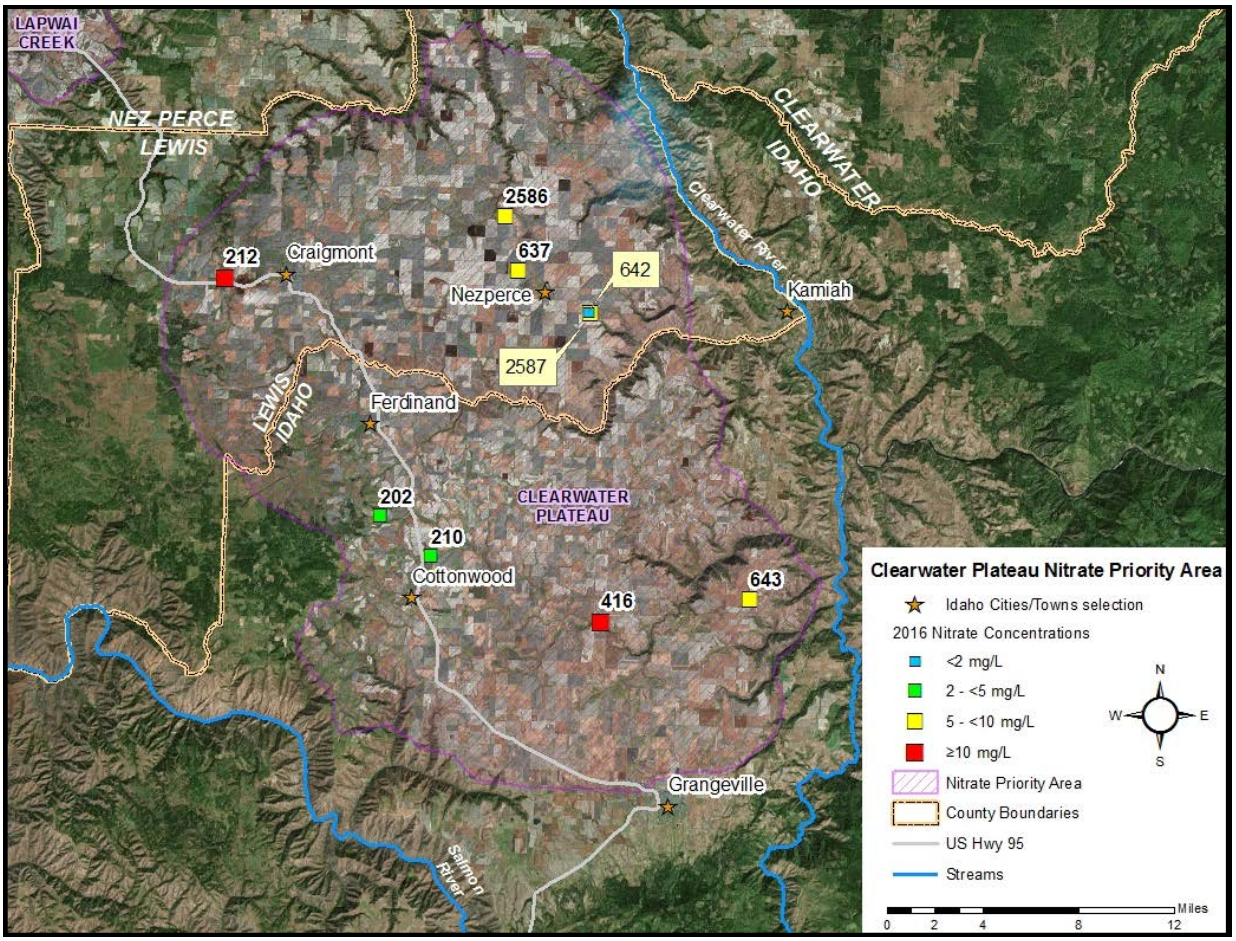


Figure 11. Sampling locations and 2016 nitrate concentrations—Clearwater Plateau NPA Ground Water Monitoring Project.

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

2.4.1.2 Methods and Results

From 2006 through 2013, DEQ conducted quarterly sampling from the Clearwater Plateau NPA network of 23 wells and up to two springs for a total of 25 sampling sites. Nitrate concentrations from sampled sites were compared seasonally for several years to identify wells with similar seasonal trends and wells with apparent anomalies. Wells with anomalies were addressed to identify and resolve isolated or localized situations and dropped from the ambient monitoring network.

DEQ partnered with STRATA for the 2016 sampling efforts for the Clearwater Plateau NPA Ground Water Quality Monitoring Project due to staff transitions during the sampling season.

STRATA staff were responsible for selecting sites, acquiring sampling permission, collecting samples, delivering samples to the lab, and providing DEQ with all field and lab data. Samples from nine wells were collected on June 7 according to the Camas Prairie ground water sampling QAPP (DEQ 2005). The samples were submitted to Anatek Labs Inc. for nitrate plus nitrite total nitrogen (nitrate) analysis.

Figure 11 shows sample collection locations and nitrate results for the June 7 sampling event. Water quality field parameters (pH, temperature, specific conductivity, DO, and oxygen reduction potential) were measured at each site before sample collection, when possible, to ensure adequate purging of the well for a representative sample of the local aquifer. Well 2586 produced very little water so it was not purged before sample collection to ensure sufficient quantities were available for the sample and homeowner (Table 16).

Table 16. Water quality field parameters—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Well ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)
202	400	06/07/2016	13.29	7.09	195	8.16	152
210	500	06/07/2016	15.45	7.42	296	3.71	158
212	400	06/07/2016	13.73	7.63	361	6.6	150
416	Unk	06/07/2016	13.96	7.14	376	5.95	166
637	Unk	06/07/2016	15.47	7.62	356	8.27	140
642	Unk	06/07/2016	12.64	7.64	326	6.09	140
643	145	06/07/2016	15.86	7.76	383	9.47	103
2586	Unk	06/07/2016	—	-—	—	—	—
2587	Unk	06/07/2016	13.51	7.58	433	8.44	172

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; mV = millivolts; Unk = Unknown. Well log not found; (—) = not analyzed.
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

Nitrate Results

Of the nine sampled sites, two wells had reported nitrate concentrations in excess of the EPA's MCL of 10 mg/L (Table 17). The highest reported nitrate concentration was 19.4 mg/L at Well 212 (Figure 11).

Table 17. Nitrate (nitrate plus nitrite) results—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate plus Nitrite[a] (mg/L)
Primary or Secondary Standard:			**10**
202	400	06/07/2016	3.70
210	500	06/07/2016	3.74
212	400	06/07/2016	**19.4**
416	Unk	06/07/2016	**18.6**
637	Unk	06/07/2016	5.50
642	Unk	06/07/2016	1.83
643	145	06/07/2016	6.64
2586	Unk	06/07/2016	5.50
2587	Unk	06/07/2016	7.87

Notes: Unk = Unknown. Well log not found.
[a] Contaminant with a National Primary Drinking Water Regulation standard.

Nitrate concentrations from summer sampling events over the past 10 years are shown in Figure 12. Of the seven project wells sampled in 2016 with historical data, two wells (wells 212 and 416) have remained above the MCL. Nitrate concentrations from Well 642 show the most variability among sampling years, while data for Well 416 show the greatest increase in nitrate concentration over time with an increase of 4.9 mg/L. A total of four wells (Wells 212, 416, 637, and 643) shows an overall increase in nitrate concentration from 2008 to 2017.

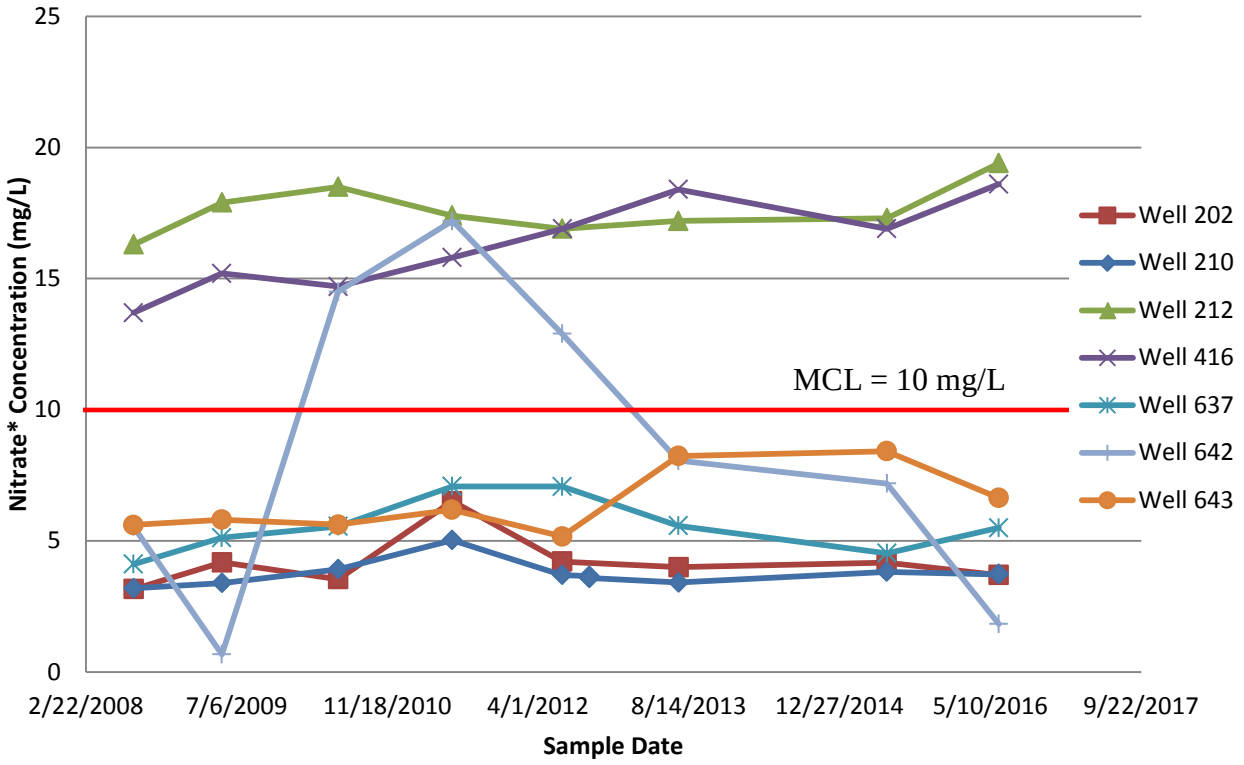


Figure 12. Summer nitrate concentrations—Clearwater Plateau NPA Ground Water Monitoring Project. *Nitrate concentration is representing either nitrate as N or nitrate plus nitrite as N.

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 multiple year trend analysis. This long-term ground water quality monitoring will determine the effectiveness of the GWQM plan in improving ground water quality in this area.

Current sample results show that ground water in the Clearwater Plateau contains elevated nitrate concentrations, with some locations exceeding EPA's MCL of 10 mg/L. Nitrogen isotope analysis from 2005 indicates that both inorganic and organic nitrogen contribute to the elevated concentrations as most results were between 4‰ and 9‰ (consistent with mixed sources) or over 9‰ (consistent with waste sources) (Table 12; Seiler 1996). Based on the large areal extent of degraded ground water in the Clearwater Plateau NPA in general, commercial fertilizer, livestock manure, and septic discharge are all potential sources of elevated nitrate concentrations detected within the project area.

Partnering with STRATA in the 2016 allowed this objective to be achieved by sampling wells in the Clearwater Plateau project area during a period of staff transition at DEQ's Lewiston Regional Office.

2.4.1.4 Recommendations

DEQ recommends yearly monitoring of this NPA to track changes in ambient nitrate concentration relative to changes in land use or source controls. This project will attempt to

identify nitrate trends within the network over multiple years to identify changes in ambient conditions. For future yearly NPA monitoring, an effort should be made to secure sampling permission for a greater number of wells than was achieved in 2016. A larger data set will allow for better trend analysis and a clearer vision of the overall conditions within this NPA.

Ground water conditions may also be represented in spring water. Monitoring spring water when ground water provides the only source of water to a spring can also be used to determine ground water nitrogen loads to surface water. This information may be useful in determining if and where ground water nitrogen is contributing to surface water concentrations within the drainage basin. The information may also be useful in identifying areas to focus BMP implementation efforts. A report by Baldwin et al. (2008), which summarizes data collected for this project from 2005 through 2007, is a resource for additional information.

2.4.2 Lindsay Creek NPA Ground Water Monitoring Project

2.4.2.1 Purpose and Background

The Lindsay Creek NPA was designated in 2008 based on ground water quality data from the IDWR, ISDA, USGS, and DEQ. The NPA encompasses the Lindsay and Tammany Creek watersheds. The 2007 Lindsay Creek total maximum daily load (TMDL) determined that ground water base flow is a nitrogen contributor to Lindsay Creek and required a reduction in nitrogen loading (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 multiple year trend analysis to detect nitrate changes in ground water in the Lindsay Creek NPA and also extend ground water quality monitoring to include the aquifer within the Tammany Creek watershed.

The project area is located east and southeast of Lewiston, Idaho. The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also common in the area. The area is underlain by the Tertiary Columbia River Basalts and consists of units that formed when lava flows filled in the 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 150 to 1,025 feet.

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

DEQ has collected ground water quality data from 14 locations (wells and springs) as part of an ambient ground water quality monitoring network from 2010 through 2015. Nitrate

concentrations from sampled wells and springs 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.

2.4.2.2 Methods and Results

DEQ partnered with STRATA for the 2016 sampling efforts for the Lindsay Creek NPA Ground Water Quality Monitoring Project. STRATA staff was responsible for selecting sites, acquiring sampling permission, collecting samples, delivering samples to lab, and providing DEQ with all field and lab data. A total of four wells were included in the 2016 sampling efforts for the Lindsay Creek NPA Ground Water Quality Monitoring Project. All samples were collected on June 3 by STRATA staff.

Water quality field parameters (pH, temperature, specific conductivity, DO, and oxygen reduction potential) were measured at each site before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 18).

Table 18. Water quality field parameters—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth[a] (feet)	Sample Date	Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxygen Reduction Potential (mV)	pH[b]
1038	150	6/3/2016	14.12	979	11.04	136	8.14
1312	1025	6/3/2016	19.57	189	7.20	132	8.11
1315	589	6/3/2016	14.06	457	11.92	143	8.01
2022	950	6/3/2016	16.49	209	6.56	110	*8.66*

Notes: degrees Celsius (°C); microsiemens per centimeter (µS/cm); milligrams per liter (mg/L); millivolts (mV). Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. These regulations apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

[a] Differences in well depths between 2015 and 2016 for Wells 1315 and 2022 reflect changes to the well (i.e., deepening of the well) or more accurate information.

[b] 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.

Samples were collected for nitrate plus nitrite as N (nitrate). All samples were submitted for analysis to Anatek Labs, Moscow, Idaho.

Nitrate Results

The reported nitrate concentrations ranged from <0.1 mg/L to 12.4 mg/L; three of the four sample sites had positive nitrate concentrations (Table 19). Only one well (Well 1315) had a nitrate concentration that exceeded the MCL of 10 mg/L. The spatial distribution of nitrate concentrations is presented in Figure 13.

Table 19. Nitrate results—Lindsay Creek NPA Ground Water Monitoring Project.

Site ID	Well Depth (Feet)	Date Sampled	Nitrate + Nitrite[a] (mg/L)
1038	150	6/3/2016	7.42
1312	1025	6/3/2016	0.334
1315	589	6/3/2016	**12.4**
2022	950	6/3/2016	<0.1

Notes: Bolded red numbers indicate EPA's National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), was exceeded. The MCL for nitrate is 10 mg/L.
[a] Contaminant with a National Primary 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 multiple year trend analysis for nitrate. Because only four wells were sampled, no significant comparisons could be made against data from previous years for the project as a whole. On an individual basis, nitrate levels remained relatively constant in all four wells as compared to previous years. Of the four wells sampled, only one well exceeded the EPA MCL of 10 mg/L. Well 1315 had the highest reported nitrate concentration of 12.4 mg/L. This project has transitioned to yearly sampling, so seasonal fluctuations were not evaluated as they have been in previous years.

Tracking trends in ambient nitrate ground water concentration due to changes in land uses or source controls will be accomplished by comparing trends over multiple years. This comparison will assist in determining nitrate concentration variability due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions, and variations in leaching rates related to the amount and timing of precipitation that is available to mobilize nitrogen below the crop root zone. Multiple year trend analysis of ambient nitrate concentrations has not yet been conducted because additional data and compilation are needed before conducting such analyses. Data and resources are anticipated to be available to complete the trend analysis phase of the project in the future.

Partnering with STRATA allowed the project objectives to be achieved by sampling wells in the Lindsay Creek area during a period of staff transition at DEQ's Lewiston Regional Office.

2.4.2.4 Recommendations

Yearly monitoring of wells and springs in the Lindsay Creek NPA should continue to establish an ambient ground water quality data set. Continuing to develop the ambient ground water quality data set allows DEQ to track multiple year trends, specifically for nitrate. For future yearly NPA monitoring, an effort should be made to secure sampling permission for a greater number of wells than was achieved for the Lindsay Creek NPA in 2016. 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, once sufficient data are collected. Wells yielding nitrate concentrations or other parameters inconsistent with the ambient conditions

should be evaluated to determine if they represent the impacted aquifer. Multiple year trend analysis should be completed to quantify long-term trends in nitrate concentration.

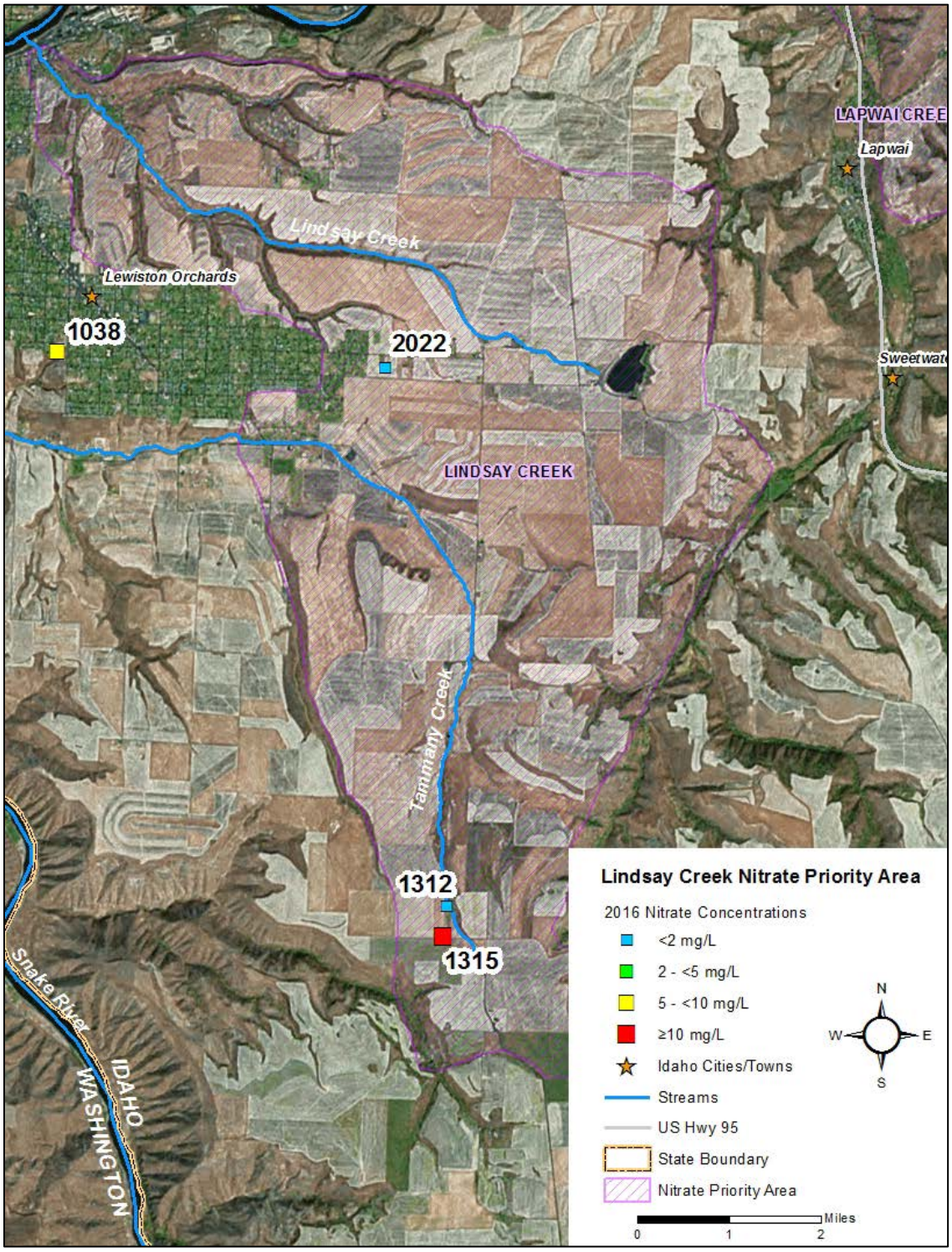


Figure 13. Sample locations and 2016 nitrate concentrations—Lindsay Creek NPA Ground Water Monitoring Project.

2.5 Pocatello Region

Three ground water quality monitoring projects were conducted in the Pocatello region in 2016 using public funds.

2.5.1 PRO Ambient Ground Water Quality Monitoring Project Purpose and Background

In 1976, the USGS undertook a broad study of ground water quality in southeastern Idaho (Seitz and Norvitch 1979). The study sampled 103 wells in Bannock, Bear Lake, Caribou, and Power Counties (Figure 14) and described the general water quality conditions in the study area. This data set represents a valuable historical reference, against which current conditions can be compared.

The multiyear Pocatello Regional Office (PRO) Ambient Ground Water Quality Monitoring Project is designed to provide the data necessary for evaluating ambient ground water quality in portions of Bannock, Bear Lake, Caribou, and Power Counties. Ground water samples will be collected from the same wells previously examined by Seitz and Norvitch (1979), allowing for direct comparison with historical conditions. Data gathered through this project will help evaluate current ground water conditions, identify areas and possible sources of degraded ground water quality, and evaluate changes in water quality over time. Continuing the work started by Seitz and Norvitch, the data will also provide a reference for future sampling.

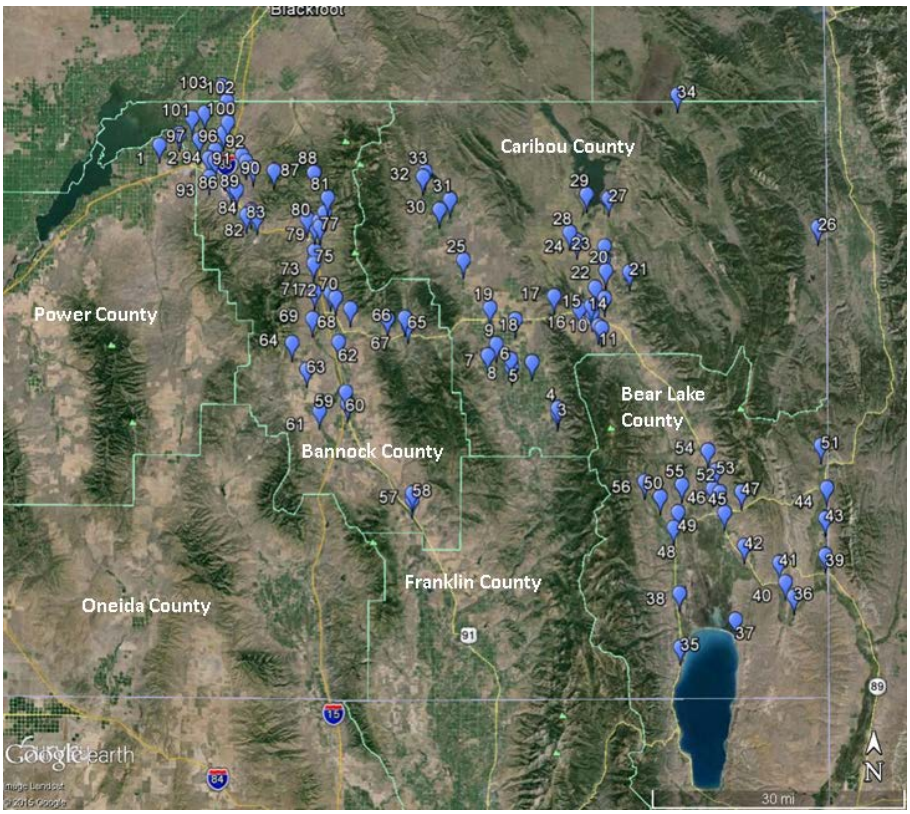


Figure 14. 2014 Google Earth map of approximate locations of 103 wells from Seitz and Norvitch (1979).

2.5.1.2 Methods and Results

Sample sites for the project are identified using information from Seitz and Norvitch (1979). To maintain consistency with that study, sampling is limited to July through September. Each year, a portion of the original wells are investigated for potential resampling with the entire inventory expected to be investigated over several years. In September 2016, two wells were sampled in Caribou County (Figure 15) according to procedures outlined in the appropriate QAPP (DEQ 2011b) and FSP (DEQ 2014c).

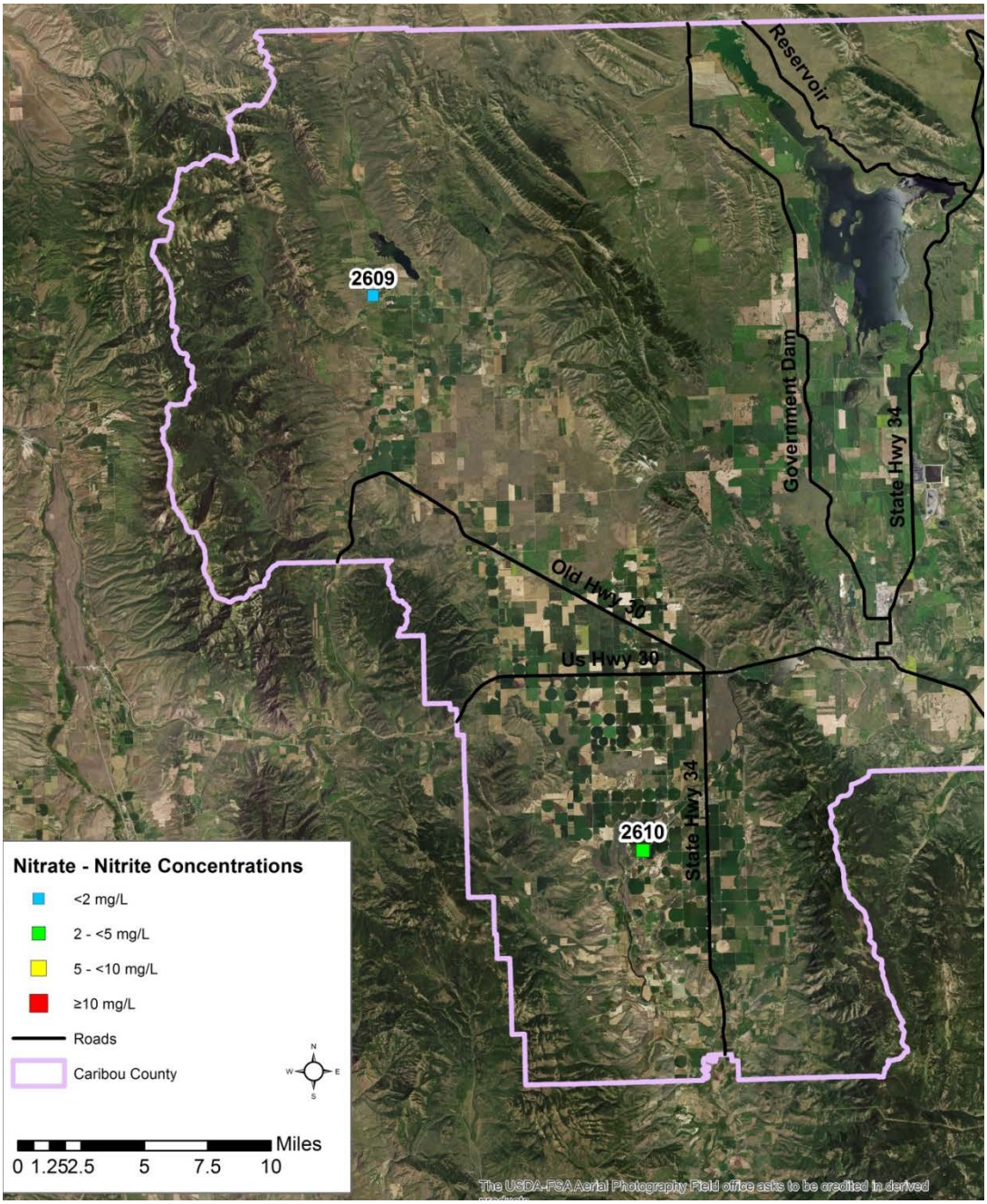


Figure 15. Well locations and nitrate concentrations for September 2016 sampling—PRO Ambient Regional Ground Water Monitoring Project.

Water quality field parameters (temperature, specific conductivity, pH, and DO) were measured in the field before sampling to ensure the well was properly purged and the samples would represent aquifer conditions (Table 20). Samples were submitted to IBL for analysis. Water chemistry analyses included calcium, magnesium, sodium, potassium, chloride, sulfate, alkalinity, arsenic, fluoride, silica, nitrate plus nitrite, ammonia, and total phosphorus. Samples were also analyzed at IAS Envirochem, Pocatello, Idaho, for TC and *E. coli* bacteria. Stable isotopes of oxygen and hydrogen (δ18OH2O and δDH2O) were measured at the University of Arizona Laboratory of Isotope Geochemistry. Results of the analyses for major ions are presented in Table 21, while additional inorganic constituents, nutrients, isotopes, and bacteria results are presented in Table 22.

Table 20. Water quality field parameters from 1976 and 2016—PRO Ambient Regional Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH[a]
2609	63	8/24/1976	9.0	513	—	7.5
		9/27/2016	8.71	548	2.30	7.22
2610	170	8/26/1976	11.0	927	—	7.6
		9/27/2016	5.68	894	7.60	7.62

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; (—) = not analyzed.
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

Nitrate plus Nitrite as N (Nitrate), Ammonia, and Total Phosphorous Results

The reported nitrate concentrations in the two sampled wells were <0.010 mg/L (Well 2609) and 3.3 mg/L (Well 2610); both results were below the nitrate MCL of 10 mg/L. Ammonia was detected at a low concentration in Well 2609, which also had low DO and no nitrate. The presence of ammonia in lieu of nitrate is consistent with a lack of oxygen in the ground water.

The reported total phosphorus concentrations were 0.059 mg/L (Well 2609) and 0.11 mg/L (Well 2610). Concentrations in 2016 were similar with concentrations in 1976 (Table 22).

Bacteria Results

Both wells were sampled for TC and *E. coli*. None of the samples had a positive detection of either TC or *E.coli*.

Arsenic Results

Arsenic was detected at one of the two wells (Well 2609), with a concentration of 6.5 µg/L. This concentration is below the arsenic MCL of 10 µg/L.

Table 21. Major ion results from 1976 and 2016—PRO Ambient Regional Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Calcium	Magnesium	Sodium	Potassium	Chloride[a]	Sulfate[a]	Alkalinity (as $CaCO_3$)
			(mg/L)						
Primary or Secondary Standard:			***No Stand.***	***No Stand.***	***No Stand.***	***No Stand.***	***250***	***250***	***No. Stand.***
2609	63	8/24/1976	61	17	14	1.2	22	18	215
		9/27/2016	75	18	14	1.2	12.4	14.5	250
2610	170	8/26/1976	66	50	58	6.9	53	77	356
		9/27/2016	72	54	32	5.1	39.5	83.0	313

Notes: mg/L = milligrams per liter; No Stand. = 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. National Primary and Secondary Drinking Water Regulation standards apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

Table 22. Inorganic, nutrient, isotope, and bacteria results from 1976 and 2016—PRO Ambient Regional Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Inorganic and Nutrient Concentrations						Isotopes[a]		Bacteria	
			Arsenic[b]	Fluoride[b]	Silica as SiO_2	Nitrate plus Nitrite[b]	Ammonia	Total Phosphorus	δ^2H	$\delta^{18}O_{H2O}$	Total Coliform[c]	*E. coli*[b]
			(µg/L)	(mg/L)					(‰ VSMOW-SLAP)		(MPN/100 mL)	
Primary or Secondary Standard:			***10***	***4***	***No Stand.***	***10***	***No Stand.***	***No Stand.***	***No Stand.***		***1 cfu/ 100 mL***	***<1 cfu/ 100 mL***
2609	63	8/24/1976	NA	0.4	33	0.35	—	0.01	—	—	—	—
		9/27/2016	6.5	0.326	40	<0.010	0.035	0.059	-131.0	-17.1	<1	<1
2610	170	8/26/1976	NA	0.3	22	2.8	—	0.09	—	—	—	—
		9/27/2016	<2.0	0.280	21	3.3	<0.010	0.11	-120.9	-15.2	<1	<1

Notes: No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; (—) = not analyzed.
[a] Stable isotope analytical results are presented as delta values (δ) reported as parts per thousand (identified as per mill or ‰) compared to a standard. Standards for $\delta^{18}O_{H2O}$ and δ^2H are Vienna Standard Mean Ocean Water (VSMOW)-Standard Light Antarctic Precipitation (SLAP).
[b] Contaminant with a National Primary Drinking Water Regulation standard. National Primary and Secondary Drinking Water Regulation standards apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.
[c] TC 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 TC is not a violation of these rules. TC 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.

Fluoride Results

The reported fluoride concentrations were 0.280 mg/L (Well 2610) and 0.326 mg/L (Well 2609); both detections are well below the MCL of 4 mg/L and the NSDWR standard of 2 mg/L (Table 22). Concentrations in 2016 were similar with concentrations in 1976 (Table 22).

Isotope Results

Stable isotopes of oxygen ($\delta^{18}O_{H2O}$) and hydrogen (deuterium or $\delta^{2}H$) were measured at each well and reported relative to Vienna Standard Mean Ocean Water (VSMOW)-Standard Light Antarctic Precipitation (SLAP) reference material. The $\delta^{18}O_{H2O}$ and deuterium ratios for the two wells (Wells 2609 and 2610) are both consistent with the Global Meteoric Water Line and appear to reflect recharge conditions of cooler regions as they are more depleted (negative) values (Table 22). The stable isotopes on the nitrate (δ^{15}Nnitrate and δ^{18}Onitrate) were not analyzed by the time of this report.

2.5.1.3 Conclusions

The objectives of this project are to characterize current ground water conditions, identify areas and possible sources of degraded ground water quality, and evaluate changes in water quality over time. The data collected also provides a reference for future sampling. The data set presented here is part of a multiyear effort to resample the regional monitoring network established by Seitz and Norvitch (1979). As such, a broader and more complete analysis will be reserved until data collection is complete.

The data set compiled from the 2016 sampling indicated no primary or secondary drinking water standards were exceeded and results were similar to results obtained in 1976.

2.5.1.4 Recommendations

DEQ recommends increasing the number of wells and continuing the multiyear data collection effort to achieve project goals.

Homeowners are encouraged to regularly test their wells for known contaminants and to maintain septic systems and wellheads.

2.6 Twin Falls Region

Two ground water quality monitoring projects were conducted in the Twin Falls region in 2016 using public funds.

2.6.1 Southwest Jerome County Dairy Complaint Follow-Up Project

2.6.1.1 Purpose and Background

In June 2016, DEQ received a complaint regarding alleged mismanagement of dairy waste in southwest Jerome County. The complainant was concerned that the dairy involved was managing several lagoons (storage ponds) with minimal freeboard (the distance between the

water level and the upper edge of the lagoon) and that an unlined irrigation pond was being used as a manure waste lagoon near the property. The complaint was referred to the ISDA. ISDA replied that the dairy was being inspected and had a number of compliance issues regarding management of their waste. In September, DEQ received another call from the homeowner with continuing concerns about bacterial contamination and nitrate levels in the ground water; noting that the nitrate concentration in his well water was approaching 10 mg/L and his neighbor's had a recent nitration concentration 15.8 mg/L. ISDA was contacted and replied that a consent order with waste handling stipulations had been signed with the dairy.

Ground water quality monitoring of several wells in the vicinity was conducted by DEQ to respond to homeowners' concerns, with the additional purpose of collecting information in an area that has been studied by DEQ, ISDA, and USGS in the past to determine if another regional study may be warranted (DEQ 2013b; Carlson and Atlakson 2006; Skinner and Donato 2003) (Figure 16). In a 2010 DEQ study of the area, 20 domestic wells were sampled for nitrate with results ranging from 1.6 mg/L to 23 mg/L. Local land uses appeared to be adding nitrogen to the ground water and degrading the local ground water flow system, while the regional flow system seemed to be less impacted (DEQ 2013b).

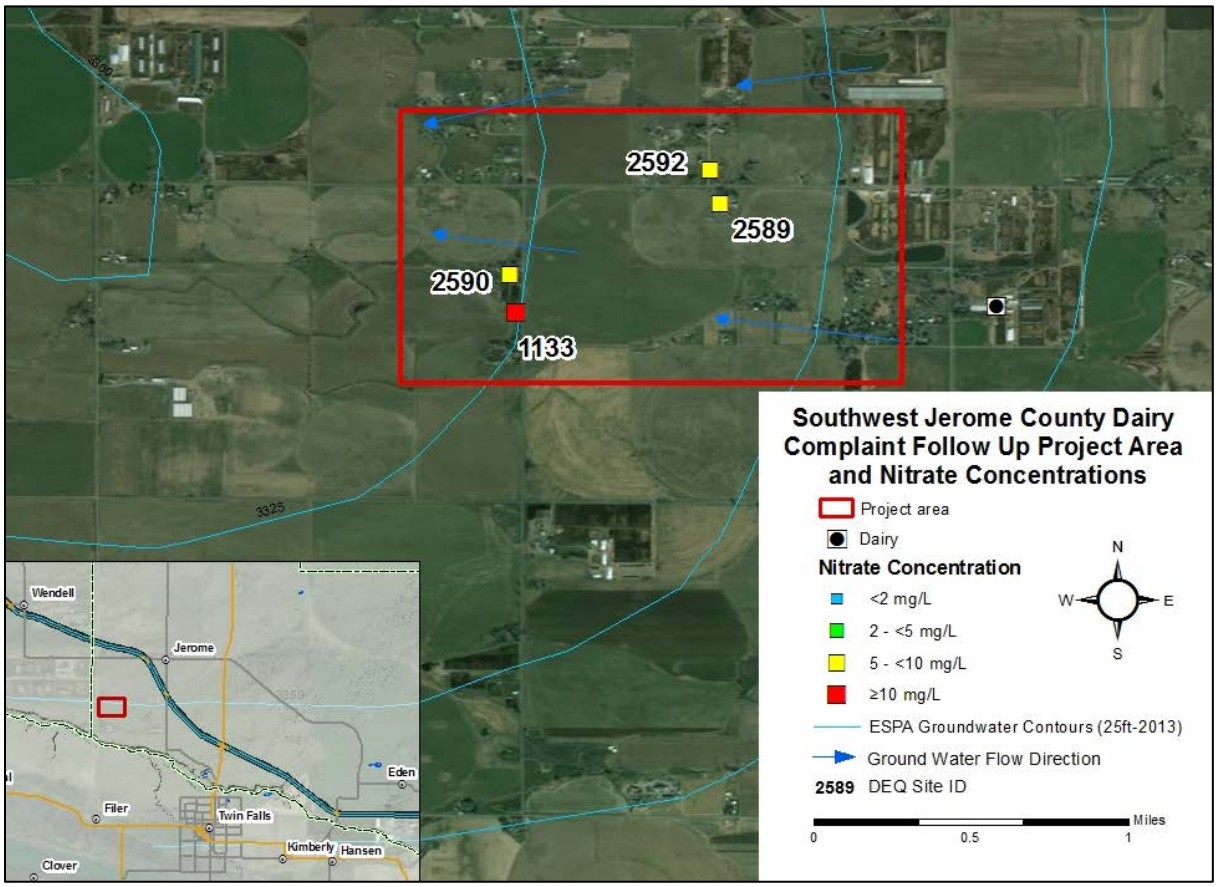


Figure 16. Project location map and nitrate results—Southwest Jerome County Dairy Complaint Follow-up.

In addition, during the 2012 NPA evaluation, geostatistical Kriging produced a small area in the western part of Jerome County where 25% of wells had nitrate concentrations greater than

5 mg/L. While the area was too small to justify as a NPA, the elevated nitrate concentrations may merit further investigation. Jerome County's predominant land use is agriculture. According to the United States Department of Agriculture (USDA), Census of Agriculture for 2012, 79% of the county is in use as cropland, and they rank third in the state for quantity of cattle and second for milk production sales (USDA 2012).

2.6.1.2 Methods and Results

On October 20, 2016, four wells were sampled in the project area after gaining homeowner permissions. Water quality field parameters (pH, temperature, specific conductivity, and 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 23).

Table 23. Ground water quality results—Southwest Jerome County Dairy Complaint Follow-up.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH[a]
1133	280	10/20/2016	14.7	1214	7.72	7.26
2589	155	10/20/2016	15.2	773	6.90	7.42
2590	260	10/20/2016	15.35	353	6.58	7.60
2592	223	10/20/2016	13.75	775	6.74	7.35

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

Samples were collected for nitrate, chloride, TC, and *E. coli*. All samples were submitted for analysis to Magic Valley Labs, Twin Falls, Idaho. Nitrogen isotope samples were collected and submitted to the University of Arizona for the stable isotope analysis of total nitrogen in water ($\delta^{15}N$). All sampling was conducted according to the QAPP (DEQ 2014d) for complaint follow-ups in the Twin Falls region.

Nitrate Results

The reported nitrate concentrations ranged from 8.05 mg/L to 19.5 mg/L; all four wells sampled had nitrate concentrations of 5 mg/L or greater (Table 24). The nitrate MCL of 10 mg/L was exceeded in one sample (Well 1133). Well 1133 was sampled in 2010 and had a concentration of 5.9 mg/L, indicating that the nitrate concentration in this well has more than tripled in 6 years.

Table 24. Ground water quality results—Southwest Jerome County Dairy Complaint Follow-up.

DEQ Site ID	Well Depth (feet)	Sample Date	Chloride[a] (mg/L)	Nitrate[b] (mg/L)	δ15N (‰)
Primary or Secondary Standard:			**250**	**10**	**No Stand.**
1133	280	10/20/2016	86.3	**19.5**	7.5
2589	155	10/20/2016	50.6	8.06	8.9
2590	260	10/20/2016	52.6	8.05	8.0
2592	223	10/20/2016	47.6	8.07	9.8

Notes: mg/L = milligrams per liter; ‰ = per mil; No Stand. = 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. National Primary and Secondary Drinking Water Regulation standards apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.
[b] Contaminant with a National Primary Drinking Water Regulation standard. National Primary and Secondary Drinking Water Regulation standards apply to public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

Chloride Results

The reported chloride concentrations ranged from 47.6 mg/L to 86.3 mg/L (Table 24). The NSDWR standard for chloride is 250 mg/L. Previous studies in the Magic Valley indicate a linear correlation between chloride and nitrate (DEQ 2013b; DEQ 2017). While the results from this study may not warrant use in a linear correlation due to the small sample size, they do not conflict with the findings from those earlier studies (Figure 17). Consideration should be taken when interpreting these results due to the small sample size.

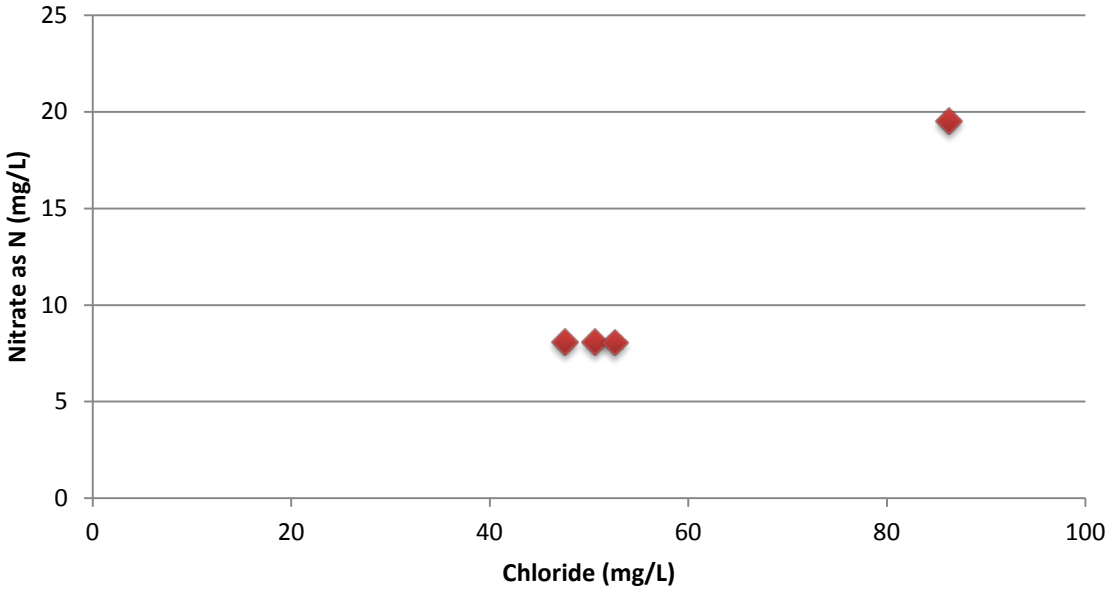


Figure 17. Chloride versus nitrate concentrations—Southwest Jerome County Dairy Complaint Follow-up.

Nitrogen Isotopes

Nitrogen isotope ratios (typically denoted as δ15N) are used in differentiating potential sources of nitrate in the ground water, especially combined with oxygen isotope ratios and major ion chemistry. Sources of nitrate in agricultural areas include commercial fertilizers, animal or human waste, and other organic nitrogen sources in the soil. Each of these has a distinguishing nitrogen isotope signature. Typical $\delta^{15}N$ ranges for fertilizer and waste are -4‰ to +4‰ and greater than 9‰, respectively. Organic or mixed sources are considered to fall between 4‰ and 9‰ (Table 12; Seiler 1996).

The 2016 nitrogen isotope ratios ($\delta^{15}N$) ranged from 7.5‰ to 9.8‰ (Table 24). All but one well (Well 2592) were in the range of organic nitrogen in the soil or mixed organic waste sources. Well 2592 had a nitrogen isotope ration of 9.8‰, which suggests an animal or human waste source (Table 12).

Bacteria Results

Bacteria samples were collected at all sites as a courtesy to the homeowners. Presence or absence of TC and *E. coli* was tested rather than a count. TC bacteria was present in two samples (Wells 2589 and 2590); *E. coli* was absent in all 4 samples (Table 25).

Table 25. Bacteria results—Southwest Jerome County Dairy Complaint Follow-up.

DEQ Site ID	Well Depth (feet)	Sample Date	Total Coliform[a]	*E. coli*[b]
Primary or Secondary Standard:			***1 cfu/100 mL***	***<1 cfu/100 mL***
2589	155	10/20/2016	Present	Absent
2592	223	10/20/2016	Absent	Absent
2590	260	10/20/2016	Present	Absent
1133	280	10/20/2016	Absent	Absent

[a] TC 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 TC is not a violation of these rules. TC 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 colony forming units per 100 milliliters (cfu/100 mL), analytical results provided in most probable number per 100 milliliters (MPN/100 mL) are acceptable for comparison to the standard. For these samples, the presence or absence of TC and *E. coli* was determined rather than a count.
[b] Contaminant with a National Primary Drinking Water Regulation standard.

2.6.1.3 Conclusions

Nitrate concentrations in areas dominated by agricultural land uses continue to be elevated. The increase in nitrate in Well 1133 since the last sampling in 2010 merits further study.

2.6.1.4 Recommendations

Additional ground water quality monitoring should be conducted in the project area to more accurately assess any nitrate trends over time and to better understand the sources of the nitrate contamination in the region. The dramatic increase in nitrate concentration in Well 1133 since the 2010 sample should be further investigated.

If resources become available in the future, DEQ recommends developing a comprehensive report to compile and analyze all ground water data collected by ISDA, IDWR, USGS, USDA Agricultural Research Service, and DEQ for this area to determine nitrate influences and sources.

As a precaution, the well owners whose water exceeded the drinking water standard were advised not to drink or cook with the water or to install a point of use treatment system to reduce the nitrate level in their drinking water.

DEQ should continue to work with agencies and organizations to promote BMPs that protect ground water from excessive nitrate leaching from soils on agricultural and residential land.

2.6.2 Springdale Ground Water Monitoring Project

2.6.2.1 Purpose and Background

The purpose of this project was to further investigate and evaluate any changes in ground water nitrate concentrations in the Springdale area by resampling project wells from previous DEQ and ground water studies (Figure 18). In 2015, wells were resampled within the Springdale project area from previous DEQ ground water studies (Schorzman and Baldwin 2009; DEQ 2013b; DEQ 2017). An additional sampling round was conducted in 2016. This summary is intended to summarize the 2016 sampling results, while comparing the data with the 2015 results, and present results of a trend analysis using historical data collected by both DEQ and ISDA at the same wells.

The 2008–2009 DEQ ground water study included both fall and spring sampling of 13 domestic wells, all of which were completed in the shallow alluvial aquifer (less than 200 feet deep). Follow-up sampling was done in 2010 at 12 of the 13 wells plus an additional 7 wells. Both the 2009 and 2010 studies concluded that nitrate concentrations depended on local land-use practices in proximity to each well. Nitrogen isotope values suggested the source of nitrogen in most wells was a mixture of commercial fertilizer and animal or human waste or organic nitrogen in soil (Schorzman and Baldwin 2009; DEQ 2013). This area was also extensively studied by ISDA for many years before 2008 (Carlson et al. 2005; Tesch et al. 2003a; Tesch et al. 2003b). Annual ground water nitrate sampling was conducted from 1998 to 2004, when anywhere from 33% to 45% of wells fell within the 5–10 mg/L nitrate range and 9%–19% exceeded the EPA drinking water standard of 10 mg/L for nitrate (Carlson et al. 2005).

In 2014, the Marsh Creek NPA, which includes the Springdale area and the city of Burley, was ranked as the most impacted NPA in the state and showed an increasing trend in nitrate levels. The NPA includes 154 square miles of northern Cassia County along the Snake River. Mean nitrate level was 7.16 mg/L, and of 402 sample sites, 64% showed nitrate levels higher than 5 mg/L.

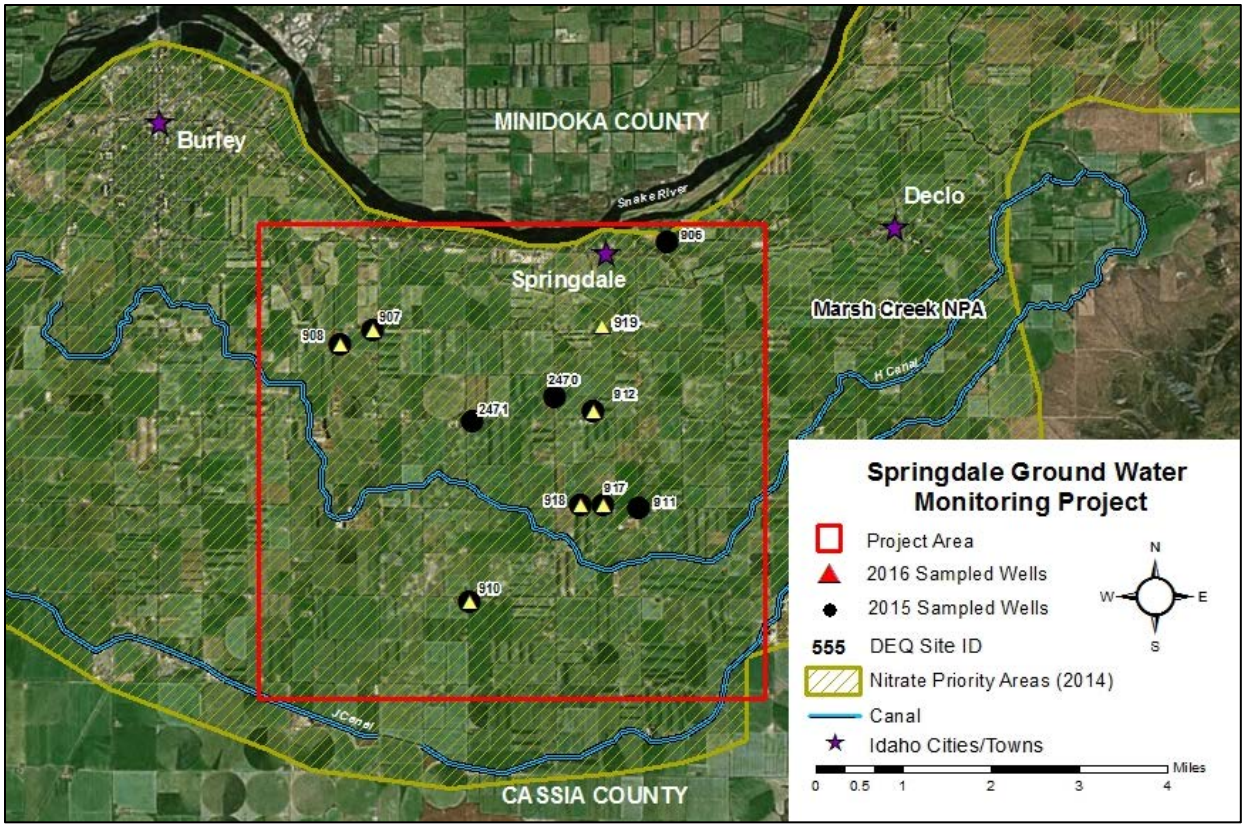


Figure 18. Project location map—Springdale Ground Water Monitoring Project.

The study area is situated at the northern edge of the Oakley Fan, an alluvial fan between the Albion Mountain Range on the south and the Snake River to the north. Generally, ground water flow direction follows the natural drainage of the Oakley Fan from southeast to the northwest (Schorzman and Baldwin 2009). However, localized flow varies within the study area. Geology in the project area consists of older sedimentary units, followed by rhyolite and basalt units, topped by the most recent alluvial deposits. Remnants of prehistoric Burley Lake deposits consisting of clay, silt, sand, and gravel that range from unconsolidated to well-compacted overlie the basalt flows (Schorzman and Baldwin 2009). The Albion Mountains to the southeast represent the sedimentary rocks composed of limestone, sandstone, and shale. The wells sampled for this project draw water from the shallow upper alluvium, which is composed of sand and gravel with interbedded clay layers (Carlson et al. 2005). None of the wells encounter the underlying basalt flows according to the well logs.

2.6.2.2 Methods and Results

On March 21, 2016, seven wells were resampled within the Springdale project area. Wells from the 2015 sampling round that were not historically sampled and could not be included in the trend analysis were not included in the 2016 sampling effort. Well 911 could not be sampled in 2016 due to a lack of access to water from an outside spigot.

Water quality field parameters (pH, temperature, specific conductivity, and 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 26).

Table 26. Water quality field parameters—Springdale Ground Water Monitoring Project.

DEQ Site ID	Well Name	Well Depth (feet)	Sample Date	Field Measurements			
				Water Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH[a]
907	SC-2	UNK	03/21/2016	9.60	1010	2.84	7.42
908	SC-3	58	03/21/2016	14.33	933	5.07	7.37
910	SC-5	61	03/21/2016	12.06	1021	6.15	7.46
912	SC-7	55	03/21/2016	11.20	1086	1.51	7.53
917	SC-12	UNK	03/21/2016	12.94	939	3.22	7.73
918	SC-13	UNK	03/21/2016	11.85	1067	4.80	7.50
919	SC-14	80	03/21/2016	11.76	855	6.09	7.59

Notes: °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; UNK = Unknown. Well log was not found.
[a] Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR standard 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.

Samples were collected for nitrite plus nitrate (nitrate), chloride, TC and *E. coli*. Because ammonia was not detected in any of the low DO samples during the 2015 sampling round, it was not included in the lab analyses during the 2016 sampling round. All samples were submitted for analysis to Magic Valley Labs, Twin Falls, Idaho. Nitrogen isotope samples were collected and submitted to the University of Arizona for the stable isotope analysis of total nitrogen in water ($\delta^{15}N$). Results for all lab analyses are shown in Table 27. Results from the previous sampling round in summer of 2015 are also shown in Table 27 for comparison.

All sampling was conducted according to the QAPP (DEQ 2014d) and FSP (DEQ 2015c), and FSP amendment (DEQ 2016e).

Table 27. Inorganic and nitrogen isotope results—Springdale Ground Water Monitoring Project.

DEQ Site ID	Well Name	Well Depth (feet)	Sample Date	Chloride[a] (mg/L)	Nitrite + Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:				*250*	*10*	*No Stand.*
907	SC-2	UNK	08/19/2015	46.9	**26**	7.4
			03/21/2016	58.2	**31.6**	7.6
908	SC-3	58	07/21/2015	39.2	**13.5**	8.9
			03/21/2016	48.7	**17.4**	8.9
910	SC-5	61	07/21/2015	32.6	**12.0**	5.7
			03/21/2016	44.0	**15.6**	5.6
912	SC-7	55	08/19/2015	42.4	**18.9**	5.0
			03/21/2016	47.1	**20.9**	5.3
917	SC-12	UNK	08/19/2015	35.8	**12.9**	5.2
			03/21/2016	40.8	**14.5**	5.5
918	SC-13	UNK	08/19/2015	50.3	**16.6**	4.1
			03/21/2016	48.9	**20.7**	4.2
919	SC-14	80	—	—	—	—
			03/21/2016	31.9	7.03	—

Notes: mg/L = milligrams per liter; ‰ = per mil; UNK = Unknown. Well log was not found; (—) = data unavailable or not analyzed. Bolded red numbers indicate EPA's National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), was exceeded. These regulations apply to public water systems but can be applied to private wells to evaluate water quality. Numbers in parentheses are results from 2015 sampling round.
[a] Contaminant with a National Secondary Drinking Water Regulation standard.
[b] Contaminant with a National Primary Drinking Water Regulation standard.

Nitrate plus Nitrite (Nitrate) Results

The reported nitrite plus nitrate (nitrate) concentrations (Table 27) ranged from 7.03 mg/L (Well 919) to 31.6 mg/L (Well 907). Nitrate concentrations exceeded the MCL of 10 mg/L in six of the seven wells that were resampled. Spatial distribution of nitrate concentrations is shown in Figure 19.

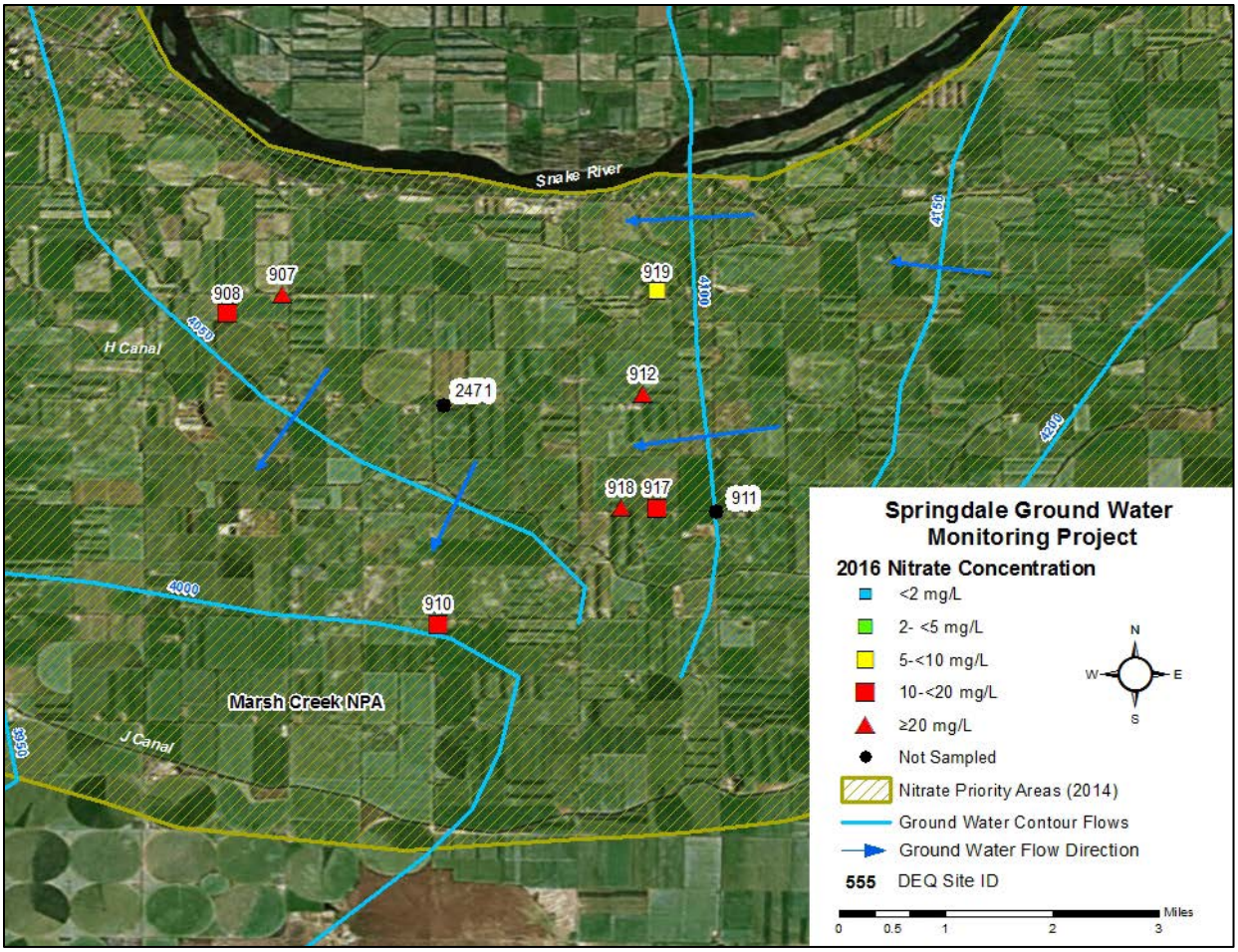


Figure 19. Sampling locations and nitrate concentrations—Springdale Ground Water Monitoring Project.

Nitrate Trend Analysis

The nitrate data collected in 2016 and 2015 along with additional historical DEQ and ISDA data were used to update a Mann-Kendall trend analysis completed for the project in 2009 (Table 28). The updated trends remained the same for all wells with the exception of three wells (Wells 911, 917, and 919). Data from Well 911 suggests a decreasing trend through 2015, compared to 2009 when there was no evidence of a trend. Well 917 showed no evidence of a trend in 2016, while in 2009 data suggested an increasing trend. Additionally, Well 919 was included in this sampling effort because it is part of the ISDA 790 project, and historical data were available for the trend analysis. While no trend analysis was run in 2009, the 2016 trend analysis for Well 919 indicated an increasing trend.

Table 28. Mann-Kendall trend analysis of nitrate data with corresponding historical data provided by ISDA (790 and 930 projects)—Springdale Ground Water Monitoring Project.

DEQ Site ID	ISDA Site ID	Sample Size	Mean Nitrate (mg/L)	Standard Deviation	Trend Analysis	Confidence Level (%)	Trend Analysis 2009
907 (SC-2)	9303701	12	18.5	6.1	—	—	—
908 (SC-3)	7901401	19	15.7	2.8	Increasing	90	Increasing
910 (SC-5)	7901901	19	11.5	2.0	Increasing	90	Increasing
911 (SC-6)[a]	9304601	11	22.8	1.7	Decreasing	80	—
912 (SC-7)	9306101	11	16.9	2.4	Increasing	90	Increasing
917 (SC-12)	9304801	11	13.8	1.4	—	—	Increasing
918 (SC-13)	9304901	11	14.7	2.9	Increasing	90	Increasing
919 (SC-14)	7901501	18	7.9	2.0	Increasing	90	NA
2471 (SC-15)[a]	9301501	9	5.4	4.6	Decreasing	90	Decreasing

Notes: (—) = no evidence of a trend ; NA = not applicable, data were not used in the 2009 trend analysis
[a] Not sampled in 2016.

Time series plots showing the regression line and the 95% confidence limits for each sampling site are provided in Figure 20. Although Well 907 appears to have an increasing trend, the variability of the data resulted in a *no trend* conclusion.

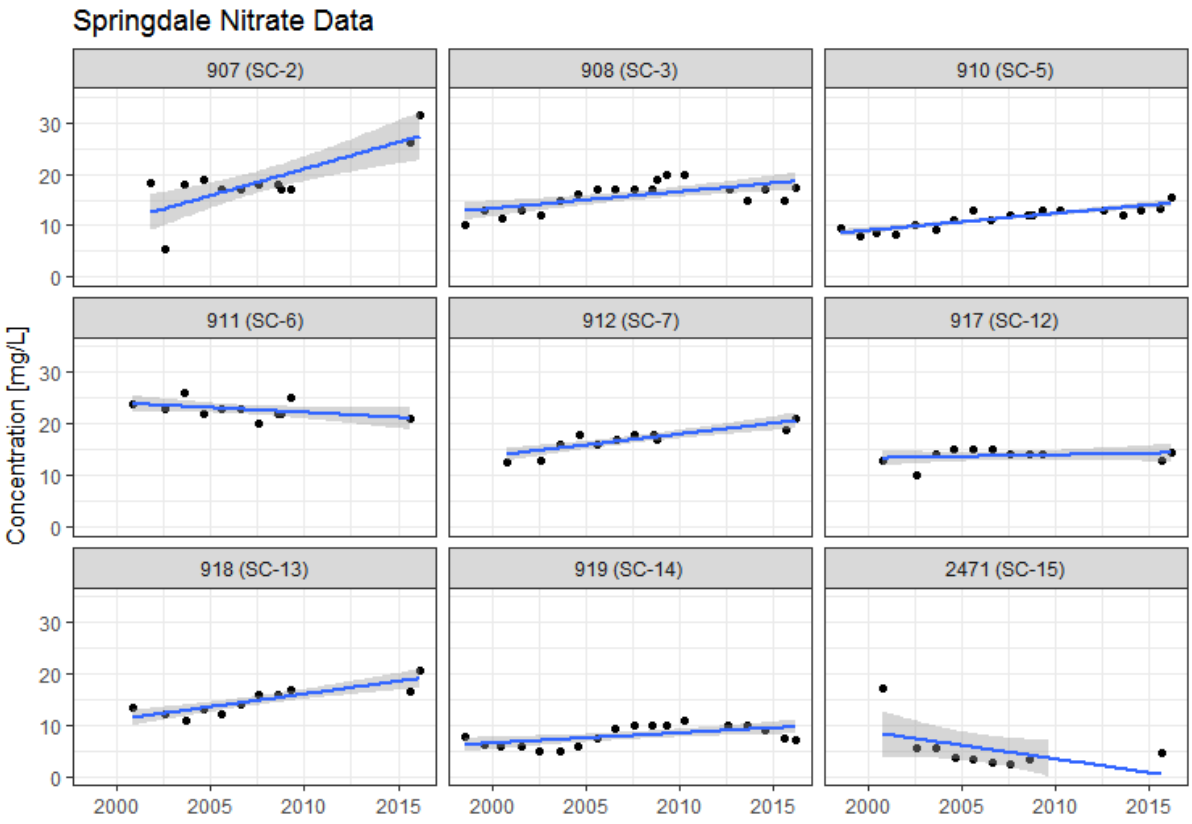


Figure 20. Time series plots with linear regression line—Springdale Ground Water Monitoring Project. (Shading represents the 95% confidence level on the line.)

Chloride Results

Chloride concentrations shown in Table 27 ranged from 31.9 mg/L (Well 919) to 58.2 mg/L (Well 907). Results are similar to the 2015 sampling round.

Nitrogen Isotopes

Nitrogen isotope ratios (typically denoted as δ15N) are used in differentiating potential sources of nitrate in the ground water, especially combined with oxygen isotope ratios and major ion chemistry. Sources of nitrate in agricultural areas include commercial fertilizers, animal or human waste, and other organic nitrogen sources in the soil. Each of these has a distinguishing nitrogen isotope signature. Typical $\delta^{15}N$ ranges for fertilizer and waste are -4‰ to +4‰ and greater than 9‰, respectively. Organic or mixed sources are considered to fall between 4‰ and 9‰ (Seiler 1996).

Results for 2016 isotope ratio analyses are presented in Table 27. Nitrogen isotope ratios in 2016 (March) were similar to ratios in 2015 (August). The δ15N values ranged from 4.2‰ to 8.9‰, which are all in the range of organic nitrogen in the soil or mixed waste sources (Table 27).

Bacteria Results

Bacteria samples were collected at all sites as a courtesy to the homeowners. Presence or absence of TC and *E. coli* was tested rather than a count because this was a second sampling round in less than a year. Of the seven samples collected, one site had a positive detection of TC bacteria; none of the samples indicated the presence of *E. coli* (Table 29).

Table 29. Bacteria results—Springdale Ground Water Monitoring Project.

DEQ Site ID	Well Name	Well Depth (feet)	Sample Date	Total Coliform[a]	*E. coli*[b]
Primary or Secondary Standard:				***1 cfu/100 mL***	***<1 cfu/100 mL***
907	SC-2	—	3/21/2016	Absent	Absent
908	SC-3	58	3/21/2016	Absent	Absent
910	SC-5	61	3/21/2016	Absent	Absent
912	SC-7	55	3/21/2016	Absent	Absent
917	SC-12	—	3/21/2016	Absent	Absent
918	SC-13	—	3/21/2016	Present	Absent
919	SC-14	80	3/21/2016	Absent	Absent

Note: (—) = data unavailable or not analyzed.
[a] TC 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 TC is not a violation of these rules. TC 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 colony forming units per 100 milliliters (cfu/100 mL), analytical results provided in most probable number per 100 milliliters (MPN/100 mL) are acceptable for comparison to the standard. For these samples, the presence or absence of TC and *E. coli* was determined rather than a count.
[b] Contaminant with a National Primary Drinking Water Regulation standard.

2.6.2.3 Conclusions

The purpose of this report is to summarize and compare the 2016 data with the previous year, and to present results of a trend analysis using historical data collected at the same wells by both

DEQ and ISDA. The trend in nitrate concentration at the sampled wells, for the most part, is increasing and similar to 2009 trend results. Nitrate concentrations in Well 911, which showed no evidence of a trend in 2009 is suggesting a decreasing trend—the only well with evidence of a decreasing trend in the study.

Nitrate concentrations continue to exceed the MCL in a majority of the sampled wells completed in the shallow alluvial aquifer of Springdale; six of seven wells samples had concentrations that exceeded the MCL. This shallow, perched alluvial aquifer was initially described by Rupert (1997). Skinner and Donato (2003) reported that the water level is about 100 feet above that of the Snake River Plain aquifer and is not connected to the eastern Snake River Plain aquifer like the deeper aquifer. The water table is fairly flat and any contamination does not move through the aquifer very quickly. If nitrate inputs continue over time and penetrate the clay layers separating the shallow and deep aquifer, eventually the deeper aquifer may become impacted.

2.6.2.4 Recommendations

The Springdale area appears to be very susceptible to contamination from agricultural land uses. While DEQ continues to promote the use of BMPs, which have been proven to protect ground water from excessive nitrate leaching from soils on agricultural and residential land, the increasing nitrate trend may take a long time to reverse itself given that the primary land use is agriculture. As a precaution, well owners whose water met or exceeded the drinking water standard were advised not to drink or cook with the water or to install a point of use treatment system to reduce the nitrate levels in their drinking water. Private well owners in the region should generally be informed that either point of use treatment systems need to be installed or wells need to be deepened to tap into the lower, less impacted aquifer.

If resources become available in the future, DEQ recommends developing reports that compile and analyze all ground water data collected by ISDA, IDWR, USGS, UDSA Agricultural Research Service, and DEQ for this area (dating back to the late 1990s) to gain a better understanding of the area and the ground water impact from nitrate.

3 DEQ Cooperative Projects

This section presents data from special ground water quality monitoring projects that were conducted jointly by DEQ and other state agencies in calendar year 2016.

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 2016.

3.1.1 Purpose

The IDWR Statewide Ambient Ground Water Quality Monitoring Network has developed a ground water monitoring network across Idaho to assess ground water quality. DEQ partnered with IDWR and paid for analysis of dissolved methane and nitrogen isotope ($\delta^{15}N$) to help assess ground water quality in southern Idaho. The counties of interest for this project included

Washington, Gem, Payette, Owyhee, Canyon, and Bonneville (specifically the Grays Lake area). The ground water samples were collected by IDWR staff during statewide network sampling events, while DEQ paid for the analysis. 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 nitrogen source evaluation. Dissolved methane and nitrogen isotope results are provided in Appendix A.

3.1.2 Methods and Results

IDWR collected and analyzed samples for dissolved methane from 41 domestic wells across the state following its EPA-approved QAPP (IDWR 2016b). Samples for dissolved methane analysis were submitted to IBL in Boise, Idaho, and subcontracted to Pace Analytical, Inc. in Minneapolis, Minnesota (Table A1).

The nitrogen isotope samples from 16 wells (those with nitrate concentrations greater than 5 mg/L) were sent for analysis to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson (Table A2).

Methane Results

Dissolved methane concentrations reported for this project ranged from <10.0 µg/L (nondetect) to 17.1 µg/L. Of the 41 samples collected for methane analysis, three samples (from Payette, Owyhee and Bingham Counties) (7%) had measurable concentrations of methane (Table A1; Figures A1 and A2). There is no MCL or NSDWR standard for dissolved methane in ground water. The hazard with methane in ground water results 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).

Nitrogen Isotope Results

Nitrogen isotope ($\delta^{15}N$) ratio analysis was performed on samples from 16 wells, all of which had nitrate concentrations at or greater than 5 mg/L. The $\delta^{15}N$ values ranged from 2.3‰ to 19.3‰ (Table A2). Of the 16 wells sampled, 2 wells had $\delta^{15}N$ ratios ranging from +2.3‰ to +3.8‰, suggesting commercial fertilizer as the likely nitrate source; 11 wells had $\delta^{15}N$ ratios between +4.4‰ and +8.5‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; 3 wells had $\delta^{15}N$ values equal to or greater than +9‰, suggesting an animal or human waste source as the likely nitrate source (Table A2). Spatial distribution of the $\delta^{15}N$ ratios is shown in Figure A3.

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 of concern and hopefully protect private well owners from the explosive risk from elevated concentrations of methane.

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 2016.

3.2.1 Purpose

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

3.2.2 Methods and Results

In cooperation with DEQ, ISDA collected and analyzed a total of 271 nitrate samples (from 238 domestic wells) across the state following its EPA-approved QAPP (ISDA 2011). Three of the 238 wells (Wells 8421601, 8421701, and 8421801) were sampled twice—once in the spring and once in the fall. The 271 samples included 30 quality assurance samples (29 duplicates samples and 1 blank sample). Samples for nitrate 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 for $\delta^{15}N$ analysis. Water quality field parameters (pH, temperature, and specific conductivity) were measured and recorded before sample collection. Field parameter and nitrate results are shown in Appendix B.

Nitrate (as Nitrate and Nitrate plus Nitrite) Results

Nitrate (including both nitrate and nitrate plus nitrite) concentrations for this project ranged from nondetect (<0.010 mg/L) to 110 mg/L. Out of the 241 samples collected for nitrate analysis, 70 samples (29%) were between 5 mg/L (half the EPA MCL of 10 mg/L) and 10 mg/L; 60 samples (25%) 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]) sampled in 2016 had 10% or more of the 10 mg/L or greater nitrate concentrations. In total, 187 samples (78%) were at or greater than 2 mg/L, indicating some type of non-naturally occurring nitrogen source; 2 mg/L is generally considered background level (DEQ 2014a).

Well locations and nitrate concentrations are shown in Table B1 and Figures B1–B19.

Nitrogen Isotope Results

ISDA collected 117 nitrogen isotope ($\delta^{15}N$) samples from 102 wells (includes 15 duplicate samples not included in this report), all but one of which had nitrate concentrations at or greater than 5 mg/L. The $\delta^{15}N$ values ranged from 1.5‰ to 23.9‰ (Table B1). $\delta^{15}N$ values for 25 samples (8 samples or 32% from project 710 [Washington/Payette Counties]) ranged from +1.4‰ to +3.9‰, suggesting commercial fertilizer as the likely nitrate source; 67 samples had $\delta^{15}N$ values between +4.0‰ and +8.5‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; 10 samples (3 samples from project 730 [Minidoka County]) had $\delta^{15}N$ values equal to or greater than +9‰, suggesting an animal or human waste source as the likely nitrate source (Table 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 241 samples collected for nitrate analysis, 60 samples (25%) met or exceeded the EPA nitrate MCL of 10 mg/L and 70 samples (29%) were between 5 mg/L and 10 mg/L. The nitrate results indicate degraded ground water in specific vulnerable aquifers. These data will be helpful in the next NPA delineation and ranking process conducted by DEQ and the Ground Water Monitoring Technical Committee. The nitrogen isotope ratios provide one line of evidence for the potential sources of nitrogen contributing to the nitrate concentrations in ground water.

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.

References

Alt, D.D. and D.W. Hyndman. 1995. *Northwest Exposures, A Geologic Story of the Northwest*. Missoula, MT: Mountain Press Publishing Company.

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

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

Carlson, R., J. Fox, and C. Tesch. 2005. *Ground Water Quality Monitoring Results for Northern Cassia County, Idaho*. ISDA Technical Results Summary #24.

Carlson, R. and J. Atlakson. 2006. *Ground Water Quality Monitoring Results for Gooding-Jerome-Lincoln Counties, Idaho.* Boise, ID: Idaho State Department of Agriculture. ISDA Technical Results Summary #30.

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

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

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

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

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

DEQ (Idaho Department of Environmental Quality). 2011b. *Quality Assurance Project Plan and Sampling and Analysis Plan for General Ground Water Monitoring Activities*. Pocatello, ID: DEQ. TRIM record number 2014AGV495.

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

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

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

DEQ (Idaho Department of Environmental Quality). 2014b. *Regional Generic Quality Assurance Project Plan: Regional Nitrate Priority Area Ground Water Monitoring Activities Boise Region.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2014c. *Field Sampling Plan: Ambient Regional Ground Water Monitoring Project*. Pocatello, ID: DEQ. TRIM record number 2014AGV508.

DEQ (Idaho Department of Environmental Quality). 2014d. *Quality Assurance Project Plan: Twin Falls Regional Office Ground Water Follow-up Monitoring Projects*. Twin Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2015a. *Boise Regional Office Generic Quality Assurance Project Plan, Gas Field Ground Water Monitoring*. Boise, ID: DEQ. TRIM record number 2014AGV804.

DEQ (Idaho Department of Environmental Quality). 2015b. *Boise Regional Office Generic Quality Assurance Project Plan: Local Synoptic Ground Water Monitoring*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2015c. *Field Sampling Plan: Springdale Ground Water Monitoring Project*. Twin Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2016a. *Field Sampling Plan, Baseline Ground Water Monitoring Project, City of Emmett*. Boise, ID: DEQ. TRIM record number 2016AGV449.

DEQ (Idaho Department of Environmental Quality). 2016b. *Field Sampling Plan: Locust Lane Local Synoptic Ground Water Monitoring Project, Nampa, Idaho.* Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2016c. *Field Sampling Plan, Lower Payette Nitrate Priority Area Regional Ground Water Monitoring Network, Payette County, Idaho*. Boise, ID: DEQ. TRIM record number 2016AGV250.

DEQ (Idaho Department of Environmental Quality). 2016d. *Field Sampling Plan: North Rapid Creek Lane Local Synoptic Ground Water Monitoring Project, Kuna, Idaho.* Boise, ID: DEQ. TRIM record number 2016AGV99.

DEQ (Idaho Department of Environmental Quality). 2016e. *Amendment to Field Sampling Plan: Springdale Ground Water Monitoring Project*. Twin Falls, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2017. *Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2015*. Boise, ID: DEQ. Ground Water Technical Report No. 49.

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

EPA (US Environmental Protection Agency). 1977. *Environmental Effects of Septic Tank Systems*. Ada, OK: EPA, Office of Research and Development.

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

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

IDWR (Idaho Department of Water Resources). 2016a. *Statewide Ground Water Quality Monitoring (GWQM).* www.idwr.idaho.gov/water-data/ground-water-quality/map.

IDWR (Idaho Department of Water Resources). 2016b. *Standard Operating Procedures for the Statewide Ground Water Quality Monitoring Program, June 1, 2016 through May 31, 2017.* Boise, ID: IDWR.

ISDA (Idaho State Department of Agriculture). 2011. *Regional Ground Water and Pesticides Monitoring Program – Quality Assurance Project Plan*. Boise, ID: ISDA.

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

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

Rupert, M.G. 1997. *Nitrate (NO2+NO3-N) in Ground Water of the Upper Snake River Basin, Idaho and Western Wyoming, 1991-95*. US Geological Survey Water-Resources Investigation Report 97-4174.

Schorzman, K. and J. Baldwin. 2009. *Nitrate and Emerging Contaminants Evaluation of Springdale, Idaho: Cassia County Nitrate Priority Area.* Boise, ID: Idaho Department of Environmental Quality. Ground Water Technical Report No. 39.

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

Seitz, H.R. and R.F. Norvitch. 1979. *Ground-Water Quality in Bannock, Bear Lake, Caribou, and Part of Power Counties, Southeastern Idaho.* US Geological Survey Water-Resources Investigations 79-14.

Skinner, K.D. and Donato, M.M. 2003. *Probability of Detecting Elevated Concentrations of Nitrate in Ground Water in a Six-County Area of South-Central Idaho*. Boise, ID: Water-Resource Investigation Report 03-4143.

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

Tesch, C., G. Bahr, R. Carlson, and J. Fox. 2003a. *Ground Water Nitrate Monitoring in Cassia County, Idaho 2002 Isotope Data Update*. Idaho State Department of Agriculture Technical Results Summary #17.

Tesch, C., R. Carlson, and J. Fox. 2003b. *Ground water Nitrate Monitoring in Cassia County, Idaho*. Idaho State Department of Agriculture Technical Results Summary #13.

USDA (US Department of Agriculture). 2012. "Census of Agriculture." Jerome County Idaho. *https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Idaho/cp16053.pdf*

USGS (US Geological Survey). 2016. National Water Information System: Web Interface. Accessed December 2016. *https://waterdata.usgs.gov/id/nwis/uv/?referred_module=gw.*

Appendix A. Idaho Department of Water Resources (IDWR) Collected Data—2016

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

Report Map ID	IDWR Site ID	Well Depth (feet)	Sample Date	Methane (μg/L)
M-1	423707111462201	220	6/29/2016	<10.0
M-2	434234116504601	224	7/7/2016	17.1
M-3	433744116491901	92	7/7/2016	<10.0
M-4	433116116375501	122	7/7/2016	<10.0
M-5	433513116294401	173	7/7/2016	<10.0
M-6	433710116391401	48	7/7/2016	<10.0
M-7	434417116564401	190	7/8/2016	<10.0
M-8	434408117000701	168	7/8/2016	<10.0
M-9	434806116555501	59	7/8/2016	<10.0
M-10	434525116305102	248	7/11/2016	<10.0
M-11	434554116403101	147	7/11/2016	<10.0
M-12	433948116331501	95	7/11/2016	<10.0
M-13	433432116364101	118	7/11/2016	<10.0
M-14	434516116354401	215	7/11/2016	<10.0
M-15	431625111463301	155	7/13/2016	10.6
M-16	433452116515401	120	7/14/2016	<10.0
M-17	432826116471001	450	7/14/2016	<10.0
M-18	425926116202802	82	7/14/2016	<10.0
M-19	425636115475301	260	7/14/2016	<10.0
M-20	425632116001201	440	7/14/2016	<10.0
M-21	443422116372401	398	7/27/2016	<10.0
M-22	442813116435501	990	7/27/2016	<10.0
M-23	441610116564501	80	7/27/2016	<10.0
M-24	442130116520201	100	7/27/2016	<10.0
M-25	432708116353901	720	7/21/2016	<10.0
M-26	432645116343001	685	7/21/2016	<10.0
M-27	440354116473001	245	7/12/2016	15.6
M-28	435643116461701	137	7/12/2016	<10.0
M-29	434841116445001	90	7/12/2016	<10.0
M-30	440803116383501	190	7/12/2016	<10.0
M-31	440519116544401	69	7/12/2016	<10.0
M-32	440402116552801	25.5	7/12/2016	<10.0
M-33	435717116422001	135	7/12/2016	<10.0
M-34	433317116375401	172	8/1/2016	<10.0
M-35	433109116444301	600	8/1/2016	<10.0
M-36	434213116384501	102	8/3/2016	<10.0
M-37	434138117010101	31	8/3/2016	<10.0
M-38	434509116491501	59	8/3/2016	<10.0
M-39	433549116315301	266	8/4/2016	<10.0
M-40	433951116421001	329	8/4/2016	<10.0
M-41	432719111210001	190	9/26/2016	<10.0

Notes: μg/L = microgram per liter.

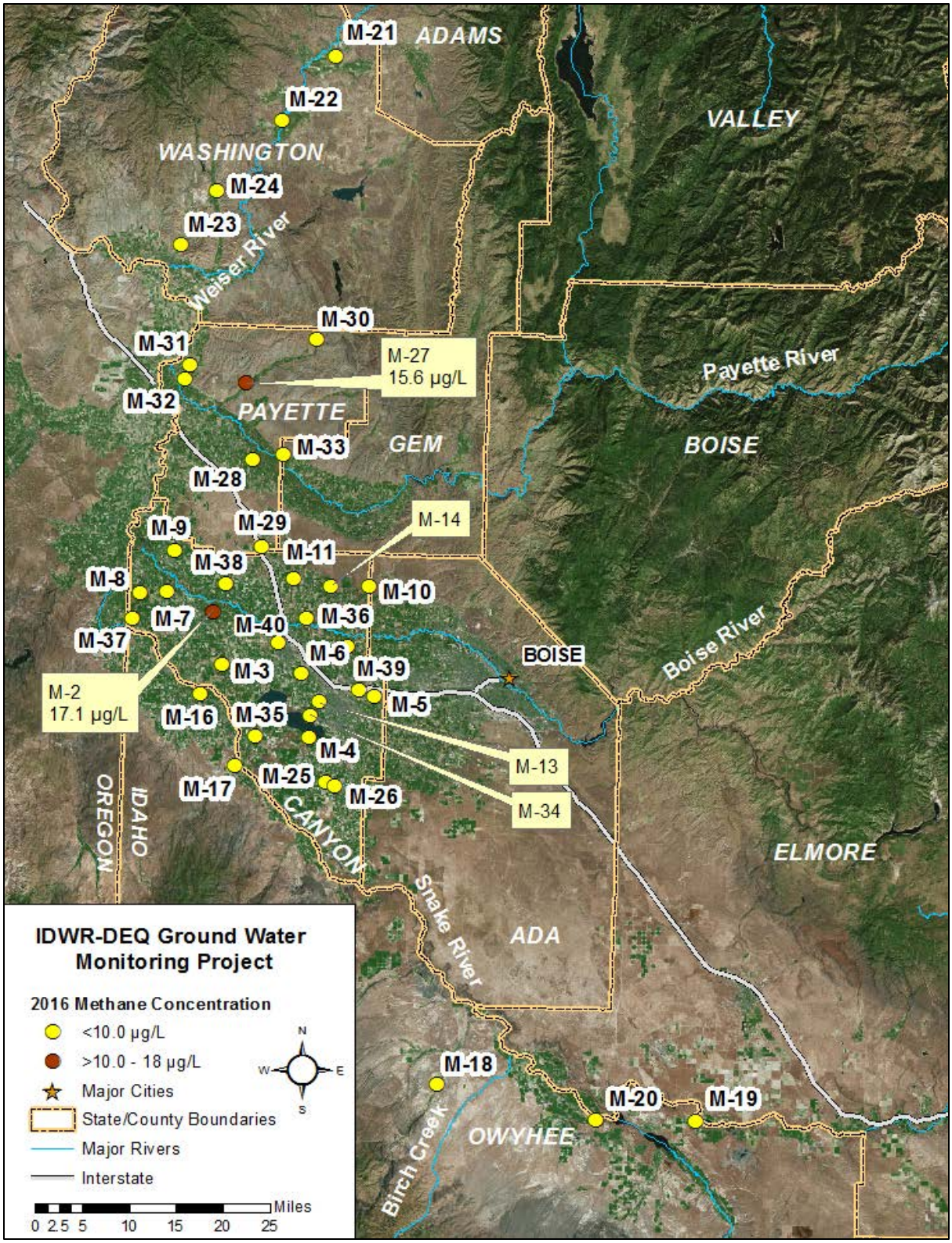


Figure A1. Dissolved methane results in southwestern Idaho—DEQ-IDWR Joint Ground Water Monitoring Project.

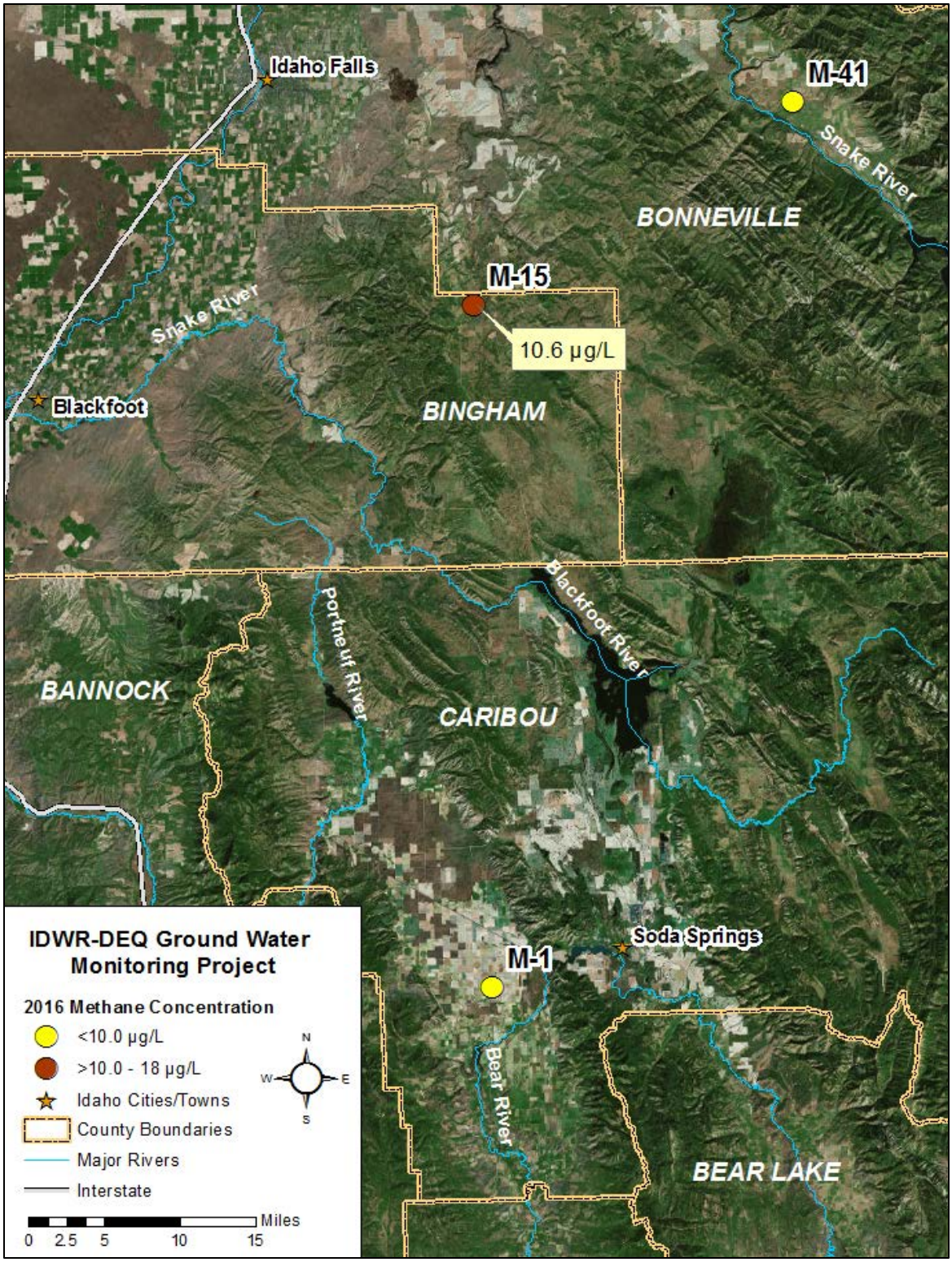


Figure A2. Dissolved methane results in eastern Idaho—DEQ-IDWR Joint Ground Water Monitoring Project.

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

Report Map ID	IDWR Site ID	County	Well Depth (feet)	Sample Date	δ15N (‰)
NI-1	434509116491501	Canyon	59	8/3/2016	5.1
NI-2	433948116331501	Canyon	95	7/11/2016	6.7
NI-3	433710116391401	Canyon	48	7/7/2016	3.8
NI-4	434408117000701	Canyon	168	7/8/2016	4.7
NI-5	434554116403101	Canyon	147	7/11/2016	6.4
NI-6	433744116491901	Canyon	92	7/7/2016	2.3
NI-7	432826116471001	Owyhee	450	7/14/2016	7.5
NI-8	433943116215901	Ada	78	7/6/2016	7.6
NI-9	433757116121101	Ada	78	6/23/2016	7.9
NI-10	430207116054901	Elmore	68	7/13/2016	10.5
NI-11	423946114512601	Twin Falls	110	7/11/2016	5.5
NI-12	422600114341901	Twin Falls	580	7/7/2016	8.5
NI-13	421856114363601	Twin Falls	140	7/14/2016	19.3
NI-14	423431113470202	Minidoka	95	7/21/2016	7
NI-15	424156113461401	Minidoka	251	7/18/2016	4.4
NI-16	421705111170601	Bear Lake	59	6/28/2016	12.8

Note: ‰ = per mil.

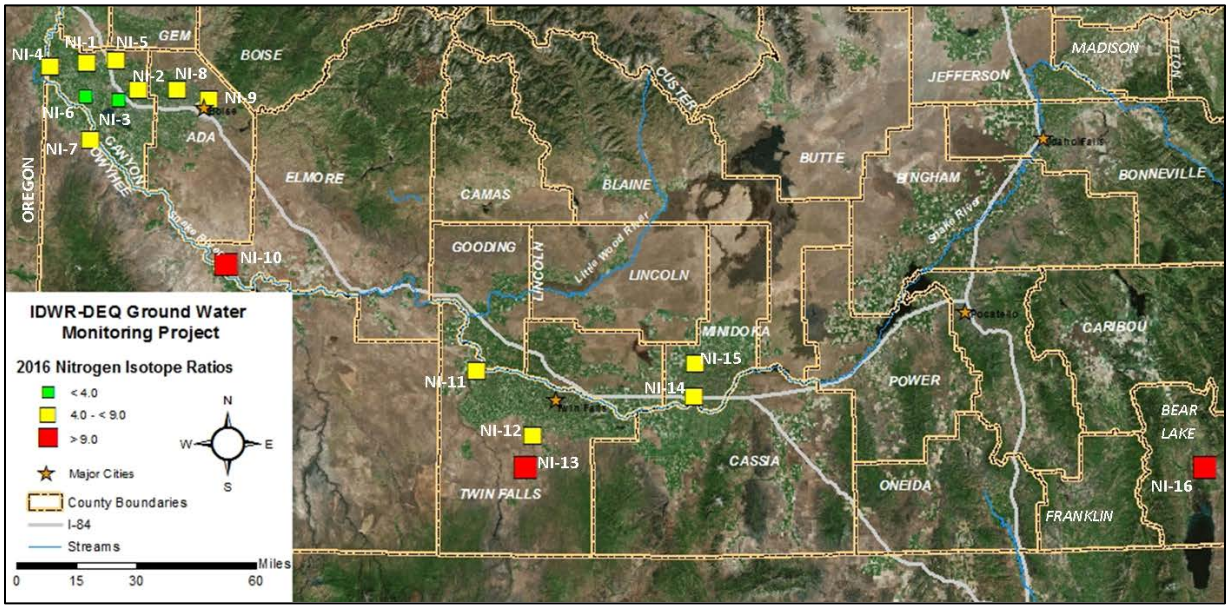


Figure A3. Nitrogen isotope ratios—DEQ-IDWR Joint Ground Water Monitoring Project.

Appendix B. Idaho State Department of Agriculture (ISDA) Collected Data—2016

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

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
2200301	220	06/07/2016	Ada/Canyon	14.3	NA	795	NA	**12**	3.6
2201701	220	06/07/2016	Ada/Canyon	17.9	NA	397	NA	2.3	NA
2201801	220	06/07/2016	Ada/Canyon	14.8	NA	604	NA	5.7	NA
2203001	220	08/03/2016	Ada/Canyon	13.8	7.14	621.3	NA	4.2	NA
2203101	220	06/13/2016	Ada/Canyon	14.3	NA	883	NA	7.6	6.7
2204701	220	06/07/2016	Ada/Canyon	15.4	NA	745	NA	5.6	6.3
2205701	220	06/13/2016	Ada/Canyon	14.7	NA	613	NA	6.3	6.0
2207301	220	06/07/2016	Ada/Canyon	15.1	NA	430	NA	2.8	NA
2207801	220	06/13/2016	Ada/Canyon	13.9	NA	774	NA	**12**	6.6
3003001	300	08/22/2016	Latah	13.5	7.60	321.4	NA	0.015	NA
3003101	300	08/22/2016	Latah	12.3	7.15	341.3	NA	4.4	NA
3003601	300	08/22/2016	Latah	15.3	*6.40*	205.4	NA	8.9	3.0
3003701	300	08/22/2016	Latah	11.6	7.14	214.1	NA	1.9	NA
3100201	310	06/15/2016	Owyhee	20.6	NA	2242	NA	0.3	NA
3100401	310	06/15/2016	Owyhee	19.7	NA	2198	NA	<0.010	NA
3100601	310	06/15/2016	Owyhee	20.7	NA	2518	NA	1.3	NA
3101101	310	08/02/2016	Owyhee	20.2	7.46	2623	NA	0.98	NA
3101601	310	06/15/2016	Owyhee	19.5	NA	2629	NA	0.034	NA
3200101	320	07/26/2016	Fremont	9.8	7.49	542.9	NA	8.4	5.3
3300401	330	08/24/2016	Nez Perce	21.7	8.17	279.5	NA	1.5	NA
3300501	330	08/23/2016	Nez Perce	14.9	8.22	339.6	NA	0.037	NA
3400101	340	09/20/2016	Payette	15.1	7.39	954.2	NA	6.0	4.6
3400501	340	09/20/2016	Payette	15.2	7.45	1057	NA	**13**	6.0
3400701	340	09/20/2016	Payette	15.9	7.60	823.3	NA	0.94	NA
3401401	340	09/20/2016	Payette	14.2	7.63	715.9	NA	3.0	NA
3401501	340	09/20/2016	Payette	14.6	7.61	1004	NA	9.8	4.5

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
5302401	530	09/19/2016	Ada	13.2	7.15	773.4	NA	**16**	8.1
5302701	530	09/19/2016	Ada	13.6	7.00	850.2	NA	**38**	6.5
5303301	530	09/19/2016	Ada	14.8	7.14	577	NA	**15**	7.4
5303401	530	09/19/2016	Ada	13.7	7.06	1106	NA	**42**	8.2
5303701	530	09/19/2016	Ada	13.2	7.05	781.2	NA	**31**	6.9
5303801	530	09/19/2016	Ada	13.5	6.87	978.5	NA	**44**	NA
7100101	710	08/16/2016	Washington/Payette	16.6	7.65	748	NA	3.9	NA
7100201	710	08/16/2016	Washington/Payette	15.3	7.31	1586	NA	**60**	3.2
7100401	710	08/16/2016	Washington/Payette	16.5	7.62	494	NA	0.47	NA
7100501	710	08/15/2016	Washington/Payette	13.6	7.61	796.3	NA	**14**	1.8
7100601	710	08/09/2016	Washington/Payette	15.0	7.40	900.9	NA	**11**	4.7
7100901	710	08/08/2016	Washington/Payette	14.4	7.30	985.2	NA	**12**	5.1
7101201	710	08/15/2016	Washington/Payette	13.5	7.37	1172	NA	7.2	7.2
7101701	710	08/09/2016	Washington/Payette	14.4	7.56	777.8	NA	9.2	3.3
7102101	710	08/09/2016	Washington/Payette	13.0	7.48	681	NA	6.1	NA
7102301	710	08/10/2016	Washington/Payette	13.6	7.23	796.3	NA	7.4	6.7
7102501	710	08/09/2016	Washington/Payette	14.4	7.06	1550	NA	**18**	8.4
7102701	710	08/10/2016	Washington/Payette	13.9	7.33	780.4	NA	9.9	NA
7102901	710	8/15/2016	Washington/Payette	14.2	7.29	960.5	NA	8.7	NA
7103301	710	08/08/2016	Washington/Payette	15.7	7.35	844.8	NA	7.0	5.9
7103601	710	08/10/2016	Washington/Payette	14.9	7.65	914.6	NA	7.4	NA
7103701	710	08/15/2016	Washington/Payette	14.2	7.34	713.1	NA	2.8	NA
7103801	710	08/09/2016	Washington/Payette	16.8	7.27	977.8	NA	**12**	4.7
7103901	710	08/08/2016	Washington/Payette	15.4	7.25	731.8	NA	9.0	1.6
7104001	710	08/09/2016	Washington/Payette	14.8	7.55	946.2	NA	**16**	2.2
7104101	710	08/08/2016	Washington/Payette	13.5	7.34	1423	NA	**26**	10.9
7104201	710	08/09/2016	Washington/Payette	14.2	7.26	641.1	NA	5.0	7.7
7104401	710	08/16/2016	Washington/Payette	16.2	7.32	816.3	NA	8.9	4.5

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
7104601	710	08/10/2016	Washington/Payette	14.2	7.16	820.5	NA	7.9	3.9
7104701	710	08/10/2016	Washington/Payette	15.5	7.46	941.1	NA	9.3	3.0
7104801	710	08/08/2016	Washington/Payette	14.1	7.60	1001	NA	**13**	1.5
7105101	710	08/10/2016	Washington/Payette	13.5	7.33	915.8	NA	9.7	6.7
7107001	710	08/08/2016	Washington/Payette	13.9	7.41	1703	NA	**35**	4.2
7107101	710	08/08/2016	Washington/Payette	14.2	7.44	688.6	NA	1.4	NA
7300201	730	07/12/2016	Minidoka	13.8	7.34	1004	NA	9.8	5.0
7300701	730	07/14/2016	Minidoka	12.5	7.43	1209	NA	9.7	NA
7300801	730	07/12/2016	Minidoka	12.3	7.37	1692	NA	**27**	4.3
7300901	730	07/18/2016	Minidoka	13.1	7.47	1062	NA	6.1	23.9
7301101	730	07/12/2016	Minidoka	15.4	7.39	690.2	NA	5.2	NA
7301301	730	07/14/2016	Minidoka	16.9	7.51	787	NA	1.0	NA
7301501	730	07/13/2016	Minidoka	15.5	7.85	654	NA	<0.010	NA
7301601	730	07/14/2016	Minidoka	13.1	7.42	1206	NA	9.9	5.8
7301801	730	07/18/2016	Minidoka	15.4	7.59	830.8	NA	6.4	3.8
7301901	730	07/18/2016	Minidoka	14.9	7.40	1115	NA	**18**	10.1
7302001	730	07/12/2016	Minidoka	16.6	7.45	646.9	NA	3.3	NA
7302101	730	07/18/2016	Minidoka	15.9	7.70	662.4	NA	3.6	NA
7302301	730	07/14/2016	Minidoka	16.9	7.49	800	NA	3.8	NA
7302801	730	07/12/2016	Minidoka	13.6	7.36	2639	NA	8.5	12.9
7303001	730	07/14/2016	Minidoka	15.2	7.55	858	NA	3.4	NA
7303101	730	07/13/2016	Minidoka	15.0	7.65	720	NA	4.9	NA
7303201	730	07/20/2016	Minidoka	13.2	7.20	1421.8	NA	**41**	11.0
7303401	730	07/12/2016	Minidoka	13.2	7.62	623.2	NA	0.21	NA
7303501	730	07/12/2016	Minidoka	13.1	7.61	1153	NA	0.28	NA
7303901	730	07/14/2016	Minidoka	15.4	7.50	962	NA	7.7	4.3
7304101	730	07/12/2016	Minidoka	14.4	7.53	736.4	NA	8.7	4.8
7304301	730	07/12/2016	Minidoka	14.8	7.44	708.1	NA	5.3	NA

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
7304501	730	07/12/2016	Minidoka	13.2	7.38	982.6	NA	9.4	4.7
7400401	740	07/18/2016	Minidoka	13.7	7.80	612.5	NA	2.2	NA
7401801	740	07/20/2016	Minidoka	14.5	7.57	972.3	NA	6.1	NA
7402001	740	07/18/2016	Minidoka	14.2	7.64	1072	NA	6.8	6.2
7403201	740	07/20/2016	Minidoka	14.7	7.60	885.3	NA	4.6	NA
7404801	740	07/20/2016	Minidoka	14.0	7.47	934	NA	7.6	6.0
7404901	740	07/20/2016	Minidoka	19.7	8.06	476.4	NA	0.75	NA
7405101	740	07/20/2016	Minidoka	15.0	7.68	811.5	NA	5.6	NA
7501401	750	08/11/2016	Jerome/Gooding/Lincoln	14.8	7.74	721	NA	3.8	NA
7502401	750	08/09/2016	Jerome/Gooding/Lincoln	15.8	7.70	765.4	NA	3.0	NA
7504701	750	08/10/2016	Jerome/Gooding/Lincoln	15.3	7.53	789.1	NA	4.9	NA
7504801	750	08/10/2016	Jerome/Gooding/Lincoln	15.4	7.52	710.6	NA	2.4	NA
7505501	750	08/10/2016	Jerome/Gooding/Lincoln	15.4	7.48	646.9	NA	3.8	NA
7505601	750	08/11/2016	Jerome/Gooding/Lincoln	15.1	7.42	691.8	NA	3.6	NA
7505801	750	08/14/2016	Jerome/Gooding/Lincoln	15.2	7.32	680.1	NA	3.3	NA
7507001	750	08/10/2016	Jerome/Gooding/Lincoln	14.3	7.50	1179	NA	**12**	3.0
7507401	750	08/09/2016	Jerome/Gooding/Lincoln	16.8	7.61	724.1	NA	3.8	NA
7700601	770	07/19/2016	Gem/Payette	15.1	7.00	494	NA	2.4	7.9
7701101	770	07/06/2016	Gem/Payette	15.6	7.50	672	NA	8.8	3.6
7701401	770	06/15/2016	Gem/Payette	15.5	NA	704	NA	<0.010	NA
7701701	770	07/06/2016	Gem/Payette	14.2	7.20	1122	NA	8.1	NA
7702001	770	06/15/2016	Gem/Payette	15.3	NA	1227	NA	**13**	9.2
7702501	770	07/19/2016	Gem/Payette	14.9	7.70	686	NA	6.6	NA
7702801	770	07/19/2016	Gem/Payette	16.8	7.10	263	NA	1.3	NA
7703001	770	07/19/2016	Gem/Payette	14.6	7.80	233	NA	1.1	NA
7703501	770	07/06/2016	Gem/Payette	15.5	*8.90*	202	NA	<0.010	NA
7703601	770	06/15/2016	Gem/Payette	14.1	NA	959	NA	**15**	5.7
7705301	770	06/15/2016	Gem/Payette	14.2	NA	1199	NA	**14**	4.5

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
7801701	780	06/27/2016	Twin Falls	14.7	NA	967	NA	7.3	NA
7803601	780	06/28/2016	Twin Falls	9.0	NA	1262	NA	8.5	5.8
7804201	780	06/28/2016	Twin Falls	9.1	NA	1010	NA	7.1	7.5
7804301	780	06/29/2016	Twin Falls	9.2	NA	1089	NA	7.9	7.5
7804401	780	06/29/2016	Twin Falls	11.1	NA	1071	NA	3.5	NA
7805501	780	06/29/2016	Twin Falls	10.0	NA	1075	NA	**11**	NA
7805601	780	06/29/2016	Twin Falls	10.2	NA	1046	NA	7.3	7.0
7805701	780	06/28/2016	Twin Falls	9.6	NA	1129	NA	**12**	8.2
7806401	780	06/29/2016	Twin Falls	10.9	NA	926	NA	5.0	NA
7806601	780	06/29/2016	Twin Falls	8.7	NA	1102	NA	6.6	NA
7900101	790	09/06/2016	Cassia	17.5	7.76	951.3	NA	5.1	NA
7900601	790	09/06/2016	Cassia	12.6	7.68	956.3	NA	9.6	5.8
7900701	790	09/06/2016	Cassia	12.8	7.19	864.5	NA	**10**	6.2
7900801	790	09/07/2016	Cassia	13.4	7.52	843	NA	**11**	7.8
7900901	790	09/08/2016	Cassia	14.0	7.45	686	NA	3.2	NA
7901101	790	09/08/2016	Cassia	15.7	7.61	680	NA	4.0	NA
7901301	790	09/06/2016	Cassia	16.5	7.39	1165	NA	4.0	NA
7901401	790	09/07/2016	Cassia	14.2	7.46	960	NA	**16**	9.0
7901501	790	09/07/2016	Cassia	14.2	7.57	864	NA	6.4	4.2
7901601	790	09/13/2016	Cassia	11.8	7.52	954	NA	**11**	3.3
7901701	790	09/13/2016	Cassia	12.6	7.61	746	NA	7.2	3.8
7901801	790	09/13/2016	Cassia	14.2	7.63	649	NA	3.6	NA
7901901	790	09/12/2016	Cassia	12.2	7.49	1022	NA	**15**	5.9
7902001	790	09/12/2016	Cassia	13.1	7.49	965.2	NA	**19**	4.8
7902101	790	09/12/2016	Cassia	15.3	7.55	806.6	NA	**14**	4.8
7902201	790	09/07/2016	Cassia	12.7	7.13	768	NA	2.1	NA
7902401	790	09/07/2016	Cassia	13.2	7.24	825	NA	3.1	NA
7903201	790	09/07/2016	Cassia	12.3	7.36	947	NA	**11**	NA

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
7903501	790	09/12/2016	Cassia	12.0	7.53	979	NA	**16**	6.5
7903601	790	09/13/2016	Cassia	13.3	7.57	828	NA	**10**	7.4
7903701	790	09/13/2016	Cassia	13.7	7.03	997	NA	**14**	8.5
7903801	790	09/06/2016	Cassia	14.3	7.36	914.2	NA	**19**	NA
7904001	790	09/06/2016	Cassia	13.8	7.39	808.7	NA	5.5	NA
7904401	790	09/08/2016	Cassia	13.9	7.69	594	NA	5.2	NA
7907301	790	09/13/2016	Cassia	12.7	7.64	787	NA	**10**	NA
8050301	805	07/26/2016	Madison/Fremont/Teton	11.0	7.63	538.1	NA	6.4	5.8
8050801	805	07/26/2016	Madison/Fremont/Teton	12.8	7.59	406.3	NA	5.2	NA
8051301	805	07/26/2016	Madison/Fremont/Teton	10.0	7.55	535.9	NA	4.6	NA
8051401	805	07/26/2016	Madison/Fremont/Teton	11.8	7.51	461.2	NA	7.9	3.9
8053401	805	07/26/2016	Madison/Fremont/Teton	11.0	7.65	373	NA	1.5	NA
8053501	805	07/26/2016	Madison/Fremont/Teton	9.7	7.43	552.9	NA	**11**	4.5
8054601	805	07/26/2016	Madison/Fremont/Teton	11.5	7.63	550.6	NA	**12**	7.4
8100401	810	07/11/2016	Elmore	14.0	7.73	1328	NA	**15**	5.5
8100601	810	09/14/2016	Elmore	13.2	7.53	1400	NA	**21**	3.6
8104801	810	09/14/2016	Elmore	18.5	8.38	343.5	NA	1.9	NA
8201201	820	08/30/2016	Kootenai/Bonner	9.6	7.98	291.4	NA	2.5	NA
8204601	820	08/24/2016	Kootenai/Bonner	10.3	8.16	313.9	NA	1.4	NA
8204701	820	08/30/2016	Kootenai/Bonner	9.9	7.74	361.3	NA	1.0	NA
8204801	820	08/30/2016	Kootenai/Bonner	9.3	7.97	316.7	NA	0.61	NA
8205001	820	08/24/2016	Kootenai/Bonner	14.5	8.02	326.7	NA	1.8	NA
8205101	820	08/24/2016	Kootenai/Bonner	9.0	8.03	364.5	NA	2.1	NA
8205201	820	08/24/2016	Kootenai/Bonner	10.4	8.20	292.9	NA	1.6	NA
8300201	830	07/27/2016	Jefferson	12.9	8.06	324.3	NA	3.5	NA
8300301	830	07/27/2016	Jefferson	13.8	7.98	344.6	NA	4.9	NA
8300401	830	07/27/2016	Jefferson	14.0	8.06	322.4	NA	3.4	NA
8300501	830	07/27/2016	Jefferson	13.8	8.03	348	NA	4.3	NA

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
8301101	830	07/27/2016	Jefferson	12.8	8.06	319.9	NA	1.1	NA
8303001	830	07/27/2016	Jefferson	11.4	7.86	772.3	NA	7.0	7.1
8404301	840	07/25/2016	Bonneville/Jefferson/Madison	13.5	7.62	440.1	NA	0.76	NA
8405001	840	07/25/2016	Bonneville/Jefferson/Madison	12.6	7.61	485	NA	1.7	NA
8405801	840	07/25/2016	Bonneville/Jefferson/Madison	13.0	7.52	517.8	NA	0.96	NA
8406101	840	07/25/2016	Bonneville/Jefferson/Madison	13.8	7.52	499.4	NA	0.63	NA
8407501	840	06/15/2016	Bonneville/Jefferson/Madison	12.4	6.80	547	NA	1.5	NA
8420101	842	10/17/2016	Bingham/Bonneville	13.2	7.32	553.8	NA	1.2	NA
8420201	842	10/17/2016	Bingham/Bonneville	13.3	7.46	444.4	NA	1.4	NA
8420301	842	10/17/2016	Bingham/Bonneville	12.8	7.49	501.6	NA	2.1	NA
8420401	842	10/17/2016	Bingham/Bonneville	15.1	7.56	618	NA	2.2	NA
8420501	842	10/17/2016	Bingham/Bonneville	12.9	7.59	477	NA	2.1	NA
8420601	842	10/17/2016	Bingham/Bonneville	12.3	7.52	482.4	NA	2.1	NA
8420701	842	10/18/2016	Bingham/Bonneville	13.1	7.38	638.5	NA	1.9	NA
8420801	842	10/18/2016	Bingham/Bonneville	13.9	7.37	476.7	NA	0.74	NA
8420901	842	10/18/2016	Bingham/Bonneville	13.3	7.30	577	NA	2.1	NA
8421001	842	10/19/2016	Bingham/Bonneville	12.7	7.49	616.4	NA	4.6	NA
8421101	842	10/17/2016	Bingham/Bonneville	13.2	7.45	457.7	NA	1.7	NA
8421201	842	10/19/2016	Bingham/Bonneville	13.2	7.40	598.6	NA	3.1	NA
8421301	842	10/19/2016	Bingham/Bonneville	13.0	7.39	595.9	NA	3.0	NA
8421401	842	10/19/2016	Bingham/Bonneville	13.5	6.86	670.4	NA	2.4	NA
8421501	842	10/19/2016	Bingham/Bonneville	12.8	7.02	579.4	NA	3.2	NA
8421601	842	5/9/2016	Bingham/Bonneville	13.2	7.27	556	1.99	NA	NA
8421601	842	10/18/2016	Bingham/Bonneville	13.1	7.49	588.8	NA	2.7	NA
8421701	842	3/22/2016	Bingham/Bonneville	10.0	7.24	544	1.85	NA	NA
8421701	842	10/18/2016	Bingham/Bonneville	12.6	7.51	567.5	NA	2.0	NA
8421801	842	3/22/2016	Bingham/Bonneville	9.4	7.32	522	2.04	NA	NA
8421801	842	10/18/2016	Bingham/Bonneville	13.9	7.58	475.4	NA	1.3	NA

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
8421901	842	10/19/2016	Bingham/Bonneville	12.8	NA	568.4	NA	2.7	NA
8600801	860	08/02/2016	Owyhee	16.0	7.60	1057	NA	<0.010	NA
8601101	860	06/15/2016	Owyhee	14.8	NA	2461	NA	3.9	NA
8601401	860	08/03/2016	Owyhee	15.1	7.27	1496	NA	6.6	7.1
8601801	860	08/03/2016	Owyhee	16.7	7.91	1088	NA	<0.010	NA
8602001	860	08/03/2016	Owyhee	14.7	7.11	2331	NA	8.8	6.5
8602901	860	08/02/2016	Owyhee	18.3	7.63	2366	NA	0.11	NA
8603001	860	08/02/2016	Owyhee	19.9	7.24	1513	NA	<0.010	NA
8650101	865	06/20/2016	Owyhee	15.5	NA	1169	NA	**13**	5.9
8650201	865	06/22/2016	Owyhee	16.0	NA	961	NA	**12**	3.6
8650301	865	06/20/2016	Owyhee	15.0	NA	3030	NA	**110**	6.4
8650501	865	06/22/2016	Owyhee	17.2	NA	2386	NA	**18**	9.7
8650601	865	06/22/2016	Owyhee	13.5	NA	1404	NA	5.7	NA
8650701	865	06/22/2016	Owyhee	15.7	NA	1618	NA	**44**	2.3
8653401	865	06/29/2016	Owyhee	15.3	7.35	970	NA	2.9	NA
8655001	865	06/29/2016	Owyhee	14.4	7.31	1070	NA	6.0	NA
8657801	865	06/20/2016	Owyhee	15.6	NA	1435	NA	**28**	5.8
8700501	870	06/22/2016	Gooding	12.1	NA	964	NA	**14**	3.3
8700601	870	06/22/2016	Gooding	15.9	NA	762	NA	8.6	4.5
8700801	870	06/21/2016	Gooding	15.4	NA	1016	NA	6.6	NA
8701201	870	06/21/2016	Gooding	15.0	NA	904	NA	7.6	2.8
8701401	870	06/22/2016	Gooding	14.2	NA	997	NA	6.4	6.0
8701601	870	06/22/2016	Gooding	16.9	NA	835	NA	7	7.7
8706201	870	06/21/2016	Gooding	15.5	NA	1311	NA	**19**	10.0
8706501	870	06/21/2016	Gooding	19.4	NA	325	NA	<0.010	NA
8900401	890	07/11/2016	Elmore	17.9	7.30	1030	NA	8.8	3.6
8900501	890	07/11/2016	Elmore	25.0	7.48	734	NA	3.4	NA
8900601	890	09/14/2016	Elmore	16.4	7.49	828.6	NA	3.4	NA

ISDA Well ID	ISDA Project No.	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductivity (µS/cm)	Nitrate[b] (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:					***6.5–8.5***	***NA***	***10***	***10***	***NA***
8900801	890	07/11/2016	Elmore	16.7	7.41	1650	NA	**42**	2.8
8901801	890	07/11/2016	Elmore	17.1	7.50	1143	NA	**10**	2.9
8902201	890	07/11/2016	Elmore	17.6	7.60	1127	NA	**15**	4.2
9500201	950	08/24/2016	Nez Perce/Lewis/Idaho	13.5	7.47	607.7	NA	5.7	NA
9501201	950	08/21/2016	Nez Perce/Lewis/Idaho	12.0	7.53	337.3	NA	1.7	NA
9501401	950	08/24/2016	Nez Perce/Lewis/Idaho	11.0	7.25	1151	NA	**37**	13.7
9501901	950	08/23/2016	Nez Perce/Lewis/Idaho	15.3	7.82	431.4	NA	1.1	NA
9502201	950	08/23/2016	Nez Perce/Lewis/Idaho	12.1	7.80	493.1	NA	**10**	4.8
9502801	950	08/24/2016	Nez Perce/Lewis/Idaho	12.5	8.00	429.9	NA	0.14	NA
9504501	950	08/21/2016	Nez Perce/Lewis/Idaho	8.9	7.24	286.1	NA	2.8	NA
9505101	950	08/23/2016	Nez Perce/Lewis/Idaho	16.0	6.88	422.1	NA	8.6	7.3
9505401	950	08/24/2016	Nez Perce/Lewis/Idaho	12.1	7.69	622.8	NA	**14**	2.8
9505501	950	08/23/2016	Nez Perce/Lewis/Idaho	18.6	8.46	321.7	NA	0.018	NA
9505701	950	08/21/2016	Nez Perce/Lewis/Idaho	10.8	7.53	319.9	NA	2.8	NA
9506001	950	08/23/2016	Nez Perce/Lewis/Idaho	10.8	7.04	249.3	NA	6.3	NA
9506401	950	08/23/2016	Nez Perce/Lewis/Idaho	12.3	7.80	363.7	NA	<0.010	NA
9507001	950	08/23/2016	Nez Perce/Lewis/Idaho	11.7	7.53	784.2	NA	**20**	5.3
9507501	950	08/24/2016	Nez Perce/Lewis/Idaho	13.7	7.01	303.2	NA	0.48	NA
9507901	950	08/24/2016	Nez Perce/Lewis/Idaho	12.6	7.98	327.3	NA	1.4	NA

Notes: NA = not analyzed. Bolded red numbers indicate EPA's National Primary Drinking Water Regulation standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was exceeded. These regulations apply to public water systems only and are used with 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.

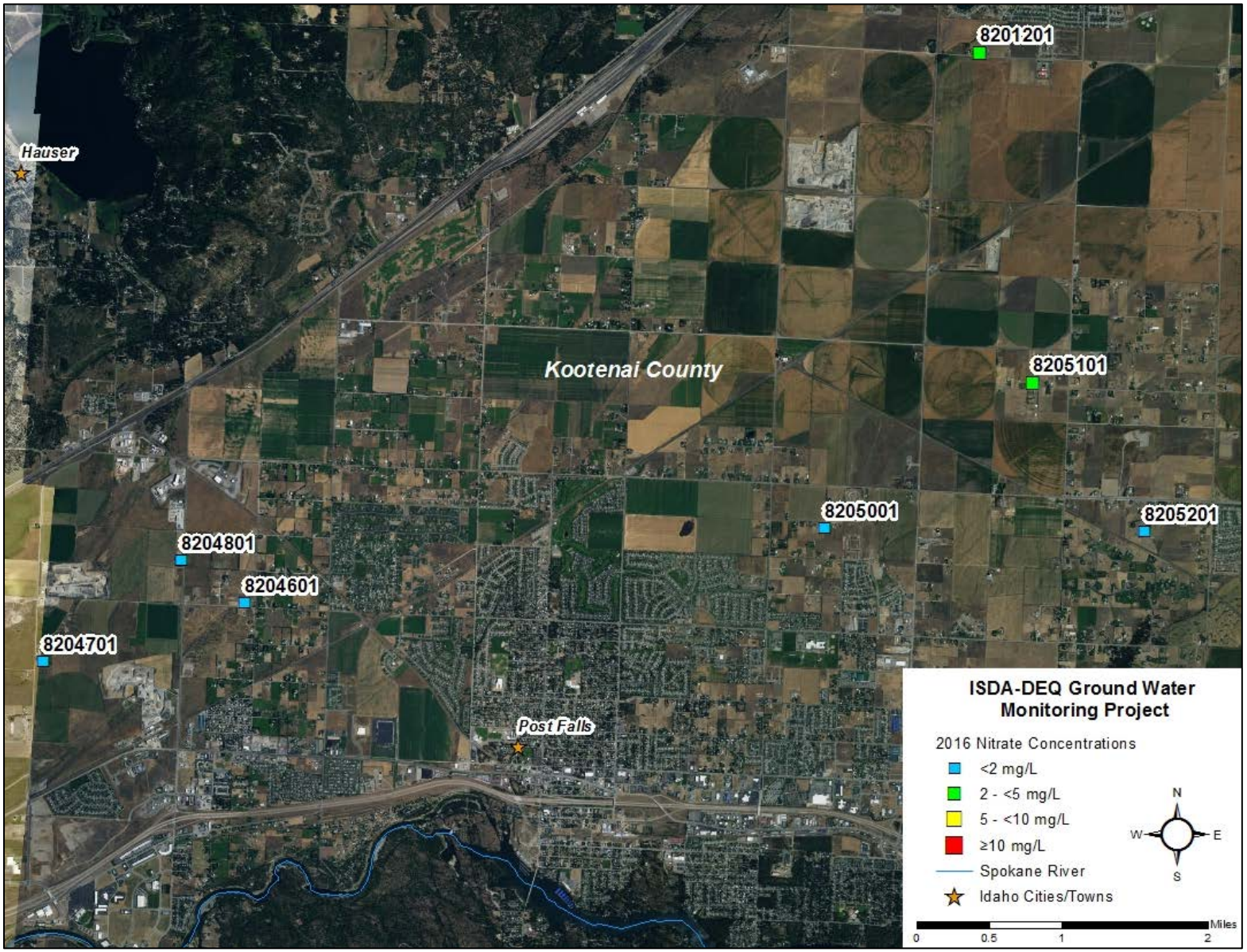


Figure B1. Kootenai County nitrate concentrations, 2016 ISDA data.

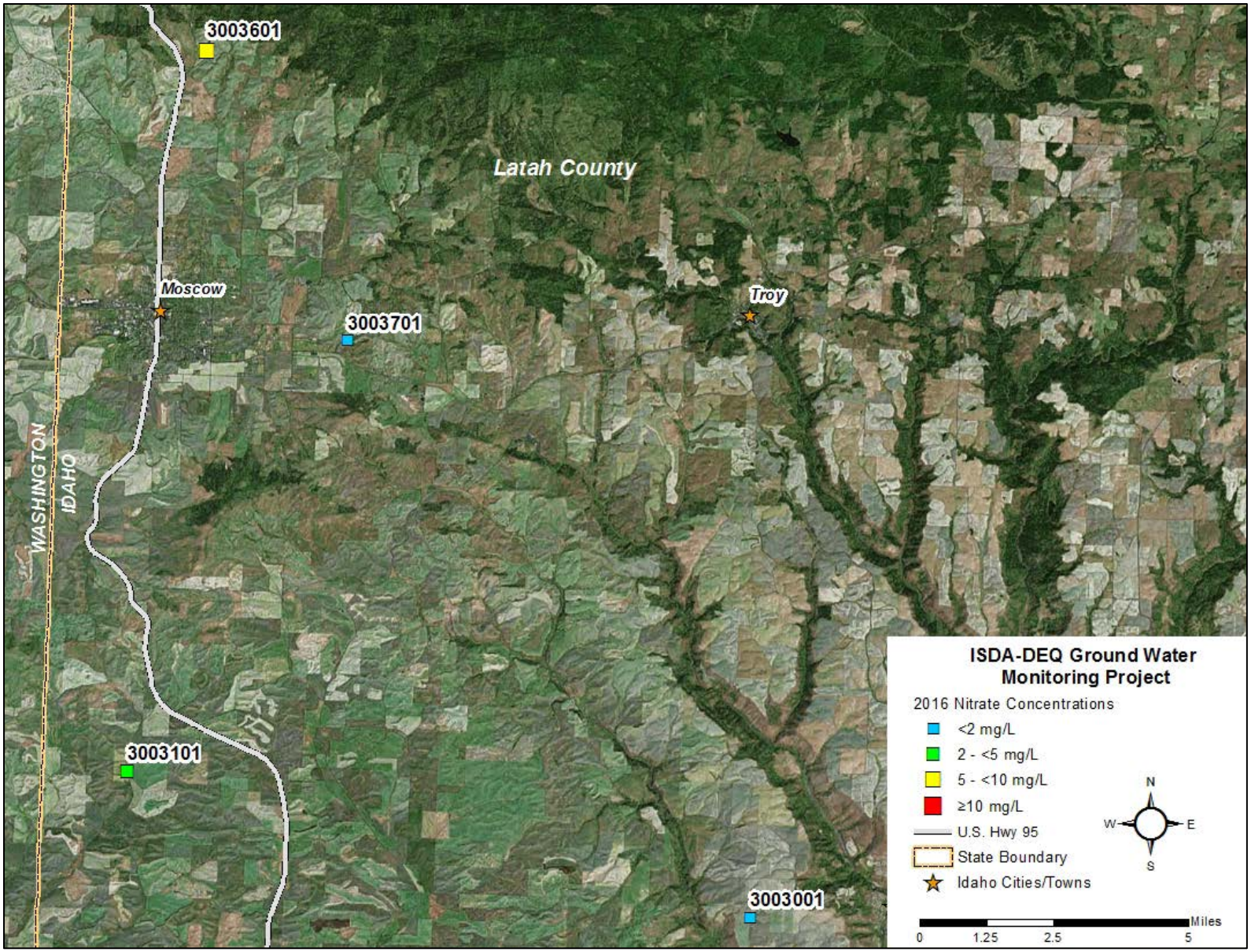


Figure B2. Latah County nitrate concentrations, 2016 ISDA data.

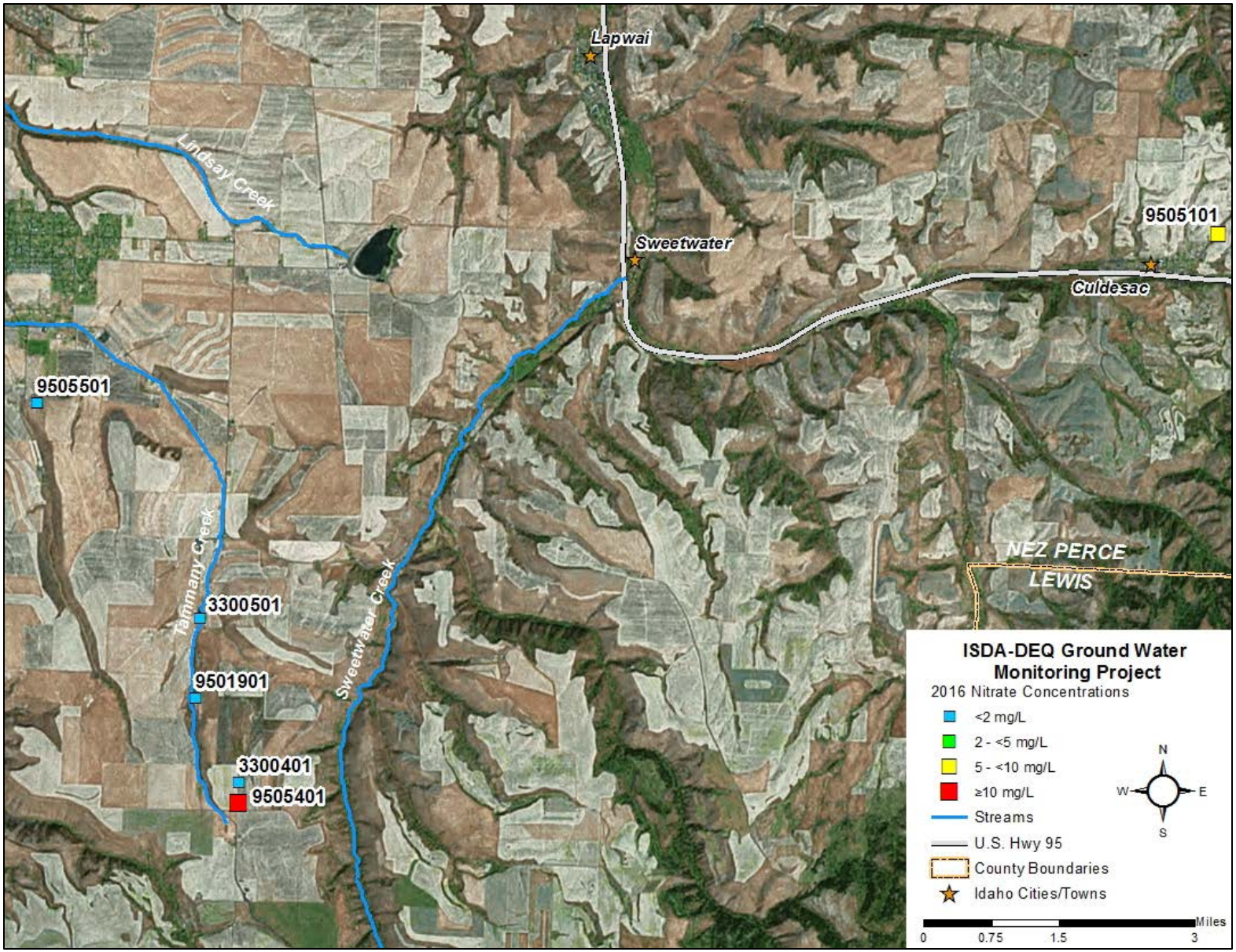


Figure B3. Nez Perce County nitrate concentrations, 2016 ISDA data.

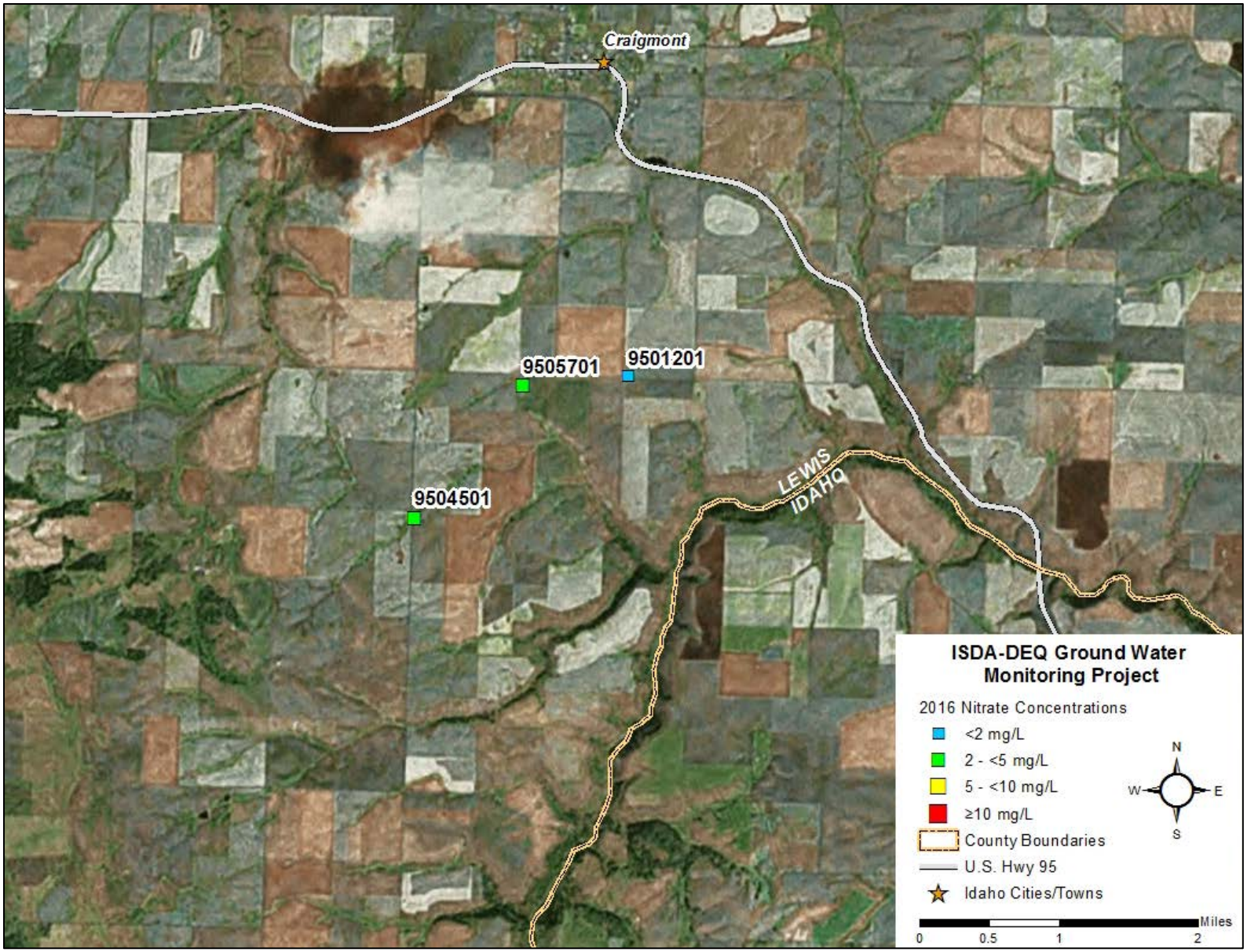


Figure B4. Lewis County nitrate concentrations, 2016 ISDA data.

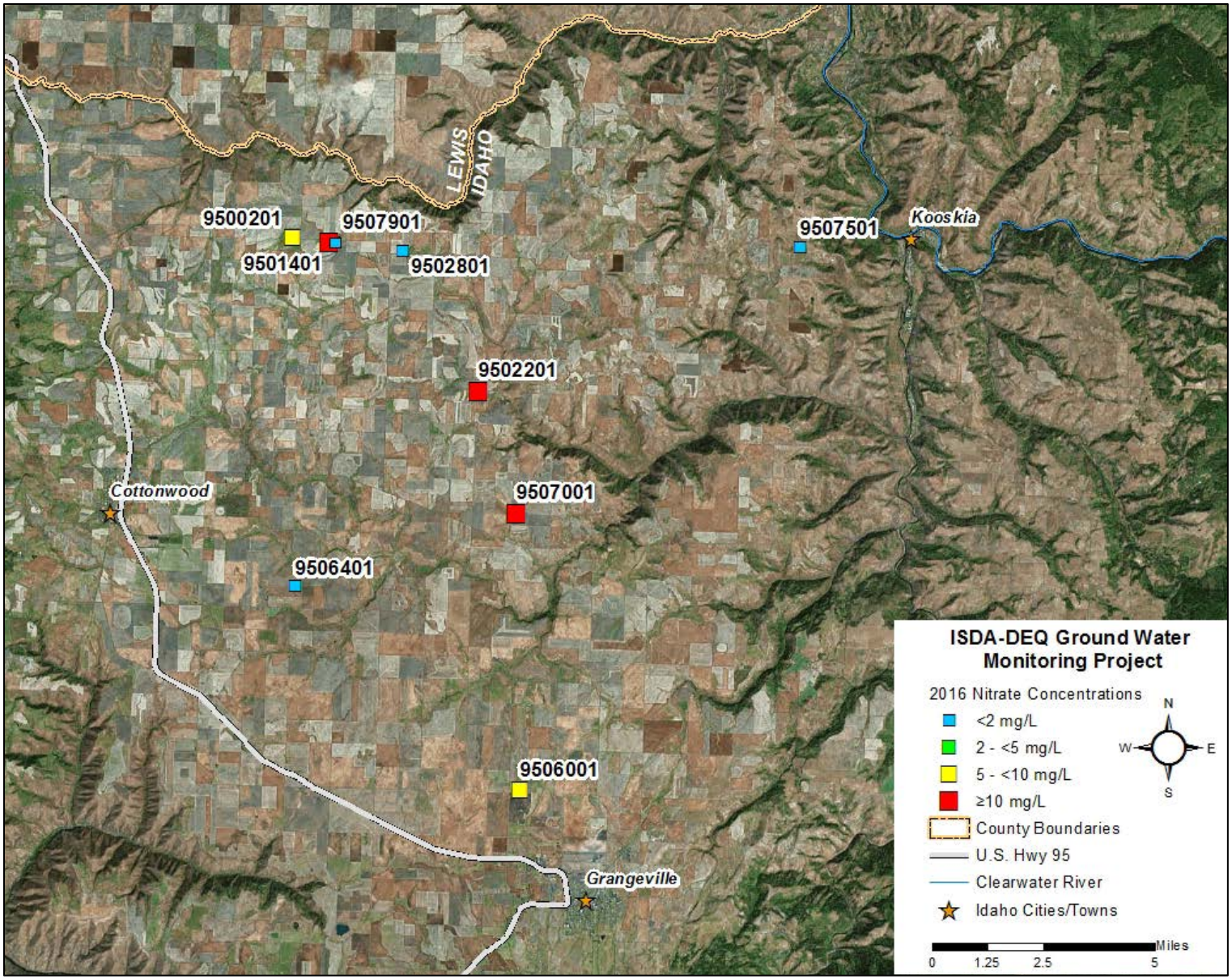


Figure B5. Idaho County nitrate concentrations, 2016 ISDA data.

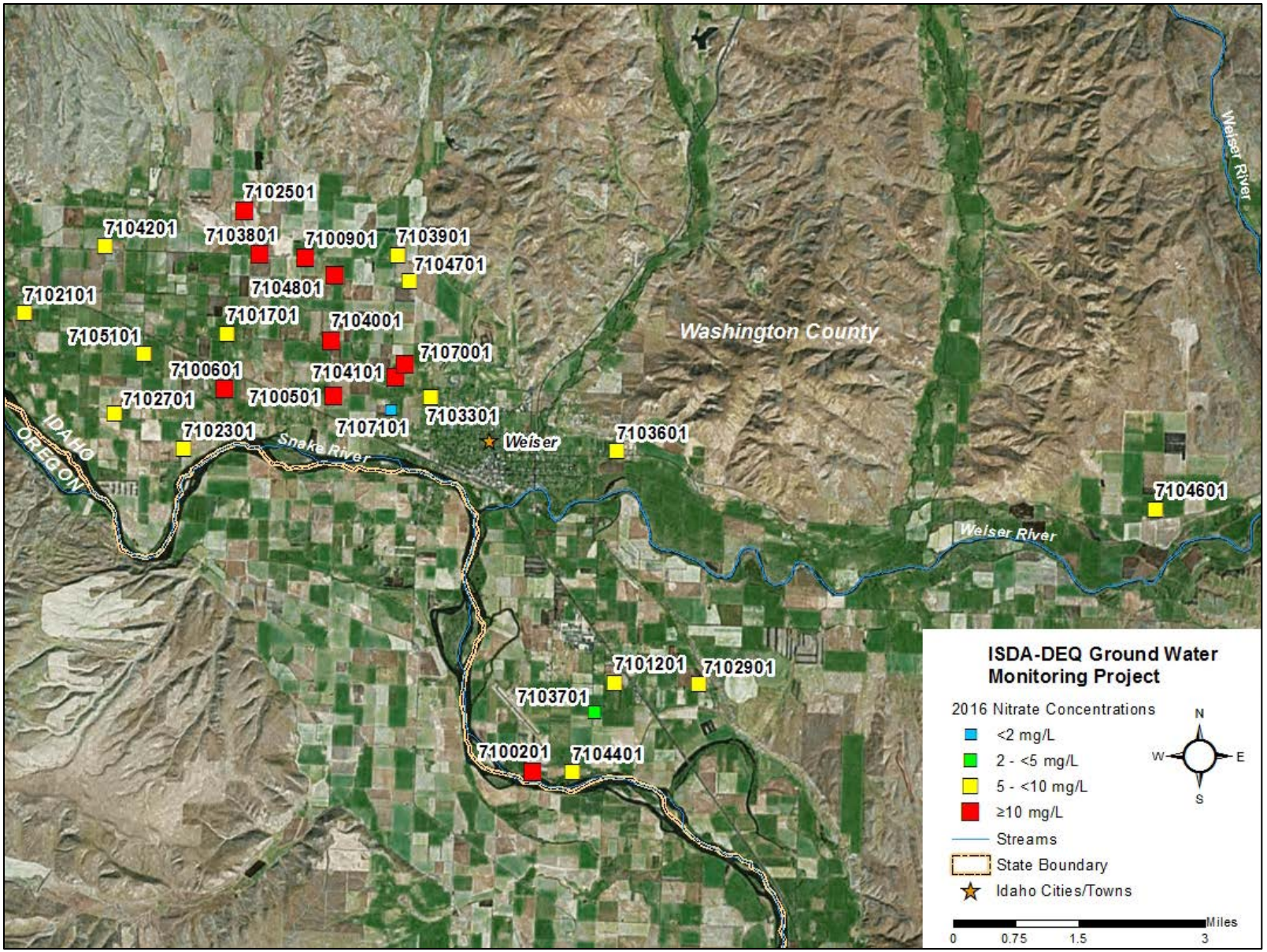


Figure B6. Washington County nitrate concentrations, 2016 ISDA data.

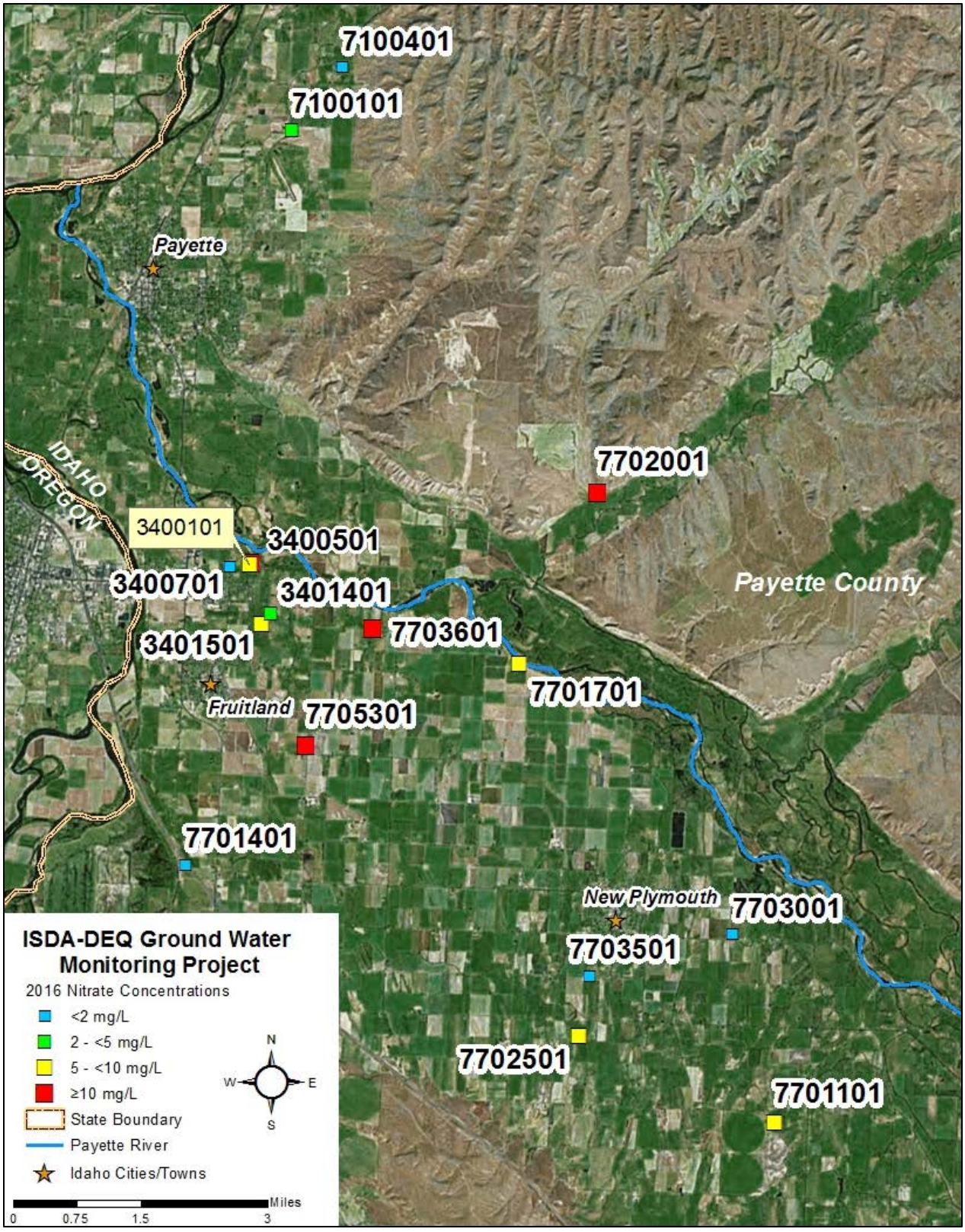


Figure B7. Payette County nitrate concentrations, 2016 ISDA data.

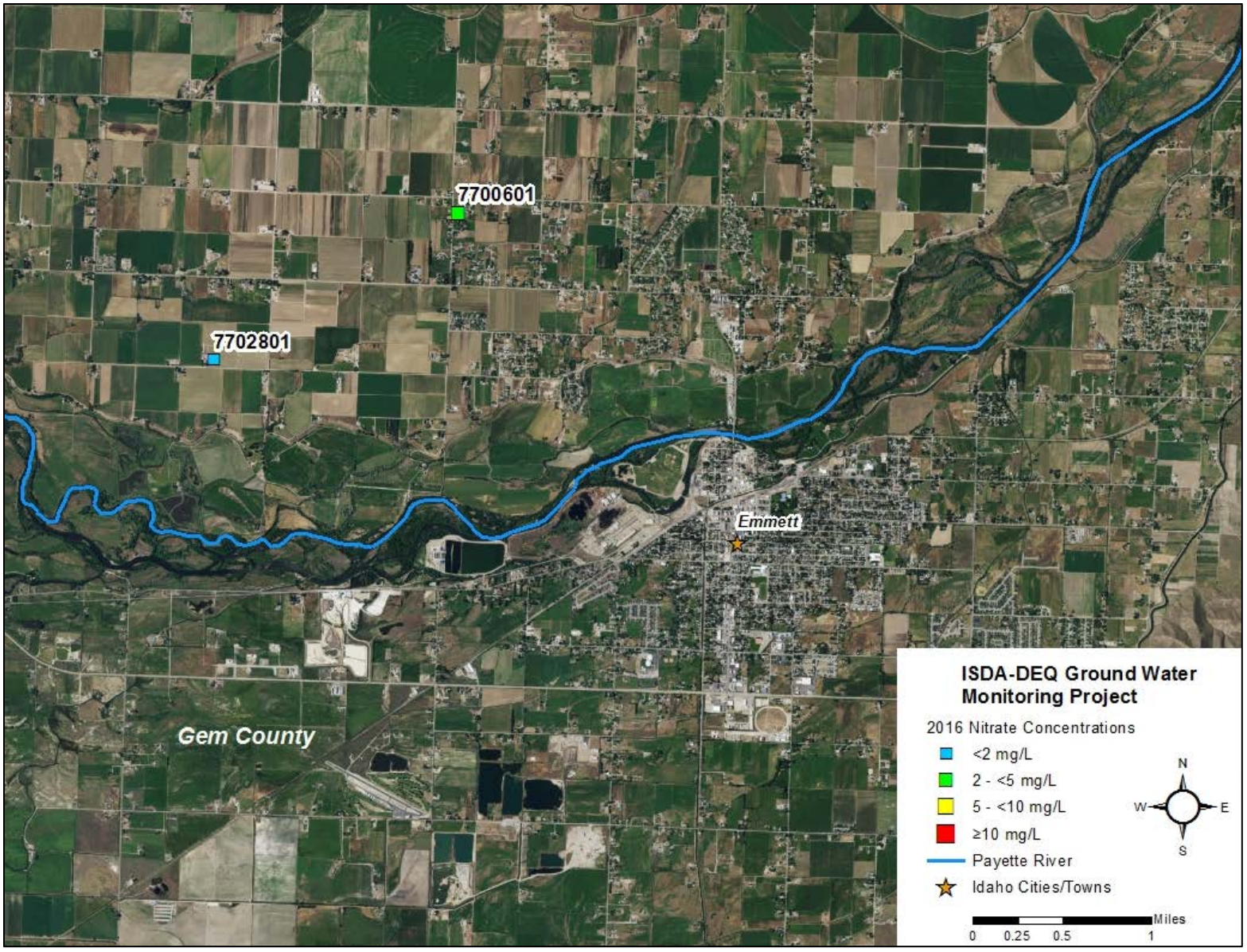


Figure B8. Gem County nitrate concentrations, 2016 ISDA data.

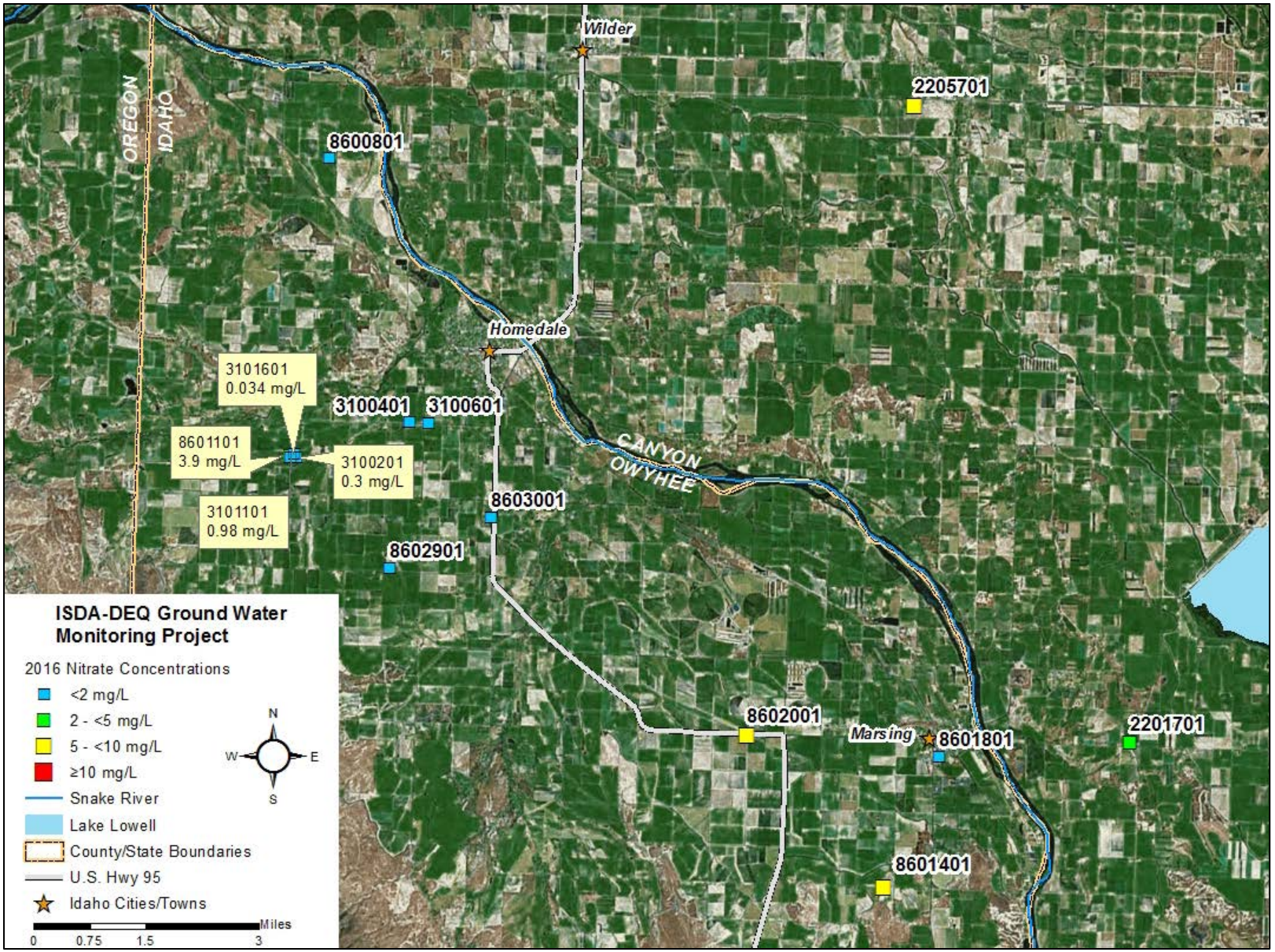


Figure B9. Owyhee County and west Canyon County nitrate concentrations, 2016 ISDA data.

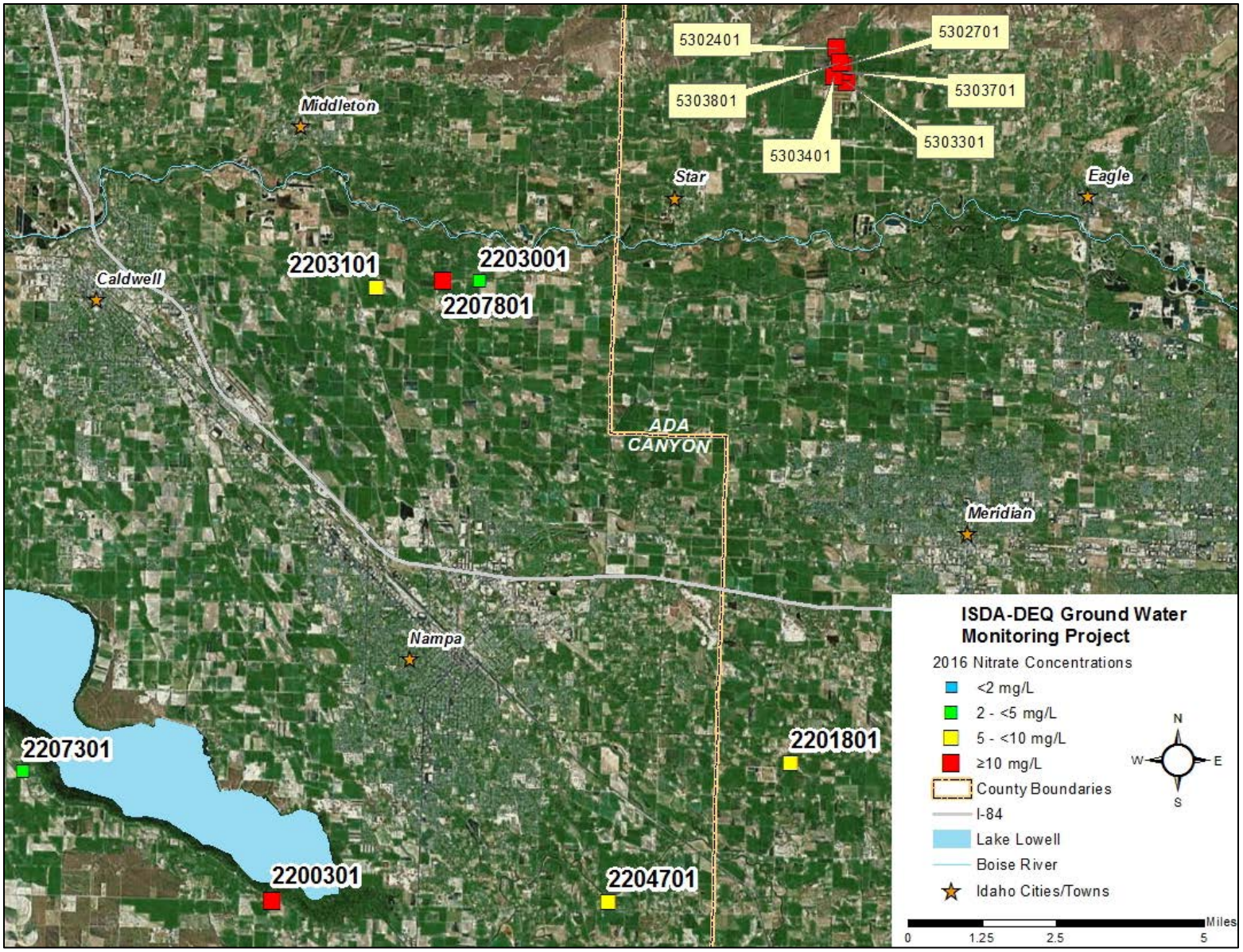


Figure B10. East Canyon County and Ada County nitrate concentrations, 2016 ISDA data.

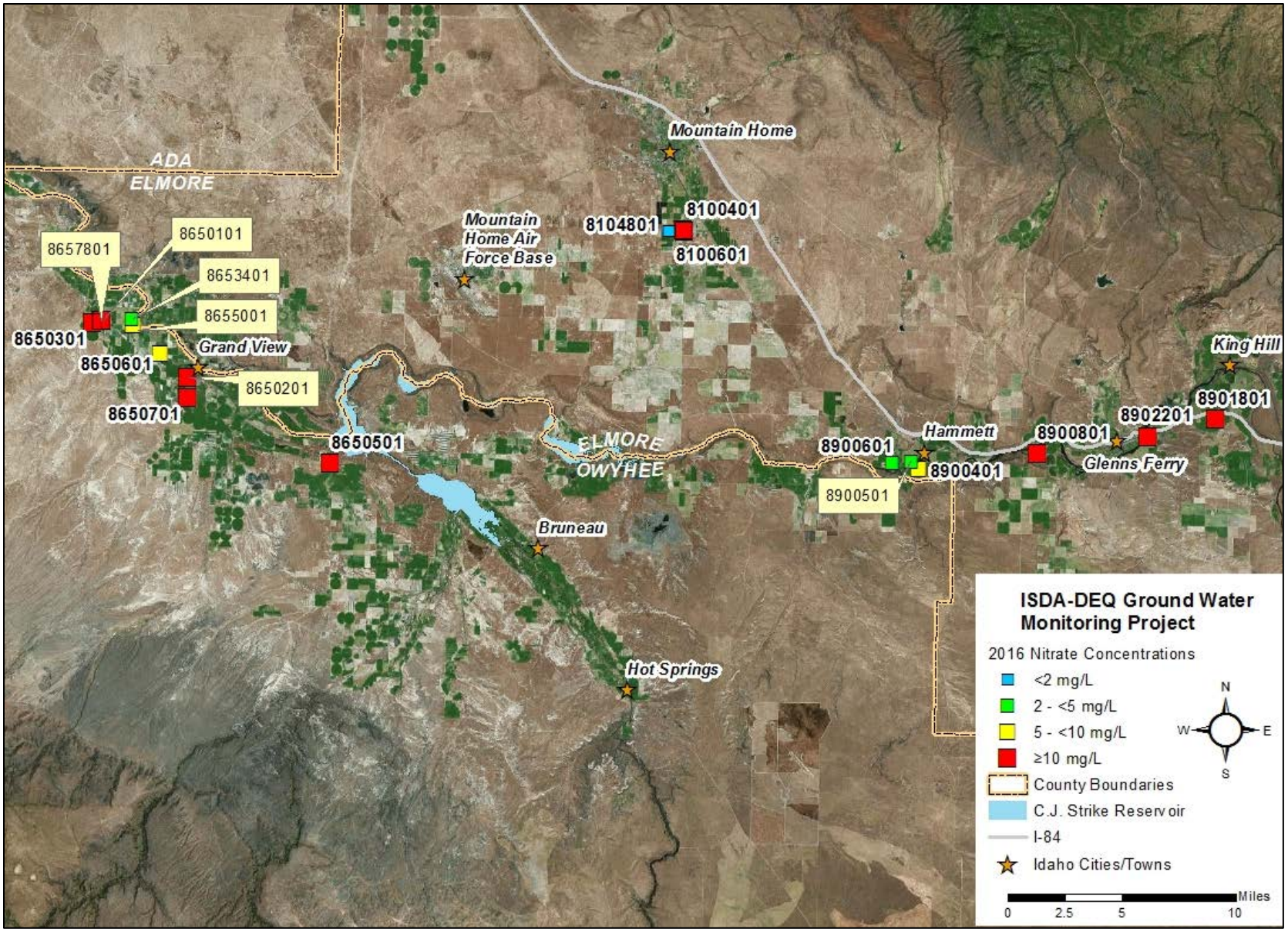


Figure B11. East Owyhee County and Elmore County nitrate concentrations, 2016 ISDA data.

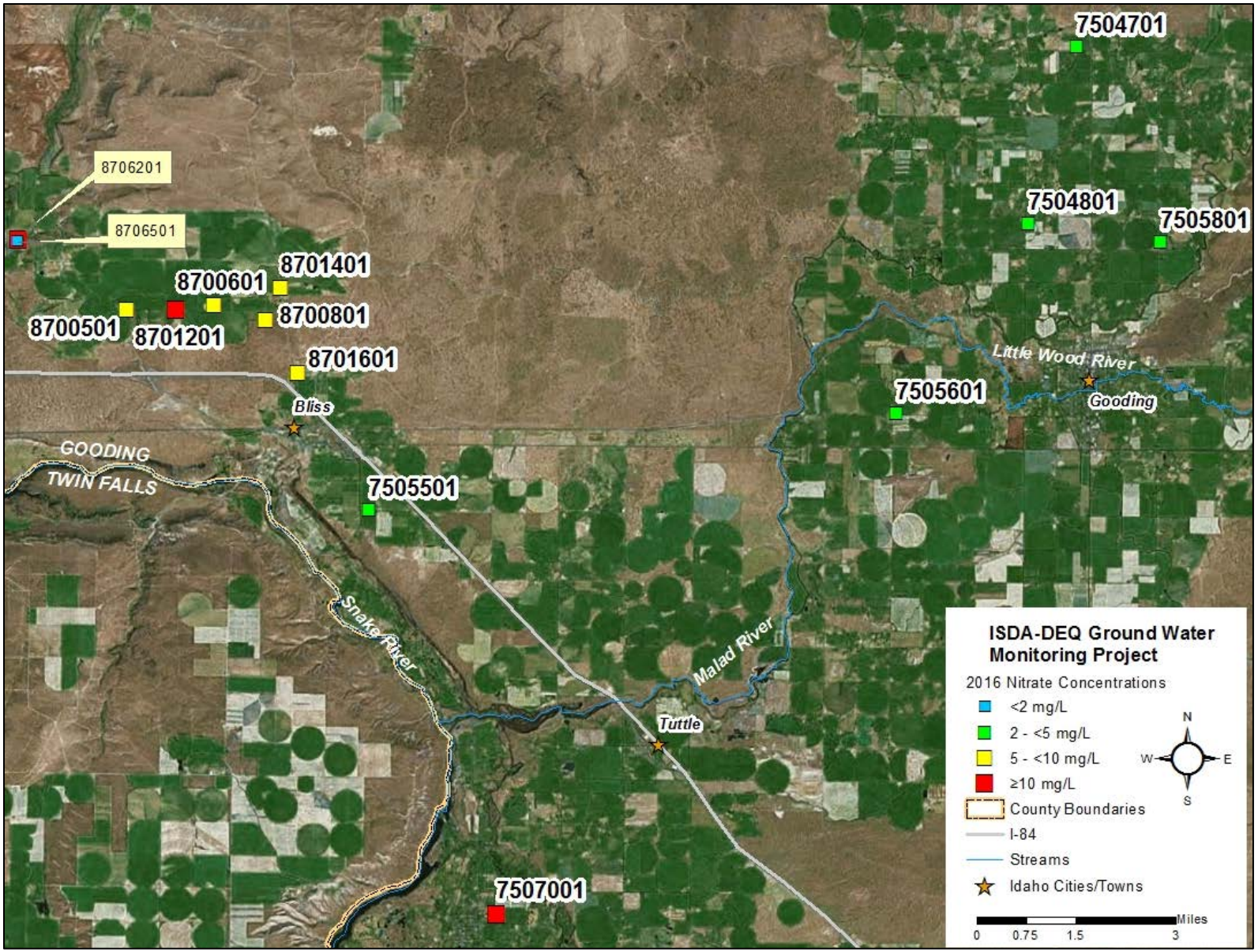


Figure B12. Gooding County nitrate concentrations, 2016 ISDA data.

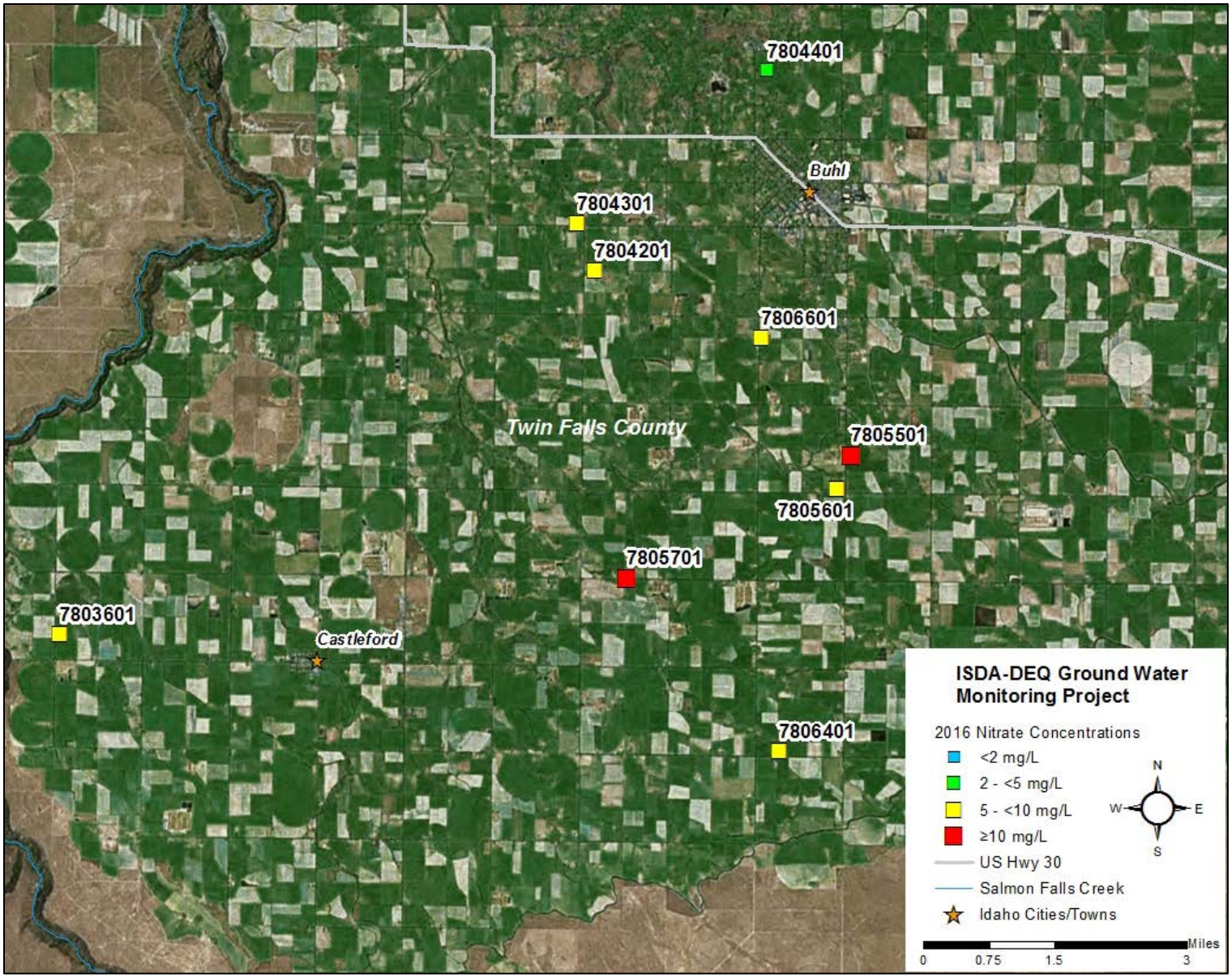


Figure B13. Twin Falls County nitrate concentrations, 2016 ISDA data.

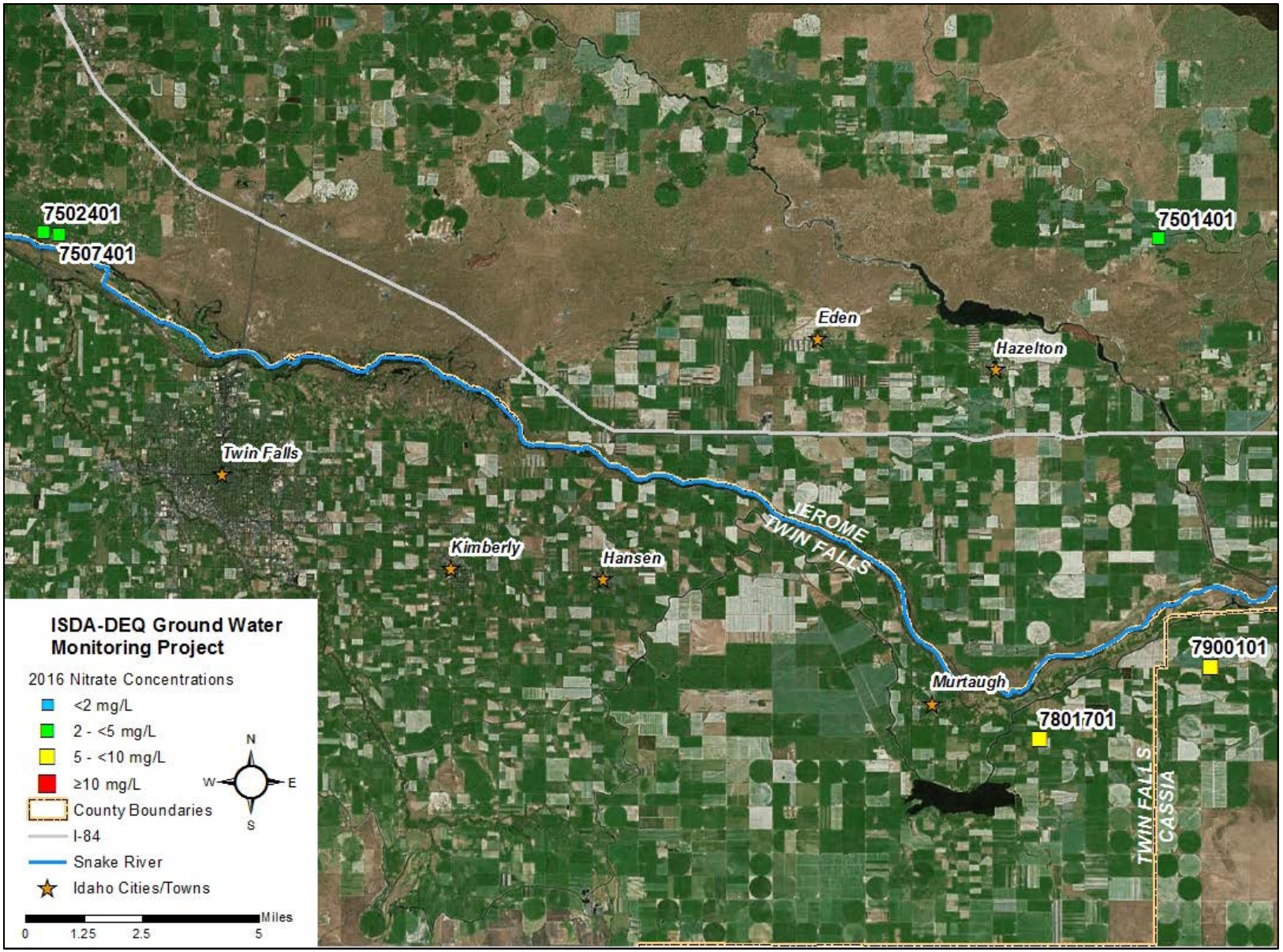


Figure B14. East Twin Falls, Jerome, and Cassia Counties nitrate concentrations, 2016 ISDA data.

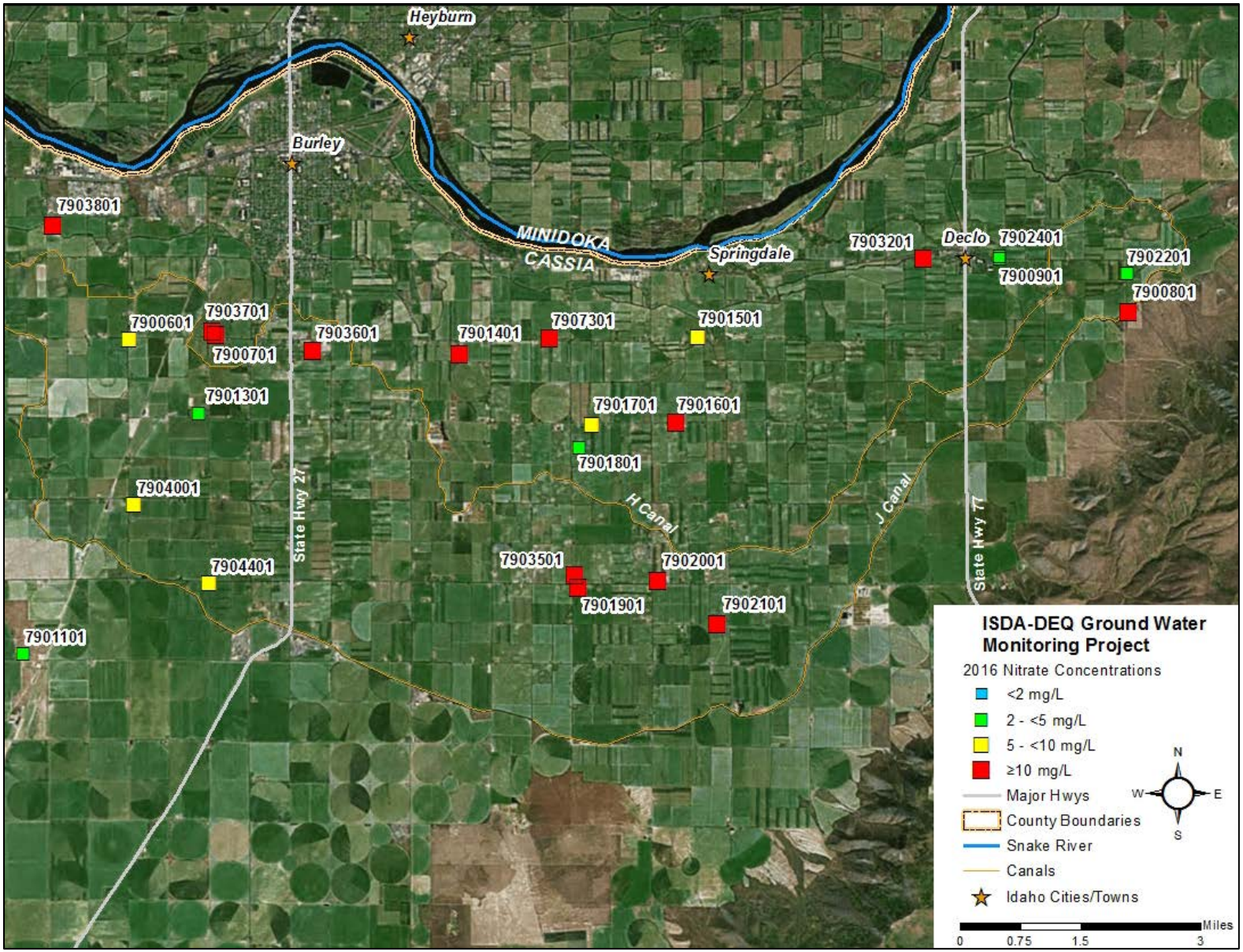


Figure B15. Cassia County nitrate concentrations, 2016 ISDA data.

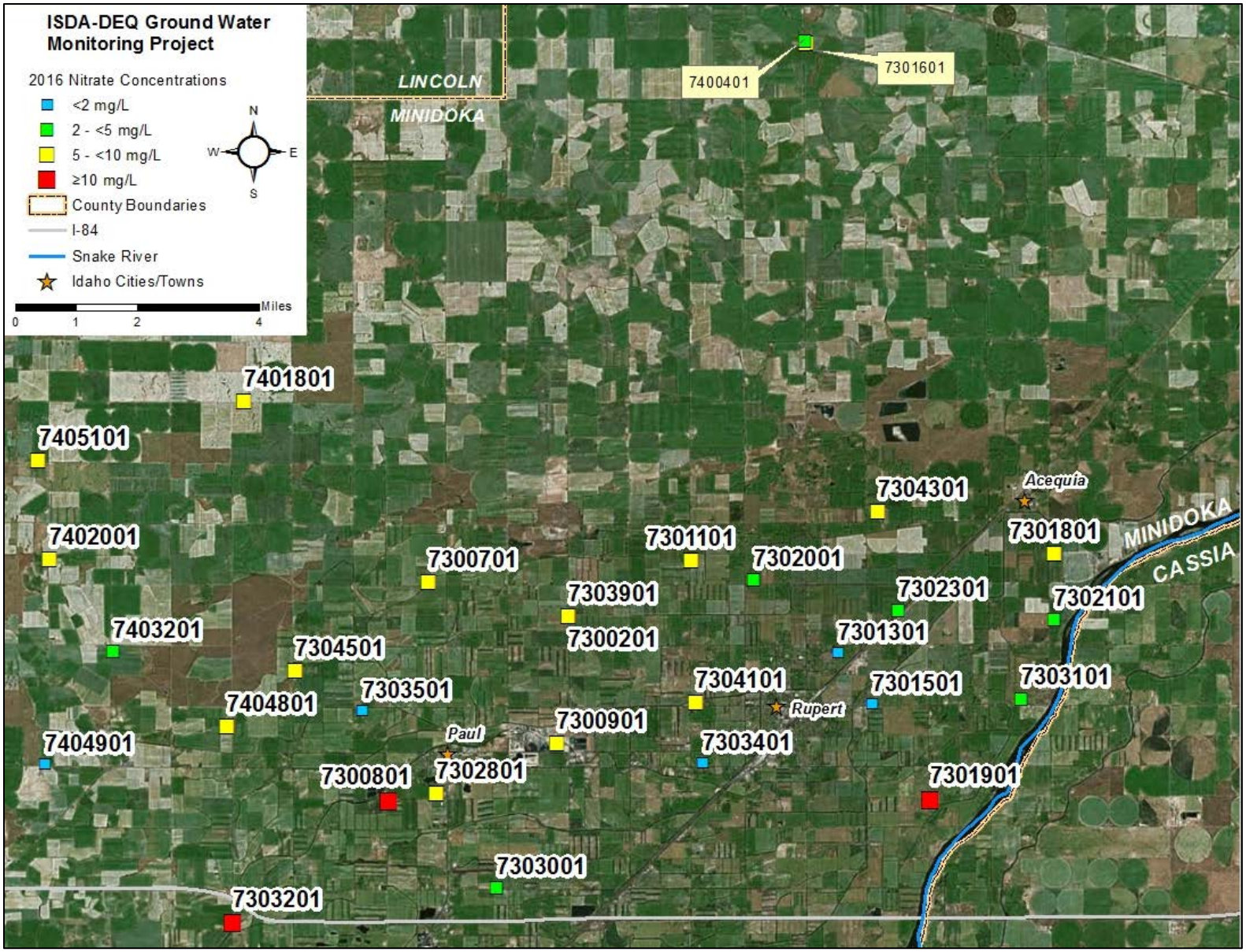


Figure B16. Minidoka County nitrate concentrations, 2016 ISDA data.

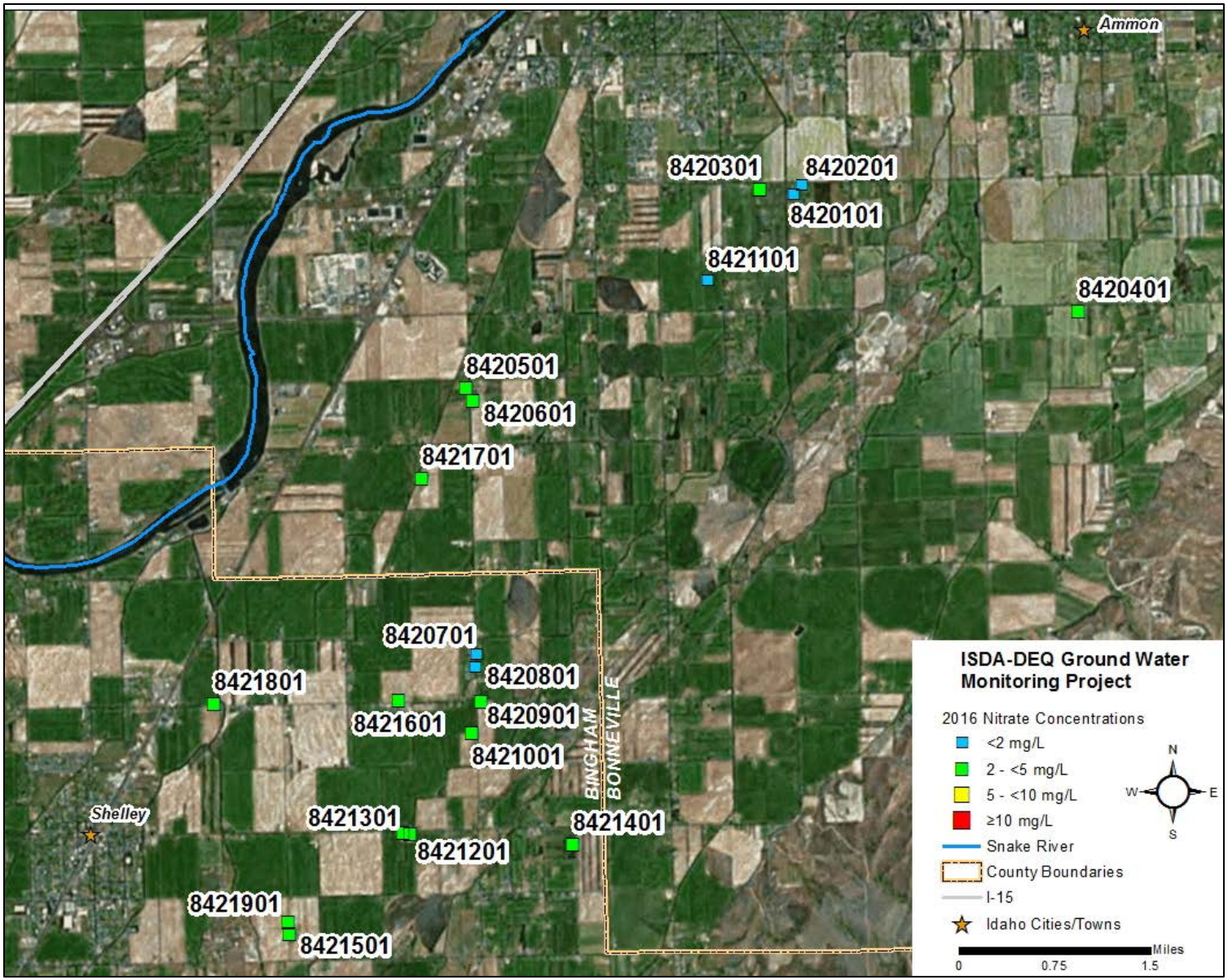


Figure B17. Bingham and Bonneville Counties nitrate concentrations, 2016 ISDA data.

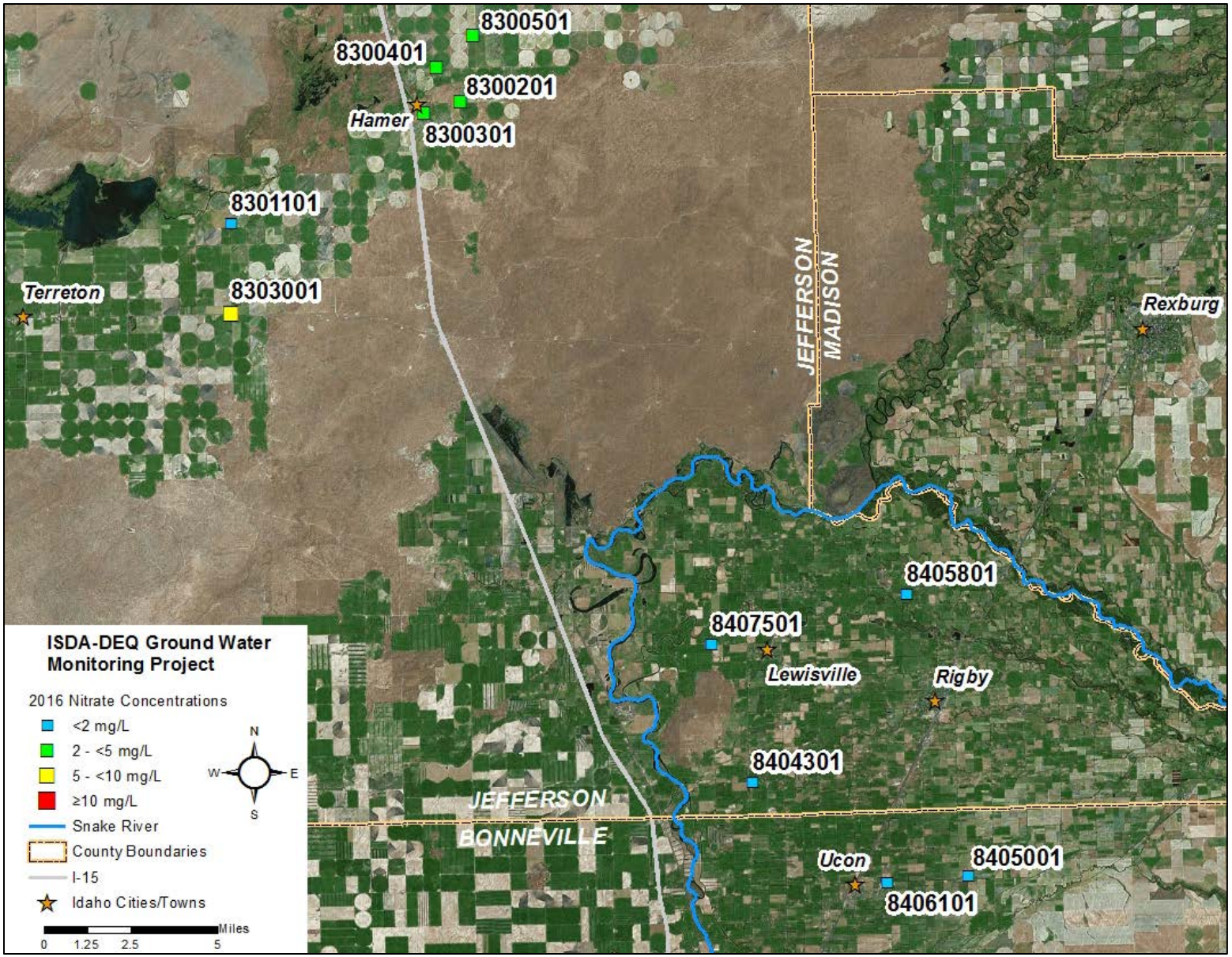


Figure B18. Bonneville and Jefferson Counties nitrate concentrations, 2016 ISDA data.

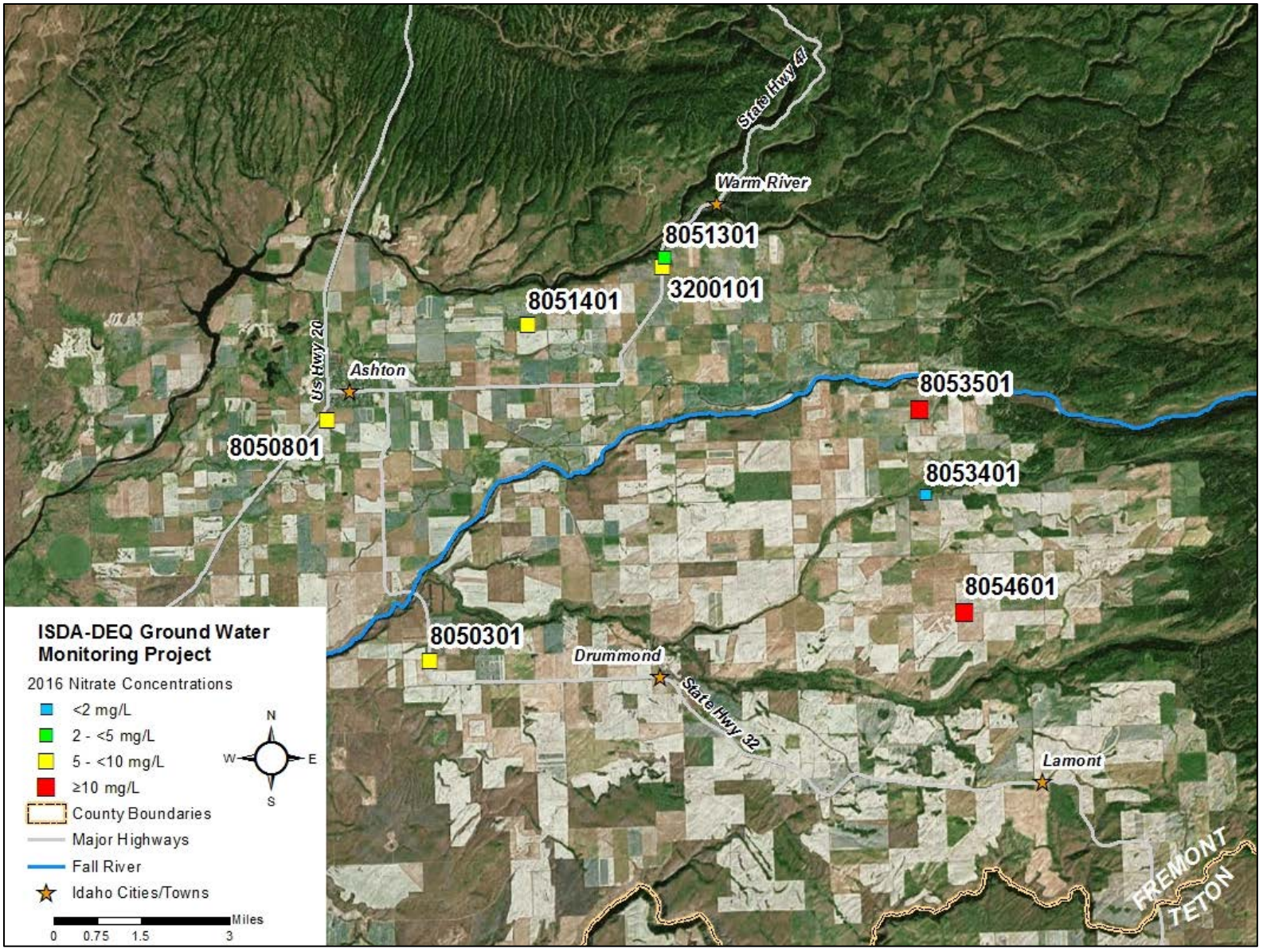


Figure B19. Fremont County nitrate concentrations, 2016 ISDA data.