Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2017

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- Tyler Reed created all figures in Appendix B.

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Acronyms, Abbreviations, and Symbols

°C	degrees Celsius
µg	micrograms
µS	microsiemens
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylene
$CaCO_3$	calcium carbonate
cfu	colony forming unit
cm	centimeter
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
ESRP	Eastern Snake River Plain
FSP	field sampling plan
GWQM	ground water quality management
IBL	Idaho Bureau of Laboratories
IDAPA	refers to citations of Idaho's administrative rules
IDWR	Idaho Department of Water Resources
ISDA	Idaho State Department of Agriculture
L	liter
m+p-Xylene	meta-Xylene plus para-Xylene
MCL	maximum contaminant level
mg	milligram
mL	milliliter
MPN	most probable number
NA	not applicable
ND	nondetect
NPA	nitrate priority area
NPDWR	National Primary Drinking Water Regulation
NSDWR	National Secondary Drinking Water Regulation
o-Xylene	orthoxylene
per mil (‰)	parts per thousand

pCi	picocuries
PWS	public water system
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
TC	total coliform
TDS	total dissolved solids
$\delta^{15}N$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{15}N_{nitrate}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N of the nitrate molecule
$\delta^{18}O$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O
$\delta^{18}O_{nitrate}$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O of the nitrate molecule

1 Introduction

Ground water is a key resource in Idaho—providing drinking water to 95% of Idahoans—and a critical component of the state's economy. The economic and social vitality of 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 US Environmental Protection Agency (EPA) set National Primary Drinking Water Regulations (NPDWRs) as legally enforceable standards, expressed as maximum contaminant levels (MCLs), which apply to PWSs. The established levels protect public health by limiting the amount of contaminants in drinking water. EPA also 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*) bacteria sampling results were compared to the ground water quality standards in Idaho's Ground Water Quality Rule (IDAPA 58.01.11), rather than national regulations. The single samples collected during these projects were not appropriate for comparison to the national standards, which are based on exceedances during a month-long sampling period.

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

Field measurements taken during follow-up investigations and monitoring projects should be considered estimates and not used for determining exceedances of Idaho's ground water quality standards. Field measurements are used to monitor well water during purging and ensure water in the wellbore is removed from the well before sampling, and to qualitatively evaluate water quality variability between wells.

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

34 areas in the state with elevated concentrations of nitrate (as N)[1] in ground water. These NPAs are ranked based on population, water quality, and water quality trends. The basis for an NPA is 25% or more of the wells sampled within the designated area have nitrate concentrations meeting or exceeding 5 milligrams per liter (mg/L). EPA established an MCL for nitrate at 10 mg/L, and Idaho adopted this MCL as the ground water quality standard. The NPAs are reevaluated and reranked approximately every 5 years following the NPA delineation and ranking process (DEQ 2014a).

Prioritization effectively allocates resources for water quality improvement strategies. DEQ worked with state and federal agencies and stakeholders to develop ground water quality improvement plans, (i.e., 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.

DEQ’s Ground Water Program implemented regional ground water monitoring using a statistically based approach to determine the monitoring network design. Most of these regional projects focused on areas designated as NPAs. This report provides an overview of DEQ’s ground water monitoring projects and investigation activities accomplished with public funds during 2017. It does not include results from privately funded activities, including monitoring required by permits, monitoring associated with ongoing environmental remediation projects, Kootenai County Aquifer Protection District funding, or PWS requirements.

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

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

2 Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects conducted by DEQ in calendar year 2017. Projects are presented by DEQ regional office and identified in Figure 1.

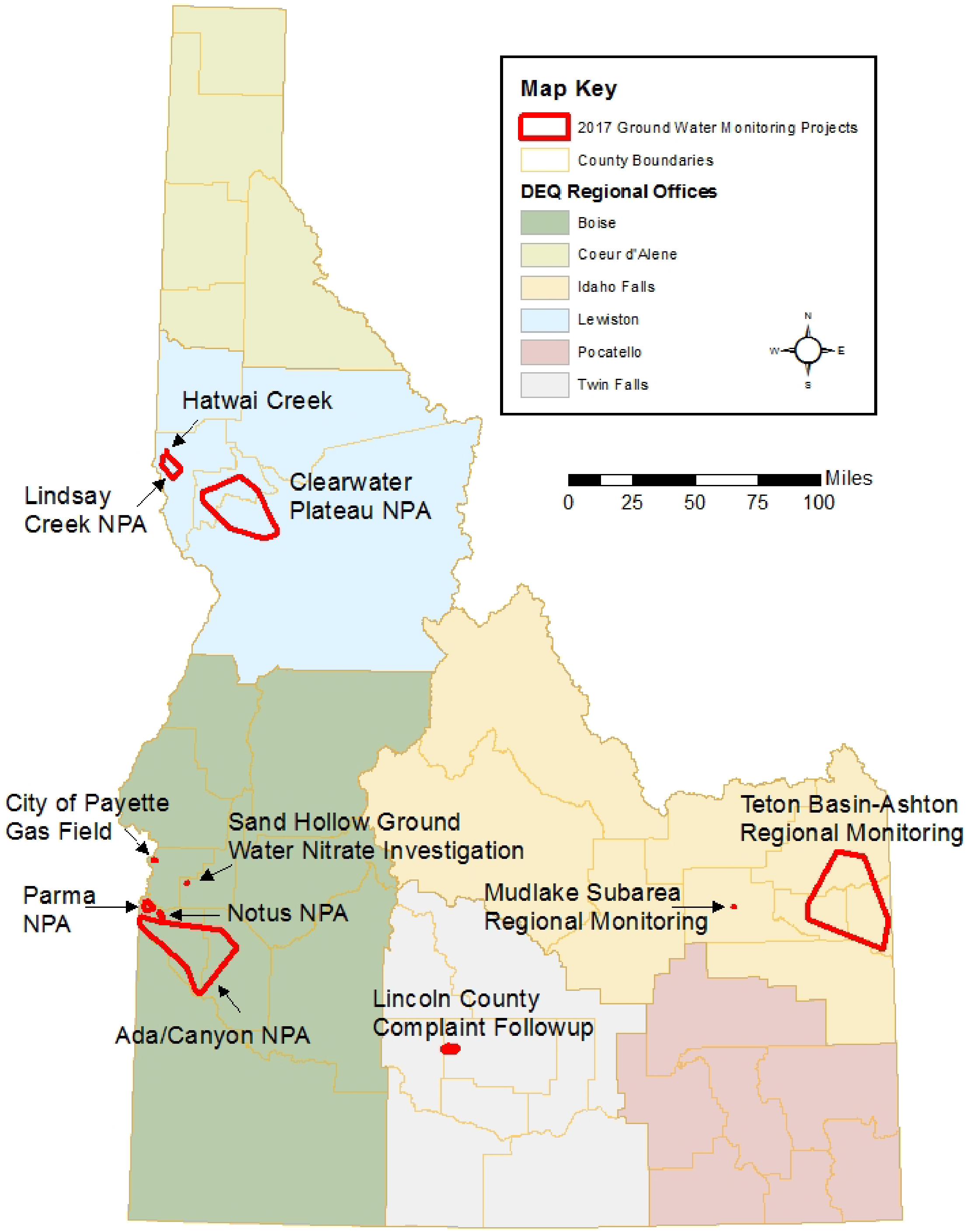

Figure 1. DEQ's 2017 ground water quality project locations by region.

All ground water quality data in this section are provided through an *interactive mapping application* available on DEQ's website. The application contains ground water quality data that DEQ or its contractors collected from 1987 to the present. The application can be used to view and download data 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

Five ground water quality monitoring projects were conducted in the Boise region in 2017 using public funds.

2.1.1 Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project

2.1.1.1 Purpose and Background

The Ada/Canyon NPA monitoring project was sampled in 2017 with existing and newly added wells to determine if the ground water quality in the project area has changed since last monitored in 2012. This regional ground water quality monitoring project was first established in 2012 to collect ground water quality data to evaluate trends in ground water nitrate concentrations in and around the Ada/Canyon NPA (Figure 2). Among the state's 34 NPAs, the Ada/Canyon NPA is ranked 4, with 1 as the most degraded and 34 the least. Figure 2 shows the Ada/Canyon NPAs in western Ada County and eastern Canyon County. The data collected from this effort 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 the wells are distributed across the area and located to accurately represent the area's ground water quality.

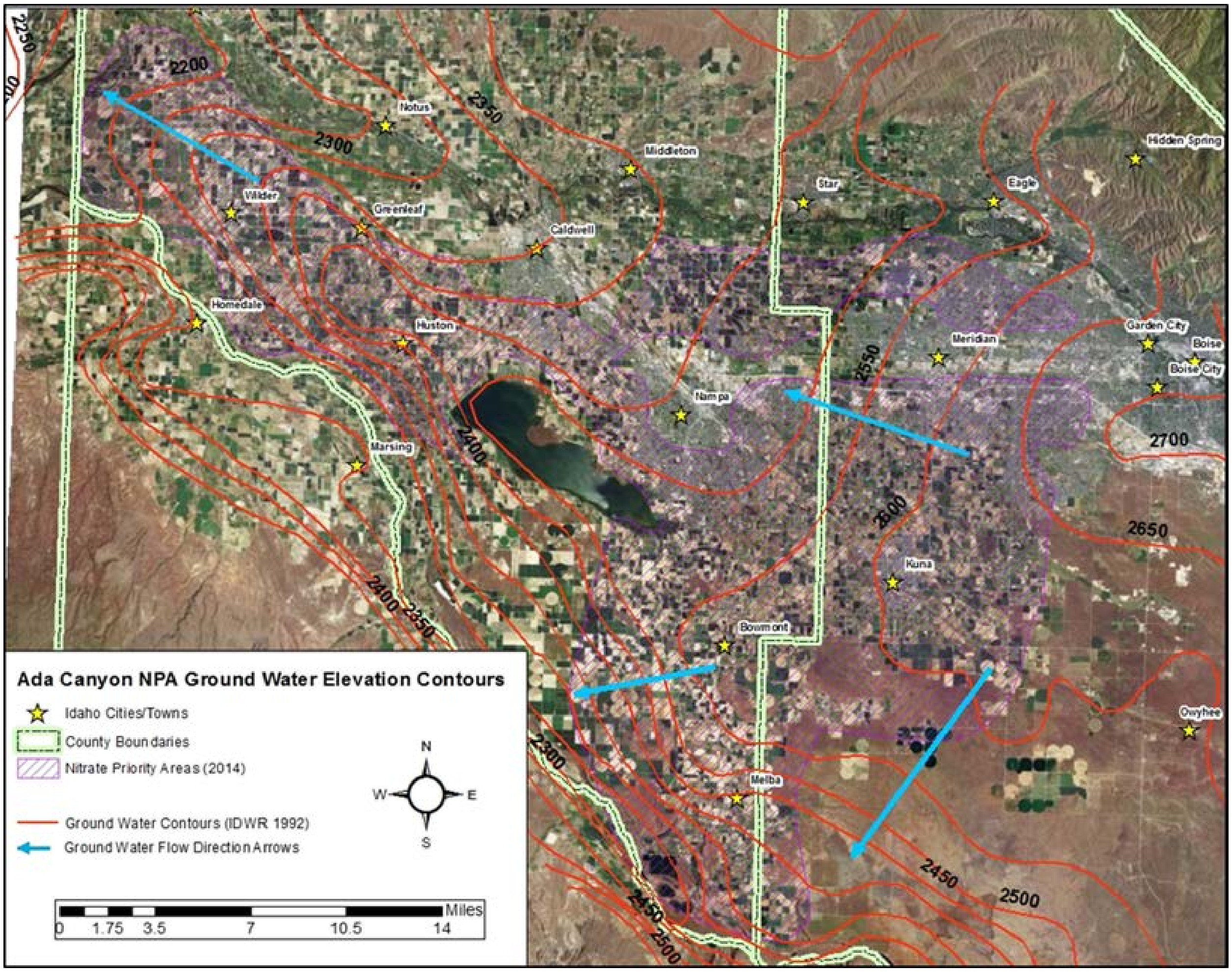

Figure 2. Location of Ada/Canyon NPA and ground water elevation contours—Ada/Canyon NPA Ground Water Monitoring Project.

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

Many wells in the Ada/Canyon NPA draw water from relatively shallow sand and gravel aquifers. A layer of blue clay often underlies these upper aquifers; the clay acts as a barrier to downward ground water movement and separates the shallow aquifers from deeper aquifers located within and below the clay layer (Newton 1991). For both the 2017 and the 2012 Ada/Canyon NPA project, DEQ reviewed IDWR well logs to assess the lithology of the subsurface in the area. The review indicated the blue clay layer is located approximately 25–500 feet below ground surface (bgs) in the Ada/Canyon NPA. Wells selected for sampling were completed at 450 feet deep or less.

2.1.1.2 Methods and Results

In 2017, 123 wells were sampled for the Ada/Canyon NPA ground water quality monitoring project; 23 wells were added to the project during this sampling effort. The wells sampled in 2012 and 2017 were chosen according to the statistical process specified in the regional monitoring network design (DEQ 2011a) and described in the 2012 ground water quality monitoring summary report (DEQ 2014b). A statistical approach, developed for DEQ by Dr. Steinhorst of the University of Idaho, was used to determine the number of samples needed in Stratum 1 (the area of the NPA) and Stratum 2 (a 1-mile wide buffer area surrounding Stratum 1) to ensure the sampling event was statistically valid (Steinhorst 2011). All samples were collected according to the regional quality assurance project plan (QAPP) (DEQ 2017a) and field sampling plan (FSP) (DEQ 2017b). Water quality field parameters (pH, temperature, specific conductivity, and dissolved oxygen [DO]) were measured at each well before collecting samples to ensure adequate purging of the well for a representative sample of the local aquifer (Table 1).

Table 1. Water quality field parameters—Ada/Canyon NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1644	232	09/05/2017	16.39	763	7.35	6.96
1955	60	09/26/2017	15.08	546	7.21	4.19
1956	82	09/26/2017	15.01	376	7.10	2.40
1958	134	09/12/2017	14.49	776	7.39	8.76
1959	140	09/13/2017	15.19	348	7.54	4.00
1960	110	09/05/2017	17.58	754	7.64	3.10
1961	260	09/05/2017	21.07	554	7.97	7.27
1962	300	09/06/2017	16.00	720	7.51	6.79
1964	288	09/06/2017	14.75	389	7.75	6.54
1965	191	09/06/2017	16.19	313	7.83	6.98
1966	147	09/11/2017	17.05	800	7.65	8.19
1968	78	09/12/2017	15.11	561	7.15	7.66
1969	81	09/13/2017	15.16	636	7.25	6.14
1970	115	09/13/2017	15.62	647	7.27	5.39
1971	85	09/11/2017	15.25	605	7.70	8.69
1973	80	09/11/2017	15.11	680	7.65	8.73
1975	80	09/19/2017	14.76	968	7.46	8.24
1976	83	09/13/2017	15.29	686	7.29	4.64
1977	57	09/13/2017	16.14	642	7.17	2.53
1978	102	09/13/2017	16.21	648	7.07	5.56
1981	100	09/20/2017	14.11	757	6.82	3.55
1982	38	09/20/2017	17.96	258	7.58	4.19
1984	80	09/25/2017	15.49	912	7.74	3.82
1985	62	09/25/2017	14.39	256	7.50	5.65
1989	94	10/18/2017	14.87	1110	7.12	3.34
1993	142	10/02/2017	15.39	569	7.47	5.52
1994	61	10/02/2017	14.54	733	7.38	6.04
1995	190	10/03/2017	15.11	525	7.55	7.41
1996	200	10/03/2017	14.33	515	7.43	6.14
1998	70	09/19/2017	15.36	1380	7.25	1.37
2001	440	09/11/2017	22.96	414	7.84	1.03
2005	58	10/04/2017	15.13	625	7.21	2.21

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2006	98	09/27/2017	14.40	1050	6.90	4.85
2007	75	10/04/2017	15.13	698	7.22	2.40
2008	80	09/25/2017	15.46	280	7.76	1.11
2015	80	09/12/2017	15.00	554	7.17	8.70
2016	63	09/12/2017	14.23	655	7.17	9.96
2017	105	09/12/2017	14.33	560	7.24	9.38
2018	137	09/12/2017	14.63	465	7.37	8.25
2019	131	09/12/2017	14.04	549	7.34	9.64
2020	150	10/03/2017	14.91	311	7.74	7.56
2039	70	09/18/2017	13.86	800	6.88	9.91
2042	46	09/19/2017	14.12	1130	7.31	1.80
2043	65	09/13/2017	17.35	744	7.33	4.60
2046	240	10/04/2017	15.30	761	7.28	2.35
2047	75	10/03/2017	14.36	666	7.31	6.17
2049	89	10/04/2017	15.51	491	7.26	2.09
2051	66	10/02/2017	14.56	482	7.44	5.02
2052	78	10/02/2017	14.05	542	7.30	5.70
2053	98	10/02/2017	14.71	752	7.22	5.48
2054	82	09/27/2017	14.55	697	7.03	7.15
2057	84	09/18/2017	15.92	643	7.55	8.45
2058	60	09/18/2017	14.96	1120	7.65	5.97
2061	72	09/19/2017	13.83	861	7.43	8.84
2062	34	09/18/2017	13.09	987	7.22	11.51
2063	41	09/18/2017	14.42	2390	7.49	1.00
2064	423	09/11/2017	24.06	437	8.09	0.98
2067	143	09/25/2017	14.52	568	7.04	6.06
2068	108	09/11/2017	16.68	635	7.62	9.16
2069	155	09/18/2017	17.59	666	7.42	1.27
2071	157	10/03/2017	14.78	787	7.30	6.43
2072	105	09/19/2017	16.15	1020	7.56	1.20
2073	277	09/06/2017	23.53	1460	7.34	1.10
2074	70	09/26/2017	14.39	675	7.16	4.66
2075	60	09/26/2017	14.53	592	7.24	5.95
2076	75	09/25/2017	14.74	517	7.17	5.14
2078	90	09/18/2017	15.30	1190	6.92	8.41
2080	79	09/20/2017	14.76	634	7.34	4.39
2081	160	09/19/2017	17.2	1120	7.33	6.96
2591	116	10/03/2017	13.75	520	7.56	6.94
2611	83	09/19/2017	14.81	924	7.12	0.82
2612	292	09/06/2017	16.10	607	7.56	6.51
2613	61	09/20/2017	18.14	845	7.14	4.75
2614	284	09/05/2017	16.61	647	7.03	8.11
2615	246	09/06/2017	15.55	672	7.43	7.33
2616	80	10/03/2017	14.68	310	6.99	7.13
2618	92	09/05/2017	17.89	732	7.52	7.75
2620	98	09/20/2017	15.14	858	7.47	7.28
2621	96	10/18/2017	14.83	632	7.34	6.64
2622	147	09/27/2017	13.96	401	7.35	8.04
2623	96	10/02/2017	14.58	638	7.53	4.11

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2624	110	09/06/2017	15.63	672	7.61	6.16
2625	40	09/26/2017	19.29	412	7.66	4.19
2626	177	10/03/2017	14.32	729	7.26	6.73
2627	118	09/06/2017	15.32	926	7.45	5.50
2628	318	09/19/2017	19.16	703	7.86	0.98
2629	123	10/03/2017	13.76	553	7.48	8.07
2630	111	10/02/2017	13.22	424	*6.33*	5.94
2631	67	09/20/2017	15.67	857	7.26	6.90
2632	143	09/05/2017	16.75	303	6.91	8.69
2633	135	09/11/2017	16.25	523	7.79	9.23
2634	52	09/18/2017	15.74	695	7.35	7.22
2635	122	09/12/2017	14.57	433	7.38	10.46
2636	95	10/02/2017	13.25	133	*5.73*	1.34
2637	102	09/06/2017	16.02	561	7.71	5.99
2638	74	09/25/2017	16.28	426	8.05	1.64
2639	122	09/05/2017	19.29	650	7.56	6.78
2640	111	09/12/2017	13.56	569	6.94	8.36
2641	62	09/19/2017	14.19	1010	7.95	1.31
2642	63	09/13/2017	15.15	581	7.25	4.54
2643	112	09/11/2017	15.02	786	7.44	9.31
2644	84	09/26/2017	16.81	391	7.60	3.96
2656	80	09/25/2017	15.13	272	7.73	1.78
2657	90	09/18/2017	15.97	1090	7.38	3.41
2658	197	09/18/2017	16.63	385	7.76	9.27
2660	100	09/13/2017	15.21	781	7.08	5.25
2661	97	09/25/2017	18.54	549	7.71	4.60
2662	403	09/11/2017	22.02	552	7.73	1.07
2663	170	09/26/2017	14.75	391	7.29	7.16
2664	225	10/04/2017	15.72	606	7.72	4.77
2665	256	10/04/2017	14.00	449	6.91	2.42
2682	250	09/26/2017	18.47	484	7.52	1.21
2684	65	10/18/2017	14.52	1000	7.39	0.92
2685	300	10/18/2017	16.56	717	7.85	9.93
2686	56	11/07/2017	14.01	343	6.63	1.84
2687	75	11/07/2017	15.49	783	7.38	3.85
2688	240	11/08/2017	15.79	817	7.56	8.45
2690	57	11/08/2017	14.55	1300	7.25	3.11
2691	32	11/08/2017	14.41	752	7.24	2.70
2692	130	11/14/2017	15.42	1270	6.95	3.69
2693	129	11/14/2017	18.94	494	7.14	3.42
2694	90	11/14/2017	16.51	415	7.42	6.36
2704	87	09/08/2017	14.26	1080	7.18	1.49

a. Contaminant with a National Secondary Drinking Water Regulation (NSDWR) standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

The water samples were submitted to Idaho Bureau of Laboratories (IBL) in Boise, Idaho, using procedures outlined in the QAPP and FSP. IBL analyzed the samples for nutrients (nitrate, nitrite [as N][2], and ammonia) and bacteria (TC and *E. coli*).

Wells with a DO less than 2.00 mg/L, as determined by field analysis, were also analyzed for ammonia according to the FSP (DEQ 2017b). 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.

Nutrient Results

Nitrate concentrations ranged from <0.10 to 30.4 mg/L. Nitrate concentrations exceeded the nitrate MCL of 10 mg/L in 19 of the 123 wells sampled. Nitrate concentrations were ≥5 mg/L (one-half the MCL) in 60 of the 123 wells sampled (Table 2).

Figure 3 shows the nitrate concentration results from the 123 wells sampled during the 2017 sampling event.

Table 2. Nutrient and bacteria results—Ada/Canyon NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations			Isotopes	Bacteria[a]	
			Nitrite[b]	Nitrate[b]	Ammonia	$\delta^{15}N$ (‰)	*E. coli*	Total Coliform (TC)
			mg/L				MPN/100 mL	
Water Quality Standard:			1.0	10	No Stand.	No Stand.	<1.0	1.0
1644	232	09/05/2017	<0.30	7.01	—	3.9	<1.0	<1.0
1955	60	09/26/2017	<0.30	2.98	—	—	<1.0	1.0
1956	82	09/26/2017	<0.30	2.34	—	—	<1.0	<1.0
1958	134	09/12/2017	<0.30	6.35	—	5.0	<1.0	<1.0
1959	140	09/13/2017	<0.30	1.33	—	—	<1.0	<1.0
1960	110	09/05/2017	<0.30	3.20	—	—	<1.0	<1.0
1961	260	09/05/2017	<0.30	4.20	—	6.4	<1.0	<1.0
1962	300	09/06/2017	<0.30	**17.6**	—	3.9	<1.0	<1.0
1964	288	09/06/2017	<0.30	2.98	—	—	<1.0	1.0
1965	191	09/06/2017	<0.30	1.56	—	—	<1.0	<1.0
1966	147	09/11/2017	<0.30	**10.9**	—	2.7	<1.0	2.0
1968	78	09/12/2017	<0.30	5.96	—	5.9	<1.0	<1.0
1969	81	09/13/2017	<0.30	5.27	—	5.8	<1.0	<1.0
1970	115	09/13/2017	<0.30	5.73	—	6.2	<1.0	<1.0
1971	85	09/11/2017	<0.30	6.16	—	5.5	<1.0	<1.0
1973	80	09/11/2017	<0.30	6.52	—	6.0	<1.0	13.5
1975	80	09/19/2017	<0.30	**16.8**	—	3.6	<1.0	<1.0
1976	83	09/13/2017	<0.30	6.53	—	7.1	<1.0	<1.0
1977	57	09/13/2017	<0.30	4.52	—	—	<1.0	<1.0
1978	102	09/13/2017	<0.30	**10.5**	—	2.9	<1.0	<1.0
1981	100	09/20/2017	<0.30	7.20	—	6.8	**2.0**	10.8
1982	38	09/20/2017	<0.30	0.287	—	—	<1.0	<1.0

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

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations			Isotopes	Bacteria[a]	
			Nitrite[b]	Nitrate[b]	Ammonia	$\delta^{15}N$ (‰)	*E. coli*	Total Coliform (TC)
			mg/L				MPN/100 mL	
Water Quality Standard:			1.0	10	No Stand.	No Stand.	<1.0	1.0
1984	80	09/25/2017	<0.30	**15.7**	—	3.2	<1.0	<1.0
1985	62	09/25/2017	<0.30	1.82	—	—	<1.0	1.0
1989	94	10/18/2017	<0.30	5.52	—	7.3	<1.0	70.3
1993	142	10/02/2017	<0.30	4.49	—	—	<1.0	<1.0
1994	61	10/02/2017	<0.30	8.55	—	7.2	<1.0	<1.0
1995	190	10/03/2017	<0.30	3.75	—	—	<1.0	<1.0
1996	200	10/03/2017	<0.30	4.36	—	—	<1.0	8.6
1998	70	09/19/2017	<0.30	<0.18	1.4	—	<1.0	<1.0
2001	440	09/11/2017	<0.30	<0.18	0.087	—	<1.0	<1.0
2005	58	10/04/2017	<0.30	2.86	—	—	<1.0	<1.0
2006	98	09/27/2017	<0.30	8.69	—	8.5	<1.0	<1.0
2007	75	10/04/2017	<0.30	3.64	—	—	<1.0	<1.0
2008	80	09/25/2017	<0.30	0.375	<0.010	—	<1.0	<1.0
2015	80	09/12/2017	<0.30	4.67	—	—	<1.0	2.0
2016	63	09/12/2017	<0.30	8.66	—	6.5	<1.0	<1.0
2017	105	09/12/2017	<0.30	5.90	—	5.7	<1.0	3.1
2018	137	09/12/2017	<0.30	2.31	—	—	<1.0	<1.0
2019	131	09/12/2017	<0.30	3.89	—	—	<1.0	<1.0
2020	150	10/03/2017	<0.30	1.11	—	—	<1.0	<1.0
2039	70	09/18/2017	<0.30	5.91	—	4.5	<1.0	<1.0
2042	46	09/19/2017	<0.30	**30.4**	<0.010	5.7	<1.0	<1.0
2043	65	09/13/2017	<0.30	5.32	—	5.1	<1.0	<1.0
2046	240	10/04/2017	<0.30	4.02	—	—	<1.0	<1.0
2047	75	10/03/2017	<0.30	4.44	—	—	<1.0	24.6
2049	89	10/04/2017	<0.30	2.50	—	—	<1.0	<1.0
2051	66	10/02/2017	<0.30	5.15	—	6.8	<1.0	<1.0
2052	78	10/02/2017	<0.30	3.23	—	—	<1.0	<1.0
2053	98	10/02/2017	<0.30	4.98	—	—	<1.0	<1.0
2054	82	09/27/2017	<0.30	6.28	—	9.1	<1.0	<1.0
2057	84	09/18/2017	<0.30	4.68	—	—	<1.0	<1.0
2058	60	09/18/2017	<0.30	**17.3**	—	3.8	<1.0	<1.0
2061	72	09/19/2017	<0.30	**29.4**		3.4	<1.0	<1.0
2062	34	09/18/2017	<0.30	**21.3**	—	2.2	<1.0	3.1
2063	41	09/18/2017	<0.30	**23.6**	<0.010	6.8	<1.0	1.0
2064	423	09/11/2017	<0.30	<0.18	0.090	—	<1.0	<1.0
2067	143	09/25/2017	<0.30	6.46	—	3.9	<1.0	<1.0
2068	108	09/11/2017	<0.30	5.50	—	5.8	<1.0	16.8
2069	155	09/18/2017	<0.30	<0.18	1.1	—	<1.0	34.1
2071	157	10/03/2017	<0.30	4.57	—	—	<1.0	1.0
2072	105	09/19/2017	<0.30	<0.18	2.9	—	<1.0	<1.0
2073	277	09/06/2017	<0.30	3.44	<0.010	—	<1.0	<1.0
2074	70	09/26/2017	<0.30	5.71	—	7.1	<1.0	<1.0
2075	60	09/26/2017	<0.30	3.99	—	—	<1.0	2.0
2076	75	09/25/2017	<0.30	2.42	—	—	<1.0	<1.0
2078	90	09/18/2017	<0.30	7.74	—	4.6	<1.0	<1.0
2080	79	09/20/2017	<0.30	6.50	—	4.1	<1.0	1.0
2081	160	09/19/2017	<0.30	**17.0**	—	4.9	<1.0	4.1

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations			Isotopes	Bacteria[a]	
			Nitrite[b]	Nitrate[b]	Ammonia	$\delta^{15}N$ (‰)	*E. coli*	Total Coliform (TC)
			mg/L				MPN/100 mL	
Water Quality Standard:			1.0	10	No Stand.	No Stand.	<1.0	1.0
2591	116	10/03/2017	<0.30	7.30	—	11.5	<1.0	3.1
2611	83	09/19/2017	<0.30	1.78	<0.010	—	<1.0	<1.0
2612	292	09/06/2017	<0.30	9.19	—	4.3	<1.0	<1.0
2613	61	09/20/2017	<0.30	7.04	—	5.6	<1.0	<1.0
2614	284	09/05/2017	<0.30	**10.7**	—	3.2	<1.0	83.6
2615	246	09/06/2017	<0.30	9.56	—	3.9	<1.0	1.0
2616	80	10/03/2017	<0.30	1.79	—	—	<1.0	<1.0
2618	92	09/05/2017	<0.30	8.10	—	5.3	<1.0	<1.0
2620	98	09/20/2017	<0.30	9.03	—	4.2	<1.0	<1.0
2621	96	10/18/2017	<0.30	4.87	—	—	<1.0	<1.0
2622	147	09/27/2017	<0.30	1.88	—	—	<1.0	<1.0
2623	96	10/02/2017	<0.30	3.68	—	—	<1.0	2.0
2624	110	09/06/2017	<0.30	6.97	—	5.6	<1.0	<1.0
2625	40	09/26/2017	<0.30	1.32	—	—	<1.0	<1.0
2626	177	10/03/2017	<0.30	5.08	—	7.8	<1.0	<1.0
2627	118	09/06/2017	<0.30	**12.0**	—	4.2	<1.0	<1.0
2628	318	09/19/2017	<0.30	<0.18	2.6	—	<1.0	<1.0
2629	123	10/03/2017	<0.30	4.68	—	—	<1.0	2.0
2630	111	10/02/2017	<0.30	2.18	—	—	<1.0	<1.0
2631	67	09/20/2017	<0.30	9.14	—	4.4	<1.0	<1.0
2632	143	09/05/2017	<0.30	6.09	—	5.3	<1.0	<1.0
2633	135	09/11/2017	<0.30	1.91	—	—	<1.0	<1.0
2634	52	09/18/2017	<0.30	4.62	—	—	<1.0	<1.0
2635	122	09/12/2017	<0.30	3.34	—	—	<1.0	2.0
2636	95	10/02/2017	<0.30	<0.18	<0.010	—	<1.0	<1.0
2637	102	09/06/2017	<0.30	5.32	—	5.9	<1.0	<1.0
2638	74	09/25/2017	<0.30	3.39	<0.010	—	<1.0	<1.0
2639	122	09/05/2017	<0.30	5.17	—	6.0	<1.0	<1.0
2640	111	09/12/2017	<0.30	6.28	—	6.1	<1.0	<1.0
2641	62	09/19/2017	<0.30	<0.18	3.8	—	<1.0	<1.0
2642	63	09/13/2017	<0.30	4.54	—	—	<1.0	65.7
2643	112	09/11/2017	<0.30	**11.8**	—	3.4	<1.0	<1.0
2644	84	09/26/2017	<0.30	0.813	—	—	<1.0	<1.0
2656	80	09/25/2017	<0.30	0.358	—	—	<1.0	<1.0
2657	90	09/18/2017	<0.30	**12.0**	—	7.4	<1.0	<1.0
2658	197	09/18/2017	<0.30	1.19	—	—	<1.0	<1.0
2660	100	09/13/2017	<0.30	**10.9**	—	7.5	<1.0	<1.0
2661	97	09/25/2017	<0.30	2.48	—	—	<1.0	<1.0
2662	403	09/11/2017	<0.30	<0.18	0.28	—	<1.0	<1.0
2663	170	09/26/2017	<0.30	2.02	—	—	<1.0	<1.0
2664	225	10/04/2017	<0.30	7.68	—	5.0	<1.0	<1.0
2665	256	10/04/2017	<0.30	2.24	—	—	<1.0	<1.0
2682	250	09/26/2017	<0.30	0.18	0.42	—	<1.0	<1.0
2684	65	10/18/2017	<0.30	<0.18	0.47	—	<1.0	<1.0
2685	300	10/18/2017	<0.30	3.56	—	—	<1.0	<1.0
2686	56	11/07/2017	<0.30	5.71	<0.010	10.5	<1.0	<1.0
2687	75	11/07/2017	<0.30	**13.8**	—	3.4	<1.0	<1.0

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentrations			Isotopes	Bacteria[a]	
			Nitrite[b]	Nitrate[b]	Ammonia	δ^{15}N (‰)	*E. coli*	Total Coliform (TC)
			mg/L				MPN/100 mL	
Water Quality Standard:			1.0	10	No Stand.	No Stand.	<1.0	1.0
2688	240	11/08/2017	<0.30	8.81	—	5.2	<1.0	<1.0
2690	57	11/08/2017	<0.30	7.20	<0.020	4.5	<1.0	<1.0
2691	32	11/08/2017	<0.30	6.77	<0.020	2.0	<1.0	<1.0
2692	130	11/14/2017	<0.30	**12.1**	—	6.2	<1.0	<1.0
2693	129	11/14/2017	<0.30	0.915	0.011	—	<1.0	<1.0
2694	90	11/14/2017	<0.30	1.55	—	—	<1.0	<1.0
2704	87	09/08/2017	<0.30	**25.5**	<0.020	4.2	<1.0	<1.0

a. TC and *E. coli* standards are in IDAPA 58.01.11.200. An exceedance of the primary ground water quality standard for TC (indicated by gray shaded numbers) do not violate 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 unit per 100 milliliters (cfu/100 mL), analytical results in most probable number (MPN)/100 mL are acceptable for comparison to the standard.
b. Contaminant with a NPDWR standard.
Notes: ‰ = permil; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded red numbers indicate either an EPA NPDWR standard, expressed as an MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

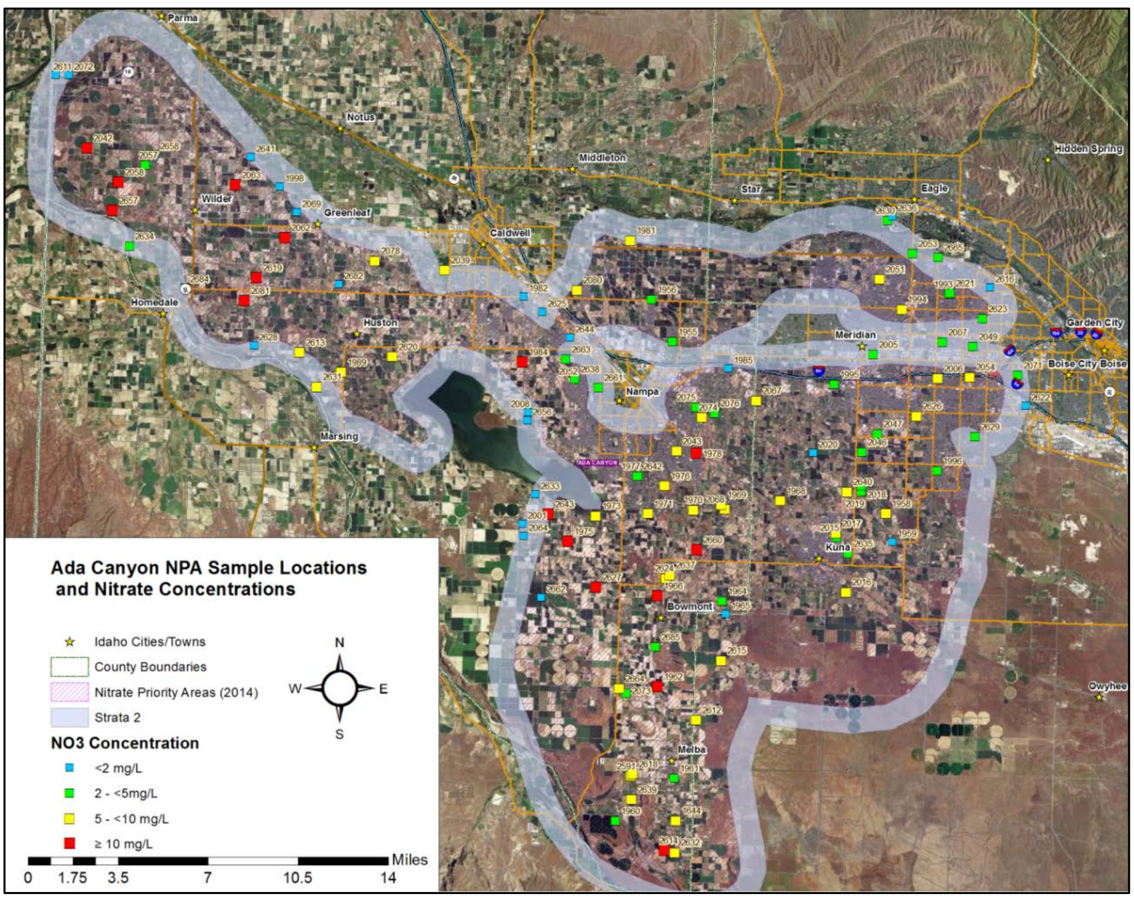

Figure 3. Sample locations and nitrate concentrations—Ada/Canyon NPA Ground Water Monitoring Project.

When compared to the sample results from the 2012 sampling event, a mix of increases and decreases in nitrate concentrations were present throughout the Ada/Canyon NPA; however, the area west and northwest of Caldwell, near Wilder and Greenleaf, experienced only increased concentrations of nitrate (Figure 4). The northeast portion of the Ada/Canyon NPA had mostly decreases in nitrate, while the central east portions of the NPA showed more of a mix of both increases and decreases.

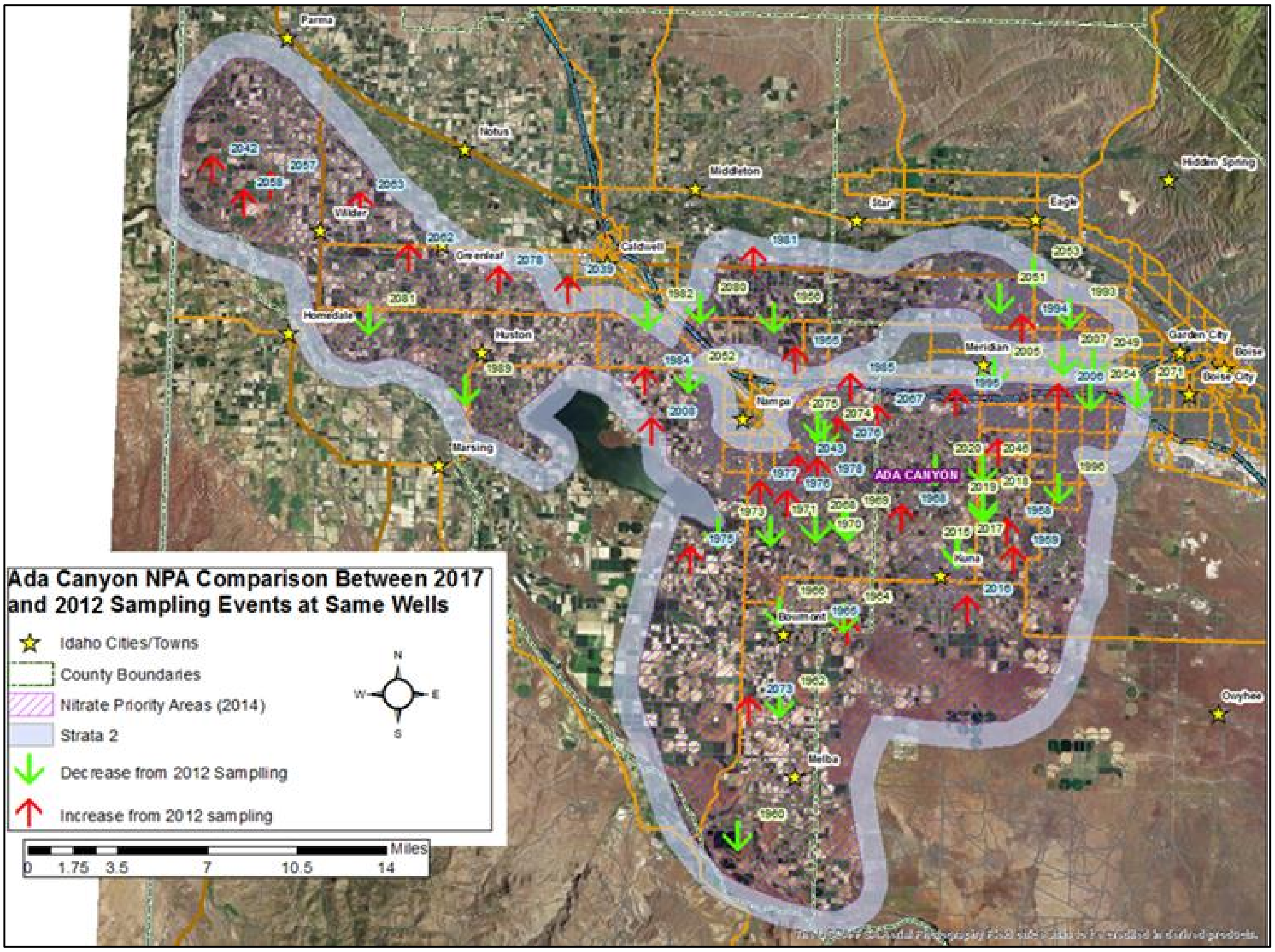

Figure 4. Change in nitrate concentrations—Ada/Canyon NPA Ground Water Monitoring Project.

Of the 123 wells sampled, 22 were analyzed for ammonia based on low concentrations of DO, as ammonia will oxidize to nitrate in the presence of oxygen. The ammonia results ranged from nondetect (less than 0.10 mg/L) to 3.8 mg/L. These concentrations are similar to the results found in the 22 wells sampled for ammonia in the 2012 sampling effort. Ammonia in ground water is often associated with impacts from sewage systems, livestock wastes, or nitrogen fertilizers. There is no MCL or NSDWR standard for ammonia in ground water.

Bacteria Results

Of the 123 wells, 25 had positive detections of TC bacteria. The concentrations ranged from 1.0 to 83.6 MPN/100 mL. *E. coli* was detected at a concentration of 2.0 MPN/100 mL in Well 1981 (Table 2).

Nitrogen Isotope Results

Nitrogen isotope ratios were determined for 61 samples, all of which had nitrate concentrations greater than or equal to 5 mg/L (Table 2). The nitrogen isotope ratio ($\delta^{15}N$) is calculated from the ratio between two stable isotopes of nitrogen, $\delta^{15}N$ and $\delta^{14}N$, in a sample and the 15N and 14N ratio of a reference standard. The $\delta^{15}N$ values are reported as per mil (‰; parts per thousand). The $\delta^{15}N$ value is used to assess the likely dominant source of the nitrogen in a sample, with lower $\delta^{15}N$ values generally indicating organic nitrogen in soil (+4 to +9‰) and/or fertilizer-sourced nitrogen (-4 to +4‰), with higher $\delta^{15}N$ values (greater than +9‰) indicating nitrogen from animal or human waste (Seiler 1996; Table 3).

The $\delta^{15}N$ results from this project ranged from 2.0‰ to 11.5‰ (Table 2). A total of 15 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 (Seiler 1996). A total of 43 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 (Seiler 1996). Wells 2054, 2591, and 2686 had a $\delta^{15}N$ ratio greater than 9‰, which is typical for animal or human waste (Seiler 1996). These isotope ratios are similar to the results from the 2012 sampling effort except for the four wells with ratios greater than 9‰; in 2012 the highest ratio recorded was 8.9‰ at Well 2042 (DEQ 2014b), which was 5.7‰ in 2017.

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

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

Source: Seiler 1996

Nitrogen isotopes can be used with other water quality data and land-use information to better determine sources of nitrogen in ground water. However, nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, and plant uptake) (Kendall and McDonnell 1998). Mixing sources with variable nitrogen isotope values along shallow ground water flow paths makes determining the sources and extent of denitrification very difficult for intermediate $\delta^{15}N$ values (Kendall and McDonnell 1998). 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 commercial fertilizers or mixed nitrogen sources, which is supported by the $\delta^{15}N$ values detected. Wells 2054, 2592, and 2686 are located in residential areas which are, or were previously served by septic systems.

2.1.1.3 Conclusions

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

Nitrate was detected at a concentration of 5 mg/L or greater in approximately half (49%) of the samples. Nitrate was detected at a concentration equal to or greater than the MCL of 10 mg/L in 19 samples (15%).

The results of the nitrate isotope analyses indicated the nitrate source for the majority of samples with nitrate concentrations of 5 mg/L or greater was from fertilizer or a mixed source (organic source and/or fertilizer). The results of the nitrate isotope analyses indicated that the 19 elevated nitrate concentrations were not from a human or animal waste source; 11 were associated with an inorganic fertilizer source, and 8 were associated with a mixed source.

Bacterial contamination is not widespread within the NPA and is likely a result of local sources and/or well construction and maintenance issues. Samples were not analyzed for arsenic during this event, so no comparison with the 2012 data was made.

2.1.1.4 Recommendations

DEQ plans to take additional samples in the Arena Lake Drain Area near Parma and Wilder to determine if irrigation water may be impacting the shallow wells. Results from this effort will be reported in the 2018 summary report.

2.1.2 Notus Nitrate Priority Area Ground Water Monitoring Project

2.1.2.1 Purpose and Background

The Notus NPA monitoring project was sampled in 2017 with existing and newly added wells to determine if the ground water quality in the project area has changed since last monitored in 2012. This regional ground water quality monitoring project was first established in 2012 to collect ground water quality data to evaluate trends in ground water nitrate concentrations in and around the Notus NPA (DEQ 2014b). Among the state’s 34 NPAs, the Notus NPA is ranked 23, with 1 as 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 regional monitoring network design (DEQ 2011a). 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 the wells are distributed across the area and located accurately to represent the area’s ground water quality.

Many wells in the Notus NPA draw water from relatively shallow sand and gravel aquifers. A layer of blue clay often underlies these upper aquifers; the clay acts as a barrier to downward ground water movement and separates the shallow aquifers from deeper aquifers located within and below the clay layer (Newton 1991). DEQ reviewed the project area well logs from IDWR’s database and determined a blue clay layer is located approximately 25 to 600 feet bgs. The clay layer can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. Well depths for wells selected for sampling ranged from 60 to

496 feet bgs in an effort to collect samples from the uppermost aquifer. The regional ground water flow direction is to the southwest (Figure 5).

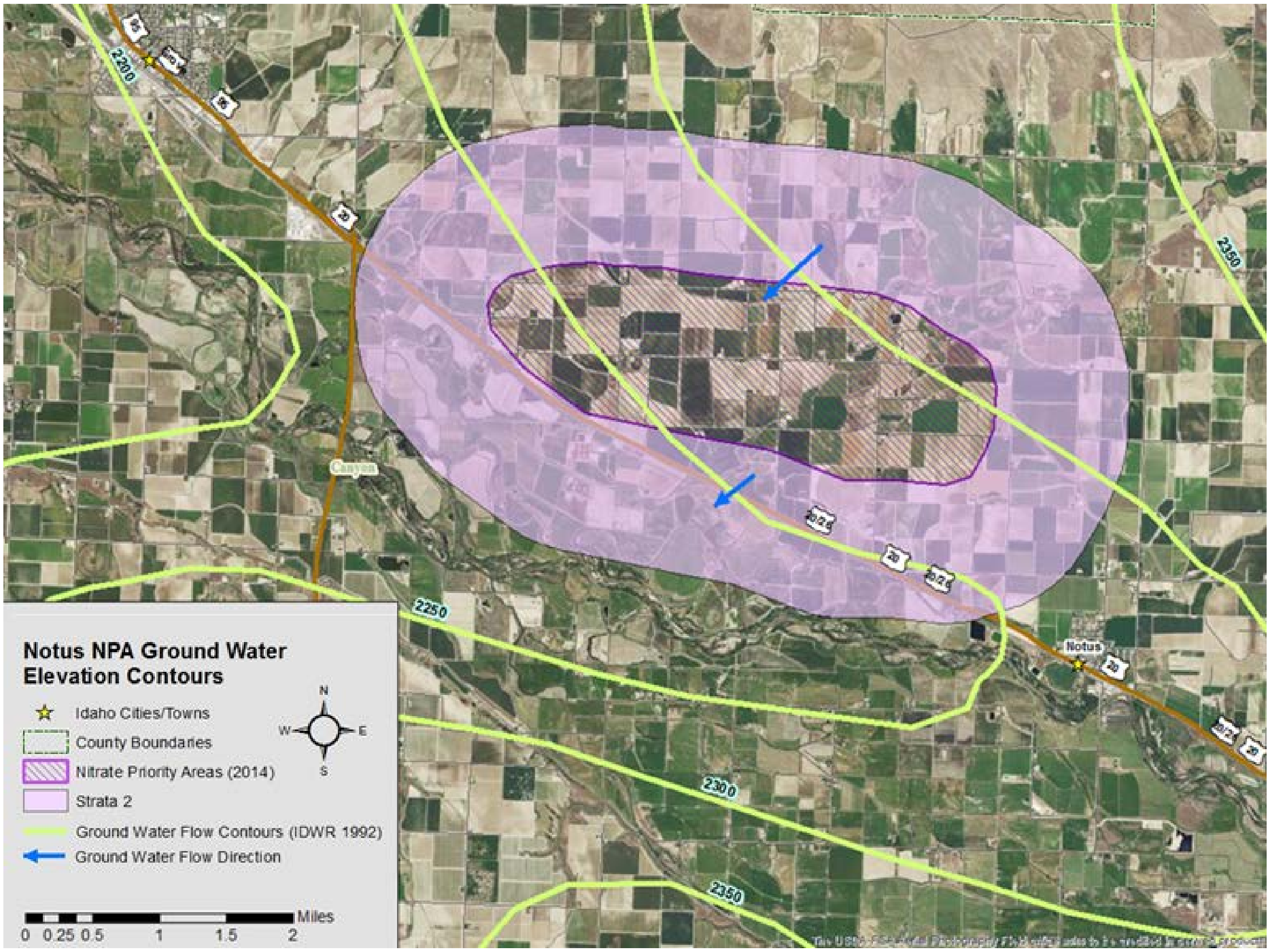

Figure 5. Ground water elevation contours—Notus NPA Ground Water Monitoring Project.

2.1.2.2 Methods and Results

In April 2017, DEQ collected ground water samples from seven private domestic wells located within the Notus NPA. The four wells that were part of the 2012 sampling are Wells 1860, 1862, 1864, and 1917 (Figure 6). The wells selected for the 2012 and 2017 sampling efforts were selected using the procedures outlined in the regional QAPP (DEQ 2017a). Program objectives, design, and well selection processes are identified in the regional monitoring network design (DEQ 2011a) and included the Steinhort (2011) statistical approach for determining the number of wells in Stratum 1 and Stratum 2. The original well selection process is explained in the 2012 summary report (DEQ 2014b).

All samples were collected according to the regional QAPP (DEQ 2017a) and FSP (DEQ 2017c). 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 4).

Table 4. Water quality field parameters—Notus NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1860	63	04/17/2017	14.46	770	7.55	6.79
1862	60	04/17/2017	15.02	620	7.51	6.26
1864	67	04/17/2017	14.78	916	7.04	3.92
1917	496	04/17/2017	22.24	353	7.37	1.76
2514	135	04/17/2017	15.52	567	8.03	0.76
2522	98	04/17/2017	15.13	875	7.85	6.18
2525	125	04/17/2017	14.05	671	7.69	8.05

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: bgs = below ground surface; °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter

Samples were collected for nutrients (ammonia, nitrate, and nitrite) and bacteria (TC and *E. coli*). All samples were submitted for analysis to the IBL in Boise. Wells with a DO less than 2.00 mg/L, as determined by field analysis, were also analyzed for ammonia according to the FSP (DEQ 2017c). 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 5).

Nutrient Results

The reported nitrate concentrations ranged from <0.18 to 14.9 mg/L; five of seven 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. Four of the wells exceeded the nitrate MCL (Table 5). The spatial distribution of nitrate concentrations is shown in Figure 6.

Wells 1917 and 2514 were sampled for ammonia due to low DO concentrations at the time of sampling (Table 5). The reported ammonia concentrations were 0.13 to 2.3 m/L (Table 5). There is currently no drinking water standard for ammonia.

Table 5. Inorganic results—Notus NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration: Nitrite[a] (mg/L)	Nutrient Concentration: Nitrate[a] (mg/L)	Nutrient Concentration: Ammonia (mg/L)	Isotopes: $\delta^{15}N$ (‰)
Water Quality Standard:			1.0	10	No Stand.	No Stand.
1860	63	04/17/2017	<0.30J	**12.1J**	—	3.6J
1862	60	04/17/2017	<0.30J	7.16J	—	5.8J
1864	67	04/17/2017	<0.30J	**12.5J**	—	4.7J
1917	496	04/17/2017	<0.30J	0.268J	2.3J	—
2514	135	04/17/2017	<0.30J	<0.18J	0.13J	—
2522	98	04/17/2017	<0.30J	**14.9J**	—	2.1J
2525	125	04/17/2017	<0.30J	**10.2J**	—	2.9J

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; ‰ = permil; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate. Bolded red numbers indicate either an EPA NPDWR standard, expressed as an MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

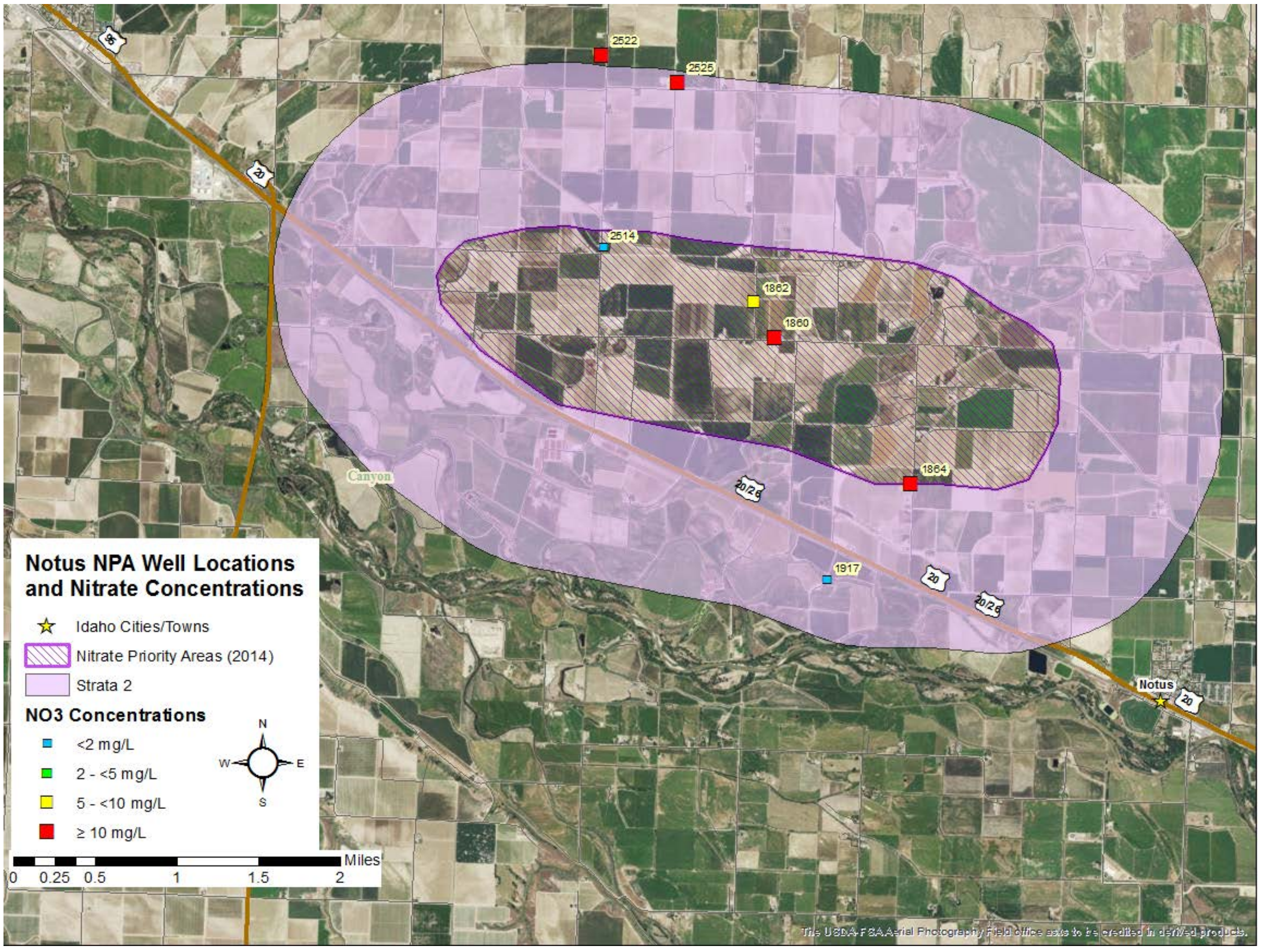

Figure 6. Nitrate concentrations—Notus NPA Ground Water Monitoring Project.

A comparison of the 2012 and 2017 nitrate sample results showed all four project wells sampled in both events had an increase in nitrate concentration from 2012 to 2017 (DEQ 2014b). The largest increase (2.5 mg/L) in nitrate concentration was at Well 1864 (Table 6). The spatial distribution of increases in nitrate concentration is shown in Figure 7.

Table 6. Comparison of nitrate concentrations from 2012 to 2017—Notus NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate[a] (10 mg/L)	Change
Water Quality Standard:			10	NA
1860	63	4/10/2012	**11**	Increase (1.1)
		04/17/2017	**12.1J**	
1862	60	4/4/2012	5.2	Increase (1.96)
		04/17/2017	7.16J	
1864	67	4/4/2012	**10**	Increase (2.5)
		04/17/2017	**12.5J**	
1917	63	4/26/2012	<0.05	Increase (0.218[b])
		04/17/2017	0.268J	

a. Contaminant with a NPDWR standard.
b. Estimated change based on value of a concentration of 0.05 mg/L.
Notes: mg/L = milligram per liter. NA = not applicable. J = Analyte was detected, but the value of the result is an estimate. Bolded red numbers indicate either an EPA NPDWR standard, expressed as an MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

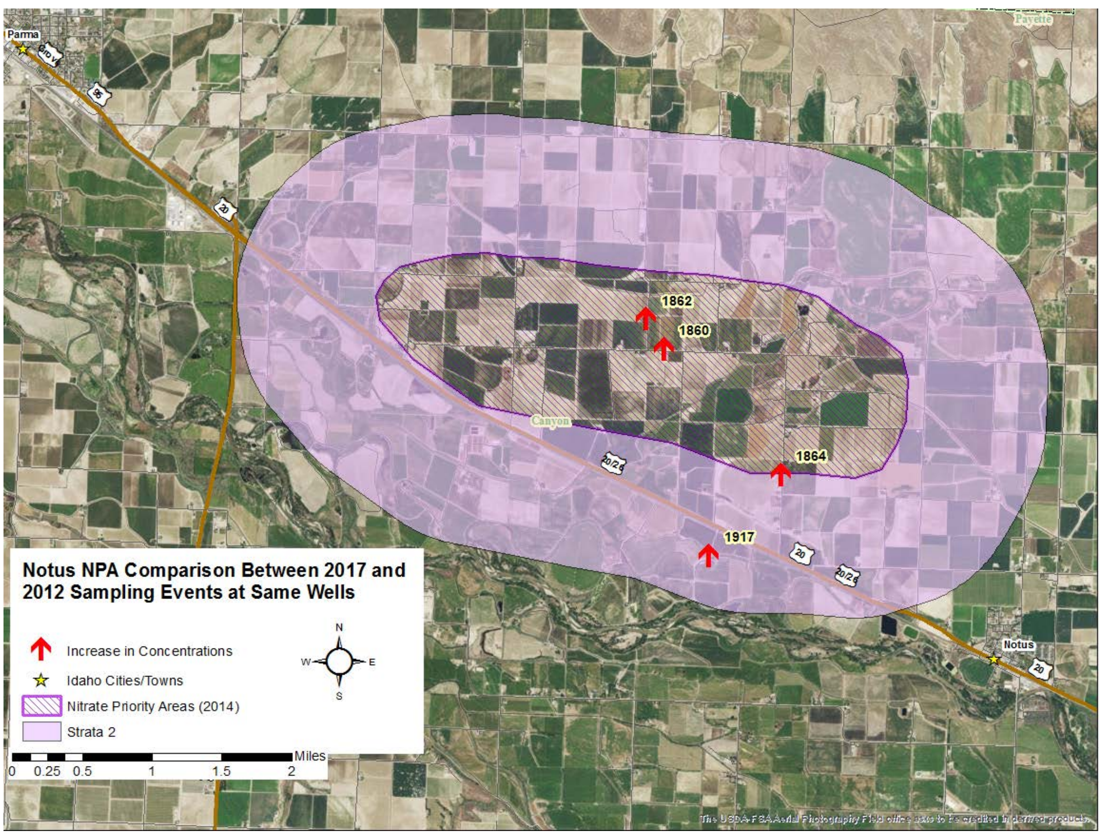

Figure 7. Changes in nitrate concentration—Notus NPA Ground Water Monitoring Project.

Bacteria Results

No TC bacteria or *E. coli* was positively detected in any of the samples (Table 7).

Table 7. Bacteria results—Notus NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform (TC)
			MPN/100 mL	
Primary or Secondary Standard:			<1	1.0
1860	63	04/17/2017	<1.0J	<1.0
1862	60	04/17/2017	<1.0J	<1.0
1864	67	04/17/2017	<1.0J	<1.0
1917	496	04/17/2017	<1.0J	<1.0
2514	135	04/17/2017	<1.0J	<1.0
2522	98	04/17/2017	<1.0J	<1.0
2525	125	04/17/2017	<1.0J	<1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters; J = Analyte was detected, but the value of the result is an estimate.

Nitrogen Isotope Results

Nitrogen isotope ($\delta^{15}N$) ratios were determined for five of the seven wells, all of which had nitrate concentrations greater than or equal to 5 mg/L (Table 5). The $\delta^{15}N$ results from this project ranged from 2.1‰ to 5.8‰ (Table 5). The nitrogen isotope sampling for Wells 2522, 2525, and1860 ranged from 2.1‰ to 3.6‰, indicating the source of nitrate in the ground water is most likely from chemical fertilizers. The nitrogen isotope sampling for Wells 1862 and 1864 was 5.8‰ and 4.7‰, respectively, indicating the source of nitrate is most likely from a mixed organic source (Table 5; Seiler 1996).

2.1.2.3 Conclusions

The criterion for NPA designation is that at least 25% of the wells sampled within the area exceed 5 mg/L nitrate (half of the EPA MCL of 10 mg/L). The 2017 resampling of the Notus NPA project found five of the seven wells sampled had nitrate values of 5 mg/L or greater. The nitrate MCL of 10 mg/L was equaled or exceeded in Wells 1860, 1864, 2522, and 2525. The highest nitrate concentration detected during the monitoring event (Well 2522) was located in a lower lying area between the foothills to the north and the Boise River to the south. The isotope ratio for Well 2522 suggests a fertilizer source of nitrogen, which is consistent with the land use of the area.

Overall, the $\delta^{15}N$ results suggest a mixture of nitrogen sources, including fertilizer and organic sources in the soil. This mixture of nitrogen sources is typical of an agricultural area with a combination of animal facilities and row crops. There does not appear to be one point source that can be considered the major contributor of nitrate to these sampling sites.

2.1.2.4 Recommendations

DEQ plans to resample this project again in 5 years to correspond with the next NPA review.

2.1.3 Parma Nitrate Priority Area Ground Water Monitoring Project

2.1.3.1 Purpose and Background

In 2012, a ground water monitoring project was established for the Parma NPA. This 2017 regional monitoring project collected data from areas sampled in 2012 to evaluate water quality in the Parma NPA (Figure 8). Among the state's 34 NPAs, the Parma NPA is ranked 22, with 1 as the most degraded and 34 the least. Program objectives, design, and well selection processes were identified in the regional monitoring network design (DEQ 2011a). DEQ will use the monitoring results for in future NPA delineation and ranking activities and to identify a local monitoring project for determining 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 the wells are distributed across the area and located accurately to represent the area's ground water quality.

Within the project area, the blue clay layer is located approximately 25–355 feet bgs and can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. All wells sampled for this project were completed to less than 150 feet bgs in an effort to sample the shallow or uppermost aquifer. The regional ground water flow direction is generally to the west (Figure 8).

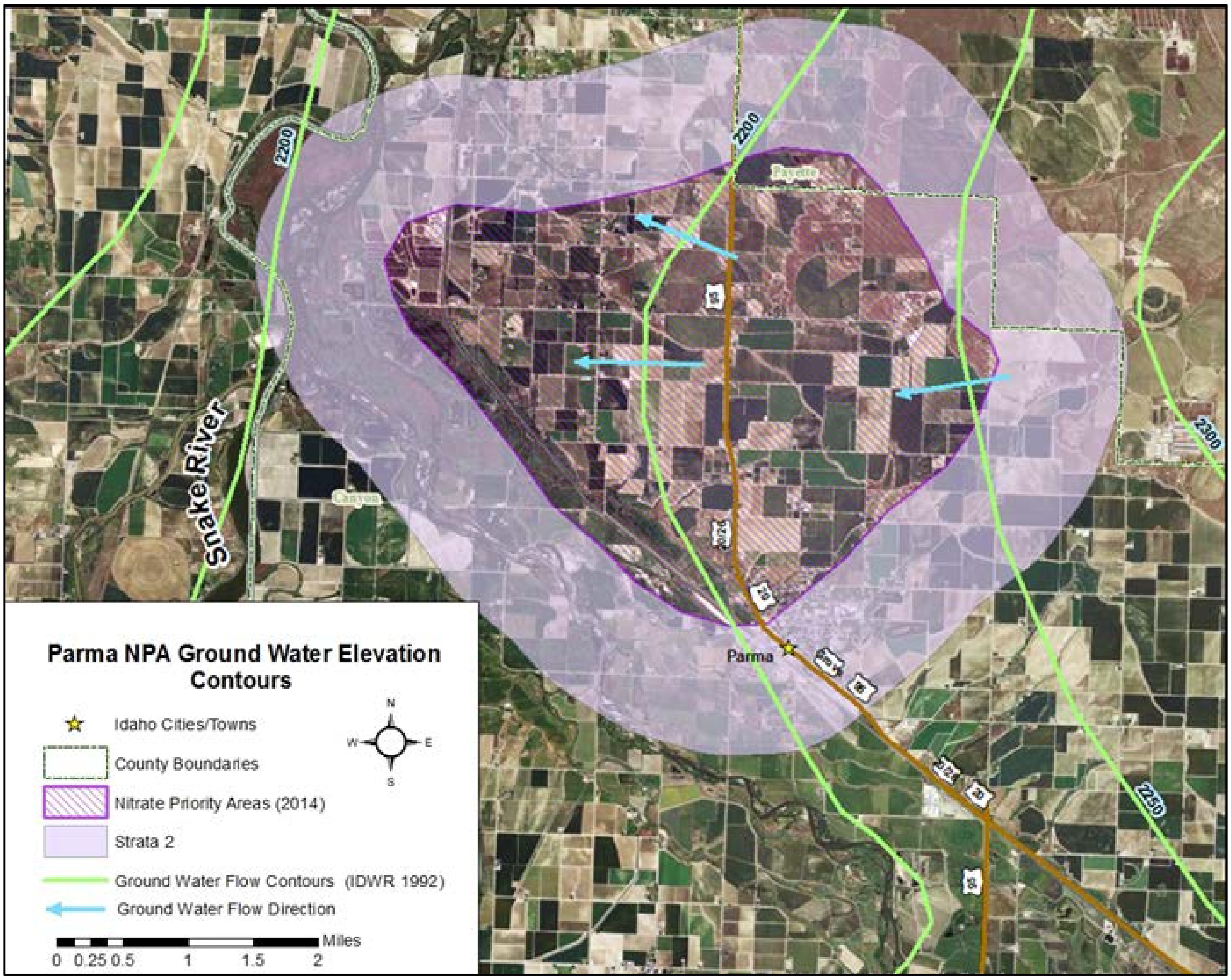

Figure 8. Ground water elevation contours—Parma NPA Ground Water Monitoring Project.

2.1.3.2 Methods and Results

In 2017, 12 wells were sampled as part of the Parma NPA ground water monitoring project, which included seven 2012 project wells and five new project wells. The seven wells from the 2012 sampling effort are Wells 1836, 1867, 1839, 1841, 1842, 1920, and 1923 (Figure 9). The wells selected for the 2012 and 2017 sampling efforts were selected using the procedures outlined in the regional QAPP (DEQ 2017a). Program objectives, design, and well selection processes are identified in the regional monitoring network design (DEQ 2011a) and included the Steinhort (2011) statistical approach for determining the number of wells in Stratum 1 and Stratum 2. The original well selection process is explained in the 2012 summary report (DEQ 2014b).

All samples were collected according to the regional QAPP (DEQ 2017a) and FSP (DEQ 2017d). 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 8).

Table 8. Water quality field parameters—Parma NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1836	103	04/24/2017	14.12	1010	7.37	2.70
1837	65	04/24/2017	14.61	588	7.37	1.89
1839	125	04/24/2017	14.38	713	7.67	7.23
1841	40	05/01/2017	14.26	931	7.03	6.62
1842	55	04/24/2017	14.91	826	6.99	3.21
1920	104	04/24/2017	15.21	765	7.49	4.58
1923	58	04/24/2017	15.59	749	7.50	3.51
2530	105	05/01/2017	13.18	907	7.08	2.92
2551	84	05/01/2017	15.65	369	7.20	0.85
2555	70	04/24/2017	16.02	659	7.53	3.59
2566	79	04/24/2017	14.10	1180	6.85	7.42
2575	98	05/01/2017	14.00	431	*6.43*	0.65

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

The water samples were submitted to the IBL in Boise, using procedures outlined in the QAPP and FSP. Samples were analyzed for nutrients (nitrate, nitrite, and ammonia) and bacteria (TC and *E. coli*) (Table 9). Wells with a DO less than 2.00 mg/L, as determined by field analysis, were also analyzed for ammonia according to the FSP (DEQ 2017d). 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 9).

Nutrient Results

The nitrate values ranged from <0.18 to 23.0 mg/L. Samples from nine of the 12 wells contained nitrate concentrations of 5 mg/L or greater, with four of the 12 samples exceeding the nitrate MCL of 10 mg/L (Table 9). The spatial distribution of nitrate concentrations is shown in Figure 9. All samples had reported nitrite concentrations less than the reporting limit of 0.3 mg/L.

Table 9. Nutrient and nitrogen isotope results—Parma NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{15}N$
			(mg/L)			(‰)
Water Quality Standard:			1.0	10	No Stand.	No Stand.
1836	103	04/24/2017	<0.30	8.24	—	9.2
1837	65	04/24/2017	<0.30	4.60	<0.010	—
1839	125	04/24/2017	<0.30	5.32	—	5.0
1841	40	05/01/2017	<0.30	**15.6**	—	4.4
1842	55	04/24/2017	<0.30	9.83	—	3.1
1920	104	04/24/2017	<0.30	**10.4**	—	6.4
1923	58	04/24/2017	<0.30	6.54	—	8.6
2530	105	05/01/2017	<0.30	**13.3**	—	6.9
2551	84	05/01/2017	<0.30	<0.18	3.1	—
2555	70	04/24/2017	<0.30	6.84	<0.010	9.0
2566	79	04/24/2017	<0.30	**23.0**	—	3.0
2575	98	05/01/2017	<0.30	<0.18	2.1	—

a. Contaminant with a NPDWR standard.

Notes: mg/L = milligram per liter; ‰ = permil; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

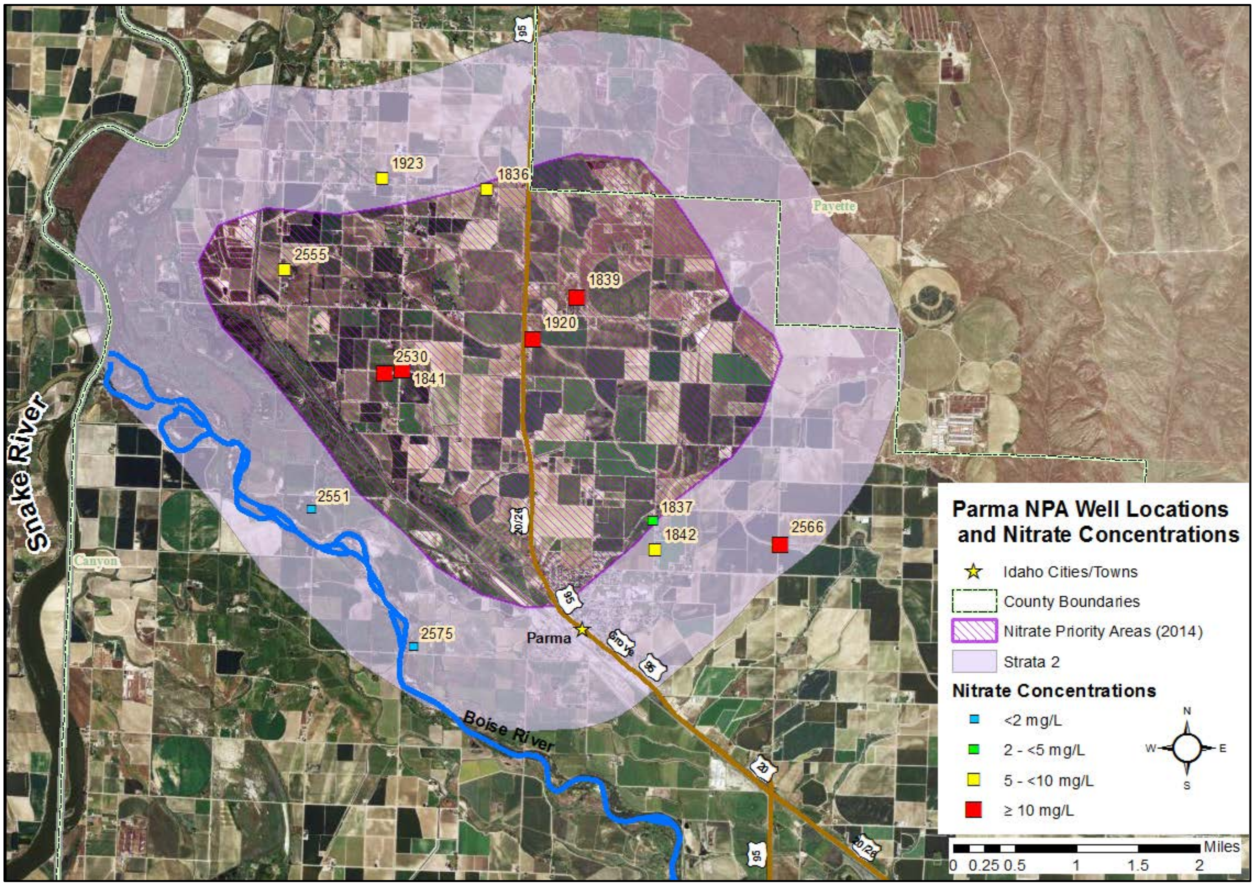

Figure 9. Private domestic drinking water well sample locations and nitrate concentrations—Parma Nitrate Priority Area Ground Water Monitoring Project.

Comparing the 2012 and 2017 nitrate sample results showed the majority of the project wells had an increase in concentration over the 5-year period, with Well 1836 showing a decrease in nitrate concentration and Well 1837 showing essentially no change (DEQ 2014b). The two largest increases in nitrate concentration (i.e., 5.6 and 5.4 mg/L) were at Wells 1841 and 1920, respectively (Table 10). The spatial distribution of changes (either increase or decrease) in nitrate concentration is shown in Figure 10.

Table 10. Comparison of nitrate concentrations from 2012 to 2017—Parma NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate[a] (mg/L)	Change
Water Quality Standard:			10	NA
1836	103	04/03/2012	**13**	Decrease (-4.76)
		04/24/2017	8.24	
1837	65	04/02/2012	4.7	No change[b] (0.1)
		04/24/2017	4.60	
1839	125	04/03/2012	1.5	Increase (3.82)
		04/24/2017	5.32	
1841	40	04/03/2012	**10**	Increase (5.6)
		05/01/2017	**15.6**	
1842	55	04/02/2012	8.6	Increase (1.23)
		04/24/2017	9.83	
1920	104	04/26/2012	5.0	Increase (5.4)
		04/24/2017	**10.4**	
1923	58	04/26/2012	3.7	Increase (2.84)
		04/24/2017	6.54	

a. Contaminant with a NPDWR standard.
b. Change in concentration was so low it was not considered a change.
Notes: mg/L = milligram per liter; (—) = not analyzed; Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

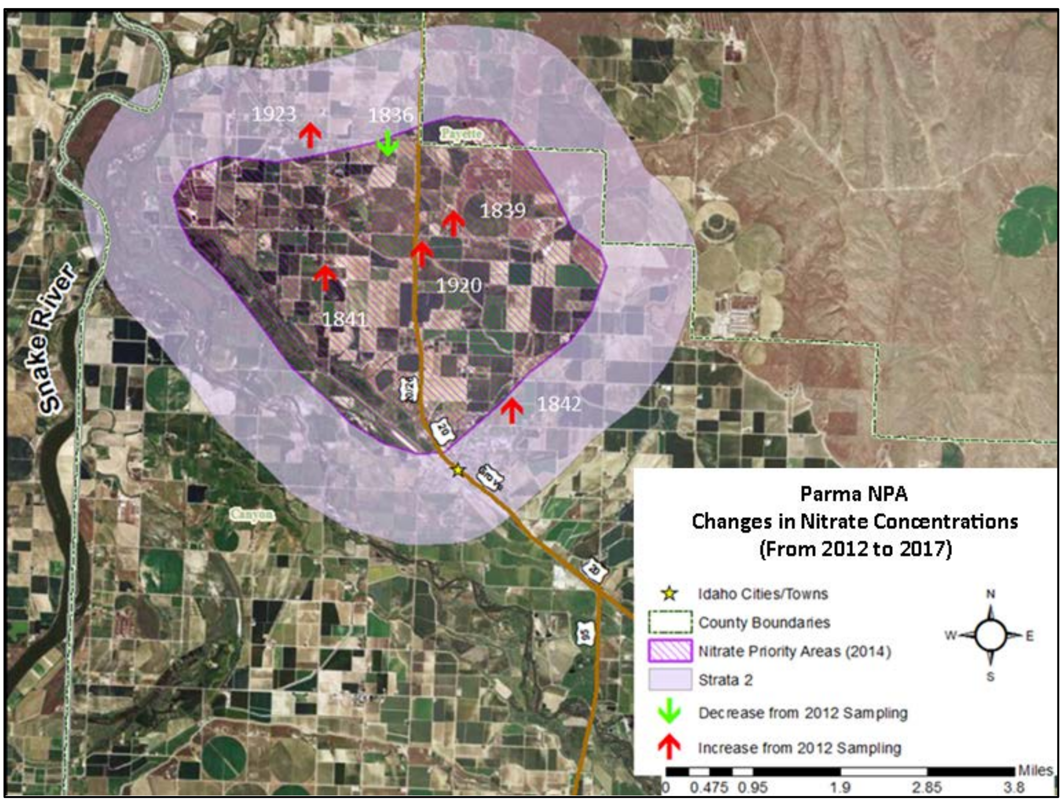

Figure 10. Changes in nitrate concentration—Parma NPA Ground Water Monitoring Project.

Bacteria Results

Of the 12 wells, three had detections of TC bacteria; the concentrations ranged from 1.0 to 95.9 MPN/100 mL. None of the 12 wells were positive for *E. coli* (Table 11).

Table 11. Bacteria results—Parma NPA Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]	
			E. coli	**Total Coliform (TC)**
			(MPN/100 mL)	
Primary or Secondary Standard:			<1	1.0
1836	103	04/24/2017	<1.0	<1.0
1837	65	04/24/2017	<1.0	<1.0
1839	125	04/24/2017	<1.0	<1.0
1841	40	05/01/2017	<1.0	<1.0
1842	55	04/24/2017	<1.0	<1.0
1920	104	04/24/2017	<1.0	<1.0
1923	58	04/24/2017	<1.0	<1.0
2530	105	05/01/2017	<1.0	2.0
2551	84	05/01/2017	<1.0	<1.0
2555	70	04/24/2017	<1.0	95.9
2566	79	04/24/2017	<1.0	<1.0
2575	98	05/01/2017	<1.0	1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters.

Nitrogen Isotope Results

Nitrogen isotope ($\delta^{15}N$) ratios were determined for nine samples, all of which had nitrate concentrations greater than or equal to 5 mg/L (Table 9). The $\delta^{15}N$ results from this project ranged from 3.0‰ to 9.2‰; two wells (1842 and 2566) had $\delta^{15}N$ values of less than 4‰, suggesting the source of nitrate in the ground water is most likely from commercial fertilizer; five wells (1839, 1841, 1920, 1923, and 2530) 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; two wells (1836 and 2555) had a $\delta^{15}N$ ratio equal to or greater than 9‰, which is typical for animal or human waste (Seiler 1996; Table 3). These isotope ratios are similar to the results from the 2012 sampling effort for Wells 1836, 1841, and 1842.

Conclusions

The criterion for NPA designation is that at least 25% of the wells sampled within the area exceed 5 mg/L nitrate (half of the EPA MCL of 10 mg/L). The 2017 resampling of the Parma NPA project found 9 of the 12 wells sampled had nitrate values of 5 mg/L or greater. The nitrate MCL of 10 mg/L was equaled or exceeded in Wells 1841, 1920, 2530, and 2566. The highest nitrate concentration detected during the monitoring event was detected at Well 2566, located in a lower lying agricultural area between the foothills to the north and the Boise River to the south. The $\delta^{15}N$ ratio for Well 2566 of 3.0‰ suggests the fertilizer source is nitrogen, which is consistent with the land use of the area.

Overall, the $\delta^{15}N$ results suggest a mixture of nitrogen sources, including fertilizer and organic sources in the soil. This mixture of nitrogen sources is typical of an agricultural area with a combination of animal facilities and row crops. Wells 1836 and 2555 had $\delta^{15}N$ results suggesting a waste (animal or human) source. These two wells are located downgradient or within proximity to an animal facility (dairy and feedlot). A nearby septic system and associated drainfield could also be a potential source of the elevated nitrate and observed nitrogen isotopic ratio.

2.1.3.3 Recommendations

DEQ plans to resample this project again in 5 years to correspond with the next NPA review.

2.1.4 City of Payette Gas Field Monitoring Project

2.1.4.1 Purpose and Background

Production quantities of natural gas have been discovered in several counties in southwestern Idaho, including Payette County. Recent interest in this resource led to establishing two gas fields in Payette County: the Hamilton Field, which underlies the area surrounding the town of New Plymouth, and the Willow Field, which underlies the foothills northeast of New Plymouth. In Idaho, the environmental effects of gas field development on ground water are unknown. Gas field development includes, but is not limited to, well drilling and drilling-related activities and treatment/enhancement of wells to increase gas production.

In 2013, the City of Payette requested sampling of their municipal wells for a baseline study of ground water quality before gas field development. Payette is located in a general downgradient ground water flow direction from the gas wells in the Hamilton and Willow Fields. The 2013 City of Payette Gas Field Ground Water Monitoring Project was established and designed to provide baseline ground water quality data for eight municipal wells operated by the City of Payette. During the September 2013 ground water sampling, 11 of 12 permitted natural gas wells had been drilled. This project is summarized in the 2013 ground water quality monitoring project summary report (DEQ 2015a).

In 2015, a follow-up ground water monitoring project to the 2013 City of Payette Gas Field Ground Water Monitoring Project collected ground water quality data to assist the city in continuing to evaluate potential impacts to ground water from gas field development and determine if drilling additional gas wells and production activity from the six operating wells affected the quality of the city's drinking water. The results of the 2015 project are summarized in the 2015 ground water quality monitoring project summary report (DEQ 2017e). At the time of the 2015 report, 17 natural gas wells had been drilled in the two gas fields, 6 of which were in production.

In 2017, the project was resampled to continue monitoring ground water quality of Payette's PWS wells.

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

The city wells sampled for the project are completed at depths ranging from 125 to 270 feet bgs. The IDWR well driller's reports suggest the subsurface in the immediate area around Payette consists of interbedded layers of gravel, sand, silt, and clay from the surface to a depth of at least 270 feet. Based on the reports, aquifers consisting of coarser-grained material (sand and gravel) supply ground water to the municipal wells. The aquifers are generally at depths ranging from approximately 130 to 270 feet bgs. The general regional ground water flow direction in Payette County is southwest toward the Snake River and locally toward the Payette River. Figure 11 shows ground water elevation contours (IDWR 1992) and the estimated ground water flow directions in the Payette area.

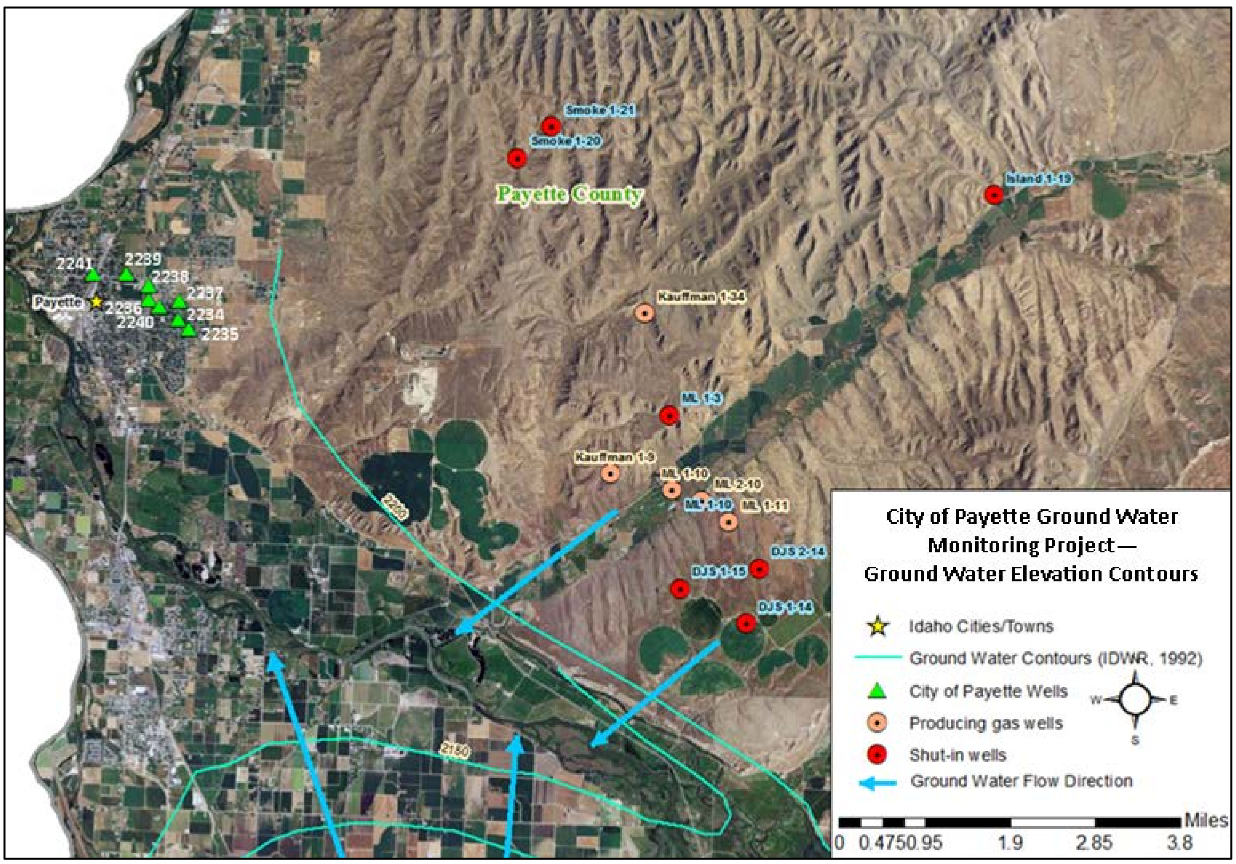

Figure 11. Project area, ground water elevation contours—City of Payette Gas Field Ground Water Monitoring Project.

2.1.4.2 Methods and Results

On July 31, 2017, at Payette city's request, DEQ collected water samples from eight Payette PWS wells using procedures outlined in the regional QAPP (DEQ 2017f) and FSP (DEQ 2017g). Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each well before sample collection (Table 12). Samples collected from the eight PWS wells were collected before water treatment.

Table 12. Water quality field parameters—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2234	198	11/16/2015	15.29	804	6.56	7.71
		07/31/2017	16.24	807	7.76	7.81
2235	194	11/16/2015	15.82	877	6.51	4.93
		07/31/2017	17.54	898	7.82	4.94
2236	287	11/16/2015	16.52	528	6.70	7.75
		07/31/2017	17.11	512	7.75	7.73
2237	228	11/16/2015	15.62	1060	6.64	9.55
		07/31/2017	16.18	1140	7.81	6.85
2238	213	11/16/2015	16.41	458	6.86	6.26
		07/31/2017	16.75	442	7.70	1.72
2239	123.8	11/16/2015	15.26	677	*6.30*	5.75
		07/31/2017	16.28	650	7.24	7.38
2240	230	11/16/2015	16.11	676	6.84	10.59
		07/31/2017	16.67	685	8.00	7.78
2241	210	11/16/2015	15.38	650	*6.35*	8.70
		07/31/2017	15.83	615	7.03	8.53

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter.

The water samples were submitted to the University of Idaho Analytical Sciences Laboratory for analysis using procedures outlined in the FSP. The lab analyzed the samples for common ions (bromide, calcium, chloride, fluoride, magnesium, orthophosphate, sodium, and sulfate) (Table 13); nutrients (nitrate and nitrite and ortho-phosphate) (Table 14); total dissolved solids (TDS) and alkalinity (Table 13); and metals (arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, potassium, selenium, uranium, vanadium, and zinc) (Table 15 and Table 16). Dissolved methane analysis was conducted by Accutest Laboratories in Wheat Ridge, Colorado (Table 17). Anatek Labs, Inc., in Moscow, Idaho, analyzed samples for benzene, toluene, ethylbenzene, and xylenes (m+p-Xylene and o-Xylene) (BTEX), diesel, gasoline and lube oil (Table 17).

General Ground Water Chemistry Results

The eight project wells were sampled for the following major ions to evaluate the general ground water chemistry: bromide, calcium, chloride, fluoride, magnesium, potassium, sodium and sulfate. Samples were also analyzed for TDS and alkalinity (as $CaCO_3$) (Table 13).

The TDS results ranged from 200 to 700 mg/L (Table 13). Wells 2235 and 2237 exceeded the NSDWR standard of 500 mg/L with concentrations of 510 and 700 mg/L, respectively. The 2017 results were consistent with the 2015 (DEQ 2017e) and 2013 (DEQ 2015a) results; however, Wells 2234, 2235, and 2237 exceeded the NSDWR standard in 2013.

Table 13. Common ion and TDS results (2015 and 2017)—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Alkalinity as ($CaCO_3$)	Bromide	Calcium	Chloride[a]	Fluoride[a,b]	Magnesium	Potassium	Sodium	Sulfate[a]	TDS[a]
			(mg/L)									
Primary or Secondary Standard:			No Stand.	No Stand.	No Stand.	250	2.0[a]/4[b]	No Stand.	No Stand.	No Stand.	250	500
2234	198	11/16/2015	350	<0.50	65	24	0.40	19	5.7	69	35	480
		07/31/2017	330	<0.1	73	40	0.19	22	6.5	70	32	460
2235	194	11/16/2015	330	<0.50	64	25	0.49	23	6.5	73	74	*510*
		07/31/2017	320	0.24	76	36	0.22	29	7.9	75	92	*540*
2236	287	11/16/2015	210	<0.50	41	10	0.23	16	3.0	40	36	310
		07/31/2017	220	<0.1	43	11	0.23	17	3.2	40	38	310
2237	228	11/16/2015	340	<0.5	95	67	0.50	36	5.4	94	160	*700*
		07/31/2017	290	0.32	98	72	0.11	37	5.6	94	170	*700*
2238	213	11/16/2015	190	<0.50	39	8.9	0.29	15	2.6	28	33	200
		07/31/2017	190	<0.10	42	9.0	0.24	15	2.7	29	33	280
2239	123.8	11/16/2015	290	<0.50	64	12	0.23	24	6.7	34	38	370
		07/31/2017	280	<0.10	64	23	0.24	25	7.2	32	41	380
2240	230	11/16/2015	310	<0.50	53	12	<0.15	20	4.5	60	39	400
		07/31/2017	380	<0.1	54	13	0.18	21	4.7	62	39	420
2241	210	11/16/2015	280	<0.50	48	12	0.19	20	4.4	54	40	380
		07/31/2017	290	<0.1	49	12	0.23	20	4.6	53	36	360

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

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

Notes: mg/L = milligrams 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 (NSDWR) standard was exceeded. These regulations are applicable for public water systems only but are recommended limits and can be applied to private wells to evaluate water quality.

Nutrient Results

Nitrate (nitrate-nitrite nitrogen) concentrations from the eight wells ranged from nondetect (less than 0.10 mg/L) to 2.1 mg/L. None of the nitrate concentrations exceeded the nitrate MCL of 10 mg/L (Table 14).

Table 14. Nitrate and ortho-phosphate results (2015 and 2017)—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration	
			Nitrate (Nitrate-Nitrite Nitrogen)[a] (mg/L)	O-Phosphate (mg/L)
Water Quality Standard:			*10*	*No Stand.*
2234	198	11/16/2015	1.9	0.15
		07/31/2017	2.1	0.13
2235	194	11/16/2015	<0.1	0.70
		07/31/2017	<0.1	0.60
2236	287	11/16/2015	<0.1	0.36
		07/31/2017	<0.1	0.58
2237	228	11/16/2015	<0.1	0.51
		07/31/2017	0.11	0.52
2238	213	11/16/2015	<0.1	1.1
		07/31/2017	<0.1	0.61
2239	123.8	11/16/2015	0.20	0.040
		07/31/2017	1.3	0.042
2240	230	11/16/2015	<0.1	0.068
		07/31/2017	<0.1	0.065
2241	210	11/16/2015	<0.1	0.083
		07/31/2017	<0.1	0.059

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter. No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

Metals and Radionuclide Results

All eight PWS wells were sampled for trace and heavy metals including: arsenic, boron, cadmium, chromium, lead, nickel, selenium, vanadium, barium, cobalt, copper, iron, manganese, molybdenum, zinc, and uranium. Results are presented in Table 15 and Table 16.

Arsenic was detected at measurable concentrations in all eight wells. The concentrations ranged from 2.1 to 23 microgram per liter (μg/L). Wells 2234 and 2235 had arsenic concentrations above the MCL of 10 μg/L, with concentrations of 16 μg/L and 23 μg/L, respectively.

Iron was detected above the NSDWR standard of 0.3 mg/L in four of the eight wells. Iron concentrations ranged from <0.1 to 0.83 mg/L (Table 16).

Manganese was detected above the NSDWR standard of 0.05 mg/L in all eight wells. Manganese concentrations ranged from 0.096 to 0.42 mg/L (Table 16).

Table 15. Metals results (2015 and 2017)—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Boron	Cadmium[a]	Chromium[a]	Lead[a]	Nickel	Selenium[a]	Vanadium
			µg/L							
Primary or Secondary Standard:			10	No Stand.	5	100	15	No Stand.	50	No Stand.
2234	198	11/16/2015	**14**	<500	<0.1	1.4	<0.1	<2.5	1.0	<20
		07/31/2017	**16**	<500	0.26J	5.4J	0.24J	<2.5	0.76	<20
2235	194	11/16/2015	**18**	<500	<0.1	<0.5	0.20	<2.5	<0.1	<20
		07/31/2017	**23**	<500	0.12J	22J	0.12J	2.5	<0.1	<20
2236	287	11/16/2015	0.42	<500	0.11	<0.5	<0.1	<2.5	<0.1	<20
		07/31/2017	2.1J	<500	<0.1	RD	0.42J	3.5	<0.1	<20
2237	228	11/16/2015	3.6	<500	<0.1	<0.5	0.28	<2.5	0.50	<20
		07/31/2017	5.7J	<500	0.14J	14J	0.14J	<2.5	<0.1	<20
2238	213	11/16/2015	2.2	<500	0.12	<0.5	<0.1	<2.5	<0.1	<20
		07/31/2017	4.4J	<500	<0.1	3.2J	0.30J	<2.5	0.11	<20
2239	123.8	11/16/2015	1.8	<500	0.55	<0.5	<0.1	<2.5	<0.1	<20
		07/31/2017	3.9J	<500	<0.1	4.9J	0.30J	<2.5	<0.1	<20
2240	230	11/16/2015	2.4	<500	<0.1	<0.5	<0.1	<2.5	0.12	<20
		07/31/2017	4.9J	<500	<0.1	RD	<0.1	<2.5	<0.1	<20
2241	210	11/16/2015	1.4	<500	0.10	<0.5	<0.1	<2.5	0.15	<20
		07/31/2017	2.4J	<500	<0.1	RD	0.23J	<2.5	<0.1	<20

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; µg/L = microgram per liter; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate; RD = rejected data. Rejected by the data validator. Results are not usable as detections or nondetects for any purpose due to a QA/QC exceedance or equipment malfunction. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

Table 16. Metals and radionuclide results (2015 and 2017)—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Barium[a]	Cobalt	Copper[a,b]	Iron[b]	Manganese[b]	Molybdenum	Zinc[b]	Uranium
			mg/L							µg/L
Primary or Secondary Standard:			2	No Stand.	1.3[a]/1.0[b]	0.3	0.05	No Stand.	5	30
2234	198	11/16/2015	0.032	<0.01	<0.02	*0.34*	*0.083*	<0.25	<0.02	4.7
		07/31/2017	0.047	<0.01	<0.02	*0.35*	*0.14J*	<0.25	<0.02	5.6
2235	194	11/16/2015	0.039	<0.01	<0.02	*0.75*	*0.30*	<0.25	<0.02	1.1
		07/31/2017	0.052	<0.01	<0.02	*0.83*	*0.38*	<0.25	<0.02	1.3
2236	287	11/16/2015	<0.02	<0.01	<0.02	0.11	*0.092*	<0.25	<0.02	<0.25
		07/31/2017	<0.02	<0.01	0.021	0.11	*0.096J*	<0.25	<0.02	<0.25
2237	228	11/16/2015	0.022	<0.01	<0.02	*0.63*	*0.36*	<0.25	<0.02	<0.25
		07/31/2017	0.026	<0.01	<0.02	*0.77*	*0.42*	<0.25	<0.02	0.27
2238	213	11/16/2015	<0.02	<0.01	<0.02	0.20	*0.15*	<0.25	<0.02	<0.25
		07/31/2017	<0.02	<0.01	<0.02	0.19	*0.15*	<0.25	<0.02	<0.25
2239	123.8	11/16/2015	<0.02	<0.01	<0.02	0.30	*0.39*	<0.25	<0.02	2.4
		07/31/2017	<0.02	<0.01	<0.02	<0.1	*0.27*	<0.25	<0.02	2.0
2240	230	11/16/2015	<0.02	<0.01	<0.02	0.16	*0.22*	<0.25	<0.02	<0.25
		07/31/2017	<0.02	<0.01	<0.02	0.18	*0.24*	<0.25	<0.02	<0.25
2241	210	11/16/2015	0.024	<0.01	<0.02	*0.83*	*0.30*	<0.25	<0.02	<0.25
		07/31/2017	0.029	<0.01	<0.02	0.19	*0.12J*	<0.25	<0.02	<0.25

a. Contaminant with a NPDWR standard.
b. Contaminant with a NSDWR standard.
Notes: mg/L = milligram per liter; µg/L = microgram per liter; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Hydrocarbon Results

All eight wells were sampled for hydrocarbons: diesel, gasoline, lube oil, benzene, toluene, ethylbenzene, and xylenes (m+p-Xylene and o-Xylene) (BTEX), and dissolved methane.

Dissolved methane was detected in all eight samples at concentrations ranging from 0.40 μg/L in Well 2238 to 184 μg/L in Well 2241 (Table 17). 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).

No other hydrocarbons were detected in any of the samples.

Table 17. Hydrocarbon results (2015 and 2017)—City of Payette Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Diesel	Gasoline	Lube Oil	Benzene[a]	Ethylbenzene[a]	m + p-Xylene	Methane[b]	o-Xylene	Toluene[a]
			mg/L			µg/L					
Primary or Secondary Standard:			No Stand.	No Stand.	No Stand.	5	700	No Stand.	No Stand.	No Stand.	1000
2234	198	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	0.84	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	0.84	<0.5	<0.5
2235	194	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	17.9	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	5.5	<0.5	<0.5
2236	287	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	4.4	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	4.0	<0.5	<0.5
2237	228	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	3.7	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	3.1	<0.5	<0.5
2238	213	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	0.50	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	0.40J	<0.5	<0.5
2239	123.8	11/16/2015	0.127	<0.1	<0.5	<0.5	<0.5	<1	1.5	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	1.5	<0.5	<0.5
2240	230	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	1.8	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	2.7	<0.5	<0.5
2241	210	11/16/2015	<0.1	<0.1	<0.5	<0.5	<0.5	<1	125	<0.5	<0.5
		07/31/2017	<0.1	<0.1	<0.5	<0.5	<0.5	<1	184	<0.5	<0.5

a. Contaminant with a NPDWR standard.
b. Methane does not have a health-based drinking water standard; however, it does have a suggested action level of 28,000 µg/L based on risk for explosion.
Notes: mg/L = milligram per liter; µg/L = microgram per liter; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate.

2.1.4.3 Conclusions

The 2017 City of Payette Natural Gas Ground Water Monitoring Project was designed to provide ground water quality data for the city's PWS wells to assist the city in determining whether gas field development has affected ground water quality at its PWS wells. This report follows up on the 2015 and 2013 sampling efforts.

Ground water samples from Wells 2234 and 2235 contained concentrations of arsenic in excess of the MCL of 10 µg/L; however, the water samples were taken before treatment and distribution to the public. The Payette has treatment in place to ensure the water they serve to customers does not exceed the MCLs.

Dissolved methane was detected in all eight wells at concentrations ranging from 0.40 to 184 µg/L. This range is similar to 2013 and 2015 results. The suggested action level for dissolved methane is 28,000 µg/L; none of the eight wells had concentrations approaching the action level.

2.1.4.4 Recommendations

Payette has several active oil and gas wells upgradient from their PWS wells; therefore, the city routinely samples their public wells for any contaminants that could be impacted by oil and gas production wells. DEQ samples the city's wells when requested, and Payette pays for all sample analyses. DEQ will consider future requests for assistance with sampling as needed.

2.1.5 Sand Hollow Creek Ground Water Nitrate Investigation

2.1.5.1 Purpose and Background

The project site is located in southwestern Gem County on the northwestern border of the Emmett North Bench NPA. The site property is located in the northern end of a hollow, which extends into the foothills on the north bench of the Payette River; Sand Hollow Creek drains the hollow. The site includes a residence, barns, and outbuildings on approximately 120 acres of farm- and rangeland. Land use south and east of the site is generally agricultural, with rangeland to the west and an approximate 1,800-head dairy (Sage Dairy) located adjacent to the north end of the property (Figure 12).

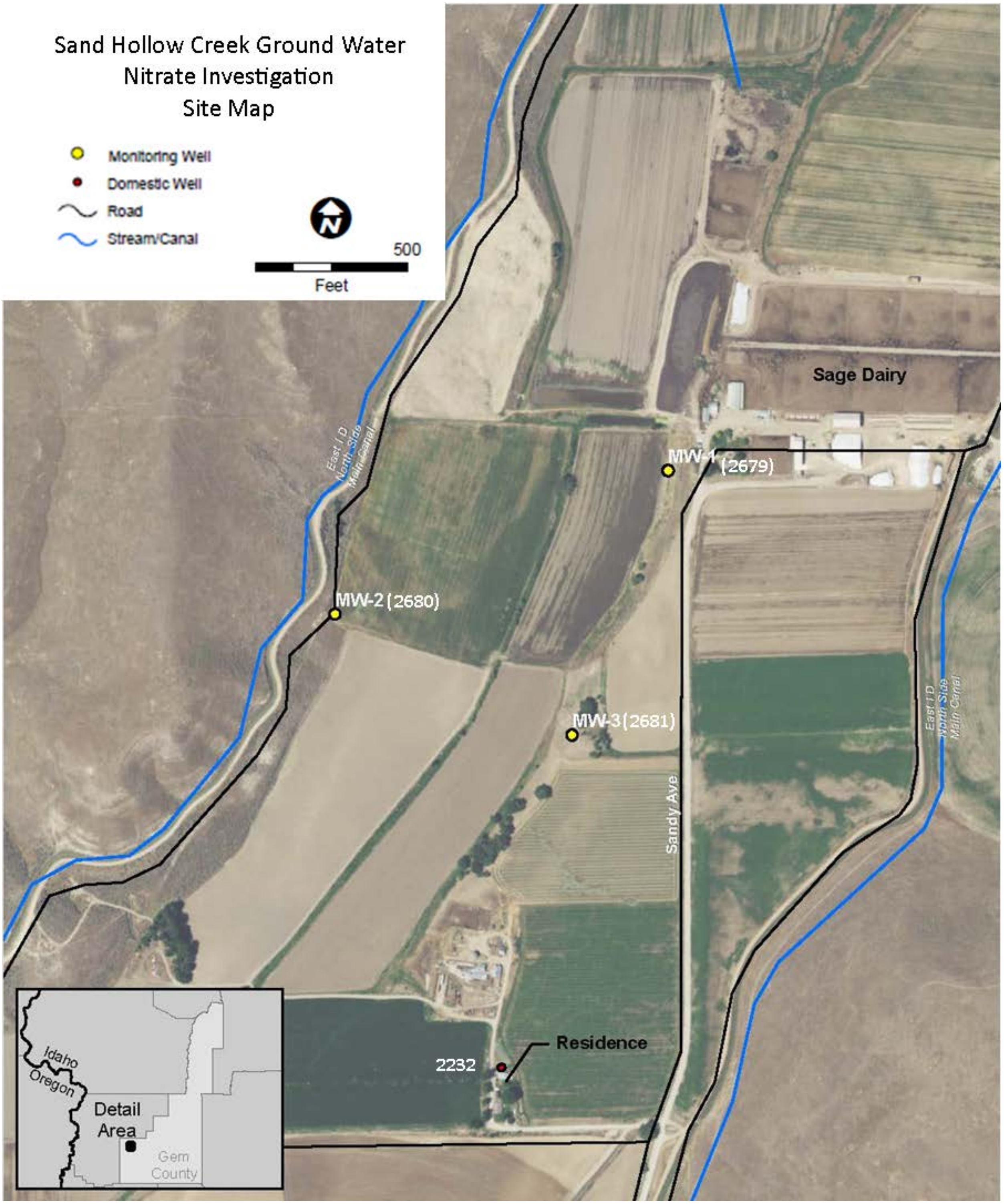

Figure 12. Project site map (modified from Tetra Tech 2017)—Sand Hollow Creek Ground Water Nitrate Investigation.

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

In December 2016, STRATA (DEQ's initial subcontractor on this project) installed three monitoring wells (MW-1, MW-2, and MW-3) at locations estimated to be upgradient or cross gradient of Well 2232 (Figure 12). The monitoring wells were installed to identify the ground water flow direction and assess ground water quality upgradient of the domestic well. The northernmost monitoring well (MW-1), located adjacent to the diary property, was completed at a depth of 61 feet bgs and was screened from 40 to 60 feet bgs. MW-2, located on the west edge of the site (elevation is approximately 27 feet higher than MW-1), was completed at a depth of approximately 40 feet bgs and screened from 20 to 40 feet bgs. MW-3, located in the central site property (approximately 15 feet higher than MW-1), was completed at a depth of approximately 45 feet bgs and screened from 25 to 45 feet bgs. Subsurface lithology at all wells generally consisted of poorly graded sand, silty sand, and clay. The depth to ground water at well installation was approximately 6 feet (MW-1), 32 feet (MW-2), and 33 feet (MW-3).

In January 2017, DEQ selected Tetra Tech, Inc. as the new contractor for 5-years. In April 2017, Tetra Tech prepared a QAPP outlining the organization, goals, scope of work, and quality assurance/quality control (QA/QC) criteria for investigating nitrate in ground water at the site (Tetra Tech 2017).

2.1.5.2 Methods and Results

In April and November 2017, Tetra Tech measured ground water elevations at the monitoring wells and collected ground water samples from the three monitoring wells and Well 2232.

Water quality field parameters (pH, temperature, specific conductance, DO, turbidity, and oxygen-reduction potential) were measured during well purging and ground water sample collection at each well to ensure a representative sample of ground water was collected. Water quality field parameters for monitoring wells MW-1 (2679), MW-2 (2680), MW-3 (2681), and Well 2232 are presented in Table 18.

Table 18. Water quality field parameters—Sand Hollow Creek Ground Water Nitrate Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Turbidity (NTU)	Specific Conductance (µS/cm)	Oxidation-Reduction Potential (mV)	pH[a]	Dissolved Oxygen (mg/L)
2232	Unk	04/20/2017	13.6	1.5	680	236	6.50	5.40
		11/06/2017	13.38	0	745	240	7.22	6.96
MW-1 (2679)	60	04/20/2017	13.3	33	670	215	*6.30*	1.80
		11/06/2017	13.50	26.7	564	219	7.91	2.06
MW-2 (2680)	40	04/20/2017	14.1	6	150	201	7.10	6.40
		11/06/2017	14.94	3.8	144	209	8.15	7.41
MW-3 (2681)	45	04/20/2017	13.7	62	550	206	6.80	5.00
		11/06/2017	13.56	118.2	454	211	7.31	5.92

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; NTU = nephelometric turbidity units; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

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

Ground Water Flow Direction

Based on the ground water elevations gauged at the monitoring wells, the general ground water flow direction calculated for both the April and November 2017 monitoring events was to the south-southeast with a gradient of approximately 0.014 feet per foot. The November 2017 ground water elevation, potentiometric surface, and approximate ground water flow direction is shown in Figure 13.

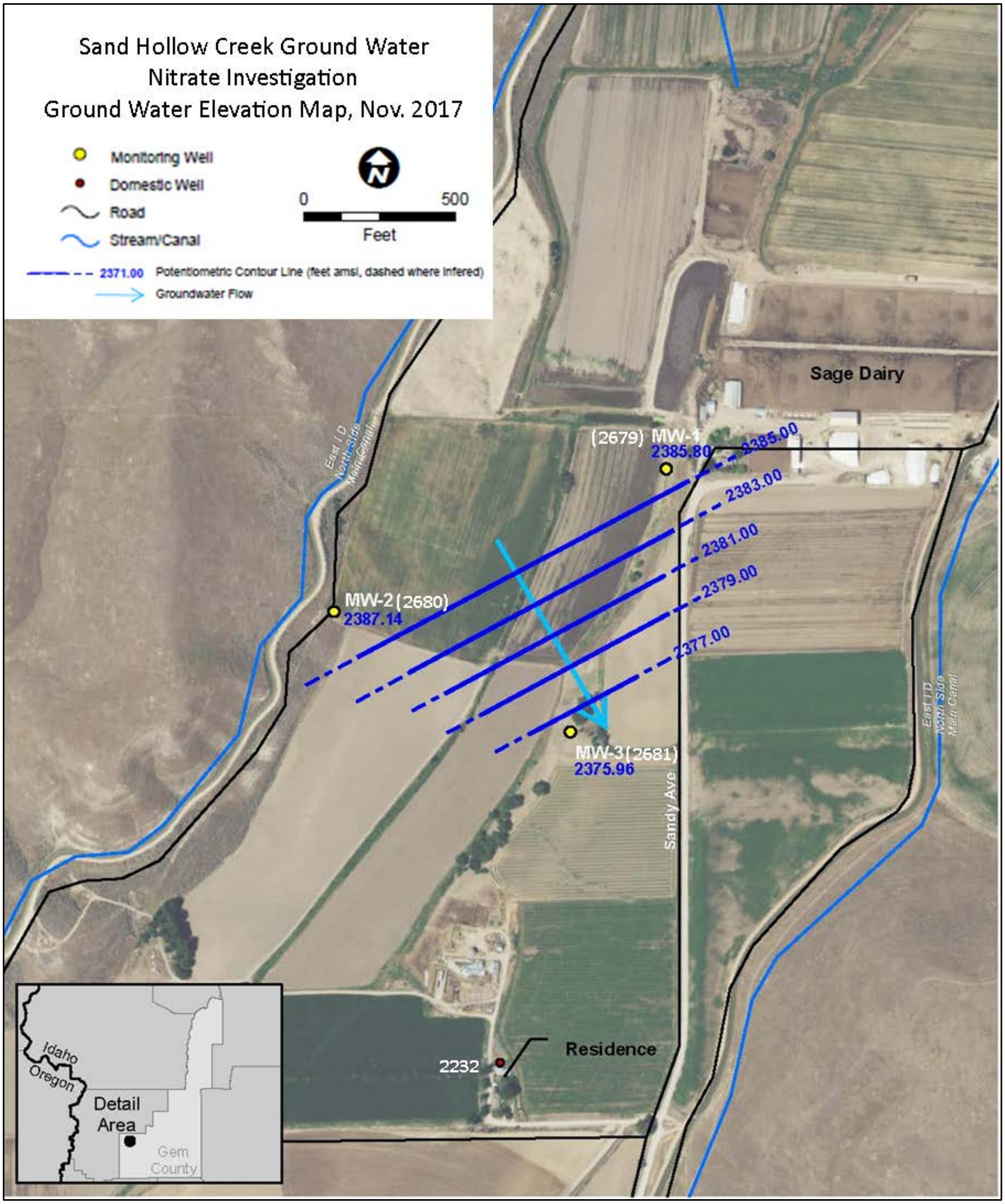

Figure 13. Ground water elevation (from November 2017 water level measurements) and ground water flow direction (modified from Tetra Tech 2017)—Sand Hollow Creek Ground Water Nitrate Investigation.

General Ground Water Chemistry Results

Analytical results for common cations are shown in Table 19. Analytical results for common anions, alkalinity, and TDS are shown in Table 20. Water chemistry at all wells was generally acceptable, with the secondary drinking water standard for iron exceeded in the samples collected in April and November 2017 from monitoring wells MW-1, MW-2, and MW-3, and secondary drinking water standard for TDS exceeded for the sample collected from Well 2232 in November 2017.

Table 19. Common cation and metal results—Sand Hollow Creek Ground Water Nitrate Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Barium[a]	Calcium	Iron[b]	Magnesium	Manganese[b]	Potassium	Sodium
			(mg/L)						
Primary or Secondary Standard:			2	No Stand.	0.3	No Stand.	0.05	No Stand.	No Stand.
2232	Unk	04/20/2017	0.171	86.8	<0.100	24.4	<0.0050	3.81	37.5
		11/06/2017	0.223	97.7	<0.100	29.8	<0.005	4.42	37.4
MW-1 (2679)	60	04/20/2017	0.249	65.6	*1.44J*	15.6	0.0470	3.53	67.8
		11/06/2017	0.211	58.7	*0.946*	13.6	0.0385	2.89	60.6
MW-2 (2680)	40	04/20/2017	0.0200	20.0	*0.333*	5.66	0.0122	0.815	6.01J
		11/06/2017	0.0366	20.5	*0.805*	5.06	0.0192	0.336J	4.15
MW-3 (2681)	45	04/20/2017	0.109	66.9	*2.01*	22.0	0.0439	2.18	31.3
		11/06/2017	0.141	58.2	*1.43*	18.1	0.0346	1.58	24.6

a. Contaminant with a NPDWR standard.
b. Contaminant with a NSDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Table 20. Common anion, bicarbonate, and TDS results—Sand Hollow Creek Ground Water Nitrate Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bicarbonate	Bromide	Chloride[a]	Fluoride[a,b]	Sulfate[a]	Total Dissolved Solids[a]
			(mg/L)					
Primary or Secondary Standard:			No Stand.	No Stand.	250	2.0/4	250	500
2232	Unk	04/20/2017	327	<2.5	5.1	<0.50	22.3	469
		11/06/2017	407	<2.5	5.8	0.47J	18.6	*543*
MW-1 (2679)	60	04/20/2017	247	<2.5	14.9	<0.50	28.8	445
		11/06/2017	245	<2.5	12.6	0.34J	27.8	446
MW-2 (2680)	40	04/20/2017	78.7	<2.5	2.0J	0.43J	2.6J	116
		11/06/2017	76.9	<2.5	1.7J	0.42J	3.3J	119
MW-3 (2681)	45	04/20/2017	277	<2.5	3.5	0.51	21.3	399
		11/06/2017	261	<2.5	3.9	0.77	12.1	338

a. Contaminant with a NSDWR standard.
b. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Nutrient Results

Laboratory analyses of the ground water samples collected in April 2017 detected nitrate at a concentration exceeding the MCL of 10 mg/L in the samples collected from MW-1 (18.7 mg/L) and Well 2232 (11.0 mg/L). Nitrate was detected at a concentration less than the MCL in the samples collected from MW-2 (0.18 mg/L) and MW-3 (3.8 mg/L) (Table 21). Ammonia was not detected in any ground water sample at a concentration greater than the laboratory detection limit of 0.10 mg/L.

The analyses of the samples collected in November 2017 detected nitrate at a concentration exceeding the MCL in the samples collected from MW-1 (17.5 mg/L) and Well 2232 and (10.1 mg/L). Nitrate was detected at a concentration less than the MCL in the samples collected from MW-2 (0.13 mg/L) and MW-3 (1.5 mg/L). Ammonia was not detected in any ground water sample at a concentration greater that the laboratory detection limit of 0.10 mg/L.

Table 21. Nutrient results—Sand Hollow Creek Ground Water Nitrate Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration (mg/L)			Nitrogen Isotope
			Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{15}N$ (‰)
Water Quality Standard:			1.0	10	No Stand.	No Stand.
2232	Unk	04/20/2017	<0.050	**11.0**	<0.10	6.3
		11/06/2017	<0.050	**10.1**	<0.10	7.2
MW-1 (2679)	60	04/20/2017	<0.050	**18.7**	<0.10	9.0
		11/06/2017	<0.050	**17.5**	<0.10	8.2
MW-2 (2680)	40	04/20/2017	<0.050	0.18J	<0.10	—
		11/06/2017	<0.050	0.13	<0.10	—
MW-3 (2681)	45	04/20/2017	<0.050	3.8	<0.10	5.2
		11/06/2017	<0.050	1.5	<0.10	4.6

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; J = Analyte was detected, but the value of the result is an estimate. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

Nitrogen Isotope Results

Nitrogen isotope ratio ($\delta^{15}N$) analyses was performed on the samples collected from MW-1, MW-3, and the domestic well for both the April and November 2017 ground water monitoring events (Table 21).

The $\delta^{15}N$ values for the samples collected from MW-1 in April and November 2017 were 9.0‰ and 8.2‰, respectively. These values indicate a likely source of organic nitrogen in soil or potentially a mixed source of organic nitrogen and animal waste. The $\delta^{15}N$ values for the samples collected from Well 2322 in April and November were 6.3‰ and 7.2‰, respectively, indicating a potential source of organic nitrogen in soil or a mixed nitrogen source. The $\delta^{15}N$ values for the samples collected from the MW-3 in April and November were 5.2‰ and 4.6‰, respectively, indicating a potential source of organic nitrogen in soil or a mixed nitrogen source of organic nitrogen in soil and commercial fertilizer.

2.1.5.3 Conclusions

The elevated nitrate concentrations and $\delta^{15}N$ values for the samples collected from MW-1 in April and November, and monitoring well location adjacent to and south of the dairy, indicate nitrate sources at the dairy are impacting downgradient ground water. The source of the elevated nitrate concentrations detected in the analyses of samples collected from Well 2322 is undetermined. Potential sources include an on-site source, fertilizer applied to the site's fields located to the north and east of the well; fertilizer and/or liquid or solid animal waste applied to off-site fields located north and east of the well, or fertilizer and/or dairy waste impact to a deeper ground water aquifer below the screened interval of MW-3.

2.1.5.4 Recommendations

DEQ recommends continued monitoring at this site. Three sampling events of monitoring wells and the domestic well have been conducted since this report was initiated. Sampling occurred in May and December 2018 and May 2019. The sampling efforts will be discussed in future 2018 and 2019 summary reports. The three sampling events occurred in May 2018 and December 2018**.**

Due to monitoring well locations, understanding of ground water flow direction is constrained. DEQ is evaluating alternative methods for determining the hydraulic connection between Well 2232 and Sage Dairy.

2.2 Idaho Falls Region

Two ground water quality monitoring projects were conducted in the Idaho Falls region in 2017 using DEQ funds.

2.2.1 Mud Lake Subarea Ground Water Monitoring Project

2.2.1.1 Purpose and Background

DEQ's Idaho Falls region is divided into three subareas (Teton Basin/Ashton, Eastern Snake River Plain [ESRP], and Mud Lake) based on land use and hydrogeologic boundaries to identify impacts or changes to ambient ground water quality. The process for identifying the subareas is described in the regional monitoring network design (DEQ 2013a). Definitions for the specific subareas are summarized in regional ambient ground water monitoring plan (DEQ 2013b). Sampling for the Mud Lake subarea was initiated in calendar year 2015 and completed in 2017. The 2017 results are summarized below. Sampling for the Teton Basin/Ashton and ESRP subareas was completed in calendar years 2013 and 2014, respectively, and results are provided in the 2013 and 2014 summary reports (DEQ 2015a; DEQ 2016).

The Mud Lake subarea covers 525 square miles of eastern Idaho, including the Mud Lake-Terreton Basin and the relatively low lands surrounding the Table Butte/Cedar Butte complex of Jefferson and Clark Counties (Figure 14). The Mud Lake subarea is within the ESRP aquifer.

The regional geology for the ESRP aquifer is dominated by basalts, interbedded sediments, and rhyolites. The shallower subsurface is dominated by lake deposits and sandy, wind-blown sediments, intercalated with basalt and other volcanic deposits. The lake sediments are sufficiently continuous and of lower permeability to support a local aquifer perched above the regional ESRP aquifer. Lake sediments and basalts are intercalated with sediments from the Beaver, Camas, and Birch Creeks and other smaller drainages. Apart from shallower, perched conditions near Mud Lake, transmissivity and aquifer thickness are again greatest toward the center of the ESRP and tend to decrease toward the margins. The ESRP aquifer tends to respond as unconfined toward the center and as confined toward the margins, reflecting the larger proportion of sediments (Stearns et al. 1939; Spinizola 1994). Major sources of recharge are downward percolation of precipitation and snowmelt, runoff from the surrounding uplands, streamflow losses from drainages to the north of the region, and direct infiltration of surface water diverted for irrigation (Graham and Campbell 1981).

The Mud Lake regional monitoring subarea was sampled in 2015 and 2016; 15 wells were sampled in fall 2015, and 8 wells were sampled in spring 2016, for 23 of a planned 25 wells sampled. Sampling extended into 2016 due to a late start for the fall sampling and late receipt of sampling permission forms. Permission was received for a 24th well in late fall, 2016. Well 2689 was sampled again with the 2017 Teton Basin-Ashton regional monitoring sites in fall 2017 and is presented here.

The intent of sampling is to assess ambient ground water conditions for the regional monitoring subarea and to identify potential nitrate sources. Results for the fall 2015 and spring 2016 Mud Lake subarea were reported with the summary report (DEQ 2017e). Wells sampled were identified following a stratified random selection process. The first suitable well (domestic well with known completion and hydrogeology representing the shallowest portion of the aquifer most likely to be impacted from activities at the surface) sampled was selected from the square-mile section where permission was received (section 2.2.1 in 2015 summary report [DEQ 2017e]).

2.2.1.2 Methods and Results

In October 2017, DEQ collected a ground water sample from one private domestic well located within the Mud Lake subarea. The project sample locations were selected from domestic and livestock wells with available well logs. Selection favored more recent wells with complete information on well construction, well-bore seals, and lithologic descriptions suggesting that ground water sampled would represent the shallowest aquifer zone. The number of sample sites needed to adequately represent the area of interest was based on a statistical process (Steinhorst 2011), with specific data used to determine the number of sample sites needed as detailed in the regional ambient ground water monitoring plan (DEQ 2013b). A goal of 20 to 25 sample sites was established. Potential sample sites (wells) were selected from randomly identified and ordered 1-mile sections completely within the 525-square-mile study area. IDWR or ISDA monitoring wells were excluded from selection. A total of 23 wells were sampled in 2015 and 2016 with a 24th well sampled in 2017. Results from these randomly selected wells can statistically represent the subarea and combined with results from other sampling networks to make inferences about the subarea (DEQ 2017e).

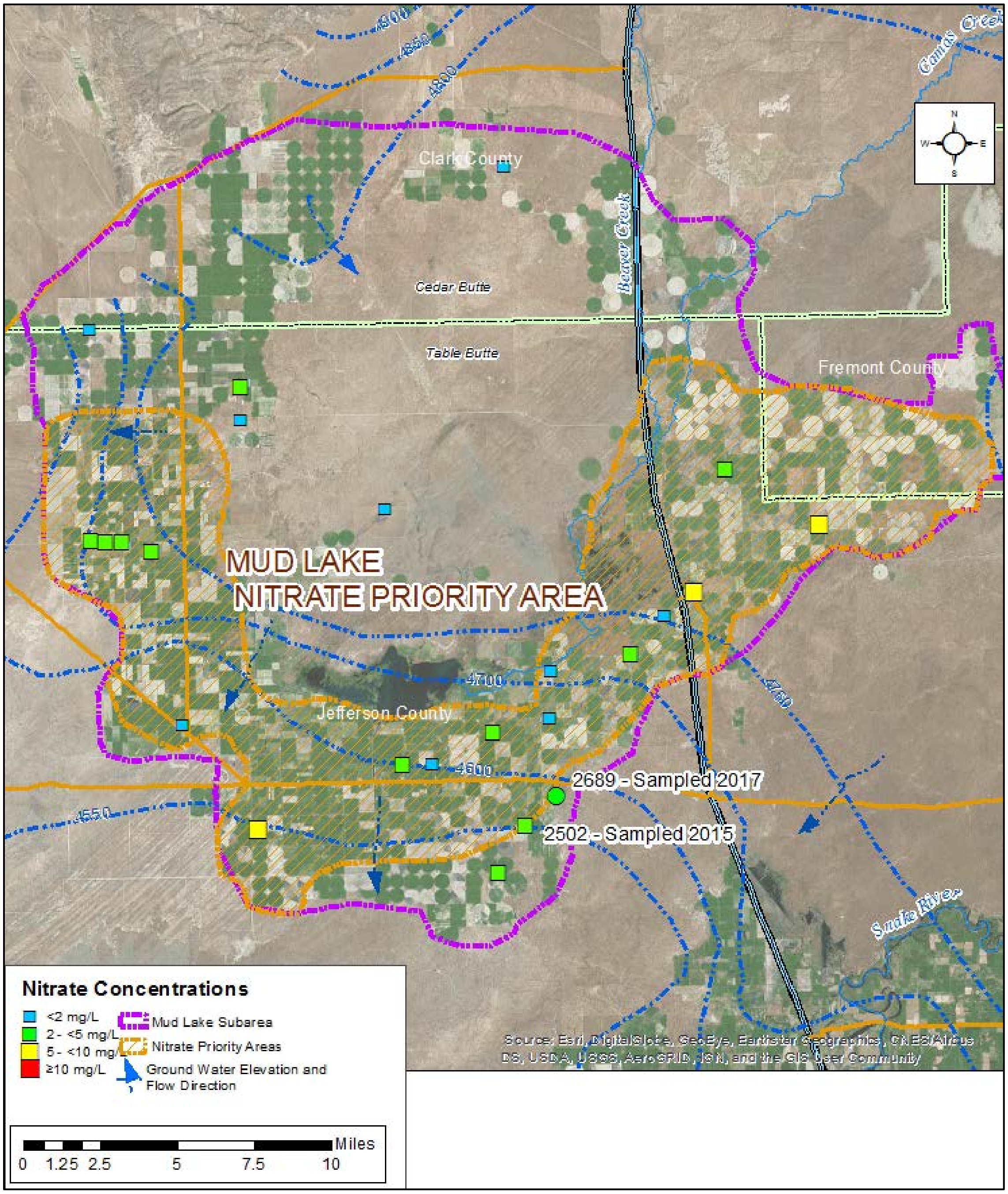

Figure 14. Project and Well 2689 location—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

Samples were analyzed by IBL in Boise for common ions (calcium, sodium, magnesium, potassium, chloride, fluoride, and sulfate), arsenic, total alkalinity, nitrite-nitrate nitrogen (nitrate), and ammonia. Samples for bacteria (TC and *E. coli*) were analyzed by IAS Environmental in Pocatello.

After receiving the major ion chemistry and nutrient results, samples for stable isotope analysis were submitted to Northern Arizona University–Colorado Plateau Stable Isotope Laboratory for stable isotopes of nitrogen and oxygen in nitrate ($\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$) and University of Arizona for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O$ and $\delta^{2}H$). All sampling was conducted according to the regional QAPP (DEQ 2011b) and FSP (DEQ 2015b).

Water quality field parameters (pH, temperature, specific conductance, organic carbon, and DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 22).

Table 22. Water quality field parameter results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2689	Ukn	10/16/2017	11.99	415	7.08	7.66

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found.

Nutrient and Isotope Results

Laboratory analyses nitrate concentration for Well 2689 was 3.4 mg/L, which is below the MCL for nitrate of 10 mg/L. The nitrate (nitrate plus nitrite) result of 3.4 mg/L was greater than the 2015/2016 median (2.4 mg/L) and is above background concentrations and indicates anthropogenic impact.

Results for $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ were 4.10‰ and -5.74‰, respectively (Table 23). Results for $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ were -134.4‰ and -17.6‰, respectively (Table 24). A plot of stable $\delta^{18}O/\delta^{2}H_{water}$ suggests that as Well 2689 plots on the regionally identified ESRP ground water line, the well is potentially impacted by recharge evaporation from irrigation (Figure 15).

Table 23. Nutrient and nitrate isotope results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration		Isotopes	
			Nitrate (Nitrate-Nitrite Nitrogen)[a] (mg/L)	Ammonia (mg/L)	$\delta^{18}O_{nitrate}$ (‰)	$\delta^{15}N_{nitrate}$ (‰)
Water Quality Standard:			10	No Stand.	No Stand.	No Stand.
2689	Ukn	10/16/2017	3.4	<0.010	-5.74	4.10

a. Contaminant with a NPDWR standard.
Notes: ‰ = permil; mg/L = milligram 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.

Table 24. Stable isotope results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	$\delta^{2}H_{water}$ (‰)	$\delta^{18}O_{water}$ (‰)
2689	Ukn	10/16/2017	-134.4	-17.6

Notes: ‰ = permil; Unk = unknown. Well log not found.

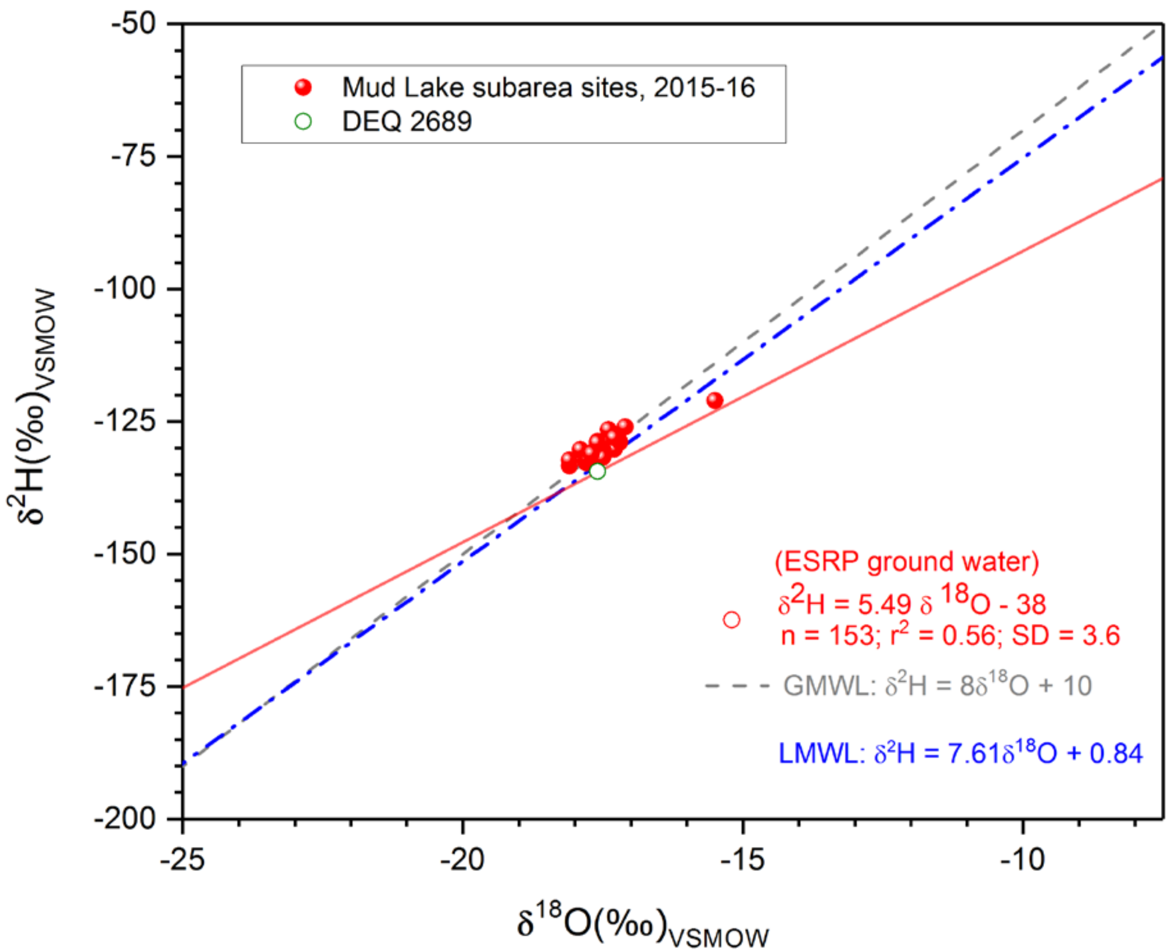

Figure 15. Local meteoric line with isotope results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

Bacteria Results

TC bacteria was detected in the sample from Well 2689 with a concentration of 1.0 MPN/100 mL, which equaled the Idaho's Ground Water Quality Rule standard for TC of 1.0 MPN/100 mL (Table 25). The sample did not confirm the presence of *E. coli*.

Table 25. Bacteria results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform (TC)
			MPN/100 mL	
Primary or Secondary Standard:			<1	1.0
2689	Ukn	10/16/2017	<1.0	1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = unknown. Well log not found.

Metals and Radionuclide Results

Results are presented in Table 26. Arsenic was detected in the sample from Well 2689 with a concentration of 2.0 micrograms per liter (µg/L), which is below the MCL of 10 µg/L. Strontium and uranium were both detected at concentrations below the NPDWR standard.

Table 26. Metals and radionuclide results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Boron	Lithium	Strontium[a]	Uranium[a]
			µg/L				
Primary or Secondary Standard:			10	No Stand.	No Stand.	8	30
2689	Ukn	10/16/2017	2.0	46.8	16.5	**154**	2.21

a. Contaminant with a NPDWR standard.
Notes: µg/L = microgram 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. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

General Ground Water Chemistry Results

Analytical results for common cations are shown in Table 27. A Piper characteristic general chemistry plot confirms that results for Well 2689 plot very near the center of 2015 results, with a slight relative increase in chloride and sulfate comparatively (Figure 16). Plots of chloride versus sulfate suggest the potential of some additional input of these ions above just natural sources, based on a departure from the approximate trend for wells showing no impacts (identified as a regional chloride-sulfate line) (Figure 17). Wells that plot above or below that line indicate a relatively larger input of one of these anions due to anthropogenic input or local variations in natural subsurface sources. When a departure from this regional trend is accompanied by a nitrate concentration indicative of impacts (above background concentrations), anthropogenic impacts are supported (Table 23 and Figure 18). Results for Well 2689 plot very similar to Well 2502, located less than 2 miles away to the south and west. The 2-year difference in sampling events may also be a factor.

Table 27. Common ion and TDS results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Alkalinity as (CaCO3)	Organic Carbon	Bromide	Calcium	Chloride[a]	Fluoride[a,b]	Magnesium	Potassium	Sodium	Sulfate[a]
			(mg/L)		(µg/L)				(mg/L)			
Primary or Secondary Standard:			No Stand.	No. Stand.	No Stand.	No Stand.	250	2.0/4	No Stand.	No Stand.	No Stand.	250
2689	Unk	10/16/2017	148	<0.5	51.9	45	19.1	0.632	13	2.9	21	21.4

a. Contaminant with a NSDWR standard.
b. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; µg/L = microgram 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.

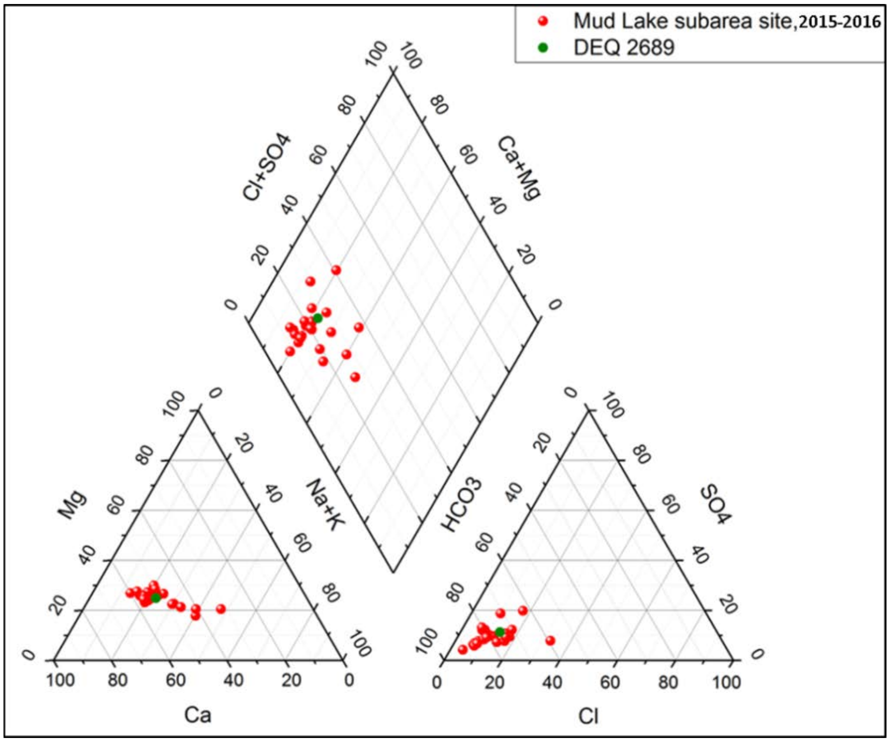

Figure 16. Piper diagram: 2017 results with the 2015–2016 results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

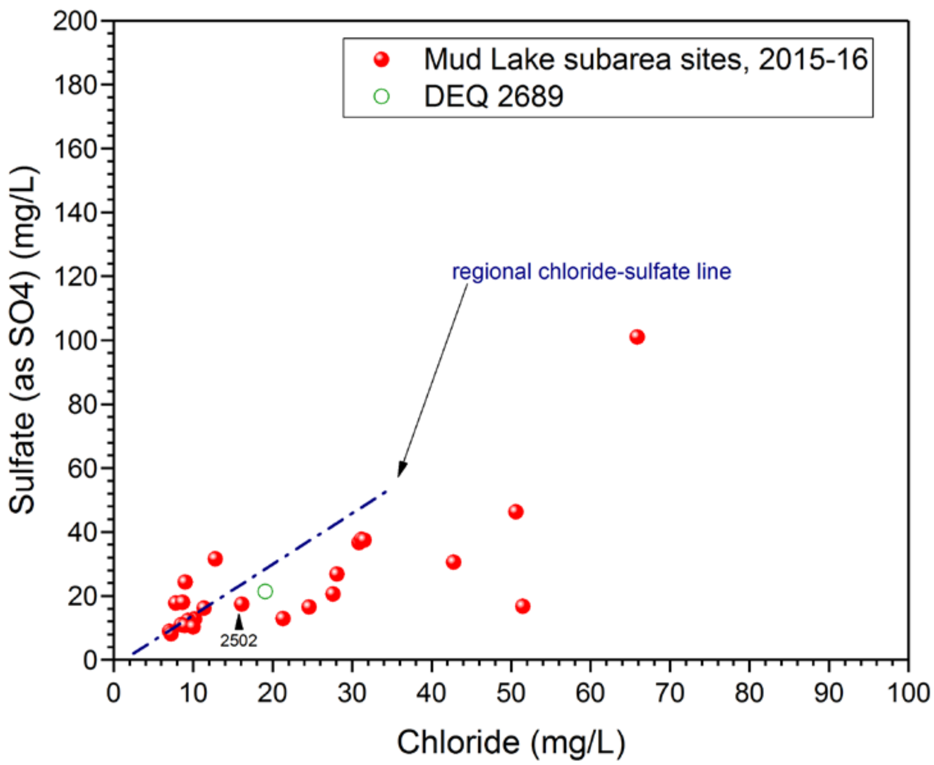

Figure 17. Sulfate versus chloride: 2017 results with 2015–2016 results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

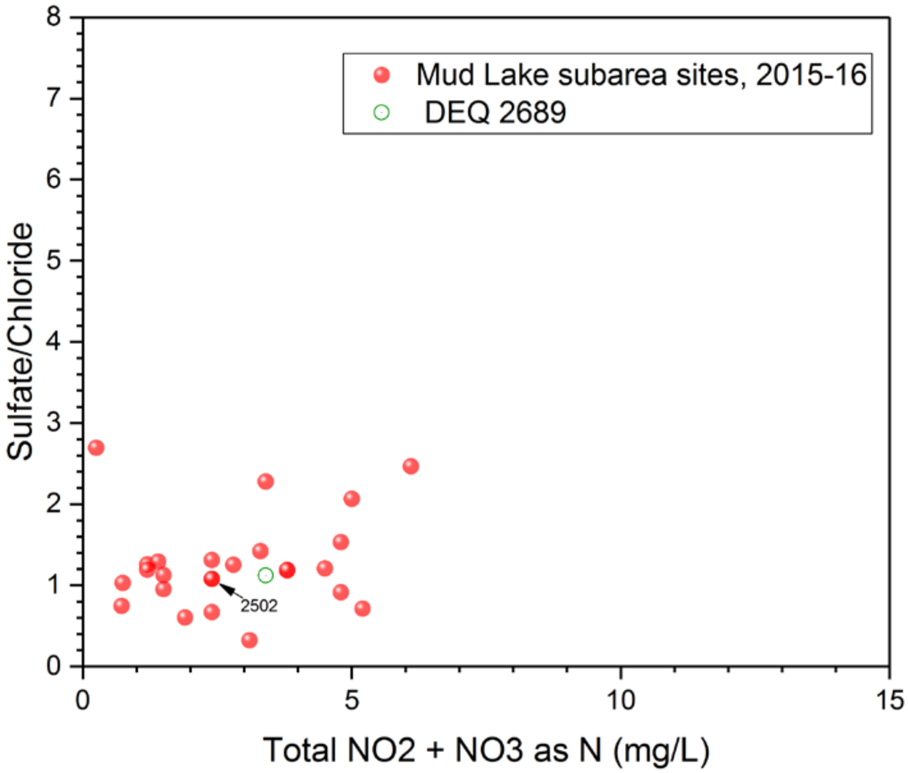

Figure 18. Sulfate/chloride ratio versus nitrate: 2017 results with 2015–2016 results—Mud Lake Subarea Regional Ground Water Quality Monitoring Project.

2.2.1.3 Conclusions

Well 2689 is located towards the southeastern portion of the regional monitoring area, close to both the identified margin of the Mud Lake NPA and regional monitoring subarea. Generally, results for all analytes were similar to the median value or slightly greater for regional results reported for 2015. The nitrate plus nitrate result was greater than the median (2.4 mg/L) and above background concentrations, indicating anthropogenic impact. The Mud Lake regional monitoring subarea will be sampled in fall 2019.

2.2.1.4 Recommendations

DEQ recommends future sampling of this project. This regional monitoring network will be due for sampling 2019.

2.2.2 Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project (Round 2)

2.2.2.1 Purpose and Background

The Idaho Falls region is divided into subareas based on land use and hydrogeologic boundaries to identify impacts or changes to ambient ground water quality. The process for defining these subareas is described in regional monitoring network design (DEQ 2013a). Definitions for the specific subareas are summarized regional ambient ground water monitoring plan (DEQ 2013b). The Teton Basin-Ashton, ESRP, and Mud Lake subareas have been defined.

The Teton Basin-Ashton subarea covers 878 square miles of eastern Idaho, consisting primarily of the Teton Basin and portions of the adjacent Henrys Fork of the Snake River/Falls River drainages on the eastern and northern-most portions of the ESRP, including the Ashton-Drummond NPA (Figure 19). Aquifer materials include alluvium and river sediments intercalated with basalts and rhyolite tuffs related to both the Yellowstone Group and Heise Group volcanics. Some areas also include glacial sediments. The Teton Valley ground water system is primarily within stream and glacial deposited sediments, basalts, silicic volcanics, and pre-Tertiary sedimentary rocks (Kilburn 1964). Major sources of recharge are downward percolation of precipitation and snowmelt, runoff from the surrounding uplands, streamflow losses, and direct infiltration of surface water diverted for irrigation (Graham and Campbell 1981).

This project summary describes the second round of regional monitoring for the Teton Basin-Ashton subarea. The first round was summarized in the 2013 summary report (DEQ 2015a).

2.2.2.2 Methods and Results

A total of 25 wells were sampled in 2017 to complete the second round of regional monitoring within the Teton Basin-Ashton subarea (Figure 19). The 25 wells included 23 sampled for the initial round of sampling in fall 2013. Permission could not be obtained to resample Well 2244. Wells 2755 and 2763 were added for 2017. The additional wells were selected following the same process as for the original monitoring network. Randomly identified 1-square-mile sections drawn from the original list were reviewed for domestic wells suitable for regional monitoring; domestic wells completed in the shallow-most portion of the aquifer and with documented well construction. Wells included in either the IDWR statewide ground water monitoring or ISDA regional monitoring programs were excluded. Samples were submitted for analysis to IBL in Boise.

A Hach Hydrolab Quanta G with a flow through cell was used to obtain field measurements for water temperature, specific conductance, pH, and DO. Field measurements are presented in Table 28.

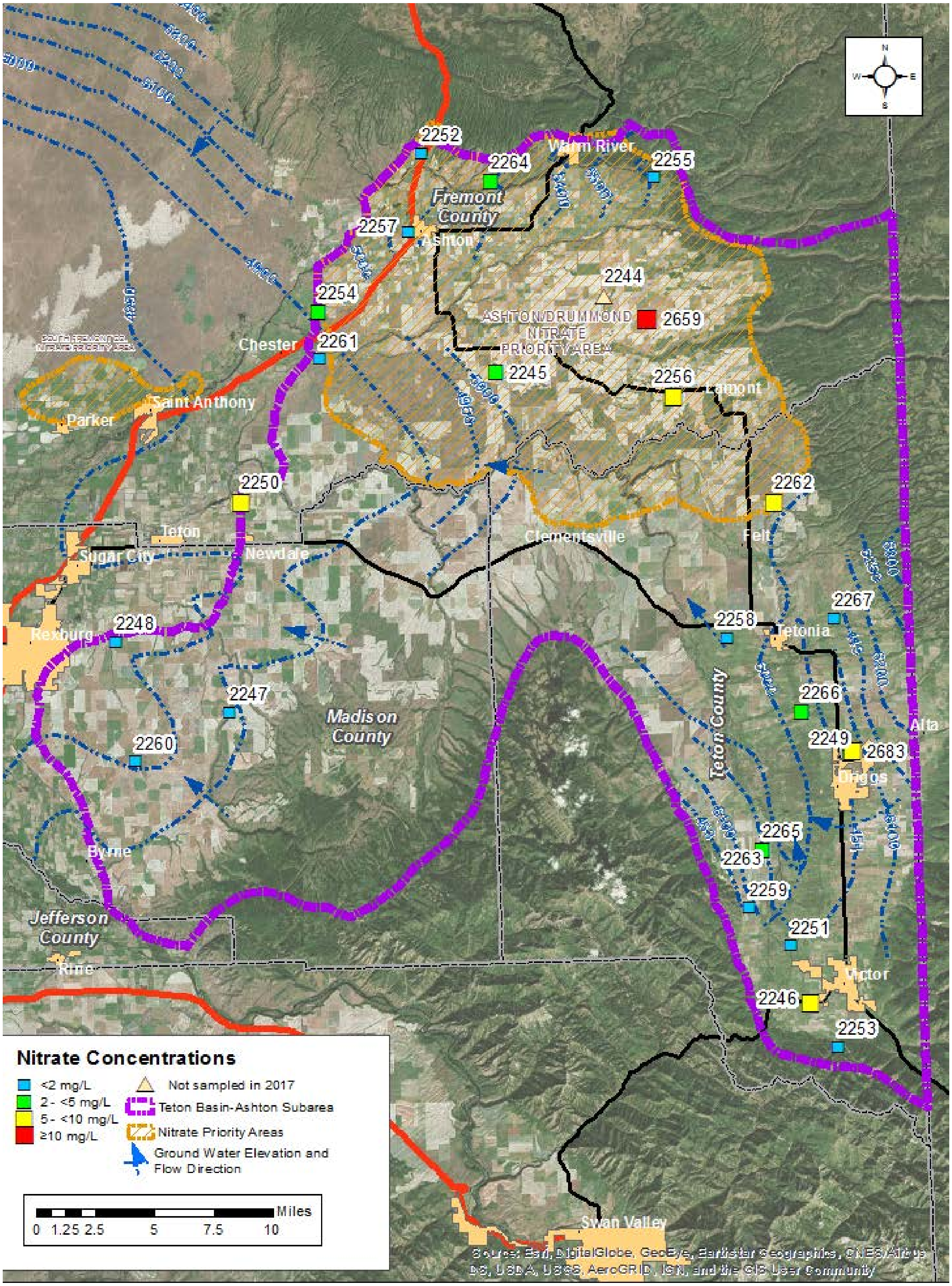

Figure 19. Project area and 2017 nitrate (nitrate-nitrite nitrogen) concentrations—Teton Basin-Ashton Subarea Regional Ground Water Monitoring project.

Table 28. Water quality field parameters—Teton Basin-Ashton Regional Monitoring Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2245	220	09/11/2017	13.69	427	7.12	8.52
2246	120	10/05/2017	9.65	556	7.01	10.34
2247	600	10/16/2017	10.90	247	6.73	8.50
2248	320	10/16/2017	13.84	410	7.30	7.09
2249	120	10/05/2017	10.33	291	7.36	9.11
2250	245	10/16/2017	13.64	561	7.41	7.64
2251	55	11/02/2017	7.55	374	7.22	7.92
2252	245	10/19/2017	13.38	145	6.89	8.15
2253	266	10/05/2017	9.56	386	7.01	8.38
2254	64	10/19/2017	11.93	347	7.00	6.19
2255	342	10/19/2017	8.82	523	7.09	2.31
2256	400	11/02/2017	9.98	567	7.26	6.80
2257	43	10/19/2017	10.88	356	6.79	4.30
2258	197	11/02/2017	8.58	351	7.34	4.56
2259	80	10/05/2017	8.96	427	7.33	0.44
2260	635	10/16/2017	11.97	284	7.30	7.01
2261	105	10/19/2017	11.71	204	6.76	5.99
2262	220	11/20/2017	9.02	699	6.90	8.21
2263	260	10/05/2017	8.88	510	7.14	0.30
2264	340	10/19/2017	12.31	224	6.96	2.54
2265	107	10/12/2017	8.41	493	7.21	11.83
2266	85	10/12/2017	9.55	397	7.26	10.64
2267	180	11/02/2017	7.94	424	7.00	7.29
2659	560	11/02/2017	9.18	594	7.21	9.30
2683	140	10/12/2017	8.10	362	7.29	11.97

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter

Water temperature ranged from 7.55 to 13.84 °C with a median value of 9.65 °C. Specific conductance ranged from 145 to 699 µS/cm, with a median value of 386 µS/cm. The pH ranged from 6.73 to 7.41 with a median value of 7.14. DO ranged from 0.30–11.97 mg/L with a median of 7.64 mg/L. Wells 2255 and 2263 had relatively low dissolved oxygen levels between 2.0 and 3.0 mg/L. Wells 2259 and 2263 yielded field measurements at anoxic levels (less than 1 mg/L DO.

Nutrient Results

Nitrate (nitrate-nitrite nitrogen) concentrations ranged from nondetect (less than 0.01 mg/L) for Wells 2259 and 2263 to 13 mg/L, with a median value of 1.8 mg/L (Table 29). Although less than the standard reporting level, IBL provided an estimated value of 0.0038 mg/L for the Well 2259 sample. Nitrate concentrations for Wells 2246, 2250, 2256, 2262, and 2683 had concentrations ranging from 5.0 to 10 mg/L; Well 2659 exceeded the 10 mg/L MCL. Wells 2251, 2256, 2259, 2263, and 2266 all had detectable ammonium, with concentrations ranging from 0.011 to 1.8 mg/L. Wells 2259 and 2263 with nitrate below the reporting level yielded detectable ammonium at concentrations of 1.8 mg/L and 0.089 mg/L. Both wells were anoxic (low DO) and returned nitrate concentrations below the reporting level of 0.01 mg/L.

Table 29. Nutrient and nutrient-related isotope results—Teton Basin-Ashton Regional Monitoring Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration		Isotopes		
			Nitrate (Nitrate-Nitrite Nitrogen)[a]	Ammonia	$\delta^{18}O_{nitrate}$	$\delta^{15}N_{nitrate}$	$\delta^{15}N$
			mg/L		‰		
Water Quality Standard:			10	No Stand.	No Stand.	No Stand.	No Stand.
2245	220	09/11/2017	3.7	<0.010	-5.60	6.20	—
2246	120	10/05/2017	7.5	<0.010	-5.50	3.53	—
2247	600	10/16/2017	0.94	<0.010	0.46	13.95	—
2248	320	10/16/2017	1.2	<0.010	-5.54	5.51	—
2249	120	10/05/2017	1.8	<0.010	-4.50	2.12	—
2250	245	10/16/2017	7.6	<0.010	-2.72	5.66	—
2251	55	11/02/2017	1.2	0.011	-8.23	4.50	—
2252	245	10/19/2017	1.5	<0.010	-5.96	2.51	—
2253	266	10/05/2017	0.13	<0.010	-8.91	3.35	—
2254	64	10/19/2017	2.8	<0.010	-6.17	4.04	—
2255	342	10/19/2017	1.5	<0.010	-6.14	3.25	—
2256	400	11/02/2017	7.5	0.016	-7.41	4.43	—
2257	43	10/19/2017	1.8	<0.010	-6.17	5.26	—
2258	197	11/02/2017	0.69	<0.010	-4.63	6.67	—
2259	80	10/05/2017	<0.010	1.8	—	—	4.72
2260	635	10/16/2017	0.37	<0.010	-8.50	5.10	—
2261	105	10/19/2017	0.67	<0.010	-8.30	4.92	—
2262	220	11/20/2017	7.3	RD	-7.64	6.67	—
2263	260	10/05/2017	<0.010	0.089	—	—	11.35
2264	340	10/19/2017	2.0	<0.010	-4.22	5.63	—
2265	107	10/12/2017	4.8	<0.010	—	—	—
2266	85	10/12/2017	2.5	0.011	-5.06	3.64	—
2267	180	11/02/2017	1.8	<0.010	-5.42	5.64	—
2659	560	11/02/2017	**13**	<0.010	-6.77	3.89	—
2683	140	10/12/2017	5.4	<0.010	-5.75	1.49	—

a. Contaminant with a NPDWR standard.

Notes: ‰ = permil; mg/L = milligram per liter; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established; RD = rejected data. (Rejected by the data validator due to improper preservation of sample). Results are not usable as detections or nondetects for any purpose due to a QA/QC exceedance or equipment malfunction; J = Analyte was detected, but the value of the result is an estimate. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWS only but are used to evaluate water quality in private wells.

Bacteria Results

TC bacteria was detected in samples in Wells 2254, 2259, 2261, 2264, and 2265 with levels ranging from 1.0 MPN/100 mL to 658.6 MPN/100 mL, and a median of 178 MPN/100 mL for wells with detections (Table 30). The highest TC detection was observed for Well 2265; concentrations observed are significantly greater than previous sampling and similar to concentrations observed in surface water. *E. coli* was not detected in any sample. All samples were collected from outdoor frost-free hydrants nearest the wellhead, which may not have been used for a number of weeks, perhaps contributing to the levels of TC observed. TC detections did not appear to be correlated to any other parameters.

Table 30. Bacteria results—Teton Basin-Ashton Regional Monitoring Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform (TC)
			MPN/100 mL	
Primary or Secondary Standard:			<1	1.0
2245	220	09/11/2017	<1.0	<1.0
2246	120	10/05/2017	<1.0	<1.0
2247	600	10/16/2017	<1.0	<1.0
2248	320	10/16/2017	<1.0	<1.0
2249	120	10/05/2017	<1.0	<1.0
2250	245	10/16/2017	<1.0	<1.0
2251	55	11/02/2017	<1.0	<1.0
2252	245	10/19/2017	<1.0	<1.0
2253	266	10/05/2017	<1.0	<1.0
2254	64	10/19/2017	<1.0	201.4
2255	342	10/19/2017	<1.0	<1.0
2256	400	11/02/2017	<1.0	<1.0
2257	43	10/19/2017	<1.0	<1.0
2258	197	11/02/2017	<1.0	<1.0
2259	80	10/05/2017	<1.0	222.4
2260	635	10/16/2017	<1.0	<1.0
2261	105	10/19/2017	<1.0	1.0
2262	220	11/20/2017	<1.0	<1.0
2263	260	10/05/2017	<1.0	<1.0
2264	340	10/19/2017	<1.0	135.4
2265	107	10/12/2017	<1.0	658.6
2266	85	10/12/2017	<1.0	<1.0
2267	180	11/02/2017	<1.0	<1.0
2683	140	10/12/2017	<1.0	<1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters

Nitrogen Isotope Results

Analysis of nitrogen isotope ratio of the nitrogen atom in the nitrate molecule ($\delta^{15}N_{nitrate}$) was completed for 23 of the 25 wells. Results for $\delta^{15}N_{nitrate}$ ranged from 1.49‰ to 13.95‰ with a median value of 4.93‰ (Table 29). Wells 2246, 2247, 2249, 2252, 2253, 2254 (included at 4.04‰), 2255, 2266, 2659, and 2683 returned $\delta^{15}N_{nitrate}$ ratios of about 4‰ and lower, indicating an inorganic nitrogen source; other processes can also impact this ratio. These wells include four of the six wells with nitrate concentrations above 5 mg/L, including Well 2659, which exceeded the 10 mg/L MCL. Of these 10 wells, eight had sulfate/chloride ratios less than 2, supporting the observation that wells with an inorganic $\delta^{15}N_{nitrate}$ signature tend to have higher sulfate concentrations relative to chloride. Another 14 wells returned $\delta^{15}N_{nitrate}$ ratios from greater than 4‰ to about 6.8‰, which are within the range attributed to a mixed or organic nitrogen source. Well 2247 had a value of 13.95‰, typically attributed to waste-related sources. Ratios of sulfate/chloride for wells with a mixed/organic to waste signature tend to be less than 2, with 12 of the 14 wells having $\delta^{15}N_{nitrate}$ ratios greater than ~5‰ returning sulfate/chloride ratios less than 2, and Wells 2248, 2260, 2262, 2245, 2257, and 2261 with sulfate/chloride ratios less than 1 are within this mixed/organic to waste range (Well 2247). A Piper diagram for wells sampled in 2017 plotted relative to $\delta^{15}N_{nitrate}$ is presented in Figure 20. The anion portion of the plot illustrates the tendency for an increase in $\delta^{15}N_{nitrate}$ ratios to correspond to a relative increase in the proportion of chloride in the sample while lower ratios of $\delta^{15}N_{nitrate}$ tend to correspond to a relative increase in sulfate. The mixed region (Cl+SO4 versus Ca+Mg) shows a general tendency for wells with lower $\delta^{15}N_{nitrate}$ ratios to have a relatively small proportion of sodium and potassium in the samples.

Samples from Wells 2259 and 2263 did not yield sufficient nitrate for analyzing $\delta^{15}N_{nitrate}$. Analysis for nitrogen isotope ratio of ammonia ($\delta^{15}N_{NH4}$) was requested for these samples; however, results have not been received from the laboratory. Analysis of nitrogen isotope ratio of total nitrogen ($\delta^{15}N$) was completed for Wells 2259 and 2263; concentrations were 4.72‰ and 11.35‰ (Table 29).

General Ground Water Chemistry Results

Analytical results for common cations are shown in Table 31. Plotting chloride versus sulfate can define the relationships shown in the Piper diagram (Figure 20). Chloride and sulfate are natural constituents in ground water and will have a relative abundance determined from rock and soil materials in the local aquifer materials. Anthropogenic impacts may result in a disproportionate addition of these major anions. Sulfate can be added as ammonium sulfate or as another compound to meet soil nutrient needs. Chloride can be disproportionality added due to waste disposal from septic systems, animal wastes, or other sources. Figure 21 shows chloride versus sulfate for Teton Basin-Ashton regional monitoring sites. Due to the variety of local aquifer conditions, a single characteristic sulfate versus chloride relationship is not apparent. Wells exist where disproportionate increases of sulfate and chloride are apparent. The six wells with nitrate greater than 5 mg/L are identified (Figure 21). Other locations identified due to their higher sulfate/chloride ratio are Well 2249 (1.8 mg/L), Well 2253 (0.13 mg/L), and Well 2265 (4.8 mg/L).

Table 31. Common ion and TDS results—Teton Basin-Ashton Regional Monitoring Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Alkalinity as ($CaCO_3$) (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride (mg/L)[a]	Fluoride (mg/L)[a,b]	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)[a]
Primary or Secondary Standard:			No Stand.	No Stand.	No Stand.	250	2.0/4	No Stand.	No Stand.	No Stand.	250
2245	220	09/11/2017	185	82.3	53	15.0	0.864	16	2.6	13	10.3
2246	120	10/05/2017	246	22.6	84	4.75	<0.20	21	0.80	1.8	16.0
2247	600	10/16/2017	109	28.5	33	7.10	0.238	7.8	2.7	5.1	4.17
2248	320	10/16/2017	146	84.6	42	22.8	1.40	16	3.5	18	23.6
2249	120	10/05/2017	140	<10	44	0.575	<0.20	11	0.71	0.76	5.70
2250	245	10/16/2017	206	69.7	49	21.2	0.514	20	3.8	38	25.3
2251	55	11/02/2017	184	<10	52	1.81	<0.20	16	0.79	1.8	8.40
2252	245	10/19/2017	56	16.9	14	3.48	1.13	3.4	1.3	10	3.16
2253	266	10/05/2017	177	16.8	60	0.975	<0.20	13	1.0	2.3	22.4
2254	64	10/19/2017	145	32.9	34	9.21	1.57	12	2.8	17	7.22
2255	342	10/19/2017	274	16.3	63	1.45	0.645	26	1.8	6.2	3.40
2256	400	11/02/2017	268	33.1	68	3.46	0.580	27	2.7	9.2	6.94
2257	43	10/19/2017	147	36.2	35	13.2	1.64	11	2.4	20	6.77
2258	197	11/02/2017	184	<10	52	1.51	<0.20	13	1.1	2.9	2.83
2259	80	10/05/2017	217	15.9	52	1.61	0.273	15	1.8	15	8.08
2260	635	10/16/2017	127	25.1	32	5.92	1.51	8.7	3.8	14	6.10
2261	105	10/19/2017	80	25.6	17	7.82	*2.29*	3.9	2.5	18	3.35
2262	220	11/20/2017	272	164	66	32.3	0.283	35	1.7	26	32.4
2263	260	10/05/2017	230	16.2	47	2.45	0.285	23	2.0	29	39.8
2264	340	10/19/2017	99.0	19.0	25	2.85	1.08	8.3	0.95	7.4	3.73
2265	107	10/12/2017	197	22.5	62	3.50	<0.20	24	0.79	4.3	41.1
2266	85	10/12/2017	191	12.6	60	2.53	<0.20	15	0.74	1.6	7.36
2267	180	11/02/2017	212	26.4	56	2.92	<0.20	18	0.92	5.8	5.89
2659	560	11/02/2017	233	29.3	72	1.67	0.432	26	1.5	6.4	31.0
2683	140	10/12/2017	163	10.2	52	1.09	<0.20	15	0.77	1.0	4.99

a. Contaminant with a NSDWR standard.

b**.** Contaminant with a NPDWR standard.

Notes: mg/L = milligram per liter; µg/L = microgram per liter; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Italicized red numbers indicate an EPA NSDWR standard was exceeded. These regulations apply to PWSs only but are recommended limits and can be applied to private wells to evaluate water quality.

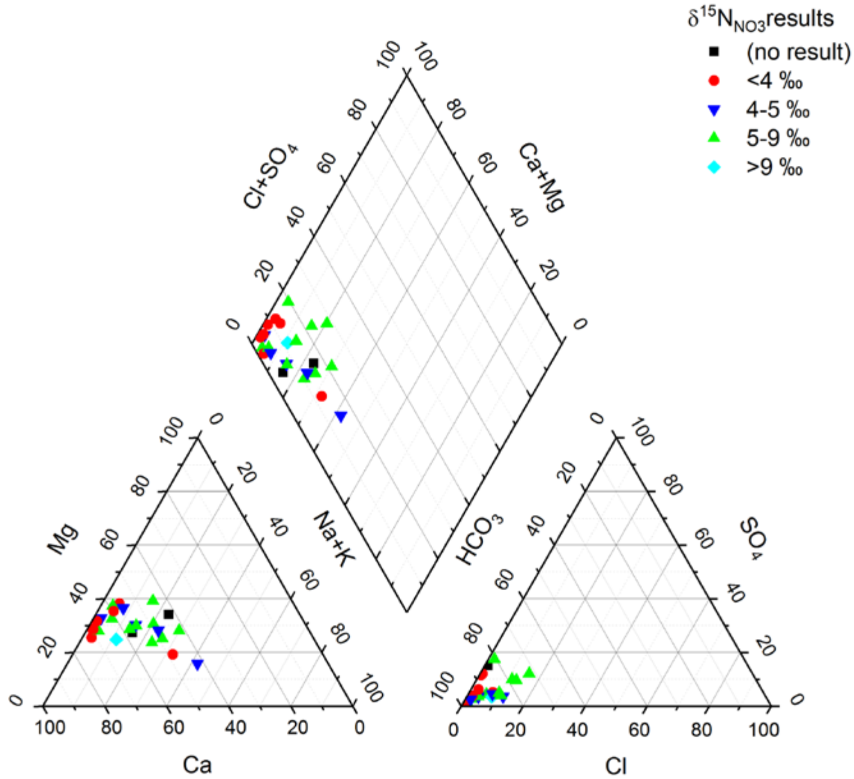

Figure 20. Piper diagram with δ^{15}N—Teton Basin-Ashton Subarea Regional Ground Water Monitoring project.

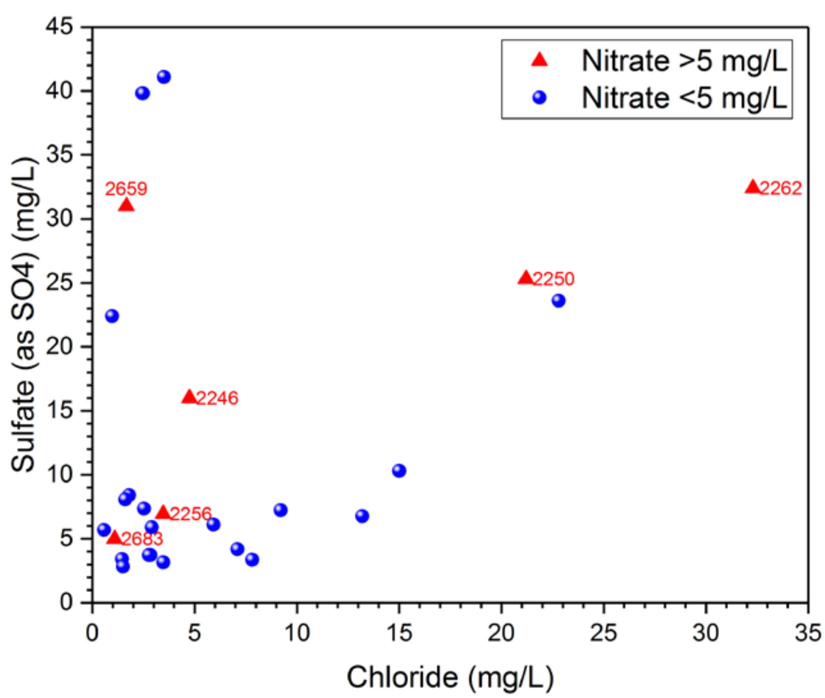

Figure 21. Comparison of chloride versus sulfate concentrations—Teton Basin-Ashton Subarea Regional Ground Water Monitoring project.

Figure 22 is a plot of $\delta^{15}N_{nitrate}$ ratios relative to the sulfate/chloride ratio. Wells with nitrate concentrations greater than 5 mg/L are identified. Wells 2249, 2253, and 2265 have with higher sulfate/chloride ratios. Wells 2249 and 2253 have high relative sulfate and $\delta^{15}N_{nitrate}$ ratios within the inorganic source range. Well 2683 (with a nitrate concentration of 13 mg/L, exceeding the MCL) and Wells 2659 and 2246 are also within the inorganic range. The combination of high sulfate/chloride and an inorganic range for $\delta^{15}N_{nitrate}$ suggests that ground water sampled at these wells is likely impacted by fertilizer-related nitrate. Well 2247, which had a sulfate/chloride ratio of 0.59 and a $\delta^{15}N_{nitrate}$ ratio of 13.95‰, is distinct from the other wells and strongly within the typical waste range (Figure 22). Wells 2256, 2250, and 2262 have nitrate concentrations greater than 5 mg/L and plot within the mixed/organic range (Figure 22). These wells plot with a sulfate/chloride ratio approximately 2 and less and do not show a strong addition of sulfate relative to ambient conditions.

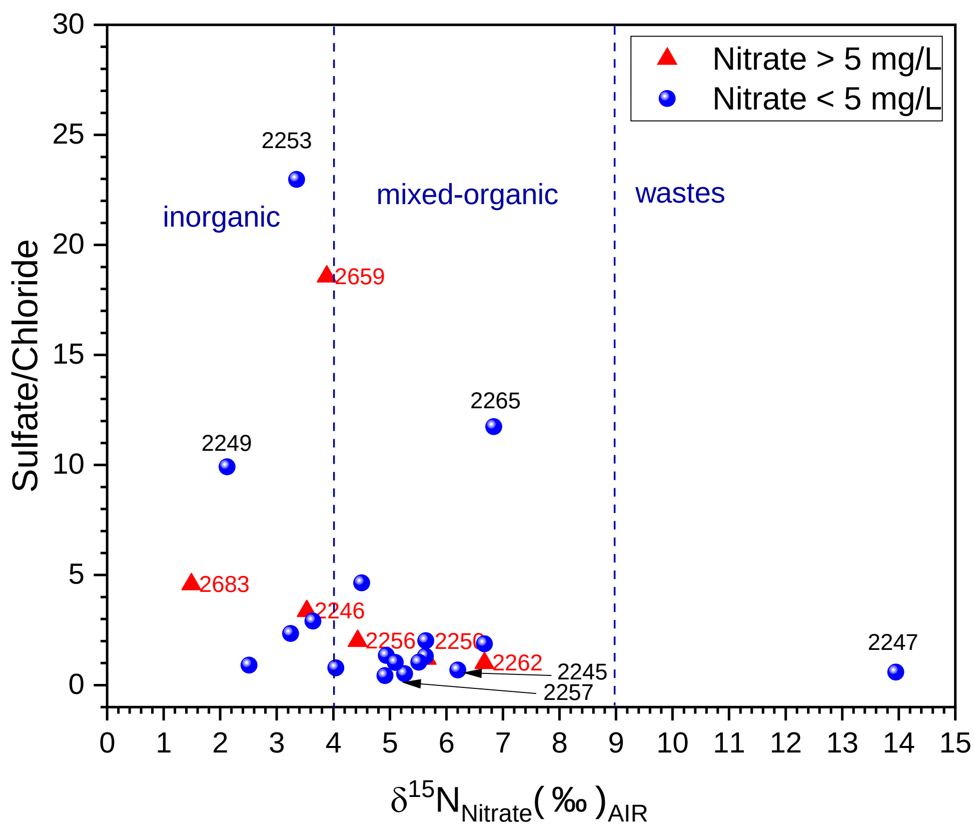

Figure 22. Comparison of $\delta^{15}N_{nitrate}$ versus sulfate/chloride ratio—Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project.

Figure 23 is a plot of $\delta^{15}N_{nitrate}$ ratios relative to nitrate concentrations. Of the six wells with nitrate concentrations above 5 mg/L, Wells 2246, 2659, and 2683 are clearly in the inorganic nitrogen range. Wells 2250, 2256, and 2262 fall within the mixed/organic nitrogen range; Wells 2250 and 2262 correlate more strongly with a mixed/organic nitrogen source than Well 2256, which is close to the inorganic range. Wells 2250 and 2262 also have a sulfate/chloride ratio close to 1, suggesting the apparent mixed organic signature may include some waste influence.

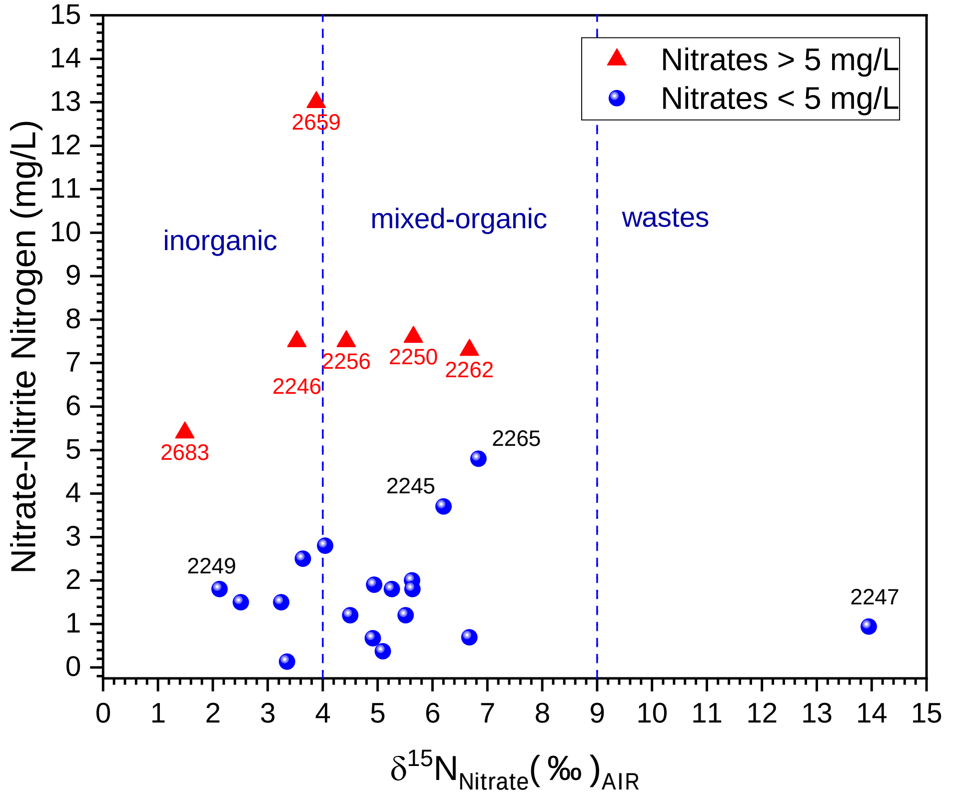

Figure 23. Comparison of $\delta^{15}N_{nitrate}$ versus nitrate—Teton Basin-Ashton Subarea Regional Ground Water Monitoring project.

The chloride versus chloride/bromide relationship is represented in Figure 24. The ratio of chloride to bromide has been used as a means to distinguish between rain water, septic and waste influences, and impact from livestock wastes. Wells with nitrate concentrations greater than 5 mg/L and selected wells that have been distinct in other graphics (Figure 22 and Figure 23) are identified. Three wells with nitrate concentrations greater than 5 mg/L plotted within the range typically observed for septic and waste influences; of those, Wells 2250 and 2262 also returned a $\delta^{15}N_{nitrate}$ ratio in the mixed-organic range and sulfate/chloride ratios near 1. Well 2247, with the $\delta^{15}N_{nitrate}$ ratio well within the waste range, also plotted within the range for septic waste (Figure 24). Well 2245 (3.7 mg/L nitrate), identified in the plot of $\delta^{15}N_{nitrate}$ versus total nitrate, also plotted in the range for septic systems and returned a sulfate/chloride ratio less than 1.

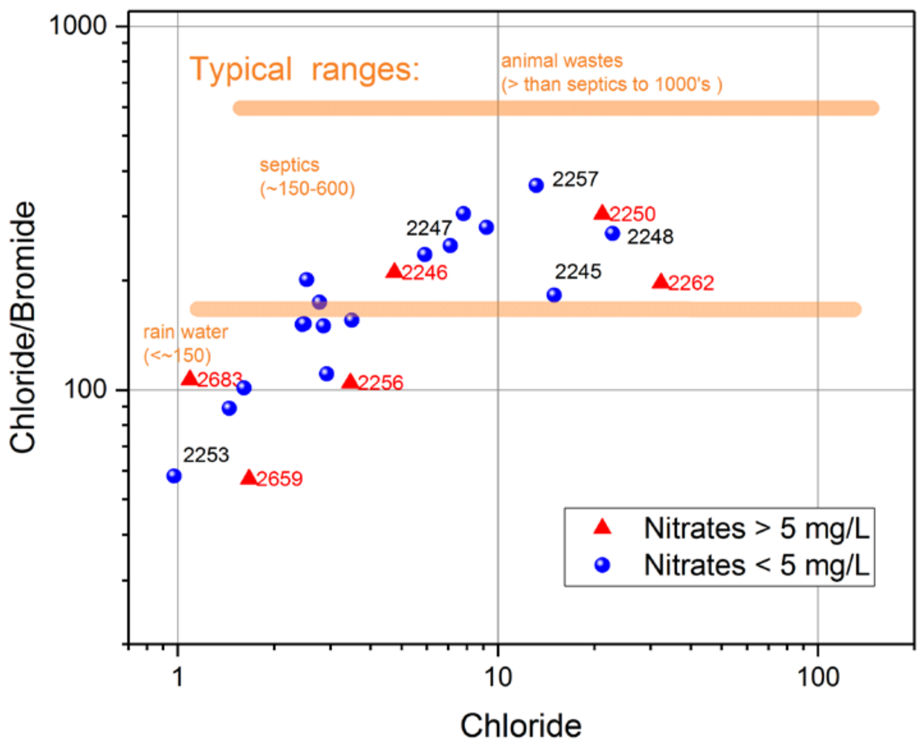

Figure 24. Comparison of chloride concentrations versus chloride/bromide ratio—Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project.

A dual isotope plot of $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$ is presented in Figure 25. The wells with nitrate concentrations exceeding 5 mg/L are distinguished from other wells. The accepted source ranges are identified for typical nitrogen sources. The samples with sufficient nitrogen in the form of nitrate, the characteristic $\delta^{18}O_{nitrate}$ values, suggest nitrification of ammonium sources with oxygen from local ground water can account for the $\delta^{18}O_{nitrate}$ values observed, indicating the nitrate observed do not represent direct infiltration of nitrate-based fertilizers. Based on discussion with local individuals, agricultural practices favor using urea and ammonium-based fertilizers. This plot suggests the observed $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$ result for Well 2247 may reflect denitrification. The combined factors of waste-related sulfate/chloride and chloride/bromide ratios support the waste signature assessment for this site.

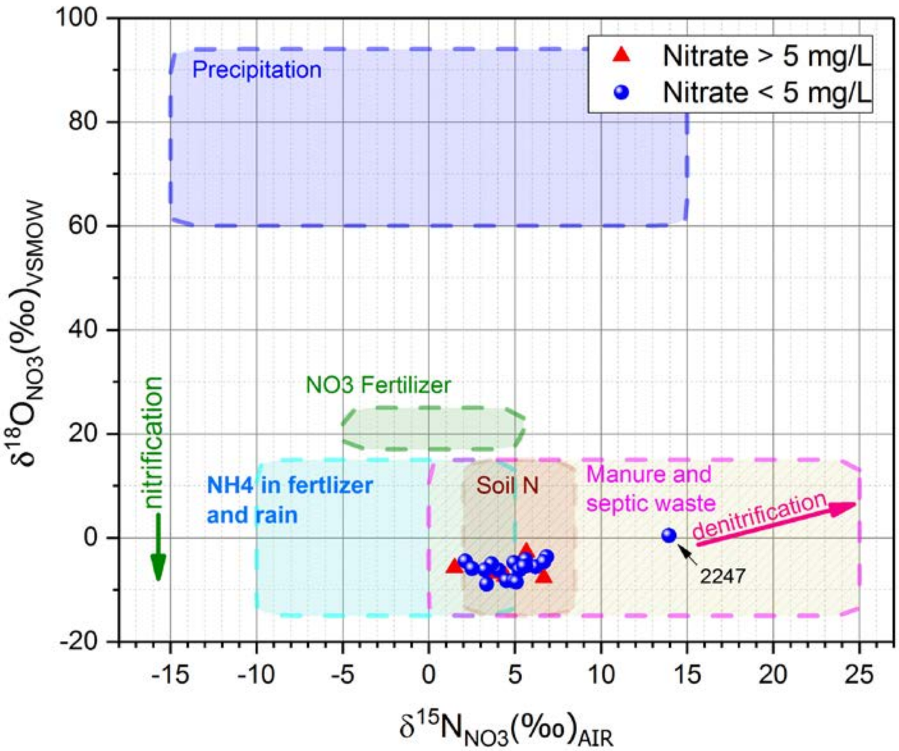

Figure 25. δ15N$_{nitrate}$ versus δ18O$_{nitrate}$—Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project.

Regional monitoring results from 2013 and 2017 sampling were compared. For the 23 sites sampled in 2013 and 2017, the 2017 nitrate result was greater for 14 sites, lower for 7 sites, and the same value for 3 sites. Figure 26 presents changes in nitrate values for the sites sampled in 2013 and 2017.

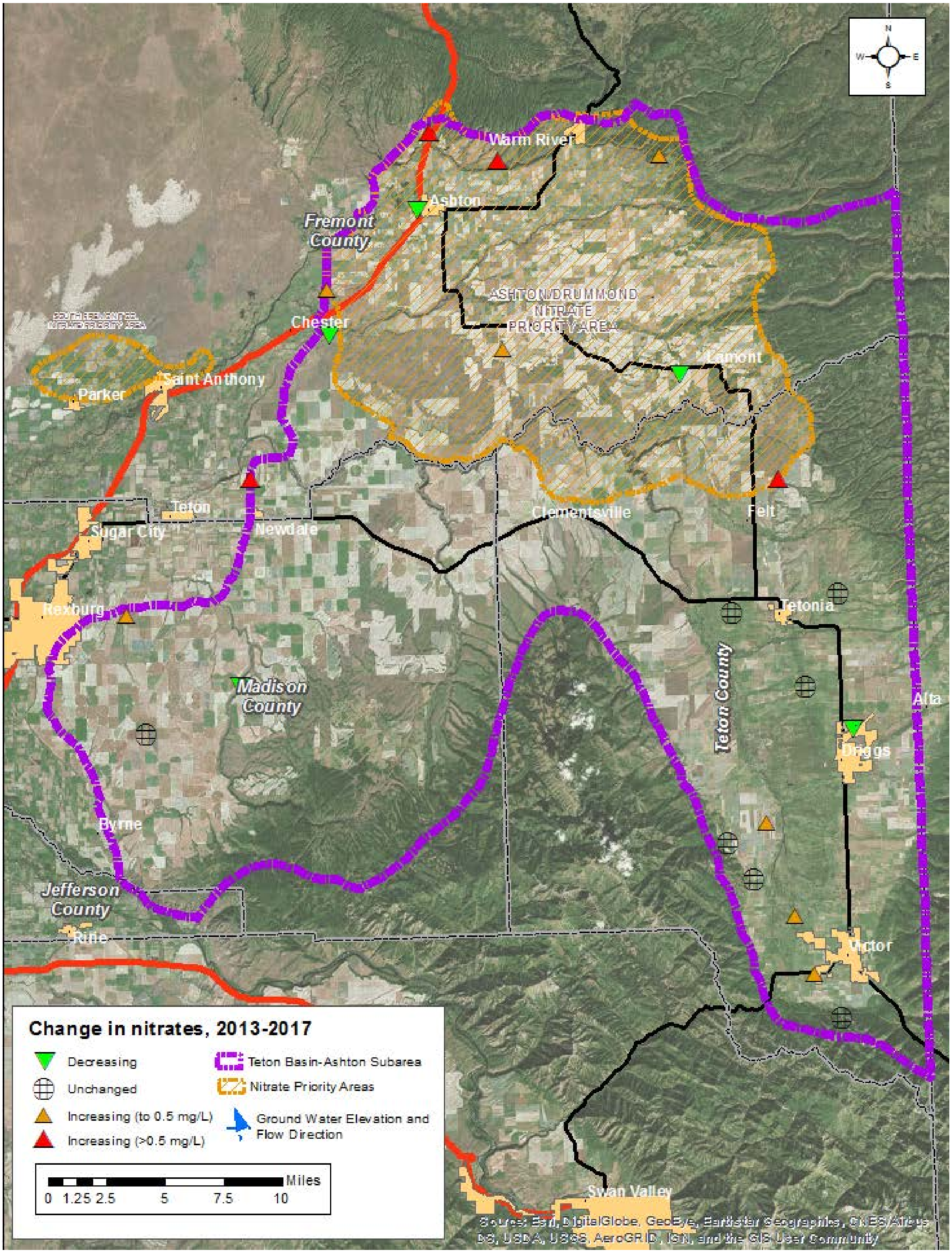

Figure 26. Changes in nitrate (nitrate-nitrite nitrogen) concentrations—Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project.

Seven sites varied by less than 0.1 mg/L and were identified as unchanged; four sites decreased by as much as 1 mg/L, Seven sites increased by as much as 0.5 mg/L, with another four sites increasing by as much as 0.8 mg/L. Results were compared to identify changes in the median nitrate value from 2013 to 2017. Box plots for nitrate values from 2013 and 2017 are presented in Figure 27.

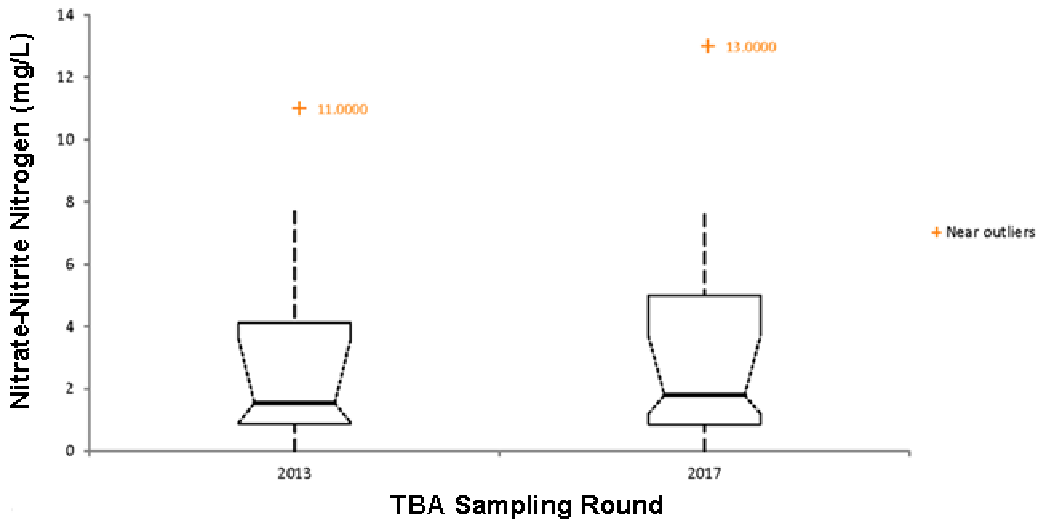

Figure 27. Box plot of nitrate concentrations: a comparison of 2013 and 2017 concentrations—Teton Basin-Ashton Subarea Regional Ground Water Monitoring Project.

The median value for 2013 sampling was 1.55 mg/L and 1.80 mg/L for 2017. The confidence interval about the medians overlap at the 95% confidence level. The populations were compared by combining tests to compare medians. The Sign Test and Wilcoxon Signed- Rank tests both yielded statistics concluding the medians were not different at the 0.05 significance level (Sign Test: probability = 0.26318, Wilcoxon Signed-Rank Test: Z = -1.4562, probability—0.1455). Both the Sign Test and Wilcoxon Signed-Rank tests require paired observations, the Mann-Whitney test, which does not require paired observations, was applied to include sites sampled in only one of the sampling periods. Test statistics for the Mann-Whitney yielded a Z score equal to -0.3702 and associated probability of 0.7099, again concluding at the 95% confidence level, the distributions were not different.

Metals and Trace Constituent Results

Samples were analyzed for additional selected metals and trace constituents (arsenic, total organic carbon, boron, lithium, strontium, and uranium) to identify possible correlations between potential nitrate sources (Table 32). A more complete review will be conducted and published at a later date to identify possible correlations.

Arsenic was detected for samples from six of 25 sites with concentrations ranging from less than the detection level of 2.0 to 5.8 µg/L (Well 2261), with a median result of 2.85 for sites with detectable levels.

Strontium was detected in all samples at concentrations ranging from 29.3 to 1,818 µg/L. The risk posed by strontium, an alkaline earth metal found naturally in the minerals celestine and strontianite, depends on the concentration ingested and on the exposure conditions. EPA's current reference concentration indicates ongoing exposure to strontium at levels above 4,000 µg/L per day may lead to negative health effects. No evidence exists that drinking water with trace amounts of naturally-occurring strontium is harmful (AWWA 2018). However, exposure to high levels of naturally-occurring strontium during infancy and childhood can affect bone growth and cause dental changes, and evidence shows that strontium increases bone density in adults. The isotope strontium-90 has been linked to bone cancers and leukemia. Strontium has 16 known isotopes. Strontium that occurs naturally in the earth has four stable isotopes (Sr-84, -86, -87, and -88). Twelve other strontium isotopes are unstable (i.e., radioactive). Strontium-90 is the most prevalent radioactive isotope in the environment, although strontium-89 is found around nuclear reactors. In the medical field, strontium-85 is used in bone-imaging processes. The Idaho Ground Water Quality Rule for strontium-90 is 8 picocuries per liter.

Uranium was detected at measurable concentrations in 24 of the 25 samples; measured concentrations were all below the MCL of 30 µg/L and ranged from 0.250 to 5.01 µg/L.

Table 32. Metals and trace constituents—Teton Basin-Ashton Regional Monitoring Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic[a]	Boron	Lithium	Strontium	Total Organic Carbon	Uranium
			µg/L				(mg/L)	µg/L
Primary or Secondary Standard:			10	No Stand.	No Stand.	No Stand.	No Stand.	30
2245	220	09/11/2017	<2.0	21.8	12.6	127	<0.5	5.01
2246	120	10/05/2017	<2.0	9.89	2.36	102	<0.5	0.500
2247	600	10/16/2017	<2.0	10.8	1.29	68.6	<0.5	0.250
2248	320	10/16/2017	2.8	32.9	17.4	123	<0.5	3.57
2249	120	10/05/2017	<2.0	<5	3.47	45.9	<0.5	2.23
2250	245	10/16/2017	2.3	111	14.6	164	<0.5	4.05
2251	55	11/02/2017	<2.0	8.60	1.96	83.8	<0.5	0.367
2252	245	10/19/2017	<2.0	15.1	17.0	29.3	<0.5	0.477
2253	266	10/05/2017	<2.0	10.5	3.11	201	<0.5	0.540
2254	64	10/19/2017	<2.0	85.4	33.0	87.6	<0.5	2.29
2255	342	10/19/2017	<2.0	14.4	12.9	119	<0.5	1.66
2256	400	11/02/2017	2.3	16.4	5.05	165	<0.5	2.30
2257	43	10/19/2017	2.9	166	24.0	103	0.530	0.572
2258	197	11/02/2017	<2.0	7.01	2.91	74.3	<0.5	2.99
2259	80	10/05/2017	<2.0	23.7	4.76	250	0.713	<0.1
2260	635	10/16/2017	3.0	20.4	15.7	81.0	<0.5	1.53
2261	105	10/19/2017	5.8	139	66.2	34.6	<0.5	0.393
2262	220	11/20/2017	<2.0	52.4	4.64	176	1.22	4.58
2263	260	10/05/2017	<2.0	34.9	16.8	1,818	<0.5	0.392
2264	340	10/19/2017	<2.0	11.1	8.31	63.7	<0.5	0.829
2265	107	10/12/2017	<2.0	10.4	2.55	308	<0.5	0.825
2266	85	10/12/2017	<2.0	7.70	1.72	64.0	<0.5	4.39
2267	180	11/02/2017	<2.0	12.8	2.49	100	<0.5	1.71
2659	560	11/02/2017	<2.0	25.6	2.79	123	0.540	0.930
2683	140	10/12/2017	<2.0	6.77	3.38	57.9	<0.5	2.24

a. Contaminant with a NPDWR standard.
Notes: µg/L = microgram per liter; No Stand. = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

2.2.2.3 Conclusions

This regional monitoring study identified areas of vulnerable or degraded water quality, collected data to aid in determining potential sources of degradation, directed and prioritized protection efforts based on potential sources, and evaluated the effectiveness of protection measures to reduce nitrate impacts.

2.2.2.4 Recommendations

DEQ will complete a technical report for this project in the future.

2.3 Coeur d’Alene Region

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

2.4 Lewiston Region

Three ground water quality monitoring projects were conducted in the Lewiston region in 2017 using public funds.

2.4.1 Clearwater Plateau NPA Ground Water Monitoring Project

This section summarizes the 2017 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Clearwater Plateau NPA, north of Grangeville, Idaho.

2.4.1.1 Purpose and Background

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. The value was later determined to be caused by a point source near the wellhead, and the site has not been sampled in subsequent years.

The Clearwater Plateau NPA was designated in part on the 1998 nitrate investigation results. In the most recent 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. The Clearwater Plateau NPA covers approximately 292 square miles or 187,000 acres of an area approximately 1,700 square miles in size north of Grangeville, known as the Clearwater Plateau (Figure 28). Three major rivers border the Clearwater Plateau; the Salmon River to the south, the Snake River to the west, and the Clearwater River to the north and east. Ground water beneath the plateau generally flows northeast through Miocene basalt layers that are overlain by loess ranging in thickness from tens to hundreds of feet and forms the present surface of the Palouse and occasionally in the alluvial valley aquifers and basement rocks (Hagan 2003). Well depths from ground water sampling locations ranged from 28 to 500 feet.

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 implementing voluntary best management practices (BMPs) to reduce nitrate concentrations in ground water.

As part of the plan, approximately $1 million of Clean Water Act §319 grant funds were expended within the NPA through 2011 for implementing agricultural ground water protection BMPs, such as direct seed practices. Direct seed practices allow 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 (i.e., Camas Prairie project) in August 2005 as part of a regional ambient ground water monitoring network. The objective of this long-term ground water monitoring is to determine the GWQM plan's effectiveness in improving ground water quality. Nitrate concentration data are periodically evaluated to determine if ambient concentrations increase or decrease.

The project area is located immediately north of Grangeville, Idaho, straddling Lewis and Idaho Counties and encompassing the towns of Cottonwood, Ferdinand, Craigmont, and Nezperce (Figure 28). The land use is primarily agricultural, specifically dry-land farming. Rangeland and grazing are also commonly found throughout the area.

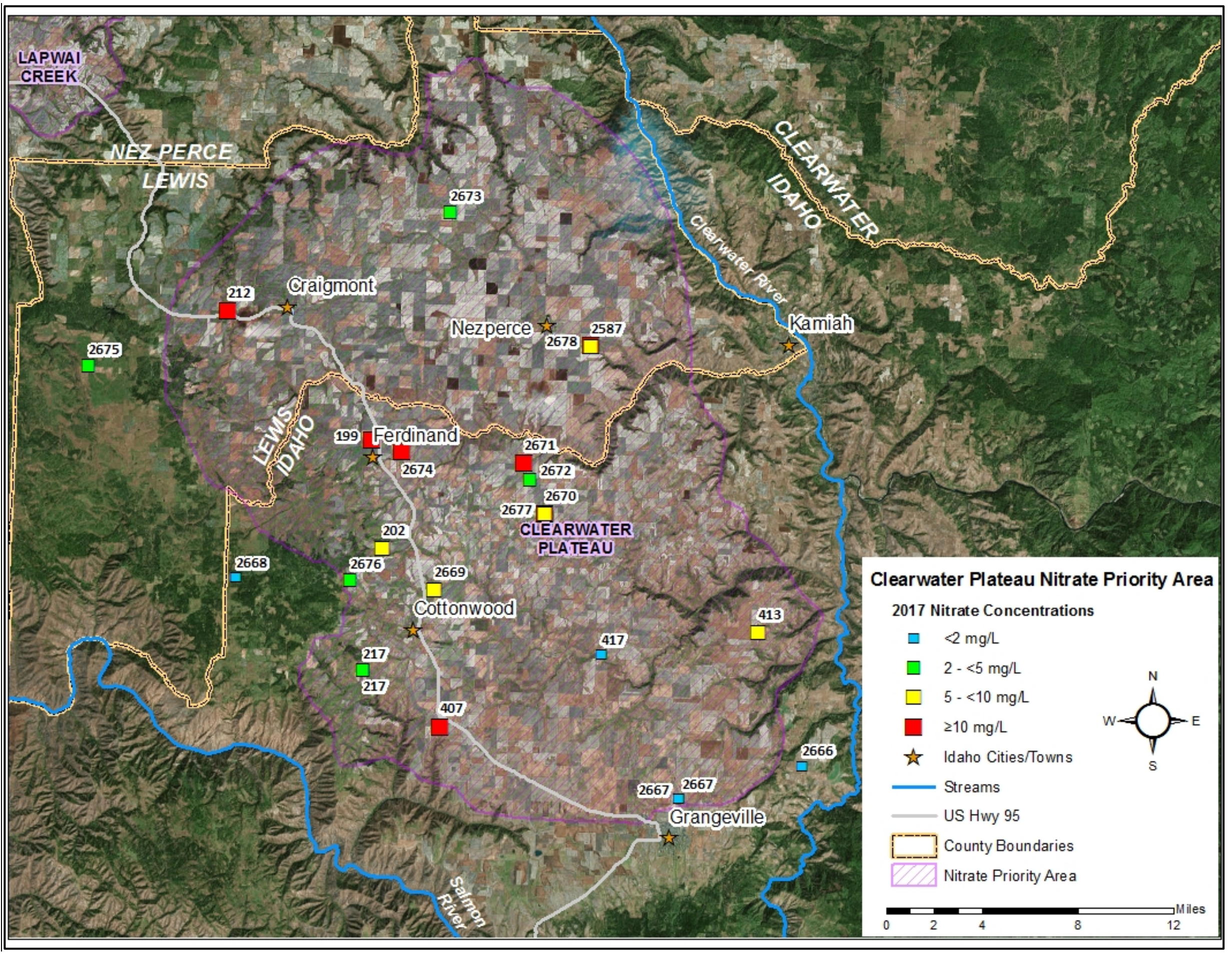

Figure 28. Sampling locations and 2017 nitrate concentrations—Clearwater Plateau NPA Ground Water Monitoring Project.

2.4.1.2 Methods and Results

In October 2017, DEQ staff sampled 21 existing project wells to assess nitrate concentrations within the Clearwater Plateau NPA (Figure 28). Well selection was conducted with an emphasis on historically sampled wells, wells with a well log, homeowner permission, and spatial distribution across the project area to achieve a representative distribution.

All samples were collected according to the regional QAPP (DEQ 2017h) and FSP (DEQ 2017i).Water quality field parameters (pH, temperature, specific conductivity, and DO) 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 (Table 33). Samples were collected for nitrate (nitrate-nitrite nitrogen). All samples were submitted for analysis to Anatek Labs, Moscow, Idaho.

Table 33. Water quality field parameters—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
199	140	10/04/2017	10.0	590	7.80	10.12
202	400	10/03/2017	12.0	335	7.37	5.06
212	400	10/04/2017	13.4	451	8.03	7.12
217	200	10/03/2017	13.6	301	7.48	6.32
407	475	10/02/2017	14.5	511	7.98	4.70
413	Unk	10/02/2017	16.1	462	7.27	7.10
417	187	10/02/2017	12.5	426	8.20	0.12
2587	Unk	10/04/2017	12.4	480	7.80	8.19
2666	700	10/02/2017	19.2	290	8.25	0.08
2667	380	10/02/2017	13.5	324	8.11	0.05
2668	Unk	10/03/2017	10.8	149.5	6.54	4.36
2669	300	10/03/2017	11.3	441	7.23	8.36
2670	300	10/04/2017	12.4	705	7.58	4.91
2671	127	10/03/2017	11.1	1207	7.64	8.53
2672	Unk	10/03/2017	14.6	414	7.07	4.98
2673	400	10/04/2017	11.7	405	8.28	0.81
2674	Unk	10/03/2017	11.4	577	7.39	7.25
2675	12	10/04/2017	8.5	108.1	*6.07*	4.09
2676	Unk	10/03/2017	10.7	206.6	7.09	4.50
2677	Unk	10/04/2017	13.3	746	7.69	4.76
2678	340	10/04/2017	11.8	579	7.63	7.03

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Nitrate Results

Nitrate (nitrate-nitrite nitrogen) results ranged from less than 0.1 mg/L (nondetect) to 27.3 mg/L, which was reported for Well 2671 (Figure 28; Table 34). Of the 21 wells sampled, seven wells (or 33%) had nitrate concentrations over the 10 mg/L MCL (Table 34).

Table 34. Nitrate (nitrate- nitrite nitrogen) results—Clearwater Plateau NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration Nitrate (Nitrate-Nitrite Nitrogen)[a] (mg/L)
Water Quality Standard:			10
199	140	10/04/2017	**12.7**
202	400	10/03/2017	5.75
212	400	10/04/2017	**19.0**
217	200	10/03/2017	3.87
407	475	10/02/2017	**11.7**
413	Unk	10/02/2017	9.08
417	187	10/02/2017	<0.1
2587	Unk	10/04/2017	6.13
2666	700	10/02/2017	<0.1
2667	380	10/02/2017	<0.1
2668	Unk	10/03/2017	1.52
2669	300	10/03/2017	9.77
2670	300	10/04/2017	**15.8**
2671	127	10/03/2017	**27.3**
2672	Unk	10/03/2017	2.80
2673	400	10/04/2017	2.48
2674	Unk	10/03/2017	**11.3**
2675	12	10/04/2017	2.70
2676	Unk	10/03/2017	3.04
2677	Unk	10/04/2017	9.77
2678	340	10/04/2017	**10.5**

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

Of the seven wells that had nitrate concentrations in excess of the MCL, four were wells not previously sampled by DEQ so no historical data exist for comparison. Well 199 has been sampled since 2008 with nitrate concentrations ranging from 7.35 to 9.74 mg/L until 2015 when the concentration jumped to 12.4 mg/L. Well 199 was not sampled in 2016, but the 2017 nitrate concentration elevated to 12.7 mg/L (Table 34). Well 212 has also been sampled since 2008 and historically had elevated nitrate concentration ranging from 16.3 to 21.4 mg/L. The 2017 result of 19.0 mg/L was consistent with historical concentrations at this site. Well 407 has been sampled regularly since 2008, and nitrate concentrations have been highly variable, ranging from 0.913 to 8.74 mg/L. The nitrate concentration was at its highest (15 mg/L) in September 2011. The 2017 result of 11.7 mg/L nitrate is the second highest concentration on record for this site. The preceding sample collected in June 2015, contained a nitrate concentration of 1.05 mg/L. Further investigation is needed to determine what is causing the variation in nitrate concentrations at this site.

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 several locations exceeding EPA's MCL for nitrate 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) (Seiler 1996; Table 3). Based on the large areal extent of degraded ground water in the Clearwater Plateau NPA, commercial fertilizer, livestock manure, and septic discharge are all potential sources of elevated nitrate concentrations detected within the project area.

DEQ was successful in increasing the sampling size for this project compared to the 2016 sampling effort. A larger data set allows for better trend analysis and a clearer vision of the overall conditions within this NPA. Four new wells had nitrate detections above the EPA nitrate MCL of 10 mg/L. Nine new wells were under the MCL in this sampling and have no prior data for comparison; however, Wells 2669 and 2677 were close to the MCL with concentrations of 9.77 mg/L. Wells 199, 212, and 407 had detections above the MCL, but the concentrations were within their historical range. Wells 217 and 413 had concentrations below the MCL; however, both had all-time high nitrate concentrations slightly above their historical ranges. Continued annual monitoring will indicate increasing trends in the nitrate concentration at these sites or just a year of elevated concentrations.

2.4.1.4 Recommendations

DEQ recommends yearly monitoring of the Clearwater Plateau 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 as well as changes in ambient conditions. Available nitrogen source tracking tools may be needed since nitrogen isotope analysis has not been completed for this project in over 10 years.

DEQ may consider monitoring spring water when ground water provides the only source of water to a spring. This information may determine if and where ground water nitrogen is contributing to surface water concentrations within the drainage basin and identify areas to focus BMP implementation efforts. Baldwin et al. (2008) summarizes data collected for this project from 2005 through 2007.

2.4.2 Lindsay Creek NPA Ground Water Monitoring Project

This section summarizes the 2017 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Lindsay Creek NPA, near Lewiston, Idaho.

2.4.2.1 Purpose and Background

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

The goal of the Lindsay Creek NPA Ground Water Monitoring Project (previously referred to as the Tammany and Lindsay Creeks Ground Water Monitoring Project) is to create an ambient ground water quality monitoring network to complete a multiple year trend analysis that detects nitrate changes in ground water in the Lindsay Creek NPA and extend ground water quality monitoring to include the aquifer within the Tammany Creek watershed.

The project area is located east and southeast of Lewiston, Idaho. 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 total maximum daily load (DEQ 2010).

DEQ collected ground water quality data from as many as 14 locations (wells and springs) as part of an ambient ground water quality monitoring network from 2010 through 2016. 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

In June 2017, DEQ sampled a total of 24 sites (22 wells and 2 springs) as part of the Lindsay Creek NPA project; six of the 24 sites were new wells added to the project in 2017 (Figure 29). Site selection was conducted with an emphasis on historically sampled wells, wells with a well log, homeowner permission, and spatial distribution across the project area achieve a representative distribution.

All samples were collected according to the regional QAPP (DEQ 2017h) and FSP (DEQ 2017j). 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 35). Samples were collected for nitrate (nitrate-nitrite nitrogen) and bacteria (TC and *E. coli*). All samples were submitted for analysis to Anatek Labs, Moscow, Idaho.

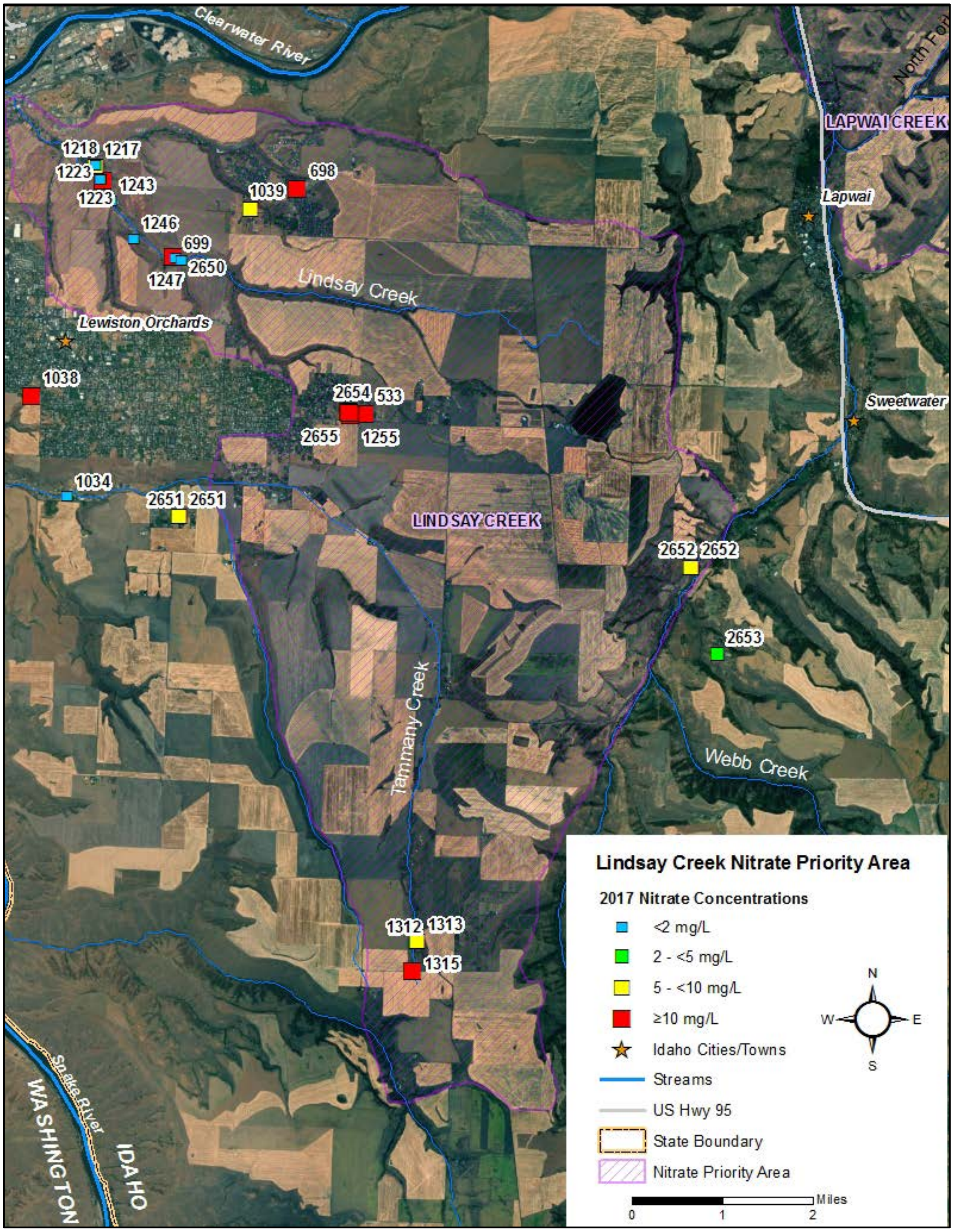

Figure 29. Sampling locations and 2017 nitrate concentrations—Lindsay Creek NPA Ground Water Monitoring Project.

Table 35. Water quality field parameters—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
533	225	06/07/2017	15.1	915	7.85	8.53
698	Unk	06/05/2017	16.4	1665	7.74	9.17
699	285	06/06/2017	18.7	403	8.09	5.47
1034	Unk	06/08/2017	17.2	543	8.12	4.23
1038	150	06/08/2017	13.1	1595	7.85	9.71
1039	Unk	06/05/2017	15.3	887	7.76	8.69
1217	264	06/06/2017	18.6	588	8.31	0.10
1218	28	06/06/2017	14.8	962	7.29	8.88
1223	20	06/05/2017	17.0	598	8.35	0.31
1225	16	06/05/2017	13.9	1053	7.29	6.94
1243	15	06/06/2017	19.1	597	8.31	0.05
1246	575	06/06/2017	21.4	289	*8.76*	1.42
1247	Spring	06/06/2017	15.0	1351	7.88	9.79
1255	200	06/06/2017	18.3	1006	7.78	9.25
1312	1025	06/07/2017	19.2	204.7	8.26	7.41
1313	Spring	06/07/2017	19.6	658	7.31	5.48
1315	589	06/07/2017	13.9	607	7.74	9.57
2022	950	06/07/2017	17.8	243	*8.75*	2.04
2650	380	06/06/2017	18.1	409	8.14	7.18
2651	Unk	06/07/2017	17.5	915	7.56	8.63
2652	Unk	06/08/2017	15.0	486	7.48	9.36
2653	302	06/08/2017	16.9	321	7.80	8.62
2654	197	06/06/2017	14.6	1013	7.75	9.45
2655	203	06/06/2017	17.3	1009	7.70	9.16

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Nitrate Results

The reported nitrate concentrations ranged from nondetect (less than 0.1 mg/L) to 15.6 mg/L; nitrate was detected above the laboratory detection limit in 16 of the 24 (66%) sampled wells (Figure 29 and Table 36). A total of nine wells (37.5% of wells sampled) had a nitrate concentrations that exceeded the nitrate MCL of 10 mg/L. The spatial distribution of nitrate concentrations is presented in Figure 29.

Table 36. Nitrate results—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration Nitrate (Nitrate-Nitrite Nitrogen)[a] (mg/L)
Water Quality Standard:			10
533	225	06/07/2017	**11.0**
698	Unk	06/05/2017	**14.4**
699	285	06/06/2017	<0.1
1034	Unk	06/08/2017	<0.1
1038	150	06/08/2017	**13.8**
1039	Unk	06/05/2017	7.96
1217	264	06/06/2017	<0.1
1218	28	06/06/2017	5.32
1223	20	06/05/2017	<0.1
1225	16	06/05/2017	**12.4**
1243	15	06/06/2017	<0.1
1246	575	06/06/2017	<0.1
1247	Spring	06/06/2017	**10.6**
1255	200	06/06/2017	**12.9**
1312	1025	06/07/2017	0.377
1313	Spring	06/07/2017	8.30
1315	589	06/07/2017	**15.6**
2022	950	06/07/2017	<0.1
2650	380	06/06/2017	<0.1
2651	Unk	06/07/2017	7.72
2652	Unk	06/08/2017	6.91
2653	302	06/08/2017	3.87
2654	197	06/06/2017	**10.0**
2655	203	06/06/2017	**13.0**

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

Of the 12 sites with elevated nitrate, Wells 2654 and 2655 were new, so no historic data are available for comparison. However, these two wells are located on the same property, only a couple hundred feet apart. Wells 1225 and 1247 had not been sampled since 1988, but current nitrate levels did not vary much from the 1988 concentrations. Wells 533, 1255, and 1315 had nitrate concentrations over the MCL but were all within the respective historic ranges. Wells 698 and 1038 were the only sites with nitrate concentrations above the MCL with notable changes. Well 698 showed a 6.6 mg/L decrease in concentration from 21.0 mg/L in 2008 to 14.4 mg/L in 2017. Well 1038 has been sampled annually since 2010. The 2017 concentration of 13.8 mg/L is an increase of 5.4 mg/L above historic high of 8.37 mg/L in 2011 and up from 7.42 mg/L in 2016. This rise in nitrate concentration prompted the well owner to contact DEQ upon receiving the 2017 sampling results with concerns of a possible City of Lewiston pump station leak near the property. The well owner was concerned about the leak impacting the nitrate level in the well and the potential risks to an infant living in the home. DEQ conducted follow-up sampling in 2018 of this site to monitor the nitrate concentration.

Most of the wells under the nitrate MCL had been sampled historically and were within their historical ranges of nitrate concentrations. Wells 1243 and 1246 were both last sampled in 1988, and both had significant decreases in nitrate concentrations. The nitrate concentration at Well 1243 declined from 7 mg/L in 1988 to below the detection limit (less than 0.1 mg/L) in 2017. The nitrate concentration in Well 1246 decreased from 11.9 mg/L in 1988 to below the detection limit (less than 0.1 mg/L) in 2017. Land use in these two locations does not appear to have changed much since 1998, so the reason for the decline is unclear.

Bacteria Results

A total of 10 wells were positive for TC; Well 1225 with TC was also positive for *E. coli* at a concentration of 3.1 MPN/100 mL. TC concentration ranged from 1 MPN/100 mL to 307.6 MPN/100 mL (Table 37).

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.

Of the 24 wells sampled, nine wells exceeded the EPA nitrate MCL of 10 mg/L. Well 1315 had the highest reported nitrate concentration of 15.6 mg/L, which is up from the 2016 concentration of 12.4 mg/L.

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.

2.4.2.4 Recommendations

Yearly monitoring of wells and springs in the Lindsay Creek NPA should continue to enhance the ambient ground water quality data set. Continuing to develop the ambient ground water quality data set allows DEQ to track multiple-year trends, specifically for nitrate. For future yearly NPA monitoring, outlier tests and common ion chemistry could be used to determine if samples represent ambient conditions and to monitor long-term trends in ground water quality, 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. Nitrogen isotope analysis should be included in future sampling efforts to help determine sources of nitrate.

Results from Wells 1243 and 1246 were inconsistent with historical data. DEQ recommends future sampling efforts at these locations include ammonia due to low DO concentrations. It is also recommended that staff confirm these wells are the same as the 1988 sample locations, and if confirmed, no modifications (i.e., deepening) have been made to the wells over the past 30 years.

Table 37. Bacteria results—Lindsay Creek NPA Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]	
			E. coli (MPN/100 mL)	Total Coliform (MPN/100 mL)
Primary or Secondary Standard:			<1	1.0
533	225	06/07/2017	<1	<1
698	Unk	06/05/2017	<1	<1
699	285	06/06/2017	<1	<1
1034	Unk	06/08/2017	<1	—
1038	150	06/08/2017	<1	—
1039	Unk	06/05/2017	<1	161.6
1217	264	06/06/2017	<1	<1
1218	28	06/06/2017	<1	9.5
1223	20	06/05/2017	<1	12.2
1225	16	06/05/2017	**3.1**	99.1
1243	15	06/06/2017	<1	<1
1246	575	06/06/2017	<1	<1
1247	Spring	06/06/2017	<1	307.6
1255	200	06/06/2017	<1	<1
1312	1025	06/07/2017	<1	1.0
1313	Spring	06/07/2017	<1	117.2
1315	589	06/07/2017	<1	5.2
2022	950	06/07/2017	<1	<1
2650	380	06/06/2017	<1	14.5
2651	Unk	06/07/2017	<1	<1
2652	Unk	06/08/2017	<1	—
2653	302	06/08/2017	<1	—
2654	197	06/06/2017	<1	<1
2655	203	06/06/2017	<1	1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = unknown. Well log not found; (—) = not reported by the laboratory. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

2.4.3 Hatwai Creek Nitrate Investigation Project

This section summarizes the 2017 sampling results from a ground water quality investigation surrounding an elevated nitrate concentration in the Hatwai Creek watershed, in Lewiston, Idaho.

2.4.3.1 Purpose and Background

This monitoring project investigated local ground water nitrate concentrations by sampling private, domestic wells near PWS wells for Eaton Mobile Home Park, which have known elevated nitrate contamination. Sampling near the mobile home park wells will help characterize the extent of contamination in the surrounding area.

The Eaton Mobile Home Park, a PWS serving drinking water to its residents, is located in Lewiston, Idaho. As a PWS regulated by DEQ, the wells are routinely sampled and have shown nitrate concentrations above 10 mg/L. Evaluating the water quality in nearby private domestic wells may help understand the extent and possible sources of the nitrate in the mobile home park wells.

The ground water wells in this project area are most closely associated with the Hatwai Creek watershed and are located at the base of a steep grade. Industrial and residential land uses exist in the low-lying area. The surrounding hillsides and plateau at the top of the grade are mostly used for livestock grazing and other agricultural activities.

2.4.3.2 Methods and Results

In June 2017, three wells were sampled for nitrate within the project area (Figure 30). The project area and target wells were based on proximity to the well with known elevated nitrate with the goal of further understanding the extent of the elevated nitrate. Approximately 15 permission letters were mailed to homeowners in the project area, but only two letters were returned. Shortly before project sampling began, the owner of the Eaton Mobile Home Park wells decided they no longer wanted DEQ to sample their wells as part of this project. DEQ was granted permission to sample three wells not including the mobile home park wells.

All samples were collected according to the regional QAPP (DEQ 2017h) and FSP (DEQ 2017k). Water quality field parameters (pH, temperature, specific conductivity, and DO) 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 (Table 38). Nitrate (nitrate-nitrite nitrogen) samples were submitted to Anatek Labs, Inc. in Moscow, Idaho.

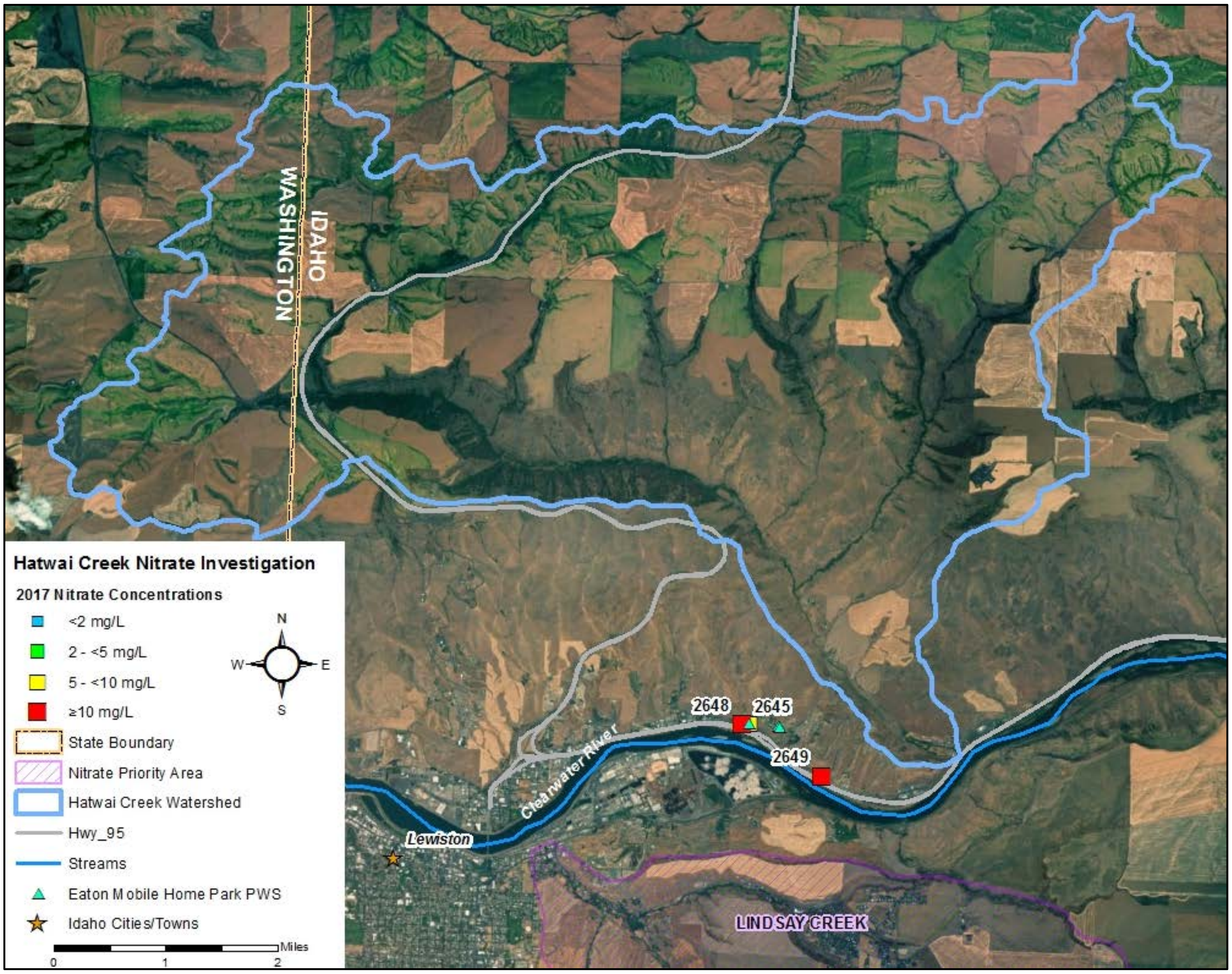

Figure 30. Project location map and nitrate results—Hatwai Creek Nitrate Investigation.

Table 38. Water quality field parameters—Hatwai Creek Nitrate Investigation Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2645	160	06/13/2017	16.6	590	7.41	3.50
2648	Unk	06/13/2017	16.6	414	7.50	11.20
2649	Unk	06/08/2017	17.2	1163	7.23	7.62

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found.

Nitrate Results

Nitrate (nitrate- nitrite nitrogen) results ranged from 8.12 to 21.4 mg/L, which was reported for Well 2649 (Figure 30; Table 39). Two of the three wells sampled had nitrate concentrations over the 10 mg/L MCL (Table 39).

Table 39. Nitrate (nitrate-nitrite nitrogen) results—Hatwai Creek Nitrate Investigation Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration Nitrate (Nitrate-Nitrite Nitrogen)[a] (mg/L)
Water Quality Standard:			10
2645	160	06/13/2017	8.12
2648	Unk	06/13/2017	**13.7**
2649	Unk	06/08/2017	**21.4**

a. Contaminant with a NPDWR standard.
Notes: mg/L = milligram per liter; Unk = unknown. Well log not found. Bolded red numbers indicate either an EPA NPDWR standard, expressed as a MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

Bacteria Results

Of the three wells sampled, Well 2649 had positive detections of both TC and *E. coli* bacteria at a concentration of 29.5 MPN/100 mL (Table 40).

Table 40. Bacteria results—Hatwai Creek Nitrate Investigation Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a] *E. coli* (MPN/100 mL)	Total Coliform (MPN/100 mL)
Primary or Secondary Standard:			<1	1.0
2645	160	06/13/2017	<1	<1
2648	Unk	06/13/2017	<1	<1
2649	Unk	06/08/2017	**29.5**	29.5

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = unknown. Well log not found. Bolded red numbers indicate either an EPA NPDWR standard, expressed as a MCL, or a IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

2.4.3.3 Conclusions

A total of three wells were sampled in June 2017 to further understand the extent and severity of nitrate contamination near PWS wells with known elevated nitrate in the Hatwai Creek watershed. Homeowner participation in the project area was low with only three granting DEQ permission to sample. All three wells showed degradation as nitrate was elevated; two of the three wells had nitrate concentrations that exceeded EPA's MCL of 10 mg/L making them unsafe for human consumption. Of those two wells with nitrate above 10 mg/L (Figure 30; Table 39), Well 2649 also posed acute health risk due the presence of *E. coli* (Table 40).

Because so few wells were sampled for this project, it is difficult to make any determinations about the ground water quality within the project area.

2.4.3.4 Recommendations

DEQ would consider future sampling to increase the number of wells within the project area. It would be beneficial to build a more complete picture of the extent of the nitrate contamination in the area north of Lewiston.

2.5 Pocatello Region

No ground water quality monitoring projects were conducted using DEQ funds in the Pocatello region in 2017.

2.6 Twin Falls Region

One ground water quality monitoring project was conducted in the Twin Falls region in 2017 using DEQ funds.

2.6.1 Lincoln County Ground Water Quality Investigation

This section summarizes the 2017 sampling results from a ground water quality investigation associated with a flooding event in Lincoln County, Idaho.

2.6.1.1 Purpose and Background

In February 2017, rapid snowmelt and extreme flooding, combined with a dairy lagoon breach directly into the Milner-Gooding Canal, contributed to bacterial contamination of domestic wells in a 10 square mile area of Lincoln County northwest of the city of Shoshone. DEQ received a complaint of foul smelling and discolored tap water from a local resident on February 17, 2017. It was also reported that dairy lagoon water was observed in the canal system. Simultaneous with the occurrence of the degraded well water, a major portion of the overland runoff and dairy lagoon water flowing down the main canal disappeared into a fissure or sinkhole within a trench associated with construction of a hydropower plant located approximately 1 mile north of the wells with contaminated water. Construction at the hydropower plant was halted in late fall due to cold weather, but the trench that had been blasted was not sealed before the flooding event (L. Harmon, Big Wood Canal Company, personal communication with Irene Nautch, DEQ, February 22, 2017).

South Central Public Health District (SCPHD) issued an advisory to residents on February 22, 2017, to avoid using or consuming untreated well water due to possible contamination of the local aquifer. SCPHD also provided guidance on flood response on their website. Residents were provided bottled water to drink and bacteria sample bottles by the county to test their own wells. The county also provided daily transportation of samples to a lab in Twin Falls for bacteria analysis. The complaint was referred to the Idaho State Department of Agriculture (ISDA), the agency responsible for regulating dairies in Idaho.

Initial sampling of 15 homeowners' wells for bacteria testing was conducted by ISDA on February 22, 2017 (Figure 31). ISDA staff were escorted by local volunteers who knew of homeowner reports of discolored and foul smelling well water. The results from this sampling event showed nine wells contained water TC bacteria. Water samples from eight of the nine wells with TC also contained *E. coli* (see Bacteria Results, Table 42). TC counts ranged from 10 MPN/100 mL to 2,420 MPN/100 mL. The concentrations of *E. coli* ranged from 9 MPN/100 mL to 411 MPN/100 mL. Well 2601, the local fire station, had the highest *E. coli* count (411 MPN/100 mL). Six wells tested negative for both TC and *E. coli* . A detection of *E. coli* is an exceedance of the Idaho Ground Water Quality Standard.

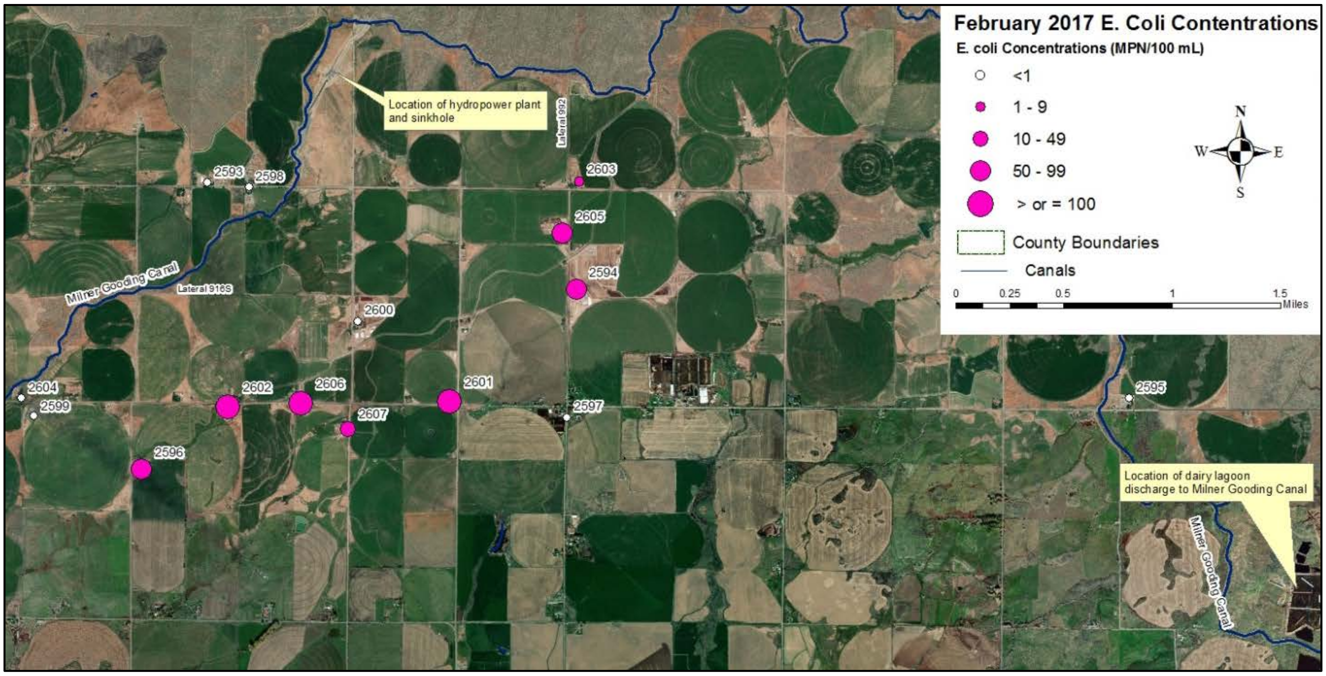

Figure 31. Initial February 2017 *E. coli* results—Lincoln County Ground Water Quality Investigation.

After receiving the laboratory results from the ISDA sampling event, multiple interagency coordination meetings were held to develop a plan to assess the bacterial contamination problem and protect public health. Representatives agreed further sampling was necessary to define the areal extent of contamination, track attenuation of the contaminant plume with time, and possibly identify the source. Consequently, sampling of 29 wells over a period of 9 weeks became a joint effort by multiple state agencies (DEQ, ISDA, Idaho Bureau of Laboratories, Idaho Department of Water Resources) and SCPHD (Figure 32). The project was designed to provide data for continuing to evaluate the ground water quality contamination occurring in this area of Lincoln County.

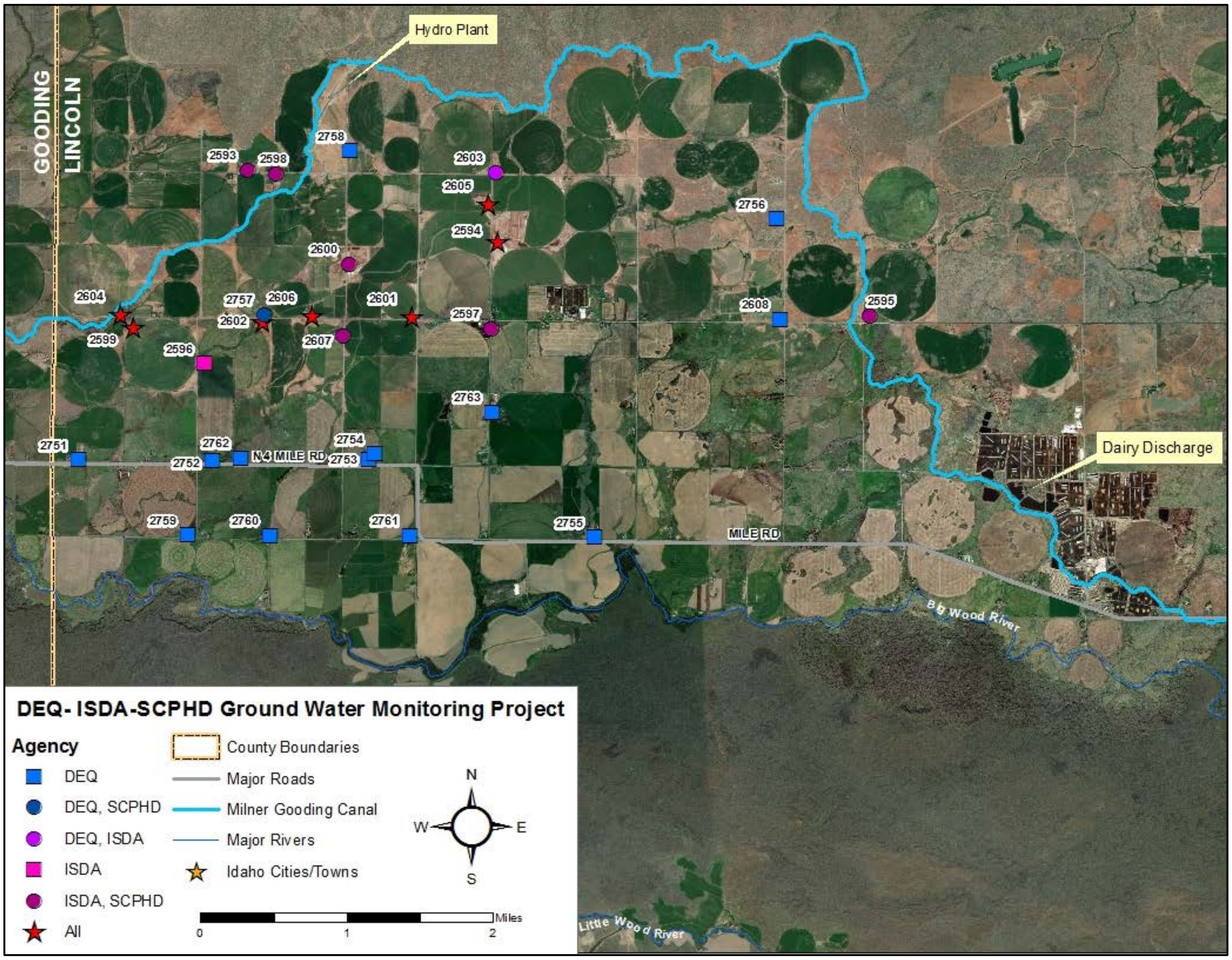

Figure 32. Project location map and location of multiagency sampling—Lincoln County Ground Water Quality Investigation.

On March 9, 2017, SCPHD sampled 14 wells. The event included resampling 13 of the 15 wells sampled by ISDA and sampling Well 2757, which was not previously sampled by ISDA. All wells that were negative for *E. coli* on February 22 remained negative. Wells 2599 and 2604, which were previously negative for TC, had TC counts of 61 and 127 MPN/100 mg/L,. Of the nine wells sampled by ISDA with TC and *E. coli*, Well 2607 dramatically increased in TC (340 to >2,420 MPN/100 mg/L) and *E. coli* (41 to 148 MPN/100 mg/L).

The project was located in an agricultural area of Lincoln County about 9 miles northwest of the city of Shoshone. It is bounded on the north by the Milner-Gooding Canal and to the south by the Big Wood River. Agricultural land use includes both irrigated crop fields and confined animal feeding operations. The area is located in the northwestern portion of the ESRP aquifer, a highly productive generally unconfined basalt aquifer. While ground water flow is generally to the west, and southwest localized flows can vary widely within short distances. Subsurface lithology generally consists of basalt with fractured components and no confining layers. Wells sampled were completed to depths ranging from 230 to 386 feet bgs and static water levels ranged from 150 to 242 feet bgs. Most wells were cased to 18 feet bgs.

2.6.1.2 Methods and Results

DEQ conducted the following sampling and included results from sampling conducted by ISDA and SCPHD for completeness and comparison.

On March 14 and 15, 2017, DEQ collected ground water samples from 22 wells. These wells included eight wells sampled by ISDA, and Well 2757 was sampled by SCPHD, which previously tested positive for *E. coli*. Five of the initial 15 wells were not sampled due to the absence of TC and *E. coli* from the March 9 samples. Wells 2607 and 2596 previously sampled by ISDA could no longer be sampled due to disconnection by the homeowners. Samples from five wells that tested positive for *E. coli* from the March 9 sampling event conducted by SCPHD were submitted to Source Molecular Corporation in Miami, Florida, for DNA testing.

Thirteen wells were added because they were within the zone of influence, including the area west of the dairy breach, south of the Milner-Gooding Canal and hydropower plant, and north of the Big Wood River (Figure 32). The locations of the 13 wells were also selected to confirm bacteria detections in water samples collected by homeowners and submitted to the laboratory.

DEQ conducted follow-up sampling events on April 5 to collect water samples from nine wells. The nine wells included seven wells that tested positive for *E. coli* and two wells that did not contain *E. coli* but had TC concentrations of 20 MPN/100 mL during the previous sampling event conducted on March 14 and 15. The results of this event indicated that water samples from only four wells contained *E. coli*, with concentrations ranging from 1 to 3.1 MPN/100 mL. Eight samples contained TC concentrations, ranging from 1 to 67.7 MPN/100 mL. One sample was negative for both TC and *E. coli*.

DEQ conducted a final sampling event on April 26 at three of the four wells that contained *E. coli*. Before sampling, the wells were disinfected following SCPHD guidance to remove any bacteria in the plumbing. After disinfection, the water systems were flushed, and the wells were allowed to stabilize for least 3 days. Samples were collected from the wells to evaluate if *E. coli* was present in the aquifer. None of the three samples contained *E. coli*.

All samples were collected according to the regional QAPP (DEQ 2013c) and FSP (DEQ 2017l).Water quality field parameters (pH, temperature, specific conductivity, turbidity, and DO) 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 (Table 41). ISDA and SCPHD measured field parameters. Bacteria and nutrient samples were submitted to IBL and Magic Valley Labs; nitrogen isotope samples were submitted to the University of Arizona Environmental Isotope Lab; bacteria samples were submitted to Source Molecular Corporation for DNA testing as part of their microbial source tracking services.

Table 41. Water quality field parameters—Lincoln County Ground Water Quality Investigation.

DEQ Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Turbidity (NTU)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2594	285	03/14/2017	15.2	7.1	531	6.84	—
2594	285	04/05/2017	16.08	—	536	7.22	1.41
2594	285	04/26/2017	15.69	—	446	*6.41*	3.24
2599	280	03/15/2017	14.63	1.6	740	7.33	—
2599	280	04/05/2017	15.63	—	705	7.38	5.88
2601	283	03/14/2017	14.93	4.2	453	7.38	—
2601	283	04/05/2017	14.89	—	443	7.52	2.15
2602	269	03/14/2017	16.58	4.5	638	7.20	—
2602	269	04/05/2017	14.91	—	464	7.39	3.62
2603	Unk	03/15/2017	18.76	1.5	250	7.29	—
2604	210	03/14/2017	13.79	2.1	774	7.17	—
2605	Unk	03/15/2017	8.32	5.2	254	6.62	—
2605	Unk	04/05/2017	7.09	—	330	7.15	4.41
2606	Unk	03/14/2017	17.8	7.2	673	6.96	—
2606	Unk	04/05/2017	17.24	—	461	7.07	0.86
2608	Unk	03/15/2017	15.88	1.5	446	7.40	—
2751	280	03/15/2017	17.21	—	615	7.88	6.03
2752	Unk	03/15/2017	14.56	—	704	7.18	0.25
2752	Unk	04/05/2017	13.74	—	575	7.21	0.69
2752	Unk	04/26/2017	15.85	—	648	7.11	0.78
2753	285	03/15/2017	14.38	—	499	6.98	4.49
2754	Unk	03/15/2017	16.55	—	545	6.97	4.47
2755	330	03/15/2017	14.54	—	691	7.31	6.57
2756	300	03/15/2017	15.7	1.3	762	7.8	—
2757	Unk	03/14/2017	17.1	5.6	873	7.18	—
2757	Unk	04/05/2017	16.73	—	602	7.15	0.31
2757	Unk	04/26/2017	16.50	—	544	7.06	0.32
2758	280	03/14/2017	17.7	1.4	502	7.77	—
2759	260	03/14/2017	15.14	—	650	7.25	4.85
2760	Unk	03/14/2017	14.81	—	527	7.12	7.45
2761	Unk	03/14/2017	15.50	—	604	7.24	7.52
2762	Unk	03/14/2017	15.32	—	651	7.24	0.68
2762	Unk	04/05/2017	15.20	—	500	7.33	1.63
2763	253	03/14/2017	14.14	—	677	7.05	6.07

a. Contaminant with a NSDWR standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for PWSs but can be applied to private wells to evaluate water quality.
Notes: °C = degrees Celsius; NTU = nephelometric turbidity units; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = unknown. Well log not found; (—) = not analyzed. Italicized red numbers indicate an EPA NSDWR standard was exceeded.

Bacteria Results

Bacteria results over time are listed in Table 42 and shown in Figure 33. The results from the March 14–15 sampling event indicated that samples from seven of the 22 wells contained *E. coli* with concentrations ranging from 1 to 3.1 MPN/100 mL. Samples from 16 of the wells contained TC, with concentrations ranging from 1 MPN/100 mL to more than 2,419.6 MPN/100 mL. Of the 13 additional wells not previously sampled, only two samples contained *E. coli*; although eight wells had positive TC counts.

Of the nine wells resampled on April 5, four samples had positive *E. coli* detections with concentrations ranging from 1 to 3.1 MPN/100 mL and eight samples had TC concentrations ranging from 1 to 67.7 MPN/100 mL. One sample was negative for both TC and *E. coli* (Table 42).

On April 26, three wells were resampled for bacteria. The fourth well that previously contained *E. coli* was unavailable for sampling. All three wells were negative for *E. coli*.

Table 42. Bacteria and bacteria DNA results—Lincoln County Ground Water Quality Investigation.

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a]				
			DNA—Cow Waste PrsAbs	DNA—Human Waste PrsAbs	DNA—Ruminant Waste PrsAbs	*E. coli* (MPN/100 mL)	Total Coliform (MPN/100 mL)
Primary or Secondary Standard:			<1	<1	<1	<1	1.0
2593	386	02/22/2017	—	—	—	<1.0	<1.0
2593	386	03/09/2017	—	—	—	<1.0	<1.0
2594	285	02/22/2017	—	—	—	**96**	548
2594	285	03/09/2017	—	—	—	**5.2**	42.6
2594	285	03/14/2017	A	A	**P**	**3.1**	17.5
2594	285	04/05/2017	—	—	—	**1.0**	2.0
2594	285	04/26/2017	—	—	—	<1.0	3.1
2595	330	02/22/2017	—	—	—	<1.0	<1.0
2595	330	03/09/2017	—	—	—	<1.0	<1.0
2596	283	02/22/2017	—	—	—	**68**	2420
2597	307	02/22/2017	—	—	—	<1.0	10
2597	307	03/09/2017	—	—	—	<1.0	<1.0
2598	280	02/22/2017	—	—	—	<1.0	<1.0
2598	280	03/09/2017	—	—	—	<1.0	<1.0
2599	280	02/22/2017	—	—	—	<1.0	<1.0
2599	280	03/09/2017	—	—	—	<1.0	60.9
2599	280	03/15/2017	—	—	—	<1.0	19.5
2599	280	04/05/2017	—	—	—	<1.0	1.0
2600	320	02/22/2017	—	—	—	<1.0	<1.0
2600	320	03/09/2017	—	—	—	<1.0	<1.0
2601	283	02/22/2017	—	—	—	**411**	2420
2601	283	03/09/2017	—	—	—	**18.1**	344.8
2601	283	03/14/2017	**P**	A	**P**	<1.0	19.9
2601	283	04/05/2017	—	—	—	<1.0	3.1
2602	269	02/22/2017	—	—	—	**100**	560
2602	269	03/09/2017	—	—	—	**14.5**	158.5
2602	269	03/14/2017	—	A	A	**3.1**	15.8
2602	269	04/05/2017	—	—	—	<1.0	1.0
2603	Unk	02/22/2017	—	—	—	**9**	82
2603	Unk	03/15/2017	—	—	—	<1.0	<1.0
2604	210	02/22/2017	—	—	—	<1.0	<1.0
2604	210	03/09/2017	—	—	—	<1.0	126.6
2604	210	03/14/2017	—	—	—	<1.0	14.4

DEQ Site ID	Well Depth (feet)	Sample Date	Bacteria Concentrations[a] DNA—Cow Waste PrsAbs	DNA—Human Waste PrsAbs	DNA—Ruminant Waste PrsAbs	*E. coli* (MPN/100 mL)	Total Coliform (MPN/100 mL)
2605	Unk	02/22/2017	—	—	—	**64**	1200
2605	Unk	03/09/2017	—	—	—	**2.0**	461.1
2605	Unk	03/15/2017	—	—	—	**1.0**	>2419.6
2605	Unk	04/05/2017	—	—	—	<1.0	67.7
2606	Unk	02/22/2017	—	—	—	**150**	1350
2606	Unk	03/09/2017	—	—	—	**21.6**	>2419.6
2606	Unk	03/14/2017	—	A	A	**3.1**	151.7
2606	Unk	04/05/2017	—	—	—	**3.1**	3.1
2607	Unk	02/22/2017	—	—	—	**41**	340
2607	Unk	03/09/2017	—	—	—	**148.3**	>2419.6
2608	Unk	03/15/2017	—	—	—	<1.0	<1.0
2751	280	03/15/2017	—	—	—	<1.0	<1.0
2752	Unk	03/15/2017	—	—	—	**1.0**	3.0
2752	Unk	04/05/2017	—	—	—	**1.0**	2.0
2752	Unk	04/26/2017	—	—	—	<1.0	<1.0
2753	285	03/15/2017	—	—	—	<1.0	1.0
2754	Unk	03/15/2017	—	—	—	<1.0	1.0
2755	330	03/15/2017	—	—	—	<1.0	3.1
2756	300	03/15/2017	—	—	—	<1.0	<1.0
2757	Unk	03/09/2017	—	—	—	**21.8**	>2419.6
2757	Unk	03/14/2017	—	A	A	**2.0**	68.0
2757	Unk	04/05/2017	—	—	—	**1.0**	2.0
2757	Unk	04/26/2017	—	—	—	<1.0	1.0
2758	280	03/14/2017	—	—	—	<1.0	<1.0
2759	260	03/14/2017	—	—	—	<1.0	<1.0
2760	Unk	03/14/2017	—	—	—	<1.0	1.0
2761	Unk	03/14/2017	—	—	—	<1.0	1.0
2762	Unk	03/14/2017	—	—	—	**2.0**	30.1
2762	Unk	04/05/2017	—	—	—	<1.0	<1.0
2763	253	03/14/2017	—	—	—	<1.0	1.0

a. TC and *E. coli* standards are from 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 cfu/100 mL, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.
Notes: MPN/100 mL = most probable number per 100 milliliters; PrsAbs = present (P) or absent (A) of bacteria; Unk = unknown. Well log not found; (—) = not analyzed. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

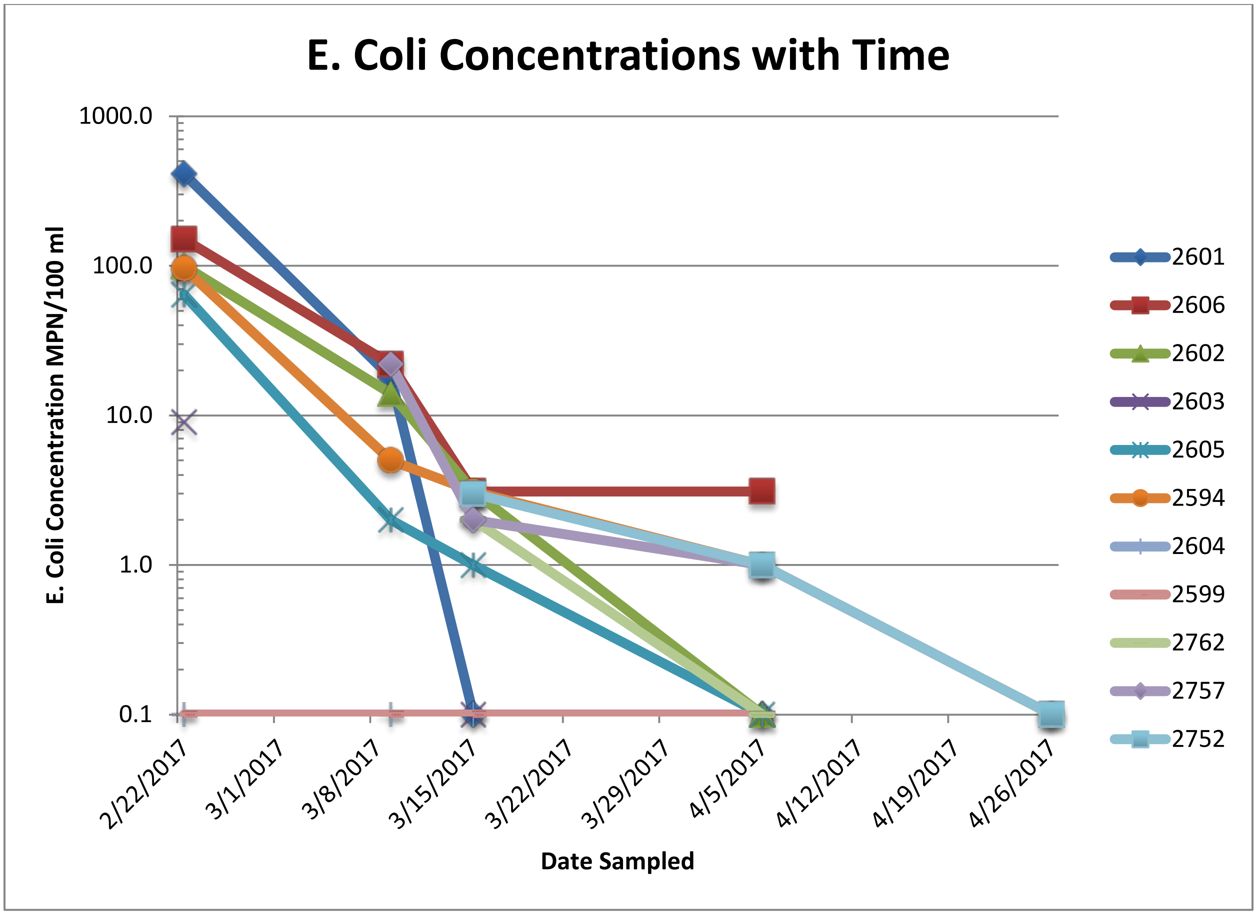

Figure 33. Changes in *E.coli* concentrations over time—Lincoln County Ground Water Quality Investigation.

Five samples collected during the March 14–15 sampling event were sent to Source Molecular Corporation in Miami, Florida, for DNA testing as part of their microbial source tracking services, to detect and quantify fecal indicator bacteria associated with humans or ruminants (i.e., cattle, sheep, antelope, and deer). Results from the DNA analysis indicate that Wells 2594 and 2601 contained ruminant fecal biomarkers (Table 42). None of the samples tested positive for either of the two human fecal biomarkers evaluated in the analysis. DEQ requested additional testing of the two positive samples for presence of a cattle fecal biomarker. Well 2601 showed the presence of cow *Bacteroidetes*, the fecal biomarker, and also had the highest *E. coli* count.

The wells with the highest *E. coli* concentrations were located along laterals in the canal system. Given the high initial *E. coli* counts and discolored and foul smelling water, it seems likely that the major source of the contamination originated from the influx of dairy lagoon water into the Milner-Gooding Canal with additional infiltration from laterals and overland flow as contributing factors. The canal company reported a flow of approximately 80 cubic feet per second (cfs) (36,000 gallons per minute) disappearing into a sinkhole or fissure where the canal channel intersects a channel associated with the construction of hydropower plant (L. Harmon, Big Wood Canal Company, personal communication with Irene Nautch, DEQ, February 22, 2017). The contaminated water found a fracture zone and moved laterally along preferential pathways to the southwest and slightly southeast, completely bypassing a 320-foot deep well to the south (Well 2600), which was cased and sealed down to 18 feet (Figure 34).

Nutrient (Nitrate and Ammonia) Results

A total of 29 wells were sampled for nitrate and ammonia during the investigation; eight wells were sampled for nitrate and ammonia in both February and March. Five sites had detections for ammonia ranging from 0.024 to 3.1 mg/L as nitrogen (N) (Table 43). These sites also were positive for *E. coli*. Four sites had nitrate concentrations above 2 mg/L, which is generally considered background level concentration (Table 43 and Figure 34). Elevated nitrate did not occur at the sites with significant bacteria impacts, suggesting nitrate was not associated with liquid manure waste or denitrification was happening at a rapid pace.

Table 43. Nutrient and nutrient-related isotope results—Lincoln County Ground Water Quality Investigation.

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration[a]		Isotopes
			Nitrate[b]	Ammonia	$\delta^{15}N$
			mg/L		(‰)
Water Quality Standard:			10	No Stand.	No Stand.
2593	386	02/22/2017	3.36	<0.05	—
2594	285	02/22/2017	1.57	0.06	—
2594	285	03/14/2017	0.829	0.49	—
2595	330	02/22/2017	1.69	<0.05	—
2596	283	02/22/2017	<0.60	0.08	—
2597	307	02/22/2017	1.19	<0.05	—
2598	280	02/22/2017	2.93	<0.05	—
2599	280	02/22/2017	1.83	<0.05	—
2599	280	03/15/2017	3.46	<0.020	—
2600	320	02/22/2017	1.69	<0.05	—
2601	283	02/22/2017	<3.0	<0.05	—
2601	283	03/14/2017	1.25	<0.010	7.7
2602	269	02/22/2017	**35.7**	0.07	—
2602	269	03/14/2017	3.80	0.46	—
2603	Unk	02/22/2017	1.45	0.07	—
2603	Unk	03/15/2017	1.49	<0.020	—
2604	210	02/22/2017	3.60	<0.05	—
2604	210	03/14/2017	4.25	<0.020	8.7
2605	Unk	02/22/2017	1.86	<0.05	—
2605	Unk	03/15/2017	1.66	<0.010	—
2606	Unk	02/22/2017	<3.0	<0.05	—
2606	Unk	03/14/2017	<0.18	3.1	5.3
2607	Unk	02/22/2017	<3.0	<0.05	—
2608	Unk	03/15/2017	3.24	<0.020	—
2751	280	03/15/2017	1.91	<0.010	—
2752	Unk	03/15/2017	<0.36	0.024	—
2753	285	03/15/2017	1.61	<0.020	—
2754	Unk	03/15/2017	1.61	<0.020	—
2755	330	03/15/2017	8.57	<0.020	10.4
2756	300	03/15/2017	1.67	<0.020	—
2757	Unk	03/14/2017	9.65	1.8	16.9
2758	280	03/14/2017	1.43	<0.020	—

DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration[a]		Isotopes
			Nitrate[b]	Ammonia	$\delta^{15}N$
			mg/L		(‰)
2759	260	03/14/2017	1.37	<0.010	—
2760	Unk	03/14/2017	1.95	<0.010	—
2761	Unk	03/14/2017	2.78	<0.020	—
2762	Unk	03/14/2017	<0.18	<0.010	—
2763	253	03/14/2017	5.65	<0.010	11.4

a. Multiple labs were used to analyze nitrate and ammonia concentrations.
b. Contaminant with a NPDWR standard
Notes: mg/L = milligram per liter; ‰ = permil; Unk = unknown. Well log not found; (—) = not analyzed; No Stand = no Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded red numbers indicate either an EPA NPDWR standard, expressed as MCL, or an IDAPA 58.01.11.200 standard was reached or exceeded. These regulations apply to PWSs only but are used to evaluate water quality in private wells.

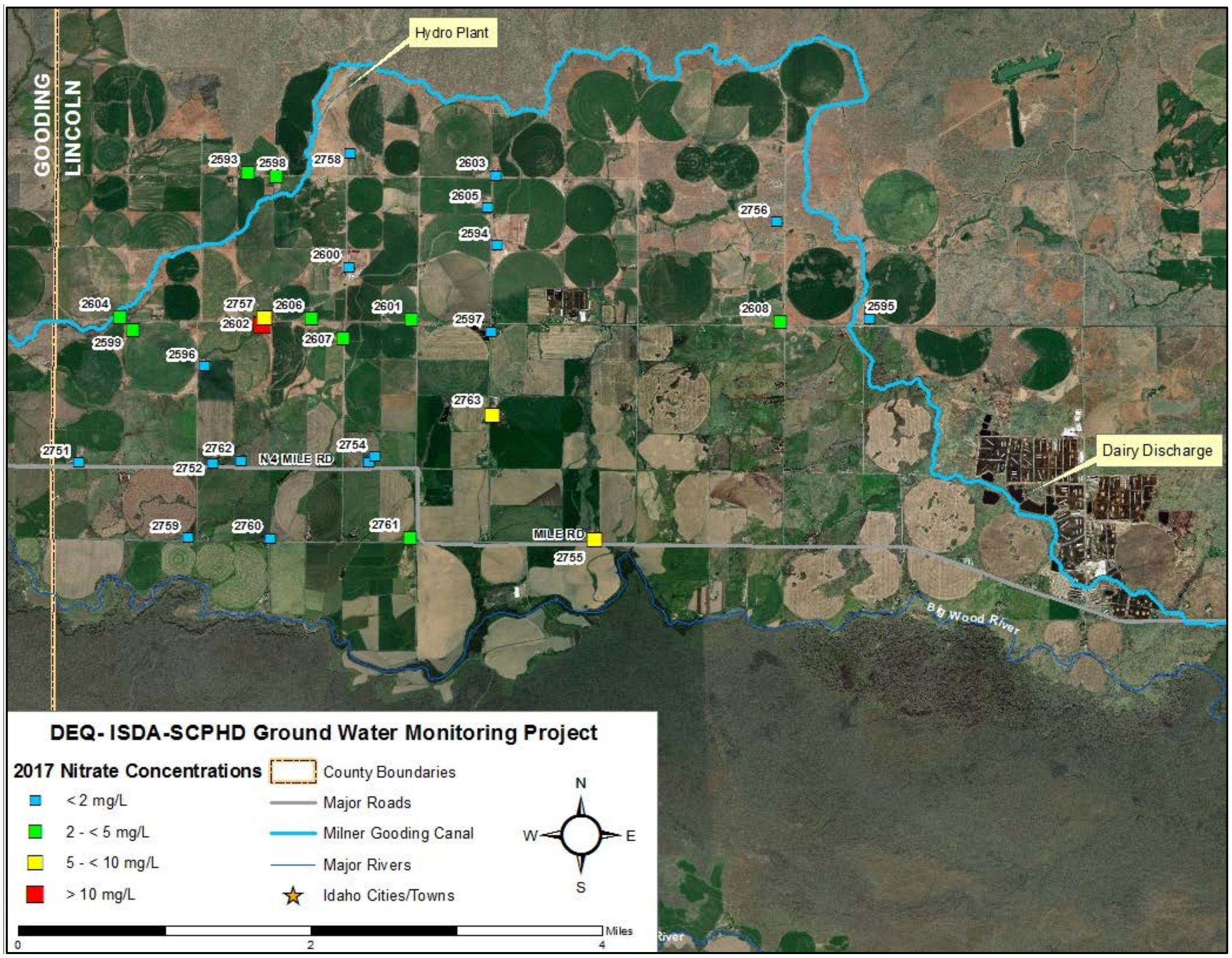

Figure 34. Nitrate results—Lincoln County Ground Water Quality Investigation.

Nitrogen Isotopes

Nitrogen isotope ($\delta^{15}N$) ratio analysis was performed on March samples from six wells. The $\delta^{15}N$ values ranged from 3.8‰ to 11.4‰ (Appendix A, Table A2). Of the six wells analyzed, three wells had $\delta^{15}N$ ratios between +4.0‰ and +9.0‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source. The other three wells had $\delta^{15}N$ values greater than +9‰, suggesting an animal or human waste source as the likely nitrate source (Table 43; Table 3; Seiler 1996).

Samples from Well 2757 with the highest $\delta^{15}N$ value (+16.9‰), also had *E. coli* concentrations ranging from 21.8 MPN/100 mL on March 9 to 1.0 MPN/100 mL on April 5. Samples from the Wells 2755 and 2763 with $\delta^{15}N$ values greater than +9‰ never had detectable concentrations of *E. coli*. However, both wells had detectable concentrations of TC at some point during the investigation.

2.6.1.3 Conclusions

Ground water sampling conducted in response to a dairy lagoon breach and pumping into the Milner-Gooding Canal in Lincoln County was a coordinated effort by multiple agencies—including DEQ, IDWR, IBL, SCPHD, and ISDA. Dairy lagoon waste and flood water traveled through the Milner-Gooding Canal until encountering fractured basalt resulting from hydropower plant construction. Observations and video indicate that significant volumes of contaminated water entered the subsurface immediately downstream of the hydropower plant. Additional infiltration from laterals (canals) and overland flow may also have contributed to the ground water contamination.

Given the high initial *E. coli* counts, and the discolored and foul smelling water, it seems likely that the major source of the contamination originated from the influx of dairy lagoon water into the Milner-Gooding canal. The DNA testing and nitrogen isotope values also indicate that waste from cows was a source of the ground water contamination.

Sampling at 1 to 3 week intervals demonstrated gradual attenuation of bacteria occurred over the 9 weeks of the project until no more *E. coli* were present in the wells. By the end of April, all *E. coli* results were less than 1 MPN/100 mL. TC either decreased or remained steady (after initially decreasing from initial sampling in February), indicating that the impact from the suspected source of contamination no longer existed and the contamination had moved through the area and/or degradation (die-off) of the bacteria had occurred.

An evaluation of well seal depth was conducted to determine if *E. coli* detections were influenced by well construction. Well driller logs could be associated with 16 of the wells sampled. Well logs were found for four of the 11 wells that contained samples with *E. coli*—these four wells were sealed to depths of 18 feet or less. Well seal depths for the other 12 wells with well driller logs and no detections of *E. coli* ranged from 18 to 60 feet.

The project results did not show widespread nitrate impacts, only one well was above the nitrate MCL of 10 mg/L; however, without historic data from the sample wells, it is impossible to know what impact the flooding had on nitrate levels in these wells.

2.6.1.4 Recommendations

Additional monitoring of this project was conducted in 2018, and results will be provided in the 2018 summary report.

3 DEQ Cooperative Projects

This section presents data from special ground water quality monitoring projects conducted jointly by DEQ and other state agencies in calendar year 2017.

3.1 DEQ-IDWR Ground Water Monitoring Project

In 2017, DEQ and IDWR jointly conducted the following special ground water quality monitoring and investigation projects.

3.1.1 Purpose

The IDWR Statewide Ambient Ground Water Quality Monitoring Network was developed across Idaho to assess ground water quality. DEQ partnered with IDWR to conduct analyses of dissolved methane and nitrogen isotope ($\delta^{15}N$) and assess ground water quality in Washington, Gem, Payette, Owyhee, and Canyon Counties. The ground water samples were collected by IDWR staff during statewide network sampling events, and 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 17 samples for dissolved methane from 15 domestic wells across the state following standard operating procedures for ground water quality monitoring (IDWR 2017). Samples were collected using the Isotech Laboratories Isoflask and submitted to IBL in Boise, Idaho, and subcontracted to Isotech Laboratories, Inc. (a Weatherford Company) in Champaign, Illinois (Table A1). The IsoFlask was used due to a unique design that maintains (does not alter) the quantity or isotopic characteristic of any potential dissolved hydrocarbon gasses in the sample (compared to direct fill and inverted volatile organic compound sampling).

The nitrogen isotope samples from nine wells (sites 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 0.3 to 18,000 µg/L. All 15 wells sampled and analyzed had measurable concentrations of methane (Table A1 and Figure A1). 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). All results were below the explosive risk level.

Nitrogen Isotope Results

Nitrogen isotope ($\delta^{15}N$) ratio analysis was performed on samples from nine wells, all of which had nitrate concentrations approximately 5 mg/L or greater (one had a nitrate concentration of 4.9 mg/L). The $\delta^{15}N$ values ranged from 3.8‰ to 11.4‰ (Table A2). Of the nine wells analyzed, one well had a $\delta^{15}N$ ratio less than +4.0‰, suggesting commercial fertilizer as the likely nitrate source; six wells had $\delta^{15}N$ ratios between +4.0‰ and +9.0‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; two wells had $\delta^{15}N$ values greater than +9‰, suggesting an animal or human waste source as the likely nitrate source (Table A2; Seiler 1996; Table 4). Spatial distribution of the $\delta^{15}N$ ratios is shown in Figure A2.

3.1.3 Conclusions

The cooperative project between IDWR and DEQ resulted in cost-effectively collecting additional dissolved methane data that helped assess ground water quality in southern Idaho. These data will aid in establishing a baseline for dissolved methane in drinking water in areas with potential oil and gas development and protect private well owners from the explosive risk from elevated concentrations of methane.

3.1.4 Recommendations

This project between state agencies saved time and money 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 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 2017.

3.2.1 Purpose

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

3.2.2 Methods and Results

In cooperation with DEQ, ISDA collected and analyzed a total of 290 ground water samples (from 257 domestic wells) across the state following its QAPP (ISDA 2017a) and DEQ’s regional FSP (DEQ 2017b). The 290 samples included 257 nitrate (nitrate-nitrite nitrogen) samples and 33 quality assurance samples (29 duplicates samples and 4 blank samples). A total of 15 wells were also sampled for ammonia. Samples for nitrate and ammonia analysis were submitted to IBL in Boise. 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, ammonia, nitrate, and $\delta^{15}N$ results are shown in Appendix B.

Nitrate (Nitrate-Nitrite Nitrogen) Results

Nitrate (nitrate-nitrite nitrogen) concentrations for this project ranged from nondetect (less than 0.010 mg/L) to 120 mg/L. Out of the 257 samples collected for nitrate analysis, 79 samples (29.5%) were between 5 mg/L (half the EPA MCL of 10 mg/L) and 10 mg/L; 60 samples (23%) 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 2017 had 57% of the 10 mg/L or greater nitrate concentrations. In total, 203 samples (78%) were at or greater than 2 mg/L, indicating some type of nitrogen source associated with human activities; 2 mg/L is generally considered background level (DEQ 2014a).

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

Ammonia Results

A total of 15 wells were sampled for ammonia and nitrate. Ammonia concentrations for this project ranged from nondetect (less than 0.010 mg/L) to 9.6 mg/L (Table B1). Median concentration was 5.3 mg/L. All wells sampled for ammonia were within Owyhee County, which is known to have wells drilled into a deeper, confined aquifer with low or depleted dissolved oxygen concentrations.

Nitrogen Isotope Results

ISDA collected 140 nitrogen isotope ($\delta^{15}N$) samples from 132 wells (includes seven duplicate samples and one blank sample not included in this report) with nitrate concentrations of approximately 5 mg/L or greater. The measurable $\delta^{15}N$ values ranged from 1.0‰ to 26.4‰; one sample had unmeasurable amounts of nitrate on which to run the isotope analysis (the reason for which is unknown—historically this well has had elevated nitrate concentrations) (Table B1). The $\delta^{15}N$ values for 38 samples (11 of which or 29% were from project 710 [Washington/Payette Counties]) ranged from +1.0‰ to +3.9‰, suggesting commercial fertilizer as the likely nitrate source; 83 samples had $\delta^{15}N$ values between +4.0‰ and +8.9‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source; nine samples (three of which were 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 cost-effectively collecting additional nitrate and nitrogen isotope data to assess ground water quality across the state. Out of the 257 samples collected for nitrate analysis, 60 samples (23%) met or exceeded the EPA nitrate MCL of 10 mg/L and 79 samples (31%) were between 5 and 10 mg/L. The nitrate results indicate degraded ground water in specific vulnerable aquifers within a few counties (Figures B1–B25). These data will aid 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 between state agencies saved time and money using existing ground water monitoring networks and sampling schedules. ISDA and DEQ should continue these cooperative efforts to increase program efficiency and protect ground water quality in Idaho.

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Appendix A. Idaho Department of Water Resources Collected Data—2017

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

Report Map ID	IDWR Site ID	County	Well Depth (feet)	Sample Date	Temperature (°C)	pH	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Methane (µg/L)
M-1	14N 03W 24BCA2	Washington	124	8/1/2017	13.8	6.99	231.8	0.03	2.8
M-2	08N 05W 09DAD1	Payette	180	8/18/2017	17	7.67	651	0.14	1,400
M-3	06N 04W 24ABB1	Payette	155	8/3/2017	15.5	7.43	788.5	7.75	0.3
M-4	06N 03W 10BAA1	Gem	88	8/3/2017	18	7.87	158.6	0.04	2.3
M-5	06N 02W 20ABB2	Gem	97	8/24/2017	19.2	7.94	183.7	3.58	0.82
M-6	06N 02W 24DAD1	Gem	Unk	8/24/2017	18.2	7.58	2858	0.58	32
M-7	05N 05W 34BCC1	Canyon	234	8/15/2017	19.9	7.43	899	0.32	98
M-8	05N 04W 24ABA1	Canyon	448	8/15/2017	19.4	6.97	309.5	2.41	0.97
M-9	03N 04W 12AAD2	Canyon	270	8/15/2017	18.9	7.39	325	0.47	2.8
M-10	03N 03W 09CBC1	Canyon	145	7/26/2017	13.5	7.95	458.4	0.35	7.8
M-11	06N 05W 35BAC1	Canyon	322	8/25/2017	20.9	7.58	651.8	8.23	0.52
M-12	06S 05E 26BBB1	Owyhee	205	8/14/2017	20.4	6.87	6971	0.88	5.0
M-13	04N 06W 24BDA1	Owyhee	205	8/8/2017	19.3	9.95	1212	0	18,000
M-14	02N 05W 13BCD1	Owyhee	190	8/7/2017	16.2	7.03	1816	0.94	1.8
M-15	07S 06E 16ABB2	Owyhee	185	8/18/2017	29.9	8.19	441.9	1.69	5.8

Notes: µg/L = microgram per liter. Unk = unknown. Well log not found.

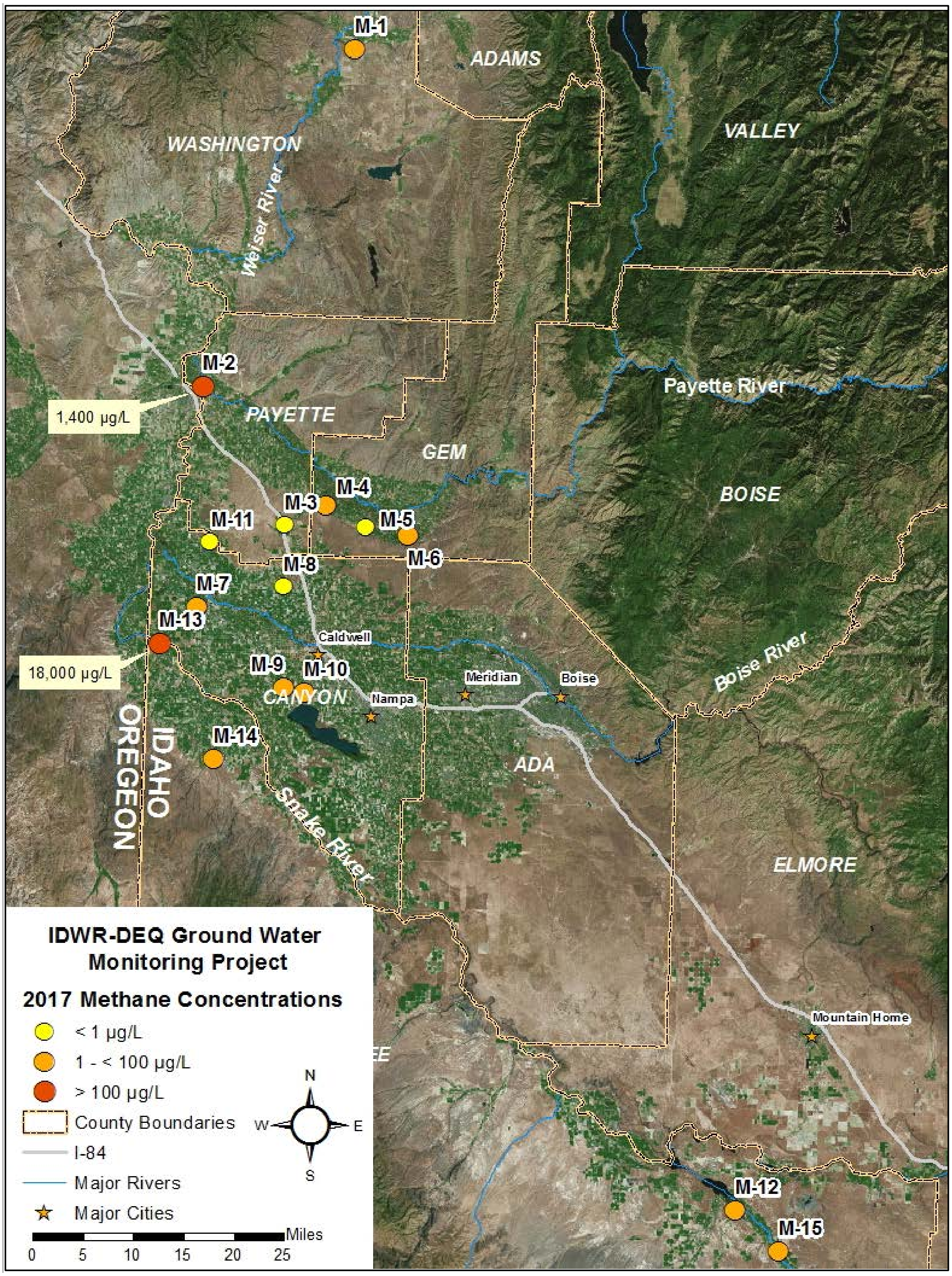

Figure A1. Dissolved methane results in southwestern Idaho—DEQ-IDWR Joint Ground Water Monitoring Project.

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

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

Notes: ‰ = per mil. (—) = not analyzed or data are unavailable.

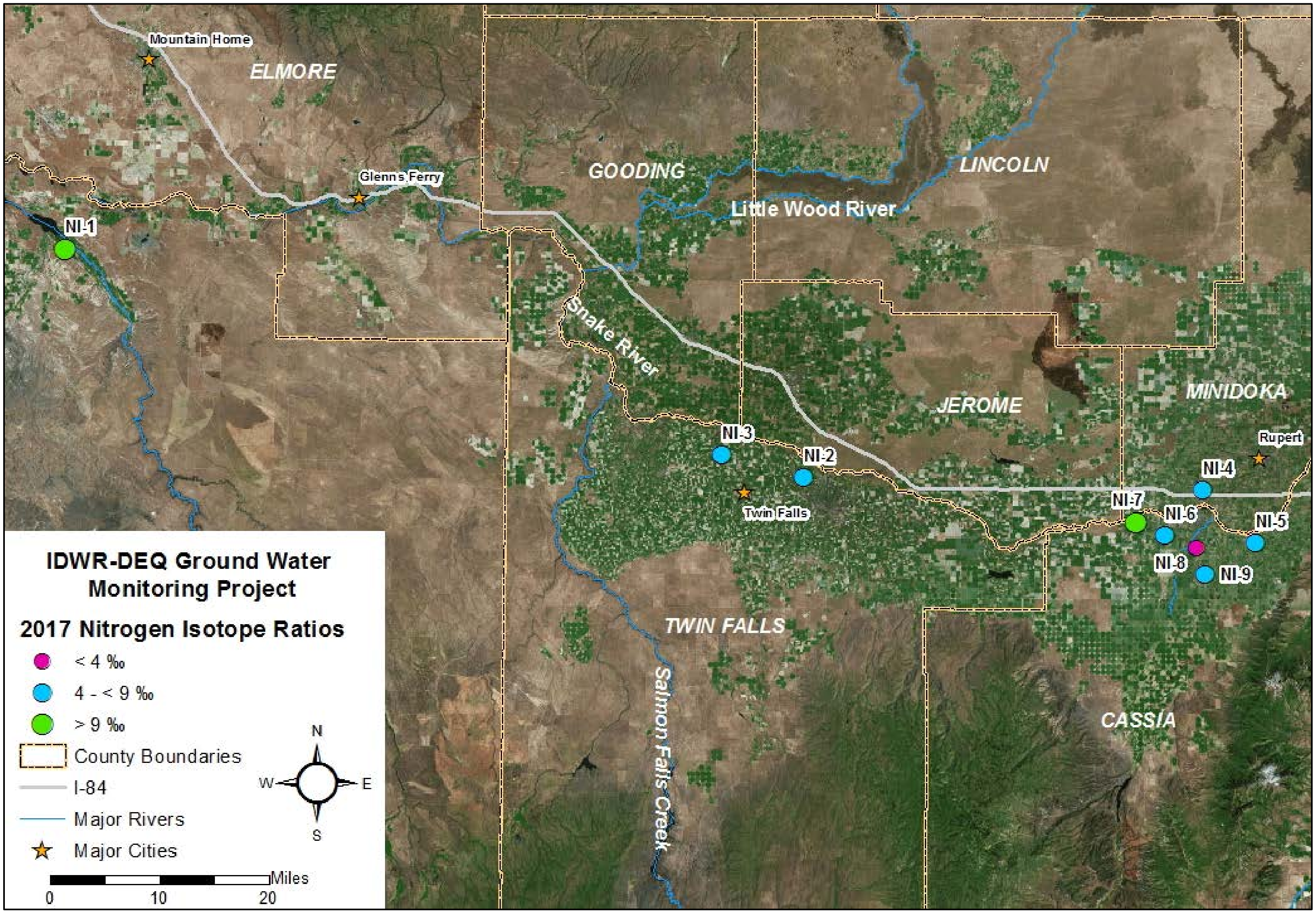

Figure A2. Nitrogen isotope ratios—DEQ-IDWR Joint Ground Water Monitoring Project.

Appendix B. Idaho State Department of Agriculture Collected Data—2017

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

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
Primary or Secondary Standard:				**NA**	**6.5–8.5**	**NA**	**NA**	**10**	**NA**
2200301	220	5/16/2017	Ada/Canyon	14.2	7.66	827.9	NA	**13**	4.1
2201301	220	5/16/2017	Ada/Canyon	14.6	7.94	677.2	NA	7	6.7
2201701	220	5/15/2017	Ada/Canyon	17.7	7.76	413.8	NA	2.3	NA
2201801	220	5/17/2017	Ada/Canyon	13.5	7.55	653.4	NA	6.2	3.4
2201901	220	5/16/2017	Ada/Canyon	15.7	7.50	685.4	NA	5.4	6.3
2203001	220	5/17/2017	Ada/Canyon	13.4	7.10	620.3	NA	5.1	NA
2203101	220	5/17/2017	Ada/Canyon	13.3	7.33	921.8	NA	8.1	6.7
2204701	220	5/16/2017	Ada/Canyon	14.9	7.39	794.7	NA	5.9	6.7
2204801	220	5/15/2017	Ada/Canyon	16.6	7.58	1198	NA	**11**	NA
3003001	300	8/16/2017	Latah	13.6	7.35	316.2	NA	0.016	NA
3003101	300	8/14/2017	Latah	12.3	6.86	340.4	NA	4.4	NA
3003601	300	8/16/2017	Latah	15.2	*6.07*	206.3	NA	8.8	2.1
3003701	300	8/14/2017	Latah	11.6	6.83	212.4	NA	1.8	NA
3100201	310	5/09/2017	Owyhee	22.6	7.77	2213	7	0.24	NA
3100401	310	5/10/2017	Owyhee	21.1	7.71	2614	6.9	0.48	NA
3100601	310	5/09/2017	Owyhee	21.2	7.54	2358	5.3	2	NA
3100701	310	5/10/2017	Owyhee	16.8	7.59	2071	7.2	<0.010	NA
3101001	310	5/08/2017	Owyhee	19.0	7.53	3339	9	0.54	NA
3101601	310	5/08/2017	Owyhee	22.8	7.78	2698	9.1	0.22	NA
3200101	320	9/12/2017	Fremont	8.1	7.49	627.2	NA	**10**	4.5
3201001	320	9/11/2017	Fremont	11.8	7.79	546.6	NA	8.1	4.1
3300401	330	8/07/2017	Nez Perce	21.9	8.14	275	NA	1.6	NA
3300501	330	8/08/2017	Nez Perce	15.0	8.13	341.5	NA	0.52	NA
3400201	340	7/24/2017	Payette	15.4	7.55	858.9	NA	6.4	NA
3400501	340	7/24/2017	Payette	15.7	7.49	1008	NA	**11**	5.7
3400701	340	7/24/2017	Payette	16.4	7.64	808.3	NA	1.1	NA
3400801	340	7/24/2017	Payette	15.0	7.44	962.9	NA	**11**	6.2
3401401	340	7/24/2017	Payette	14.2	7.62	876.6	NA	7.8	NA
3401501	340	7/24/2017	Payette	14.6	7.66	197	NA	**10**	4.4
5302001	530	6/06/2017	Ada	13.4	7.49	579.3	NA	**13**	5.7

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
5302401	530	6/05/2017	Ada	13.6	7.16	800.1	NA	**22**	7.6
5302501	530	6/05/2017	Ada	13.1	7.08	862.4	NA	**31**	7.7
5302701	530	6/06/2017	Ada	13.3	6.98	834.8	NA	**40**	5.6
5303401	530	5/17/2017	Ada	13.6	7.05	1086	NA	**45**	8.2
5303701	530	5/18/2017	Ada	13.1	*6.42*	803	NA	**34**	6.1
5303801	530	6/05/2017	Ada	13.4	6.93	876.9	NA	**46**	5.7
7100101	710	8/01/2017	Washington/Payette	16.4	7.69	697.1	NA	3.3	NA
7100201	710	8/01/2017	Washington/Payette	14.3	7.35	2157	NA	**51**	5.0
7100501	710	8/02/2017	Washington/Payette	13.8	7.60	797.4	NA	**10**	1.4
7100601	710	8/07/2017	Washington/Payette	14.9	7.41	880.9	NA	**13**	4.1
7100701	710	8/07/2017	Washington/Payette	15.0	7.35	849.5	NA	**13**	3.0
7100901	710	8/02/2017	Washington/Payette	14.4	7.29	1322	NA	**17**	6.8
7101101	710	8/01/2017	Washington/Payette	13.8	7.17	2736	NA	**33**	14.6
7101201	710	8/01/2017	Washington/Payette	13.2	7.42	938	NA	6.6	7.5
7101701	710	8/07/2017	Washington/Payette	14.6	7.60	758.6	NA	8.5	2.5
7102101	710	8/02/2017	Washington/Payette	13.3	7.48	645.3	NA	5.4	3.9
7102301	710	8/07/2017	Washington/Payette	13.6	7.25	863.3	NA	6.7	6.6
7102501	710	8/08/2017	Washington/Payette	14.6	7.03	1828	NA	**22**	9.7
7102701	710	8/07/2017	Washington/Payette	13.6	7.37	760.1	NA	8.3	4.8
7103401	710	8/01/2017	Washington/Payette	15.9	7.23	863.5	NA	4.9	5.0
7103701	710	8/01/2017	Washington/Payette	13.7	7.41	747.8	NA	3.6	NA
7103801	710	8/02/2017	Washington/Payette	16.8	7.33	973.2	NA	**13**	3.4
7103901	710	8/02/2017	Washington/Payette	15.8	7.35	707.5	NA	5.0	1.0
7104001	710	8/02/2017	Washington/Payette	14.2	7.54	933.7	NA	**16**	1.0
7104101	710	8/08/2017	Washington/Payette	13.5	7.33	1893	NA	**36**	4.9
7104201	710	8/02/2017	Washington/Payette	14.0	7.25	706.4	NA	6.5	6.0
7104401	710	8/01/2017	Washington/Payette	12.5	7.43	796.4	NA	**12**	2.2
7104601	710	8/08/2017	Washington/Payette	14.3	7.19	852.1	NA	9	3.1

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
7104701	710	8/08/2017	Washington/Payette	15.2	7.47	1102	NA	**13**	2.5
7104801	710	8/02/2017	Washington/Payette	14.4	7.64	1046	NA	**16**	1.3
7105101	710	8/07/2017	Washington/Payette	13.3	7.39	842.4	NA	**10**	5.0
7107101	710	8/08/2017	Washington/Payette	13.8	7.45	727.9	NA	1.2	NA
7300201	730	6/14/2017	Minidoka	13.2	7.32	1018	NA	9.7	5.1
7300501	730	6/14/2017	Minidoka	16.1	7.86	642.2	NA	<0.010	NA
7300801	730	6/12/2017	Minidoka	12.0	7.41	1728	NA	**28**	3.5
7300901	730	6/08/2017	Minidoka	12.7	7.46	1051	NA	5.9	26.4
7301101	730	6/14/2017	Minidoka	14.7	7.42	693.4	NA	5	3.8
7301301	730	6/07/2017	Minidoka	16.7	7.53	605.9	NA	1.2	NA
7301601	730	6/12/2017	Minidoka	12.2	7.45	934.9	NA	**10**	4.7
7302001	730	6/07/2017	Minidoka	15.9	7.50	641.3	NA	2.2	NA
7302101	730	6/15/2017	Minidoka	14.8	7.69	673.1	NA	3.6	NA
7302701	730	6/12/2017	Minidoka	13.1	7.44	927	NA	8.6	4.5
7302801	730	6/12/2017	Minidoka	12.9	7.41	2718	NA	9.6	12.8
7302901	730	6/14/2017	Minidoka	16.1	7.48	682.8	NA	2.3	NA
7303001	730	6/15/2017	Minidoka	14.7	7.58	692.6	NA	5	NA
7303101	730	6/15/2017	Minidoka	14.4	7.69	718.7	NA	4.7	NA
7303201	730	6/15/2017	Minidoka	12.8	7.24	3307	NA	**43**	9.7
7303401	730	6/08/2017	Minidoka	12.9	7.59	706.4	NA	0.38	NA
7303501	730	6/12/2017	Minidoka	12.7	7.63	1165	NA	0.16	NA
7303901	730	6/14/2017	Minidoka	14.3	7.50	679.7	NA	8.4	3.7
7304101	730	6/08/2017	Minidoka	14.3	7.56	715.7	NA	7.8	5.0
7304301	730	6/15/2017	Minidoka	14.5	7.50	677.7	NA	5.4	4.7
7304501	730	6/12/2017	Minidoka	12.2	7.44	1027	NA	**11**	4.7
7401501	740	6/07/2017	Minidoka	14.7	7.49	846.1	NA	6.6	3.9
7401701	740	6/06/2017	Minidoka	13.6	7.50	985.2	NA	8.3	6.2
7401801	740	6/06/2017	Minidoka	14.0	7.55	1026	NA	6.6	6.1

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
7403201	740	6/07/2017	Minidoka	14.4	7.59	964.7	NA	5.2	NA
7404801	740	6/07/2017	Minidoka	13.5	7.47	931.4	NA	8.4	5.9
7404901	740	6/07/2017	Minidoka	20.1	8.05	471.8	NA	0.87	NA
7405101	740	6/06/2017	Minidoka	14.6	7.65	840.5	NA	5.8	4.7
7502401	750	8/15/2017	Jerome/Gooding/Lincoln	25.0	7.71	1220	NA	3	NA
7504701	750	8/14/2017	Jerome/Gooding/Lincoln	15.1	7.58	871.1	NA	8.1	NA
7504801	750	8/14/2017	Jerome/Gooding/Lincoln	15.0	7.46	719.2	NA	3.7	NA
7504901	750	8/14/2017	Jerome/Gooding/Lincoln	15.9	7.49	575.1	NA	2	NA
7505501	750	8/15/2017	Jerome/Gooding/Lincoln	15.1	7.48	676.4	NA	4.7	NA
7505801	750	8/14/2017	Jerome/Gooding/Lincoln	15.1	7.32	580.4	NA	2.8	NA
7506701	750	8/14/2017	Jerome/Gooding/Lincoln	16.3	7.43	633.3	NA	3.6	NA
7507001	750	8/15/2017	Jerome/Gooding/Lincoln	14.1	7.53	2286	NA	**11**	3.0
7507401	750	8/15/2017	Jerome/Gooding/Lincoln	15.8	7.66	741.8	NA	3.4	NA
7700601	770	7/26/2017	Gem/Payette	15.1	7.19	408.2	NA	2	NA
7700801	770	7/25/2017	Gem/Payette	14.7	7.56	532.4	NA	3.2	NA
7701701	770	7/25/2017	Gem/Payette	14.7	7.43	1080	NA	6	9.4
7702001	770	7/26/2017	Gem/Payette	15.5	7.44	1106	NA	**11**	8.9
7702501	770	7/25/2017	Gem/Payette	14.6	7.75	637.2	NA	4.8	6.9
7702801	770	7/26/2017	Gem/Payette	17.1	7.18	326.6	NA	2.4	NA
7703001	770	7/25/2017	Gem/Payette	14.0	7.85	206.1	NA	0.96	NA
7703201	770	7/25/2017	Gem/Payette	14.0	7.66	813.6	NA	5	NA
7705301	770	7/25/2017	Gem/Payette	13.9	7.74	904	NA	**14**	4.3
7800201	780	8/30/2017	Twin Falls	14.3	7.48	836.2	NA	5.1	6.7
7800301	780	8/30/2017	Twin Falls	14.5	7.56	809.9	NA	4.8	NA
7803601	780	8/16/2017	Twin Falls	12.7	7.79	1083	NA	8.9	4.5
7803701	780	9/06/2017	Twin Falls	13.1	7.58	902.3	NA	7.4	5.7
7804201	780	9/06/2017	Twin Falls	13.1	7.49	892.7	NA	6.7	7.5
7804301	780	9/06/2017	Twin Falls	13.1	7.51	1020	NA	9.8	7.5

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
7804401	780	8/16/2017	Twin Falls	14.9	7.42	939.9	NA	3.2	NA
7804501	780	9/07/2017	Twin Falls	18.5	8.14	650.4	NA	2	NA
7805501	780	9/07/2017	Twin Falls	13.7	7.68	890.6	NA	9.8	6.1
7805601	780	9/07/2017	Twin Falls	13.8	7.69	878.4	NA	6.1	6.8
7805701	780	9/06/2017	Twin Falls	13.5	7.54	1034	NA	**13**	9.0
7806401	780	9/06/2017	Twin Falls	14.6	7.57	780.9	NA	4.1	5.9
7806601	780	9/07/2017	Twin Falls	13.3	7.54	982.6	NA	5.7	7.8
7900101	790	7/13/2017	Cassia	18.0	7.75	956	NA	5.2	5.9
7900601	790	7/12/2017	Cassia	12.7	7.67	966.9	NA	9.1	5.3
7900701	790	8/09/2017	Cassia	13.0	7.20	865.7	NA	**10**	5.8
7900801	790	8/09/2017	Cassia	13.5	7.52	815.5	NA	9.9	6.9
7900901	790	8/09/2017	Cassia	14.0	7.45	694.1	NA	5.1	NA
7901101	790	7/19/2017	Cassia	16.6	7.63	660.9	NA	3.7	NA
7901401	790	8/10/2017	Cassia	13.1	7.44	956.1	NA	**14**	8.6
7901501	790	7/12/2017	Cassia	14.6	7.54	1092	NA	6.5	4.0
7901601	790	8/09/2017	Cassia	11.7	7.53	947.6	NA	9.9	3.5
7901701	790	7/12/2017	Cassia	12.9	7.64	738.9	NA	6.4	3.8
7901801	790	7/20/2017	Cassia	14.3	7.62	632.8	NA	2	NA
7901901	790	7/20/2017	Cassia	12.3	7.48	1050	NA	**14**	4.9
7902001	790	7/20/2017	Cassia	13.3	7.47	1016	NA	**18**	4.0
7902201	790	7/13/2017	Cassia	11.4	7.13	820.2	NA	2	NA
7903201	790	7/13/2017	Cassia	12.4	7.33	937	NA	9.4	4.9
7903501	790	7/13/2017	Cassia	12.5	7.50	1025	NA	**16**	5.8
7903601	790	8/10/2017	Cassia	13.6	7.58	822	NA	9.5	7.0
7903701	790	7/12/2017	Cassia	13.8	6.97	952.8	NA	**13**	7.8
7903801	790	7/12/2017	Cassia	14.0	7.34	1108	NA	**23**	8.2
7904001	790	8/10/2017	Cassia	13.9	7.43	743.1	NA	5.2	3.8
7904101	790	7/19/2017	Cassia	12.5	7.33	656.3	NA	5.1	6.2

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
7904201	790	7/19/2017	Cassia	11.1	7.21	845	NA	**10**	5.6
7907301	790	7/13/2017	Cassia	12.8	7.63	783.1	NA	9.2	7.0
8050301	805	9/12/2017	Madison/Fremont/Teton	10.4	7.67	546.3	NA	8.9	3.8
8050801	805	9/11/2017	Madison/Fremont/Teton	12.4	7.56	409.1	NA	5.7	3.8
8050901	805	9/11/2017	Madison/Fremont/Teton	12.5	7.41	426.2	NA	4.9	NA
8051301	805	9/12/2017	Madison/Fremont/Teton	10.1	7.53	558.7	NA	4.9	NA
8051401	805	9/11/2017	Madison/Fremont/Teton	11.6	7.41	479.6	NA	9.9	3.9
8053501	805	9/12/2017	Madison/Fremont/Teton	9.6	7.38	666.7	NA	**11**	7.6
8053901	805	9/11/2017	Madison/Fremont/Teton	14.3	7.60	416.7	NA	5.5	3.3
8054601	805	9/12/2017	Madison/Fremont/Teton	11.1	7.47	981.8	NA	**32**	8.2
8055201	805	9/12/2017	Madison/Fremont/Teton	12.6	7.80	587.7	NA	8	5.0
8100401	810	7/17/2017	Elmore	14.6	7.66	1295	NA	**14**	5.9
8100601	810	7/18/2017	Elmore	13.4	7.52	1187	NA	**15**	3.7
8101701	810	7/17/2017	Elmore	13.7	7.10	459.3	NA	6.2	5.9
8102101	810	7/17/2017	Elmore	14.8	7.20	456.9	NA	8.2	2.5
8104801	810	7/17/2017	Elmore	18.8	8.40	338.7	NA	1.9	NA
8201201	820	8/21/2017	Kootenai/Bonner	9.3	8.10	286.9	NA	2.6	NA
8202901	820	8/21/2017	Kootenai/Bonner	17.1	8.19	232.4	NA	1.2	NA
8204501	820	8/21/2017	Kootenai/Bonner	9.7	7.98	340.7	NA	1.3	NA
8204601	820	8/21/2017	Kootenai/Bonner	9.9	8.15	316.7	NA	1.4	NA
8204701	820	8/21/2017	Kootenai/Bonner	9.8	7.85	358.4	NA	1.1	NA
8204801	820	8/15/2017	Kootenai/Bonner	8.9	8.05	320	NA	0.71	NA
8204901	820	8/22/2017	Kootenai/Bonner	9.6	7.88	422	NA	1.9	NA
8205001	820	8/22/2017	Kootenai/Bonner	12.3	8.02	331.5	NA	1.6	NA
8205101	820	8/22/2017	Kootenai/Bonner	8.6	7.99	355.2	NA	1.8	NA
8205201	820	8/22/2017	Kootenai/Bonner	10.0	8.10	285.1	NA	1.5	NA
8300201	830	7/19/2017	Jefferson	13.0	8.09	320.7	NA	3.6	NA
8300301	830	7/19/2017	Jefferson	12.6	7.89	389.3	NA	6.6	NA

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
8300401	830	7/19/2017	Jefferson	13.5	8.07	321.6	NA	3.6	NA
8300501	830	7/19/2017	Jefferson	13.4	8.06	345.9	NA	4.2	NA
8301801	830	8/02/2017	Jefferson	14.0	7.63	766.6	NA	4.3	6.3
8302001	830	8/02/2017	Jefferson	12.3	8.45	306.3	NA	0.018	NA
8303001	830	8/02/2017	Jefferson	11.4	7.70	796.9	NA	7.1	6.8
8401501	840	6/20/2017	Bonneville/Jefferson/Madison	11.9	7.36	568.2	NA	2.2	NA
8401601	840	7/18/2017	Bonneville/Jefferson/Madison	11.8	7.54	508.2	NA	2	NA
8404201	840	6/21/2017	Bonneville/Jefferson/Madison	12.2	7.63	457.4	NA	0.85	NA
8404301	840	7/18/2017	Bonneville/Jefferson/Madison	12.9	7.63	419.6	NA	0.86	NA
8404401	840	6/20/2017	Bonneville/Jefferson/Madison	12.7	7.54	527	NA	1.9	NA
8404801	840	7/18/2017	Bonneville/Jefferson/Madison	12.4	*4.42*	553.6	NA	1.8	NA
8404901	840	6/21/2017	Bonneville/Jefferson/Madison	12.6	7.51	507.2	NA	2	NA
8405001	840	7/18/2017	Bonneville/Jefferson/Madison	12.3	7.59	486.1	NA	1.6	NA
8405301	840	6/21/2017	Bonneville/Jefferson/Madison	10.3	7.70	482.4	NA	0.32	NA
8405801	840	6/21/2017	Bonneville/Jefferson/Madison	12.0	7.55	522.6	NA	1.1	NA
8406101	840	6/20/2017	Bonneville/Jefferson/Madison	12.9	7.52	542.8	NA	1.7	NA
8407501	840	6/20/2017	Bonneville/Jefferson/Madison	11.9	7.44	564.9	NA	1.6	NA
8420101	842	9/20/2017	Bingham/Bonneville	12.9	7.35	662.1	NA	1.1	NA
8420201	842	9/20/2017	Bingham/Bonneville	13.5	7.49	559	NA	1.7	NA
8420301	842	9/20/2017	Bingham/Bonneville	13.7	7.50	611.9	NA	2.1	NA
8420401	842	9/19/2017	Bingham/Bonneville	15.2	7.60	767	NA	2.2	NA
8420501	842	9/19/2017	Bingham/Bonneville	13.9	7.60	598.8	NA	2.3	NA
8420601	842	9/19/2017	Bingham/Bonneville	12.5	7.57	609.8	NA	2.6	NA
8420701	842	9/19/2017	Bingham/Bonneville	13.2	7.48	630.1	NA	2	NA
8420801	842	9/19/2017	Bingham/Bonneville	14.2	7.51	441.4	NA	0.54	NA
8420901	842	9/18/2017	Bingham/Bonneville	13.6	7.38	577.6	NA	2.2	NA
8421001	842	9/18/2017	Bingham/Bonneville	12.9	7.46	597	NA	3.7	NA
8421101	842	9/20/2017	Bingham/Bonneville	13.2	7.47	557.4	NA	1.7	NA

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (μS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
8421201	842	9/18/2017	Bingham/Bonneville	13.4	7.40	638.2	NA	4.5	NA
8421301	842	9/18/2017	Bingham/Bonneville	13.3	7.39	633.3	NA	4.5	NA
8421401	842	9/18/2017	Bingham/Bonneville	13.8	7.18	672.7	NA	2.6	NA
8421501	842	9/18/2017	Bingham/Bonneville	12.9	7.46	578.7	NA	3.1	NA
8421601	842	9/19/2017	Bingham/Bonneville	13.1	7.52	593.4	NA	2.7	NA
8421701	842	9/19/2017	Bingham/Bonneville	12.9	7.55	578.8	NA	2.3	NA
8421801	842	9/19/2017	Bingham/Bonneville	14.5	7.65	452.4	NA	1.4	NA
8421901	842	9/18/2017	Bingham/Bonneville	12.9	7.47	575.9	NA	2.8	NA
8600801	860	5/15/2017	Owyhee	15.9	7.60	1088	2.8	<0.010	NA
8601101	860	5/08/2017	Owyhee	15.2	7.27	2816	0.027	4.9	NA
8601401	860	5/10/2017	Owyhee	15.1	7.26	1507	<0.010	7.9	7.0
8601501	860	5/10/2017	Owyhee	19.4	6.95	1932	0.4	<0.010	NA
8601801	860	5/10/2017	Owyhee	16.0	7.91	1065	5.1	<0.010	NA
8602001	860	5/10/2017	Owyhee	14.3	7.11	2511	0.32	**12**	7.1
8602901	860	5/09/2017	Owyhee	19.2	7.66	2374	9.6	<0.010	NA
8603001	860	5/09/2017	Owyhee	20.4	7.31	1527	8.7	<0.010	NA
8603101	860	5/09/2017	Owyhee	19.2	7.71	2208	7.6	0.47	NA
8650101	865	8/28/2017	Owyhee	15.2	7.44	1178	NA	**14**	4.8
8650201	865	8/28/2017	Owyhee	16.0	7.63	895.5	NA	9.6	4.3
8650301	865	8/28/2017	Owyhee	16.7	7.00	2903	NA	**120**	6.0
8650501	865	8/28/2017	Owyhee	17.1	7.08	2440	NA	**19**	7.3
8650601	865	8/28/2017	Owyhee	12.7	7.49	1295	NA	5.5	10.0
8650701	865	8/28/2017	Owyhee	15.6	7.46	1465	NA	**36**	2.1
8651301	865	8/28/2017	Owyhee	18.8	7.65	800.4	NA	6.1	NA
8653401	865	8/28/2017	Owyhee	14.4	7.26	1196	NA	3.4	NA
8655001	865	8/28/2017	Owyhee	14.3	7.08	1144	NA	8	7.2
8656501	865	8/28/2017	Owyhee	14.6	7.69	753.7	NA	4.9	NA
8657801	865	8/28/2017	Owyhee	15.4	7.46	1447	NA	**28**	5.1

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (μS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
8700401	870	7/10/2017	Gooding	16.6	7.79	609.8	NA	1.5	NA
8700501	870	7/10/2017	Gooding	12.0	7.68	872	NA	9.9	2.7
8700601	870	7/11/2017	Gooding	15.2	7.84	465.6	NA	3.4	2.8
8700801	870	7/11/2017	Gooding	13.7	7.61	1080	NA	5.2	6.1
8701201	870	7/10/2017	Gooding	15.0	7.78	879.9	NA	7.5	2.7
8701801	870	7/11/2017	Gooding	15.9	7.42	812	NA	2.8	NA
8706201	870	7/10/2017	Gooding	15.9	7.35	1416	NA	**25**	12.1
8706501	870	7/10/2017	Gooding	19.3	7.94	319.1	NA	<0.010	NA
8900401	890	7/19/2017	Elmore	16.8	7.34	1046	NA	8.3	3.7
8900501	890	7/18/2017	Elmore	17.3	7.52	866.5	NA	3.9	NA
8900601	890	7/18/2017	Elmore	16.4	7.46	902.6	NA	6.3	NA
8900801	890	7/19/2017	Elmore	14.7	7.56	1230	NA	**24**	5.4
8901801	890	7/19/2017	Elmore	17.4	7.54	1128	NA	8	2.8
8902201	890	7/19/2017	Elmore	17.0	7.61	1186	NA	**19**	3.2
9500201	950	9/26/2017	Nez Perce/Lewis/Idaho	13.4	7.52	595.3	NA	7.2	4.3
9501201	950	9/11/2017	Nez Perce/Lewis/Idaho	12.2	7.29	374.4	NA	3.3	NA
9501401	950	8/07/2017	Nez Perce/Lewis/Idaho	11.2	7.18	1190	NA	**36**	12.7
9501901	950	8/08/2017	Nez Perce/Lewis/Idaho	15.3	7.50	511	NA	4.5	NA
9502201	950	8/21/2017	Nez Perce/Lewis/Idaho	12.3	7.73	480.3	NA	8.4	3.9
9502701	950	9/11/2017	Nez Perce/Lewis/Idaho	12.3	7.80	450.4	NA	4	NA
9502801	950	9/25/2017	Nez Perce/Lewis/Idaho	12.4	7.99	722.1	NA	**15**	NA
9503701	950	8/29/2017	Nez Perce/Lewis/Idaho	18.2	7.57	359.1	NA	<0.010	NA
9503901	950	8/21/2017	Nez Perce/Lewis/Idaho	11.1	7.40	337.7	NA	3.4	NA
9504301	950	8/07/2017	Nez Perce/Lewis/Idaho	11.8	7.45	1077	NA	**21**	3.2
9505401	950	8/08/2017	Nez Perce/Lewis/Idaho	12.3	7.71	644	NA	**12**	2.5
9505501	950	8/29/2017	Nez Perce/Lewis/Idaho	19.1	8.20	321.8	NA	0.014	NA
9505701	950	8/29/2017	Nez Perce/Lewis/Idaho	12.2	7.42	351.1	NA	2.9	NA
9506001	950	9/25/2017	Nez Perce/Lewis/Idaho	12.6	8.22	453.6	NA	<0.010	—

ISDA Well ID	Project Number	Sample Date	Project Location (County)	Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Ammonia (mg/L)	Nitrite plus Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
9506401	950	9/25/2017	Nez Perce/Lewis/Idaho	12.2	7.86	365.4	NA	<0.010	NA
9507601	950	9/11/2017	Nez Perce/Lewis/Idaho	12.4	7.71	499.9	NA	5.8	1.7
9507901	950	8/07/2017	Nez Perce/Lewis/Idaho	12.6	7.84	352.9	NA	2.1	NA

a. Contaminant with a National Secondary Drinking Water Regulation standard.
b. Contaminant with a National Primary Drinking Water Regulation standard.
Notes: NA = not analyzed. (—) = analyzed but no nitrate. Bolded red numbers indicate EPA's NPDWR standard, expressed as a maximum contaminant level (MCL), was reached or exceeded. Italicized red numbers indicate EPA's NSDWR standard was exceeded. These regulations apply to public water systems only and are used with private wells to evaluate water quality.

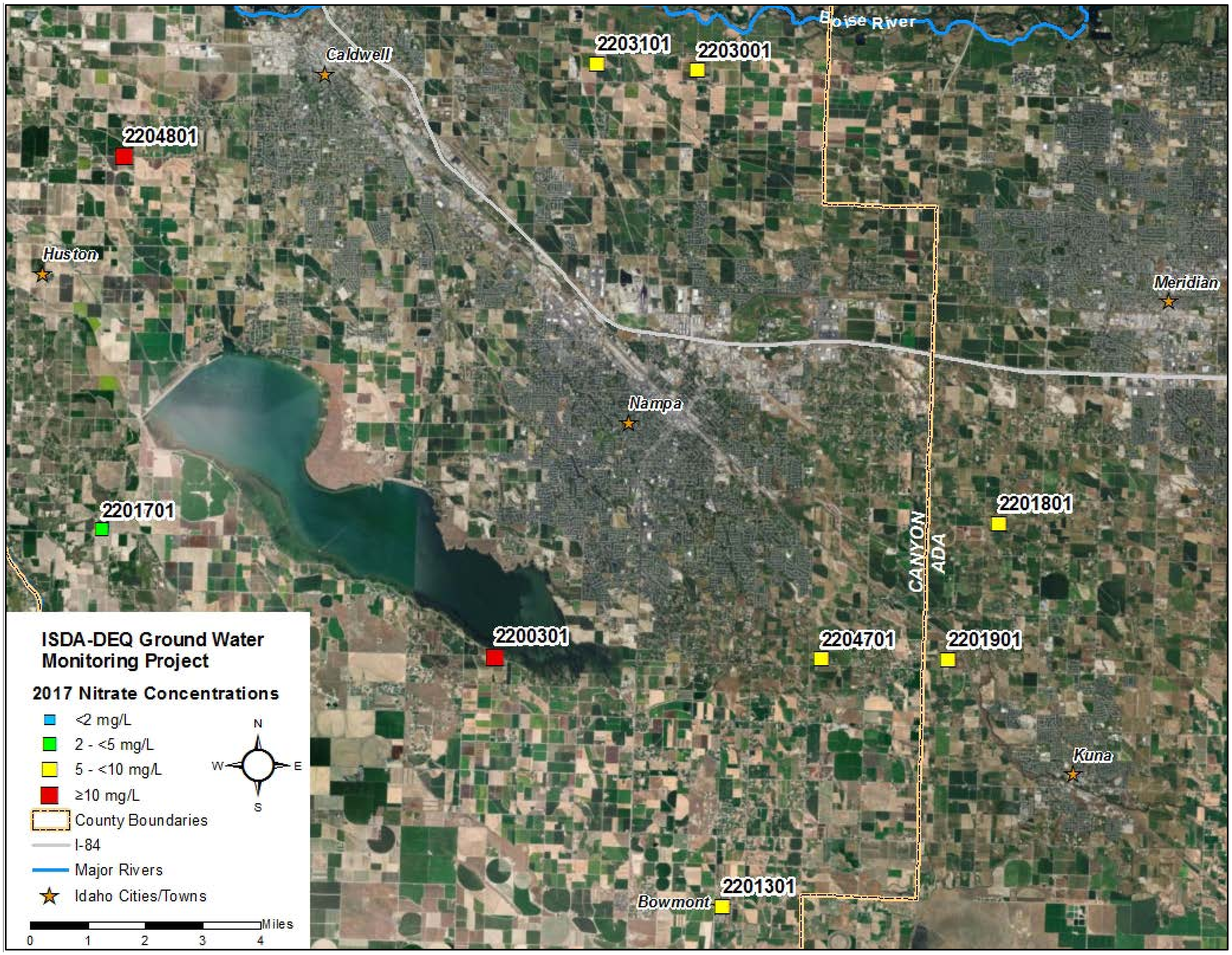

Figure B1. Project 220 (Ada and Canyon Counties) nitrate concentrations, 2017 ISDA data.

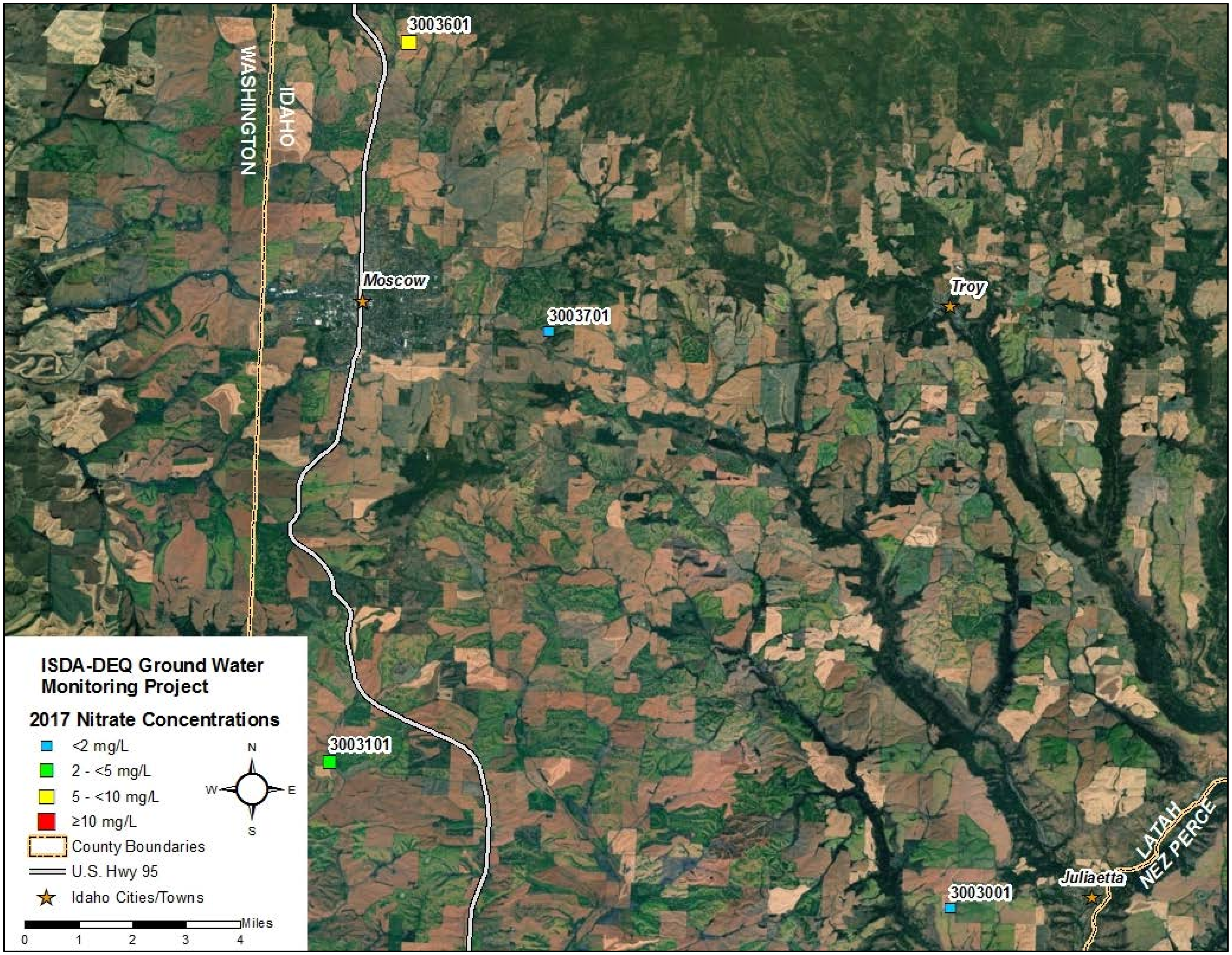

Figure B2. Project 300 (Latah County) nitrate concentrations, 2017 ISDA data.

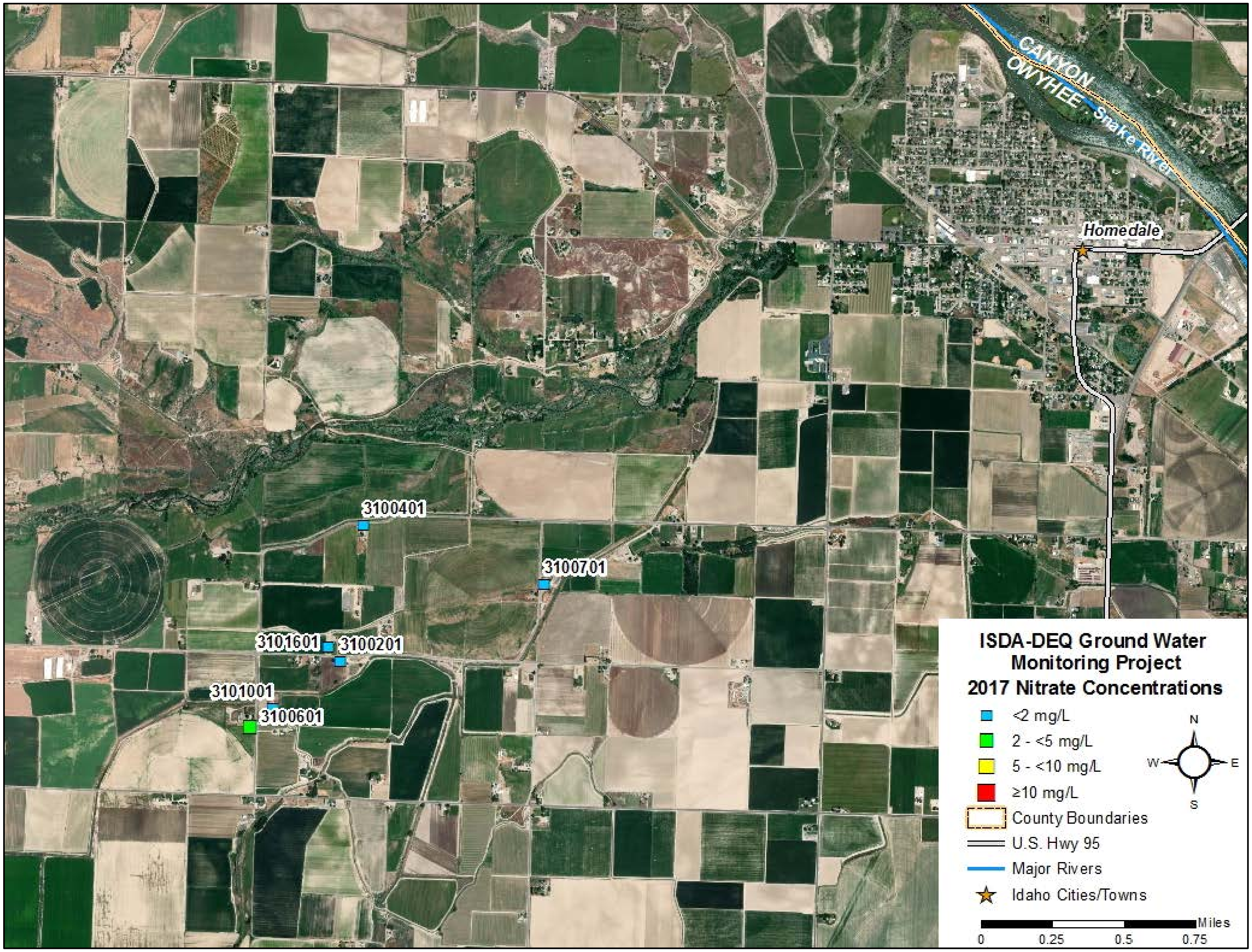

Figure B3. Project 310 (Owyhee County) nitrate concentrations, 2017 ISDA data.

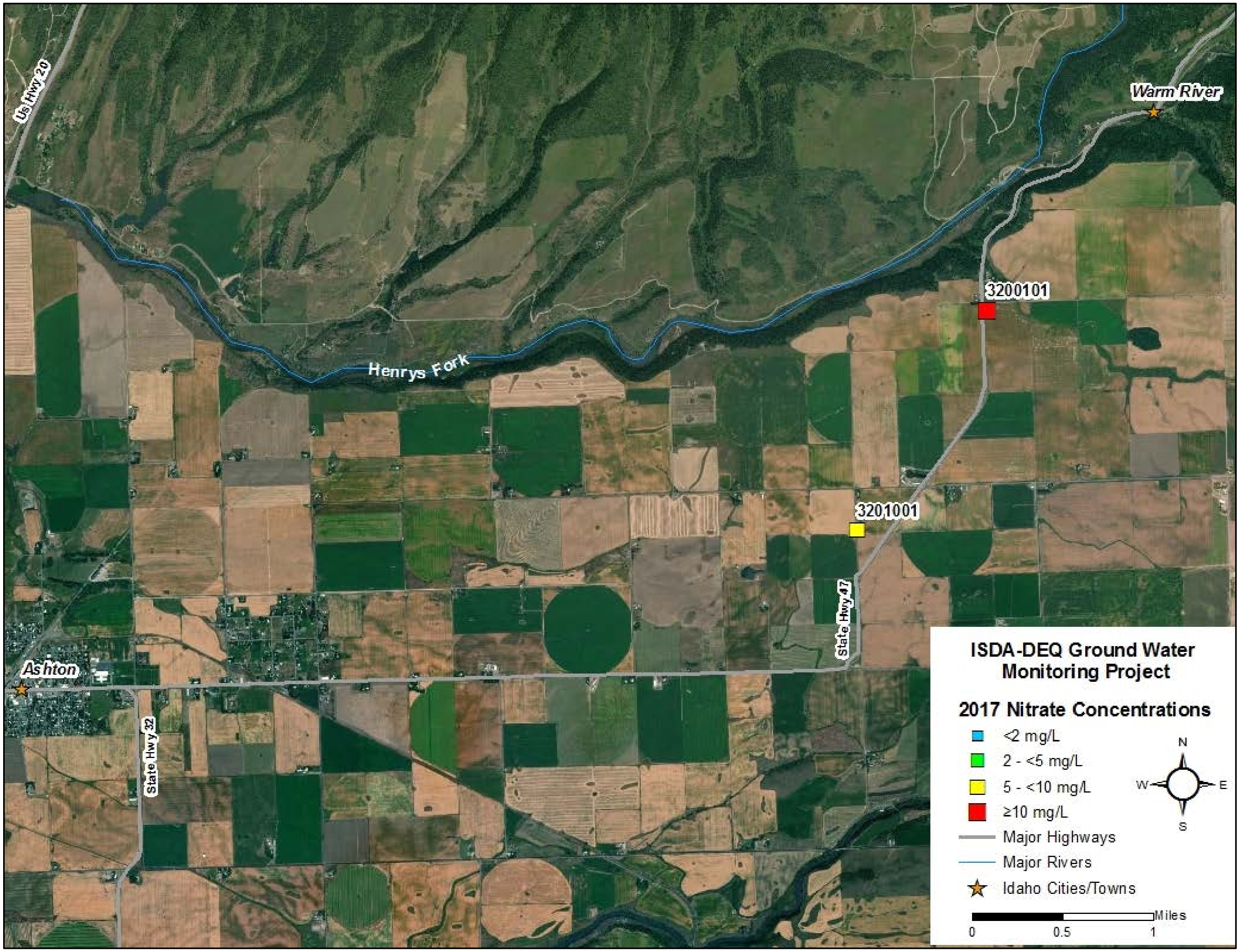

Figure B4. Project 320 (Fremont County) nitrate concentrations, 2017 ISDA data.

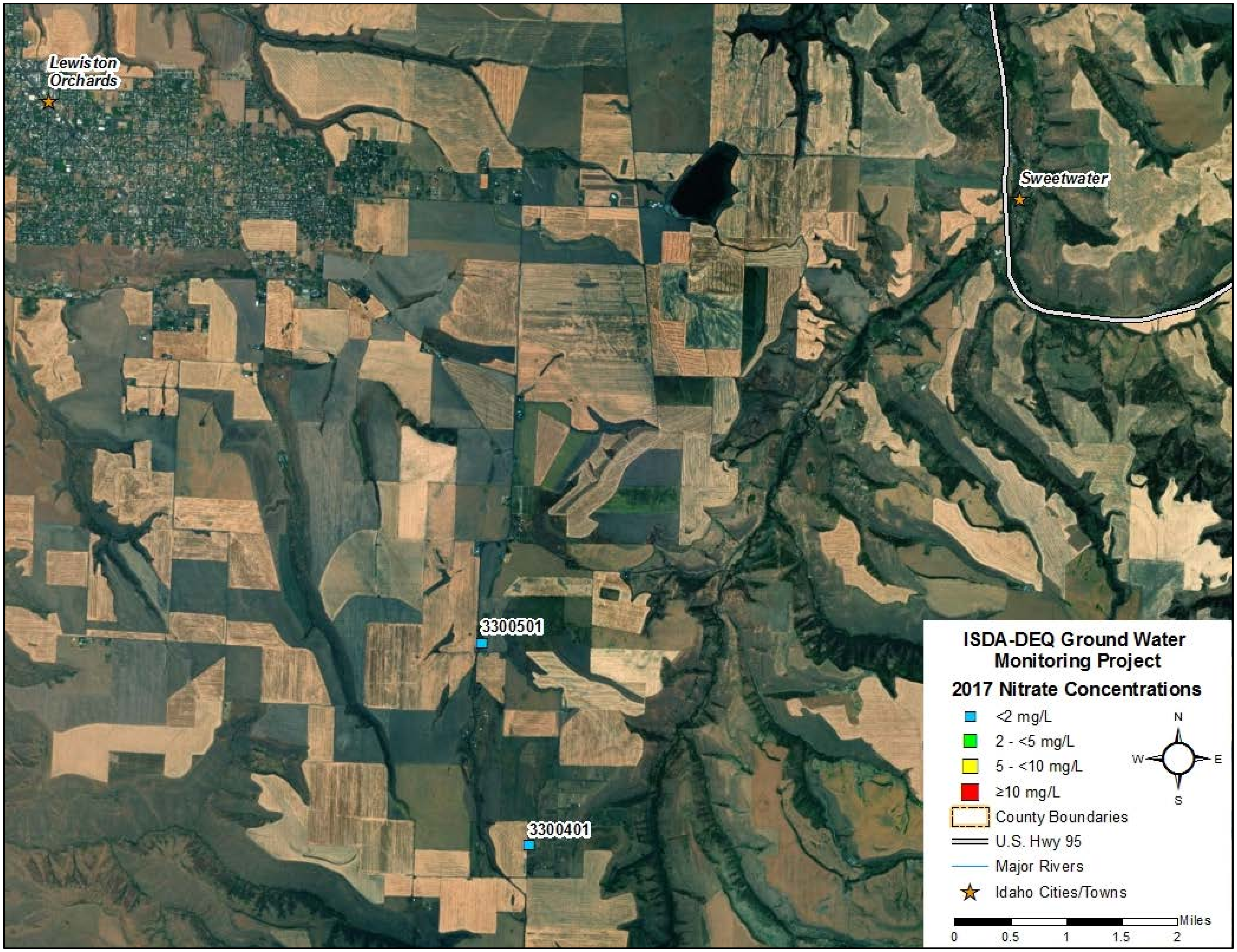

Figure B5. Project 330 (Nez Perce County) nitrate concentrations, 2017 ISDA data.

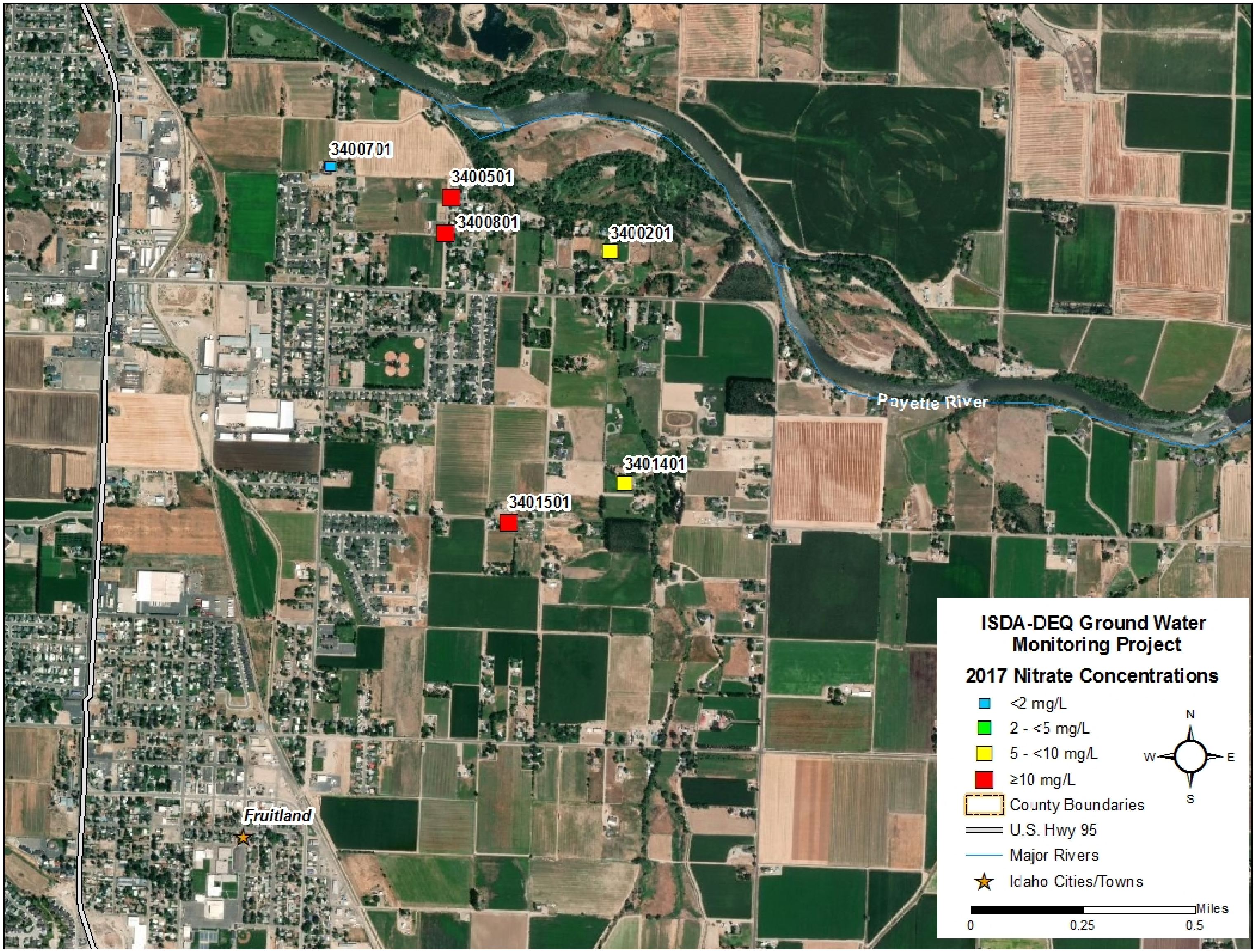

Figure B6. Project 340 (Payette County) nitrate concentrations, 2017 ISDA data.

Figure B7. Project 530 (Ada County) nitrate concentrations, 2017 ISDA data.

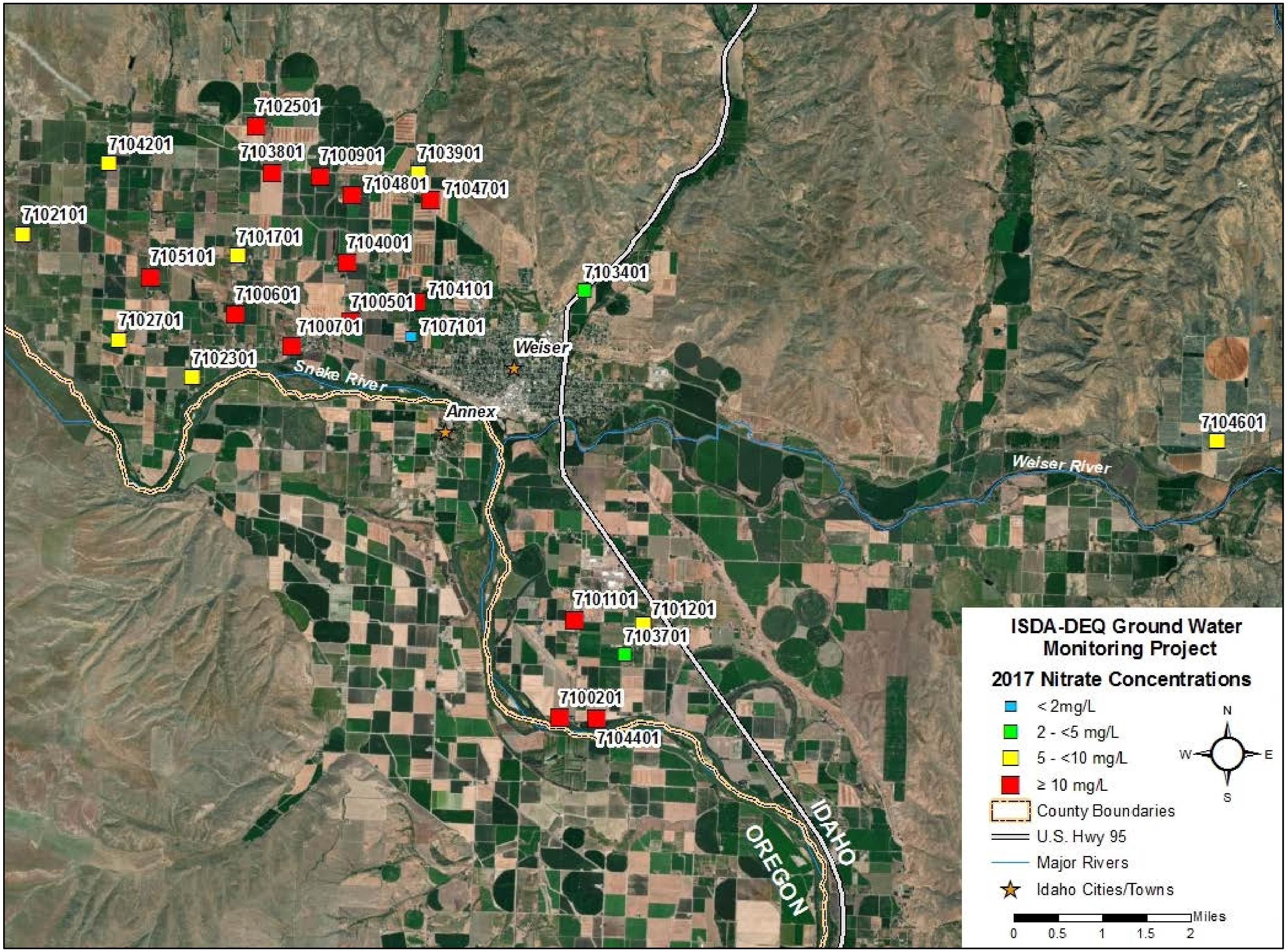

Figure B8. Project 710 (Washington County) nitrate concentrations, 2017 ISDA data.

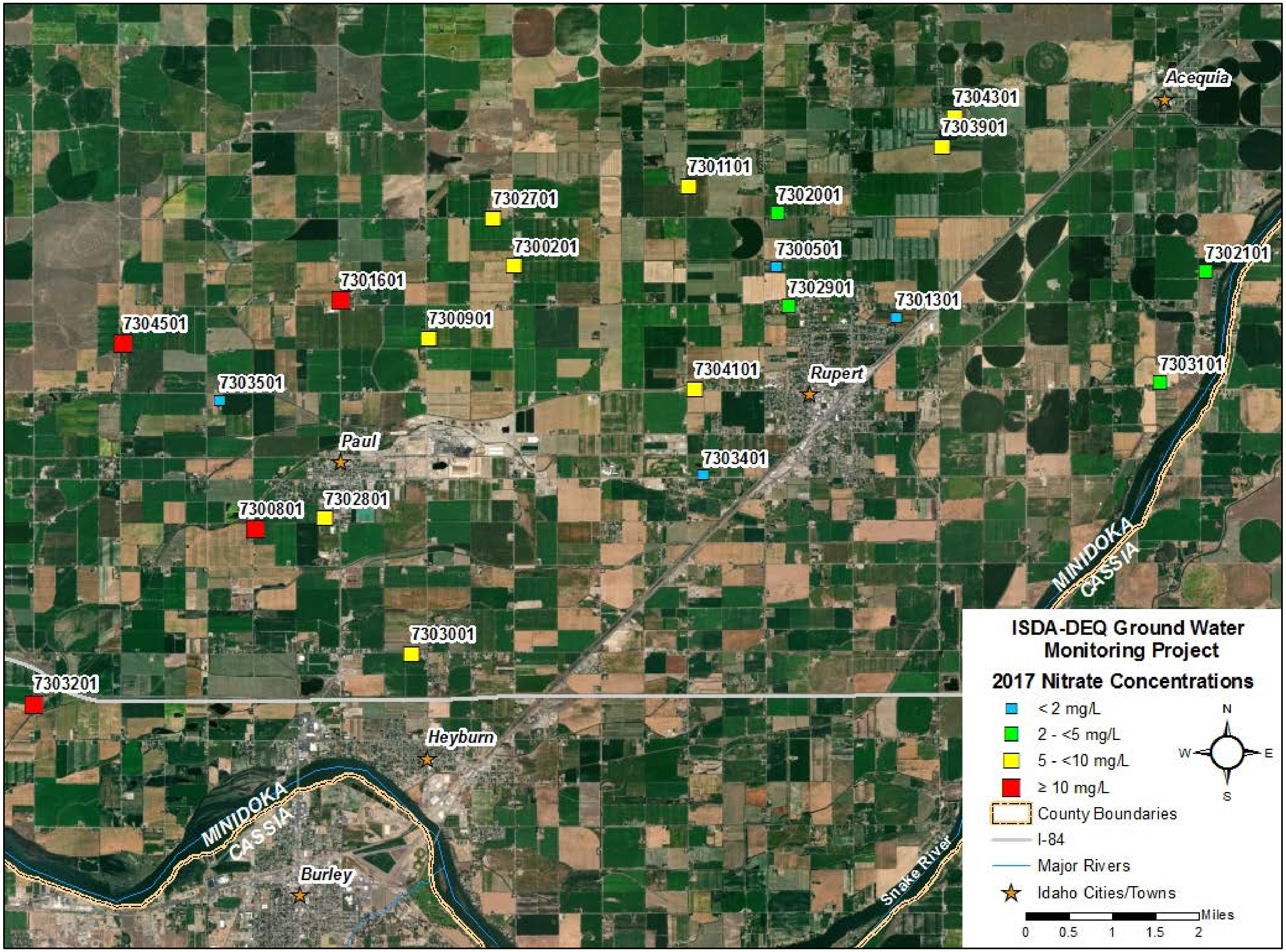

Figure B9. Project 730 (Minidoka County) nitrate concentrations, 2017 ISDA data.

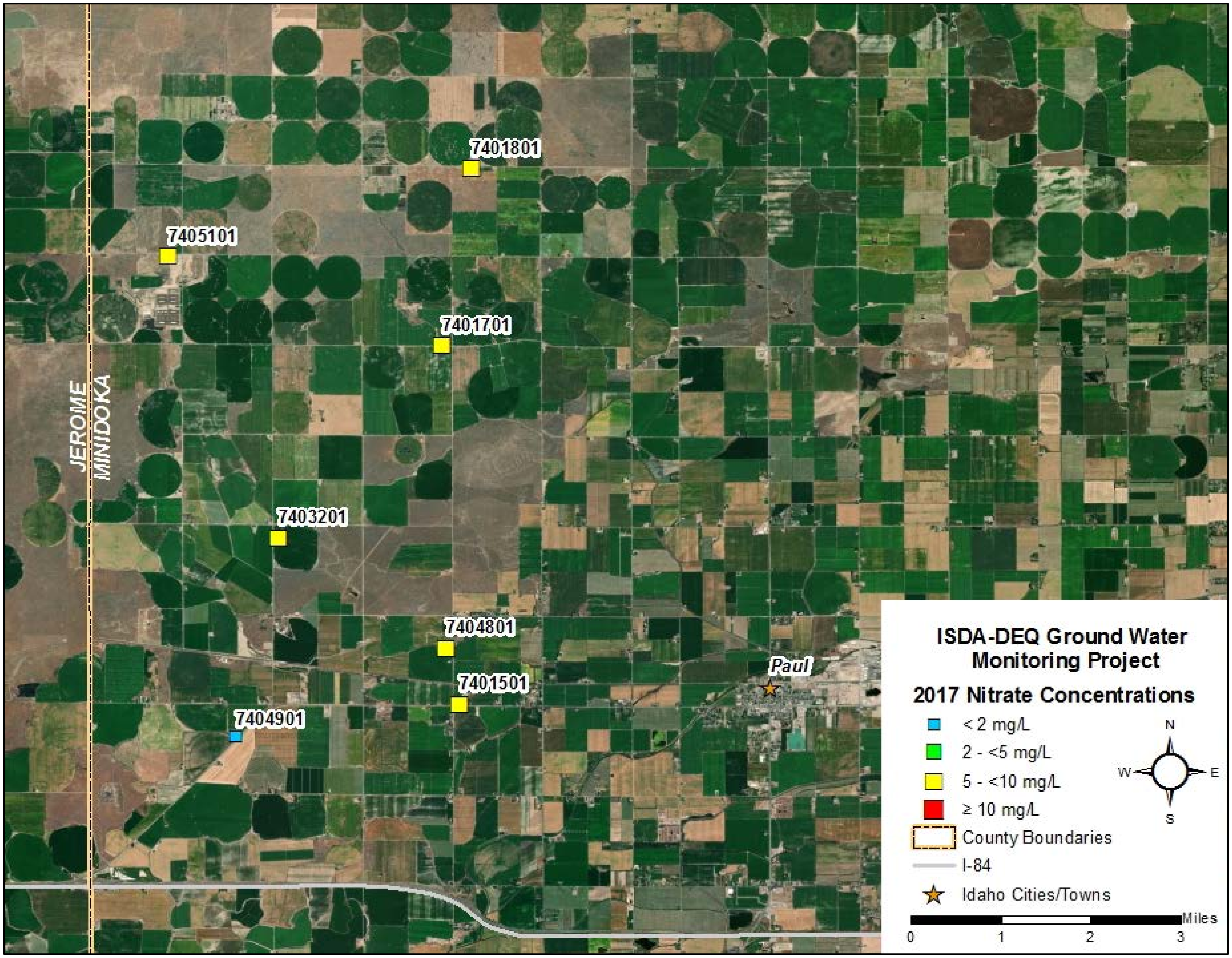

Figure B10 Project 740 (Minidoka County) nitrate concentrations, 2017 ISDA data.

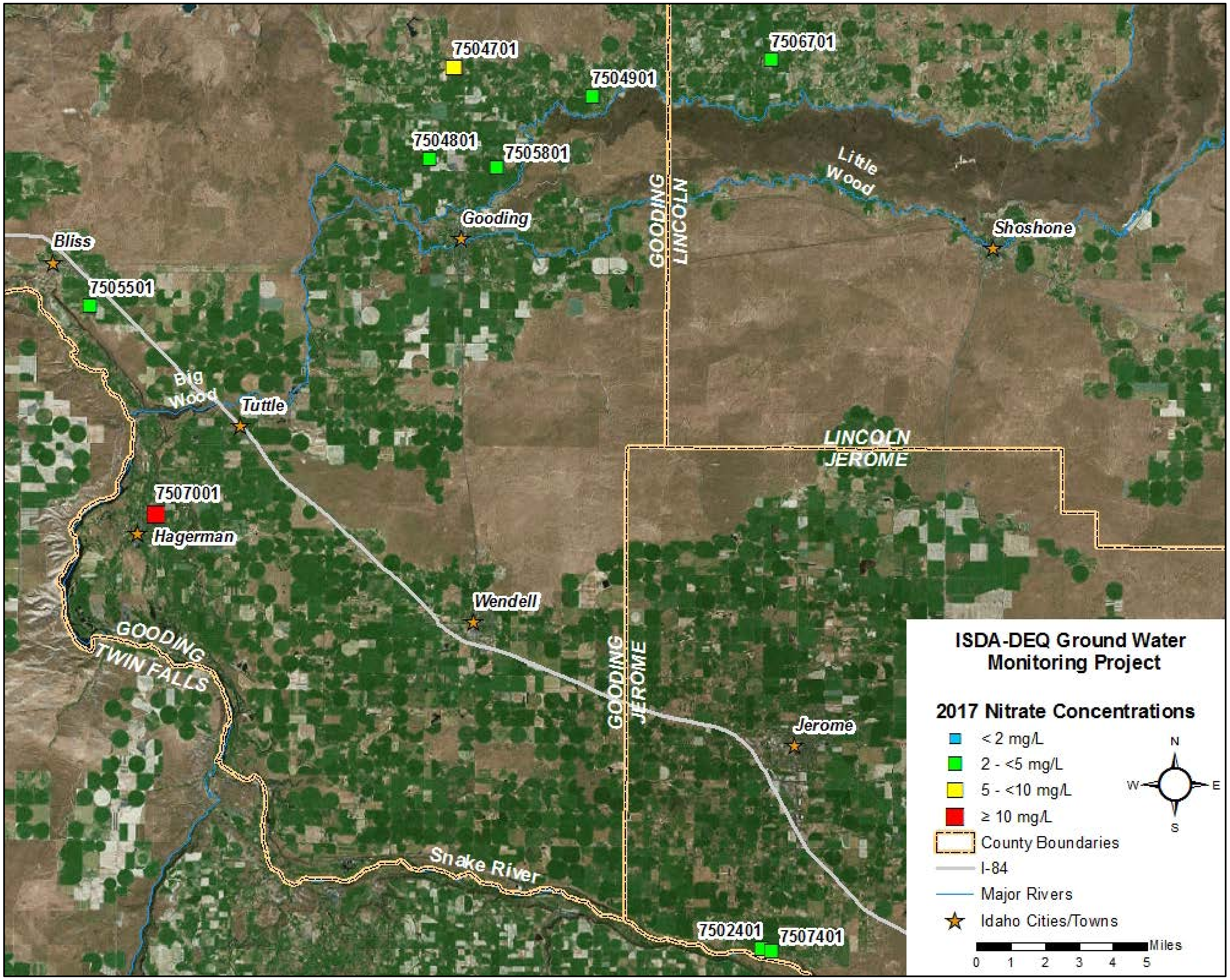

Figure B11. Project 750 (Gooding, Jerome, and Lincoln Counties) nitrate concentrations, 2017 ISDA data.

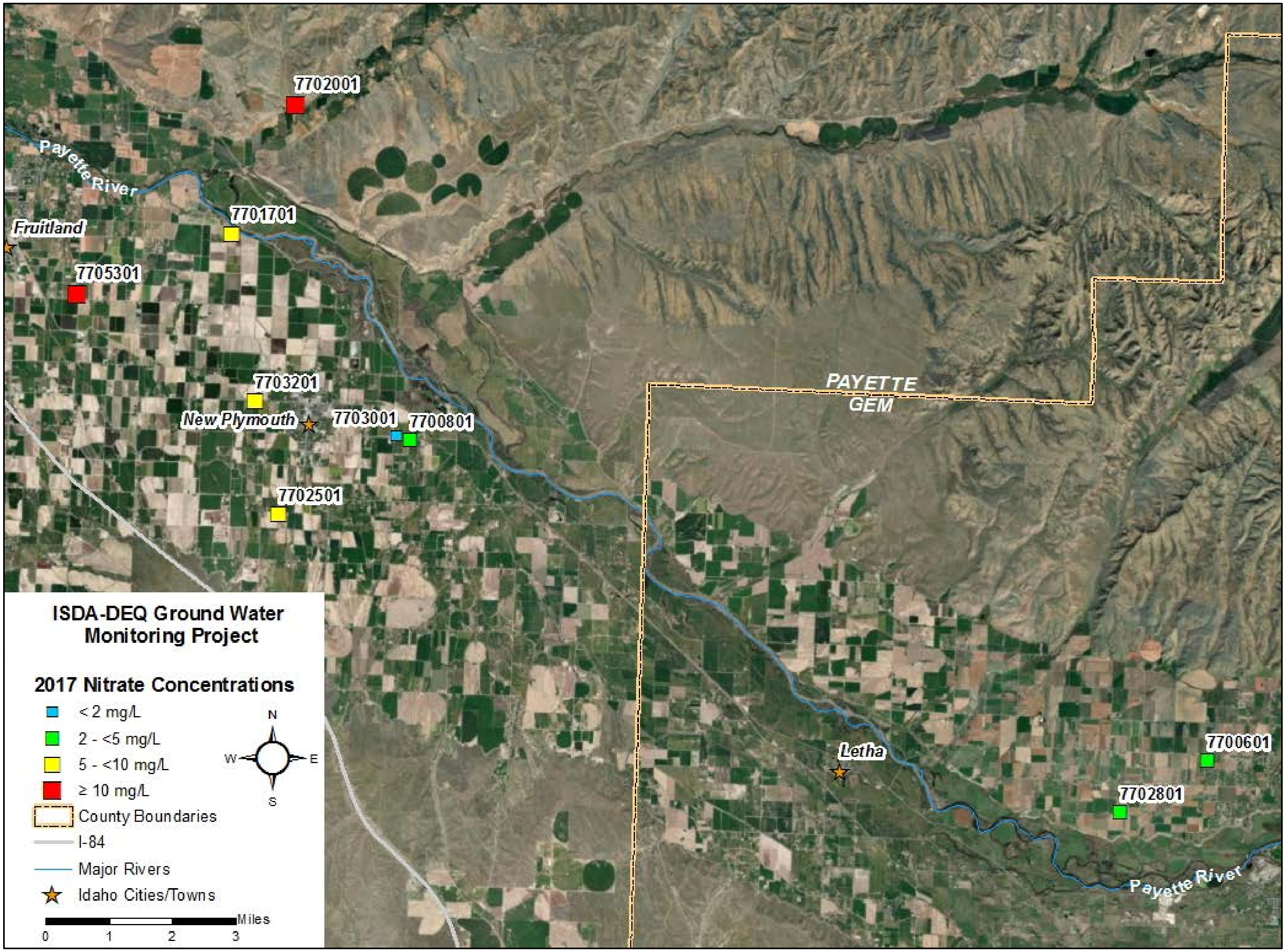

Figure B12. Project 770 (Gem and Payette Counties) nitrate concentrations, 2017 ISDA data.

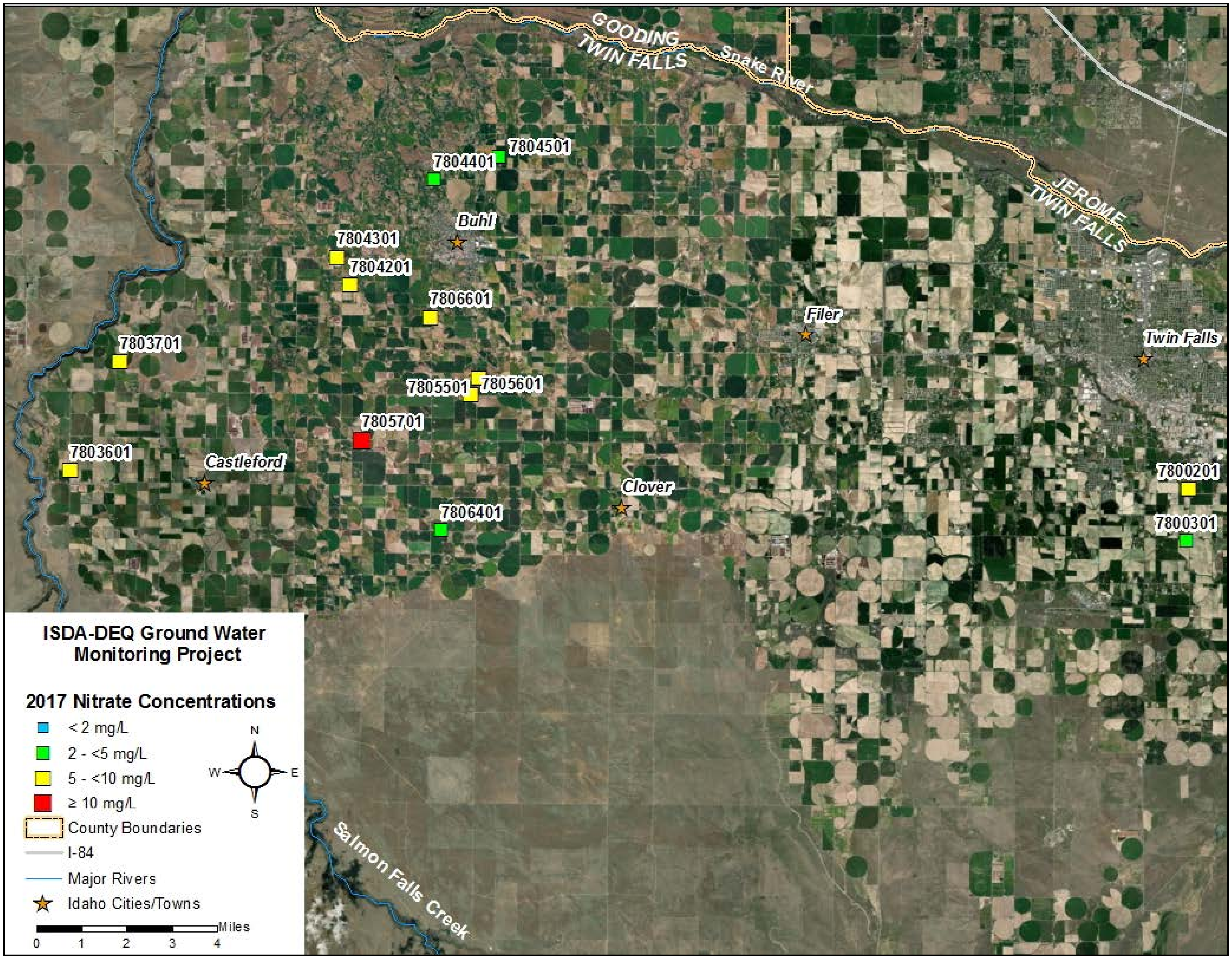

Figure B13. Project 780 (Twin Falls County) nitrate concentrations, 2017 ISDA data.

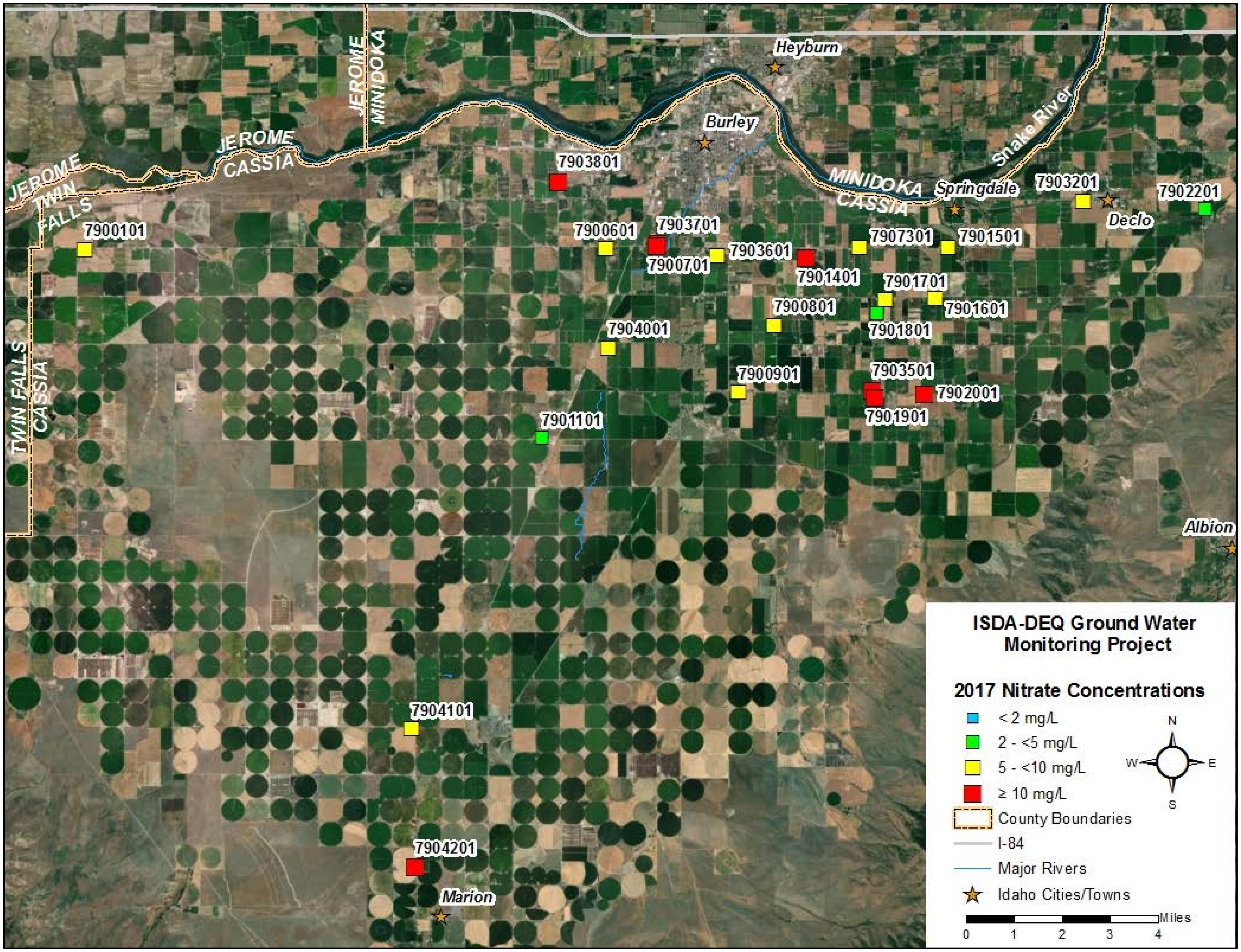

Figure B14. Project 790 (Cassia County) nitrate concentrations, 2017 ISDA data.

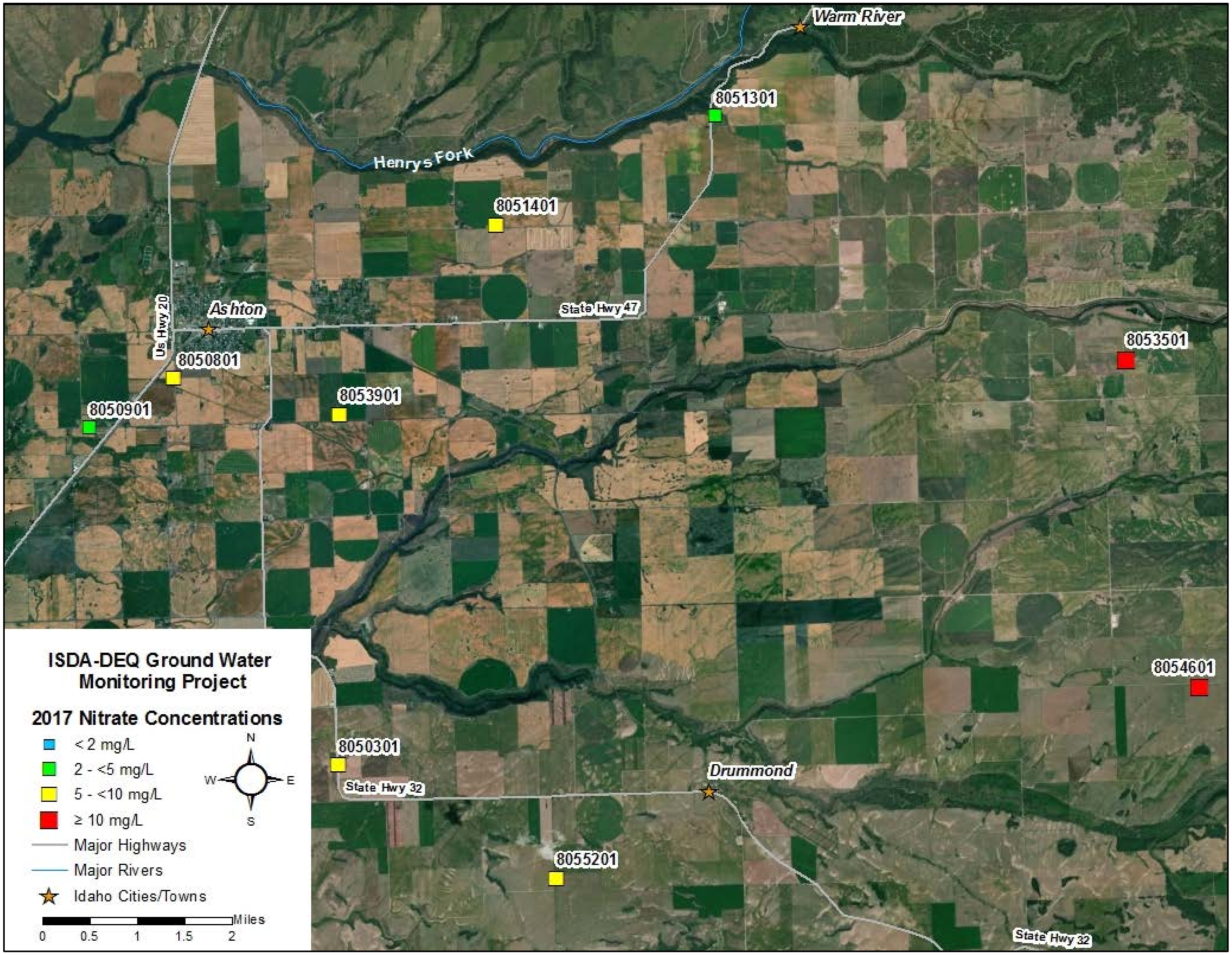

Figure B15. Project 805 (Fremont County) nitrate concentrations, 2017 ISDA data.

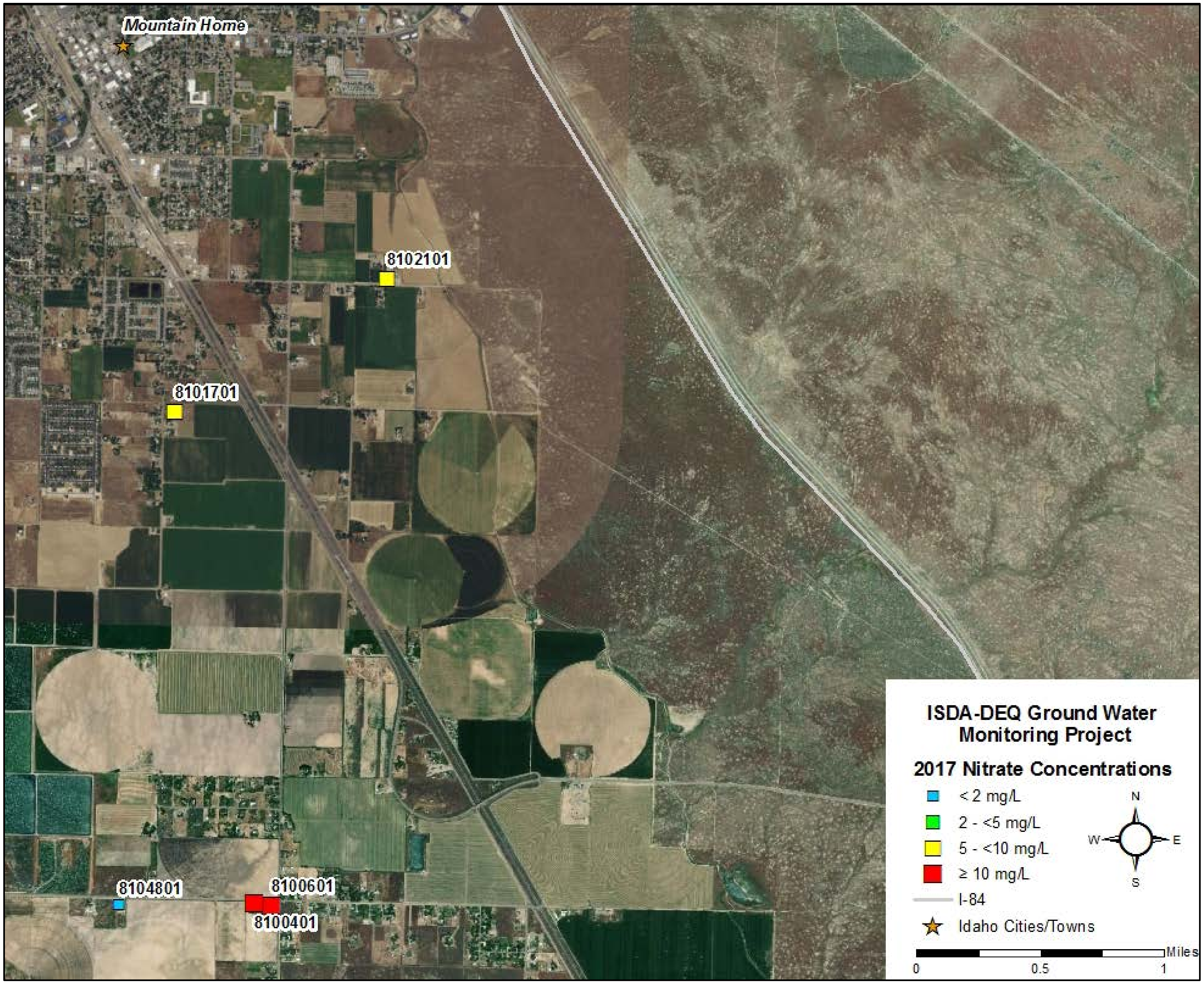

Figure B16. Project 810 (Elmore County) nitrate concentrations, 2017 ISDA data.

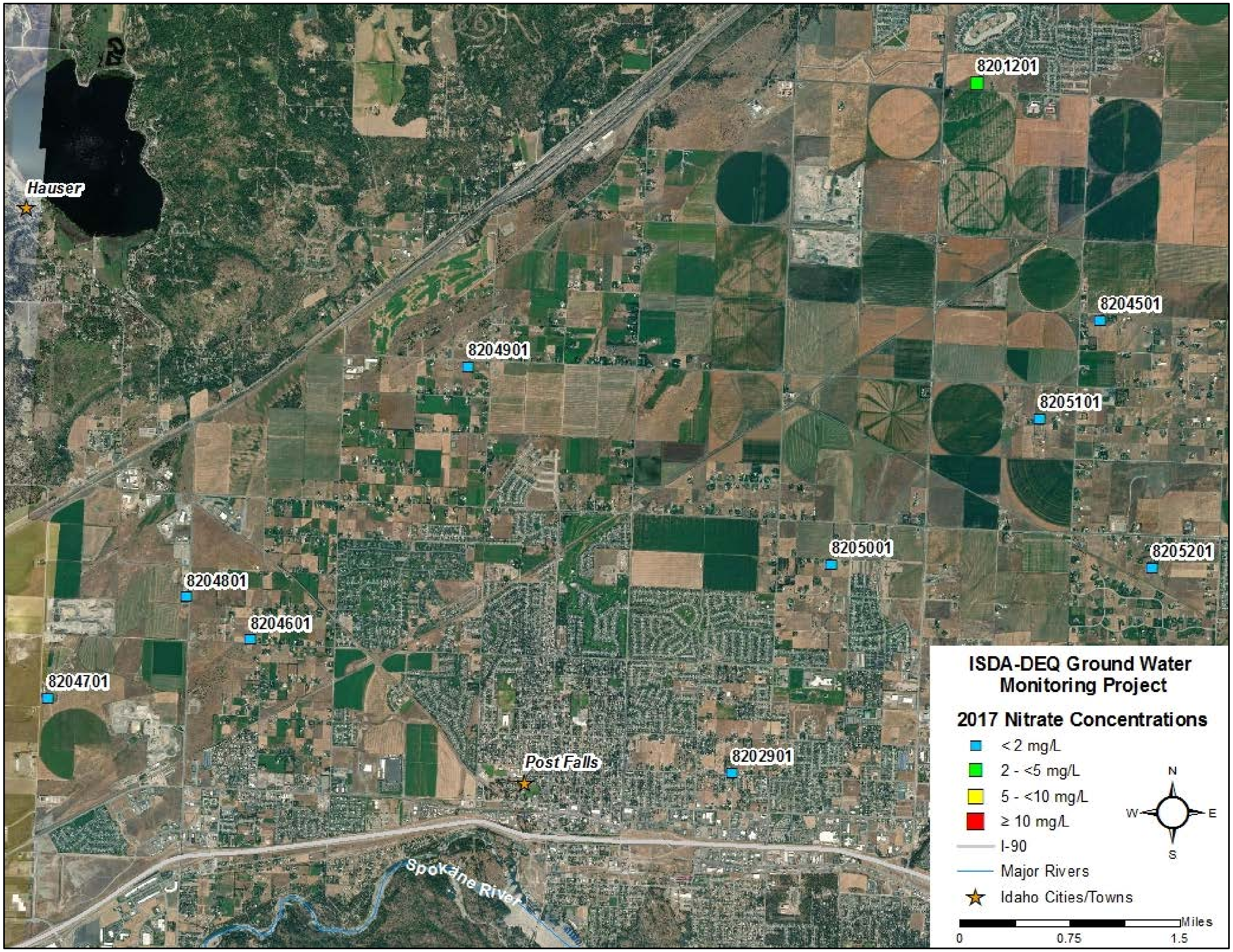

Figure B17. Project 820 (Kootenai County) nitrate concentrations, 2017 ISDA data.

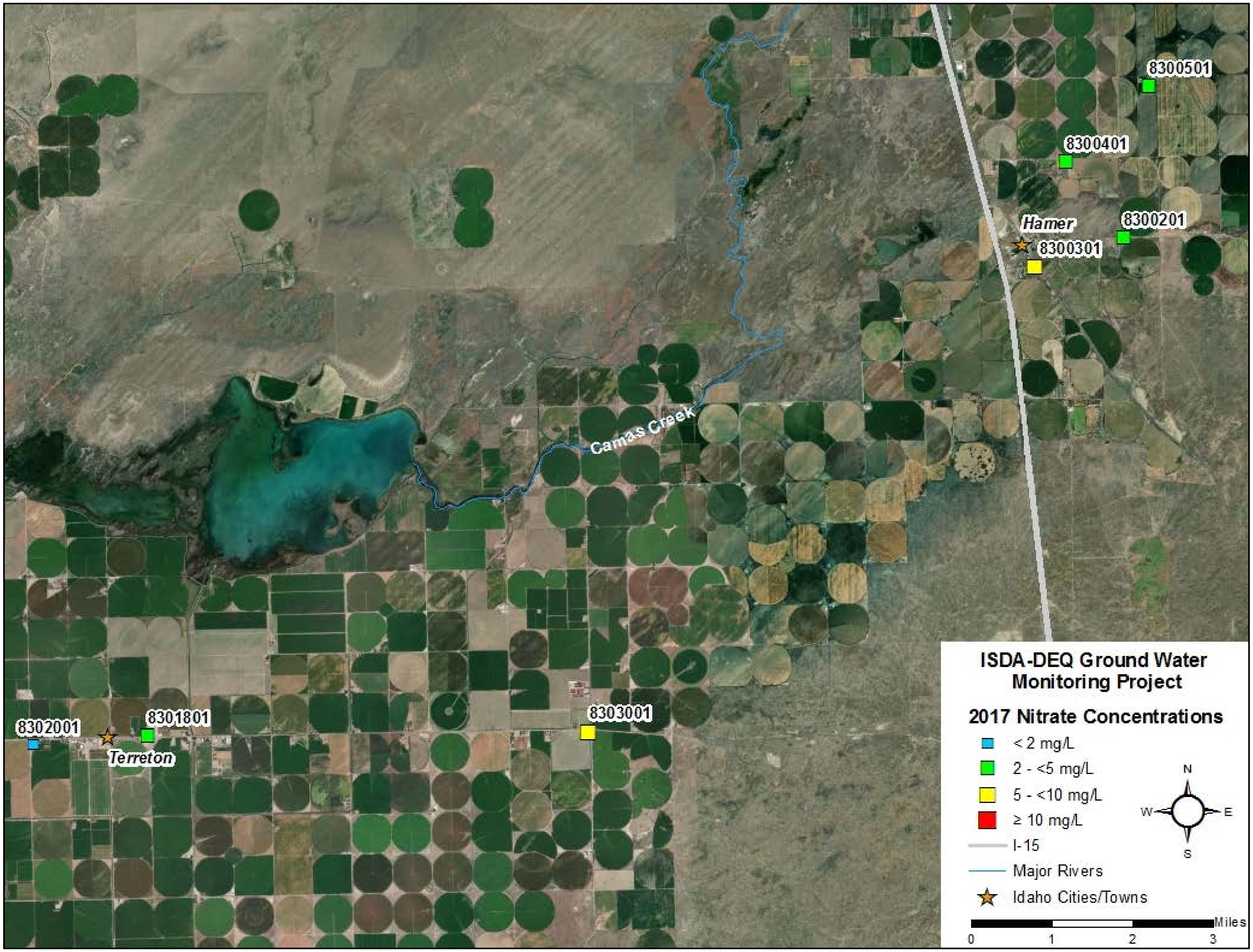

Figure B18. Project 830 (Jefferson County) nitrate concentrations, 2017 ISDA data.

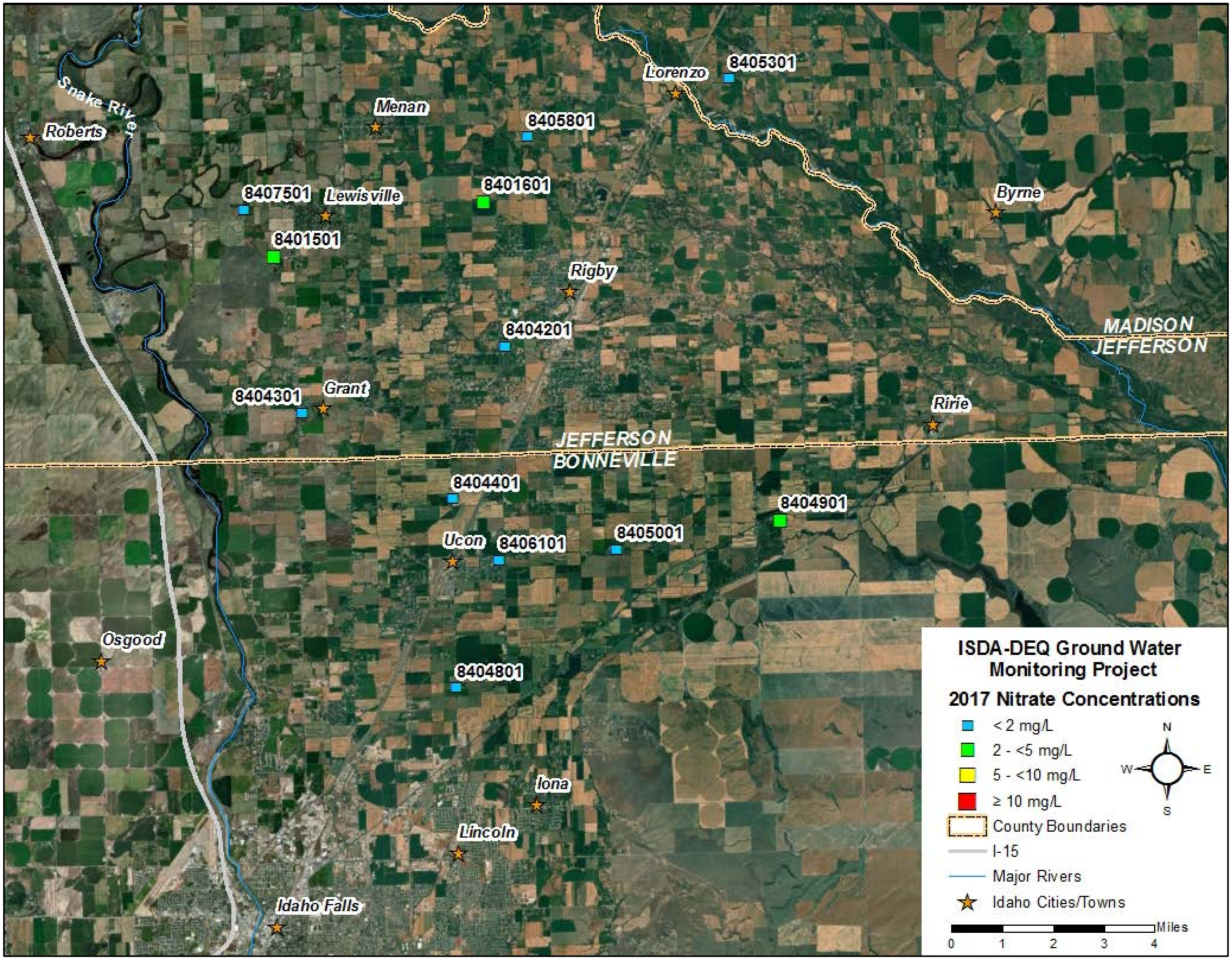

Figure B19. Project 840 (Bonneville, Jefferson, and Madison Counties) nitrate concentrations, 2017 ISDA data.

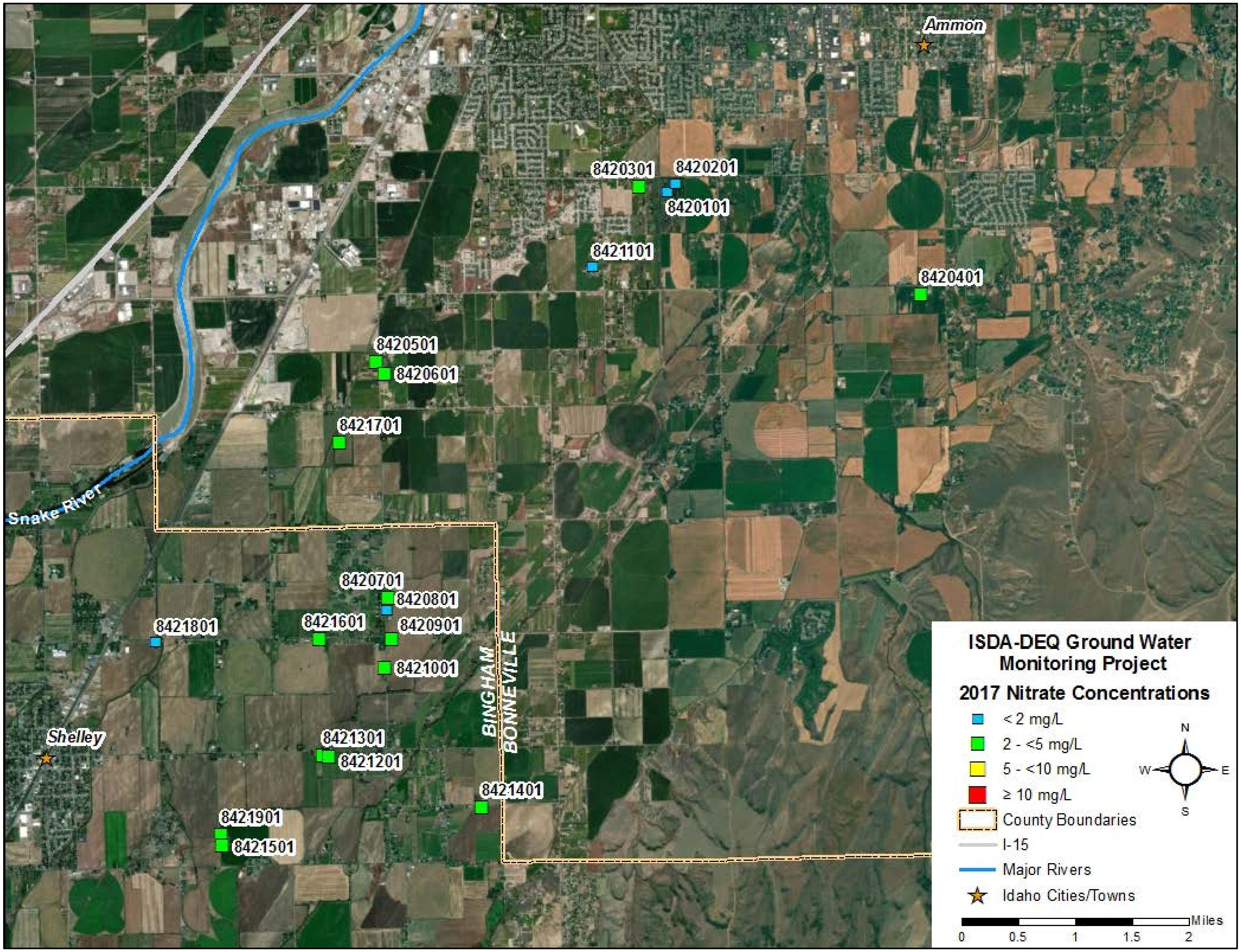

Figure B20. Project 842 (Bingham and Bonneville Counties) nitrate concentrations, 2017 ISDA data.

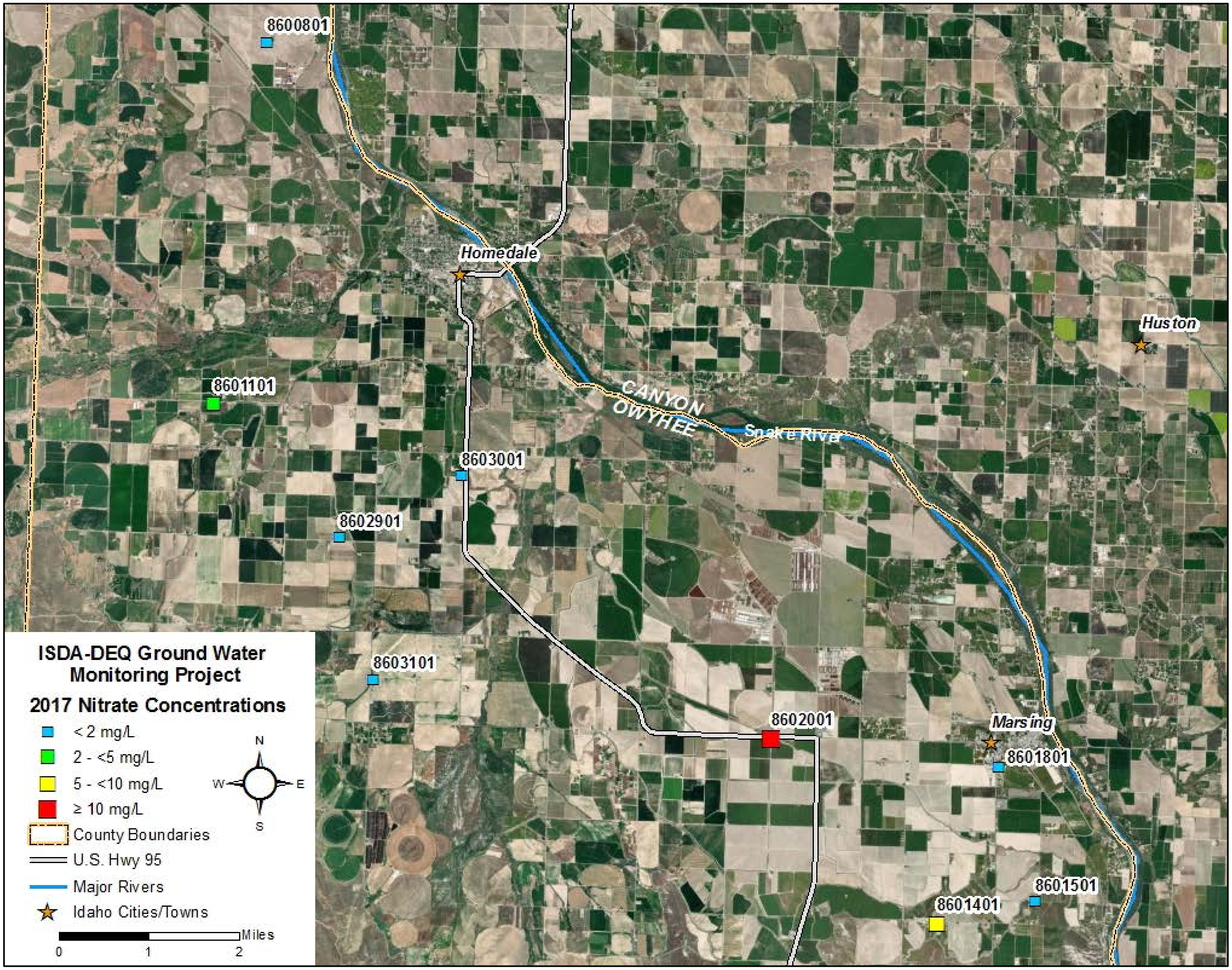

Figure B21. Project 860 (Owyhee County) nitrate concentrations, 2017 ISDA data.

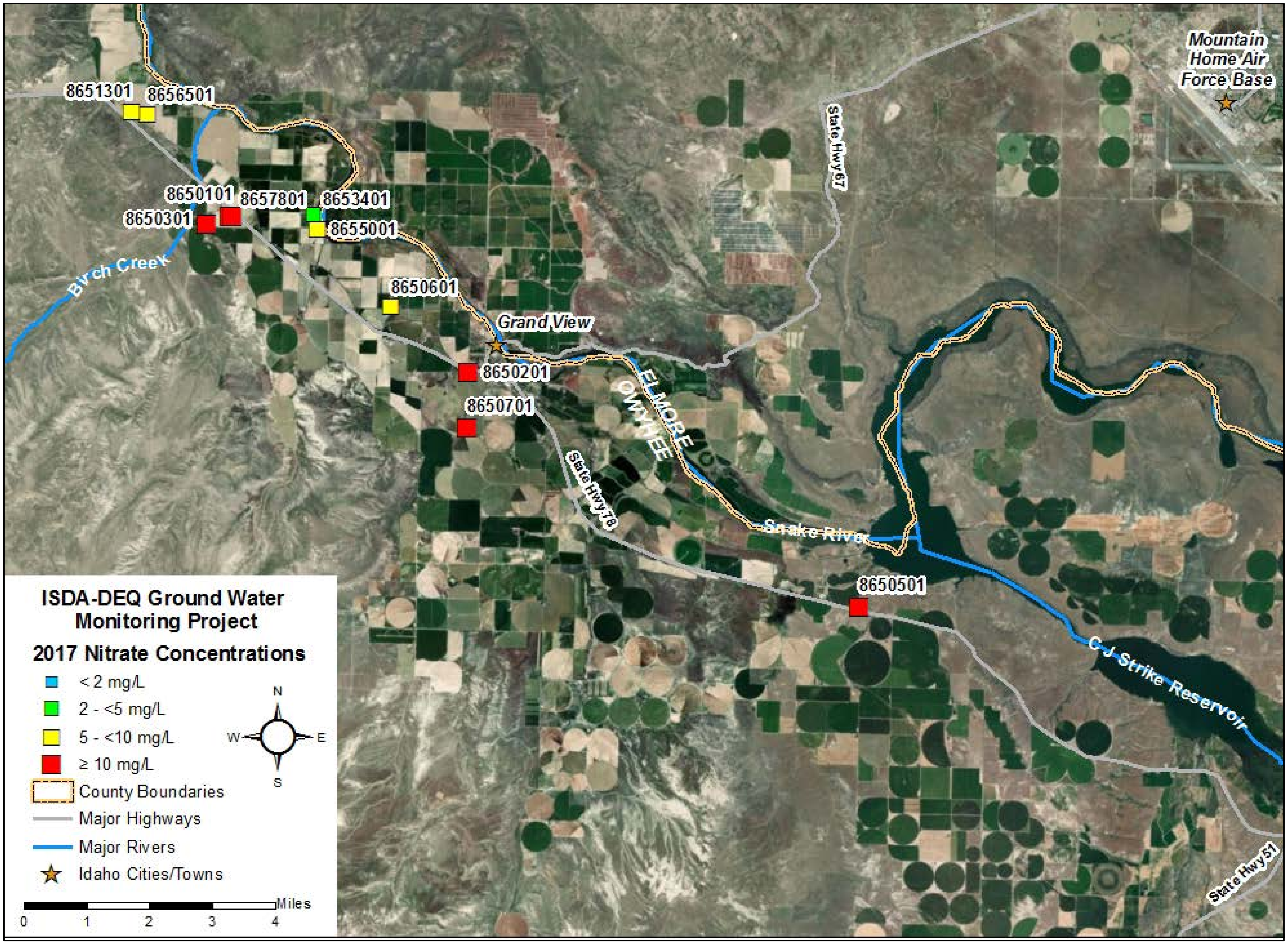

Figure B22. Project 865 (Owyhee County) nitrate concentrations, 2017 ISDA data.

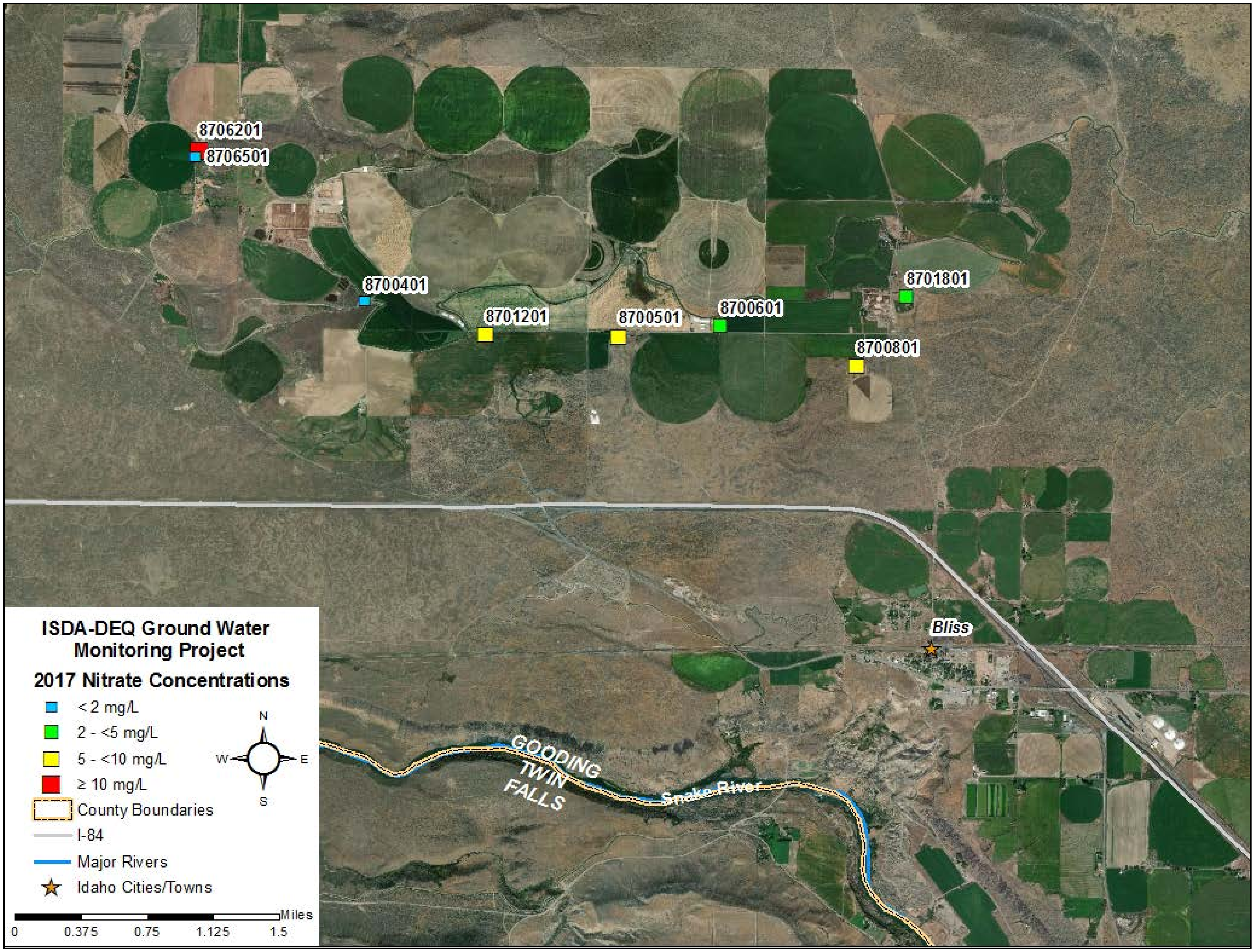

Figure B23. Project 870 (Gooding County) nitrate concentrations, 2017 ISDA data.

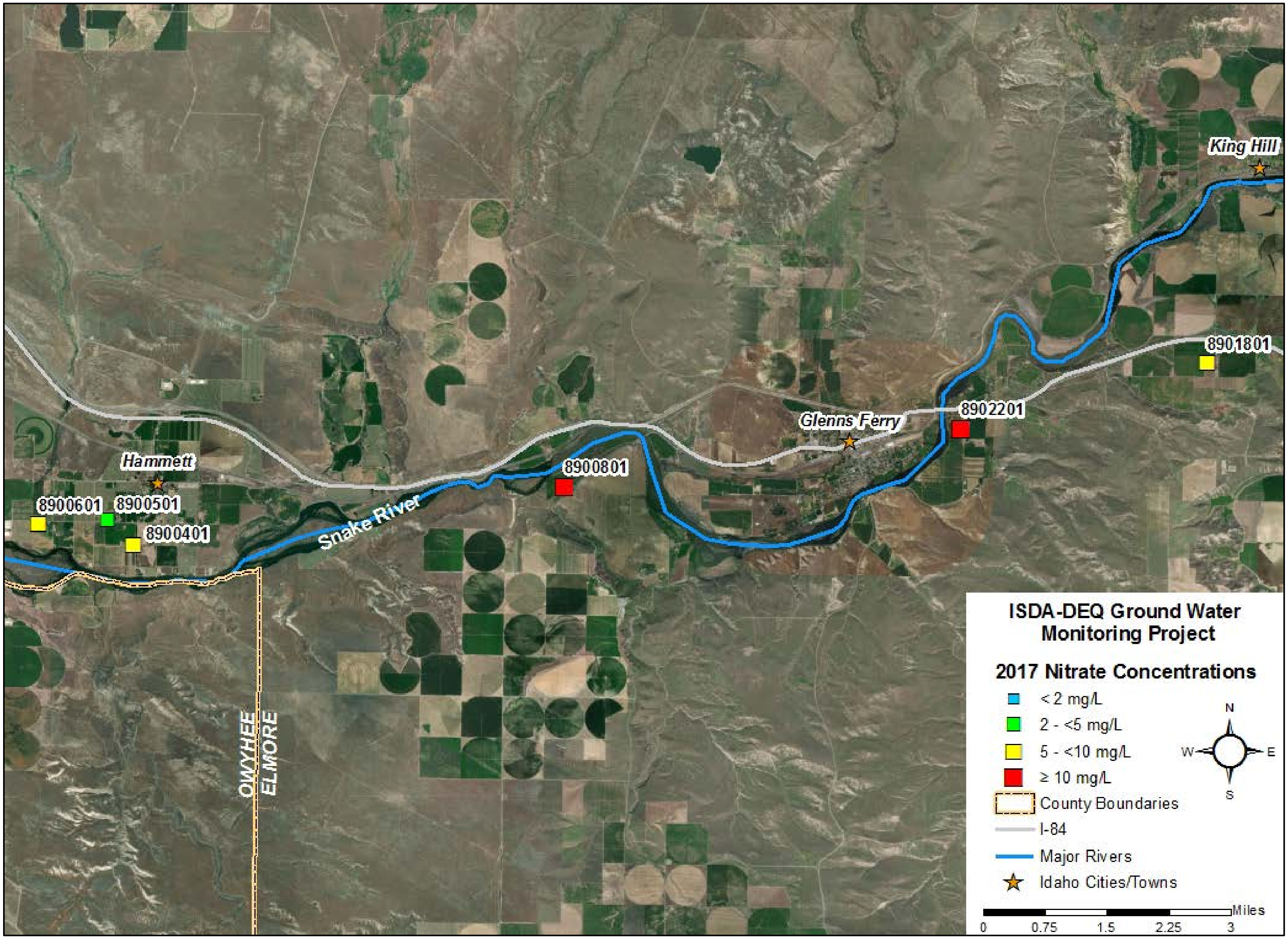

Figure B24. Project 890 (Elmore County) nitrate concentrations, 2017 ISDA data.

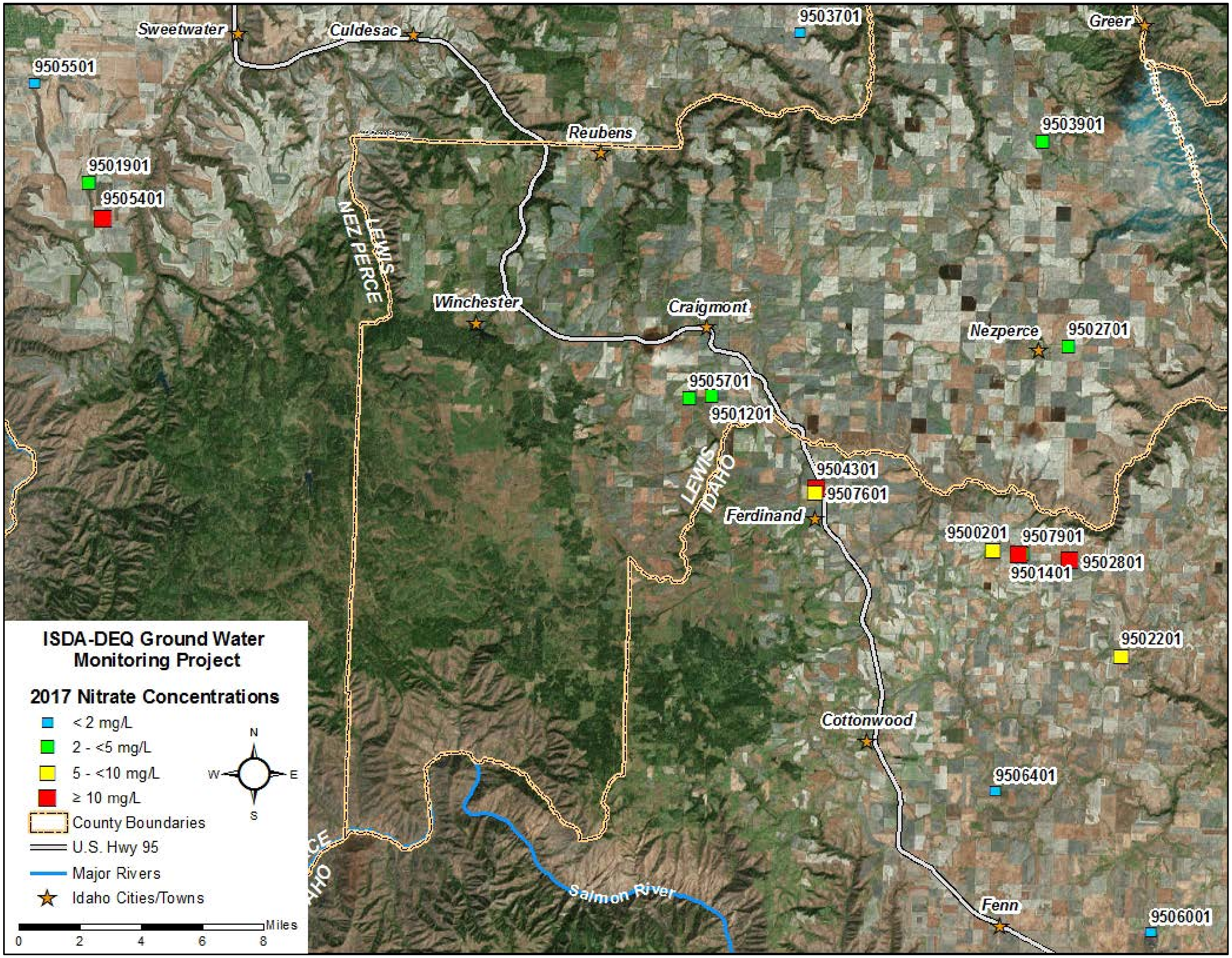

Figure B25. Project 950 (Idaho, Lewis, and Nez Perce Counties) nitrate concentrations, 2017 ISDA data.