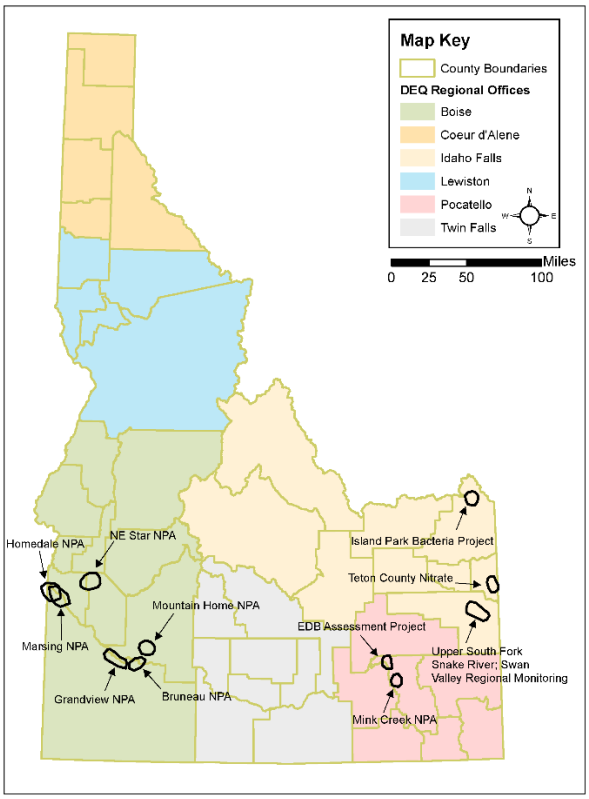
Summary Report for the Idaho Department of Environmental Quality Groundwater Quality Monitoring Projects—2021

Groundwater Quality Technical Report No. 55



State of Idaho
Department of Environmental Quality

June 2024

Acknowledgments

Thank you to the following Idaho Department of Environmental Quality staff who assisted with various sections of this summary report:

- Rebecca Goehring contributed to the Boise region project summaries (section 2.1)
- David Goings contributed to the Pocatello region project summaries (section 2.2).
- Flint Hall contributed to the Idaho Falls region project summaries (section 2.3).
- Kathryn Elliott contributed the DEQ Cooperative Projects summaries (section 3).
- Nicole Rinaldi contributed QA reviews of project data and report figures.

Also, thank you to Kathryn Elliott, Ed Hagan, Jerri Henry, and Jill White for the technical and editorial reviews that improved the quality of this report.

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DEQ. June 2024. Cost codes: 24530001.245048.22503. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Idaho Code § 60-202.

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Acronyms, Abbreviations, and Symbols

°C	degrees Celsius
µg	microgram
µS	microsiemen
$\delta^{15}N$	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
bgs	below ground surface
$CaCO_3$	calcium carbonate
cm	centimeter
DBCP	dibromochloropropane
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
DW	domestic well
E. coli	*Escherichia coli*
EDB	ethylene dibromide
EIPHD	Eastern Idaho Public Health District
EPA	United States Environmental Protection Agency
ESRP	Eastern Snake River Plain
FSP	field sampling plan
ft	feet
FTR	Friends of the Teton River
IDAPA	refers to citations of Idaho's administrative rules
IDWR	Idaho Department of Water Resources
ISDA	Idaho State Department of Agriculture
L	liter
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
per mil (‰)	parts per thousand
PWS	public water system
QAPP	quality assurance project plan
TC	total coliform
WSRP	Western Snake River Plain

1 Introduction

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

Idaho Code § 39-120 "Department of Environmental Quality Primary Administrative Agency – Agency responsibilities" designates the Idaho Department of Environmental Quality (DEQ) as the primary agency to coordinate and administer groundwater quality protection programs for the state. DEQ is also responsible for collecting and analyzing data for groundwater 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 groundwater quality monitoring and promote public awareness of groundwater issues by making results of groundwater quality investigations available to the public.

Public drinking 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 analysis of drinking water for various contaminants. DEQ ensures that follow-up monitoring is conducted when contaminants of concern are detected in PWSs. The US Environmental Protection Agency (EPA) sets National Primary Drinking Water Regulations (NPDWRs) as legally enforceable standards, expressed as maximum contaminant levels (MCLs), which apply to PWSs. The established levels protect public health by limiting the amount of contaminants in drinking water. EPA also sets National Secondary Drinking Water Regulations (NSDWRs) as nonmandatory standards established as guidelines to assist PWSs in managing their drinking water for aesthetic considerations (e.g., taste, color, and odor).

Although these limits only apply to PWSs, they can be used to evaluate water quality in private wells, as is done throughout this report. Total coliform (TC) and *Escherichia coli* (*E. coli*) bacteria sampling results were compared to the groundwater quality standards in the Idaho "Groundwater 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 Groundwater 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 groundwater protection.

Field measurements taken during follow-up investigations and monitoring projects should be considered estimates and not used for determining exceedances of Idaho's groundwater quality standards. Field measurements are used to monitor well water during purging, ensure water in

the wellbore is removed from the well before sampling, and to qualitatively evaluate water quality variability between wells.

The groundwater quality monitoring results can also be used to define and prioritize degraded groundwater quality areas, such as nitrate priority areas (NPAs). In 2020, DEQ identified 35 areas in the state with elevated concentrations of nitrate (as N)[1] in groundwater. These NPAs are ranked based on population, water quality, and water quality trends. The criterion for an NPA designation is met when 25% or more of the wells sampled within the area meet or exceed 5 milligrams per liter (mg/L) concentration, or half of the MCL (10 mg/L). EPA established an MCL for nitrate at 10 mg/L and Idaho adopted this MCL as the groundwater quality standard. The NPAs are reevaluated and reranked approximately every 5 years following the NPA delineation and ranking process (DEQ 2021a).

Prioritization effectively allocates resources for water quality improvement strategies. DEQ works with state and federal agencies and stakeholders to develop groundwater quality management plans to address groundwater degradation in NPAs. Groundwater quality data are used to evaluate the effectiveness of plan implementation.

DEQ's Groundwater Program implemented regional groundwater 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 groundwater monitoring projects and investigation activities accomplished with public funds in 2021. It does not include results from privately-funded activities, including monitoring required by permits, monitoring associated with ongoing environmental remediation projects, Kootenai County Aquifer Protection District funding, or PWS requirements.

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

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

2 Summary of Groundwater Quality Projects by Region

This section presents data from groundwater quality monitoring and investigation projects conducted by DEQ in 2021. Projects are presented by DEQ's regional offices and identified in Figure 1.

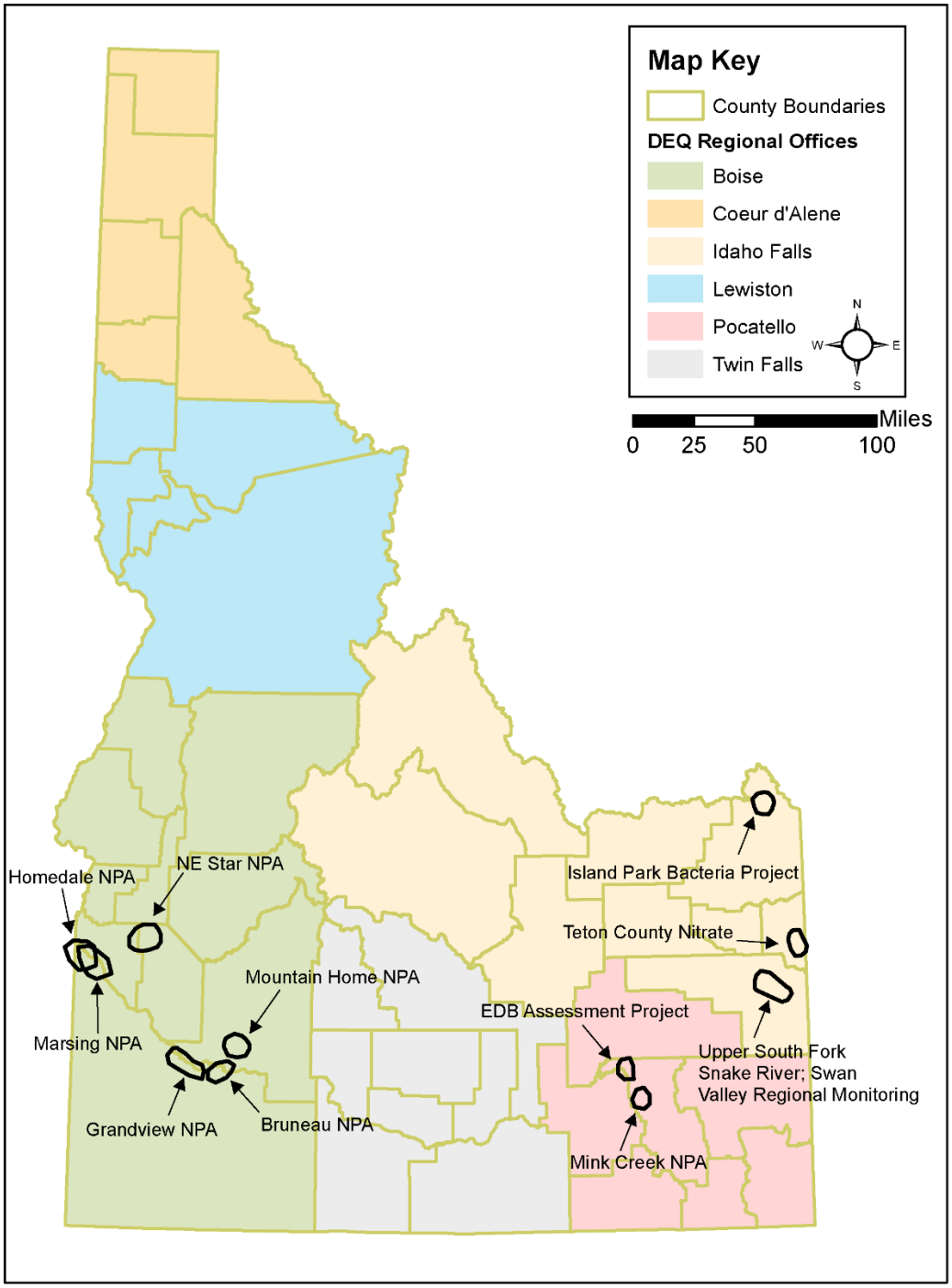


Figure 1. DEQ's 2021 groundwater quality project locations by region.

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

2.1 Boise Region

Five groundwater quality monitoring projects were conducted in the Boise region in 2021 using public funds.

2.1.1 Bruneau Nitrate Priority Area Regional Groundwater Monitoring

2.1.1.1 Purpose and Background

This groundwater monitoring project evaluated the water quality and nitrate concentrations in the Bruneau NPA in Owyhee and Elmore Counties.

In 2020, the Bruneau NPA was ranked the 19th most impacted NPA in Idaho with no observable trend due to insufficient data (DEQ 2020a).

The Bruneau NPA is located directly southwest of the Snake River near the southeast boundary of the Western Snake River Plain (WSRP), in southwest Idaho (Figure 2). Previous publications describe the strata of the WSRP basin as composed of Tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group (Newton 1991 and Shervais et al. 2002). Idaho Group sediments are generally characterized by coarse gravel and sand of alluvial fans, silt deltaic deposits, clay lacustrine deposits, and intercalated layers of volcanic ash and basalt. Sediments become finer from east to west and from the basin margins toward the center (Newton 1991).

The aquifers of the WSRP are hosted in Tertiary volcanic sediments and middle and upper strata of the overlying Tertiary and Quaternary sedimentary and volcanic deposits (Newton 1991). The upper unit is approximately 500 feet of intercalated and discontinuous sand, gravel, and clay layers (Newton 1991). In the eastern portion of the WSRP, the Glenns Ferry Formation of the Idaho Group is the primary source of groundwater (Norton et al. 1982).

The predominant land use in the Bruneau NPA is agriculture. The residences within the NPA but outside the city of Bruneau are served by private wells.

The groundwater flow direction trends north-northeast toward the Snake River (Figure 2).

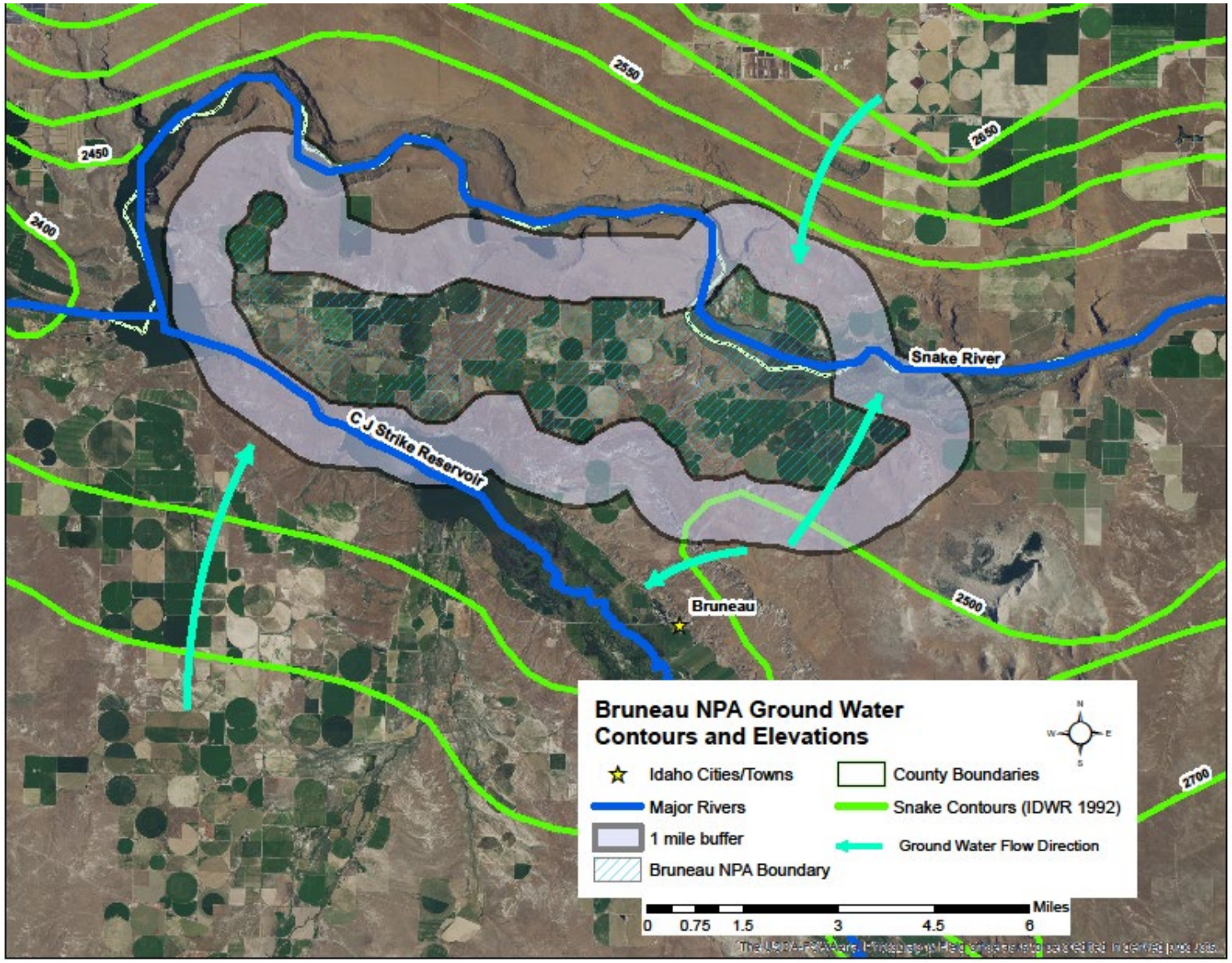


Figure 2. Groundwater contours and elevations—Bruneau NPA Groundwater Monitoring Project.

In 2021, DEQ collected groundwater samples from a combination of five domestic and irrigation wells in the Bruneau NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the *Boise Regional Office Regional Ground Water Monitoring Regional Network Design* (Regional Network Design) (DEQ 2018a).

2.1.1.2 Methods and Results

Sample locations were selected in accordance with the Regional Network Design (DEQ 2018a). DEQ identified 10 wells within the 2021 Bruneau NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design and received permission to sample five. With a sample size of five wells, due to the lack of permissions and absence of available sample locations, a mean nitrate concentration can only be estimated within 50% of the true mean for the Bruneau NPA with 90% confidence. (Figure 3). Two of the five sites were new wells (3110 and 2477). Wells 3130 and 2477 are in Elmore County and across Highway 51 from each other on the north side of the Bruneau NPA (Figure 4).

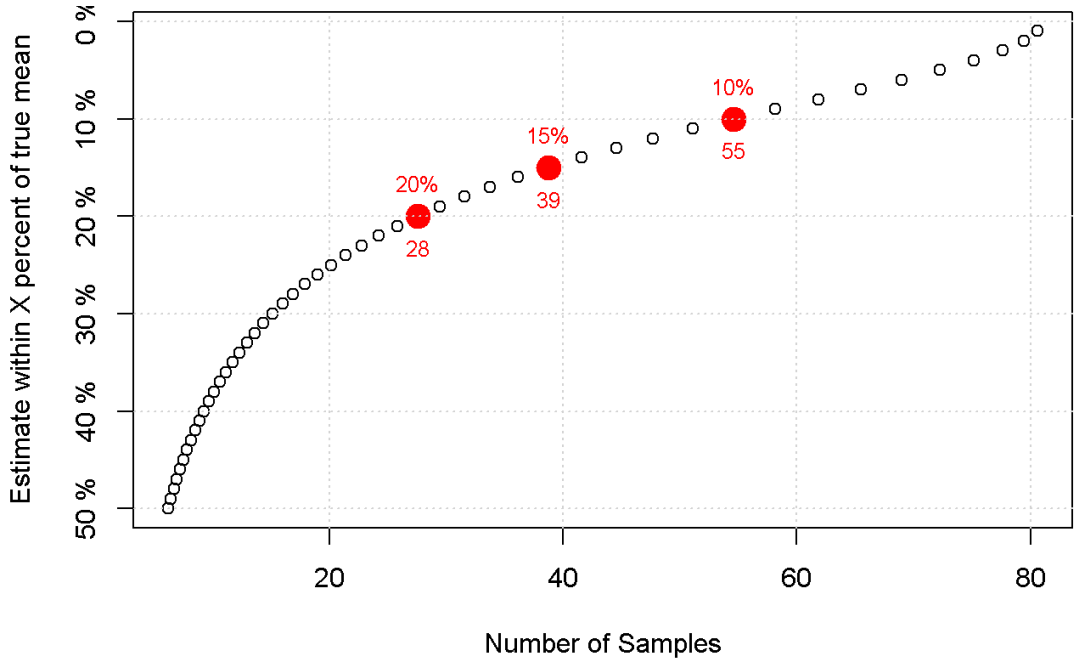


Figure 3. Number of samples needed for estimating mean nitrate concentration within a percentage of the true mean with 90% confidence—Bruneau NPA Groundwater Monitoring Project.

DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess the water quality in the project area. Nitrogen isotope samples were sent to the University of Arizona laboratory. All other samples were sent to the Idaho Bureau of Laboratories.

Water quality field parameters (i.e., pH, temperature, specific conductivity, and dissolved oxygen [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 1).

Table 1. Water quality field parameters—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2477	60	10/19/2021	16.75	1130	6.81	5.93
2480	592	10/19/2021	17.28	653	7.23	0.43
2481	115	10/19/2021	19.91	381	6.99	6.70
3129	500	10/19/2021	24.76	842	7.38	0.41
3130	68	10/19/2021	17.06	1350	6.83	3.32

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

2.1.1.2.1 Nutrient and Nitrogen Isotope Results

Nutrient and nitrogen isotope results are presented in Table 3. Two out of five (40%) wells had nitrate concentrations greater than half of the MCL of 10 mg/L (2477 and 3130). The three remaining wells had concentrations less than half the MCL. Well 2477 has a history of nitrate concentrations above the MCL. In 2015, Well 2477 had a nitrate concentration of 19 mg/L.

Well 2480 had a nitrite concentration that exceeded the MCL of 1.0 mg/L. Well 3129 had an estimated concentration of nitrite because the reported concentration was below the laboratory reporting limit. Both wells are located on the mesa between the Snake River and C.J. Strike Reservoir. Well 2480 did not have reportable concentrations of nitrite in 2015.

Figure 4 shows the location of the wells that were sampled as well and the nitrate concentrations for each well.

Wells 3129 and 2480 had ammonia concentrations of 6.2 mg/L and 0.61 mg/L, respectively. Well 3130 had an ammonia result below the detection limit. The remaining two wells were not sampled for ammonia because the DO was greater than 2 mg/L at the time of sampling.

Nitrogen isotope ($\delta^{15}N$) was analyzed for the two wells with nitrate concentrations of 5 mg/L or greater (Table 3). Wells 2477 and 3130 had isotope ratios in the +4.0‰ to +9.0‰ range, indicating the source of nitrate in the soil was most likely from a mixed or mixed organic source (Seiler 1996) (Table 2 and Table 3).

Table 2. 2021 nutrient and nutrient-related isotope results—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a] (mg/L)	Ammonia	$\delta^{15}N$ (‰)
Water Quality Standard:			**1**	**10**	**No Standard**	**No Standard**
2477	60	10/19/2021	<0.30	**17.9**	—	5.6
2480	592	10/19/2021	**2.16**	1.87	0.61	—
2481	115	10/19/2021	<0.30	<0.18	—	—
3129	500	10/19/2021	0.161J[b]	0.277	6.2	—
3130	68	10/19/2021	<0.30	**26.1**	<0.50	6.4

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; ‰ = permil; (—) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

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

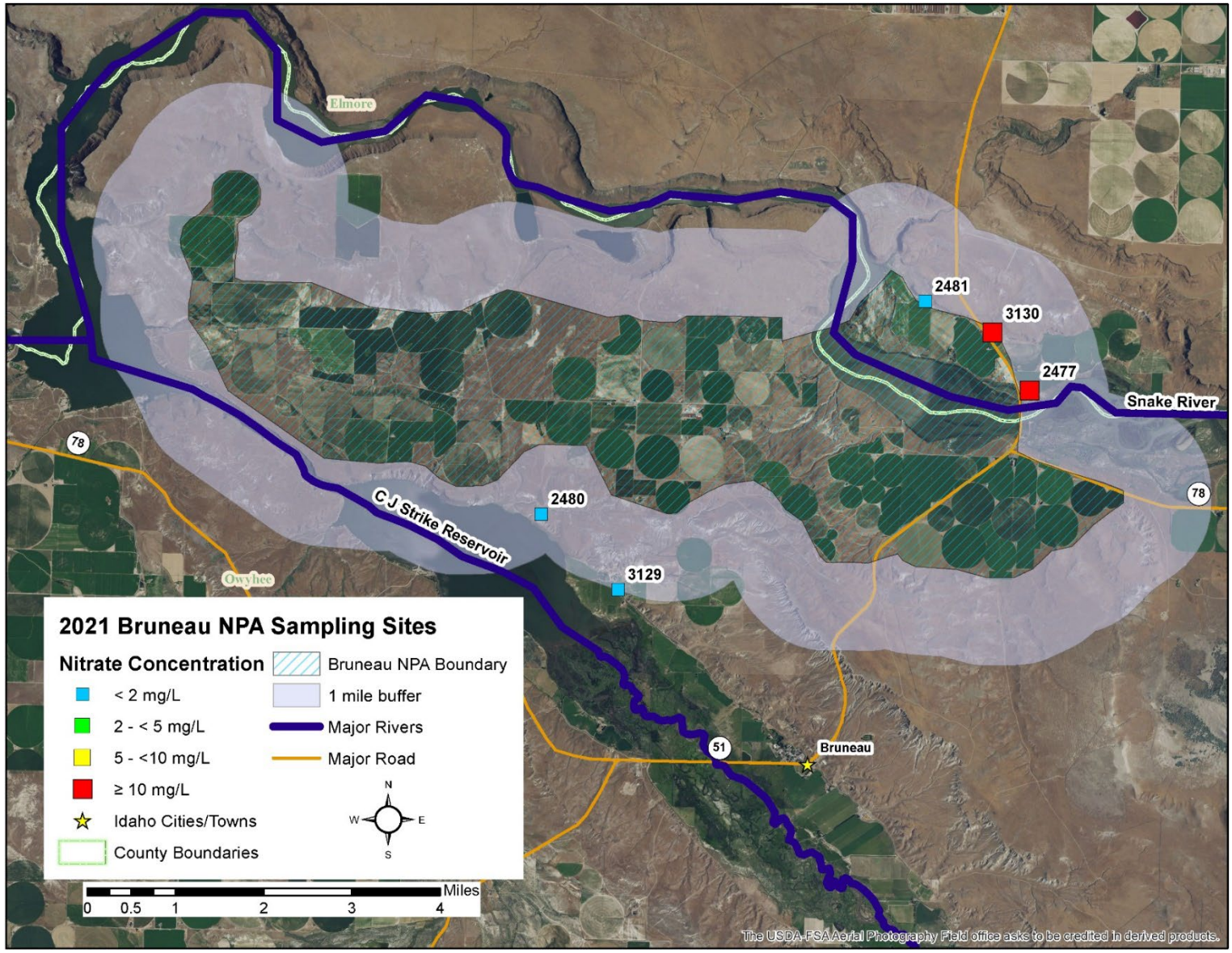


Figure 4. 2021 sample locations and nitrate concentrations—Bruneau NPA Groundwater Monitoring Project.

Three of the five wells sampled in 2021 had been sampled in 2015. Due to the small number of repeat samples little can be interpreted from the review of historical data collected by DEQ. Well 2481 had no reportable result in either 2015 or 2021. Well 2477 had a small decrease in nitrate concentration. Well 2480 had a minor increase in nitrate concentration (Table 4 and Figure 5).

Table 4. Comparison of nitrate results between 2015 and 2021—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Comparative Nitrate Concentrations		Change in Concentration
		Nitrate[a] 2015	Nitrate[a] 2021	
		(mg/L)		
Water Quality Standard:		**10**	**10**	
Sampled Date		9/14/2015	10/19/2021	
2481	115	<0.30	<0.18	—
2477	60	**19.0**	**17.9**	-1.1
2480	79	0.299J[b]	1.87	1.57

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

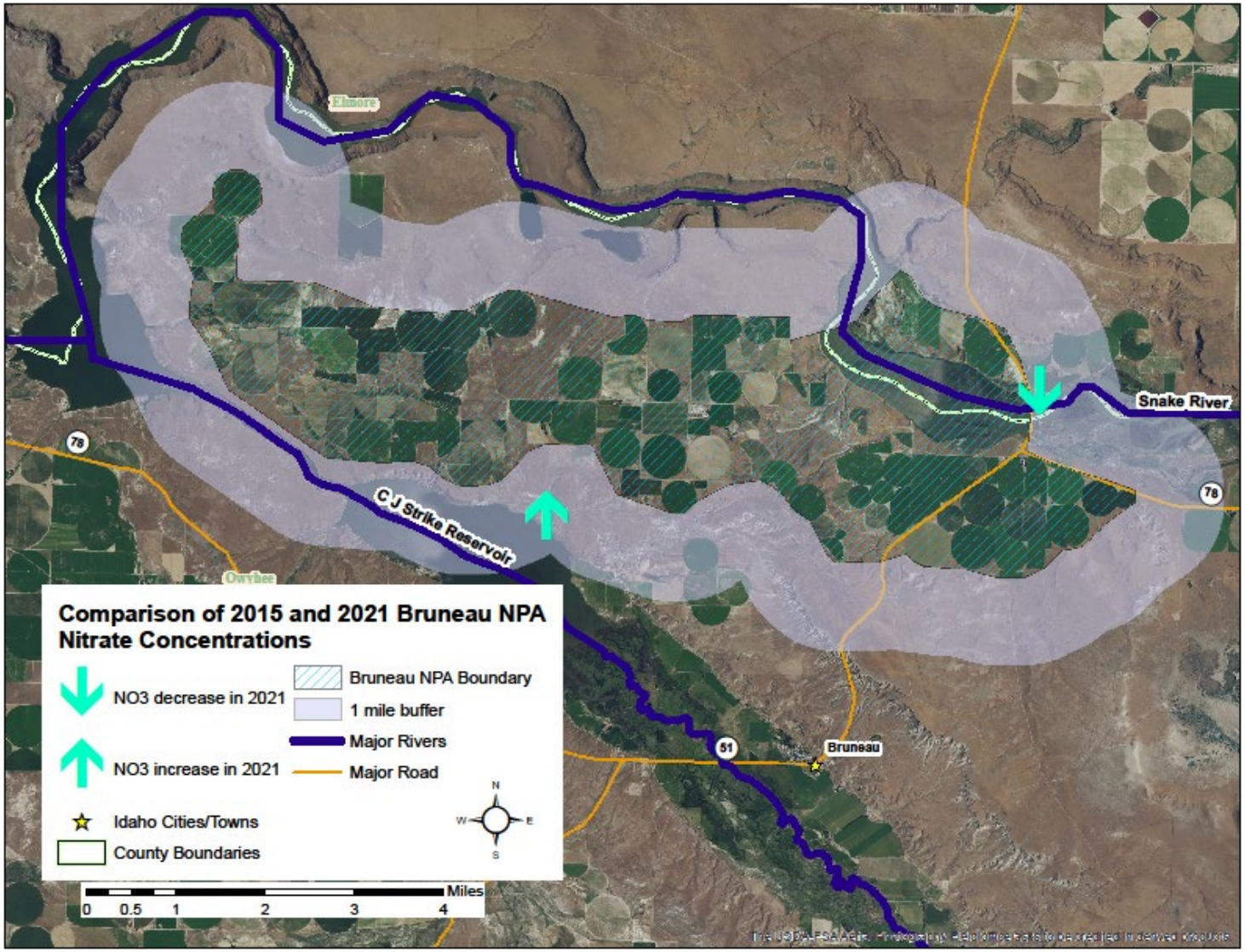


Figure 5. Sample sites nitrate concentration comparison 2015 and 2021—Bruneau NPA Groundwater Monitoring Project.

2.1.1.2.2 Bacteria Results

Bacteria results are reported in Table 5. Well 3129 had detections for both TC and *E. coli*. Well 3129 was sampled for the first time in 2021, and no historical data is available. Bacteria was not detected in the other four wells.

Table 5. 2021 bacteria results—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1.0**	**1.0**
2477	60	10/19/2021	<1.0	<1.0
2480	592	10/19/2021	<1.0	<1.0
2481	115	10/19/2021	<1.0	<1.0
3129	500	10/19/2021	**1.0**	1.0
3130	68	10/19/2021	<1.0	<1.0

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.1.2.3 Arsenic and Uranium Results

Arsenic and uranium results are presented in Table 6 and Table 7, respectively. Two of the five wells (40%) sampled in 2021 (Wells 2477 and 3130) had arsenic concentrations over the MCL of 10 micrograms per liter (µg/L) with a range from 13 µg/L to 19 µg/L. The remaining three wells had sample results below EPA's MCL, ranging from 0.21 µg/L to 5.7 µg/L (Table 6).

The locations and arsenic concentration ranges for the wells sampled in the Bruneau NPA in 2021 are shown in Table 6. Arsenic was not previously evaluated by DEQ in the Bruneau NPA, so no historical data is available for comparison.

Deterioration of layers of basalt upgradient from Wells 2477 and 3130 may contribute to the presence of arsenic in the wells.

All five wells sampled had uranium concentrations below the MCL of 30 µg/L, with a range from <1.0 µg/L to 9.8 µg/L (Table 7). The locations and range of uranium concentrations for the wells are shown in Figure 7. Uranium was not previously evaluated by DEQ in the Bruneau NPA, so no trend data is available.

Table 6. 2021 arsenic results—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
2477	60	10/19/2021	**19**
2480	592	10/19/2021	1.5
2481	115	10/19/2021	5.7
3129	500	10/19/2021	0.21
3130	68	10/19/2021	**13**

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Table 7. 2021 uranium results—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium (µg/L)[a]
Water Quality Standard:			**30**
2477	60	10/19/2021	8.5
2480	592	10/19/2021	<1.0
2481	115	10/19/2021	<1.0
3129	500	10/19/2021	<1.0
3130	68	10/19/2021	9.5

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter.
a. Contaminant with a National Primary Drinking Water Regulation standard.

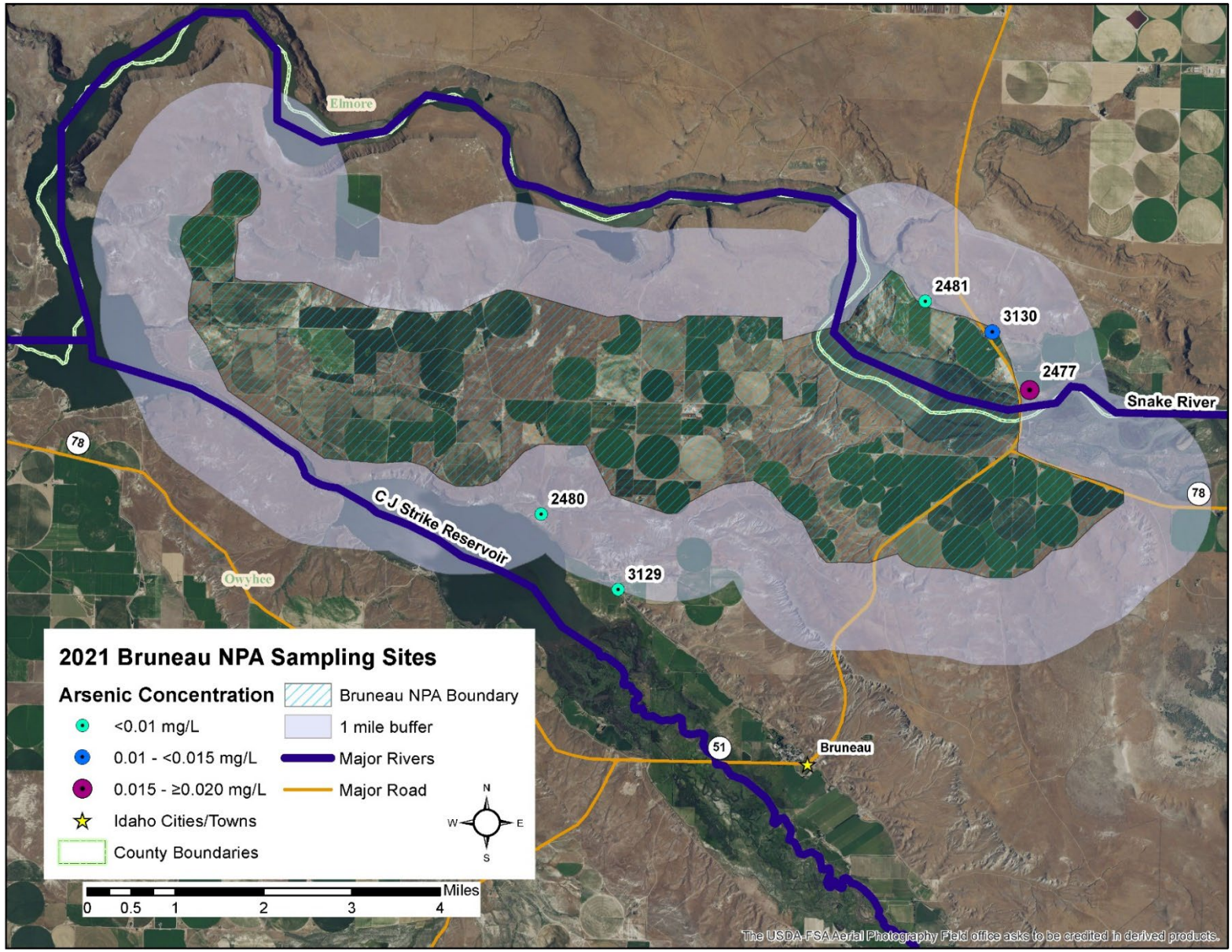


Figure 6. 2021 sample locations and arsenic concentrations—Bruneau NPA Groundwater Monitoring Project.

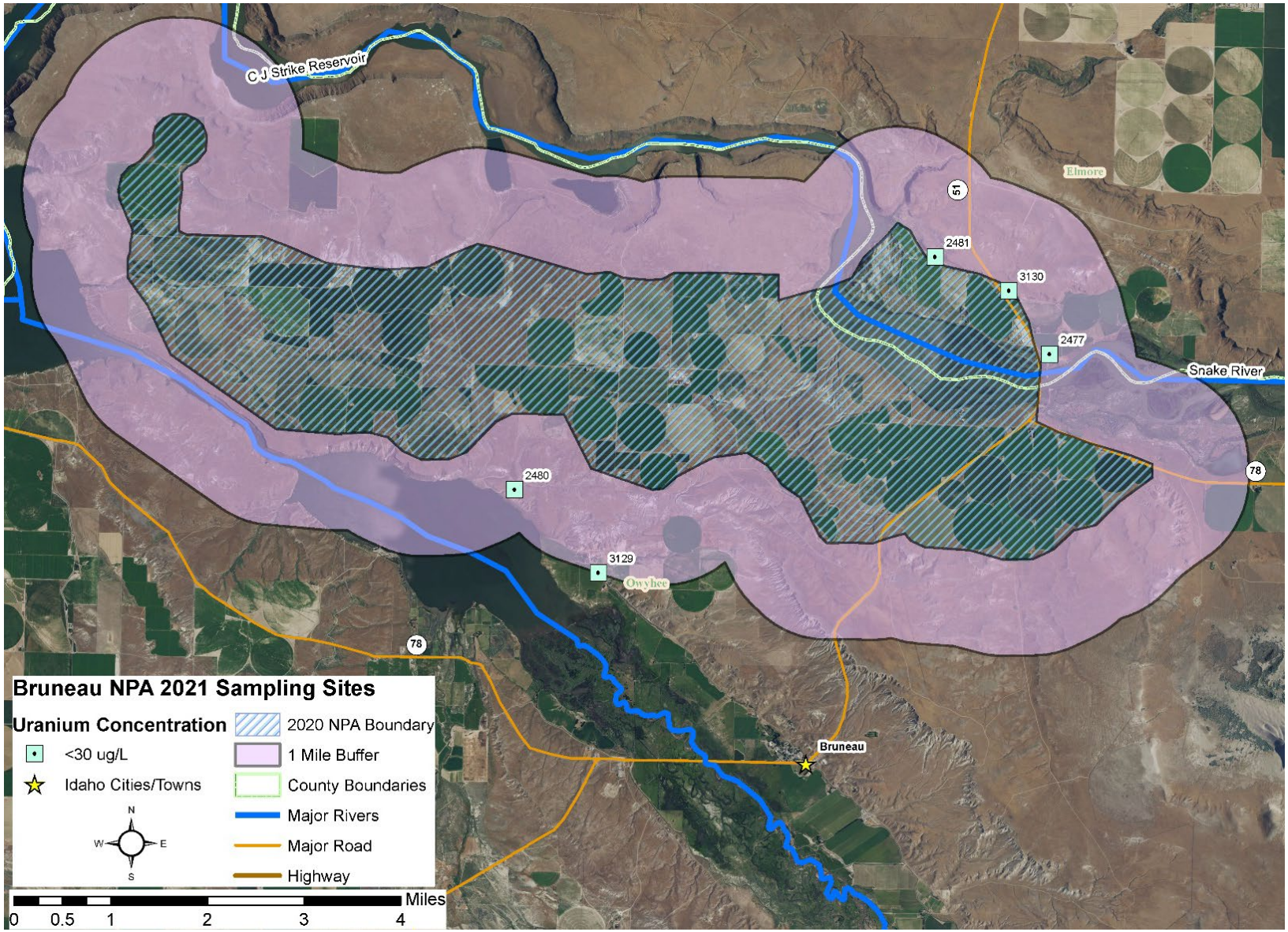


Figure 7. 2021 sample locations and uranium concentrations—Bruneau NPA Groundwater Monitoring Project.

In addition to arsenic and uranium, the five wells were also sampled for alkalinity (as calcium carbonate) to evaluate any potential relationship between the results (Table 8). Linear regression trendlines were applied to both alkalinity versus arsenic and alkalinity versus uranium data sets. Regression is a statistical method used to measure the strength and character of the relationship between two variables. No relationship between alkalinity and arsenic or uranium was identified.

Table 8. 2021 alkalinity results—Bruneau NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)
Water Quality Standard:			**No Standard**
2477	60	10/19/2021	215
2480	592	10/19/2021	309
2481	115	10/19/2021	154
3129	500	10/19/2021	282
3130	68	10/19/2021	230

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

2.1.1.3 Conclusions

Two of the five wells (2477 and 3130) sampled (40%) in the Bruneau NPA had nitrate concentrations greater than the MCL of 10 mg/L. The nitrogen isotope samples for these two wells indicated a nitrate source of mixed or mixed organic waste. Wells 2477 and 3130 also had arsenic concentrations at or above the MCL of 10 µg/L. The two wells with nitrate and arsenic above the MCL are in a small area along Highway 51 north of the Snake River and are relatively shallow in depth (i.e., 60 ft bgs and 68 ft bgs). The presence of arsenic in the two wells may be connected to well depth or local soil type and geologic formation.

All five wells had uranium concentrations below the MCL of 30 µg/L.

Bacteria samples from Well 3129 had detections for TC and *E. coli*. There is no historical data available for this well.

2.1.1.4 Recommendations

Due to reported concentrations of nitrate, arsenic, and uranium within the Bruneau NPA, homeowners with private wells are encouraged to sample their well water annually for nitrate and bacteria and every 3 to 5 years for arsenic and uranium. Due to the absence of available sample locations that meet the statistical needs of the project, it is recommended the Bruneau NPA boundaries be reevaluated by DEQ staff during the next scheduled NPA ranking.

DEQ will sample the Bruneau NPA again in 2024.

2.1.2 Grand View Nitrate Priority Area Regional Groundwater Monitoring

2.1.2.1 Purpose and Background

This groundwater monitoring project evaluated the water quality and nitrate concentrations in the Grand View NPA in Owyhee County.

In 2020, the Grand View NPA was ranked the 11th most impacted NPA with no observable statistical trend (DEQ 2020a). It is down from 7th most impacted in 2014 (DEQ 2014).

The Grand View NPA is located directly southwest of the Snake River near the southwest boundary of the WSRP, in southwest Idaho (Figure 8). The strata of the WSRP basin are composed of tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group (Newton 1991 and Shervais et al. 2002). Idaho Group sediments are generally characterized by coarse gravel and sand of alluvial fans, silt deltaic deposits, clay lacustrine deposits, and intercalated layers of volcanic ash and basalt. Sediments become finer from east to west and from the basin margins toward the center (Newton 1991).

The aquifers of the WSRP are hosted in Tertiary volcanics and middle and upper strata of the overlying Tertiary and Quaternary sedimentary and volcanic deposits (Newton 1991). The Tertiary volcanic unit is estimated to be nearly 7,000 feet thick and is identified as a geothermal water source. The middle unit is estimated to be approximately 4,000 feet thick and consists of sedimentary, volcanic, and thick clay layers. The upper unit is approximately 500 feet of intercalated and discontinuous sand, gravel, and clay layers (Newton 1991). In the eastern portion of the WSRP, the Glenns Ferry Formation of the Idaho Group is the primary source of groundwater (Norton et al. 1982).

The predominant land use in the Grand View NPA is agriculture. The residences within the NPA but outside the city of Grand View are served by private wells.

The groundwater flow direction in the Grand View NPA trends north-northeast toward the Snake River (Figure 8).

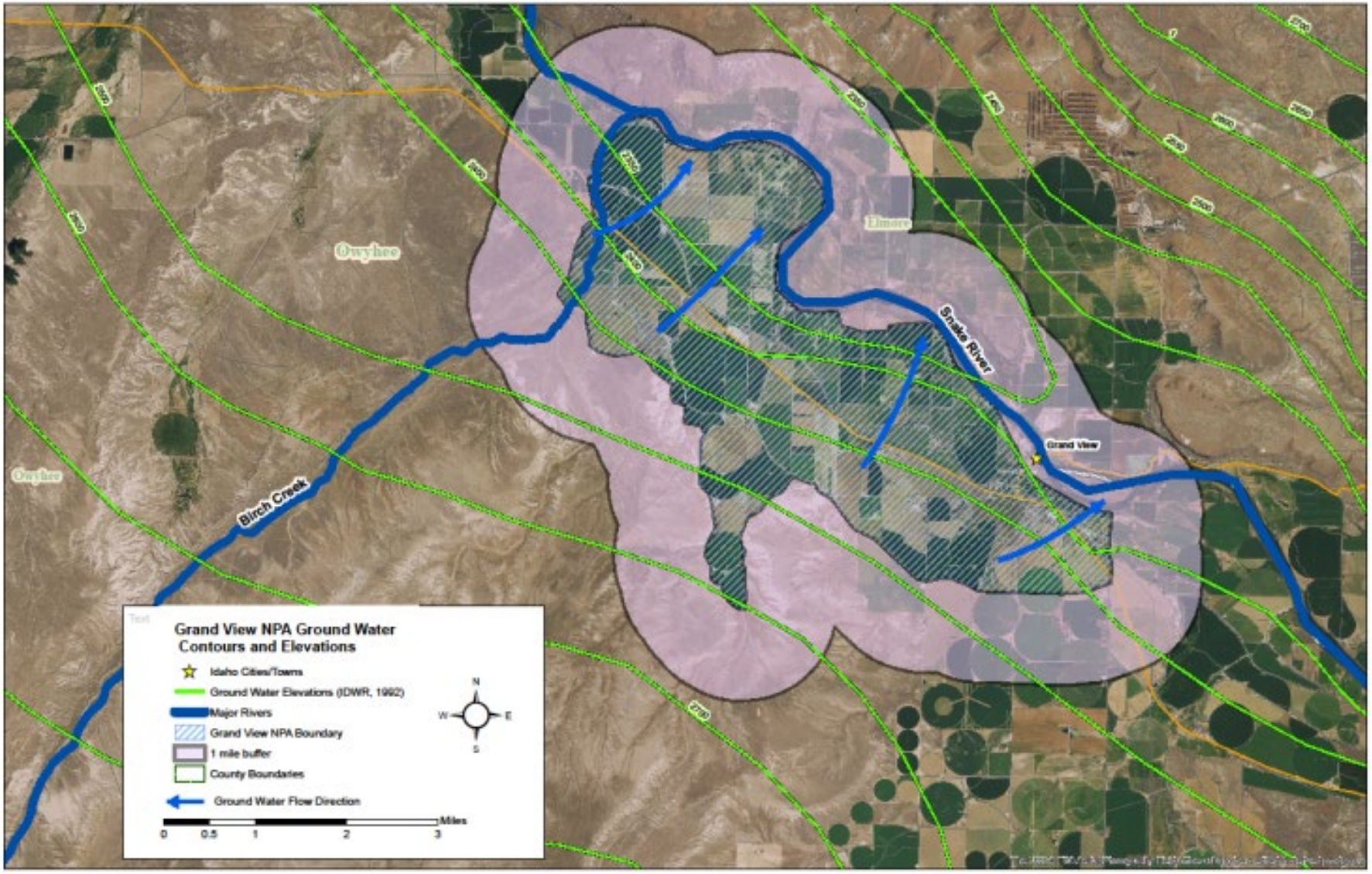


Figure 8. Groundwater contours and elevations—Grand View NPA Groundwater Monitoring Project.

2.1.2.2 Methods and Results

In 2021, DEQ collected groundwater samples from 12 domestic or irrigation wells in the Grand View NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the Regional Network Design (DEQ 2018a). DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess the water quality in the project area. Nitrogen isotope samples were sent to the University of Arizona laboratory and all other samples were analyzed by the Idaho Bureau of Laboratories.

Sample locations were selected in accordance with the Regional Network Design (DEQ 2018a).

As determined by the Regional Network Design, 49 wells should be sampled to estimate the mean within 10% at 90% confidence. DEQ identified 54 wells within the 2021 Grand View NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design. However, DEQ only received permission to sample 12 wells (Figure 9). DEQ estimates that samples collected from the 12 wells will result in an estimated mean value within 50% of the true mean at 90% confidence.

Water quality field parameters (i.e., pH, temperature, specific conductivity, and DO) were measured at each well before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 9).

Table 9. Water quality field parameters—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2482	100	10/20/2021	14.92	2400	6.83	4.81
2484	50	10/20/2021	13.85	1090	7.09	0.36
2486	78	10/20/2021	14.95	1370	7.20	0.94
2488	81	10/20/2021	17.69	755	7.48	8.60
3123	150	10/20/2021	13.85	1330	7.09	0.96
3124	32	10/25/2021	14.33	1080	6.85	0.38
3125	76	10/20/2021	14.46	1440	7.29	1.56
3126	87	10/20/2021	14.88	1390	7.33	1.17
3127	82	10/25/2021	17.91	520	7.34	6.29
3128	60	10/20/2021	16.73	965	7.40	7.85
3131	80	10/25/2021	17.09	921	7.53	4.49
3132	74	10/19/2021	17.25	2510	6.79	0.76

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter

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

2.1.2.2.1 Nutrient and Stable Isotope Results

Nutrient and nitrogen isotope results are presented in Table 10. Seven out of 12 wells had nitrate concentrations greater than half the MCL (5 mg/L) ranging from 6.91 mg/L to 61.6 mg/L. Five of those seven wells (2482, 2486, 3125, 3126, and 3132) had nitrate concentrations exceeding the MCL of 10 mg/L. The five remaining wells had concentrations less than half the MCL with concentration ranging from 0.7 mg/L to 4.76 mg/L (Table 10). Wells 3123, 3124, 3125, 3126, 3127, 3128, 3131, and 3132 were sampled for the first time in 2021. Nitrate results for the 12 wells sampled in 2021 are shown in Figure 9.

Seven wells were sampled for ammonia due to low DO results at the time of sampling. All seven wells had ammonia concentrations below the laboratory reporting limit of 0.050 mg/L (Table 10).

Table 10. 2021 nutrient and nutrient-related isotope results—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a] (mg/L)	Ammonia	$\delta^{15}N$ (‰)
Water Quality Standard:			**1.0**	**10**	**No Standard**	**No Standard**
2482	100	10/20/2021	<0.30	**61.6**	—	5.4
2484	50	10/20/2021	<0.30	6.91	<0.050	6.2
2486	78	10/20/2021	<0.30	**11.0**	<0.500	4.8
2488	81	10/20/2021	<0.30	0.70	—	—
3123	150	10/20/2021	<0.30	4.24	<0.050	—
3124	32	10/25/2021	<0.30	4.76	<0.050	—
3125	76	10/20/2021	<0.30	**14.3**	<0.050	3.2
3126	87	10/20/2021	<0.30	**11.8**	<0.050	3.7
3127	82	10/25/2021	<0.30	1.07	—	—
3128	60	10/20/2021	<0.30	4.42	—	—
3131	80	10/25/2021	<0.30	8.62	—	3.0
3132	74	10/19/2021	<0.30	**23.2**	<0.050	8.1

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; ‰ = permil; (—) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

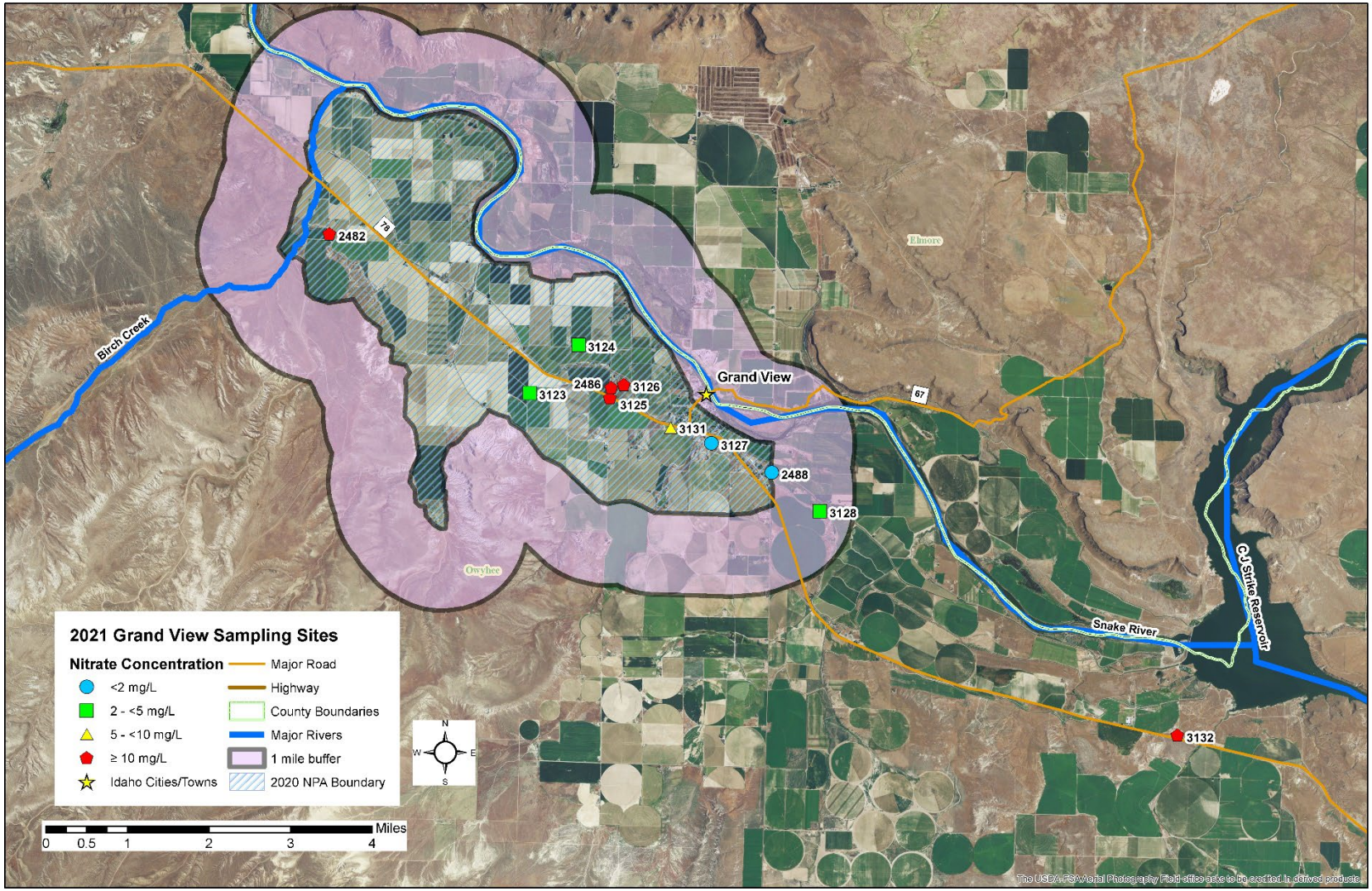


Figure 9. 2021 sample locations and nitrate concentrations—Grand View NPA Groundwater Monitoring Project.

Four of the 12 wells (33%) sampled in 2021 had been previously sampled in 2015. Table 11 shows a comparison of 2015 and 2021 results. Wells 2484, 2486, and 2488 had increases in nitrate concentrations. Well 2486 had a large increase in nitrate concentration of 11 mg/L. The only noticeable difference near Well 2486 was green, dense cropland south (upgradient) of the well and evidence of stubble in the field where the well is located, which indicates a hay or grain crop.

Well 2482 had a large decrease in the nitrate concentration of 44.4 mg/L. The reason for the decrease in nitrate concentration is currently unknown.

A map showing the areas of change is found in Figure 10.

Table 11. Comparison of nitrate results between 2015 and 2021—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Comparative Nitrate Concentrations (mg/L)		Change in Concentration
		Nitrate 2015	Nitrate[a] 2021	
Water Quality Standard:		**10**	**10**	
Sample Date		**9/21–22/2015**	**10/19–25/2021**	
2482	100	**106**	**61.6**	-44.4
2484	50	5.19	6.91	1.72
2486	79	<0.180	**11.0**	11.0
2488	81	0.669	0.703	0.034

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

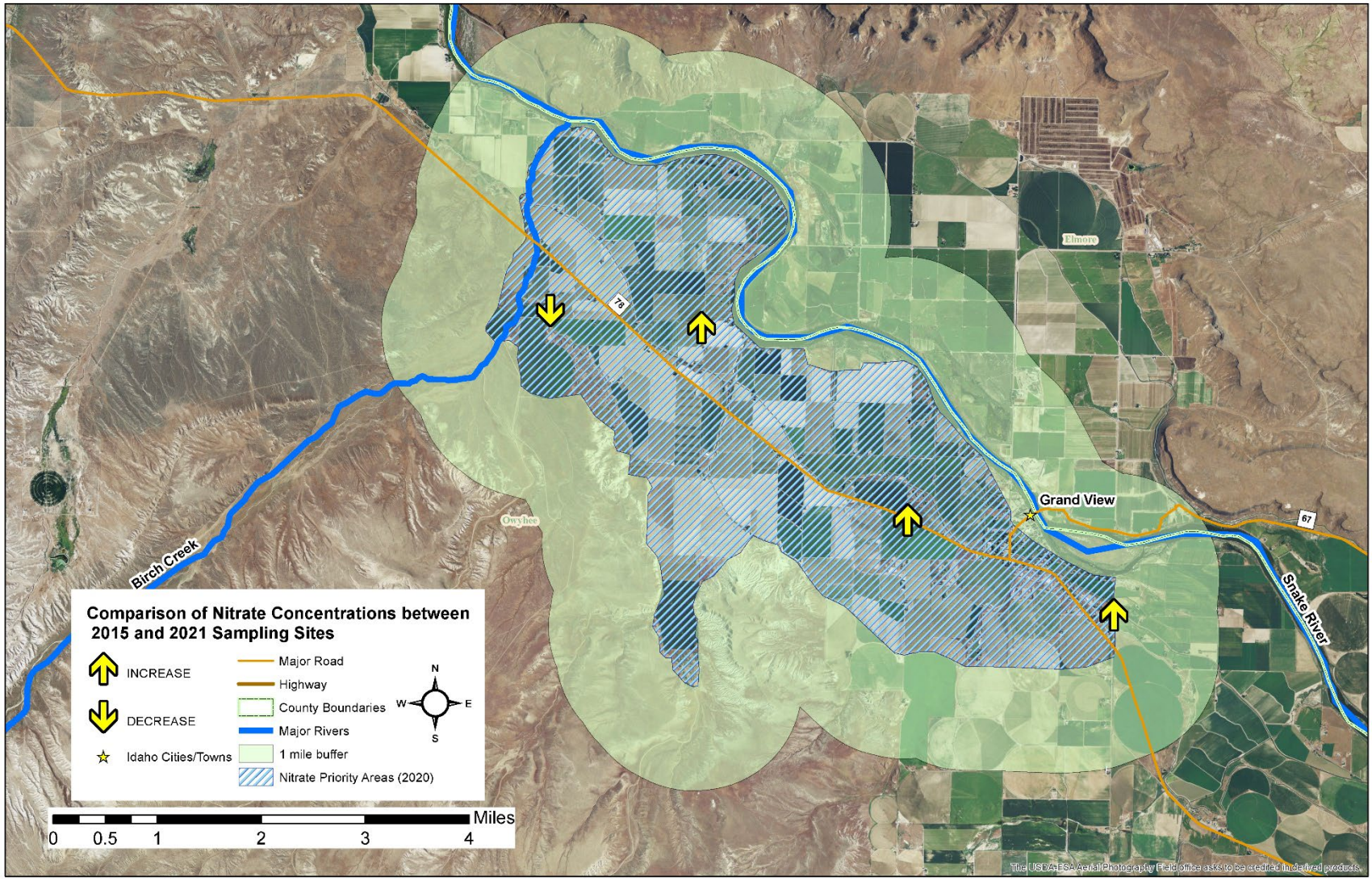


Figure 10. Sample sites nitrate concentration comparison 2015 and 2021—Grand View NPA Groundwater Monitoring Project.

Nitrogen isotope samples were collected from the seven wells with nitrate concentrations of 5 mg/L or more (Table 10). Wells 3126, 3125, and 3131 had isotope ratios in the -4.0‰ to +4.0‰ range, indicating the source of nitrate in the soil was most likely commercial fertilizer (Seiler 1996; Table 3). Wells 2482, 2484, 2486, and 3132 had isotope ratio in the +4.0‰ to +9.0‰ range, indicating the source of nitrate in the soil was most likely from a mixed or mixed organic source.

2.1.2.2.2 Bacteria Results

Bacteria results are presented in Table 12. Wells 3123 and 3132 had positive detections for TC. No wells had *E. coli* detections (Table 12). Wells 3123 and 3132 were sampled for the first time in 2021, so no historical data is available for comparison.

Well 2486 was sampled in 2015 and at that time had a TC result of 410.6 MPN/100 mL and an *E. coli* result of 2.0 MPN/100 mL. The owner was notified and reported back that the well and pressure tank had since been disinfected. Samples from 2021 did not indicate the presence of bacteria in Well 2486 during the 2021 sampling event.

Table 12. 2021 bacteria results—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1**	**1.0**
2482	100	10/20/2021	<1.0	<1.0
2484	50	10/20/2021	<1.0	<1.0
2486	78	10/20/2021	<1.0	<1.0
2488	81	10/20/2021	<1.0	<1.0
3123	150	10/20/2021	<1.0	10
3124	32	10/25/2021	<1.0	<1.0
3125	76	10/20/2021	<1.0	<1.0
3126	87	10/20/2021	<1.0	<1.0
3127	82	10/25/2021	<1.0	<1.0
3128	60	10/20/2021	<1.0	<1.0
3131	80	10/25/2021	<1.0	<1.0
3132	74	10/19/2021	<1.0	60

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per milliliter, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.2.2.3 Arsenic and Uranium Results

Arsenic results are presented in Table 13. Nine out of 12 wells (75%) had arsenic concentrations over the MCL of 10 µg/L, with concentrations ranging from 10 µg/L to 26 µg/L. The remaining three wells had results below the MCL of 10 µg/L (Table 13).

The locations and arsenic concentration ranges for the wells sampled in the Grand View NPA are shown in Figure 11. Arsenic was not previously evaluated by DEQ in the Grand View NPA, so no historic data is available for comparison.

Table 13. 2021 arsenic results—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
2482	100	10/20/2021	**14**
2484	50	10/20/2021	7.4
2486	78	10/20/2021	**14**
2488	81	10/20/2021	**16**
3123	150	10/20/2021	8.3
3124	32	10/25/2021	**10**
3125	76	10/20/2021	**13**
3126	87	10/20/2021	**12**
3127	82	10/25/2021	8.7
3128	60	10/20/2021	**23**
3131	80	10/25/2021	**26**
3132	74	10/19/2021	**24**

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

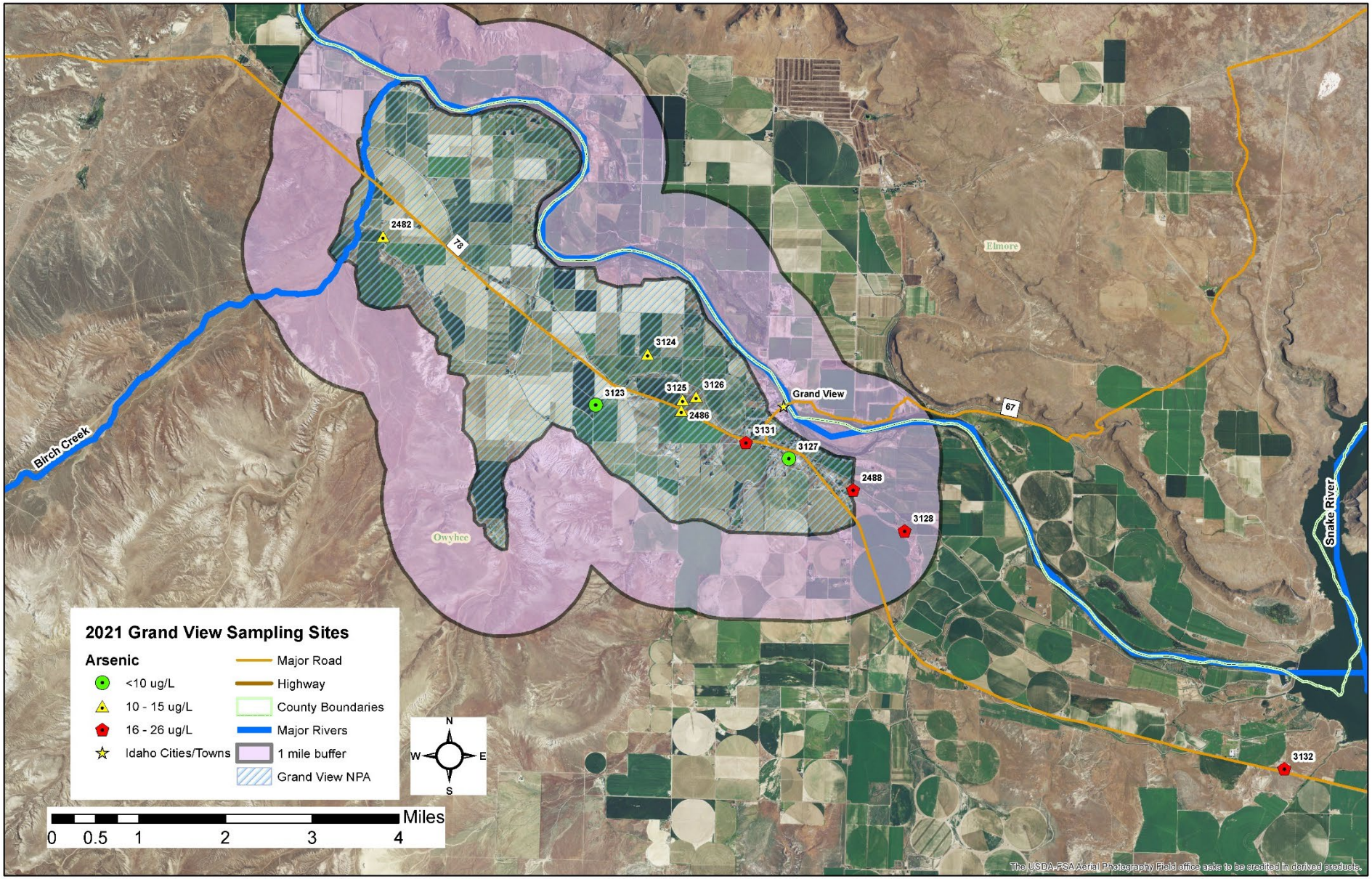


Figure 11. 2021 sample locations and arsenic concentrations—Grand View NPA Groundwater Monitoring Project.

The 2021 uranium results are presented in Table 14 and Figure 12. Seven wells (58%) had uranium concentrations at or above EPA's MCL of 30 µg/L (Wells 2486, 3123, 3124, 3125, 3126, 3128, and 3132). The remaining five wells sampled had uranium concentrations below the MCL with a range from 3.7 µg/L to 29 µg/L.

Apart from Well 2482, uranium was not previously evaluated by DEQ in the Grand View NPA, so no historical data is available for comparison. Well 2482 is located to the far west of the Grand View NPA and had a uranium concentration of 26 µg/L when analyzed in November 2015.

Table 14. 2021 uranium results—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium[a] (µg/L)
	Water Quality Standard:		**30**
2482	100	10/20/2021	29
2484	50	10/20/2021	18
2486	78	10/20/2021	**50**
2488	81	10/20/2021	11
3123	150	10/20/2021	**63**
3124	32	10/25/2021	**41**
3125	76	10/20/2021	**54**
3126	87	10/20/2021	**45**
3127	82	10/25/2021	3.7
3128	60	10/20/2021	**30**
3131	80	10/25/2021	19
3132	74	10/19/2021	**45**

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

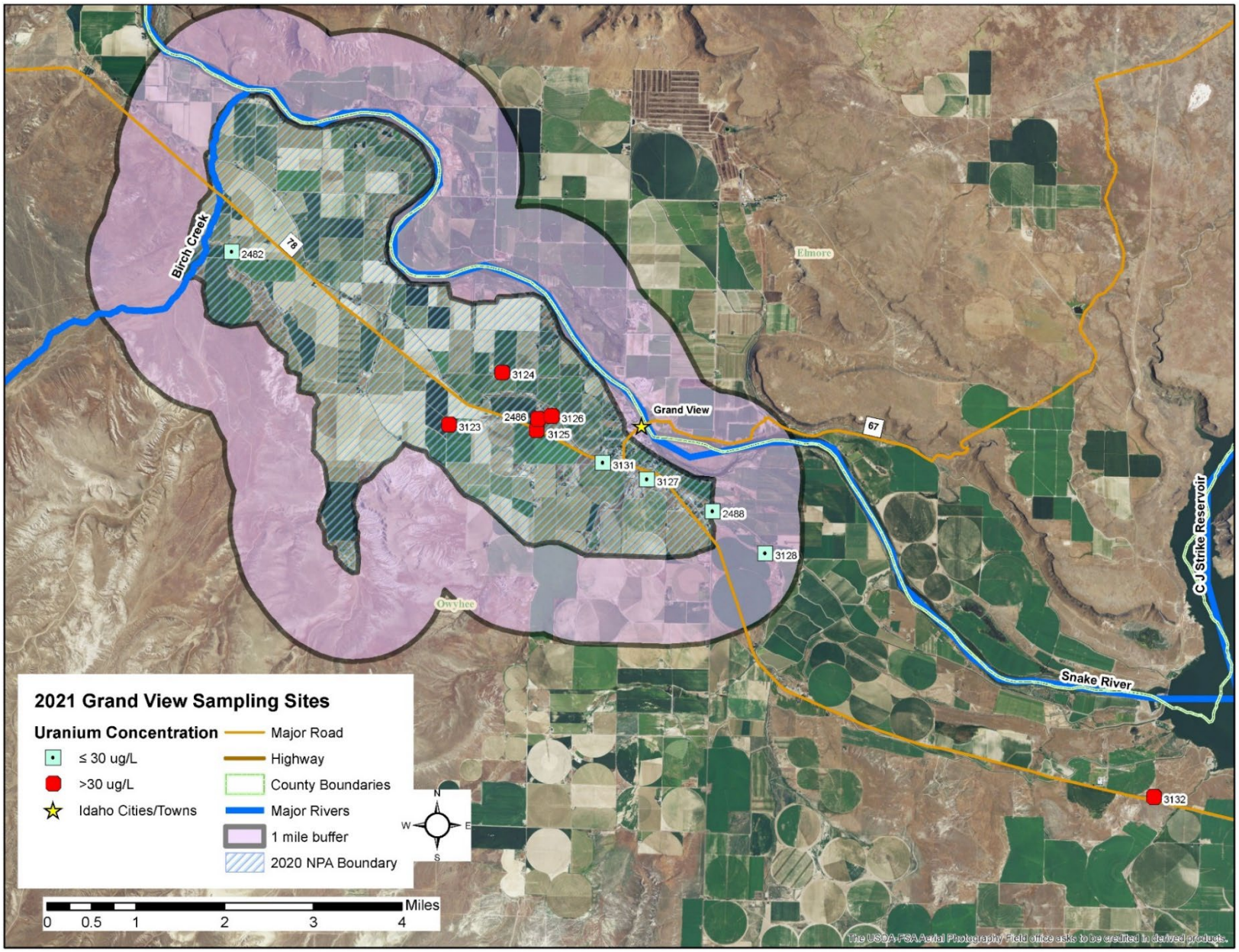


Figure 12. 2021 sample locations and uranium concentrations—Grand View NPA Groundwater Monitoring Project.

In addition to arsenic and uranium, the 12 wells were also sampled for alkalinity (as calcium carbonate) to evaluate any potential relationship between the results (Table 15). Linear regression trendlines were applied to both alkalinity versus arsenic and alkalinity versus uranium data sets. Regression is a statistical method used to measure the strength and character of the relationship between two variables. No relationship between alkalinity and arsenic was identified. A positive relationship between alkalinity and uranium was identified, with a resulting liner regression R^2 value of 0.736 (Figure 13).

Table 15. Common ion and total dissolved solids results—Grand View NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)
Water Quality Standard:			**No Standard**
2482	100	10/20/2021	411
2484	50	10/20/2021	351
2486	78	10/20/2021	434
2488	81	10/20/2021	267
3123	150	10/20/2021	573
3124	32	10/25/2021	412
3125	76	10/20/2021	401
3126	87	10/20/2021	421
3127	82	10/25/2021	184
3128	60	10/20/2021	317
3131	80	10/25/2021	258
3132	74	10/19/2021	320

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; No Stand. = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.

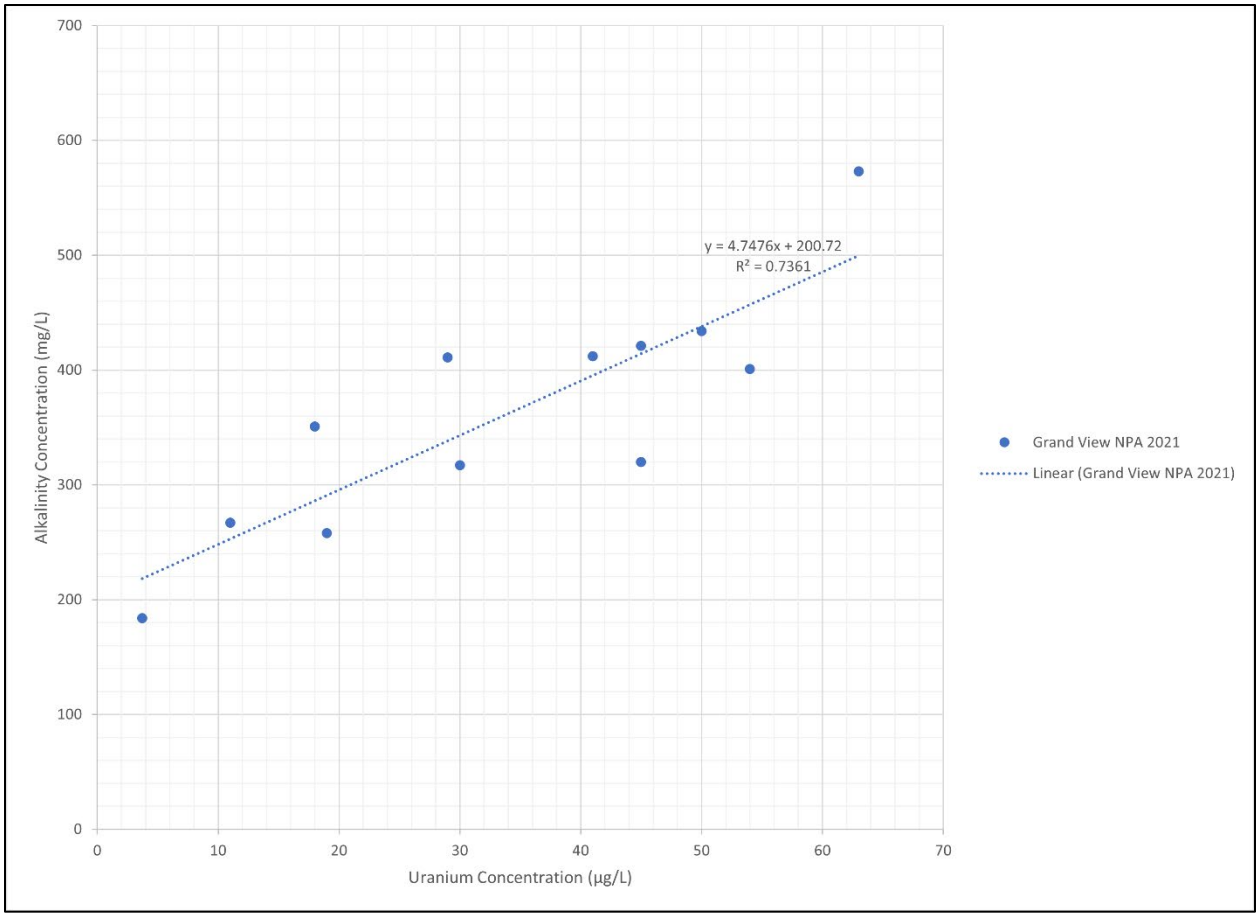


Figure 13. 2021 alkalinity and uranium plot with linear regression trendline—Grand View NPA Groundwater Monitoring Project.

2.1.2.3 Conclusions

Data collected from this study will provide valuable information for the next NPA evaluation. Seven of the 12 wells sampled (43.75%) in the Grand View NPA had nitrate concentrations greater than 5 mg/L. Wells 2486, 3125, and 3126 had isotope ratios in the commercial fertilizer range. Wells 3123, 3124, and 3128 were not analyzed for nitrogen isotopes because their nitrate concentrations were below 5 mg/L.

Nine of the 12 wells (75%) sampled in the Grand View NPA contained arsenic at or above the MCL of 10 µg/L. Deterioration of the deeper layers of limestones, sandstones, shales, and clays in the Grand View area may be the cause of the presence of arsenic in the wells tested for the Grand View NPA. The areas with arsenic above the MCL are widespread and do not seem to be connected to well depth or alkalinity.

Seven of the 12 wells sampled had uranium concentrations at or above the MCL of 30 µg/L. Five of these wells are in close proximity to each other, and the other two are east of Grand View on Highway 78. The remaining five wells sampled had uranium concentrations below the MCL with a range from <3.7 µg/L to 29 µg/L. One explanation to be considered is described in Cumberland et al. (2016). “At even low concentrations, soluble OM [organic matter] can

prevent U [uranium] sorption and lead to increased mobility. Alternatively, where solid OM is present, U mobility may be reduced through complexation and mineral formation." The agricultural areas around Grand View are rich in organic matter used as fertilizer.

Two wells had detections for TC. No wells had *E. coli* detections.

2.1.2.4 Recommendations

The seven wells containing uranium over the MCL were resampled on January 25, 2022. These samples were taken to determine if the uranium concentrations remain over the MCL when the cropland is lying fallow, and no fertilizer has been applied. All previous analytes were sampled in January and isotope samples will be submitted for all seven wells. Additional samples were taken from the seven wells in spring 2022 to determine if commercial fertilizer is still indicated as a potential source in the isotope samples. This data will be summarized in the 2022 annual summary report.

Due to the absence of available sample locations that meet the statistical needs of the project, it is recommended the Grand View NPA boundaries be reevaluated by DEQ during the next scheduled NPA ranking. DEQ will repeat the Grand View NPA sampling in 2024.

2.1.3 Homedale Nitrate Priority Area Regional Groundwater Monitoring

2.1.3.1 Purpose and Background

This groundwater monitoring project evaluated the water quality and nitrate concentrations in the Homedale NPA in Owyhee County.

In 2020, the Homedale NPA was ranked the 24th most impacted NPA with no observable trend (DEQ 2020a) compared to 28th in 2014 (DEQ 2014).

The Homedale NPA is directly southwest of the Snake River near the northwest boundary of the WSRP, in southwest Idaho. The WSRP basin is composed of Tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group (Shervais et al. 2002, and Newton 1991). Sediments become finer from east to west and from the basin margins toward the center (Newton 1991).

The predominant land use in the Homedale NPA is agriculture. The residences within the NPA but outside the city of Homedale are served by private wells.

The groundwater flow direction is variable throughout the NPA, but in general, flow is toward the Snake River. In the northwestern and southern part of the Homedale NPA, groundwater flow is northerly toward the Snake River and in the central portion of the NPA, groundwater flow is more easterly (Figure 14).

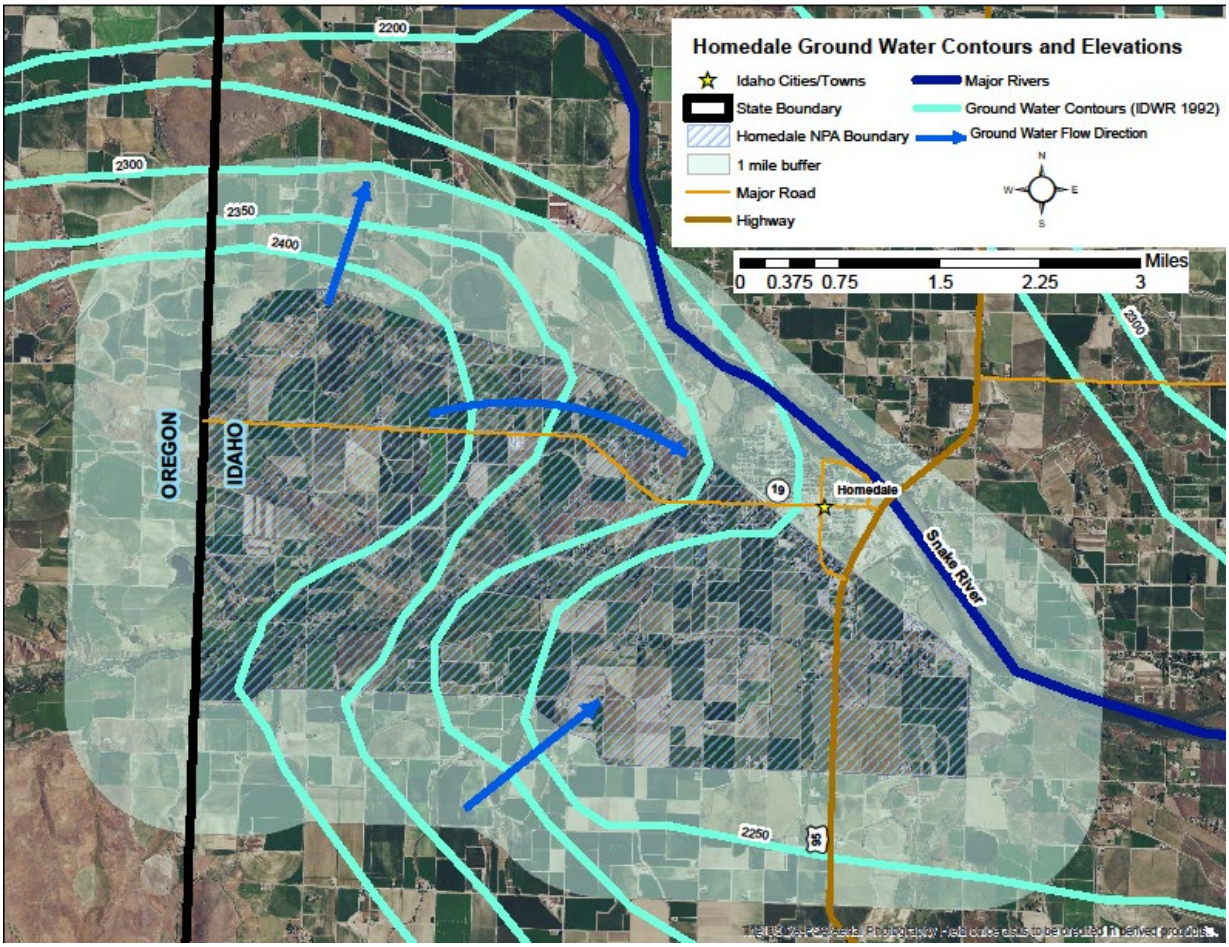


Figure 14. Groundwater contours and elevations—Homedale NPA Groundwater Monitoring Project.

2.1.3.2 Methods and Results

In 2021, DEQ collected groundwater samples from 16 domestic or irrigation wells in the Homedale NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the Regional Network Design (DEQ 2018a). DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess the water quality in the project area. Nitrogen isotope samples were sent to the University of Arizona Laboratory. All other samples were analyzed by the Idaho Bureau of Laboratories.

Sample locations were selected in accordance with the Regional Network Design.

As determined by the Regional Network Design, 43 wells should be sampled to estimate the true mean within 10% at 90% confidence.

DEQ identified 45 wells within the 2021 Homedale NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design. However, DEQ only received permission to sample

16 wells (Figure 15). DEQ estimates that samples collected from the 16 wells will result in an estimated mean value for nitrate within 40% of the true mean at 90% confidence.

Water quality field parameters (i.e., 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 16).

Table 16. Water quality field parameters—Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
96	80	05/19/2021	15.37	2610	7.42	4.25
1339	240	05/19/2021	16.75	1290	7.67	4.53
2082	40	05/25/2021	15.69	1890	7.28	5.88
2084	82	05/25/2021	14.22	1610	7.31	4.55
2086	60	05/25/2021	15.16	3560	7.15	0.28
2087	180	05/19/2021	15.37	2610	7.42	4.25
2993	70	05/25/2021	16.34	1640	6.81	0.42
2994	62	05/19/2021	16.13	1560	7.43	0.55
2996	37	05/25/2021	15.47	1090	7.58	5.71
2998	54	05/19/2021	15.72	841.0	7.58	7.33
2999	124	05/25/2021	17.16	1490	7.54	0.16
3096	45	05/19/2021	18.38	689.0	7.94	4.83
3097	105	05/19/2021	15.99	1790	7.64	3.65
3098	28	05/19/2021	13.44	1420	7.34	4.04
3099	36	05/25/2021	14.54	1440	7.34	6.44
3100	120	05/19/2021	16.11	1660	7.57	5.48

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

2.1.3.2.1 Nutrient and Nitrogen Isotope Results

Nutrient and nitrogen isotope results are presented in Table 17. Seven out of 16 wells (44%) had nitrate concentrations greater than half the MCL (1339, 2082, 2084, 2087, 3097, 3098, and 3099). Two wells (2082 and 3098) had nitrate concentrations exceeding the MCL of 10 mg/L. The nine remaining wells had concentrations less than half the MCL. Wells 1339 and 2082 had nitrate results above the MCL in 2015 and showed decreased concentrations during this sampling round (Table 18). Wells 3097, 3098, and 3099 were sampled for the first time in 2021.

Figure 15 shows the location and nitrate concentrations of the 16 wells that were sampled.

Four wells were sampled for ammonia due to low DO results at the time of sampling. The reported ammonia concentrations for the four wells ranged from <0.050 mg/L to 3.9 mg/L (Table 17).

Table 17. Nutrient and nitrogen isotope results—Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a] (mg/L)	Ammonia	$\delta^{15}N$ (‰)
Water Quality Standard:			**1.0**	**10**	**No Standard**	**No Standard**
96	80	05/19/2021	<0.30	1.40	—	—
1339	240	05/19/2021	<0.30	5.93	—	5.1
2082	40	05/25/2021	<0.30	**15.2**	—	3.2
2084	82	05/25/2021	<0.30	8.90	-	10.5
2086	60	05/25/2021	<0.30	1.00	<0.050	—
2087	180	05/19/2021	<0.30	8.39	—	5.6
2993	70	05/25/2021	<0.30	3.14	0.077	—
2994	62	05/19/2021	<0.30	0.033J[b]	3.7	—
2996	37	05/25/2021	<0.30	3.55	—	—
2998	54	05/19/2021	<0.30	3.53	—	—
2999	124	05/25/2021	<0.30	0.039J[b]	3.9	—
3096	45	05/19/2021	<0.30	0.044J[b]	—	—
3097	105	05/19/2021	<0.30	8.62	—	5.6
3098	28	05/19/2021	<0.30	**11.6**	—	3.3
3099	36	05/25/2021	<0.30	7.48	—	4.3
3100	120	05/19/2021	<0.30	2.51	—	—

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; ‰ = permil; (—) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

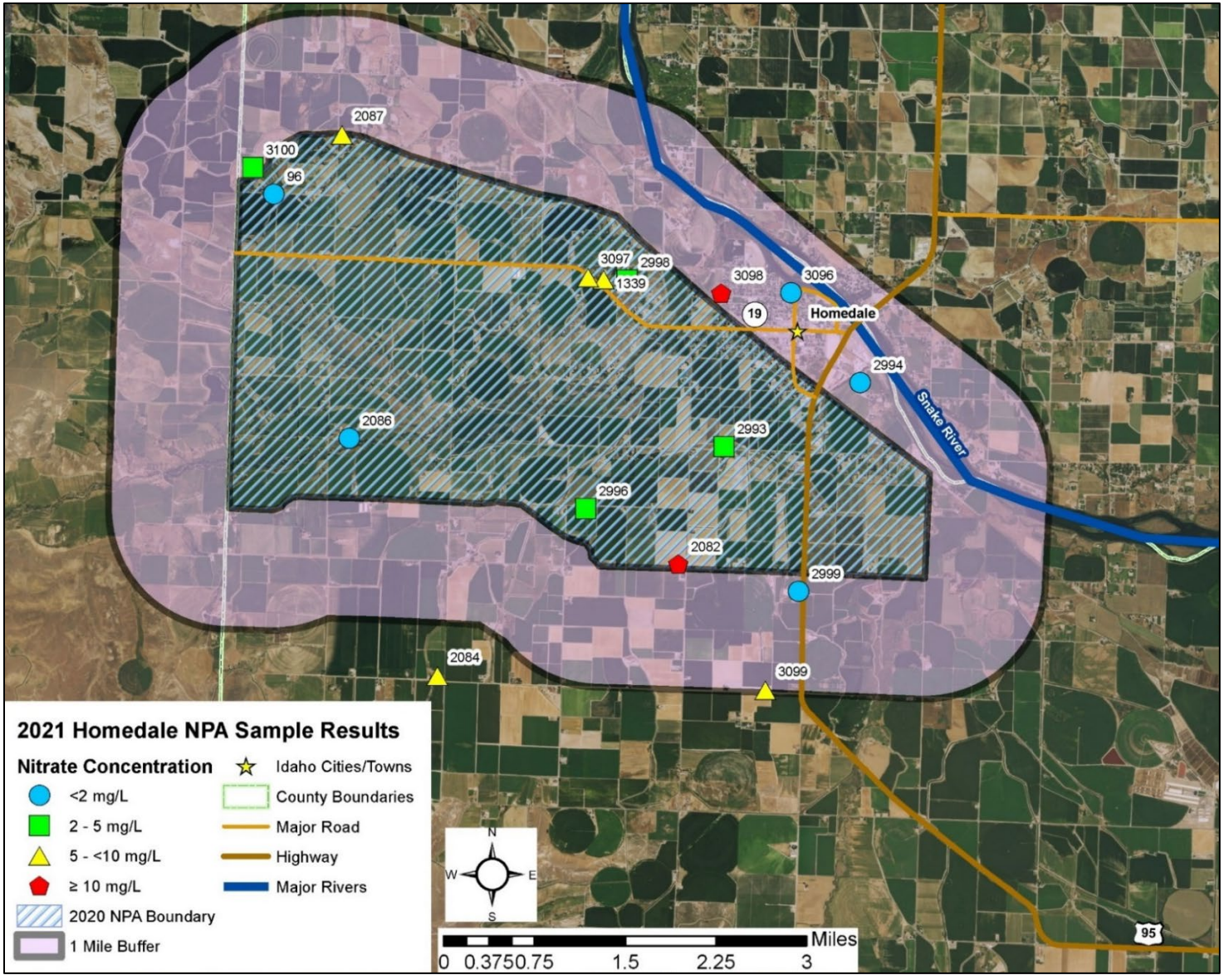


Figure 15. 2021 sample locations and nitrate concentrations—Homedale NPA Groundwater Monitoring Project.

Table 18. Comparison of nitrate results between 2015 and 2021–Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Comparative Nitrate Concentrations		Change in Concentration
		Nitrate[a] 2015 (mg/L)	Nitrate[a] 2021 (mg/L)	
Water Quality Standard:		**10**	**10**	
1339	240	**17.1**	5.93	-11.17
2082	40	**16.3**	**15.2**	-1.1
2084	82	6.01	8.90	2.89
2086	60	1.89	1.00	-0.89
2087	180	9.61	8.39	-1.22

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.

Five of the 16 wells sampled in 2021 had been previously sampled in 2015. Due to the low number of repeat samples, trends can only be reported for small areas of the NPA.

Wells 2082, 2086, and 2087 had minimal decreases in nitrate concentrations. Well 1339 had a very large decrease in the nitrate concentration.

Well 2084 was the only one of the five wells tested in 2015 that showed an increase in nitrate concentration. One potential factor for this increase is the new addition or expansion of a confined animal feeding operation to the west and upgradient from the well.

A map showing the areas of change is found in Figure 16.

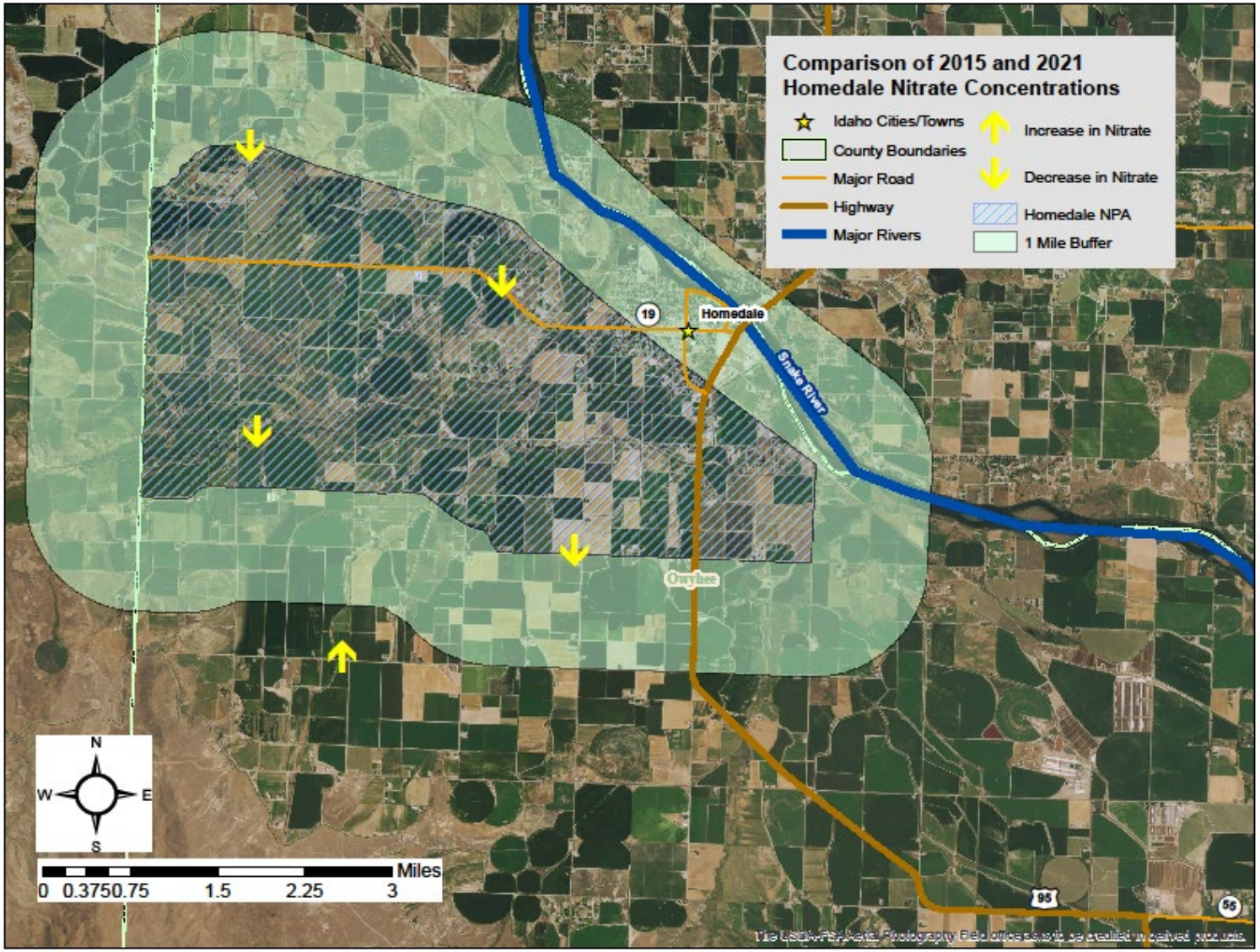


Figure 16. Sample sites nitrate concentration comparison 2015 and 2021—Homedale NPA Groundwater Monitoring Project.

Nitrogen isotope ($\delta^{15}N$) samples were collected from the seven wells with nitrate concentrations of 5 mg/L or greater (Table 17). Wells 2082 and 3098 had isotope ratios in the -4.0‰ to +4.0‰ range, indicating the source of nitrate in the soil was likely from commercial fertilizer (Seiler 1996; Table 3). These wells were also the only two wells with nitrate concentrations exceeding the MCL.

Wells 1339, 2087, 3097, and 3099 had isotope ratios in the +4.0‰ to +9.0‰ range, indicating the source of nitrate in the soil was likely from a mixed or mixed organic source. These wells are in an area of mixed agricultural and residential use.

Well 2084 had an isotope ratio above +9.0‰, indicating the source of nitrate in the soil was likely from animal or human waste. This well also had had an isotope ratio above +9.0‰ in 2015. The property is surrounded by agricultural fields and a few small, confined animal feeding operations.

2.1.3.2.2 Bacteria Results

Wells 2086, 2994, and 2998 had detections for TC. No wells had *E. coli* detections (Table 19).

Well 2086 was sampled in 2015 and does not have a history of TC in samples taken by DEQ. Wells 2994 and 2998 were sampled for the first time in 2021.

Table 19. 2021 bacteria results—Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1.0**	**1.0**
96	80	05/19/2021	<1.0	<1.0
1339	240	05/19/2021	<1.0	<1.0
2082	40	05/25/2021	<1.0	<1.0
2084	82	05/25/2021	<1.0	<1.0
2086	60	05/25/2021	<1.0	13.0
2087	180	05/19/2021	<1.0	<1.0
2993	70	05/25/2021	<1.0	<1.0
2994	62	05/19/2021	<1.0	1.0
2996	37	05/25/2021	<1.0	<1.0
2998	54	05/19/2021	<1.0	14.5
2999	124	05/25/2021	<1.0	<1.0
3096	45	05/19/2021	<1.0	<1.0
3097	105	05/19/2021	<1.0	<1.0
3098	28	05/19/2021	<1.0	<1.0
3099	36	05/25/2021	<1.0	<1.0
3100	120	05/19/2021	<1.0	<1.0

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.3.2.3 Arsenic and Uranium Results

Arsenic results are presented in Table 20. Twelve of the 16 wells (75%) sampled had arsenic concentrations over the MCL of 10 µg/L with a range of 15 µg/L to 140 µg/L (Table 20). The four remaining wells had arsenic concentrations below the MCL. The locations and arsenic concentration ranges for the wells sampled in the Homedale NPA in 2021 are shown in Figure 17.

Arsenic has not previously been evaluated by DEQ in the Homedale NPA, so no historical data is available for comparison.

Table 20. 2021 arsenic results—Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
96	80	05/19/2021	**15**
1339	240	05/19/2021	**140**
2082	40	05/25/2021	**61**
2084	82	05/25/2021	**24**
2086	60	05/25/2021	**41**
2087	180	05/19/2021	**95**
2993	70	05/25/2021	8.2
2994	62	05/19/2021	4.9
2996	37	05/25/2021	**38**
2998	54	05/19/2021	**40**
2999	124	05/25/2021	3.0
3096	45	05/19/2021	8.5
3097	105	05/19/2021	**95**
3098	28	05/19/2021	**15**
3099	36	05/25/2021	**42**
3100	120	05/19/2021	**94**

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

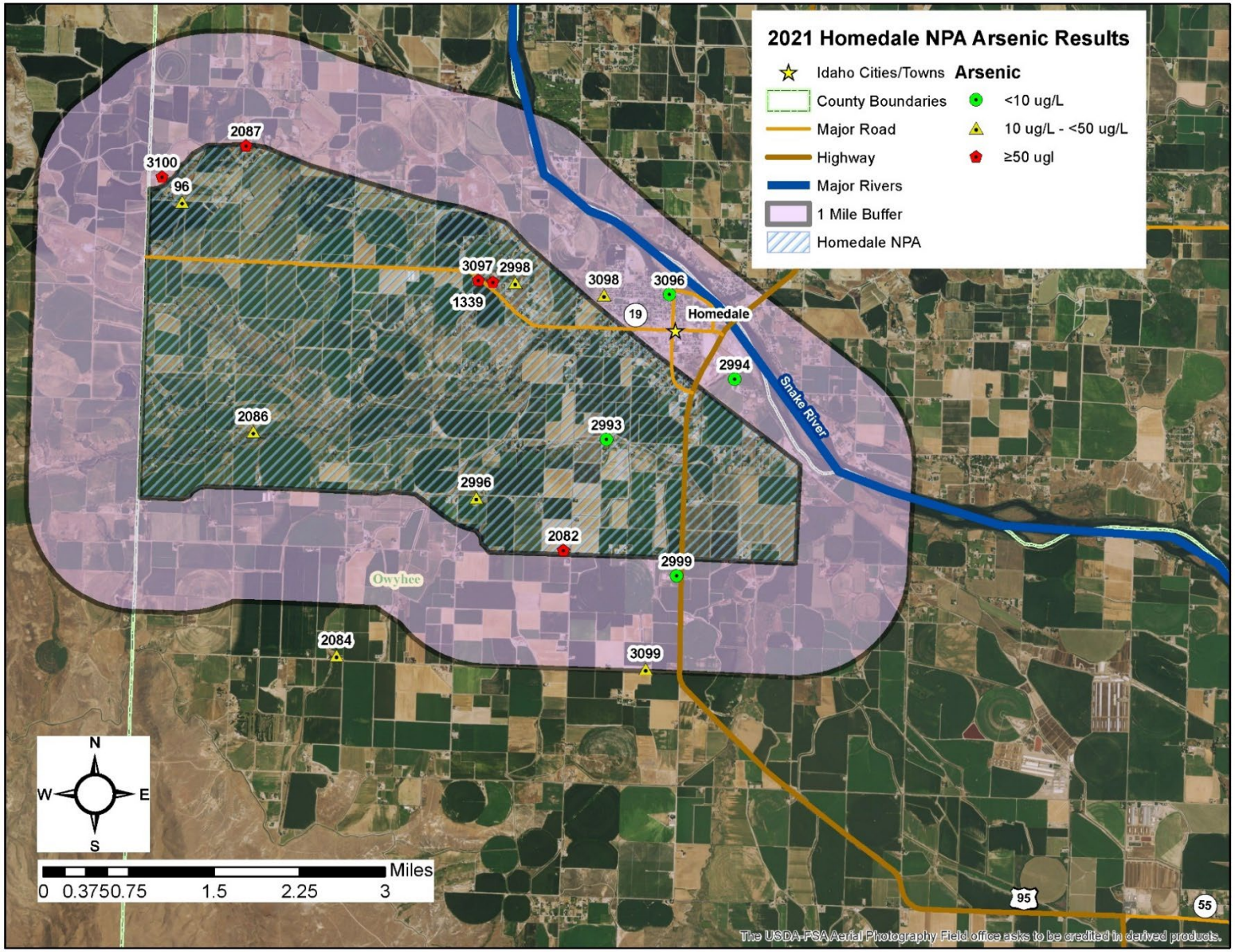


Figure 17. 2021 sample locations and arsenic concentrations—Homedale NPA Groundwater Monitoring Project.

Four out of 16 wells (25%) (2082, 2086, 2087, and 3097) had uranium concentrations at or above EPA's MCL of 30 µg/L (Table 21 and Figure 18). The remaining 12 wells had uranium concentrations below the MCL with a range from <1.0 µg/L to 19 µg/L.

Well 2082 is located near other wells that did not exceed the uranium MCL. It had a nitrogen isotope signature associated with commercial fertilizers, which can be high in uranium and can contribute to uranium in groundwater.

The uranium source for the four wells with concentrations above the MCL is likely due to granite-derived sedimentary rock in the region, which can contain concentrations well above the average 1 mg/L–3 mg/L (Cumberland et al. 2016).

Table 21. 2021 uranium results—Homedale NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium[a] (µg/L)
Water Quality Standard:			**30**
96	80	05/19/2021	11
1339	240	05/19/2021	19
2082	40	05/25/2021	**30**
2084	82	05/25/2021	9
2086	60	05/25/2021	**44**
2087	180	05/19/2021	**40**
2993	70	05/25/2021	9.6
2994	62	05/19/2021	6.3
2996	37	05/25/2021	16
2998	54	05/19/2021	9.7
2999	124	05/25/2021	0.98
3096	45	05/19/2021	<1.0
3097	105	05/19/2021	**31**
3098	28	05/19/2021	14
3099	36	05/25/2021	17
3100	120	05/19/2021	10

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

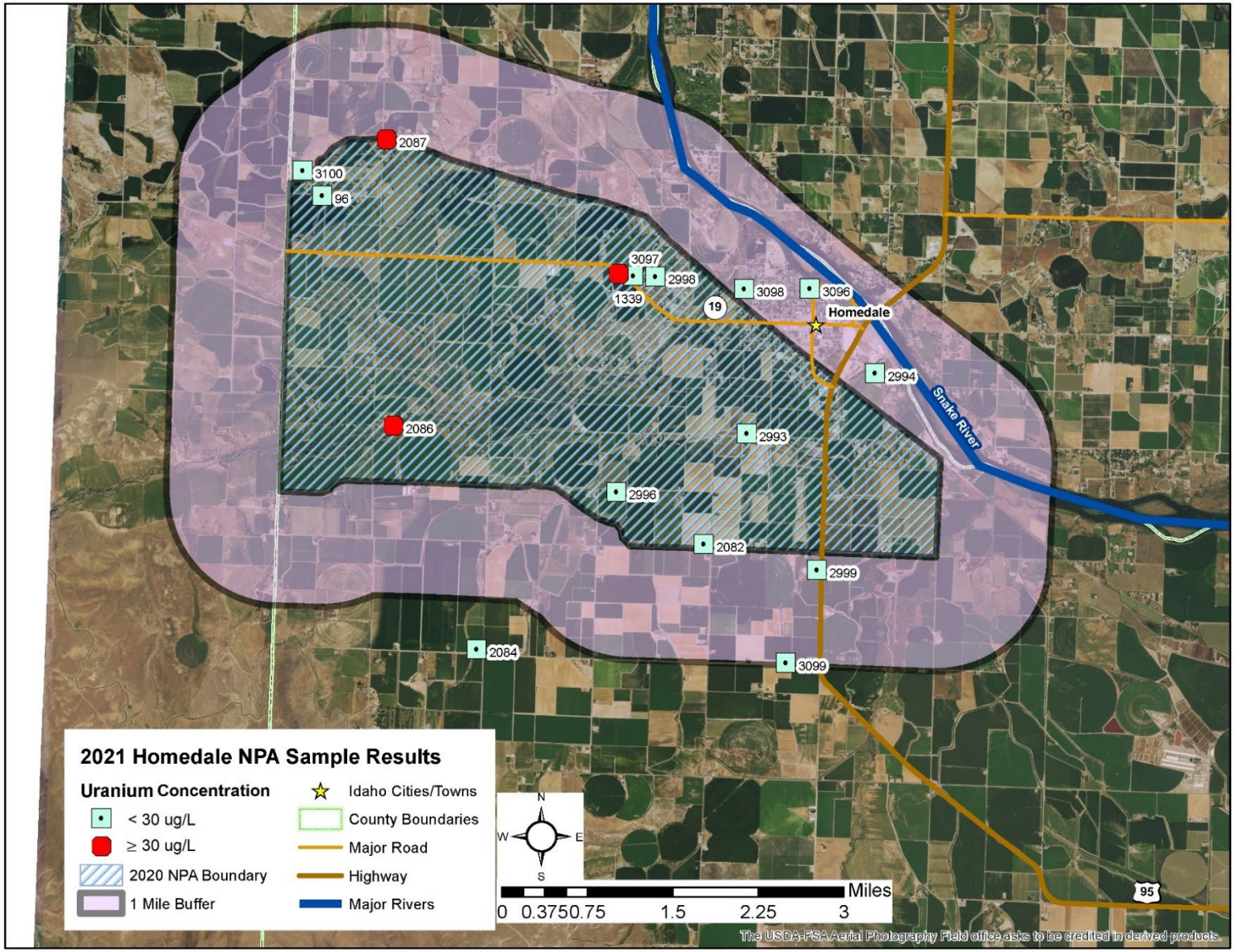


Figure 18. 2021 sample locations and uranium concentrations—Homedale NPA Groundwater Monitoring Project.

2.1.3.3 Conclusions

Seven of the 16 wells sampled (43.75%) in the Homedale NPA had nitrate concentrations greater than or equal to 5 mg/L. A change in fertilizer application around four of the wells could be a potential explanation for their decreases in nitrate. However, no clear reason was observed when sampling.

Twelve of the 16 wells (75%) sampled in the Homedale NPA contained arsenic at or above the MCL of 10 µg/L. Based on the local geology and supporting data compiled by the Idaho Department of Water Resources, higher arsenic concentrations are more common in southwestern Idaho.

Four of the 16 wells (25%) sampled had uranium concentrations equal to or above the MCL of 30 µg/L. The remaining wells had uranium concentrations below the MCL with a range from <1.0 µg/L to 19 µg/L. Uranium is a naturally occurring element in rock that can percolate into groundwater after erosion water-rock reactions. Based on local geology, this could be a natural source of uranium in groundwater wells.

Three wells had detections for TC. No wells had *E. coli* detections.

2.1.3.4 Recommendations

Due to the absence of available sample locations that meet the needs of the project, it is recommended the Homedale NPA boundaries be reevaluated by DEQ during the next scheduled NPA evaluation.

DEQ will repeat the Homedale NPA sampling in 2024.

2.1.4 Marsing Nitrate Priority Area Regional Groundwater Monitoring

2.1.4.1 Purpose and Background

In 2020, the Marsing NPA was ranked the 31st most impacted NPA with a decreasing trend (DEQ 2020a).

The Marsing NPA is located southwest of the Snake River near the northwest boundary of the WSRP, in southwest Idaho. Previous publications (Shervais et al. 2002, and Newton 1991) describe the strata of the WSRP basin as composed of Tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group. Idaho Group sediments are generally characterized by course gravel and sand of alluvial fans; sandstone, and stream conglomerates; fine sand, sandstone, mudstone, and silt deltaic deposits; sand, silt, fossiliferous sandstone, oolitic limestone, and clay lacustrine deposits; and intercalated layers of volcanic ash and basalt.

The predominant land use in the Marsing NPA is row crop agriculture. The residences within the NPA but outside the city of Marsing are served by private wells.

In the Marsing area, the Snake River flows through a wide floodplain composed of low-sloping alluvial terraces. Groundwater elevations and flow direction in the middle and upper aquifers of the WSRP were studied in 1980, and groundwater contour maps were developed for the WSRP (Newton 1991). These maps indicate that groundwater flow direction south of the Snake River trend north-northeast toward the Snake River (Figure 19).

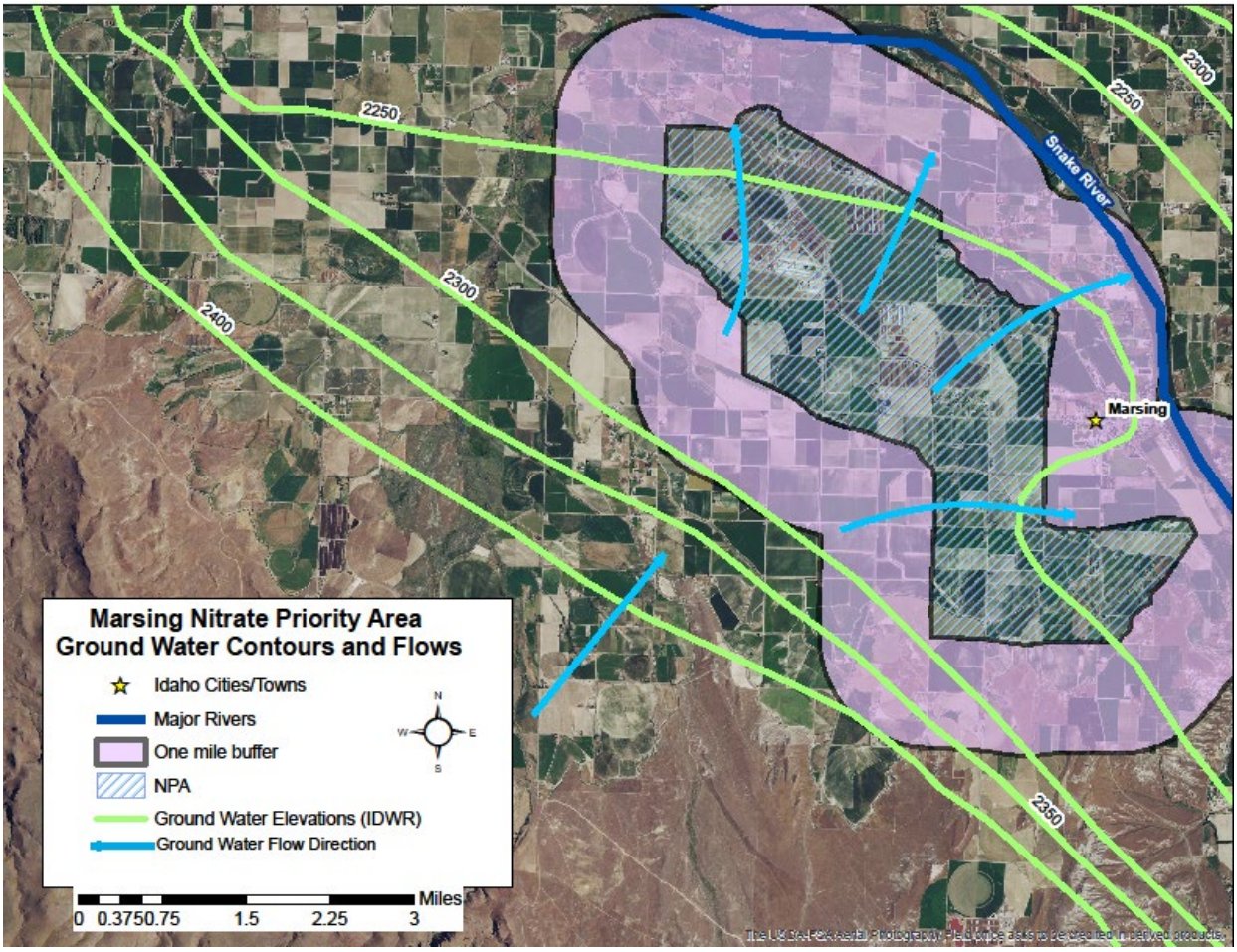


Figure 19. Groundwater contours and elevations—Marsing NPA Groundwater Monitoring Project.

In 2021, DEQ collected groundwater samples from a combination of 24 domestic and irrigation wells in the Marsing NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the Regional Network Design (DEQ 2018a). DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess the water quality in the project area. Nitrogen isotope samples were sent to the University of Arizona Laboratory. All other samples were sent to the Idaho Bureau of Laboratories.

2.1.4.2 Methods and Results

Sample locations were selected in accordance with the Regional Network Design.

The Marsing NPA is classified as a small NPA because the area of Stratum 1 (area within NPA boundaries) is less than 10 square miles. Permission was requested from well owners for all wells that met the Regional Network Design criteria.

DEQ identified 45 wells within the 2021 Marsing NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design and received permission to sample 24 wells. Two of the wells sampled were in the 2015 Marsing NPA, but boundary changes now place them in the Homedale NPA and buffer. Wells 2091 and 2455 were included with the Marsing NPA sampling event to maintain the history of the sampling results for the two wells. Figure 20 shows the location of the wells that were sampled and the nitrate concentrations for each well.

Water quality field parameters (i.e., pH, temperature, specific conductivity, and DO) were measured at each well before sample collection (Table 22).

Table 22. Water quality field parameters—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
2089	51	05/17/2021	18.53	726	8.03	0.29
2090	38	05/11/2021	16.45	2410	6.62	0.52
2091	30	05/17/2021	14.95	1370	7.46	6.82
2093	80	05/11/2021	17.04	2670	*6.47*	0.61
2095	180	05/12/2021	16.41	9410	*5.66*	0.34
2098	80	05/11/2021	16.64	2760	*3.82*	0.39
2307	98	05/11/2021	16.77	1890	6.72	0.64
2455	83	05/17/2021	16.96	1410	7.46	0.31
2457	73	05/12/2021	17.53	3100	*6.13*	5.66
2981	80	05/12/2021	15.4	3540	*6.09*	5.56
2982	88	05/12/2021	15.97	3030	*6.21*	1.90
2984	140	05/12/2021	15.17	4700	*5.99*	4.36
2985	57	05/11/2021	19.19	2090	6.81	1.10
2986	57	05/11/2021	19.68	2400	*6.32*	0.74
2987	40	05/17/2021	13.84	1280	7.33	6.25
2988	Unk	05/11/2021	16.78	2440	*6.21*	9.62
2989	85	05/17/2021	16.51	899	7.84	0.43
2990	80	05/12/2021	15.14	3700	*6.12*	4.83
2991	185	05/17/2021	17.44	814	7.47	1.52
2992	75	05/17/2021	17.58	866	7.88	0.48
3091	83	05/12/2021	14.38	10900	*5.75*	0.66
3092	Unk	05/12/2021	20.02	3080	*6.19*	0.27
3093	65	05/11/2021	15.12	2670	*3.96*	0.64
3095	93	05/17/2021	15.10	779	7.73	0.37

Notes: °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = Unknown. Well log not found. Italicized, gray shaded numbers indicate an EPA National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

2.1.4.2.1 Nutrient and Nitrogen Isotope Results

Nutrient and nitrogen isotope results are presented in Table 23. Seven out of 24 wells (29.2%) had nitrate concentrations greater than half the MCL of 10 mg/L (2091, 2455, 2984, 2987, 2988, 2990, and 3091) (Figure 20).

Three of those wells had nitrate concentrations exceeding the MCL of 10 mg/L (2091, 2984, and 2987). The 17 remaining wells had concentrations below the detection limit (Table 23). Wells 2984 and 2987 were sampled for the first time in 2021. Well 2091 had nitrate results above the MCL in 2015 (Table 24).

The reported ammonia concentrations for 18 of the wells ranged from <0.050 mg/L to 7.3 mg/L. The remaining six wells were not sampled for ammonia because the DO was greater than 2 mg/L (Table 23).

Table 23. Nutrient and nutrient-related isotope results—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a]	Ammonia	δ^{15} (‰)
			(mg/L)			
Water Quality Standard:			**1.0**	**10**	**No Stand.**	**No Stand.**
2089	51	05/17/2021	<0.30	0.0439	6.1	—
2090	38	05/11/2021	<0.30	0.18	2.8	—
2091	30	05/17/2021	<0.30	**15.6**	—	2.0
2093	80	05/11/2021	<0.30	0.136	1.1	—
2095	180	05/12/2021	<0.30	0.196	4.2	—
2098	80	05/11/2021	<0.30	<0.18	7.3	—
2307	98	05/11/2021	<0.30	<0.18	2.5	—
2455	83	05/17/2021	<0.30	5.64	0.24	15.3
2457	73	05/12/2021	<0.30	4.45	—	—
2981	80	05/12/2021	<0.30	4.93	—	—
2982	88	05/12/2021	0.30	1.29	<0.050	—
2984	140	05/12/2021	<0.30	**12.5**	<0.50	6.8
2985	57	05/11/2021	<0.30	<0.18	4.8	—
2986	57	05/11/2021	<0.30	0.381	<0.050	—
2987	40	05/17/2021	<0.30	**19**	—	8.6
2988	Unk	05/11/2021	<0.30	6.44	—	7.0
2989	85	05/17/2021	<0.30	0.0338	6.0	—
2990	80	05/12/2021	<0.30	5.04	—	5.4
2991	185	05/17/2021	0.0527	1.32	<0.050	—
2992	75	05/17/2021	<0.30	0.0394	5.5	—
3091	83	05/12/2021	<0.30	8.34	0.10	6.3
3092	Unk	05/12/2021	<0.30	0.0432	4.9	—
3093	65	05/11/2021	<0.30	<0.18	4.5	—
3095	93	05/17/2021	<0.30	0.0430	0.79	—

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, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

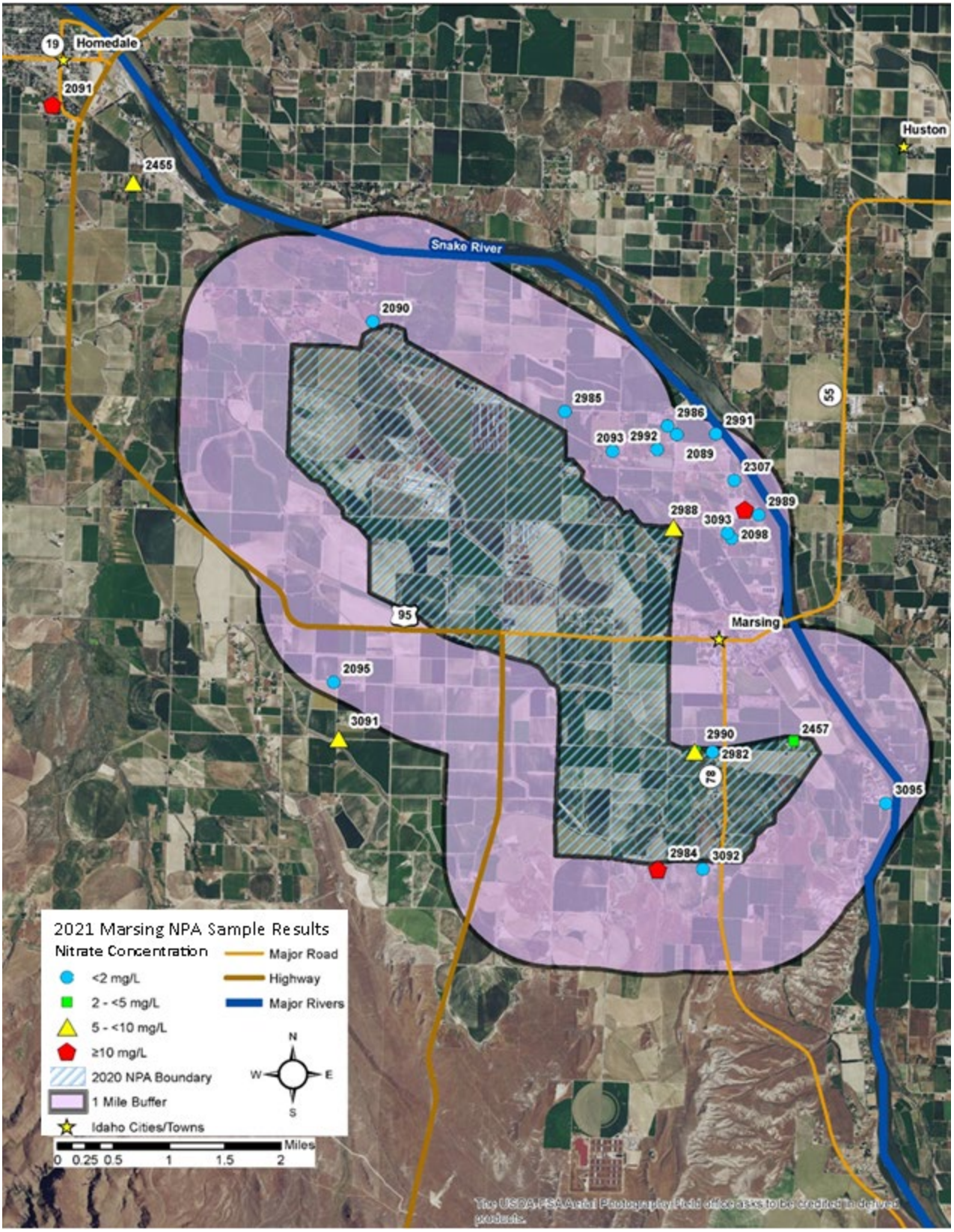


Figure 20. 2021 sample locations and nitrate concentrations—Marsing NPA Groundwater Monitoring Project.

Table 24. Comparison of nitrate results between 2015 and 2021—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Comparative Nitrate Concentrations		Change in Concentration
		Nitrate[a] 2015	Nitrate[a] 2021	
		(mg/L)		
Water Quality Standard:		**10**	**10**	
2307	98	<0.180	<0.180	0
2098	80	<0.180	<0.180	0
2095	180	<0.180	0.196	0.196
2093	80	0.554	0.136J[b]	—
2091	31	**12.1**	**15.6**	3.5
2090	38	<0.180	<0.180	0
2089	185	<0.180	0.0439J[b]	0.0439
2445	83	1.18	5.64	4.46
2457	70	5.32	4.45	-0.87

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

Nine of the 24 wells sampled in 2021 had been previously sampled in 2015. Due to the small number of repeat samples, trends can only be reported for a small area of the NPA.

Wells 2091 and 2445 saw the most significant increases in nitrate. The rest of the wells reported minimal change. Well 2457 had a small decrease. The remaining five wells had no change or the 2021 estimated results were below the lab reporting limit.

A map showing the areas of change is in Figure 21.

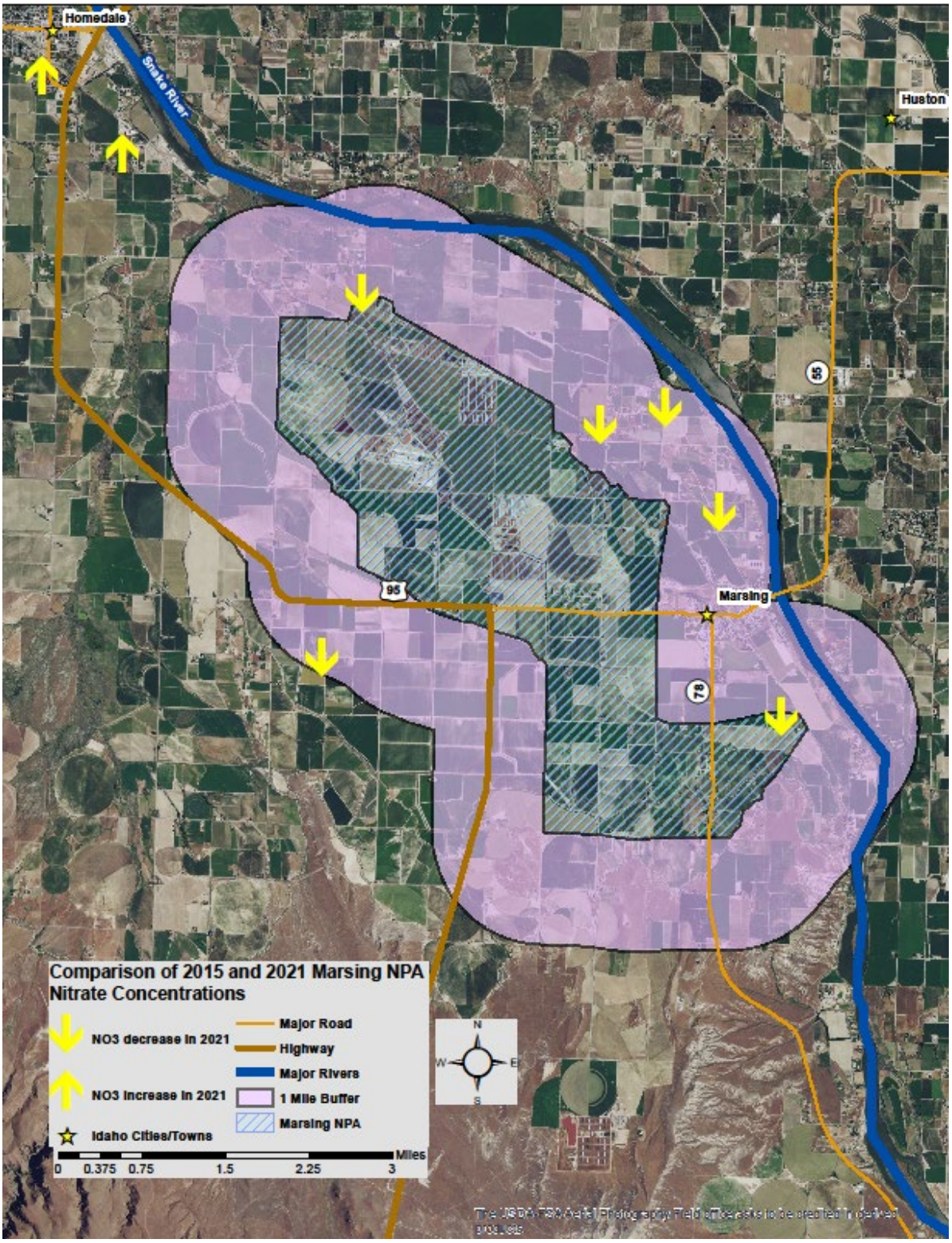


Figure 21. Sample sites nitrate concentration comparison 2015 and 2021—Marsing NPA Groundwater Monitoring Project.

Nitrogen isotope samples were collected from the seven wells with nitrate concentrations of 5 mg/L or greater (Table 23).

Well 2091 had an isotope ratio in the -4.0‰ to +4.0‰ range, indicating the source of nitrate in the soil was likely from commercial fertilizer (Seiler 1996; Table 3). This well is downgradient from several crop fields.

Wells 2090, 2984, 2987, 2988, and 3091 had isotope ratio in the +4.0‰ to +9.0‰ range, indicating the source of nitrate in the soil was likely from a mixed or mixed organic source. These wells are in a partly agricultural and partly residential area.

Well 2455 had an isotope ratio above +9.0‰, indicating the source of nitrate in the soil was likely from animal or human waste. This well is in a residential area with 1–5 acre lots. The property owners were putting in a new pole barn at the time DEQ took samples. The heavy equipment in use may have affected the septic leach field. Well 2455 was not sampled for isotopes in 2015, so no historical data is available for isotope comparison (Table 24).

2.1.4.2.2 Bacteria Results

Bacteria results are presented in Table 25. No wells had detections for *E. coli* or TC in 2021.

Table 25. 2021 bacteria results—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1.0**	**1.0**
2089	51	05/17/2021	<1.0	<1.0
2090	38	05/11/2021	<1.0	<1.0
2091	30	05/17/2021	<1.0	<1.0
2093	80	05/11/2021	<1.0	<1.0
2095	180	05/12/2021	<1.0	<1.0
2098	80	05/11/2021	<1.0	<1.0
2307	98	05/11/2021	<1.0	<1.0
2455	83	05/17/2021	<1.0	<1.0
2457	73	05/12/2021	<1.0	<1.0
2981	80	05/12/2021	<1.0	<1.0
2982	88	05/12/2021	<1.0	<1.0
2984	140	05/12/2021	<1.0	<1.0
2985	57	05/11/2021	<1.0	<1.0
2986	57	05/11/2021	<1.0	<1.0
2987	40	05/17/2021	<1.0	<1.0
2988	Unk	05/11/2021	<1.0	<1.0
2989	85	05/17/2021	<1.0	<1.0
2990	80	05/12/2021	<1.0	<1.0
2991	185	05/17/2021	<1.0	<1.0

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
2992	75	05/17/2021	<1.0	<1.0
3091	83	05/12/2021	<1.0	<1.0
3092	Unk	05/12/2021	<1.0	<1.0
3093	65	05/11/2021	<1.0	<1.0
3095	93	05/17/2021	<1.0	<1.0

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.4.2.3 Arsenic and Uranium Results

Twelve of 24 wells (50%) had arsenic concentrations over the MCL with a range from 0.011 mg/L to 0.023 mg/L (Table 26). The remaining 12 wells had concentrations either not detected or detected below EPA's MCL. Arsenic was not previously evaluated by DEQ in the Marsing NPA, so no historical data is available for comparison. The locations and arsenic concentration ranges for the wells sampled in the Marsing NPA are shown in Figure 22.

Table 26. 2021 arsenic results—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
2089	51	05/17/2021	**20**
2090	38	05/11/2021	**14**
2091	30	05/17/2021	**21**
2093	80	05/11/2021	3.2
2095	180	05/12/2021	1.4
2098	80	05/11/2021	**17**
2307	98	05/11/2021	5.7
2455	83	05/17/2021	4.0
2457	73	05/12/2021	**16**
2981	80	05/12/2021	**22**
2982	88	05/12/2021	**10**
2984	140	05/12/2021	**20**
2985	57	05/11/2021	**23**
2986	57	05/11/2021	**15**
2987	40	05/17/2021	4.3
2988	Unk	05/11/2021	7.9
2989	85	05/17/2021	9.4

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
2990	80	05/12/2021	**19**
2991	185	05/17/2021	9.2
2992	75	05/17/2021	**11**
3091	83	05/12/2021	**17**
3092	Unk	05/12/2021	6.2
3093	65	05/11/2021	<2.0
3095	93	05/17/2021	<2.0

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter; Unk = Unknown. Well log not found.
Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

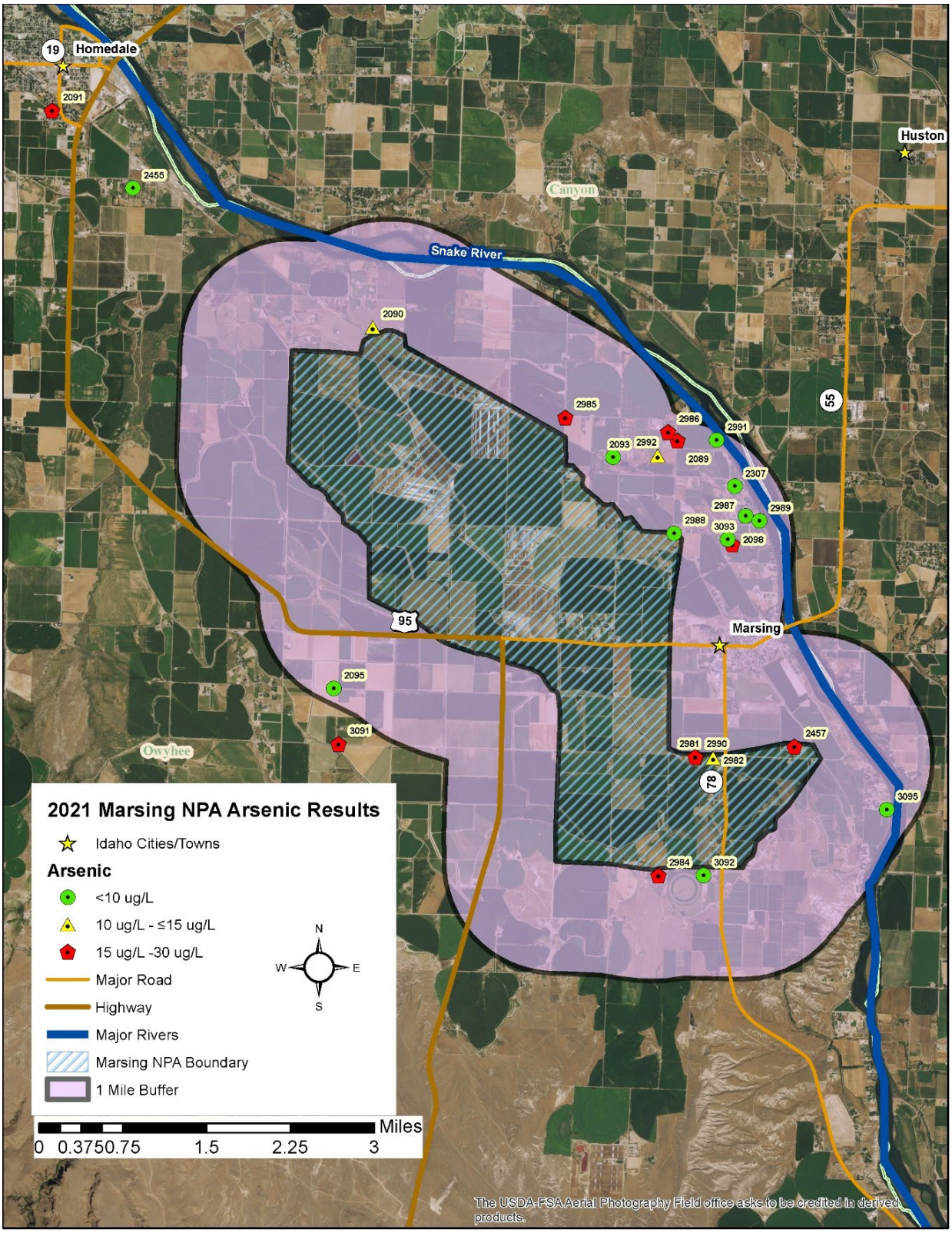


Figure 22. 2021 sample locations and arsenic concentrations—Marsing NPA Groundwater Monitoring Project.

23 out of 24 wells (96%) had uranium concentrations below the MCL of 30 µg/L with a range from <1.0 µg/L to 27 µg/L (Table 27).

The sample from Well 3091 had a uranium concentration of 160 µg/L, which is 5.3 times EPA's MCL. The lab ran the sample twice and the results were confirmed. Well 3091 was surrounded by green cropland. The $\delta^{15}N$ value for Well 3091 was 6.3‰, which indicates a mixed organic waste source. The well is not unique in location, depth, or alkalinity, and the owner could not be reached to ask additional questions. The source of uranium is unclear. Uranium was not previously evaluated by DEQ in the Marsing NPA, so no historical data is available for comparison. The locations and uranium concentrations for the wells sampled in the Marsing NPA are shown in Figure 23.

Table 27. 2021 uranium results—Marsing NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium (µg/L)[a]
Water Quality Standard:			**30**
2089	51	05/17/2021	<1.0
2090	38	05/11/2021	0.085
2091	30	05/17/2021	12
2093	80	05/11/2021	1.1
2095	180	05/12/2021	3.1
2098	80	05/11/2021	0.16
2307	98	05/11/2021	<1.0
2455	83	05/17/2021	5.8
2457	73	05/12/2021	16
2981	80	05/12/2021	21
2982	88	05/12/2021	20
2984	140	05/12/2021	19
2985	57	05/11/2021	<1.0
2986	57	05/11/2021	9.0
2987	40	05/17/2021	14
2988	Unk	05/11/2021	6.6
2989	85	05/17/2021	<1.0
2990	80	05/12/2021	27
2991	185	05/17/2021	4.1
2992	75	05/17/2021	<1.0
3091	83	05/12/2021	**160**
3092	Unk	05/12/2021	<1.0
3093	65	05/11/2021	<1.0
3095	93	05/17/2021	<1.0

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter; Unk = Unknown. Well log not found. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

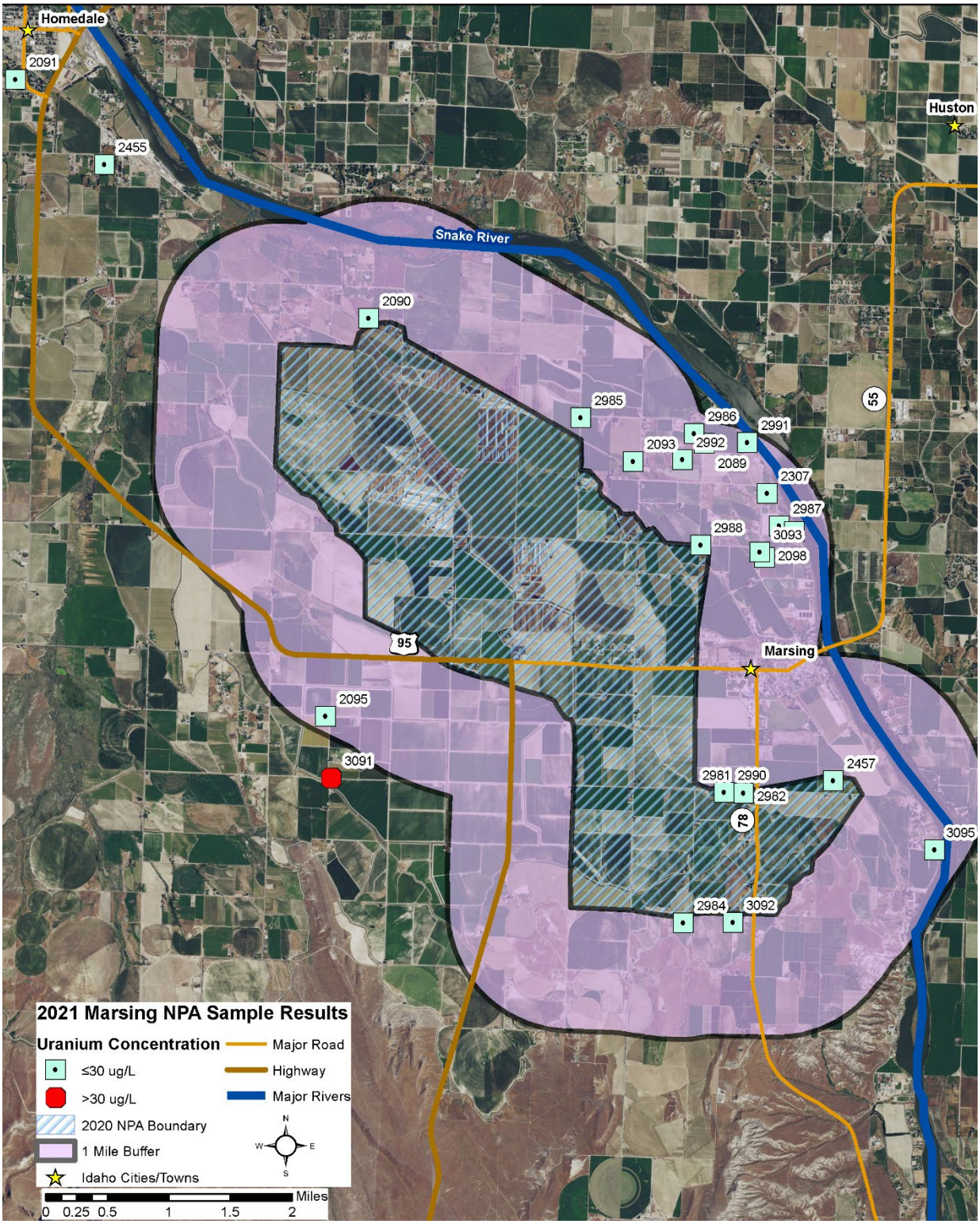


Figure 23. 2021 sample locations and uranium concentrations—Marsing NPA Groundwater Monitoring Project.

2.1.4.3 Conclusions

Seven of the 24 wells sampled (29%) in the Marsing NPA had nitrate concentrations greater than or equal to 5 mg/L.

Of the seven wells that met or exceeded 5 mg/L of nitrate, one well had a nitrogen isotope ($\delta^{15}N$) ratio in the -4.0‰ to +4.0‰ range, indicating the source of nitrate in the soil was likely from commercial fertilizer (Seiler 1996; Table 3). Five wells had isotope ratios in the +4.0‰ to +9.0‰ range, indicating the source of nitrate in the soil was likely from a mixed or mixed organic source. These wells are in a partly agricultural and partly residential area.

One well had an $\delta^{15}N$ ratio above +9.0‰, indicating the source of nitrate in the soil was likely from animal or human waste.

Thirteen of the 24 wells sampled (54%) in the Marsing NPA contained arsenic at or above the MCL of 10 µg/L. DEQ has not previously sampled this NPA for arsenic, so no historical data is available for comparison.

One well in the Marsing NPA had a uranium concentration higher than the MCL. The remaining 23 wells had uranium concentrations below the MCL. Well 3091 had a uranium concentration of 160 µg/L. Its $\delta^{15}N$ ratio (6.3‰) indicates that the nitrate source was not a commercial fertilizer. Therefore, fertilizer also is not likely to be the source for uranium. The geology described in the well driller's report is not significantly different from other wells in the area at 80 ft bgs to 90 ft bgs.

2.1.4.4 Recommendations

DEQ will repeat the Marsing NPA sampling in 2024. DEQ may consider combining the Marsing and Homedale NPAs into one NPA.

2.1.5 Mountain Home Nitrate Priority Area Regional Groundwater Monitoring

2.1.5.1 Purpose and Background

This groundwater monitoring project evaluated the water quality and nitrate concentrations in the Mountain Home NPA.

In 2020, the Mountain Home NPA was ranked the 22nd most impacted NPA with insufficient data to determine a trend (DEQ 2020a).

The Mountain Home NPA is located north of the Snake River near the northeastern boundary of the WSRP, in southwest Idaho (Figure 24). The WSRP basin is composed of Tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group (Newton 1991 and Shervais et al. 2002).

The Mountain Home NPA is located on a plateau within the WSRP and north of the Snake River. Groundwater elevation contours indicate a groundwater flow direction to the south and southwest across the Mountain Home NPA (Figure 24).

The primary land uses in the Mountain Home NPA are agriculture and residential. The primary agricultural use is irrigated cropland. The residences within the NPA are served by private wells. The city waste lagoons are located northeast of the NPA, with wastewater reuse areas inside NPA boundaries.

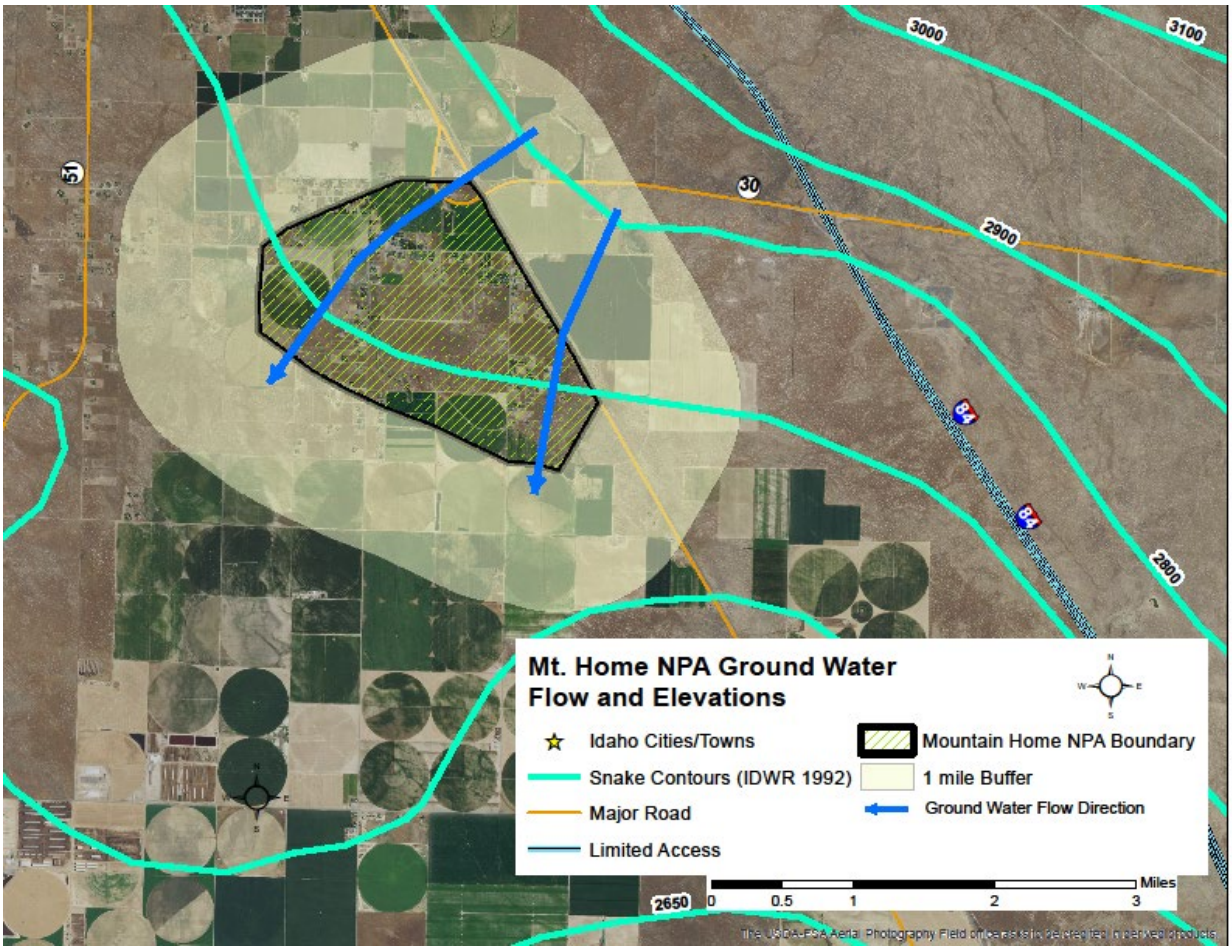


Figure 24. Groundwater contours and elevations—Mountain Home NPA Groundwater Monitoring Project.

2.1.5.2 Methods and Results

In 2021, DEQ collected groundwater samples from 13 domestic or irrigation wells in the Mountain Home NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the Regional Network Design (DEQ 2018a). DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess the water quality in the project area. Nitrogen isotope samples were sent to the University of Arizona Laboratory. All other samples were sent to the Idaho Bureau of Laboratories.

As determined by the Regional Network Design, permission was requested from well owners for all wells that met the Regional Network Design criteria.

DEQ identified 20 wells within the 2021 Mountain Home NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design and received permission to sample 13 wells. DEQ sampled 13 wells in 2014.

Water quality field parameters (i.e., pH, temperature, specific conductivity, and DO) were measured at each well before sample collection to ensure samples obtained were representative of the aquifer (Table 28).

Table 28. 2021 water quality field parameters—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
954	600	10/13/2021	17.88	357	8.18	8.69
2144	550	10/13/2021	18.38	369	8.17	9.40
2242	570	10/12/2021	23.39	319	*8.71*	3.72
2304	536	10/12/2021	15.87	682	*8.69*	8.84
2308	487	10/12/2021	20.66	524	8.20	7.46
2334	599	10/12/2021	23.81	315	*8.75*	3.55
2358	440	10/12/2021	20.77	514	*8.76*	7.52
2359	575	10/13/2021	23.47	357	7.88	7.18
2360	580	10/12/2021	24.49	325	*8.93*	3.07
2361	532	10/13/2021	19.86	413	8.18	9.21
2362	567	10/13/2021	25.32	317	8.03	4.23
2364	525	10/12/2021	17.27	778	*8.50*	8.41
2365	550	10/13/2021	14.33	945	7.18	8.72

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter. Italicized and shaded gray indicated a water quality standard was exceeded.
a. Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

2.1.5.2.1 Nutrient and Nitrogen Isotope Results

Nutrient and nitrogen isotope results for the Mountain Home NPA are presented in Table 29. Three out of 13 wells (23%) had nitrate concentrations greater than half the MCL of 10 mg/L (2304, 2364, and 2365). No wells had nitrate concentrations exceeding the MCL. The 10 remaining wells had concentrations less than half the MCL (Table 29). Well 2364 had a nitrate concentration above the MCL in 2014, but the concentration dropped to below the MCL in 2021 (Table 30). Well 954 had a nitrate concentration of 9.29 mg/L of nitrate in 2014 (Table 30). The 2021 nitrate concentration dropped to 2.03 mg/L.

Figure 25 shows the location of the wells that were sampled and the nitrate concentrations for each well.

Two out of 13 wells (2359 and 2360) were also analyzed for ammonia due to low oxygen levels (less than 2.0 mg/L) at the time of sampling. Both wells had ammonia concentrations below the reporting limit of 0.050 mg/L (Table 29).

Table 29. Nutrient and nutrient-related isotope results—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes
			Nitrite[a]	Nitrate[a]	Ammonia	$\delta^{15}N$ (‰)
			(mg/L)			
Water Quality Standard:			**1.0**	**10**	**No Standard**	**No Standard**
954	600	10/13/2021	<0.30	2.03	—	—
2144	550	10/13/2021	<0.30	2.50	—	—
2242	570	10/12/2021	<0.30	1.07	—	—
2304	536	10/12/2021	<0.30	6.74	—	5.1
2308	487	10/12/2021	<0.30	4.53	—	—
2334	599	10/12/2021	<0.30	1.12	—	—
2358	440	10/12/2021	<0.30	4.47	—	—
2359	575	10/13/2021	<0.30	3.06	<0.050	—
2360	580	10/12/2021	<0.30	0.989	<0.050	—
2361	532	10/13/2021	<0.30	2.84	—	—
2362	567	10/13/2021	<0.30	1.10	—	—
2364	525	10/12/2021	<0.30	8.51	—	6.3
2365	550	10/13/2021	<0.30	5.05	—	9.9

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; ‰ = permil; (—) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard.

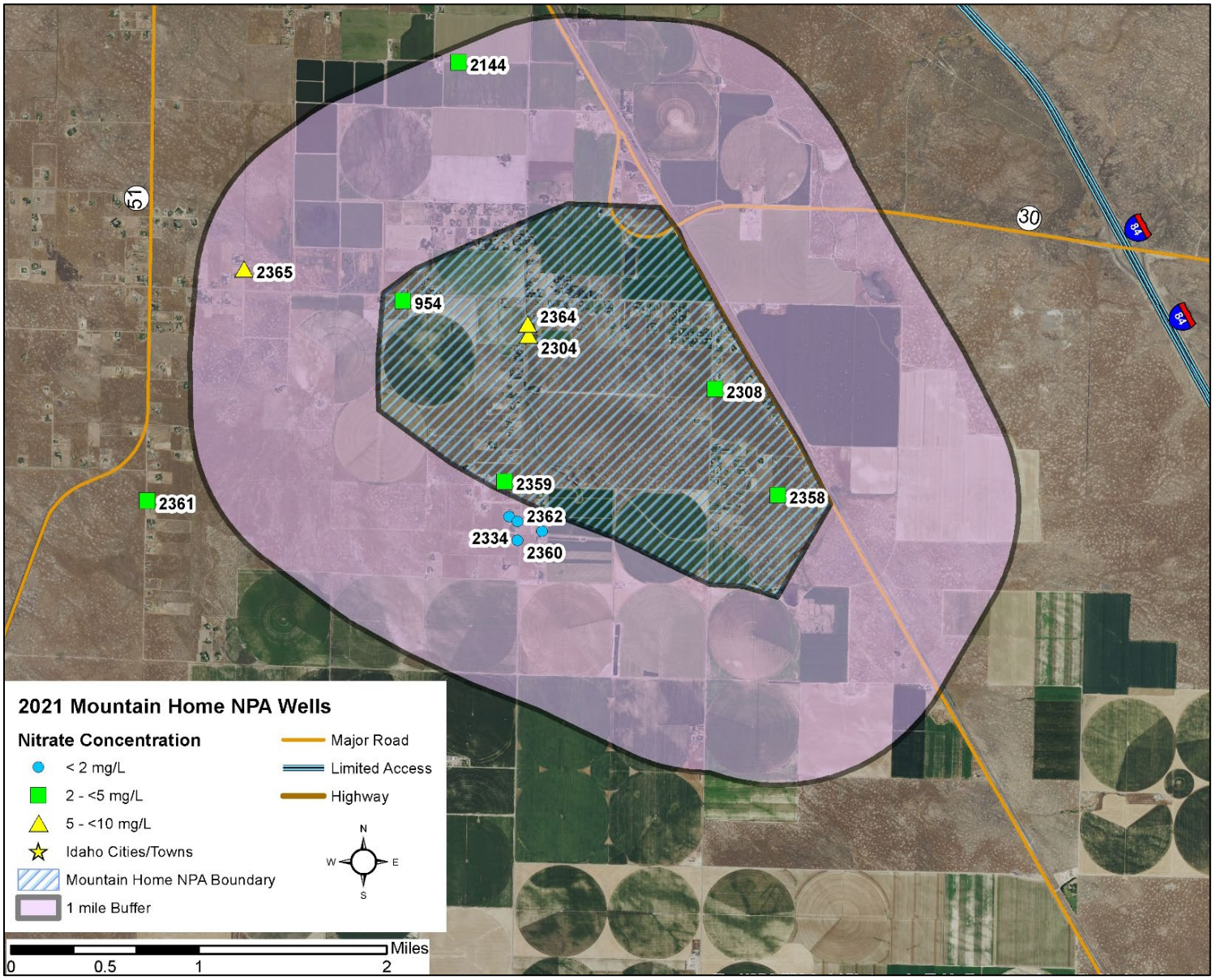


Figure 25. 2021 sample locations and nitrate concentrations—Mountain Home NPA Groundwater Monitoring Project.

Table 30. Comparison of nitrate results between 2014 and 2021—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Comparative Nitrate Concentrations		Change in Concentration
		Nitrate[a] 2014	Nitrate[a] 2021	
		(mg/L)		
Water Quality Standard:		**10**	**10**	
2358	440	4.44	4.47	0.03
2144	550	2.55	2.50	-0.05
2304	536	5.53	6.74	1.21
2308	487	5.06	4.53	-0.53
2334	599	1.08	1.12	0.04
2242	569	1.37	1.07	-0.30
2359	575	2.60	3.06	0.46
2360	580	1.14	0.989	-0.151
2361	532	2.86	2.84	-0.02
2362	567	1.07	1.10	0.03
2364	525	**10.1**	8.51	-1.59
2365	550	3.28	5.05	1.77
954	600	9.29	2.03	-7.26

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

Thirteen wells sampled in 2021 were also sampled in 2014. Figure 26 shows the areas of change. For readability, changes of less than 0.5 mg/L of nitrate were not mapped. Wells 2358, 2304, 2334, 2359, 2362, and 2365 had increases in nitrate concentrations. Well 2365 had the largest increase in nitrate concentration with +1.77 mg/L, but no detection of bacteria to indicate a septic problem. Well 2365 is the only well tested in 2021 that is directly downgradient from the city wastewater treatment plant.

Well 954 had a large decrease in the nitrate concentration between 2014 and 2021. In 2014, the property on which Well 954 is located was a residence and an auto repair shop with grass around the well house and several large trees. In 2021, the auto repair shop was no longer in business, the grass has been removed upgradient of the well, and several large trees have been removed. The front half of the lot had been cleared of bushes and weeds and non-grassy areas around the house and shop were clean and covered with dirt and gravel.

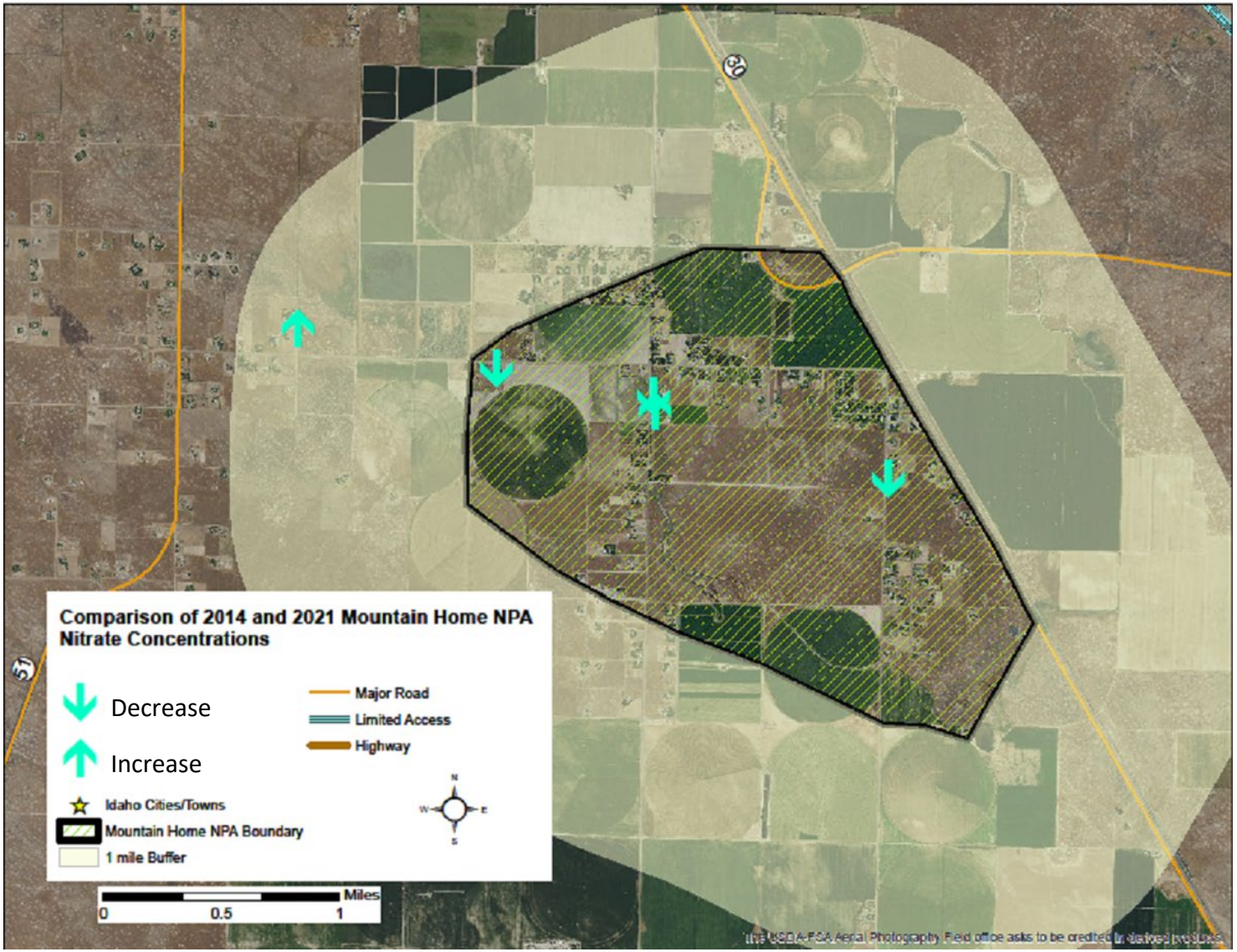


Figure 26. Sample sites nitrate concentration comparison 2014 and 2021—Mountain Home NPA Groundwater Monitoring Project.

Nitrogen isotope samples were collected from the three wells with nitrate concentrations of 5 mg/L or more (Table 29). Wells 2304 and 2364 had a nitrogen isotope ratio in the +4.0‰ to +9.0‰ range, indicating the nitrate in the soil was likely from a mixed or mixed organic source (Seiler 1996; Table 3). Well 2365 had an isotope ratio greater than +9.0‰, indicating a human or animal waste source. Well 2365 is downgradient from the wastewater treatment plant and has several houses with septic systems nearby.

2.1.5.2.2 Bacteria Results

Bacteria results are presented in Table 31. Well 2360 had a TC detection during the 2021 sampling event. No wells had *E. coli* detections (Table 31). Well 2360 did not have TC detections in 2014. There have been no known land use changes upgradient of Well 2360 since 2014.

Table 31. 2021 bacteria results—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1.0**	**1.0**
954	600	10/13/2021	<1.0	<1.0
2144	550	10/13/2021	<1.0	<1.0
2242	570	10/12/2021	<1.0	<1.0
2304	536	10/12/2021	<1.0	<1.0
2308	487	10/12/2021	<1.0	<1.0
2334	599	10/12/2021	<1.0	<1.0
2358	440	10/12/2021	<1.0	<1.0
2359	575	10/13/2021	<1.0	<1.0
2360	580	10/12/2021	<1.0	96
2361	532	10/13/2021	<1.0	<1.0
2362	567	10/13/2021	<1.0	<1.0
2364	525	10/12/2021	<1.0	<1.0
2365	550	10/13/2021	<1.0	<1.0

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.5.2.3 Arsenic and Uranium Results

All thirteen wells sampled in 2021 had arsenic detections below EPA's MCL (Table 32). Alkalinity does not seem to affect the presence of arsenic over the MCL. Arsenic was not previously evaluated by DEQ in the Mountain Home NPA, so no historical data is available for comparison. The locations and arsenic concentrations for the wells sampled in the Mountain Home NPA are shown in Figure 27.

Table 32. 2021 arsenic results—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
954	600	10/13/2021	1.0
2144	550	10/13/2021	1.0
2242	570	10/12/2021	5.4
2304	536	10/12/2021	4.6
2308	487	10/12/2021	1.7
2334	599	10/12/2021	4.7
2358	440	10/12/2021	1.5
2359	575	10/13/2021	2.7
2360	580	10/12/2021	5.7
2361	532	10/13/2021	0.93J[b]
2362	567	10/13/2021	4.4
2364	525	10/12/2021	1.8
2365	550	10/13/2021	1.8

Notes: ft bgs = feet below ground surface. µg/L = microgram per liter.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

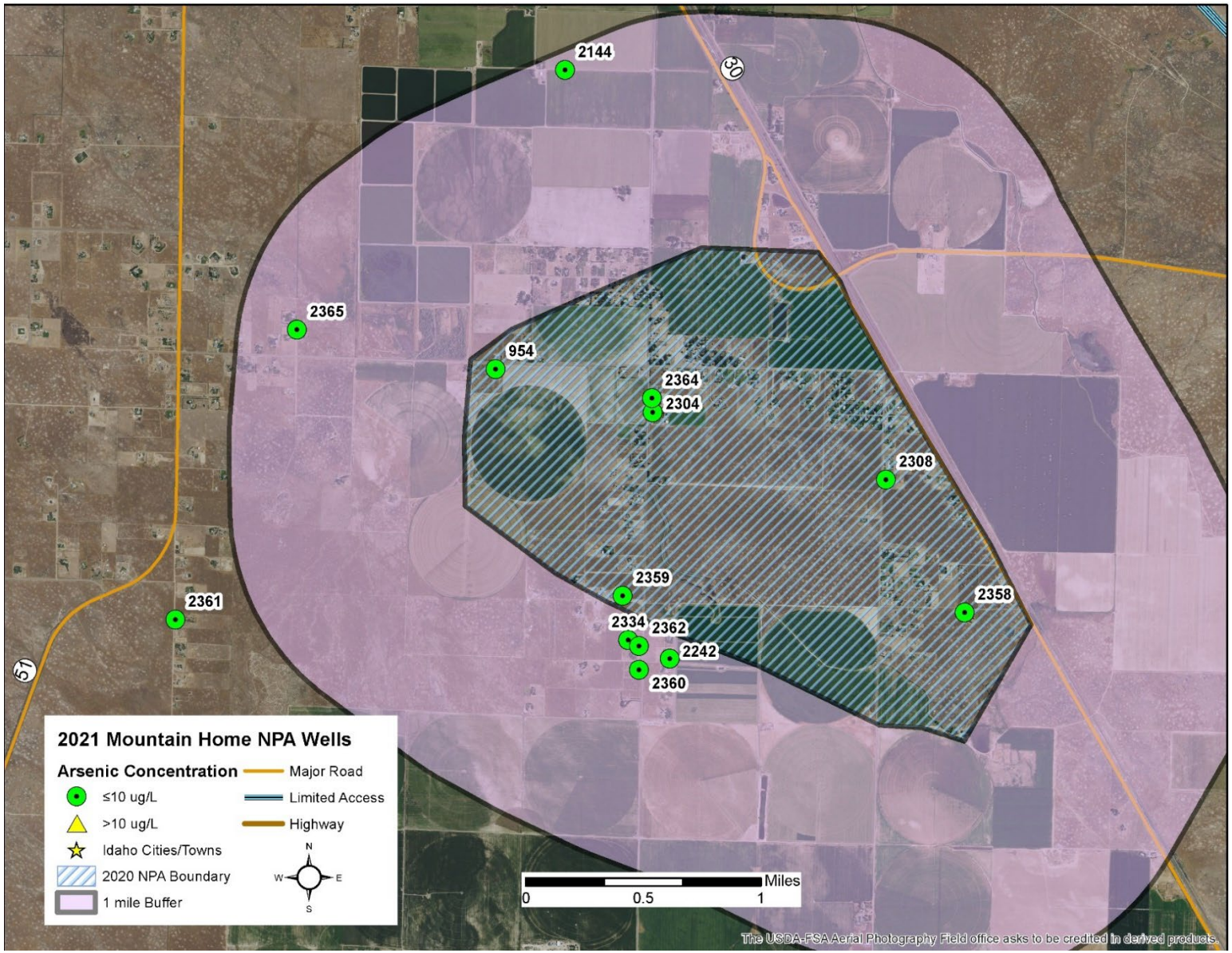


Figure 27. 2021 sample locations and arsenic concentrations–Mountain Home NPA Groundwater Monitoring Project.

All thirteen wells sampled had uranium concentrations below the MCL with a range from 1.0 µg/L to 9.3 µg/L (Table 33). Uranium was not previously evaluated by DEQ in the Mountain Home NPA, so no historical data is available for comparison. The location and uranium concentration for wells sampled in 2021 are shown in Figure 28.

Table 33. 2021 uranium results—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium (µg/L)[a]
Water Quality Standard:			**30**
954	600	10/13/2021	1.0
2144	550	10/13/2021	1.6
2242	570	10/12/2021	1.3
2304	536	10/12/2021	7.9
2308	487	10/12/2021	3.2
2334	599	10/12/2021	1.4
2358	440	10/12/2021	3.1
2359	575	10/13/2021	1.4
2360	580	10/12/2021	1.4
2361	532	10/13/2021	2.0
2362	567	10/13/2021	1.4
2364	525	10/12/2021	8.0
2365	550	10/13/2021	9.3

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter.
a. Contaminant with a National Primary Drinking Water Regulation standard.

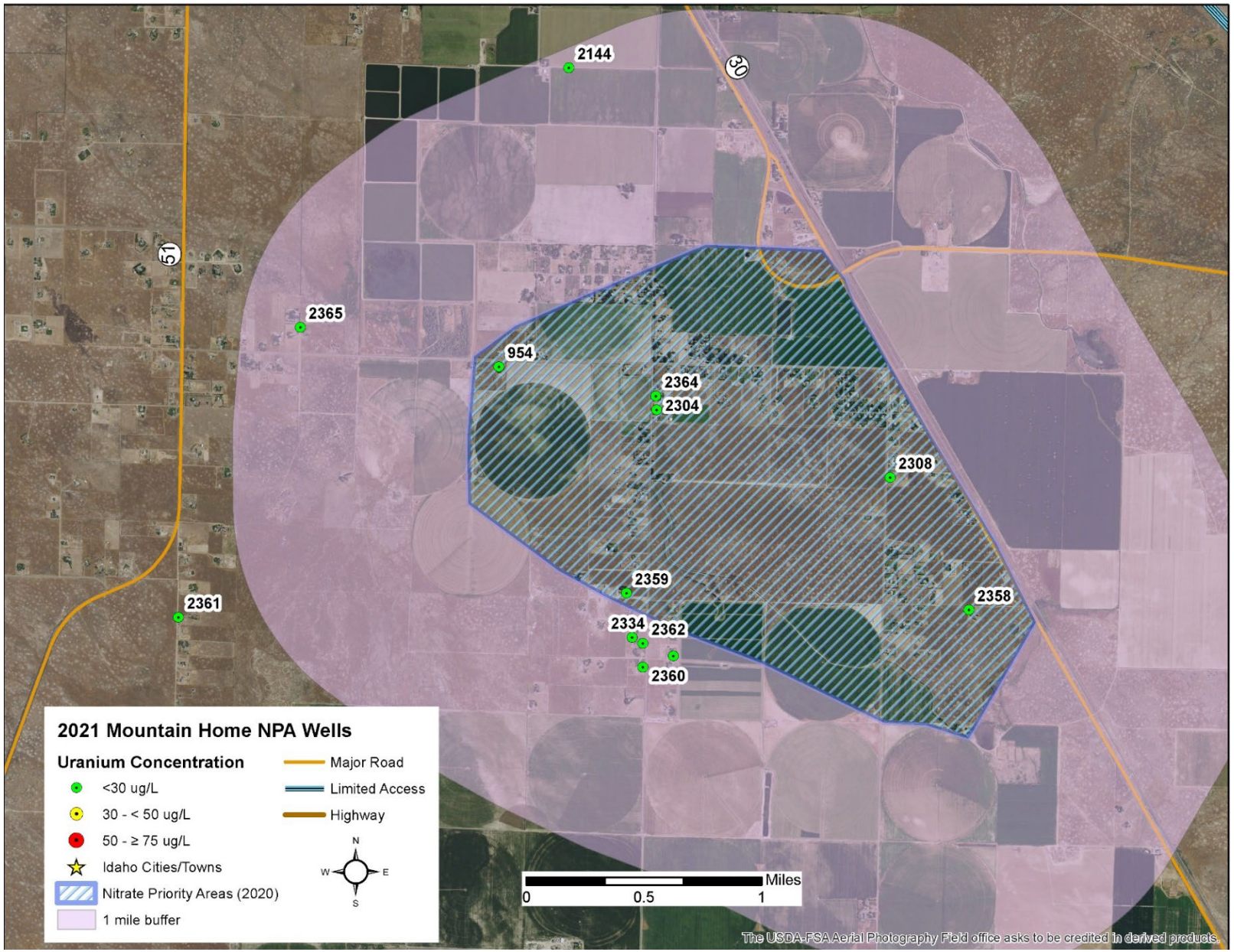


Figure 28. 2021 sample locations and uranium concentrations—Mountain Home NPA Groundwater Monitoring Project.

In addition to arsenic and uranium, the 13 wells were also sampled for alkalinity (as calcium carbonate) to evaluate any potential relationship between the analytes (Table 34). Linear regression trendlines were applied to both alkalinity versus arsenic (Figure 29) and alkalinity versus uranium (Figure 30) data sets. No relationship between alkalinity and arsenic or uranium was identified.

Table 34. Common ion and total dissolved solids results—Mountain Home NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)
	Water Quality Standard:		**No Standard**
954	600	10/13/2021	109
2144	550	10/13/2021	123
2242	570	10/12/2021	120
2304	536	10/12/2021	199
2308	487	10/12/2021	152
2334	599	10/12/2021	118
2358	440	10/12/2021	143
2359	575	10/13/2021	103
2360	580	10/12/2021	123
2361	532	10/13/2021	124
2362	567	10/13/2021	117
2364	525	10/12/2021	201
2365	550	10/13/2021	338

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

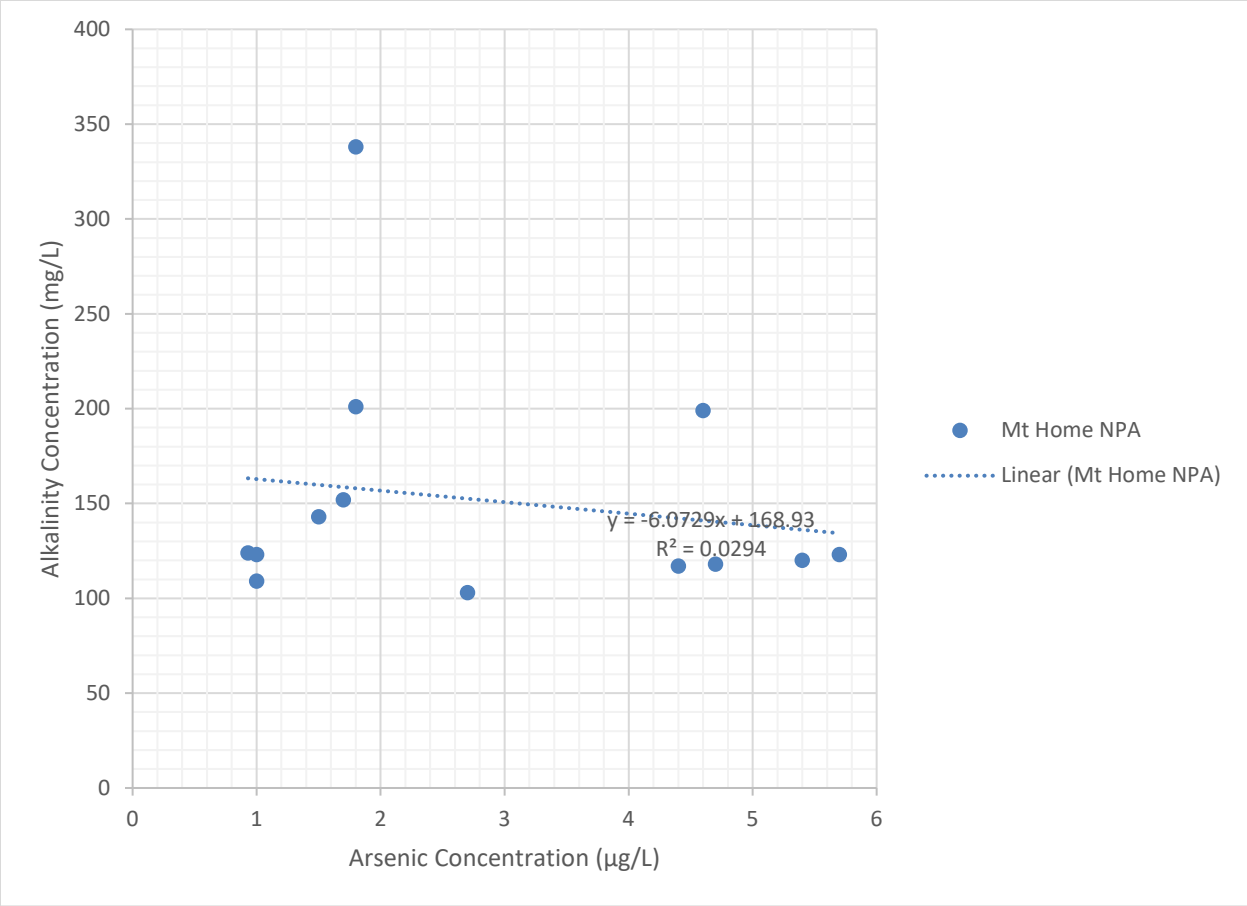


Figure 29. Linear regression of arsenic versus alkalinity—Mountain Home NPA Groundwater Monitoring Project.

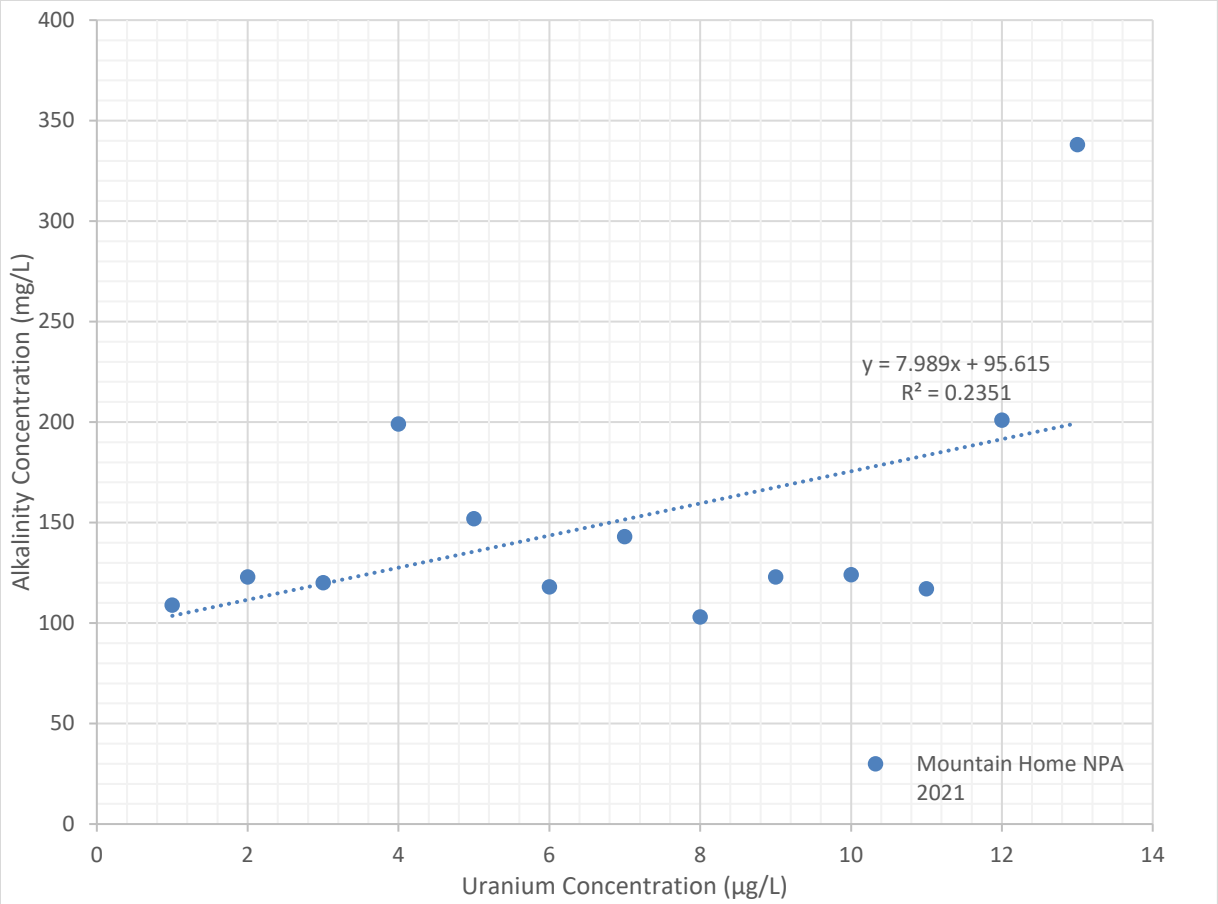


Figure 30. Linear regression of uranium versus alkalinity—Mountain Home NPA Groundwater Monitoring Project.

2.1.5.3 Conclusions

Three of the 13 wells sampled (23%) in the Mountain Home NPA had nitrate concentrations greater than or equal to 5 mg/L.

None of the 13 wells sampled in the Mountain Home NPA contained arsenic or uranium at or above their respective MCL.

One well had a detection of TC. No wells had *E. coli* detections.

2.1.5.4 Recommendations

It is recommended that the Mountain Home NPA boundaries be reevaluated during the next scheduled NPA evaluation.

Based on the 2021 sampling results, arsenic, alkalinity, and uranium do not warrant more frequent follow-up sampling.

DEQ will repeat the Mountain Home NPA sampling in 2024.

2.1.6 Northeast Star Nitrate Priority Area Regional Groundwater Monitoring

2.1.6.1 Purpose and Background

This groundwater monitoring project evaluated the water quality and nitrate concentrations in the Northeast Star NPA in Ada County, northeast of Star, Idaho.

In 2020, the Northeast Star NPA was ranked the most impacted NPA with an increasing trend (DEQ 2020a).

The Northeast Star NPA is located north of the Boise River in Ada County, Idaho. It is north of the Treasure Valley aquifer and directly south of the north boundary of the WSRP aquifer, in the Basin and Range Province, in southwest Idaho.

The WSRP basin is composed of Tertiary rhyolites and basalts overlain by Miocene to Quaternary fluvial-lacustrine sediments and volcanics of the Idaho Group (Shervais et al. 2002, and Newton 1991). Idaho Group sediments are generally characterized by course gravel and sand of alluvial fans, silt deltaic deposits, clay lacustrine deposits, and intercalated layers of volcanic ash and basalt. Sediments become finer from east to west and from the basin margins toward the center (Newton 1991).

The project area contains two aquifers: a shallow system composed of older terrace gravels, younger terrace gravels, and recent finer-grained alluvial deposits and a deeper system thought to be part of the Tertiary Glenns Ferry Formation of the Idaho Group (Howarth 1999; Bahr et al. 2000). The two systems are separated by a characteristic clay layer that ranges in thickness from 10 to 20 feet (Howarth 1999). A review of the available well logs of sampled wells shows that a clay layer is located at various depths throughout the project area, ranging from 18 to 105 ft bgs. This clay, locally identified by well drillers as “blue clay,” is often present in various thicknesses and elevations throughout the central and western Boise River valley. The clay forms confining units that can separate shallow aquifers from deeper zones (Petrich and Urban 2004). Groundwater flow direction across the Northeast Star NPA trends west-southwest toward the Snake River and Idaho-Oregon state boundary and slightly south to the Boise River (Newton 1991) (Figure 31).

The predominant land use in the Northeast Star NPA is a mix of agriculture and residential. The city of Star is currently undergoing a rise in residential building with the Star PWS adding new city utilities for new homes. Several of the wells previously sampled in the Northeast Star NPA are in areas that have been rezoned for subdivisions and the wells are no longer active.

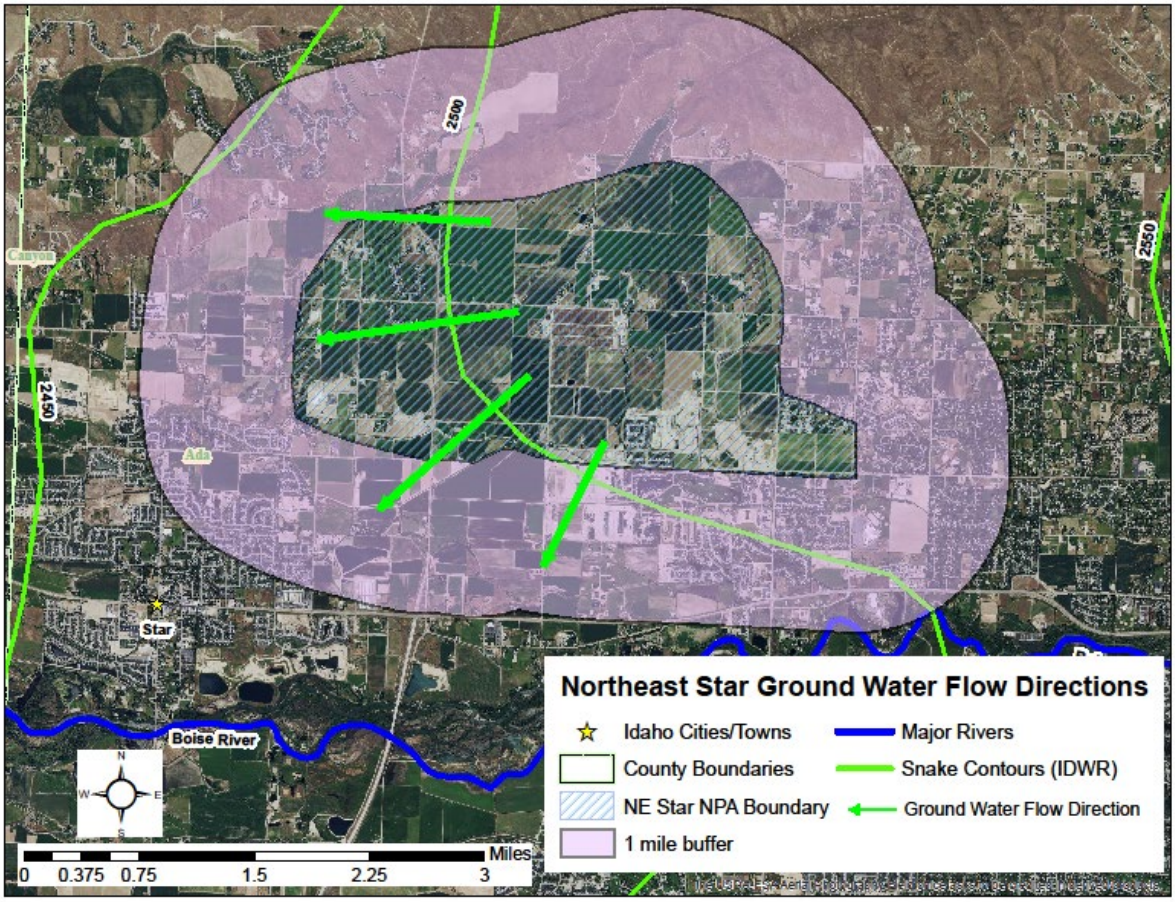


Figure 31. Groundwater contours and elevations—Northeast Star NPA Groundwater Monitoring Project.

2.1.6.2 Methods and Results

In 2021, DEQ collected groundwater samples from a combination of 19 domestic and irrigation wells in the Northeast Star NPA using procedures outlined in the Boise Regional NPA Ground Water Monitoring QAPP (DEQ 2021a). Program objectives, design, and well selection processes are identified in the Regional Network Design (DEQ 2018a).

DEQ identified 27 wells within the 2021 Northeast Star NPA boundary and 1 mile buffer that met the criteria of the Regional Network Design. DEQ received permission to sample 19 wells. Of the 19 wells, nine were previously sampled by DEQ in 2015. DEQ also sampled six of 13 wells that had been sampled in 2010 and 2015.

DEQ analyzed the groundwater samples for nitrate, nitrite, uranium, arsenic, alkalinity, bacteria, and isotopes of nitrogen to assess water quality in the project area. All samples were sent to the Idaho Bureau of Laboratories except for the nitrogen isotope samples that were sent to the University of Arizona Laboratory.

Water quality field parameters (i.e., pH, temperature, specific conductivity, and DO) were measured at each well before sample collection to ensure samples collected were representative of the aquifer (Table 35).

Table 35. Water quality field parameters—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
1153	66	09/15/2021	17.44	168	6.93	3.85
1155	38	09/15/2021	16.49	258	*5.49*	2.16
1156	110	09/15/2021	14.87	376	*5.81*	3.77
1157	144	09/15/2021	15.03	316	*6.18*	4.48
1158	79	09/15/2021	15.58	362	*6.27*	4.51
1160	98	09/15/2021	14.52	700	6.64	4.72
1167	50	09/16/2021	13.56	539	7.03	4.25
2473	105	09/16/2021	13.82	558	7.09	4.45
2474	110	09/16/2021	16.65	526	7.01	3.64
3107	44	09/16/2021	14.53	533	6.94	4.78
3108	103	09/16/2021	14.82	535	7.11	5.25
3109	87	09/16/2021	14.36	590	7.09	3.90
3111	98	09/16/2021	15.27	295	7.71	5.71
3112	112	09/15/2021	15.34	258	6.52	4.93
3113	75	09/15/2021	14.13	437	*6.49*	5.02
3114	63	09/15/2021	15.52	327	*6.46*	5.34
3115	101	09/16/2021	14.13	455	7.37	5.53
3116	90	09/16/2021	15.04	666	6.91	4.38
3117	102	09/15/2021	14.67	272	6.55	4.91

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter. Italicized, gray shaded numbers indicate an EPA National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Secondary Drinking Water Regulation standard. The NSDWR for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

2.1.6.2.1 Nutrient and Nitrogen Isotope Results

Nutrient and nitrogen isotope results for the Northeast Star NPA are presented in Table 36. Five out of 19 wells (26%) had nitrate concentrations greater than half the MCL of 10 mg/L (1160, 3113, 3109, 3116, and 3107). Three wells had nitrate concentrations exceeding the MCL (1160, 3109, and 3116). The 14 remaining wells had concentrations less than half the MCL (Table 36).

Wells 3107, 3108, 3109, 3111, 3112, 3114, 3115, 3116, and 3117 were sampled for the first time in 2021.

Figure 32 shows the location of the wells that were sampled and the nitrate concentrations for each well.

Nitrogen isotope samples were collected from the five wells with nitrate concentrations of 5 mg/L or more (Table 36). The isotope ratios for Wells 1160, 3113, 3109, 3116, and 3107 were between 4.6‰ and 6.4‰ indicating that the nitrate in the soil was likely from a mixed or mixed organic source (Seiler 1996; Table 3).

Table 36. 2021 nutrient and nitrogen isotope results—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration		Isotopes
			Nitrite[a]	Nitrate[a]	$\delta^{15}N$
			(mg/L)		(‰)
Water Quality Standard:			**1.0**	**10**	**No Standard**
1153	66	09/15/2021	<0.30	0.090J[b]	—
1155	38	09/15/2021	<0.30	2.01	—
1156	110	09/15/2021	<0.30	2.83	—
1157	144	09/15/2021	<0.30	3.20	—
1158	79	09/15/2021	<0.30	2.41	—
1160	98	09/15/2021	<0.30	**16.4**	4.6
1167	50	09/16/2021	<0.30	2.66	—
2473	105	09/16/2021	<0.30	2.57	—
2474	110	09/16/2021	<0.30	2.57	—
3107	44	09/16/2021	<0.30	5.22	6.4
3108	103	09/16/2021	<0.30	1.19	—
3109	87	09/16/2021	<0.30	**12.0**	5.3
3111	98	09/16/2021	<0.30	0.61	—
3112	112	09/15/2021	<0.30	2.37	—
3113	75	09/15/2021	<0.30	8.84	5.1
3114	63	09/15/2021	<0.30	2.60	—
3115	101	09/16/2021	<0.30	1.99	—
3116	90	09/16/2021	<0.30	**17.7**	6.0
3117	102	09/15/2021	<0.30	2.12	—

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; ‰ = permil; (—) = Not Analyzed; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Ground Water Quality Rule standard currently established. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

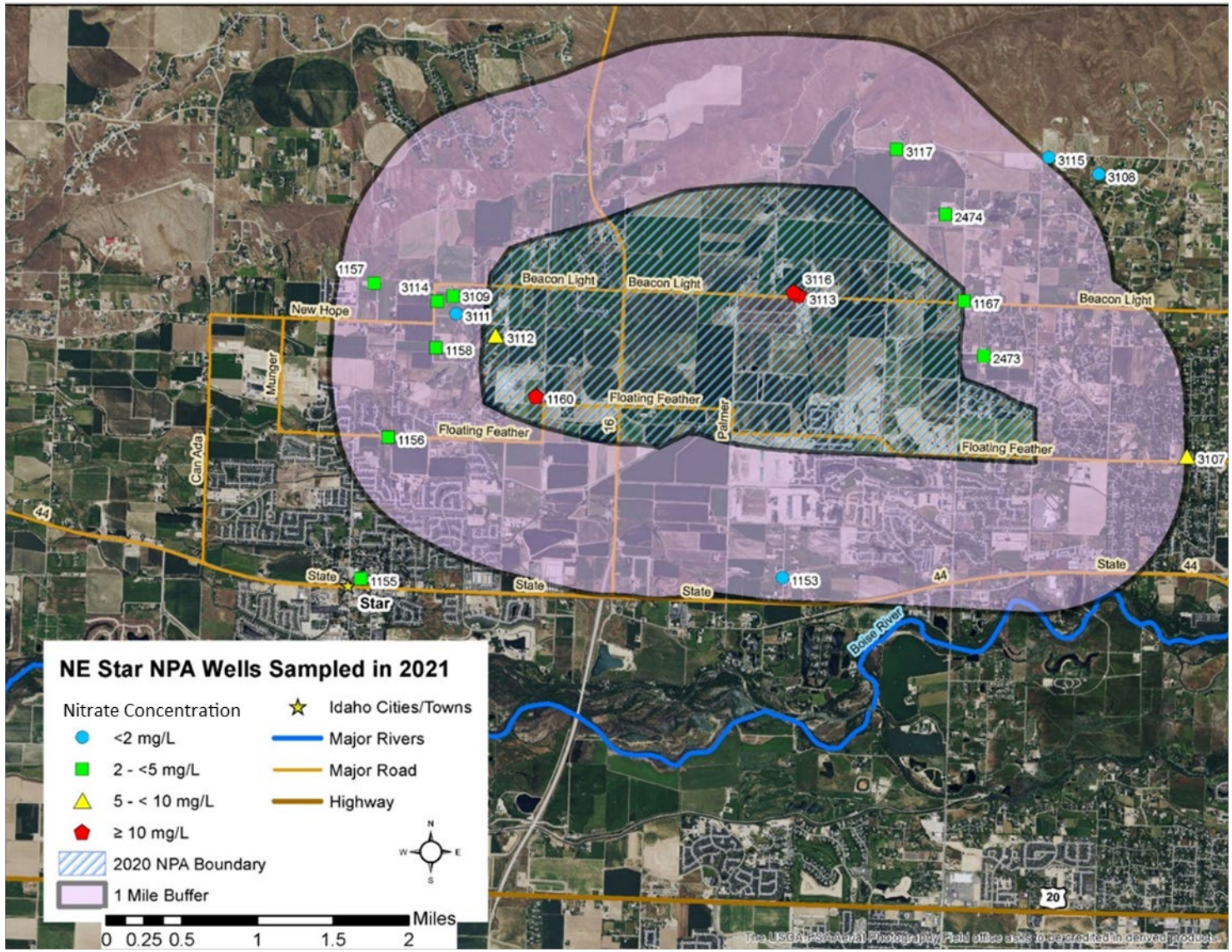


Figure 32. 2021 sample locations and nitrate concentrations—Northeast Star NPA Groundwater Monitoring Project.

Eight of the 19 wells sampled in 2021 were previously sampled in 2015 (Table 37). Wells 1156, 1157, 1160, 1167, and 2473 had small increases in nitrate concentrations. There were no noticeable changes near the wells. However, since the initial sampling of Well 1160 in 2010, the nitrate concentration has nearly doubled from 8.9 mg/L.

Wells 1153, 1155, 1158, and 2474 had small decreases in the nitrate concentrations. There were no noticeable changes near the wells. Well depth does not appear to be a factor in the increase or decrease of nitrate concentrations in the wells tested in the Northeast Star NPA.

A map showing the areas of change is found in Figure 33.

Table 37. Comparison of 2015 and 2021 nitrate results—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Nitrate Concentrations		Change in Concentration
		Nitrate 2015	Nitrate[a] 2021	
		(mg/L)		
Water Quality Standard:		**10**	**10**	
1153[b]	71	—	0.0903J[c]	—
1155	38	3.4	2.01	-1.39
1156	110	2.6	2.83	0.23
1157	144	2.9	3.20	0.3
1158	79	2.9	2.41	-0.49
1160	98	**16**	**16.4**	0.4
1167	50	2.5	2.66	0.16
2473	105	2.4	2.57	0.17
2474	110	2.7	2.57	-0.13

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; (—) = Not Analyzed. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Last sampled in 2010.
c. Data qualified with a J flag is an estimated value.

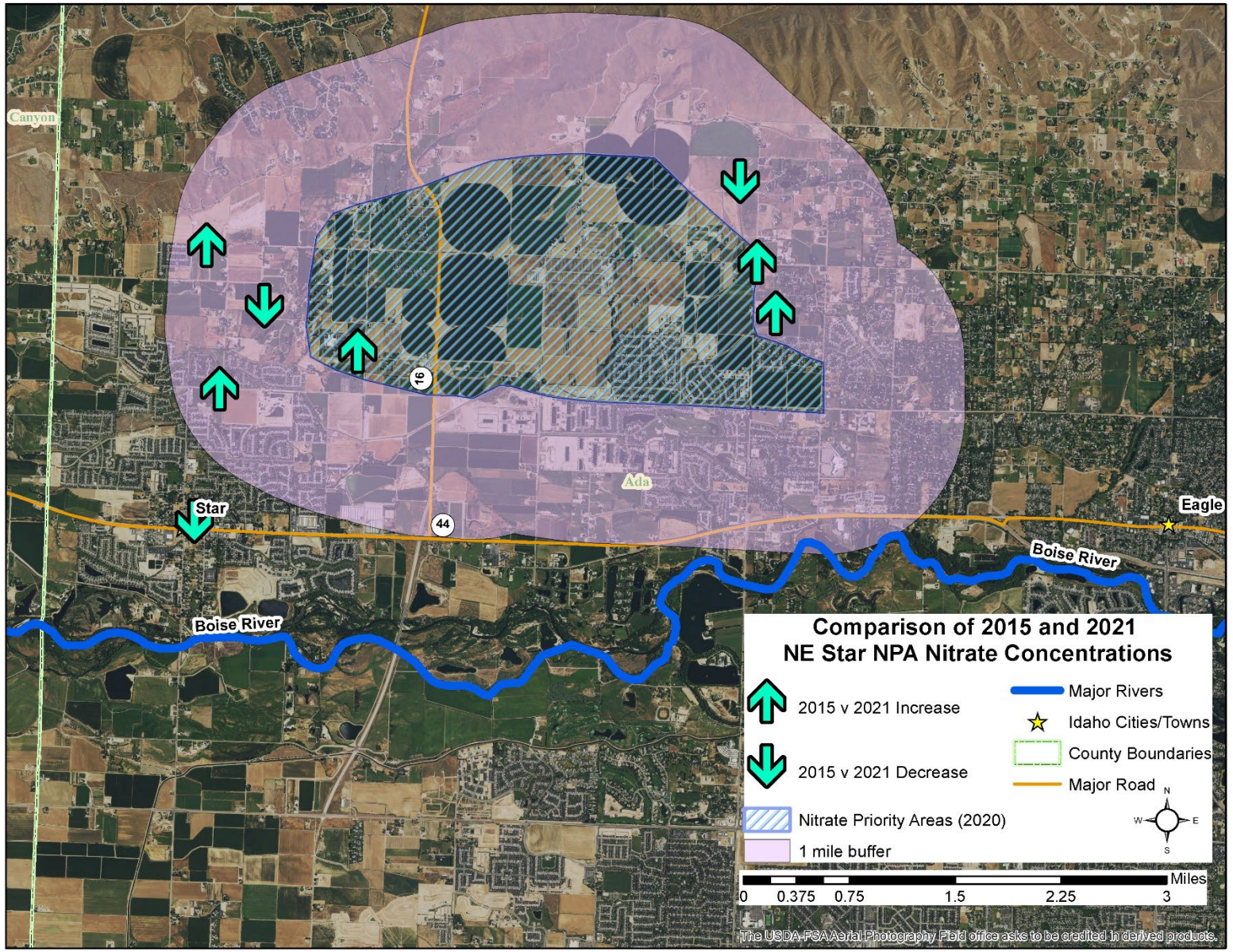


Figure 33. Sample sites nitrate concentration comparison 2015 and 2021—Northeast Star NPA Groundwater Monitoring Project.

DEQ began sampling the Northeast Star NPA in October 2010. DEQ has 11 years of sampling data from seven wells in the Northeast Star NPA (Table 38).

Table 38. Comparison of sample results from 2010 to 2021—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Depth (ft bgs)	2010 Nitrate[a]	2015 Nitrate[a] (mg/L)	2021 Nitrate[a]
Water Quality Standard			**10**	
1153	71	0.092	—	0.0903J[b]
1155	38	3.3	3.4	2.01
1156	110	2.2	2.6	2.83
1157	144	3.8	2.9	3.2
1158	79	1.7	2.9	2.41
1160	98	8.9	**16**	**16.4**
1167	50	3	2.5	2.66

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; (—) = not analyzed. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.
b. Data qualified with a J flag is an estimated value.

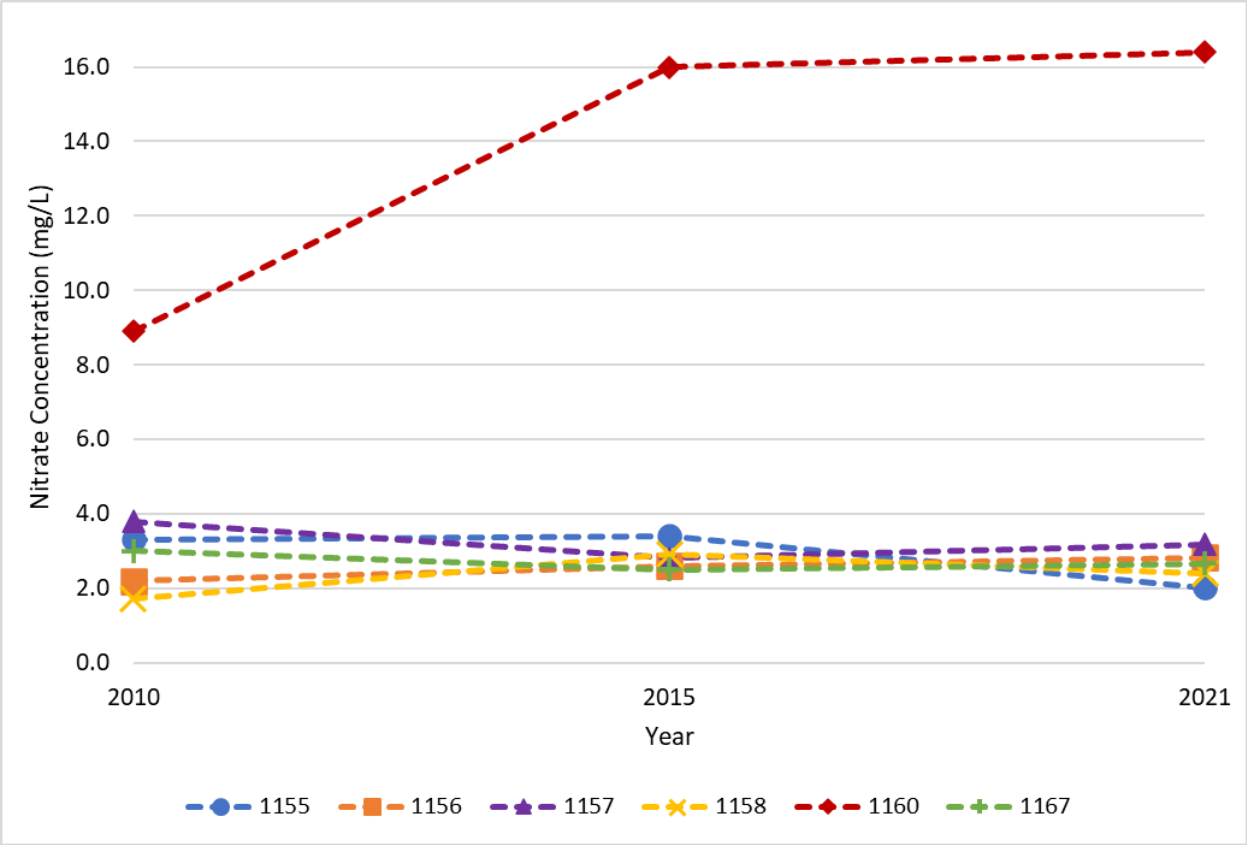


Figure 34. Graph of nitrate concentrations through three sampling events in Northeast Star NPA.

The nitrate concentrations for Wells 1155, 1156, 1157, 1158, and 1657 have varied little between the first Northeast Star NPA sampling event in 2010 and the most recent sampling event in 2021 (Figure 34). The nitrate concentration for Well 1160 almost doubled between the sampling event in 2010 and the sampling event in 2015. The isotope ratio samples for Well 1160 have remained fairly steady at 4.4‰ to 4.8‰. The area around Well 1160 was cropland until development started in 2019, so it is possible the nitrates are coming from a mixture of commercial fertilizer and organic matter.

2.1.6.2.2 Bacteria Results

Bacterial results are presented in Table 39. Wells 1160, 3113, 3117, and 3115 had detections for TC. No wells had *E. coli* detections (Table 39). Wells 3113, 3117, and 3115 were sampled for the first time in 2021 and no historical data is available.

Well 1160 was sampled in 2015 and at that time TC was not present in the sample.

Table 39. 2021 bacteria results—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1**	**1.0**
1153	66	09/15/2021	<1.0	<1.0
1155	38	09/15/2021	<1.0	<1.0
1156	110	09/15/2021	<1.0	<1.0
1157	144	09/15/2021	<1.0	<1.0
1158	79	09/15/2021	<1.0	<1.0
1160	98	09/15/2021	<1.0	2.0
1167	50	09/16/2021	<1.0	<1.0
2473	105	09/16/2021	<1.0	<1.0
2474	110	09/16/2021	<1.0	<1.0
3107	44	09/16/2021	<1.0	<1.0
3108	103	09/16/2021	<1.0	<1.0
3109	87	09/16/2021	<1.0	<1.0
3111	98	09/16/2021	<1.0	<1.0
3112	112	09/15/2021	<1.0	<1.0
3113	75	09/15/2021	<1.0	2.0
3114	63	09/15/2021	<1.0	<1.0
3115	101	09/16/2021	<1.0	4.0
3116	90	09/16/2021	<1.0	<1.0
3117	102	09/15/2021	<1.0	2.0

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.1.6.2.3 Arsenic and Uranium Results

Six out of 19 wells had arsenic concentrations over the MCL with a range from 14 µg/L to 26 µg/L. The remaining 13 wells had results below EPA's MCL (Table 40). Arsenic was not previously evaluated by DEQ in the Northeast Star NPA, so no historical data is available for comparison.

The locations and arsenic concentration ranges for the wells sampled in the Northeast Star NPA are shown in Figure 35.

Table 40. 2021 arsenic results—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Arsenic[a] (µg/L)
Water Quality Standard:			**10**
1153	66	09/15/2021	2.7
1155	38	09/15/2021	1.3
1156	110	09/15/2021	1.9
1157	144	09/15/2021	6.1
1158	79	09/15/2021	5.2
1160	98	09/15/2021	3.7
1167	50	09/16/2021	13
2473	105	09/16/2021	7.1
2474	110	09/16/2021	8.6
3107	44	09/16/2021	9.1
3108	103	09/16/2021	**17**
3109	87	09/16/2021	**14**
3111	98	09/16/2021	**20**
3112	112	09/15/2021	6.6
3113	75	09/15/2021	4.3
3114	63	09/15/2021	6.2
3115	101	09/16/2021	**26**
3116	90	09/16/2021	**14**
3117	102	09/15/2021	6.9

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

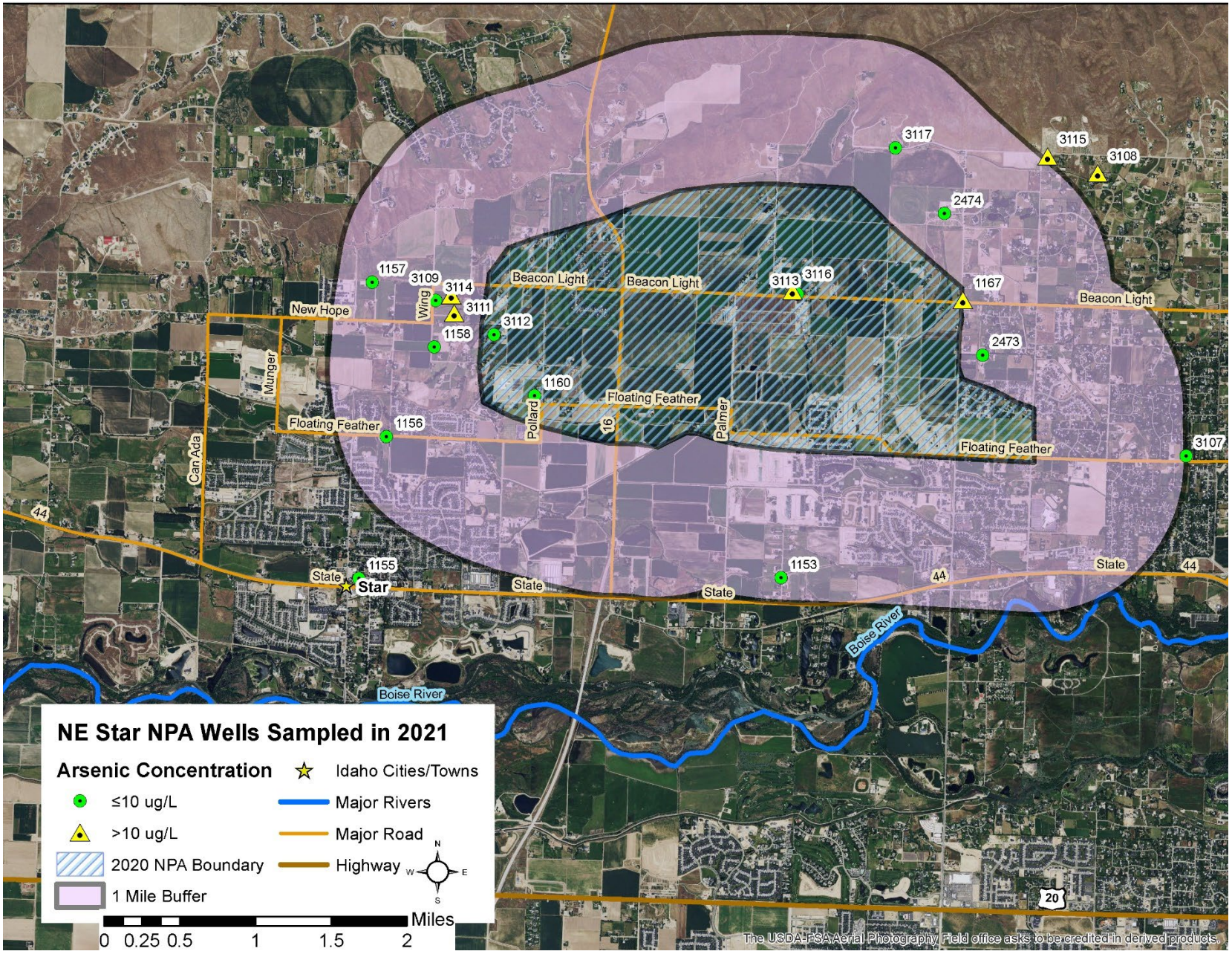


Figure 35. 2021 sample locations and arsenic concentrations—Northeast Star NPA Groundwater Monitoring Project.

Two out of 19 wells (1160 and 2724) had uranium concentrations at or above EPA's MCL of 30 µg/L (Table 41 and Figure 36). The remaining 17 wells sampled had uranium concentrations below the MCL with a range from 0.96 µg/L to 29 µg/L. Uranium was not previously evaluated by DEQ in the Northeast Star NPA, so no historical data is available for comparison. Linear regression trendlines were applied to both alkalinity versus arsenic (Figure 37) and alkalinity versus uranium (Figure 38) data sets. No relationship between alkalinity and arsenic or uranium was identified.

Table 41. 2021 uranium results—Northeast Star NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Uranium (µg/L)[a]
	Water Quality Standard:		**30**
1153	66	09/15/2021	1.2
1155	38	09/15/2021	0.96
1156	110	09/15/2021	5.0
1157	144	09/15/2021	3.0
1158	79	09/15/2021	4.2
1160	98	09/15/2021	**34**
1167	50	09/16/2021	14
2473	105	09/16/2021	29
2474	110	09/16/2021	**33**
3107	44	09/16/2021	20
3108	103	09/16/2021	17
3109	87	09/16/2021	4.0
3111	98	09/16/2021	20
3112	112	09/15/2021	1.3
3113	75	09/15/2021	2.7
3114	63	09/15/2021	1.9
3115	101	09/16/2021	21
3116	90	09/16/2021	4.5
3117	102	09/15/2021	1.4

Notes: ft bgs = feet below ground surface; µg/L = microgram per liter. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.

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

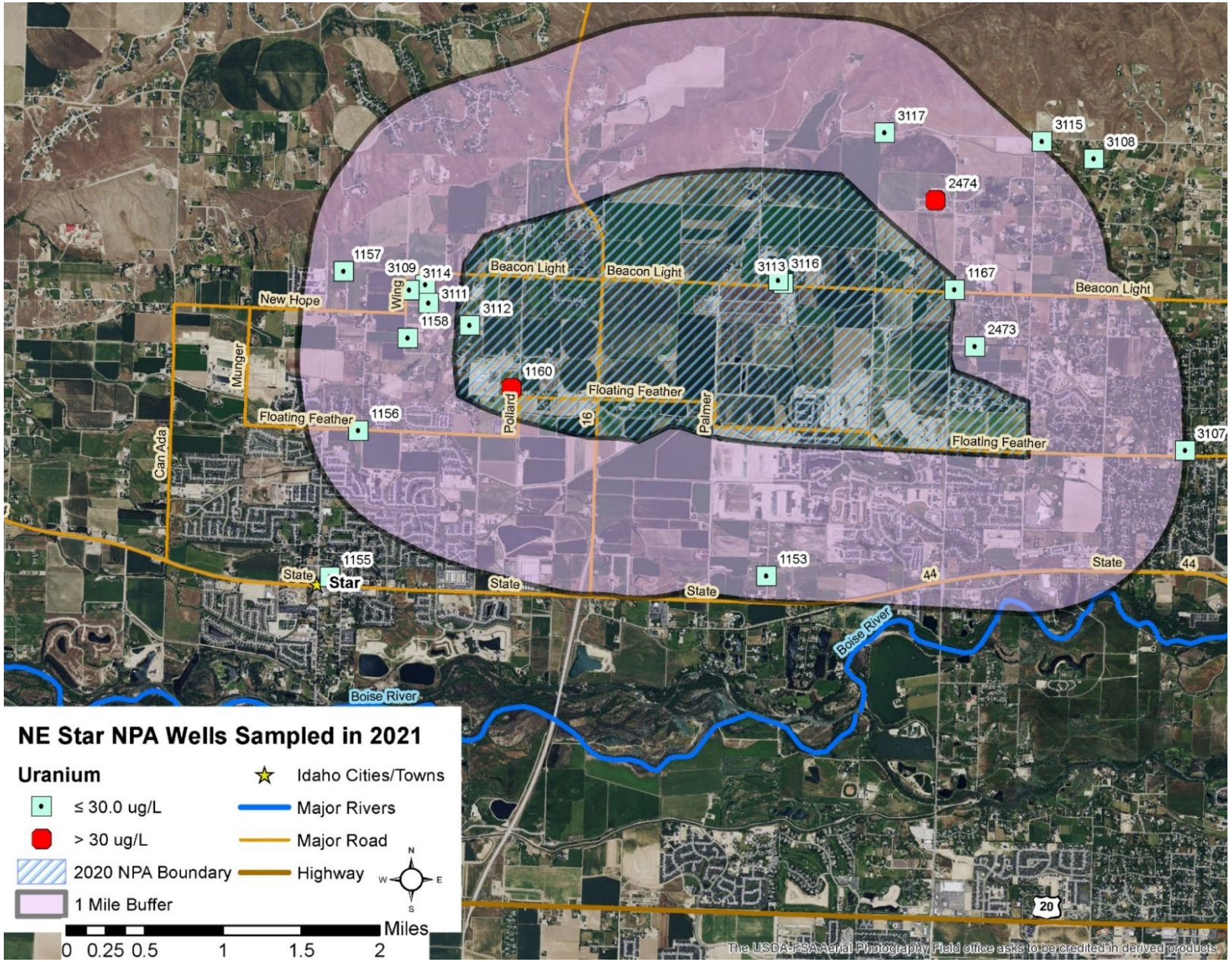


Figure 36. 2021 sample locations and uranium concentrations—Northeast Star NPA Groundwater Monitoring Project.

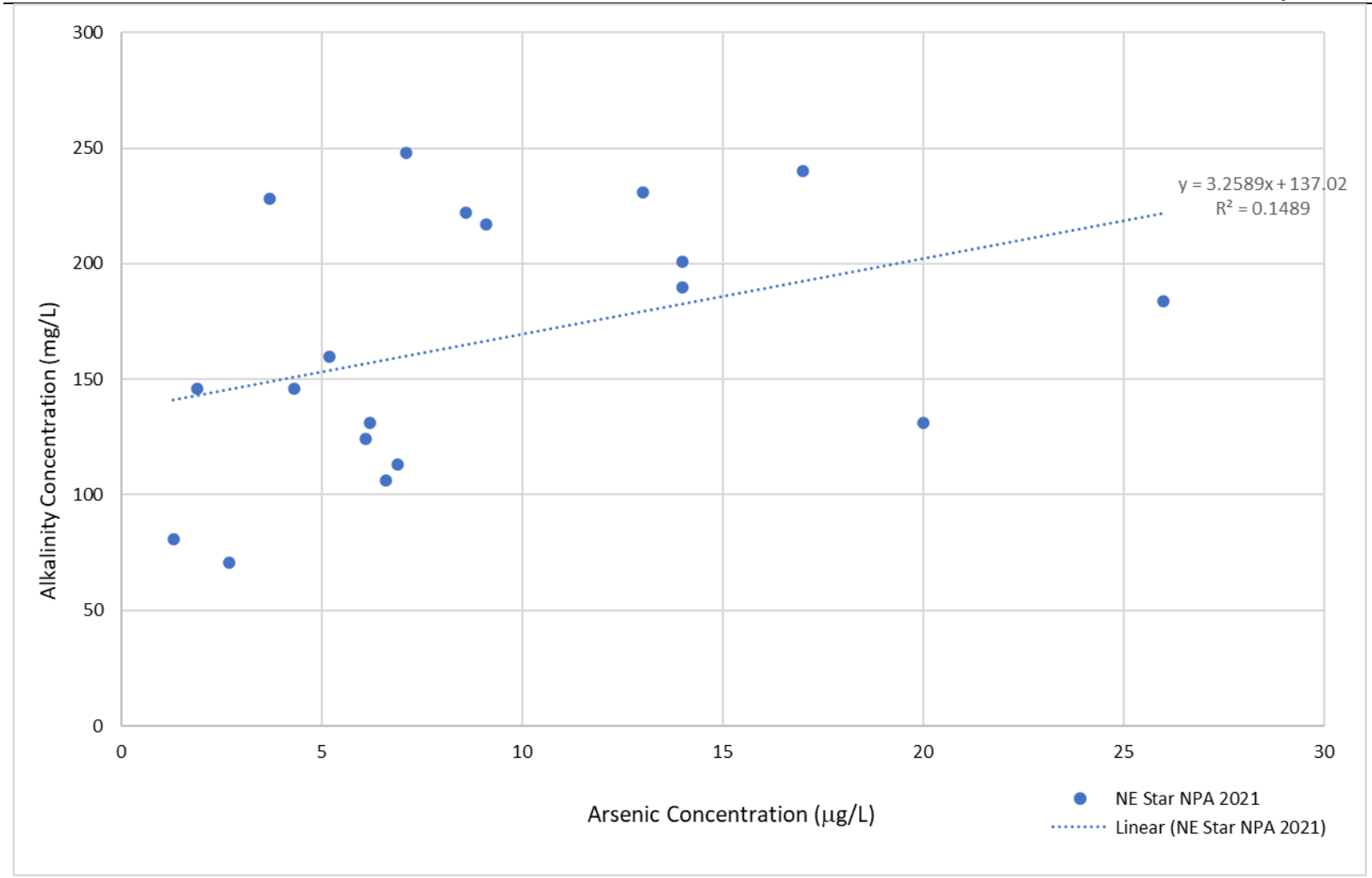


Figure 37. Linear regression of arsenic versus alkalinity—NE Star NPA Groundwater Monitoring Project.

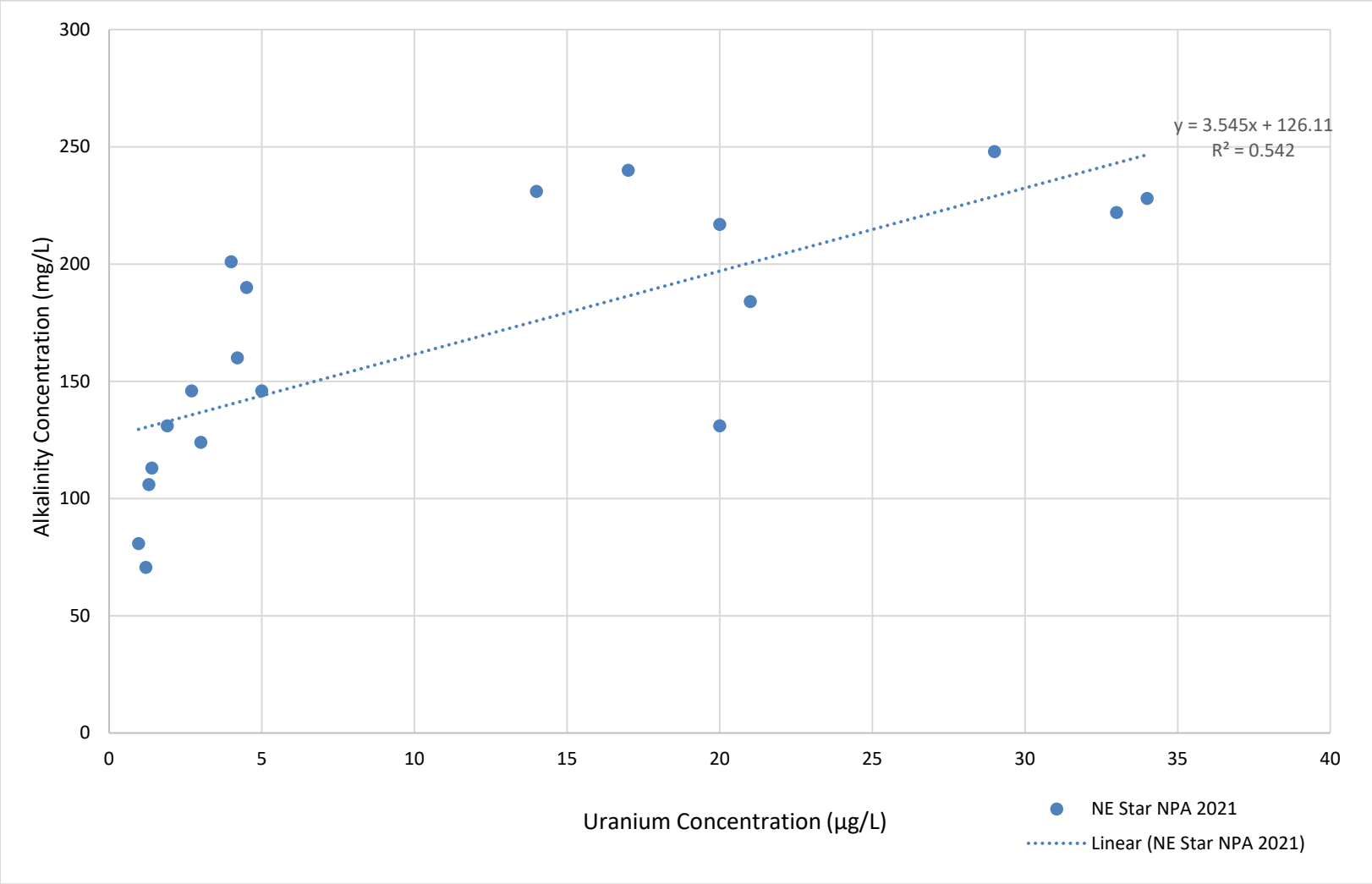


Figure 38. Linear regression of uranium versus alkalinity—NE Star NPA Groundwater Monitoring Project.

2.1.6.3 Conclusions

Five of the 19 wells sampled (26%) in the Northeast Star NPA had nitrate concentrations greater than or equal to 5 mg/L.

Wells 3116 and 3109 are located just north (up/side gradient) of a former 226+ acre feed lot that was active in 2015 but is now owned by developers. There are more than 200 acres of cropland located to the north (upgradient) of Wells 3116 and 3109.

Well 1160 was surrounded by cropland in 2000. A small building boom in 2005 added 10–15 houses on septic systems upgradient from Well 1160. The remaining area was farmland. In 2020, a large building boom added 50–100 houses or spaces for houses around Well 1160 on the north, east, and west. These new residences are connected to city utilities.

The three wells that had nitrate concentrations above the MCL had well depths between 87 and 98 ft bgs in a layer of sand or sand and gravel just above a thin blue clay layer. However, these same depths and lithologies apply to other wells in the Northeast Star NPA that had concentrations of 2 mg/L or less.

It appears the only common factor between Wells 1160, 3109, and 3116 is the history of agricultural activity on nearby properties.

Six of the 19 wells sampled had arsenic concentrations over the MCL with a range from 14 µg/L to 26 µg/L. The remaining 13 wells had sample results detected below the MCL. Alkalinity and location do not seem to affect the presence of arsenic over the MCL.

A review of the well drillers' reports for the area confirms the geologic composition is silt, sand, gravel, and clay. Deterioration of the silt, sand, gravel, and clay in the northeast Star area may contribute to the presence of arsenic in the wells tested for the Northeast Star NPA.

Two of the 19 wells sampled had uranium concentrations above the MCL of 30 µg/L. The two wells are located on opposite sides of the Northeast Star NPA.

Neither depth nor alkalinity appear to be an explanation for the presence or variation of concentration of uranium in all 19 wells.

Four wells had detections for TC. No wells had *E. coli* detections. Well 1160 had TC present in the 2021 well sample, but not in the 2015 well sample.

2.1.6.4 Recommendations

The boundaries for the Northeast Star NPA will be reassessed during the next NPA evaluation. DEQ will repeat the northeast Star NPA sampling in 2025.

2.2 Pocatello Region

Two groundwater quality monitoring projects were conducted in the Pocatello region in 2021 using public funds.

2.2.1 Mink Creek Nitrate Priority Area Regional Groundwater Monitoring Project

2.2.1.1 Purpose and Background

The Mink Creek NPA groundwater monitoring project evaluated trends in groundwater nitrate concentrations in the Mink Creek area in Bannock County (Figure 39). The Mink Creek NPA was initially designated based on data collected in 2006, and those wells previously sampled were prioritized when selecting locations for the 2021 sampling.

Mink Creek is a tributary to the Portneuf River flowing from the Bannock Range just south of Pocatello. The lower 3.5 miles of the canyon has been developed for semirural, residential use with individual septic systems. The upper portion of the canyon is US Forest Service land with some livestock grazing. The valley floor consists of alluvial deposits overlying highly varied Tertiary volcanoclastic deposits and Cambrian and older, sedimentary, and metamorphic units that make up the flanks of the canyon (Rodgers and Othberg 1999). Most of the logs for wells situated on the valley floor indicate total depths between 100 and 200 feet and static water levels, at the time of drilling, ranging from 18 to 120 feet. These wells appear to have been completed in the alluvial valley fill aquifer. Groundwater recharge originating as precipitation over the Bannock Range, including that occurring in the Mink Creek basin, contributes an estimated 5.4 billion gallons per year to the Lower Portneuf Aquifer (Welhan 2006) and results in a general north to northeast groundwater flow direction along the axis of the developed portion of Mink Creek canyon to the confluence with the lower Portneuf Aquifer.

2.2.1.2 Methods and Results

A total of 12 sites were sampled in 2021 for the Mink Creek NPA groundwater monitoring project. Groundwater samples were collected from private domestic, irrigation, and livestock wells. The wells previously sampled were prioritized when selecting locations for the 2021 sampling event. Samples were submitted to the Idaho Bureau of Laboratories for analysis of concentrations of nitrate+nitrite and ammonia using methods 353.2 and 350.1, respectively, and to IAS Envirochem for determine TC and *E. coli* bacteria concentrations. All sampling was conducted in accordance with the quality assurance project plan (QAPP) (DEQ 2011a) and field sampling plan (FSP) (DEQ 2021b). Water quality field parameters (i.e., pH, temperature, specific conductance, and DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 42).

Because of the nature of the plumbing associated with irrigation Well 3121, it was not possible to collect field parameter data or a bacteria sample. Nutrients were sampled at Well 3121 following a 1-hour purge.

Table 42. Water quality field parameters—Mink Creek NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
3001	Unk	09/07/2021	10.48	599	7.17	3.35
3004	Unk	09/08/2021	11.87	1250	7.10	7.83
3005	101	09/14/2021	12.01	1720	7.08	7.51
3007	Unk	09/07/2021	13.78	964	7.08	8.23
3008	Unk	09/08/2021	16.71	1050	7.40	3.72
3011	Unk	09/15/2021	13.26	1670	7.13	9.92
3012	Unk	09/13/2021	13.29	1400	7.12	7.33
3017	168	09/07/2021	15.29	652	7.26	9.72
3018	Unk	09/13/2021	15.07	412	7.42	7.58
3019	Unk	09/13/2021	14.35	779	7.15	9.57
3120	300	09/14/2021	15.61	469	7.38	0.62

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

2.2.1.2.1 Nutrient Results

Nitrate+nitrite concentrations ranged from below the detection limit to 13 mg/L (Table 43 and Figure 39). The nitrate MCL of 10 mg/L was exceeded in three of the 12 wells sampled. Nitrate+nitrite concentrations were ≥5 mg/L (one-half the nitrate MCL) in four of 12 wells sampled. No ammonia was detected in any of the wells.

Table 43. 2021 nutrient results—Mink Creek NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate+Nitrite[a] (mg/L)	Ammonia (mg/L)
Water Quality Standard:			**10**	**No Stand.**
3001	Unk	09/07/2021	0.24	<0.050
3004	Unk	09/08/2021	**13**	<0.050
3005	101	09/14/2021	**12**	<0.050
3007	Unk	09/07/2021	4.0	<0.050
3008	Unk	09/08/2021	0.87	<0.050
3011	Unk	09/15/2021	**12**	<0.050
3012	Unk	09/13/2021	8.6	<0.050
3017	168	09/07/2021	1.3	<0.050
3018	Unk	09/13/2021	0.46	<0.050
3019	Unk	09/13/2021	2.8	<0.050
3120	300	09/14/2021	0.0060	<0.050
3121	Unk	09/08/2021	<0.010	<0.050

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate+Nitrite[a] (mg/L)	Ammonia (mg/L)

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. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Primary Drinking Water Regulation standard.

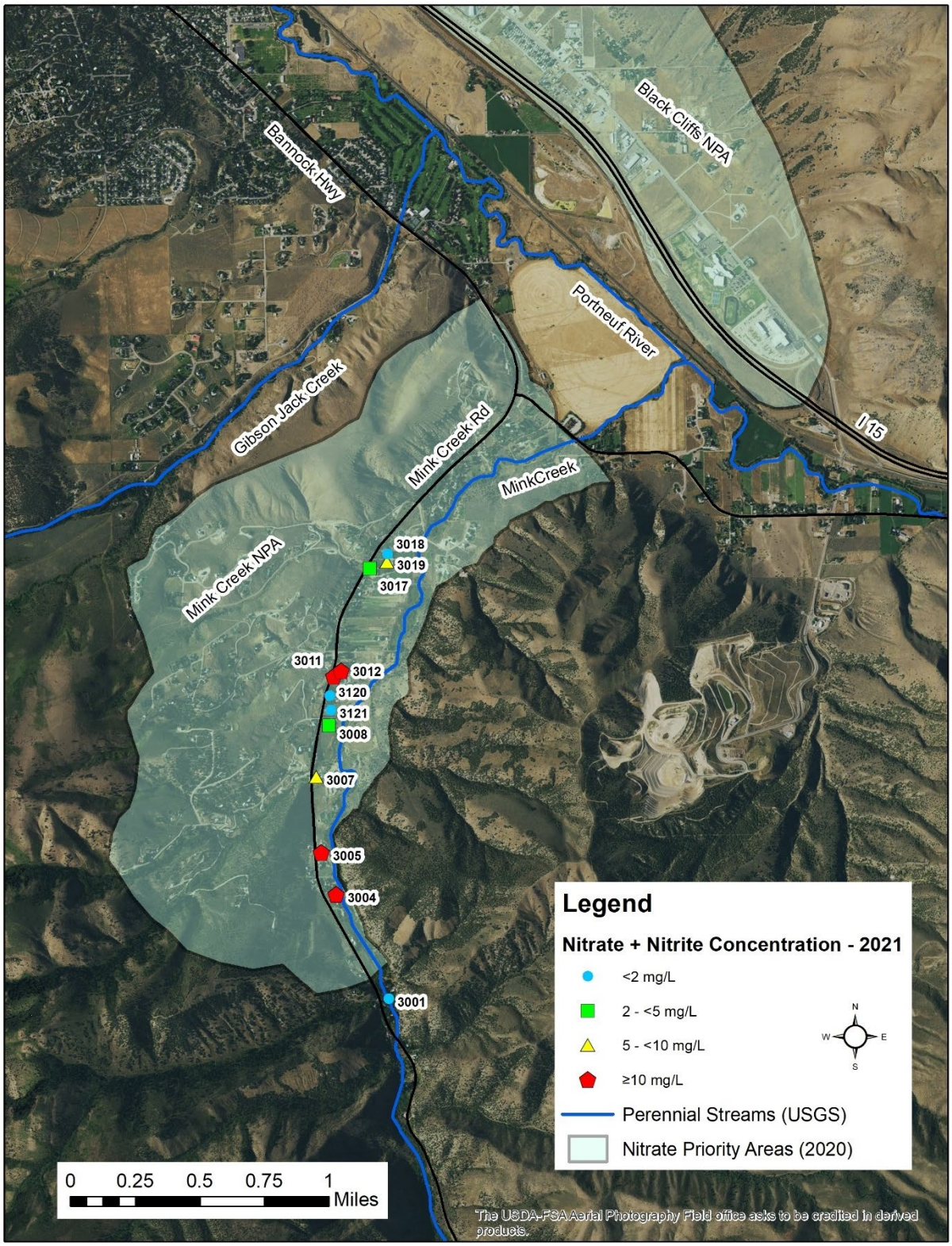


Figure 39. 2021 nitrate concentration results—Mink Creek NPA Groundwater Monitoring Project.

2.2.1.2.2 Bacteria Results

Two of the wells had positive detections of TC bacteria, with concentrations of 4.1 and 47.9 MPN/100 mL. No *E. coli* were detected in any of the wells (Table 44).

Well 3004 had an ultraviolet bacterial filter in place that prevented reporting of representative bacterial data.

Table 44. 2021 bacteria results—Mink Creek NPA Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1**	**1.0**
3001	Unk	09/07/2021	<1.0	<1.0
3005	101	09/14/2021	<1.0	<1.0
3007	Unk	09/07/2021	<1.0	<1.0
3008	Unk	09/08/2021	<1.0	<1.0
3011	Unk	09/15/2021	<1.0	48
3012	Unk	09/13/2021	<1.0	4.1
3017	168	09/07/2021	<1.0	<1.0
3018	Unk	09/13/2021	<1.0	<1.0
3019	Unk	09/13/2021	<1.0	<1.0
3120	300	09/14/2021	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.2.1.3 Conclusions

The 2021 Mink Creek NPA groundwater monitoring project evaluated nutrient concentrations in 12 wells and bacterial concentrations in 10 wells in the area. The nitrate MCL of 10 mg/L was exceeded in three of the 12 wells, with one well exceeding 5 mg/L (one-half the nitrate MCL). Groundwater samples from two wells indicated the presence of TC bacteria. No ammonia or *E. coli* were detected in any of the sampled wells.

2.2.1.4 Recommendations

The data collected through this project provide a reference for future sampling. Additional sampling locations will be identified to assess the concentration of contaminants at those locations and further evaluate groundwater conditions and trends. Additional sampling in the Mink Creek NPA was conducted in 2022 and will be reported in future reports.

2.2.2 Ethylene Dibromide Assessment Project

2.2.2.1 Purpose and Background

This project is a follow up assessment of an area of known ethylene dibromide (EDB), also known as 1, 2 Dibromoethane, contamination in Bannock and Power Counties, north and west of Chubbuck, Idaho (DeJongh 1996; Safford 2005). Dibromochloropropane (DBCP), a soil fumigant formerly used in agriculture, was also included in the analyses. This sampling effort assessed the current state of EDB contamination, south of Reservation Road and east of Laughran/Tank Farm Road (Figure 40). The data will provide guidance for future sampling. No synoptic sampling of the wells off the Fort Hall Indian Reservation has been conducted since 2005, and potentially impacted residents may be unaware of the current state of groundwater contamination in the area.

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

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

EDB is considered a dense nonaqueous phase liquid and apparent concentrations of this relatively insoluble compound can be affected by the length and position of the screened interval within a well and samples from adjacent wells may indicate significantly different levels of contamination, potentially interfering with characterization of the plume. The volatility of the compound makes collecting a representative sample more difficult, and the low drinking water standard makes sampling by the well owner generally unadvisable. Residents in the impacted area depend on DEQ for reliable information about their potential exposure to this compound.

The study area is in southeast Idaho. The Fort Hall Indian Reservation borders the area to the north and west. Land use is semirural residential surrounded by agricultural uses; heavy industrial areas are located to the southwest.

Two primary aquifers exist in the study area. The shallower aquifer is composed of sand and gravel (Michaud Gravel), whereas the deeper aquifer is in the Eastern Snake River Plain (ESRP) basalt. For wells used in the 2005 study, driller's logs indicate that sand and gravel wells are drilled to depths between 65 ft bgs and 186 ft bgs, and basalt wells are drilled to depths between 160 ft bgs and 204 ft bgs. Mean depth to groundwater is 64.82 feet (Safford 2005). Groundwater flow in the area is generally to the southwest (Parliman and Young 1992). The previous EDB studies in the area found the presence of the compound in both the upper alluvial and lower basalt aquifers.

2.2.2.2 Methods and Results

The 2021 sampling campaign focused on the area south and east of the reservation boundary, in which EDB has been previously detected. To inform additional groundwater users and expand the data set for the extent of contamination, sampling locations were primarily selected from those wells that had not been previously sampled. A total of nine sites were sampled in 2021 for EDB and DBCP. Samples were sent to Intermountain Analytical Services EnviroChem for analysis. The resultant data will provide guidance for additional sampling and subsequent data collection efforts. All sampling was conducted in accordance with the project QAPP (DEQ 2011a) and the FSP (DEQ 2018b); however, one cooler containing five samples was delayed during shipping and arrived at the laboratory at a temperature above acceptable limits. Results from those five samples were rejected as part of the data validation process.

Water quality field parameters (i.e., pH, temperature, specific conductance, and DO) were measured before sample collection to ensure adequate purging of the well for a representative sample of the local aquifer (Table 45).

Table 45. Water quality field parameters—Ethylene Dibromide Assessment Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
3102	Unk	08/30/2021	14.31	661	7.46	7.15
3102	Unk	08/30/2021	14.31	664	7.47	6.38
3103	140	08/31/2021	14.63	721	7.34	6.50
3104	140	08/30/2021	15.70	605	7.33	6.72
3105	140	08/31/2021	15.15	611	7.35	7.33
3106	Unk	08/31/2021	14.84	634	7.37	8.22
3118	Unk	08/30/2021	17.20	763	7.30	7.44
3119	154	09/01/2021	13.01	554	7.76	5.22
3122	158	09/01/2021	12.64	676	7.58	5.78

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)

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

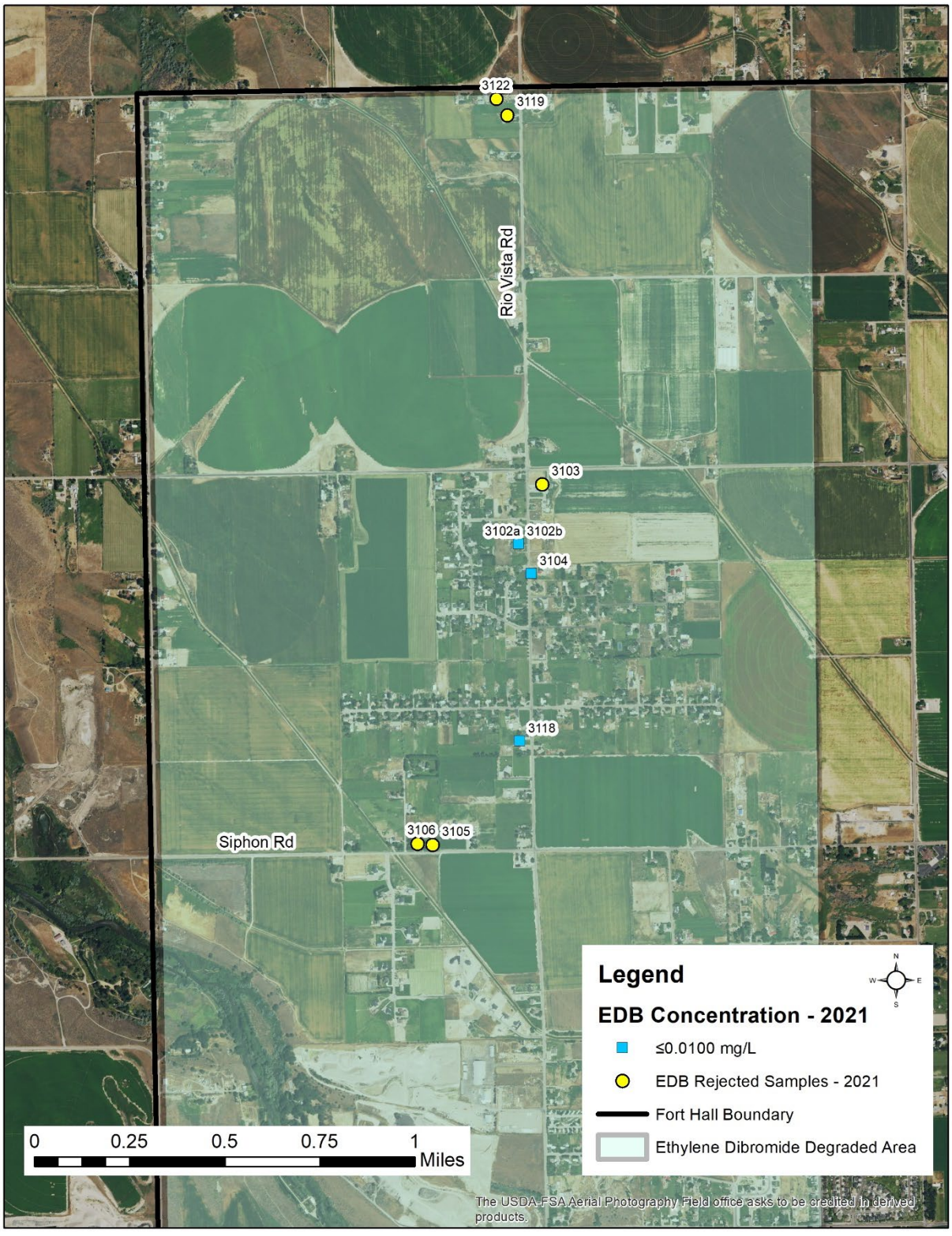


Figure 40. 2021 ethylene dibromide sample results—Ethylene Dibromide Assessment Groundwater Monitoring Project.

EDB and DBCP Results

EDB and DBCP results are presented in Table 46. None of the sites had detections of either EDB or DBCP. Five of the samples were rejected during the data validation process due to a temperature exceedance during shipment. Of those five locations, one site (Well 3103) had been sampled previously in 2004 with no EDB or DBCP detected.

Table 46. 2021 VOC results—Ethylene dibromide Assessment Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Dibromochloropropane (DBCP) (µg/L)[A]	Dibromoethane,1,2- (EDB) (µg/L)[A]
Water Quality Standard:			**0.2**	**0.05**
3102	Unk	08/30/2021	<0.0200	<0.0100
3102	Unk	08/30/2021	<0.0200	<0.0100
3103	140	08/31/2021	R	R
3104	140	08/30/2021	<0.0200	<0.0100
3105	140	08/31/2021	R	R
3106	Unk	08/31/2021	R	R
3118	Unk	08/30/2021	<0.0200	<0.0100
3119	154	09/01/2021	R	R
3122	158	09/01/2021	R	R

Notes: µg/L = microgram per liter; Unk = Unknown. Well log not found; R = rejected by the data validator. Results are not usable as detects or nondects for any purpose due to a QA/QC exceedance or equipment malfunction.
a. Contaminant with a National Primary Drinking Water Regulation standard.

2.2.2.3 Conclusions

There were no detections of EDB or DBCP in any of the wells. Property owners and residents were advised of the concentration of EDB and DBCP in their water source. Well owners for the five rejected samples were advised of the circumstances and notified that DEQ would resample in 2022. The 2022 sample results will be reported in the 2022 annual report.

2.2.2.4 Recommendations

The data collected through this project provide a reference for future sampling. Additional sampling locations will be identified to further define the extent of the EDB plume and assess the concentration of the contaminant at those locations. To decrease the potential for exceeding sample method storage temperatures during sample transport, DEQ will use a different laboratory and shipping courier.

In future sampling, DEQ may evaluate the potential correlation between EDB concentration and well depth and consider whether the screened interval crosses the sand and gravel/basalt boundary. Residents in the impacted area continue to depend on DEQ for reliable information about their potential exposure to this compound, and continued monitoring of new and existing sampling locations will be required into the foreseeable future.

2.3 Idaho Falls Region

Three groundwater quality monitoring projects were conducted in the Idaho Falls region in 2021 using public funds.

2.3.1 Upper South Fork Snake River; Swan Valley Subarea Regional Groundwater Monitoring Project

2.3.1.1 Purpose and Background

The DEQ Idaho Falls region includes five regional monitoring subareas (Teton Basin/Ashton, ESRP, Mud Lake, Big Lost River, and Upper South Fork Snake River) based on land use and hydrogeologic boundaries to help identify impacts or changes to ambient groundwater quality. The process for identifying the regional subareas is described in the Regional Network Design (DEQ 2013b). Definitions for the specific subareas are summarized in *Idaho Falls Regional Office Ambient Ground Water Monitoring Plan Development: Defining Subareas* (DEQ 2013a).

Sampling for upper South Fork Snake River was completed in fall 2021 and spring 2022. This annual project summary includes a complete report of this round of sampling, with results from 2021 and 2022.

An aquifer dominated by alluvial sediments and glacial outwash is present in the valley of the South Fork Snake River, a tributary to the ESRP aquifer. The upper South Fork Snake River, Swan Valley subarea includes the upper portion of the aquifer within Swan Valley (Figure 41). The subarea is about 48 mi^2, covering about 14.5 miles down river from the base of Palisades Dam to where the valley narrows, and about 15.5 miles upstream from the ESRP aquifer. Elevation ranges from 5,600 feet to 5,250 feet within the subarea with about 7 inches to 18 inches of annual precipitation.

The objectives of this regional monitoring study were to identify areas of vulnerable or degraded water quality, collect data to aid in determining potential sources of degradation to direct and prioritize groundwater protection efforts based on potential sources, and evaluate the effectiveness of management practices used to reduce nitrate impacts.

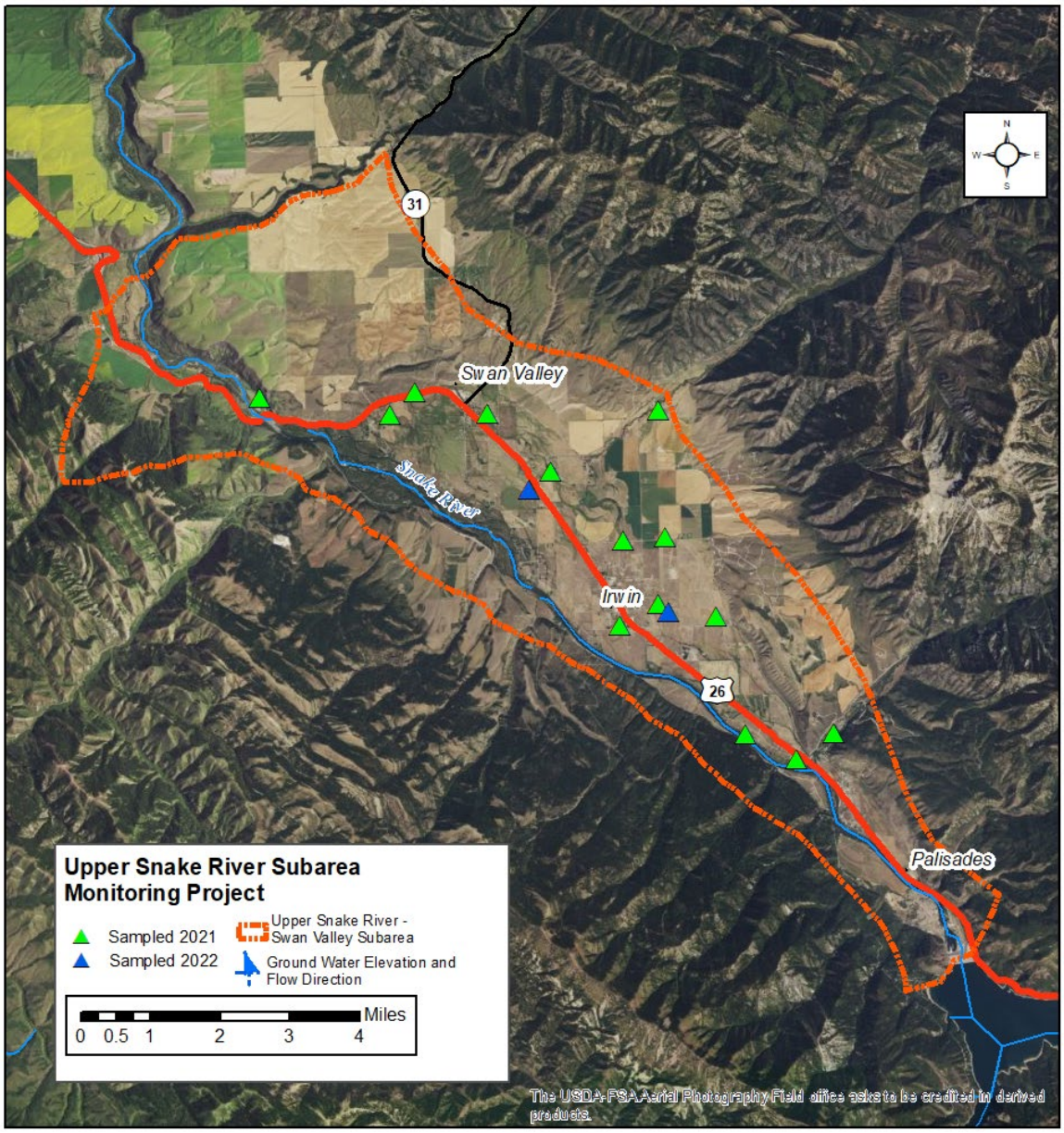


Figure 41. Site location map—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

2.3.1.2 Methods and Results

Potential sample sites were selected from randomly identified and ordered 1-mile sections completely within the 48 square-mile study area. Sections that included wells sampled by IDWR or ISDA were excluded. Selection favored more recent wells with complete information for well construction, well-bore seals, and lithologic descriptions suggesting that groundwater 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), using existing nitrate results available from the data set from the most recent NPA analysis

(nitrate results available through 2018). A goal of 20 to 22 sample sites was established. Permission to sample was eventually received for a total of 16 wells.

Sites were sampled in October and November 2021 (14 wells) and April 2022 (two wells) (Figure 42). Wells sampled in 2022 (3147 and 3187) were already "winterized" during the fall 2021 sampling period. Results from these randomly selected wells can statistically represent the subarea and can be combined with results from other sampling networks to make inferences concerning the subarea.

The 16 project wells were sampled following the appropriate QAPP (DEQ 2011b) and FSP (DEQ 2021c).

Samples were analyzed by the Idaho Bureau of Laboratories for common ions (calcium, sodium, magnesium, potassium, chloride, fluoride, and sulfate), arsenic, total alkalinity, nitrite+nitrate (nitrate), and ammonia. Samples for bacteria (TC and *E. coli*) were analyzed by Teton Microbiology Laboratory. After receiving the major ion chemistry and nutrient results, samples for stable isotope analysis were submitted to UC Davis for stable isotopes of nitrogen and oxygen in nitrate ($\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$) and the University of Arizona for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O_{water}$ and $\delta^{2}H_{water}$). Samples were submitted to the University of Idaho Analytical Services Laboratory for total bromide and boron at trace levels.

Water quality field parameters (pH, temperature, specific conductance, and DO) were measured at each site before sample collection. Field parameter measurements for the upper Snake River subarea (Table 47) for pH ranged from 6.76 to 7.45 with a mean and median of 7.2 and 7.3. Measurements for water temperature ranged from 5.8 °C to 12.3 °C, with a mean and median of 9.8 °C. Measurements for specific conductance ranged from 363 µS/cm to 1,580 µS/cm, with a mean and median of 718 and 570 µS/cm. Measurements for DO ranged from 2.56 mg/L to 8.18 mg/L, with a mean and median of 5.2 mg/L and 5.0 mg/L.

Table 47. Water quality field parameters—Upper South Fork Snake River, Swan Valley Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
3139	60	10/28/2021	12.30	1344	6.76	5.23
3140	78	10/27/2021	10.28	466	7.35	6.50
3141	120	10/27/2021	11.04	1580	6.81	3.20
3142	98	10/28/2021	11.50	525	7.32	8.18
3143	180	10/27/2021	10.74	492	7.26	6.14
3144	80	10/27/2021	11.39	1204	6.86	2.96
3145	60	10/28/2021	9.78	535	7.35	5.79
3146	60	10/27/2021	9.31	363	7.41	4.85
3148	Unk	10/27/2021	11.20	1158	6.91	4.07
3149	Unk	12/13/2021	7.33	384	7.43	3.32
3150	60	11/15/2021	9.65	624	7.24	7.70
3151	80	11/15/2021	9.85	562	7.45	5.41
3152	121	12/13/2021	8.86	602	7.28	4.12
3153	100	11/30/2021	7.54	441	7.33	2.56
3147	78	4/27/2022	9.68	625	7.33	7.84
3187	90	4/27/2022	5.86	578	7.45	4.74

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

2.3.1.2.1 Nutrient and Nitrogen Isotope Results

Nitrate concentrations for the upper Snake River subarea ranged from less than 0.068 mg/L to 4.8 mg/L, with a mean and median of 1.35 mg/L and 0.745 mg/L, respectively (Table 48). Four sites exceeded 2 mg/L (Wells 3140, 3187, 3145, and 3143) with values of 2.2 mg/L, 3.6 mg/L, and 4.4 mg/L in addition to the maximum value of 4.8 mg/L. The spatial distribution of nitrate concentrations is presented in Figure 42. These sites with elevated nitrate are in the central portion of the study area and are centrally located within the valley. Four additional sites returned nitrate greater than the median value and likely reflect some degree of anthropogenic impact: Wells 3142 (1.1 mg/L), 3147 (0.81 mg/L), 3150 (1.1 mg/L, and 3152 (0.99 mg/L).

Ammonia was reported below the reporting limit of 0.050 mg/L for all samples from all sites (Table 48).

Table 48. Nutrient and nutrient-related isotope results—Upper South Fork Snake River, Swan Valley Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes		
			Phosphorus	Nitrate+Nitrite[a]	Ammonia	O-18 Nitrate	N-15-Nitrate	δ^{15}
			(mg/L)			(‰)		
Water Quality Standard:			**No Stand.**	**10**	**No Stand.**	**No Stand.**	**No Stand.**	**No Stand.**
3139	60	10/28/2021	0.0056	0.15	<0.050	-11.9	8.29	7.5
3140	78	10/27/2021	0.0079	2.2	<0.050	-7.45	3.84	—
3141	120	10/27/2021	0.011	0.26	<0.050	-8.76	6.53	8.5
3142	98	10/28/2021	0.0070	1.1	<0.050	-6.73	3.37	—
3143	180	10/27/2021	0.0079	4.8	<0.050	-5.34	9.60	—
3144	80	10/27/2021	0.0064	0.24	<0.050	-7.20	5.74	—
3144	80	10/27/2021	—	—	—	—	—	5.4
3145	60	10/28/2021	0.015	4.4	<0.050	-5.78	3.89	—
3146	60	10/27/2021	0.017	0.068	<0.050	-6.44	3.89	—
3147	78	4/27/2022	0.0074	0.81	<0.050	-4.78	3.49	—
3148	Unk	10/27/2021	0.020	0.29	<0.050	-4.09	5.00	R
3149	Unk	12/13/2021	0.0055	0.58	<0.050	-2.86	10.4	10.5
3150	60	11/15/2021	0.0075	1.1	<0.050	-6.94	3.84	—
3151	80	11/15/2021	0.014	0.33	<0.050	-8.43	6.10	5.8
3152	121	12/13/2021	0.0096	0.99	<0.050	-5.50	5.21	3.8
3153	100	11/30/2021	0.010	0.68	<0.050	-5.38	4.68	4.0
3187	90	4/27/2022	0.0085	3.6	<0.050	-6.48	4.05	—

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.
R = Rejected by the data validator. Results are not usable as detects or nondetects for any purpose due to a QA/QC exceedance or equipment malfunction.
a. Contaminant with a National Primary Drinking Water Regulation standard.

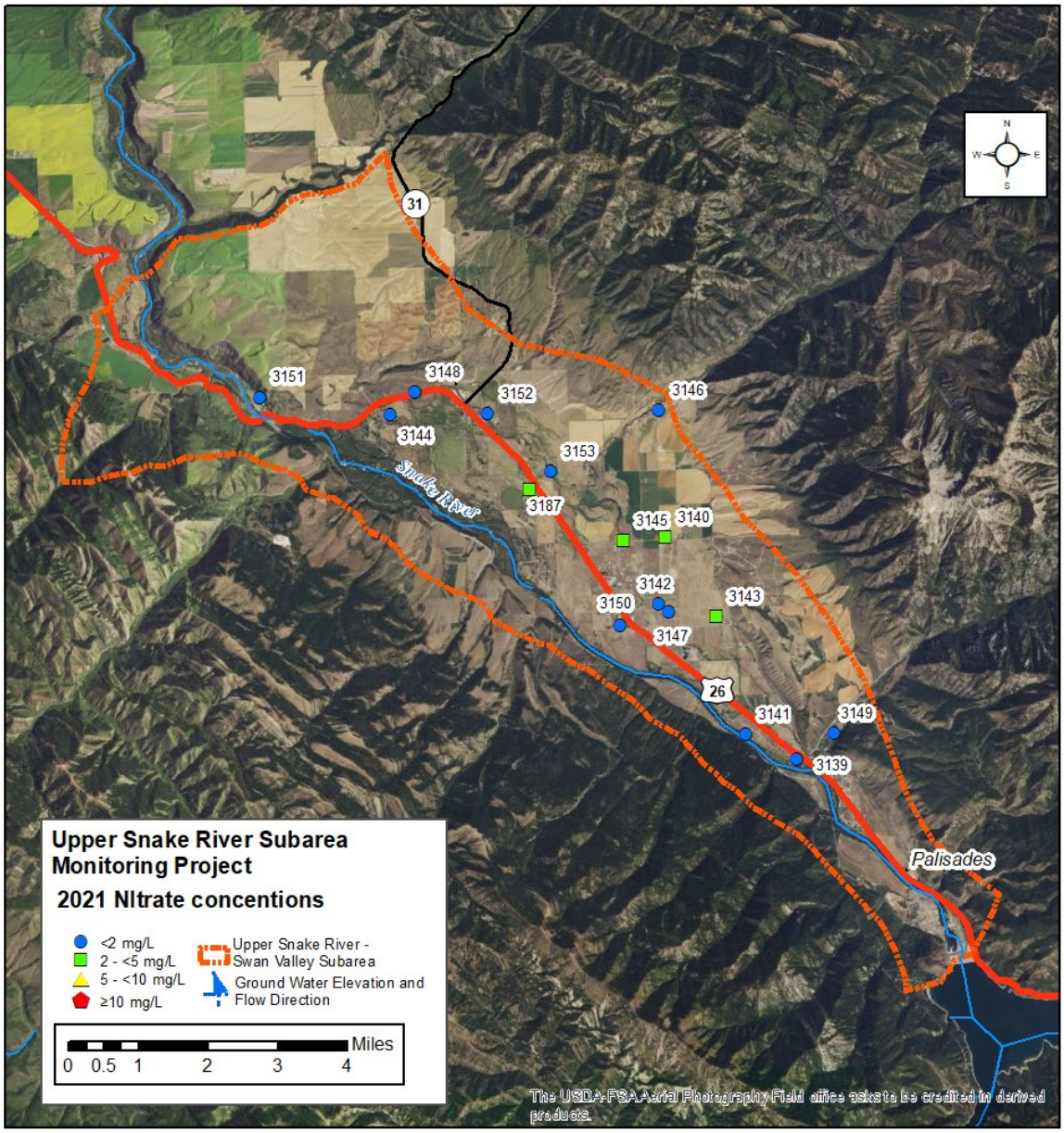


Figure 42. 2021 nitrate concentrations—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

Stable isotope results can also aid in understanding the possible ongoing thermodynamic or biochemical processes within the system.

Stable isotopes of N and O for nitrate are analyzed from the same sample and provide the context for understanding isotopic fractionation due to largely microbial-facilitated nitrogen cycling processes. While characteristic ranges for $\delta^{15}N_{nitrate}$ values have been correlated to likely sources, these ranges overlap to some degree; supporting information can aid in interpreting the most likely source as well as secondary processes that might result in isotopic fractionation, modifying the observed signature. Ranges for $\delta^{18}O_{nitrate}$ reflect the source of the related ^{18}O in nitrate: atmospheric as the result of the chemical process used to create anthropogenic nitrate

with a characteristic ^{18}O value of ~23‰, or nitrification of ammonium from any source (inorganic fertilizer, mineralization of natural soil organic matter, organic fertilizer, composts of wastes). The signature for $\delta^{18}O_{nitrate}$ will typically reflect the following proportion: $\delta^{18}O_{nitrate}$ = 2/3 $\delta^{18}O_{water}$ +1/3 $\delta^{18}O_{air}$.

Results for stable isotope analyses are presented in Table 48 and Table 49. The $\delta^{15}N_{nitrate}$ values for the wells sampled ranged from 3.37‰ to 10.37‰ (Figure 43). A total of six wells had isotope $\delta^{15}N_{nitrate}$ values <~4‰, suggesting an inorganic source (possibly commercial fertilizer); an additional seven sites returning values 4‰–5‰, these sites are likely either reflective of inorganic sources or organic sources including mineralized soil N. An additional seven sites ranged from ~6‰ to <8‰; these sites more likely reflect a mixed or soil/organic source. Three sites (Wells 3139, 3143, and 3149) reported $\delta^{15}N_{nitrate}$ values >~8‰–9‰, suggesting a reduced or possible waste source.

Nitrate-impacted sites, Wells 3140, 3145, and 3187, plotted <~4‰, with lower chloride values (<~11 mg/L), and generally higher proportional sulfate concentrations (SO_4/Cl >1.7). Three of the sites with nitrate ~1 mg/L (Wells 3142, 3145, and 3147), also plotted <~4‰ but with slightly higher chloride levels (~15 mg/L–27 mg/L) and with proportional sulfate concentrations (SO_4/Cl >1.7), suggesting an inorganic fertilizer impact. Analysis of nearby land uses indicates significant alfalfa and grain production near the well sites. Wells 3141, 3144, and 3151 with ambient nitrate levels (less than the median value of 0.745 mg/L) and an organic/mixed $\delta^{15}N_{nitrate}$ ratio likely represent an ambient, organic nitrogen signature. The combination of enriched $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ for Well 3149 (10.37‰–2.86‰) along with low DO supports denitrification to explain the observed isotopic values for this site.

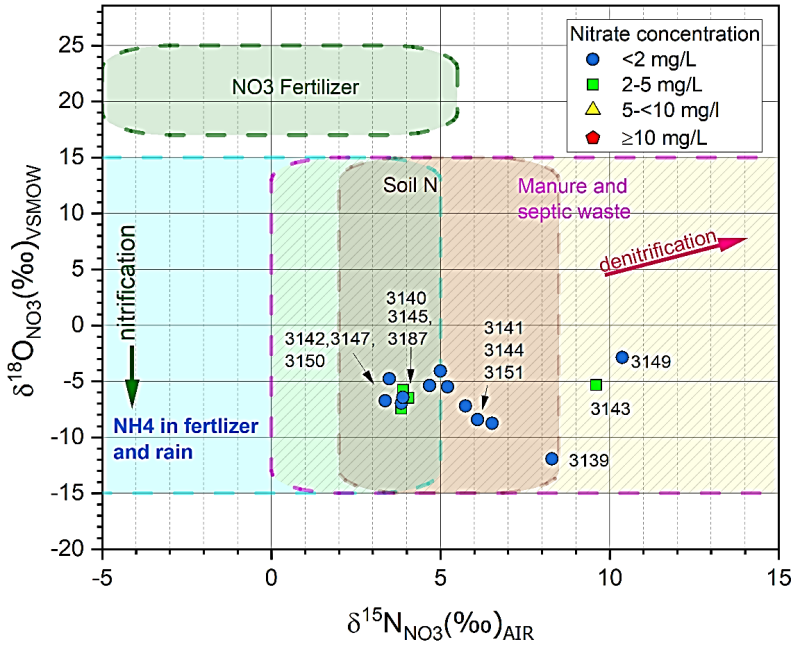


Figure 43. Plot of $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ stable isotope values—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project (ranges of isotopic values and sources from Kendall et al. 2007).

Stable isotopes of oxygen ($\delta^{18}O_{water}$) and hydrogen ($\delta^{2}H_{water}$ [deuterium]) in groundwater can help identify the likely source and timing of recharge. Results for $\delta^{18}O_{water}$ and $\delta^{2}H_{water}$ are presented in Table 49 and Figure 44. The figure also presents the Global Meteoric Water Line, and a Local Meteoric Water Line based on sampling specific to the upper Snake River Basin, and a line characteristic for ESRP groundwater sites (Cecil et al. 2005). Elevated nitrates are identified in Wells 3145, 3146, 3140, and 3187. Well 3145 plots slightly more enriched (less negative) correlating to warmer weather precipitation as opposed to groundwater representing average annual precipitation. Well 3151 plots less enriched (more negative) indicating wintertime precipitation, which may reflect groundwater dominated by discharge from Palisades Reservoir due to water from the spring runoff of snowmelt. No sites appeared to plot along the characteristic groundwater line reflecting summer evaporation.

Table 49. Stable isotope results—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	$\delta^{2}H_{water}$ (‰)	$\delta^{18}O_{water}$
3139	60	10/28/2021	-133.8	-17.9
3140	78	10/27/2021	-130.1	-17.2
3141	120	10/27/2021	-134.8	-17.8
3142	98	10/28/2021	-131.4	-17.4
3143	180	10/27/2021	-131.7	-17.5
3144	80	10/27/2021	-132.9	-18.0
3145	60	10/28/2021	-126.9	-16.9
3146	60	10/27/2021	-128.9	-17.4
3148	Unk	10/27/2021	-134.9	-18.1
3149	Unk	12/13/2021	-133.4	-17.6
3150	60	11/15/2021	-132.7	-17.5
3151	80	11/15/2021	-138.7	-18.2
3152	121	12/13/2021	-132.3	17.6
3153	100	11/30/2021	-128.5	17.4
3147	78	4/27/2022	-131.1	-17.5
3187	90	4/27/2022	130.8	-17.3

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

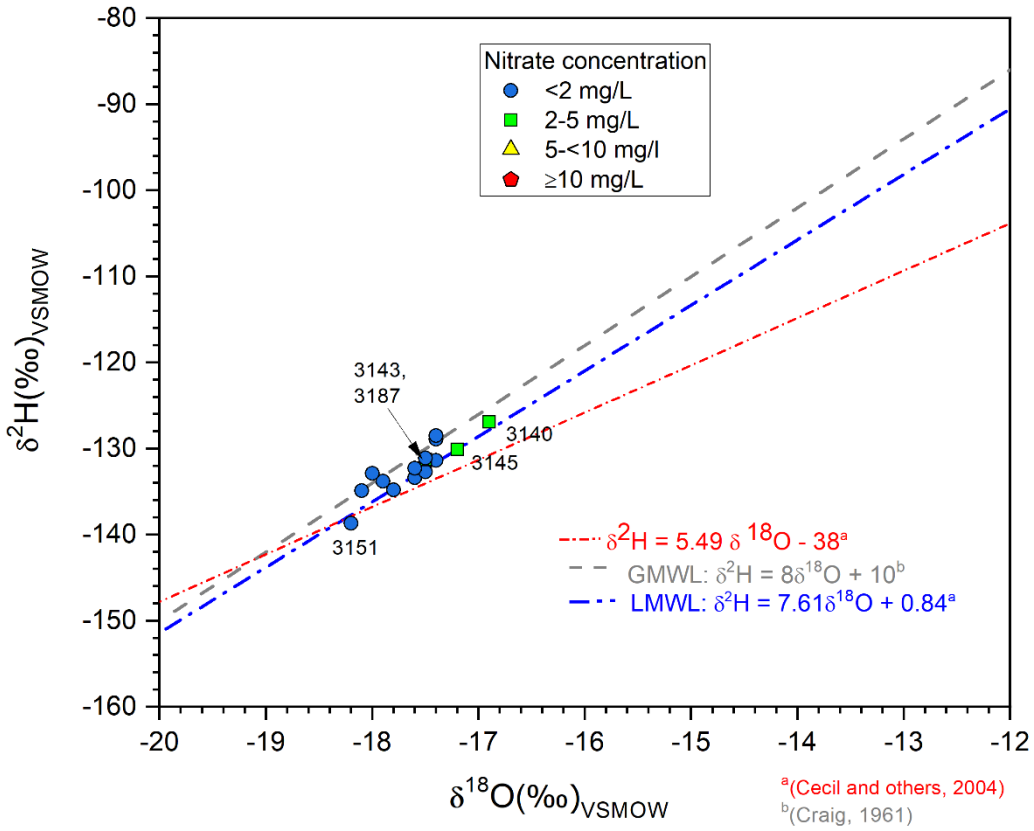


Figure 44. Stable isotopes of oxygen and hydrogen results—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

2.3.1.2.2 Bacteria Results

TC bacteria are a group of bacteria common in the environment (such as soil) and are generally not harmful. *E. coli* bacteria (a type of coliform bacteria) are found in human or animal fecal matter. *E. coli* in groundwater provides strong evidence that human or animal fecal waste is present and a greater potential for pathogenic organisms exists. Bacterial analyses aid in identifying potential impacts or influences at the wellhead or sample point. TC was detected in Well 3150 (48.7 MPN/100 mL), Well 3148 (7.3 MPN/100 mL), and Well 3153 (1.0 MPN/100 mL) (Table 50). All wells were negative for *E. coli*.

Table 50. 2021 bacteria results—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1**	**1.0**
3139	60	10/28/2021	<1	<1
3140	78	10/27/2021	<1	<1
3141	120	10/27/2021	<1	<1
3142	98	10/28/2021	<1	<1
3143	180	10/27/2021	<1	<1
3144	80	10/27/2021	<1	<1
3145	60	10/28/2021	<1	<1
3146	60	10/27/2021	<1	<1
3148	Unk	10/27/2021	<1	7.3
3149	Unk	12/13/2021	<1	<1
3150	60	11/15/2021	<1	48.7
3151	80	11/15/2021	<1	<1
3152	121	12/13/2021	<1	<1
3153	100	11/30/2021	<1	1.0

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.3.1.2.3 General Groundwater Chemistry

Common ion chemistry provides a picture of the overall relative character of groundwater, including mixing from different sources and changes in groundwater chemistry from processes such as dissolution of the aquifer matrix, infiltration, and impacts from contamination sources. Major ion chemistry along with field parameters can also provide clues to ongoing chemical processes and indications of the favored chemical forms for nitrogen in groundwater (Table 51).

The Piper trilinear water chemistry plot (Piper diagram) can identify major trends in groundwater chemistry. Based on the common ion results, the groundwater in the upper South Fork Snake River, Swan Valley subarea is primarily a calcium-bicarbonate water with generally low, but increasing, relative proportions of chloride and sulfate and an increasing proportion calcium. The increases are primarily with the general direction of groundwater flow—towards the river from the range front and with the downstream flow (Table 51 and Figure 45). Trends in major cations likely reflect mixing of groundwater from tributary basins to the north with underflow related to the Snake River. Trends in anions, increasing proportions of chloride and sulfate, likely reflect a combination of impacts. Wells 3139, 3141, 3144 and 3148, with greater concentrations and proportions of chloride and sulfate, may represent a combination of soil

organic and possibly waste impacts despite low nitrate concentrations. Well 3151 also stands out with a greater proportion of sodium-potassium and low nitrate levels. Nitrate-impacted Wells 3140, 3143, 3145, and 3187 are not distinct based on major ions, while the wells with nitrates ~1 mg/L (3142, 3147, 3150, and 3152), located close to the Snake River in an area of development, are intermediate between the group with greater concentrations and proportions of chloride and sulfate and sites downgradient, likely reflecting mixing with the downgradient flow.

Table 51. Common ion and total dissolved solids results—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride (mg/L)[a]	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)[a]
Water Quality Standard:			**No Stand.**	**No Stand.**	**No Stand.**	**250**	**No Stand.**	**No Stand.**	**No Stand.**	**250**
3139	60	10/28/2021	—	69	140	—	34	11	80	—
3140	78	10/27/2021	221	29	61	4.86	19	2.4	4.4	20.7
3141	120	10/27/2021	458	86	160	159	46	11	91	185
3142	98	10/28/2021	221	18	69	15.3	17	3.5	10	32.6
3143	180	10/27/2021	214	18	64	6.37	18	4.4	6.7	24.3
3144	80	10/27/2021	351	49	130	91.9	38	7.8	57	180
3145	60	10/28/2021	238	52	70	11.0	21	2.9	3.9	19.1
3146	60	10/27/2021	187	6.4	53	0.68	13	0.91	1.7	11.9
3148	Unk	10/27/2021	342	47	130	81.6	39	6.9	51	172
3149	Unk	12/13/2021	187	21	56	4.48	15	0.80	2.5	20.7
3150	60	11/15/2021	235	20	74	27.4	22	3.2	19	54.2
3151	80	11/15/2021	210	29	47	31.8	15	4.8	46	37.9
3152	121	12/13/2021	252	18	72	18.8	23	3.3	24	52.4
3153	100	11/30/2021	218	9.8	55	4.36	17	3.3	16	25.7

Notes: mg/L = milligram per liter; µg/L = microgram 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.

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

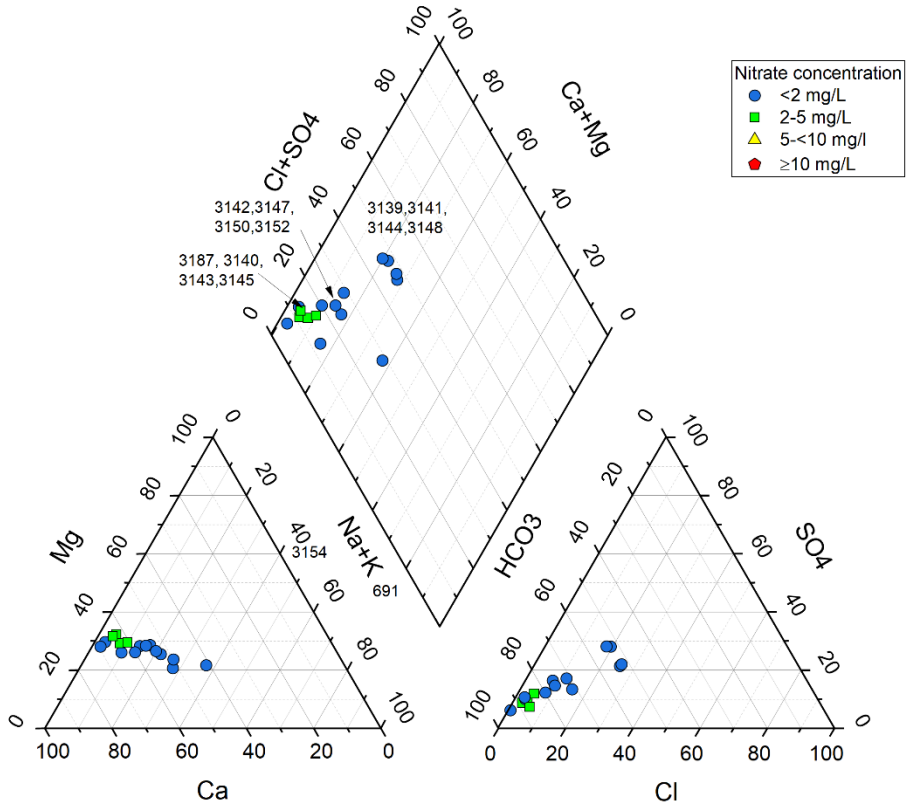


Figure 45. Piper diagram for 2021 major ion data—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

2.3.1.2.4 Trace Element Results

Samples from all 16 sites were analyzed for boron and bromide at trace levels as indicators for potential nitrate sources (Table 52). There are no drinking water standards or health advisories for boron or bromide. Boron concentrations ranged from <5.0 µg/L to 330 µg/L, with a median value of 48.5 µg/L. Bromide was detected for all sites with concentrations ranging from 2.2 µg/L to 86 µg/L, with a median value of 21.5 µg/L. Boron is naturally present in geologic materials and can be a significant micronutrient used in east Idaho for potatoes and alfalfa. Boron can also be a significant tracer related to household cleaning products in domestic sewage. Bromide in the context of the ratio with chloride aids in decerning dominant sources of chloride, including atmospheric, soils, and geologic materials, and anthropogenic sources such as wastes. Analysis of regional monitoring data has also indicated that trends in bromide concentrations with respect to chloride, nitrate, and $\delta^{15}N_{nitrate}$ may aid in discerning contribution of nitrates due to mineralization from organic sources. Wells with the highest boron values (3148 [170 µg/L], 3144 [190 µg/L], 3139 [270 µg/L], and 3141 [330 µg/L]) include four of the five highest bromide values (Table 51: 3148 [47 µg/L], 3144 [49 µg/L], 3139 [69 µg/L], 3141 [86 µg/L]), and

return $\delta^{15}N_{nitrate}$ values from 5.0 ‰ to 8.29‰, within the range attributed to organic or waste nitrogen sources.

Table 52. 2021 metals results—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Boron (µg/L)
	Water Quality Standard:		**No Stand.**
3139	60	10/28/2021	270.0
3140	78	10/27/2021	18.81
3141	120	10/27/2021	330.0
3142	98	10/28/2021	40.28
3143	180	10/27/2021	37.11
3144	80	10/27/2021	190.0
3145	60	10/28/2021	28.85
3146	60	10/27/2021	<100.0
3148	Unk	10/27/2021	170.0
3149	Unk	12/13/2021	<100.0
3150	60	11/15/2021	68.65
3151	80	11/15/2021	120.0
3152	121	12/13/2021	74.57
3153	100	11/30/2021	50.14

Notes: µg/L = microgram 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.

2.3.1.2.5 Ionic Mass Ratios—Chloride-Bromide

The ratio of chloride to bromide has been used to trace the origin of salinity in groundwater, aiding to distinguish between precipitation, soil water/groundwater, and water impacted by septic and animal wastes. Characteristic chloride/bromide ratios for the chloride sources develop due to relative differences in aqueous solubility between Cl^- and Br^- and depend upon regional natural and anthropogenic chloride sources and factors including variations in rainfall ratios, local evaporite deposits, fertilizer application, and practices such as using salt for deicing roadways (Davis et al. 1998; Showers et al. 2008). General ranges for chloride/bromide ratios for different sources are summarized as ~50–150 for rainfall, soil water/most groundwater ~150–300, potential septic/waste influences ~300–600, and impact from livestock wastes generally >~600–1,000's (Davis et al. 1998; Showers et al. 2008; Panno et al. 2006).

Chloride/bromide ratios ranged from 107–1,875, with a mean and median of 929 and 947 (Figure 46). Nine sites show chloride/bromide ratios ~>850. Four sites were identified with some degree of likely anthropogenic impact (nitrate ~ 1). The remaining sites with elevated ratios are likely due to sediments/hydrogeology and not directly to anthropogenic impacts. Chloride/bromide ratios for nitrate-impacted Wells 3140 and 3145 reflect low values suggesting soil/groundwater chloride sources and $\delta^{15}N_{nitrate}$ values <~4‰, supporting an inorganic fertilizer

source. Well 3187 with a similar isotopic value and a higher chloride/bromide ratio likely reflects some mixture with the higher chloride bromide ratios due to the local hydrogeology, while supporting an inorganic fertilizer source. Well 3143 has a chloride/bromide ratio within the typical septic range, is located physically distant from those sites with a high chloride/bromide trend attributed to hydrogeology, and likely reflects a waste influence, supported by the enriched $\delta^{15}N_{nitrate}$ value (9.6‰). Wells 3149 and 3146 reflect ambient conditions or low degree of impact with the combination of the lower chloride concentrations and chloride/bromide ratios. Well 3150 (nitrate 1.1 mg/L, $\delta^{15}N_{nitrate}$ values <~4‰, chloride/bromide 1,370, and TC 48.7 MPN/100 mL) likely reflects an inorganic fertilizer impact, with the high chloride/bromide range likely from the discussed hydrogeology, and bacteria detection possibly related to contamination at the point of sampling. Bacteria detection is not uncommon when sampling from an exterior faucet.

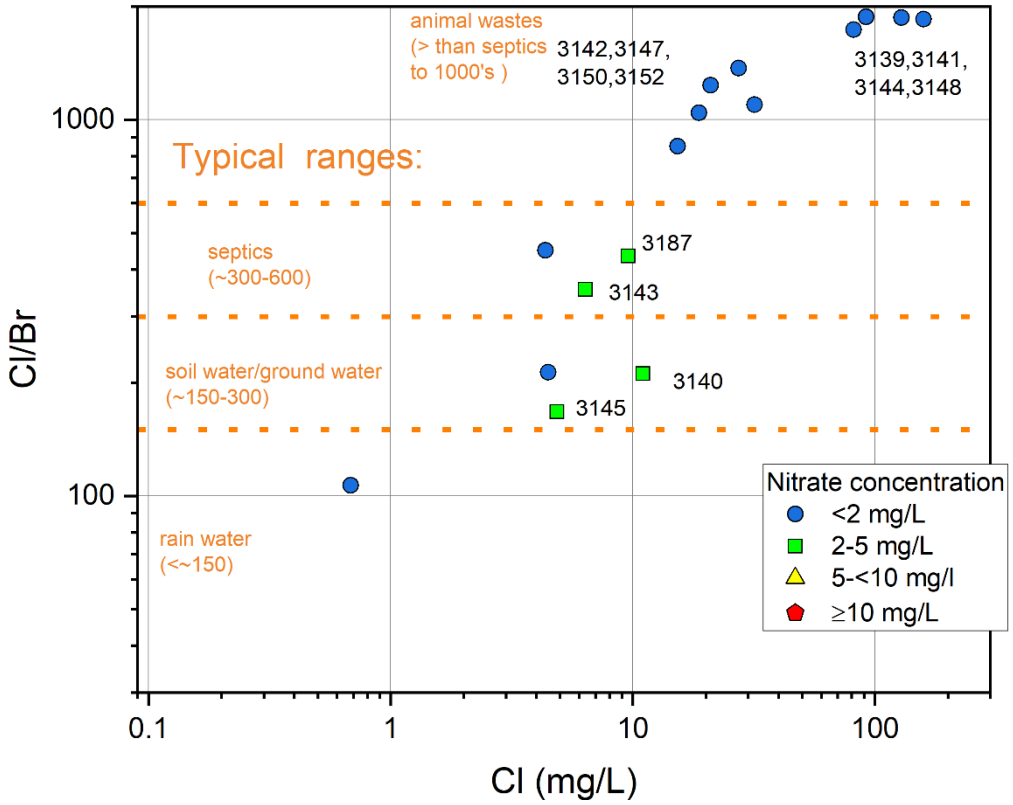


Figure 46. Plot of chloride/bromide—Upper South Fork Snake River, Swan Valley Subarea Groundwater Monitoring Project.

2.3.1.3 Conclusions

Major ion chemistry, presented with a Piper diagram, suggests that the variation in common ions may be explained as primarily a mixture of water with a higher chloride and boron concentration closer to the Snake River and potentially related to buried sediments with the valley with lower chloride and boron waters from recharge to the north and west of the river. Three of the four nitrate impacted sites suggest an inorganic/fertilizer nitrogen source, and results from the fourth site suggest a septic/waste influence. Three sites with nitrate ~1 mg/L

(greater than the median nitrate value for the study area) also plotted within the typical inorganic $\delta^{15}N_{nitrate}$ range (<~4‰), with slightly higher chloride levels (~15 mg/L–27 mg/L) and with proportional sulfate concentrations (SO_4/Cl >1.7) supporting an interpretation of an inorganic fertilizer impact.

2.3.1.4 Recommendations

Major ion chemistry, chloride, sulfate, and stable isotopes should be considered for sampling to identify potential nitrate sources. Assessment of the potential sources of nitrate observed should consider a combination of factors and characterize the potential sources of recharge/mixing of as well as nitrate sources.

Further support for nitrate source evaluation may come from trace elements or other indicators. Conclusions from this analysis should help to refine future projects and suggested analytes as well as serve as guidance for interpreting monitoring results for evaluating potential nitrate sources to groundwater across Idaho.

2.3.2 Teton County Public Nitrate Follow-up Sampling

2.3.2.1 Purpose and Background

Local Teton Valley nonprofit group, Friends of the Teton River (FTR), whose focus is protection and improvement of water quality for the Teton watershed, has sponsored public groundwater sampling events within the Teton basin. Sponsored events from 2012 to 2017 included the Teton High School Environmental Science Class, where members of the public brought water samples from their private wells for nitrate screening using nitrate test strips. For consistency and to facilitate recording, the samples were taken to Teton High School, and measurements were recorded using a color-coded pin placed by the well owner on a map to indicate their well location. Sampling event results were transferred to a Google map format with approximate locations. Results suggested increasing nitrate levels in certain areas that were also experiencing increases in residential building.

Consulting with DEQ, FTR designed a cost-share sampling program using a contract lab certified for drinking water analyses. The package included TC (presence/absence), nitrate+nitrite, fluoride, chloride, and sulfate, with the option for additional analyses (pH, total hardness, lead, and arsenic). FTR split the cost for the basic package with the homeowner. The participant was required to include an address for the well the sample was drawn from. A total of 153 samples were submitted in the 2019, 2020, and 2021 sampling events. Six sites exceeded 5 mg/L nitrate+nitrite, and an additional 22 sites ranged from 3 mg/L to <5 mg/L. The maximum concentration reported was 7.2 mg/L, with a median of 1.2 mg/L–1.3 mg/L overall.

Project design allowed for sites identified with elevated nitrates and in areas of apparent increasing water quality impact to be resampled by DEQ to provide a broader list of analytes to consider in DEQ's regional monitoring efforts. Of particular interest is an accompanying sulfate/chloride ratio which for regional monitoring has been correlated to distinguish between sites influenced by ammonium sulfate fertilizers and waste-related nitrate sources. Regional

monitoring includes nitrate source tracers (bromide and boron), stable isotopes of nitrogen and oxygen in nitrate ($\delta^{15}N_{NO3}$, $\delta^{18}O_{NO3}$), and oxygen and hydrogen in water ($\delta^{18}O_{H2O}$, $\delta^{2}H_{H2O}$). The combination of additional source tracers and stable isotopes aid in distinguishing sources and understanding the timing of infiltration moving nitrates to groundwater (Murgulet and Tick 2013; Benjamin et al. 2004).

2.3.2.2 Methods and Results

Sample locations were selected from the domestic wells with elevated nitrates representing a range of sulfate/chloride ratios identified from the public sampling. Eight sites were sampled in November 2021 (Figure 47).

The eight project wells were sampled following the appropriate QAPP (DEQ 2011b) and FSP (DEQ 2021d).

Water quality field parameters (pH, temperature, specific conductance, and DO) were measured at each site before sample collection. Field parameter measurements for the Teton follow-up sampling project (Table 53) for pH ranged from 7.65 to 11.06 with a mean and median of 7.48 and 7.43. Measurements for water temperature ranged from 5.8 °C to 12.3 °C, with a mean and median of 8.7 °C and 8.4 °C. Measurements for specific conductance ranged from 422 µS/cm to 1081 µS/cm, with a mean and median of 557 µS/cm and 493 µS/cm. DO measurements ranged from 6.51 mg/L to 15.09 mg/L, with a mean and median of 9.1 mg/L and 9.6 mg/L. The range of parameters represents impacted sites and not overall groundwater quality. The high DO value for Well 3154 is likely the product of a hole in the discharge line within the well resulting in a super-saturated DO value and is not representative of the groundwater.

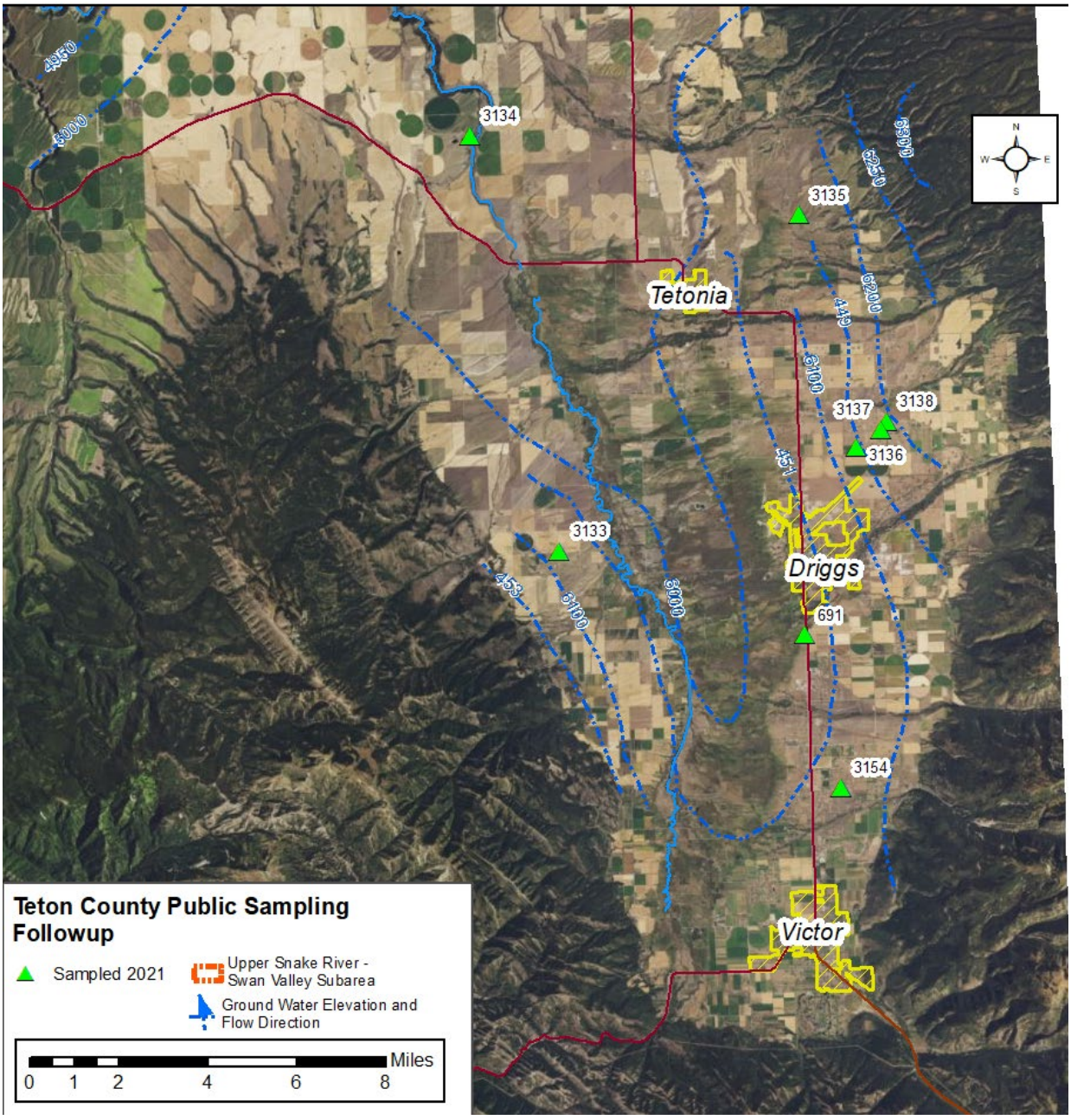


Figure 47. Sample site locations—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

Table 53. Water quality field parameters—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
691	80	11/02/2021	7.65	422	7.47	11.22
3133	206	11/02/2021	8.21	552	7.52	8.53
3134	500	11/02/2021	8.81	1081	7.65	7.45
3135	Unk	11/15/2021	8.62	514	7.14	6.51
3136	200	11/02/2021	7.99	432	7.52	9.94
3137	200	11/02/2021	9.31	474	7.49	9.34
3138	Unk	11/15/2021	11.06	513	7.37	8.81
3154	Unk	12/13/2021	7.83	466	7.28	15.09

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

2.3.2.2.1 Nutrient and Nitrogen Isotopes Results

Nitrate concentrations for the follow-up nitrate sampling ranged from 3.0 mg/L to 9.5 mg/L, with a mean and median of 5.9 mg/L and 5.6 mg/L, respectively (Table 54). Four sites exceeded 5 mg/L (Well 3133 [9.1 mg/L], 3134 [9.5 mg/L], 3135 [6.2 mg/L], and 3154 [6.2 mg/L). These sites are distributed across the study area, with three distinct forested, shrub, or agricultural areas. The fourth site is in a subdivision between Victor and Driggs. Wells 3136, 3137, and 3138 are located within 1 mile of each other just north of the airport in Driggs. The spatial distribution of nitrate concentrations is presented in Figure 48.

Ammonia was reported below the reporting limit of 0.050 mg/L for all samples from all sites (Table 54).

Table 54. Nutrient and nutrient-related isotope results—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration			Isotopes		
			Phosphorus	Nitrate+Nitrite[a]	Ammonia	O-18 Nitrate	N-15-Nitrate	N-15/14
			(mg/L)				(‰)	
Water Quality Standard:			**No Stand.**	**10**	**No Stand.**	**No Stand.**	**No Stand.**	**No Stand.**
691	80	11/02/2021	0.058	4.9	<0.050	-8.11	3.16	—
3133	206	11/02/2021	0.031	9.1	<0.050	-6.57	3.00	—
3134	500	11/02/2021	0.015	9.5	<0.050	-7.55	5.52	13.6
3135	Unk	11/15/2021	0.062	6.2	<0.050	-7.38	8.61	—
3136	200	11/02/2021	0.029	3.0	<0.050	-7.66	4.81	—
3137	200	11/02/2021	0.034	3.7	<0.050	-7.70	5.22	—
3138	Unk	11/15/2021	0.029	4.8	<0.050	-7.64	5.56	—
3154	Unk	12/13/2021	0.020	6.2	<0.050	-7.46	2.52	—

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.

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

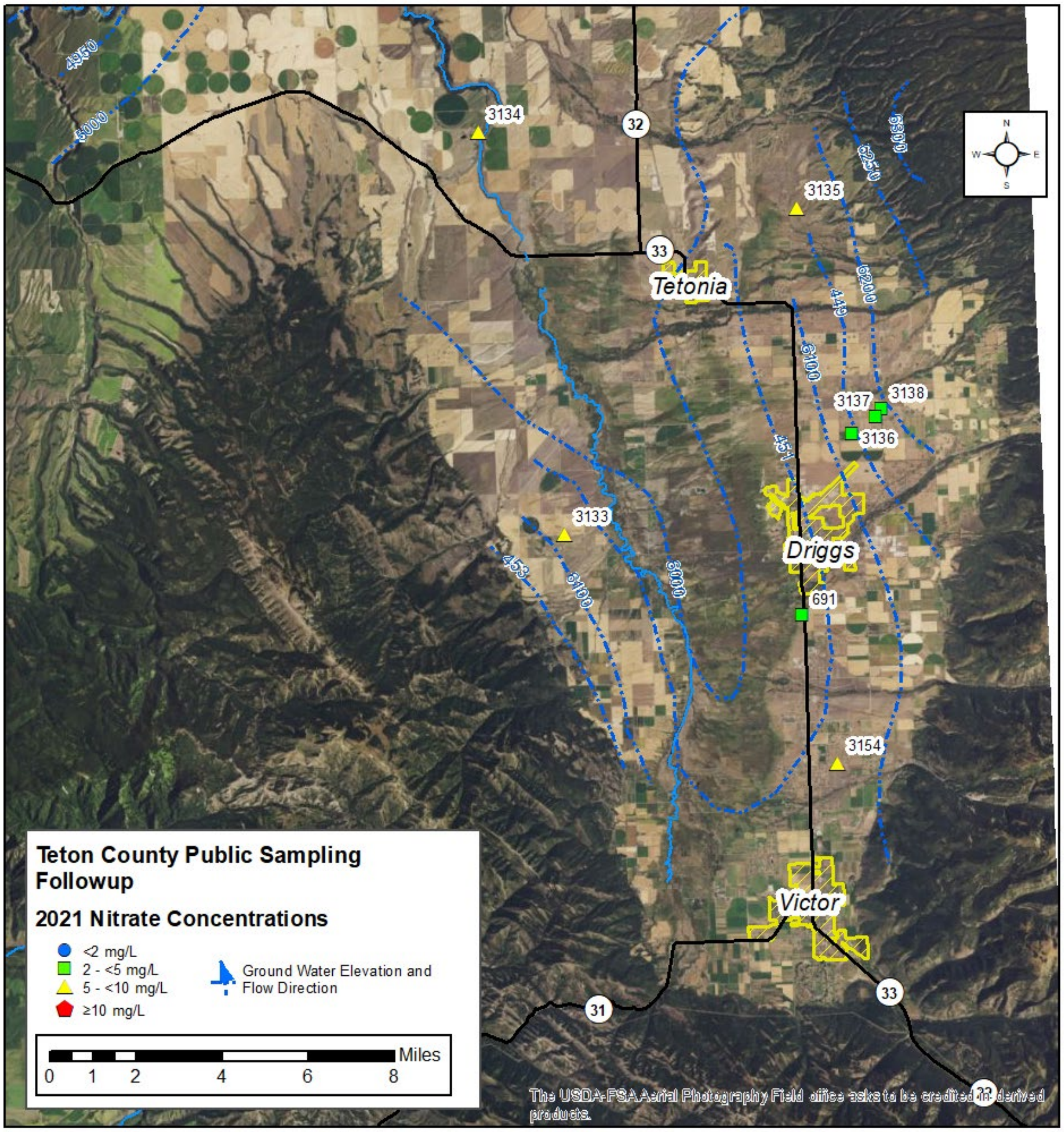


Figure 48. 2021 nitrate concentrations—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

Stable isotopes of N and O for nitrate are analyzed from the same sample and provide the context for understanding isotopic fractionation due to largely microbial-facilitated nitrogen cycling processes. While characteristic ranges for $\delta^{15}N_{nitrate}$ values have been correlated to likely sources, these ranges overlap to some degree; supporting information can aid in interpreting the most likely source and secondary processes that might result in isotopic fractionation, modifying the observed signature. Ranges for $\delta^{18}O_{nitrate}$ reflect the source of the related ^{18}O in nitrate: atmospheric as the result of the chemical process used to create anthropogenic nitrate with a characteristic ^{18}O value of ~23‰ or nitrification of ammonium from any source (inorganic fertilizer, mineralization of natural soil organic matter, organic fertilizer, composts of

wastes. The signature for $\delta^{18}O_{nitrate}$ will typically reflect the following proportion: $\delta^{18}O_{nitrate}$ = 2/3 $\delta^{18}O_{water}$ +1/3 $\delta^{18}O_{air}$.

Results for stable isotope analyses are presented in Table 54 and Table 55. The $\delta^{15}N_{nitrate}$ values for the wells sampled ranged from 2.5‰ to 8.6‰ (Figure 49). A total of three wells had isotope $\delta^{15}N_{nitrate}$ values <~4‰, suggesting an inorganic source (possibly commercial fertilizer). Of these, Wells 691 (3.16‰) and 3133 (3.00‰) show alfalfa and grains as the dominant nearby land use. The dominant land use near Well 3154 is open grass and developed lands. Wells 3134, 3136, 3167, and 3138 returned values 4‰–<6‰ and likely reflect inorganic or organic sources including mineralized soil N. The high chloride, sulfate, and bromide, with an $\delta^{15}N_{nitrate}$ value in the soil organic to waste range, may reflect a mixed source influence. Well 3135 returned a value in the range typically attributed to wastes (>~8‰–9‰). The range of $\delta^{18}O_{nitrate}$ values reflect nitrification of soil or inorganic-related ammonium as opposed to an atmospheric $\delta^{18}O$ value related to inorganic nitrate fertilizer.

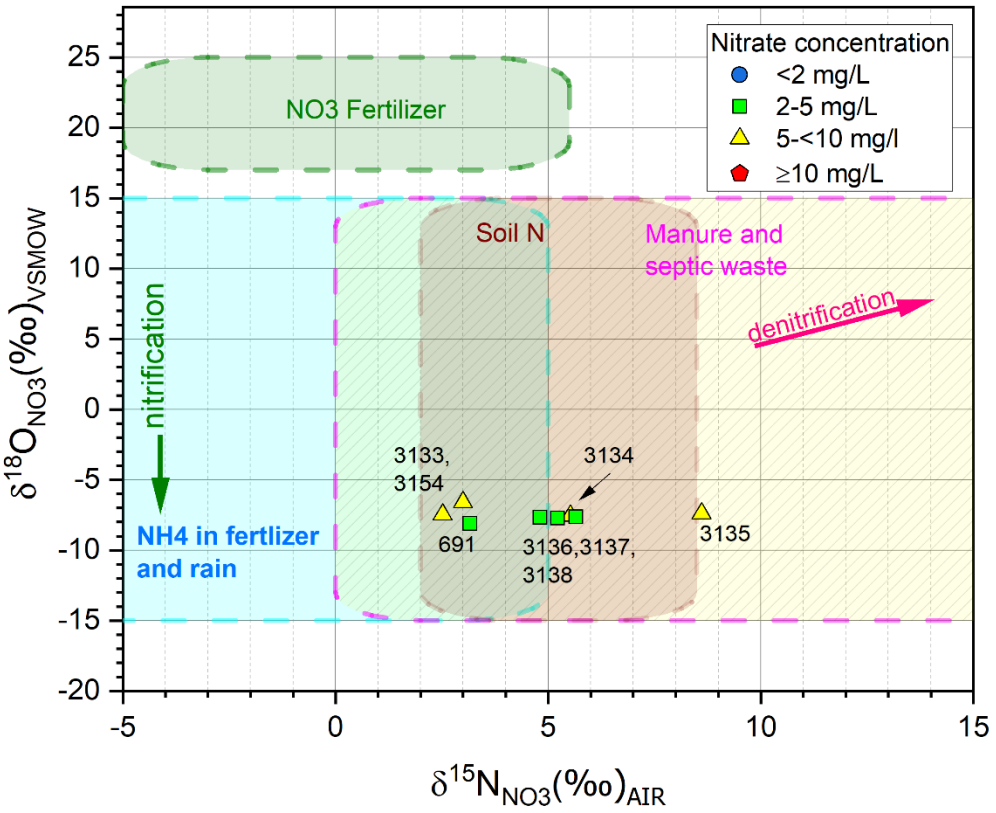


Figure 49. Plot of $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ stable isotope values—Teton County Nitrate Follow-Up Groundwater Monitoring Project (ranges of isotopic values and sources from Kendall et al. 2007).

Stable isotopes of oxygen ($\delta^{18}O_{water}$) and hydrogen ($\delta^{2}H_{water}$ [deuterium]) in groundwater can identify the likely source and timing of recharge. Results for $\delta^{18}O_{water}$ and $\delta^{2}H_{water}$ are presented in Table 55 and Figure 50. The figure also presents the Global Meteoric Water Line, a Local Meteoric Water Line based on sampling specific to the upper Snake River Basin, and a line characteristic for ESRP groundwater sites (Cecil et al. 2005). Wells 0691, 3136, 3137, 3138 and Wells 3133, 3135, and 3154 plot together but on different meteoric water lines, likely reflecting

average annual precipitation from slightly different recharge sources. Well 3134 is distinct, plotting more like winter snowmelt. No sites appeared to plot along the characteristic groundwater line reflecting summer evaporation.

Table 55. Stable isotope results—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	H-2 Water (‰)	O-18 Water (‰)
691	80	11/02/2021	-129.8	-17.5
3133	206	11/02/2021	-131.5	-17.3
3134	500	11/02/2021	-142.9	-18.7
3135	Unk	11/15/2021	-131.6	-17.2
3136	200	11/02/2021	-131.7	-17.8
3137	200	11/02/2021	-130.5	-17.7
3138	Unk	11/15/2021	-132.7	-17.9
3154	Unk	12/13/2021	-129.6	-17.1

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

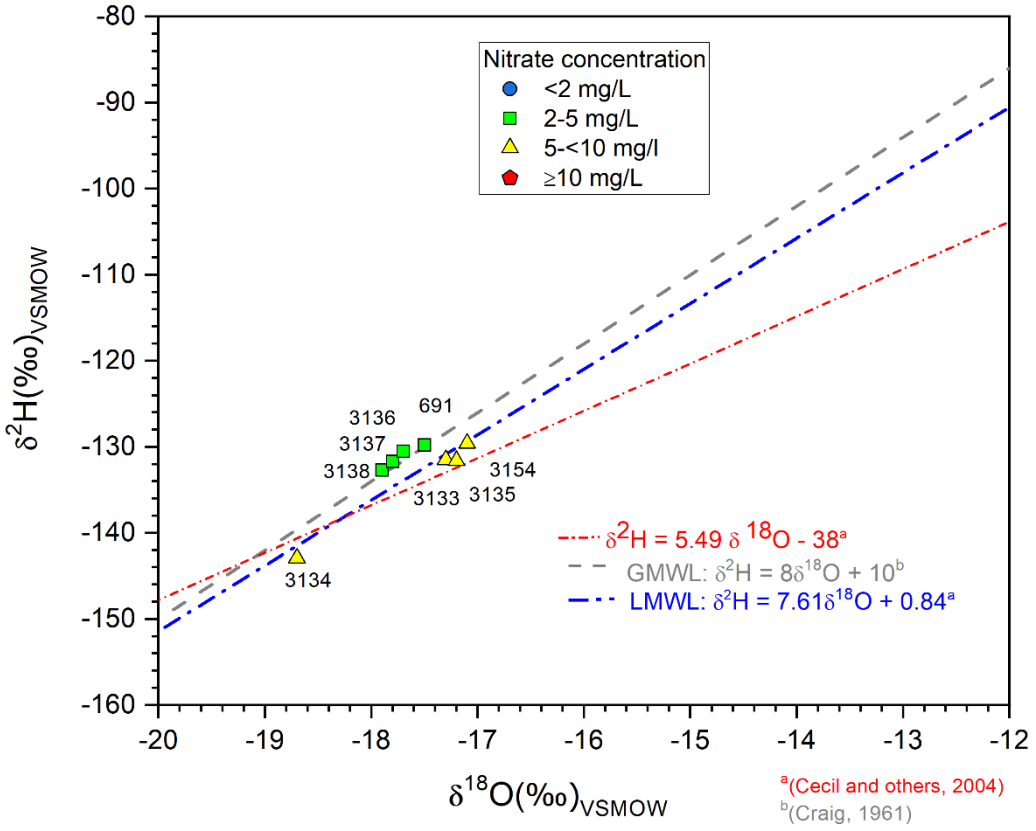


Figure 50. Plot of $\delta^{18}O_{water}$ and $\delta^{2}H_{water}$ stable isotope values—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

2.3.2.2.2 Bacteria Results

TC bacteria are a group of bacteria common in the environment (e.g., soil) and are generally not harmful. *E. coli* bacteria (a type of coliform bacteria) are found in animal fecal matter. *E. coli* in groundwater provides strong evidence that human or animal fecal waste is present and a greater potential for pathogenic organisms exists. Bacterial analyses aid in identifying potential impacts or influences at the wellhead or sample point. TC was detected in Wells 3133 (1.0 MPN/100 mL) and 3135 (2.0 MPN/100 mL) (Table 56). All wells were negative for *E. coli*.

Table 56. 2021 bacteria results—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1.0**	**1.0**
691	80	11/02/2021	<1.0	<1.0
3133	206	11/02/2021	<1.0	1.0
3134	500	11/02/2021	<1.0	<1.0
3135	Unk	11/15/2021	<1.0	2.0
3136	200	11/02/2021	<1.0	<1.0
3137	200	11/02/2021	<1.0	<1.0
3138	Unk	11/15/2021	<1.0	<1.0
3154	Unk	12/13/2021	<1.0	<1.0

Notes: MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found.
a. Total coliform and *E. coli* standards are from Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it indicates whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.3.2.2.3 General Groundwater Chemistry

Common ion chemistry provides a picture of the overall relative character of groundwater, including mixing from different sources and changes in groundwater chemistry from processes such as dissolution of the aquifer matrix, infiltration, and impacts from contamination sources. Major ion chemistry along with field parameters can also provide clues to ongoing chemical processes and indications of the favored chemical forms for nitrogen in groundwater (Table 57).

Table 57. Common ion and total dissolved solids results—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3) (mg/L)	Bromide (µg/L)	Calcium (mg/L)	Chloride (mg/L)[a]	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)[a]
Water Quality Standard:			**No Stand.**	**No Stand.**	**No Stand.**	**250**	**No Stand.**	**No Stand.**	**No Stand.**	**250**
691	80	11/02/2021	205	12	59	1.64	19	0.68	1.9	11.8
3133	206	11/02/2021	222	70	76	15.7	16	1.40	13	15.8
3134	500	11/02/2021	241	600	97	142	62	2.00	21	88.5
3135	Unk	11/15/2021	227	37	66	7.35	18	0.92	13	11.1
3136	200	11/02/2021	216	17	55	2.47	21	0.74	3.1	8.03
3137	200	11/02/2021	237	18	59	2.58	24	0.82	3.6	9.07
3138	Unk	11/15/2021	249	18	68	3.02	22	0.84	4.3	10.9
3154	Unk	12/13/2021	228	13	67	2.69	20	0.74	0.99	8.42

Notes: mg/L = milligram per liter; µg/L = microgram 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.
a. Contaminant with a National Secondary Drinking Water Regulation standard.

The Piper trilinear water chemistry plot (Piper diagram) can identify major trends in groundwater chemistry. Based on the common ion results, the groundwater in the Teton County sampling is primarily calcium-bicarbonate water (Figure 51). Well 3134 is distinct with a significant increase in chloride and sulfate compared to the other sites. The group of sites with nitrates >5 mg/L (Wells 3133, 3134, 3135, and 3154) show a trend of increasing chloride and sulfate. The remainder of the sites are not distinct.

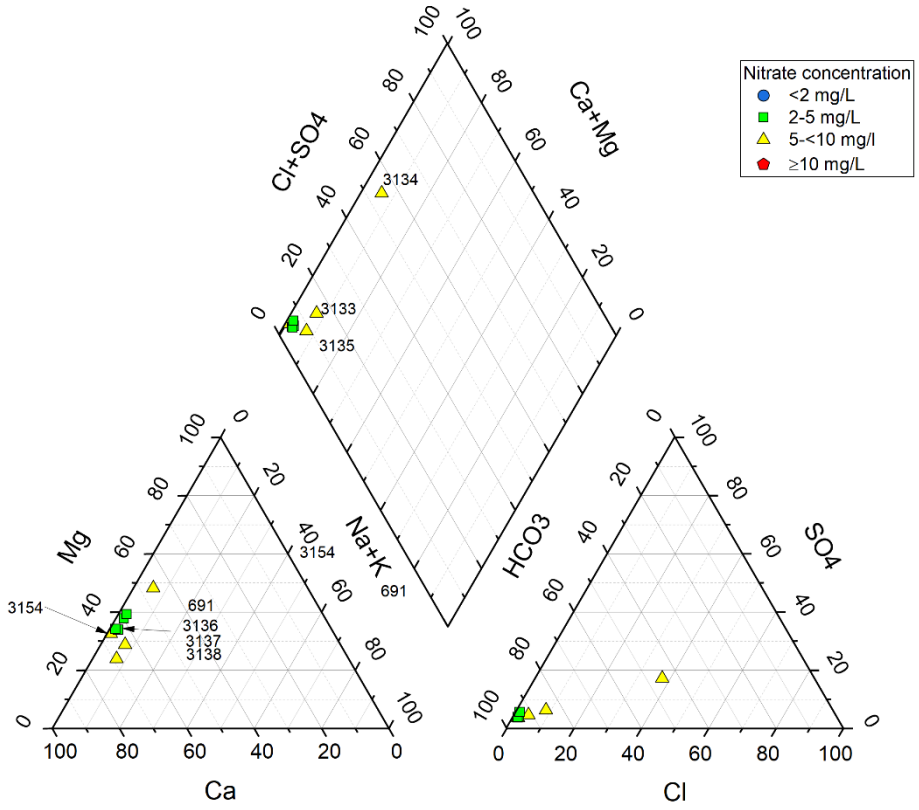


Figure 51. Piper diagram for 2021 major ion data—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

2.3.2.2.4 Trace Elements Results

Samples from all eight sites were analyzed for boron and bromide at trace levels as indicators for potential nitrate sources (Table 57 and Table 58). There are no drinking water standards or health advisories for boron or bromide. Boron concentrations ranged from <5.0 µg/L to 20 µg/L, with a median value of 49 µg/L. Bromide was detected for all sites with concentrations ranging from 12 µg/L to 600 µg/L, with mean and median values of 98 µg/L and 18 µg/L. Boron is naturally present in geologic materials and can be significant as a micronutrient in east Idaho for potatoes and for alfalfa. Boron can also be a significant tracer related to household cleaning products in domestic sewage. Bromide sources include mineralized organic materials, and in the context of the ratio with chloride, aids in decerning dominant sources of chloride; atmospheric, soils and geologic materials, and from anthropogenic sources including wastes. The elevated bromide value for Well 3134 corresponds to elevated chloride and sulfate levels compared to the other sites sampled.

Table 58. 2021 metals results—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Boron (µg/L)
	Water Quality Standard:		**No Stand.**
691	80	11/02/2021	<5.0
3133	206	11/02/2021	5.6
3134	500	11/02/2021	16
3135	Unk	11/15/2021	20
3136	200	11/02/2021	6.3
3137	200	11/02/2021	9.1
3138	Unk	11/15/2021	9.7
3154	Unk	12/13/2021	<5.0

Notes: µg/L = microgram 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.

2.3.2.2.5 Ionic Mass Ratios—Chloride-Bromide

The ratio of chloride to bromide has been used to trace the origin of salinity in groundwater, aiding to distinguish between precipitation, soil water/groundwater, and water impacted by septic and animal wastes. Characteristic chloride/bromide ratios for the chloride sources develop due to relative differences in aqueous solubility between Cl^- and Br^- and depend on regional natural and anthropogenic chloride sources; variations in rainfall ratios, local evaporite deposits, and fertilizer application; and practices such as salt for deicing roadways (Davis et al. 1998; Showers et al. 2008). General ranges for chloride/bromide ratios for different sources are summarized as ~50–150 for rainfall, ~150–300 for soil water/most groundwater, ~300–600 for potential septic/waste influences, and >~600 to 1,000s from livestock wastes (Davis et al. 1998; Showers et al. 2008; Panno et al. 2006).

All sites returned ratios for chloride/bromide within the range indicating some impact in addition to just atmospheric precipitation, with values from 137–237, and a mean and median of 182 and 183, respectively (Figure 52). Sites with isotopic nitrate indicators reflecting soil/organic to wastes (Wells 3135, 3138, 31.34, 3136, and 3137) (Figure 52) returned chloride/bromide values within a range expected for soils but less than expected for wastes. This result is likely due to their location higher within the basin—closer to the recharge, which suggests that regional context should be considered when interpreting chloride mass ratios.

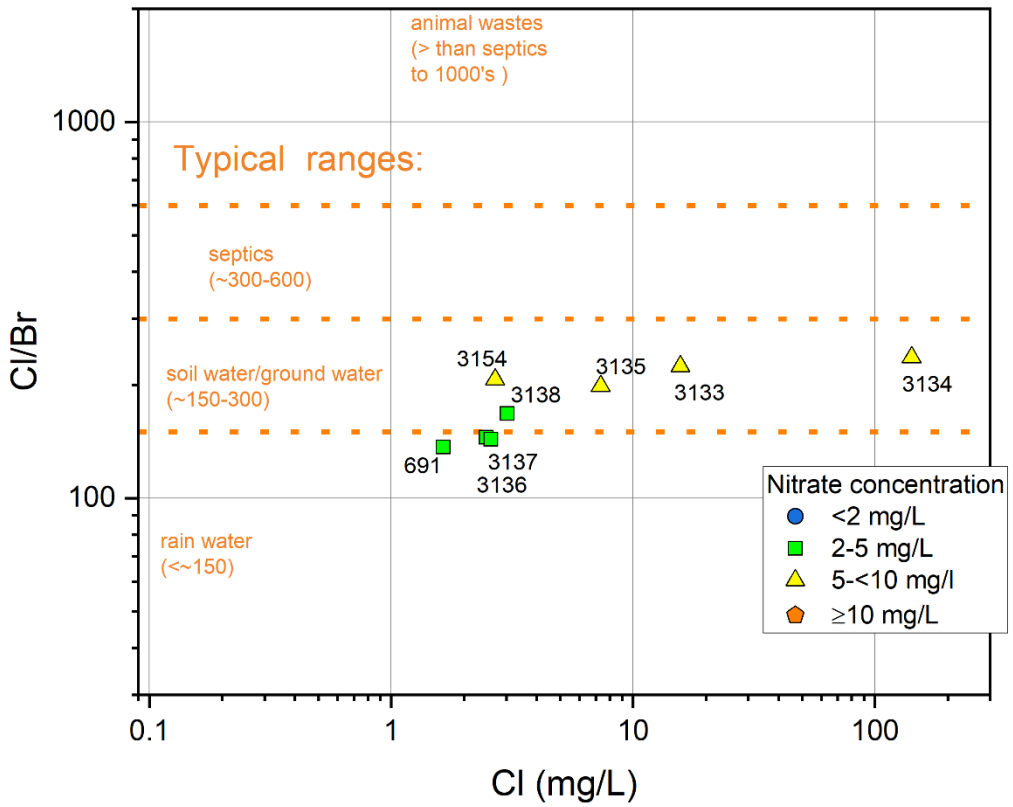


Figure 52. Plot of chloride/bromide—Teton County Nitrate Follow-Up Groundwater Monitoring Project.

2.3.2.3 Conclusions

This sampling study was conducted to confirm previous results that indicated elevated nitrates for sites identified in a public sampling event sponsored by FTR and to determine how these sites fall into DEQ's regional groundwater monitoring efforts to evaluate potential sources of anthropogenic impacts to groundwater.

Nitrate concentrations for the sites sampled ranged from 3.0 mg/L to 9.5 mg/L. Major ion chemistry, presented with a Piper diagram (Figure 51), suggests that the four sites with the highest nitrate values (6.2 mg/L–9.5 mg/L) also reflects a trend of increasing proportions of chloride, sulfate, and bromide with increasing nitrate and an increasing chloride/bromide ratio distinct from the other sites. Of these four sites, two reflect an inorganic nitrate range ($\delta^{15}N_{nitrate}$ <~4‰) and two reflect a mixed organic ($\delta^{15}N_{nitrate}$ >4‰ and ~6‰–7‰) or waste ($\delta^{15}N_{nitrate}$ >~8‰–9‰) range. The remaining sites (3.0 mg/L–4.9 mg/L nitrate) reflected lower chloride concentrations with low but proportionally increasing sulfate concentrations and similar major ion chemistry. Of this grouping, the site with the greatest sulfate-to-chloride ratio had an inorganic fertilizer value ($\delta^{15}N_{nitrate}$ <3.2‰), and the remaining sites had mixed/organic $\delta^{15}N_{nitrate}$ range (3 mg/L–4.8 mg/L). These sites are located closely to each other and share similar ranges of chloride, sulfate, and bromide, suggesting an overall organic impact not specific to an individual home. This organic impact may be related to a combination of historic land uses and distributed septic tanks in the area.

Nitrate source indicators include proportional concentrations/ratios of chloride, sulfate, boron, and bromide, with isotopes, nitrogen, and water.

2.3.2.4 Recommendations

The combination of major ion chemistry, chloride, sulfate, and stable isotopes should be considered for sampling to identify potential nitrate sources. When assessing the potential sources of nitrate, characterize the potential sources of recharge/mixing and nitrate sources and establish the regional context for these indicators. From this analysis, suggested analytes and guidance for interpreting monitoring results can be refined to evaluate potential nitrate sources to groundwater across Idaho.

2.3.3 Island Park Groundwater Bacteria Investigation

2.3.3.1 Purpose and Background

In the spring 2020, routine well sampling by PWS in the Mack's Inn and Island Park Village area showed an increase in TC and *E. coli* bacteria detections. In response, DEQ's Idaho Falls Regional Office and the Eastern Idaho Public Health District (EIPHD) partnered with Fremont County, City of Island Park, and PWS operators to determine possible causes for the bacteria detections. The investigation addressed the following questions:

- What are the primary sources of bacterial contamination? Is impact from surface water a significant source, or are there other sources?
- What role does snowmelt play in the timing of bacteria detections in drinking water wells?
- What physical factors control why some sites are impacted and others are not?

Two rounds of sampling were planned: an initial round in late summer/fall 2020 and a follow-up round in spring 2021. Sampling design also allowed for modification to sites and analytes based on results from the initial sampling round. The 2020 initial sampling and conclusions are discussed here. Results and conclusions from the 2021 sampling including a discussion of multivariate statistical analysis will be included in a later report.

Selected groundwater and surface water sites were sampled in fall 2020 and analyzed for bacteria, common ion chemistry, and stable isotopes. Field parameter measurements (water temperature, pH, specific conductance, and DO) were measured at the time of collection.

Sites sampled included PWS wells and private domestic wells (DWs) in the Mack's Inn and Island Park Village areas (Figure 53). Samples were collected from surface water sites to represent possible sources of bacteria and recharge and analyzed for bacteria and other characteristics to identify possible bacteria sources. A combination of data review and analysis methods were used to determine similar sites and characteristics and similar sources or factors impacting them. The results were reviewed to relate sampling outcomes to typical interpretations of geochemical characteristics and general water infiltration sources. Multivariate analysis methods were used to identify related groupings of geochemical characteristics, spatially-related groups, or statistically significant clusters, and the appropriate

interpretive context. This report focuses on the bacterial, common-ion chemistry, and stable isotope results. This combination of relational factors helps identify bacteria source signatures and specific characteristics driving the seasonal and location variability. The outcome of these steps provides the basis for a path forward for those responsible for and impacted by bacteria contamination in the Mack's Inn/Island Park Village area.

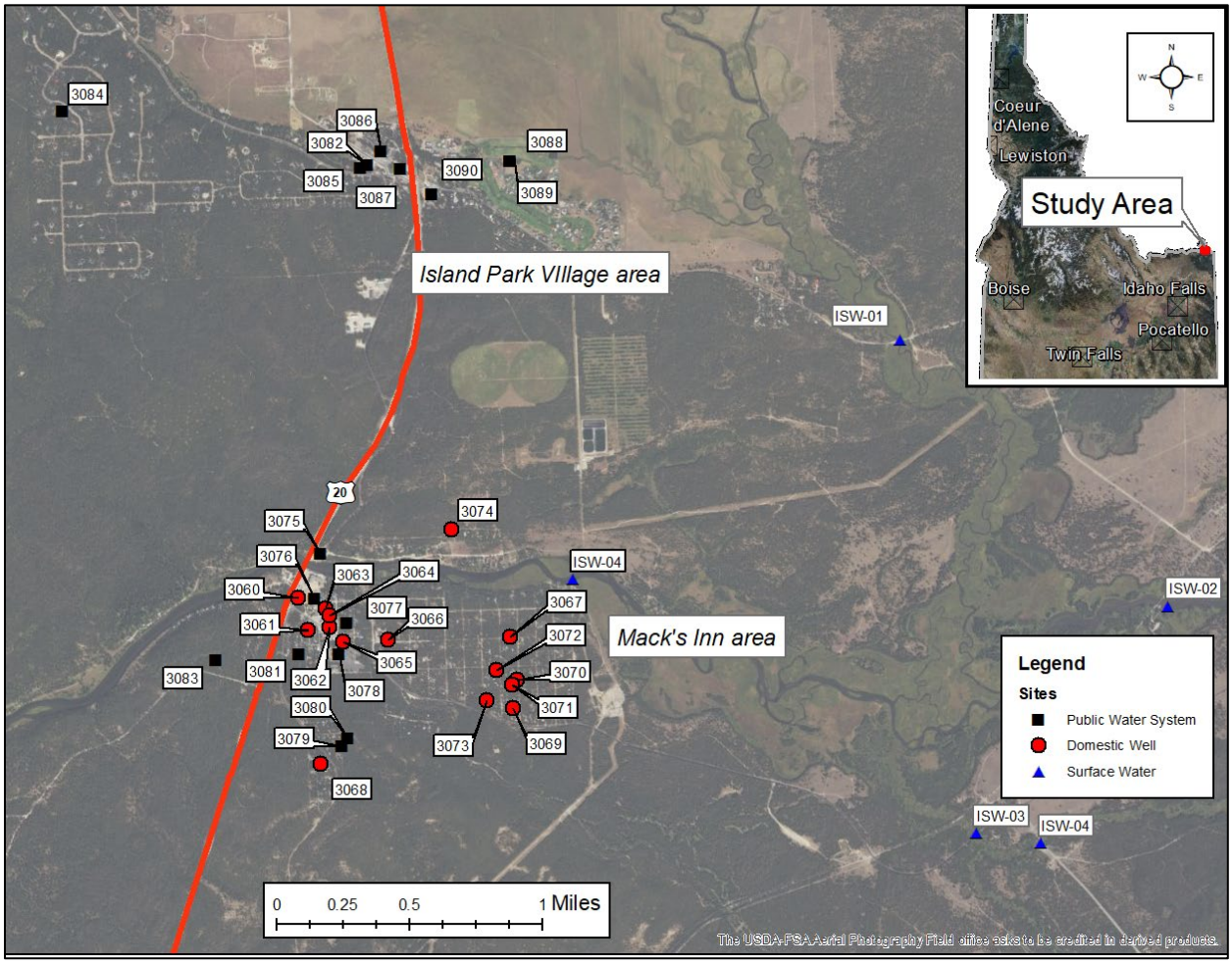


Figure 53. 2020 monitoring locations—Island Park Bacteria Investigation Groundwater Monitoring Project.

2.3.3.2 Methods and Results

A total of 36 sites were sampled in August 2020, including 15 private DWs from the Mack's Inn area, 16 PWS wells from both the Mack's Inn and Island Park Village areas. Five surface water sites were characterized for possible sources of recharge or impact. The PWS wells accounted for nearly all the available PWS sources. The DW sites were chosen from a list of well owners volunteering to participate. The sites sampled were those that were successfully contacted. The compilation of sites represents less than 10% of known wells in the study area. Well construction information could be confirmed for 11 of the 16 PWS wells and only four of the 15 DW sites. The surface water sites represented the nearest five tributaries to the Henrys Fork of the Snake River.

Samples collected for 2020 were analyzed for field parameters (water temperature, pH, specific conductance, and DO), bacteria (TC, *E. coli*), common ion chemistry (calcium, magnesium, sodium, potassium, total alkalinity, chloride, sulfate [SO_4]), nutrients (nitrate+nitrite [NO_2 +NO_3]), and ammonium [NH_4] for selected sites), and stable isotopes of oxygen and hydrogen in water ($\delta^{18}O$, $\delta^{2}H$). All samples were collected according to the project QAPP (DEQ 2020b) and FSP (DEQ 2020c). Water quality field parameters (pH, temperature, specific conductance, and DO) were measured at each groundwater and surface water site before sample collection (Table 59).

Table 59. Water quality field parameters—Island Park Bacteria Investigation Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
Water Quality Standard:			**No Standard**	**No Standard**	**6.5-8.5**	**No Standard**
3060	Unk	08/06/2020	8.67	90	6.88	8.05
3061	Unk	08/13/2020	8.26	149	*6.49*	4.56
3062	Unk	08/13/2020	7.26	157	*6.47*	3.63
3063	Unk	08/13/2020	8.60	118	*6.33*	7.53
3064	Unk	08/13/2020	7.75	214	7.53	0.30
3065	83	08/13/2020	7.44	200	6.87	1.00
3066	Unk	08/13/2020	6.88	133	*6.37*	5.11
3067	Unk	08/13/2020	8.06	99	*6.32*	7.00
3068	160	08/13/2020	7.74	99	6.84	4.43
3069	Unk	08/13/2020	7.53	132	6.93	7.05
3070	Unk	08/13/2020	7.94	105	6.81	7.38
3071	Unk	08/13/2020	11.05	110	6.92	6.50
3072	80	08/13/2020	7.16	96	6.76	7.85
3073	70	08/13/2020	9.54	143	7.01	4.76
3074	Unk	08/13/2020	6.08	121	6.61	8.43
3075	Unk	08/06/2020	6.54	78	*6.47*	9.59
3076	285	08/06/2020	7.20	86	7.99	7.62
3077	122	08/06/2020	6.56	111	*6.41*	7.89
3078	Unk	08/06/2020	9.16	125	*6.49*	6.37
3079	Unk	08/06/2020	6.69	116	6.54	8.72
3080	Unk	08/06/2020	6.86	107	*6.41*	7.03
3081	125	08/06/2020	7.67	138	6.52	5.90
3082	65	08/06/2020	7.08	78	*6.34*	9.98
3083	119	08/13/2020	7.41	101	*6.22*	4.89
3084	290	08/06/2020	6.07	70	7.48	6.45
3085	140	08/06/2020	6.71	77	6.91	8.29
3086	150	08/06/2020	7.39	76	6.80	8.05
3087	143	08/06/2020	6.59	86	6.66	7.75

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	Specific Conductance (µS/cm)	pH[a]	Dissolved Oxygen (mg/L)
3088	145	08/06/2020	6.44	85	6.74	7.24
3089	207	08/06/2020	6.95	85	6.74	7.41
3090	106	08/06/2020	6.79	142	6.56	6.35
ISW-01	—	08/06/2020	20.45	197	*8.78*	8.77
ISW-02	—	08/06/2020	12.96	97	7.08	9.33
ISW-03	—	08/06/2020	17.85	95	7.72	8.14
ISW-04	—	08/06/2020	18.18	130	8.42	9.02
ISW-05	—	08/13/2020	18.01	119	7.73	8.33

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens/centimeter; pH = standard pH units; mg/L = milligram per liter; Unk = Unknown. Well log not found; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Groundwater Quality Rule standard currently established; (–) = Not analyzed or not applicable. Italicized, gray shaded numbers indicate an EPA National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Contaminant with a National Secondary Drinking Water Regulation standard (NSDWR). The NSDWR standard for pH is 6.5–8.5. NSDWR standards are recommended limits for public water systems but can be applied to private wells to evaluate water quality.

Samples were analyzed by the Idaho Bureau of Laboratories for common ions (calcium, sodium, magnesium, potassium, chloride, fluoride, and sulfate), nitrite+nitrate (nitrate), and ammonia. Samples for bacteria (TC and *E. coli*) were analyzed by Teton Microbiology Laboratory and Boise State University Stable Isotope Laboratory for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O_{water}$ and $\delta^{2}H_{water}$).

2.3.3.2.1 Nutrient and Stable Isotopes Results

The 2020 nitrate (total NO_2 +NO_3 as N) results are presented in Table 60. While bacteria in groundwater is the primary concern for the Mack's Inn and Island Park Village area, nitrate concentrations are considered with this study to aid in distinguishing between natural and anthropogenic sources of water quality impact. Waste sources of nitrogen, septic or sewage/sanitary wastes, which are also sources of TC and *E. coli*, tend to have elevated nitrate concentrations. Nitrogen (N) may also be present as ammonium (NH_4) (the ionic form of ammonia [NH_3]). Ammonium and nitrate are also present at low levels in precipitation. Where DO in groundwater is very low, nitrogen will commonly be present as both nitrate and ammonium but with a greater proportion as ammonium.

Primary natural sources of nitrate in groundwater for Island Park include precipitation (as snowmelt and rain), and organic matter from soils. Other likely sources include wastes from individual septic systems and possible leaks from sewer systems. There are very few areas where nitrate fertilizer might be applied within the study area. While there are cattle grazing on

the Henry's Lake flats to the north and abundant wildlife, concentrations of animals are distant from sites sampled in this study.

The 2020 nitrate concentrations ranged from nondetect (less than 0.010 mg/L) to 0.90 mg/L (Well 3090), with a mean and median of 0.27 mg/L and 0.28 mg/L, respectively (Table 60). Samples from four sites were analyzed for ammonium (NH_4^+), with two sample results less than the reporting level (<0.050 mg/L) and two results with reportable results, 0.12 mg/L and 0.10 mg/L. Sites were selected for ammonium analysis based on low DO reported in the field. Sites with detectable ammonium reported DO measurements of 0.30 mg/L and 1.00 mg/L; two sites with ammonium at less than reportable levels were DO at 3.63 mg/L and 4.56 mg/L. Well 3064, with 0.12 mg/L ammonium was the only groundwater with a less-than-reportable nitrate concentration. The nitrate concentration observed for Well 3090, being significantly greater than the observed interquartile range, can be characterized as an outlier.

Table 60. Nutrient and nutrient-related isotope results—Island Park Bacteria Investigation Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate+Nitrite[a]	Ammonia
			(mg/L)	
Water Quality Standard:			**10**	**No Standard**
3060	Unk	08/06/2020	0.14	—
3061	Unk	08/13/2020	0.33	<0.050
3062	Unk	08/13/2020	0.39	<0.050
3063	Unk	08/13/2020	0.41	—
3064	Unk	08/13/2020	<0.010	0.12
3065	83	08/13/2020	0.18	0.10
3066	Unk	08/13/2020	0.26	—
3067	Unk	08/13/2020	0.31	—
3068	160	08/13/2020	0.17	—
3069	Unk	08/13/2020	0.29	—
3070	Unk	08/13/2020	0.31	—
3071	Unk	08/13/2020	0.30	—
3072	80	08/13/2020	0.32	—
3073	70	08/13/2020	0.28	—
3074	Unk	08/13/2020	0.21	—
3075	Unk	08/06/2020	0.18	—
3076	285	08/06/2020	0.11	—
3077	122	08/06/2020	0.33	—
3078	Unk	08/06/2020	0.31	—
3079	Unk	08/06/2020	0.30	—
3080	Unk	08/06/2020	0.23	—
3081	125	08/06/2020	0.38	—
3082	65	08/06/2020	0.18	—

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Nutrient Concentration	
			Nitrate+Nitrite[a]	Ammonia
			(mg/L)	
3083	119	08/13/2020	0.20	—
3084	290	08/06/2020	0.13	—
3085	140	08/06/2020	0.15	—
3086	150	08/06/2020	0.18	—
3087	143	08/06/2020	0.24	—
3088	145	08/06/2020	0.35	—
3089	207	08/06/2020	0.34	—
3090	106	08/06/2020	0.90	—
ISW-01	—	08/06/2020	<0.010	—
ISW-02	—	08/06/2020	0.10	—
ISW-03	—	08/06/2020	0.053	—
ISW-04	—	08/06/2020	0.027	—
ISW-05	—	08/13/2020	0.033	—

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; Unk = Unknown. Well log not found; (—) = Not analyzed or not applicable; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Groundwater Quality Rule standard currently established.
a. Contaminant with a National Primary Drinking Water Regulation standard.

Stable isotope results can aid in understanding the possible ongoing thermodynamic or biochemical processes within the system. Results for stable isotope analyses are presented in Table 61. Isotopes of oxygen and hydrogen in water ($\delta^{18}O_{water}$, $\delta^{2}H_{water}$) aid in understanding the timing of precipitation and factors impacting the "history" of the water. Results are compared to the Global Meteoric Water Line, and Local Meteoric Water Line based on precipitation and snow samples from the upper Snake River Basin (Cecil et al. 2005) (Figure 54). Isotopic ratios vary due to factors including the temperature during precipitation and the potential for evaporation. Summer precipitation tends to plot less negatively on the graphic (to the upper right), winter precipitation tends to plot more negatively, and the average annual precipitation tends to plot as an average of the two. Meteoric Water Lines tend to have a slope of about 8. Water that is partially evaporated when applied as irrigation water will plot less-negative and have a lower slope than a meteoric water line. Most sampled sites reflect an $\delta^{18}O_{water}$, $\delta^{2}H_{water}$ result characteristic of average annual precipitation. Wells 3064 and 3065 plot more depleted for both $\delta^{18}O_{water}$ and $\delta^{2}H_{water}$, reflecting recharge dominated by winter precipitation/snowmelt. Wells 3074 and 3090 reflect less depleted, summer precipitation, and Wells 3066 and 3089 fall more closely to the characteristic trend reflecting evaporation. Surface water site ISW-01 is located on Henry's Lake Outlet, upstream from the Mack's Inn area and likely upgradient from the study area. ISW-04 also reflects more of a summer precipitation signature.

Table 61. Stable isotope results—Island Park Bacteria Investigation Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	δ^2H_{Water} (‰)	$\delta^{18}O_{Water}$
	Water Quality Standard:		**No Standard**	**No Standard**
3060	Unk	08/06/2020	-137.5	-18.1
3061	Unk	08/13/2020	-136.6	-18.2
3062	Unk	08/13/2020	-137.2	-18.3
3063	Unk	08/13/2020	-133.4	-17.7
3064	Unk	08/13/2020	-141.9	-18.5
3065	83	08/13/2020	-140.4	18.3
3066	Unk	08/13/2020	135.2	-17.0
3067	Unk	08/13/2020	-133.7	-17.8
3068	160	08/13/2020	-136.5	-17.9
3069	Unk	08/13/2020	-135.3	-18.3
3070	Unk	08/13/2020	-134.7	-18.1
3071	Unk	08/13/2020	-133.4	-18.1
3072	80	08/13/2020	-133.5	-17.8
3073	70	08/13/2020	-136.7	-18.3
3074	Unk	08/13/2020	-131.4	-17.3
3075	Unk	08/06/2020	-134.7	-17.8
3076	285	08/06/2020	-137.6	-18.4
3077	122	08/06/2020	-134.9	-17.9
3078	Unk	08/06/2020	-135.1	-18.0
3079	Unk	08/06/2020	-133.4	-18.0
3080	Unk	08/06/2020	-133.9	-17.9
3081	125	08/06/2020	-135.8	-18.1
3082	65	08/06/2020	-133.4	-18.1
3083	119	08/13/2020	-135.7	-17.7
3084	290	08/06/2020	-133.4	-18.4
3085	140	08/06/2020	-133.6	-18.3
3086	150	08/06/2020	-132.2	-18.3
3087	143	08/06/2020	-131.3	-17.9
3088	145	08/06/2020	-133.0	-17.8
3089	207	08/06/2020	-134.8	-17.8
3090	106	08/06/2020	-129.7	-17.5
ISW-01	—	08/06/2020	-120.6	-15.6
ISW-02	—	08/06/2020	-134.6	-18.5
ISW-03	—	08/06/2020	-133.5	-18.5
ISW-04	—	08/06/2020	-130.1	-17.4
ISW-05	—	08/13/2020	-135.3	-17.8

DEQ Site ID	Well Depth (ft bgs)	Sample Date	δ^2H_{Water} (‰)	$\delta^{18}O_{Water}$

Notes: ft bgs = feet below ground surface; ‰ = permil; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Groundwater Quality Rule standard currently established; Unk = Unknown; Well log not found; (–) = Not analyzed or not applicable.

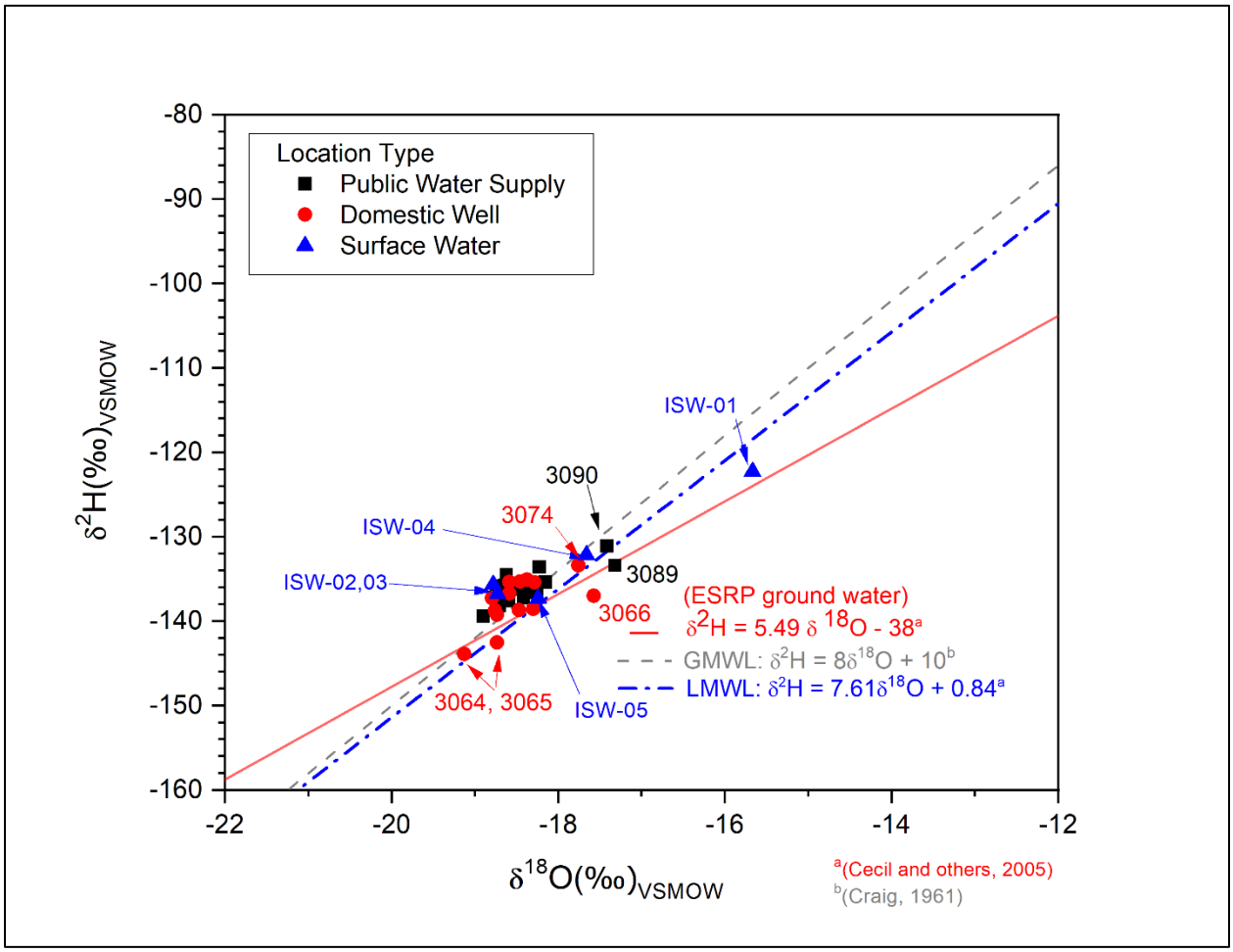


Figure 54. Stable isotope plot of δ^2H_{water} versus $\delta^{18}O_{water}$—Island Park Bacteria Investigation Groundwater Monitoring Project.

2.3.3.2.2 Bacteria Results

TC bacteria are commonly present in soils but do not travel very far in groundwater. TC bacteria can also be present within the plumbing fixtures and not from bacteria in the groundwater. TC and *E. coli* are nearly always detected in surface water. Both families of bacteria can be present intermittently at the same location. TC bacteria are a group of bacteria common in the environment (e.g., soil) and are generally not harmful. *E. coli* bacteria (a type of coliform bacteria) are found in human and animal fecal matter. *E. coli* in groundwater provides strong evidence that human or animal fecal waste is present and a greater potential for pathogenic organisms exists. Bacterial analyses aid in identifying potential impacts or influences at the wellhead or sample point.

A total of 17 groundwater sites were positive for bacteria; 12 of the 17 were positive for TC and 5 sites were positive for both TC and *E. coli*. TC concentrations ranged from 1.0 MPN/100 mL to 727.0 MPN/100 mL. All five surface water site samples contained TC and *E. coli*, which is common for surface water. The surface water TC concentrations ranged from 517.2 MPN/100 mL to 2419.6 MPN/100 mL. *E. coli* concentrations in surface water ranged from 4.1 MPN/100 mL to 68.9 MPN/100 mL (Table 62). PWS and DW sites with bacteria detections are identified in Figure 55.

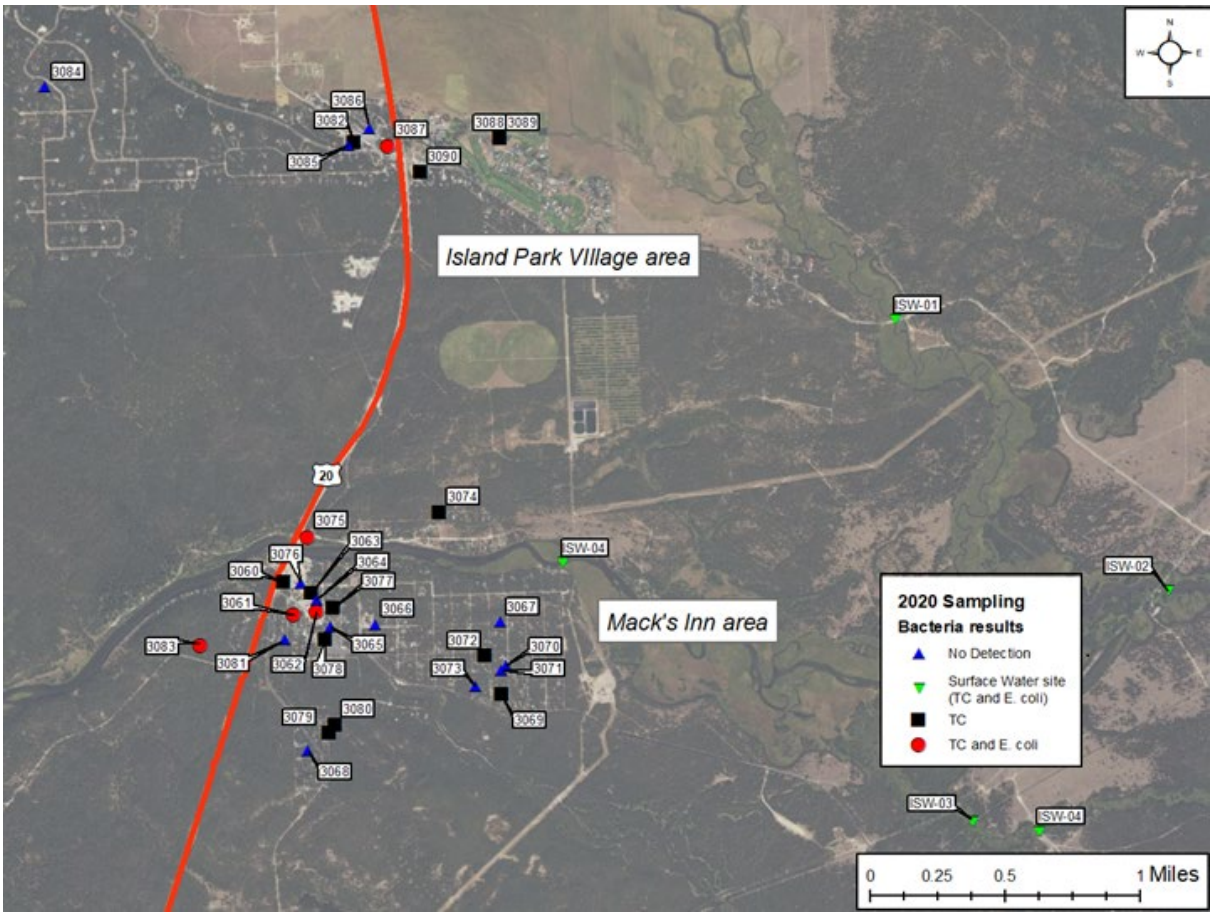


Figure 55. 2020 bacteria results—Island Park Bacteria Investigation Groundwater Monitoring Project.

Table 62. 2020 bacteria results—Island Park Bacteria Investigation Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	
Water Quality Standard:			**<1**	**1.0**
3060	Unk	08/06/2020	<1.0	2.0
3061	Unk	08/13/2020	**1.0**	3.1
3062	Unk	08/13/2020	**1.0**	1.0
3063	Unk	08/13/2020	<1.0	2.0
3064	Unk	08/13/2020	<1.0	<1.0
3065	83	08/13/2020	<1.0	<1.0
3066	Unk	08/13/2020	<1.0	<1.0
3067	Unk	08/13/2020	<1.0	<1.0
3068	160	08/13/2020	<1.0	<1.0
3069	Unk	08/13/2020	<1.0	4.1
3070	Unk	08/13/2020	<1.0	<1.0
3071	Unk	08/13/2020	<1.0	<1.0
3072	80	08/13/2020	<1.0	28
3073	70	08/13/2020	<1.0	<1.0
3074	Unk	08/13/2020	<1.0	2.0
3075	Unk	08/06/2020	**41**	727
3076	285	08/06/2020	<1.0	<1.0
3077	122	08/06/2020	<1.0	2.0
3078	Unk	08/06/2020	<1.0	2.0
3079	Unk	08/06/2020	<1.0	1.0
3080	Unk	08/06/2020	<1.0	1.0
3081	125	08/06/2020	<1.0	<1.0
3082	65	08/06/2020	<1.0	58
3083	119	08/13/2020	**1.0**	248
3084	290	08/06/2020	<1.0	<1.0
3085	140	08/06/2020	<1.0	<1.0
3086	150	08/06/2020	<1.0	<1.0
3087	143	08/06/2020	**6.3**	77
3088	145	08/06/2020	<1.0	<1.0
3089	207	08/06/2020	<1.0	1.0
3090	106	08/06/2020	<1.0	19
ISW-01	—	08/06/2020	**69**	2419
ISW-02	—	08/06/2020	**4.1**	613
ISW-03	—	08/06/2020	**48**	517
ISW-04	—	08/06/2020	**36**	517
ISW-05	—	08/13/2020	**29**	1120

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Bacteria Concentrations[a]	
			E. coli	Total Coliform
			(MPN/100 mL)	

Notes: ft bgs = feet below ground surface; MPN/100 mL = most probable number per 100 milliliters; Unk = Unknown. Well log not found; (–) = Not analyzed or not applicable. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
a. Total coliform and *E. coli* standards are from Idaho "Groundwater Quality Rule" (IDAPA 58.01.11.200). An exceedance of the primary groundwater quality standard for total coliform (indicated by gray shaded numbers) is not a violation of these rules. Total coliform is not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present. Although the standards are given in colony forming units per 100 milliliters, analytical results provided in MPN/100 mL are acceptable for comparison to the standard.

2.3.3.2.3 General Groundwater Chemistry

Common ion chemistry provides a picture of the overall relative character of groundwater, including mixing from different sources and changes in groundwater chemistry from processes such as dissolution of the aquifer matrix, infiltration, and impacts from contamination sources. Common ion chemistry along with field parameters can also provide clues to ongoing chemical processes and indications of the favored chemical forms for nitrogen in groundwater (Table 63).

Differences in general groundwater chemistry between sites are summarized by a type of ternary diagram referred to as a Piper diagram. Water quality results are represented by the proportional composition of the common ions (calcium, magnesium, sodium, potassium, total alkalinity [as CaCO3], chloride, and sulfate), in terms of their electrochemical equivalent concentration (milliequilivents per liter). Results are presented as their proportional cation and anion concentrations and as proportions calcium+magnesium and chloride+sulfate. The significance of this presentation is that the proportional differences in composition are not masked by mass concentrations. Presenting results as a Piper diagram aids in understanding mixing between chemical sources. Figure 56 suggests the general water chemistry as reflected by data from ISW-04 (Henry's Fork at Mack's Inn) can be interpreted as a mixture of upgradient surface water chemistry (ISW-01 Henry's Lake Outlet) and groundwater. Overall, the regional groundwater is described as a calcium-magnesium or magnesium-bicarbonate water type. The additional surface water sites ISW-02, -03, -05 (Big Springs, Lucky Dog, and Moose Creek) are more of a sodium-bicarbonate water type. Distinct sample sites identified (Wells 3075, 3090, 3074, and 3083) differ with a chemistry reflecting a proportional increase in chloride compared to the surface water sites and other groundwater sites. These specific sites are among those that had positive bacteria detections.

Table 63. Common ion and total dissolved solids results—Island Park Bacteria Investigation Groundwater Monitoring Project.

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3)	Calcium	Chloride[a]	Magnesium	Potassium	Sodium	Sulfate[a]
					(mg/L)				
Water Quality Standard:			**No Standard**	**No Standard**	**250**	**No Standard**	**No Standard**	**No Standard**	**250**
3060	Unk	08/06/2020	41.3	9.0	0.725	2.5	2.1	4.0	1.53
3061	Unk	08/13/2020	68.9	16	2.84	4.8	2.4	7.2	1.46
3062	Unk	08/13/2020	74.2	16	3.23	5.1	2.4	7.3	1.47
3063	Unk	08/13/2020	49.8	12	4.02	3.4	2.1	5.4	1.90
3064	Unk	08/13/2020	107	21	1.23	7.2	2.7	9.8	0.246
3065	83	08/13/2020	102	20	1.57	6.8	2.8	9.1	0.634
3066	Unk	08/13/2020	60.4	14	2.35	3.9	2.2	6.5	1.86
3067	Unk	08/13/2020	43.5	9.4	2	2.5	2.2	5.7	1.88
3068	160	08/13/2020	45.6	9.5	1.47	2.9	1.9	5.0	1.69
3069	Unk	08/13/2020	61.5	13	2.20	3.4	2.6	8.0	2.06
3070	Unk	08/13/2020	46.6	9.8	2.01	2.5	2.4	6.7	1.93
3071	Unk	08/13/2020	45.6	9.2	2.18	2.4	2.4	6.5	1.90
3072	80	08/13/2020	41.3	9.0	2.14	2.3	2.3	5.9	1.89
3073	70	08/13/2020	73.1	14	1.94	4.3	2.5	7.4	1.67
3074	Unk	08/13/2020	28.6	9.0	18.1	2.5	1.7	8.9	1.56
3075	Unk	08/06/2020	29.7	7.6	4.32	1.9	1.2	4.1	1.46
3076	285	08/06/2020	41.3	8.4	0.724	2.9	1.5	3.8	1.57
3077	122	08/06/2020	47.7	11	3.29	3.0	1.9	5.0	2.13
3078	Unk	08/06/2020	55.1	13	2.86	3.5	2.2	5.9	1.68
3079	Unk	08/06/2020	49.8	11	3.25	3.0	2.1	6.2	1.70
3080	Unk	08/06/2020	47.7	10	2.21	2.6	2.2	6.4	1.73
3081	125	08/06/2020	64.7	14	3.11	4.2	2.2	6.4	1.47
3082	65	08/06/2020	37.1	8.2	0.945	2.4	1.2	3.0	1.27
3083	119	08/13/2020	39.2	8.9	6.57	2.4	1.6	6.8	1.62

DEQ Site ID	Well Depth (ft bgs)	Sample Date	Alkalinity as (CaCO3)	Calcium	Chloride[a]	Magnesium	Potassium	Sodium	Sulfate[a]
					(mg/L)				
3084	290	08/06/2020	31.8	7.9	1.11	1.8	1.1	3.3	1.37
3085	140	08/06/2020	37.1	8.6	0.834	2.4	1.2	3.1	1.28
3086	150	08/06/2020	37.1	8.3	1.43	2.4	1.1	3.0	1.20
3087	143	08/06/2020	38.2	9.0	3.40	2.7	1.3	3.5	1.19
3088	145	08/06/2020	41.3	9.8	1.26	3.0	1.5	2.5	1.20
3089	207	08/06/2020	41.3	9.7	1.24	3.0	1.5	2.6	1.17
3090	106	08/06/2020	39.2	13	17.3	3.8	1.8	7.3	2.41
ISW-01	—	08/06/2020	109	24	1.31	9.7	1.4	2.9	3.31
ISW-02	—	08/06/2020	37.1	5.2	2.73	0.78	2.8	13	2.29
ISW-03	—	08/06/2020	31.8	4.4	2.07	0.66	2.8	11	2.02
ISW-04	—	08/06/2020	63.6	12	2.10	4.0	2.3	8.8	2.59
ISW-05	—	08/13/2020	46.6	4.8	3.45	0.74	3.4	18	2.82

Notes: ft bgs = feet below ground surface; mg/L = milligram per liter; No Standard = No Primary or Secondary Drinking Water Regulation or Idaho Groundwater Quality Rule standard currently established; Unk = Unknown. Well log not found; (—) = Not analyzed or not applicable.

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

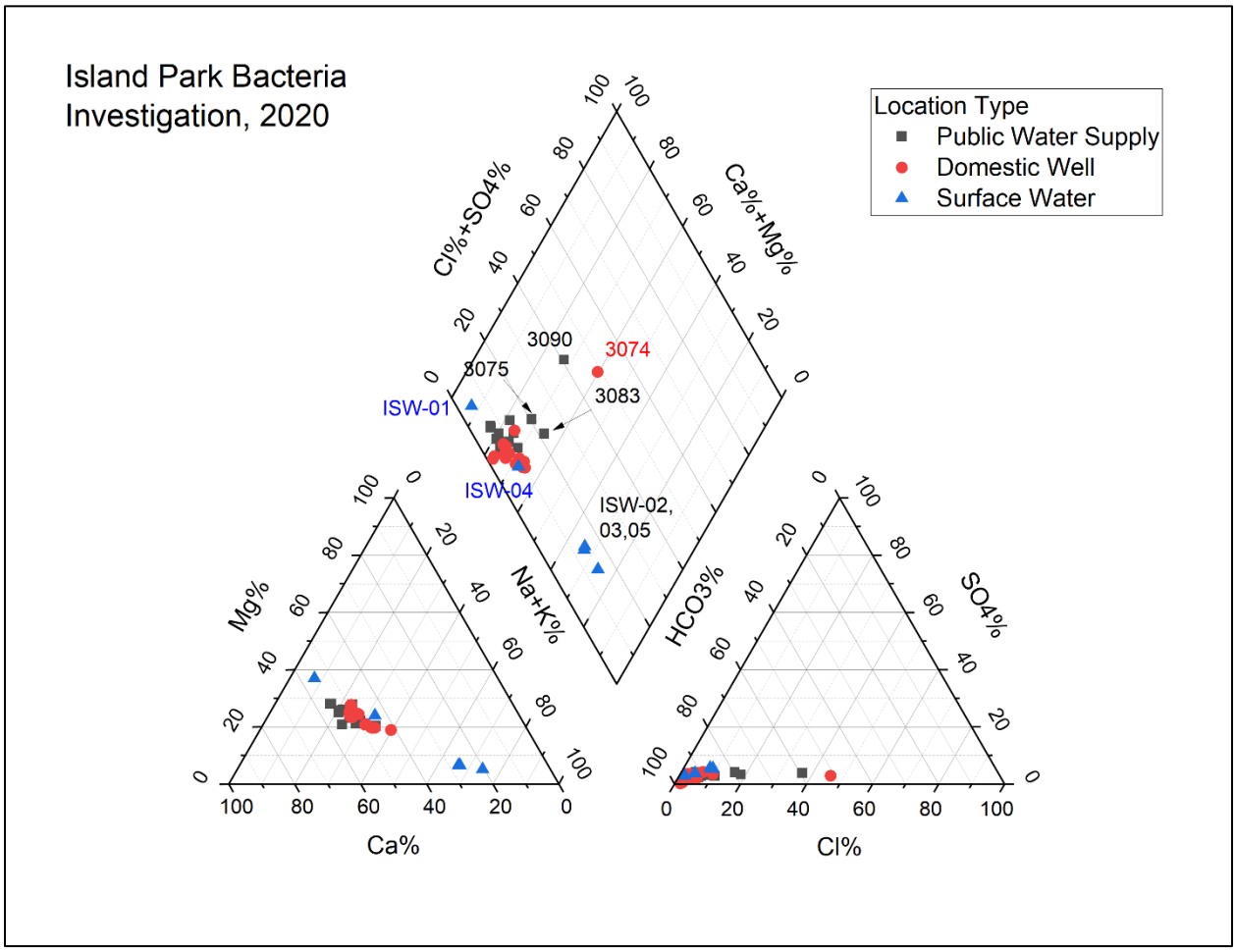


Figure 56. Piper diagram with 2020 common ion data—Island Park Bacteria Investigation Groundwater Monitoring Project

2.3.3.3 Conclusions

This regional monitoring study investigated the increase in bacteria detections near Mack's Inn and Island Park Village area in PWS wells to determine potential sources of contamination and the extent of the impact. The 2020 sampling activities and results are summarized, and additional data collected in 2021 was provided to the community in an *IDEQ Island Park Bacteria Investigation*.

TC bacteria detections for both PWS wells and DWs were relatively widespread for the 2020 sampling period, with 17 of 31 groundwater sites (10 PWS and 7 DW) with a positive detection of TC; 5 of these sites (3 PWS and 2 DW) also had *E. coli* detections. As expected, surface water sites were positive for both TC and *E. coli* and had higher concentrations than groundwater sites. Seasonality for bacteria detections will be assessed when the 2021 (spring) sampling data are presented in the 2021 annual report. A complete summary of 2020 and 2021 sampling results is provided in the *IDEQ Island Park Bacteria Investigation*.

An interim conclusion from nitrate and ammonium sampling is that evaluating nitrogen input from atmospheric sources and from the Mack's Inn/Island Park treated wastewater land application site may aid in discerning possible waste-related nitrate impacts to groundwater.

Review of common ion chemistry presented as a Piper diagram illustrates that most groundwater sites plot between surface water sites ISW-01 and ISW-04, suggesting a combination of the representative chemistry from ISW-01 and most groundwater sites reflects the common ion chemistry represented by ISW-04. The chemistry represented by the remaining surface water sites (ISW-02,03,05) is distinct. Wells 3090. 3074, 3083, and 3075 reflect a water source with a proportionally greater chloride composition and a general mixing of the ISW-01-type water. This proportionally greater chloride-type water can largely explain the variation in groundwater chemistry. These distinct sites also returned bacteria detections, and one site returned a nitrate result distinct from other sites.

Review of results for stable isotopes of oxygen and hydrogen in water ($\delta^{18}O_{water}$, $\delta^{2}H_{water}$) identified Wells 3090 and 3074 with a less-depleted, more summer precipitation-like signature distinct from most groundwater sites. Surface water sites ISW-01 and 04 also plot distinct, with that summer-like signature. This combination by itself, considering the spatial relationship of the sites, does not support a conclusion that surface water from these sites have a strong influence on groundwater. Wells 3064 and 3065 plot in a region that would conclude the groundwater for those sites is significantly influenced by winter snow melt, and melting winter snows are likely a factor in driving existing bacteria sources through the soil profile to groundwater for some areas. Surface water from Henry's Lake Outlet and the Henry's Fork in the Mack's Inn area is less likely to be a significant influence on bacteria occurrence.

Impacted sites more frequently included older wells completed under older and less-stringent construction standards.

2.3.3.3 Recommendations

Based on this investigation, DEQ recommends PWS operators contact DEQ's Idaho Falls Regional Office Source Water Protection staff to discuss source water protection for their systems. Operators are also encouraged to reach out to their regional Drinking Water Compliance staff if they have reoccurring bacteria detections. Options may include drilling a new well that seals out shallow (surface) sources of contamination or modifying an existing seal; consolidating with another PWS with the added benefit of sharing the infrastructure costs; or installing necessary treatment to provide safe and reliable drinking water to its consumers.

Private DW owners impacted by the bacteria contamination (and others with concerns) are encouraged to contact DEQ, EIPHD, or Idaho Department of Water Resources staff to learn more about options to provide safe drinking water to their homes. Options include onsite treatment, new well construction or well modification, or connection to a PWS. Private well owners are encouraged to test their well water regularly—DEQ and EIPHD have recommendations for the list of constituents and frequency of sampling as well as a list of certified laboratories for sample analysis. Monitoring tutorial videos created by Idaho Department of Health and Welfare staff are available on their website along with health

information for select contaminants commonly detected in groundwater. Well owners with a septic system are also strongly encouraged to have their system professionally serviced every 3 to 5 years (or more frequently, depending on level of use).

City and county officials are encouraged to investigate potential contamination sources (leaks in sewer collection lines), identify active septic systems, and work with the property owners to connect to the central wastewater system. Development and enforcement of ordinances to protect groundwater quality is encouraged. Such ordinances could require new construction and development to connect to the nearest PWS and central wastewater system and increase the required bacteria sampling frequency from private wells serving known rentals.

3 DEQ Cooperative Project

This section presents data from special groundwater quality monitoring projects conducted jointly by DEQ and other state agencies in calendar year 2021.

3.1 DEQ-IDWR Groundwater Monitoring Project

This section presents data from special groundwater quality monitoring and investigation projects that were conducted jointly by DEQ and IDWR in calendar year 2021.

3.1.1 Purpose and Background

The IDWR Statewide Ambient Groundwater Quality Monitoring Network assesses groundwater quality across Idaho. DEQ partnered with IDWR to collect dissolved methane and nitrogen isotope ($\delta^{15}N$) samples from select wells to help assess groundwater quality in Idaho. The counties of interest for the methane analysis included Canyon, Elmore, Gem, and Payette, and the $\delta^{15}N$ samples were based on nitrate concentration. The groundwater samples were collected by IDWR staff during statewide network sampling events, while DEQ paid for the analysis. The addition of $\delta^{15}N$ will assist in future nitrogen source evaluation. Results are provided in Appendix A.

3.1.2 Methods and Results

IDWR collected 10 samples for dissolved methane from 10 domestic wells across the southwest portion of the state following its Standard Operating Procedures for the Statewide Ground Water Quality Monitoring Program (IDWR 2022). Samples were collected using the Isotech Laboratories Isoflask and were submitted to the Idaho Bureau of Laboratories and subcontracted to Isotech Laboratories, Inc. (Appendix A, Table A-1). The IsoFlask was used due to its unique design that maintains (does not alter) the quantity or isotopic characteristic of any potential dissolved hydrocarbon gases in the sample (as compared to direct fill and inverted VOC sampling). Nitrogen isotope samples were collected from 24 wells (sites with nitrate concentrations greater than 5 mg/L) in 2021. The 2021 isotope samples were submitted together to the University of Arizona for analysis (Appendix A).

3.1.2.1 Methane Results

Dissolved methane concentrations reported for this project ranged from nondetect (<0.2 μg/L) to 30 μg/L (Appendix A, Table A-1 and Figure A-1); 7 of 10 samples had a reportable concentration ranging from 0.2 μg/L to 30 μg/L, while three of the 10 samples were nondetect. There is no MCL or NSDWR standard for dissolved methane in groundwater. The hazard with methane in groundwater occurs when dissolved methane exsolves (outgasses) from the water into the surrounding air or a confined space, where it can potentially ignite and/or explode. The suggested action level for methane is 28,000 μg/L (Eltschlager et al. 2001). All results were below the explosive risk level.

3.1.2.2 Nitrogen Isotope Results

The 2021 $\delta^{15}N$ results are presented in Appendix A, Table A-1 and Figure A-2. The $\delta^{15}N$ ratios ranged from 2.3‰ to 17.9‰. Two of the 24 samples (8.3%) had a ratio consistent with inorganic sources (<4.0‰); 19 (79.2%) samples had ratios consistent with a mixed or organic source of nitrogen (4.0‰–<9.0‰); three (12.5%) samples had ratios consistent with waste (animal or human) sources of nitrogen (≥9.0‰) (Seiler 1996; Table 3).

3.1.3 Conclusions

The cooperative project between IDWR and DEQ resulted in the cost-effective collection of additional $\delta^{15}N$ data that will assist in future nitrogen source evaluation. The methane data provides conformation of ambient methane presence in groundwater.

3.1.4 Recommendations

This collaborative effort between state agencies in Idaho saved time and money by using existing groundwater monitoring networks and sampling schedules. IDWR and DEQ should continue these cooperative projects to increase program efficiency and protect groundwater quality in the state.

3.2 DEQ-ISDA Groundwater Monitoring Project

This section presents data from special groundwater quality monitoring and investigation projects that were conducted jointly by DEQ and ISDA in calendar year 2021.

3.2.1 Purpose and Background

The ISDA Groundwater Program developed a groundwater monitoring network across Idaho to assess the impacts of pesticide use on groundwater quality. DEQ partnered with ISDA and paid for analysis of nitrate, arsenic, uranium, and $\delta^{15}N$ to assess groundwater quality across the state. The groundwater samples, collected by ISDA staff during pesticide sampling events, will identify areas of concern and potential health impacts associated with degraded groundwater quality. The information will augment data from PWS, IDWR Statewide Ambient Groundwater

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 submitted groundwater samples from a total of 251 domestic wells from 26 projects across the state following its Ambient Groundwater Quality Monitoring QAPP (ISDA 2017a) and corresponding regional FSPs: Ambient Groundwater Quality Monitoring—Boise Regional Office FSP; Ambient Groundwater Quality Monitoring—Idaho Falls Regional Office FSP; Ambient Groundwater Quality Monitoring—Northern [Coeur d'Alene and Lewiston] Regional Offices FSP; Ambient Groundwater Quality Monitoring—Pocatello Regional Office FSP; and Ambient Groundwater Quality Monitoring—Twin Falls Regional Office FSP (ISDA 2020b-f). The analytes of interest included nitrate (nitrate-nitrite nitrogen), ammonia, arsenic, uranium, and nitrogen ($\delta^{15}N$) isotope. All 251 wells sampled were sampled for nitrate. A subset of the 251 wells were also sampled for ammonia or arsenic and uranium, based on location in known areas with presence of elevated concentrations or special interest. In addition, 44 quality assurance samples were collected—41 duplicate samples and three blank samples were analyzed. Samples for nitrate, ammonia, arsenic, and uranium analysis were submitted to the Idaho Bureau of Laboratories. Most samples with nitrate concentrations above 5 mg/L were sent to the University of Arizona 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 Table B-1 (Appendix B).

3.2.2.1 Nitrate (Nitrate-Nitrite Nitrogen) Results

Nitrate (nitrate-nitrite nitrogen) concentrations for this project ranged from nondetect (<0.010 mg/L) to 79 mg/L. Out of the 251 sites with samples collected for nitrate analysis, 68 samples (27%) were between 5 mg/L (half the EPA MCL of 10 mg/L) and 10 mg/L; 52 samples (21%) met or exceeded the MCL. Five of the 26 ISDA projects (Projects 710 [Washington/Payette Counties], 730 [Minidoka County] and 790 [Cassia County], 865 [Owyhee County], and 950 [Clearwater/Lewis/Nez Perce Counties]) sampled in 2021 had 60% of the 10 mg/L or greater nitrate concentrations. In total, 180 samples (72%) 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 2014).

Well locations and nitrate concentrations are shown in Appendix B, Table B-1 and Figures B-1–B-23.

3.2.2.2 Ammonia Results

A total of 13 wells were sampled for ammonia in addition to nitrate. Ammonia concentrations for this project ranged from nondetect (<0.050 mg/L) to 9.8 mg/L (Appendix B, Table B-1). The median concentration was 7.9 mg/L. All 13 wells sampled for ammonia were within Owyhee County, which is known to have wells drilled into a deeper, confined aquifer with low or depleted DO concentrations. There is currently no MCL or Groundwater Quality Rule standard for ammonia.

3.2.2.3 Nitrogen Isotope Results

DEQ submitted a total of 104 ISDA-collected nitrogen isotope ($\delta^{15}N$) samples from 103 wells with nitrate concentrations of approximately 5 mg/L or greater (one sample was a duplicate for quality assurance). The 104 samples were collected from 103 wells from 19 projects, including Projects 220 (Ada and Canyon Counties), 300 (Latah County), 340 (Payette County), 350 (Ada County), 530 (Ada County), 710 (Washington and Payette Counties), 730/740 (Minidoka County), 770 (Gem and Payette Counties), 780 (Twin Falls County), 790 (Cassia County), 805 (Fremont, Madison, and Teton Counties), 830 (Jefferson County), 840 (Bonneville, Jefferson, Madison Counties), 860/865 (Owyhee County), 870 (Gooding County), 890 (Elmore County), and 950 (Clearwater, Lewis, and Nez Perce Counties).

The measurable $\delta^{15}N$ values ranged from 0.1‰ to 19.6‰. A total of 45 (43%) wells had samples with values between 0.1‰ and 3.9‰, suggesting commercial fertilizer as the likely nitrogen source. A total of 54 (52%) wells had samples with $\delta^{15}N$ values between 4.0‰ and 8.6‰, suggesting organic nitrogen in soil or a mixed nitrogen source as the likely nitrate source. The remaining four (5%) wells had samples with a $\delta^{15}N$ value greater than 9‰; suggesting a waste (animal or human) source of nitrogen. (Seiler 1996; Table 3 and Table B-1). Three of the four wells with $\delta^{15}N$ values suggesting a potential waste isotopic signature were from Project 730 in Minidoka County.

3.2.2.4 Arsenic Results

A total of 33 wells were sampled for arsenic in addition to nitrate. Arsenic concentrations for this project ranged from nondetect (<1.0 µg/L) to 36 µg/L (Appendix B, Table B-1). The median concentration was 6.0 mg/L. The 33 wells sampled for arsenic were within Ada, Canyon, Gem, and Payette Counties, which have been shown through sampling conducted by IDWR to have elevated arsenic and uranium concentrations. The MCL for arsenic is 10 µg/L, and the Idaho Ground Water Quality Rule standard is 50 µg/L. A total of 10 wells (30%) had concentrations above the MCL. None of the sampled sites had a detection above the Idaho Ground Water Quality Rule standard. Well owners with concentrations exceeding the MCL are advised to treat their drinking water or use an alternative source of water.

3.2.2.5 Uranium Results

The 33 wells sampled for arsenic (and nitrate) were also sampled for uranium. Uranium (nonradioactive) concentrations for this project ranged from 1.40 µg/L to 67.0 µg/L (Appendix B, Table B-1). The median concentration was 11 mg/L. The MCL is 30 µg/L. There is no Idaho Ground Water Quality Rule standard. A total of five wells (15%) had a detection that exceeded the MCL; two of the five wells had concentrations that were more than double the MCL. Well owners with concentrations exceeding the MCL are advised to treat their drinking water or use an alternative source of water.

3.2.3 Conclusions

The cooperative project between ISDA and DEQ resulted in the cost-effective collection of additional nitrate and nitrogen isotope data that helped assess groundwater quality across the state. Out of the 251 samples collected for nitrate analysis, 52 (21%) wells had samples that met or exceeded the EPA nitrate MCL of 10 mg/L and 68 (27%) wells had samples between 5 mg/L and 10 mg/L. The nitrate results indicate degraded groundwater in specific vulnerable aquifers within a few counties (Appendix B, Figures B-1–B-23). These data will be helpful in the next NPA delineation and ranking process conducted by DEQ and the Groundwater Monitoring Technical Committee. The nitrogen isotope ratios provide one line of evidence for the potential sources of nitrogen contributing to the nitrate concentrations in groundwater.

3.2.4 Recommendations

This cooperative effort between state agencies in Idaho saved time and money by using existing groundwater monitoring networks and sampling schedules. ISDA and DEQ should continue these cooperative projects to increase program efficiency and protect groundwater quality in the state.

When budgets allow, arsenic and uranium samples should be collected in areas with known elevated concentrations to provide more information about the presence of those naturally occurring constituents of concern. This data provides valuable information to homeowners and those working to better understand areas with concentrations at levels that present human health risks.

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Appendix A. Idaho Department of Water Resources Collected Data–2021

Table A-1. 2021 Field parameters, nitrate, and nitrogen isotope results—DEQ-IDWR Joint Groundwater Monitoring Project.

Map ID	IDWR Station Name	County	Well Depth (ft bgs)	Sample Date	Water Temperature (°C)	pH[a]	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Methane (µg/L)[b]
	Water Quality Standard:				**No Standard**	**6.5–8.5**	**No Standard**	**No Standard**	**No Standard[c]**
M-1	07N 03W 09CDB1	Gem	135	8/5/2021	15.3	7.3	549.9	0.040	0.64
M-2	07N 04W 13CBB1	Payette	137	7/6/2021	18.0	*9.1*	166.8	<0.010	3.2
M-3	08N 05W 03BAD1	Payette	26	7/8/2021	14.3	7.2	622.1	4.25	0.20
M-4	09N 05W 27DAA1	Payette	69	7/8/2021	16.4	7.0	696.6	4.85	<0.20
M-5	02N 04W 13ACD1	Canyon	205	6/24/2021	18.5	7.1	1600	0.81	6.2
M-6	04N 04W 05CAC1	Canyon	224	8/4/2021	15.9	8.2	369.6	0.08	30
M-7	04N 06W 11DCA1	Canyon	31	8/10/2021	15.7	7.6	645.1	4.60	<0.20
M-8	05N 05W 28CDBB1	Canyon	190	8/5/2021	15.7	7.7	1106	0.040	7.3
M-9	05N 06W 25CDD1	Canyon	168	7/14/2021	17.0	7.5	937.1	1.39	0.45
M-10	04S 03E 33ADDA1	Elmore	68	6/23/2021	15.6	7.2	1145	2.88	<0.20

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligram per liter; µg/L = microgram per liter. Italicized, gray shaded numbers indicate an EPA National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.

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

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

c. Explosive risk for dissolved methane is 28,000 µg/L.

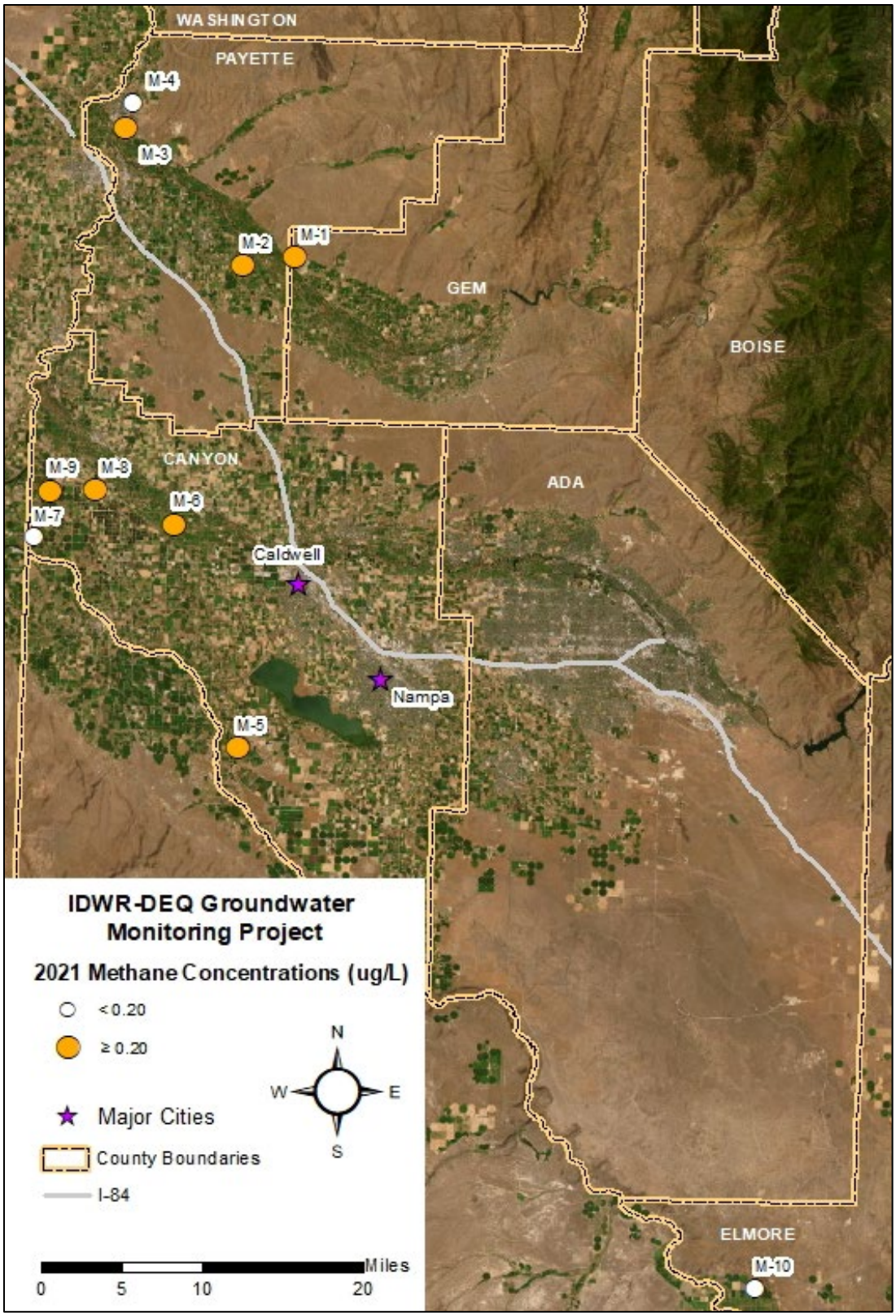


Figure A-1. 2021 dissolved methane results in southwest Idaho—DEQ-IDWR Joint Groundwater Monitoring Project.

Table A-2. 2021 nitrogen isotope results—DEQ-IDWR Joint Groundwater Monitoring Project.

Map ID	IDWR Site ID	County	Well Depth (ft bgs)	Sample Date	Temperature (°C)	pH[a]	Dissolved Oxygen (mg/L)	Specific Conductance (uS/cm)	Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
	Water Quality Standard:				**No Standard**	**6.5-8.5**		**No Standard**	**10**	**No Standard**
N-1	01N 01W 07CAB1	ADA	461	7/15/2021	—	—	—	—	8.9	7.6
N-2	03N 02E 25AAC1	ADA	70	6/16/2021	15.3	6.58	5.55	494.3	3.9	6.7
N-3	04N 01E 29BABD2	ADA	78	8/3/2021	15.1	7.06	5.10	765.0	5.0	7.1
N-4	09S 38E 04BCC1	BANNOCK	80	7/7/2021	12.7	7.43	7.71	697.7	8.6	7.4
N-5	13S 44E 23BBB1	BEAR LAKE	59	6/29/2021	9.7	7.03	4.92	1576	**32**	12
N-6	62N 01E 12CAD1	BOUNDARY	38	7/26/2021	9.4	7.09	2.00	1155	**28**	7.9
N-7	02N 02W 12CDD1	CANYON	90	7/15/2021	15.7	7.59	8.35	756.8	6.2	5.5
N-8	03N 02W 31BCC1	CANYON	172	7/15/2021	15	7.77	4.84	773.0	4.4	5.6
N-9	03N 03W 03BBC1	CANYON	110	7/26/2021	—	—	—	—	8.4	6.0
N-10	03N 04W 04BDA1	CANYON	92	7/14/2021	16.7	7.53	7.39	630.3	8.2	2.3
N-11	05N 04W 21DCBB1	CANYON	59	7/14/2021	15.4	7.48	6.13	1141	14	5.6
N-12	05N 06W 25CDD1	CANYON	168	7/14/2021	17	7.49	1.39	937.1	7.1	5.0
N-13	06N 05W 07ABB2	CANYON	57	7/6/2021	14.4	7.27	6.04	676.8	4.4	6.1
N-14	36N 02E 22BBBC1	CLEARWATER	615	7/19/2021	17.8	7.53	7.22	400.3	**15**	18
N-15	04S 03E 33ADDA1	ELMORE	68	6/23/2021	15.6	7.23	2.88	1145	**16**	13
N-16	37N 05W 12ABC1	LATAH	52	7/21/2021	12.9	7.18	6.18	317.9	6.2	3.7
N-17	08S 23E 28CAC1	MINIDOKA	251	7/8/2021	14.5	7.54	7.61	941.1	9.4	4.5
N-18	36N 02W 31DBA1	NEZ PERCE	630	7/21/2021	14.9	7.18	9.60	279.0	9.2	7.6
N-19	09S 28E 14CDBB1	POWER	888	6/21/2021	12.7	7.55	7.83	1153	**10**	4.6
N-20	07N 45E 32DAC1	TETON	240	6/29/2021	8.7	7.14	6.78	717.9	5.3	6.5
N-21	09S 16E 26BCA1	TWIN FALLS	77	6/29/2021	17.2	7.01	7.42[c]	906.5	5.2	5.4
N-22	10S 18E 08CDD1	TWIN FALLS	345	6/29/2021	16.7	7.61	7.26[c]	815.0	4.7	5.1

Map ID	IDWR Site ID	County	Well Depth (ft bgs)	Sample Date	Temperature (°C)	pH[a]	Dissolved Oxygen (mg/L)	Specific Conductance (uS/cm)	Nitrate[b] (mg/L)	$\delta^{15}N$ (‰)
N-23	11S 16E 27CCC1	TWIN FALLS	580	6/29/2021	16.7	7.54	7.74[c]	879.3	9.8	8.4
N-34	13S 16E 08BBAC1	TWIN FALLS	140	7/27/2021	13.8	7.18	9.32[c]	1868	5.6	8.6

Notes: ft bgs = feet below ground surface; °C = degrees Celsius; µS/cm = microsiemens per centimeter; milligram per liter; ‰ = per mil; (–) = not analyzed or data are unavailable. Bold gray shaded numbers indicate an EPA primary drinking water standard regulation was exceeded. Bolded, gray shaded numbers indicate either an EPA National Primary Drinking Water Regulation (NPDWR) standard, expressed as a maximum contaminant level (MCL), or Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.200) standard was reached or exceeded. These regulations apply to public water systems only but are used to evaluate water quality in private wells.
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 public water systems but can be applied to private wells to evaluate water quality.
b. Contaminant with a National Primary Drinking Water Regulation standard.
c. DO values were converted from % saturation to mg/L using estimated surface elevation and water temperature.

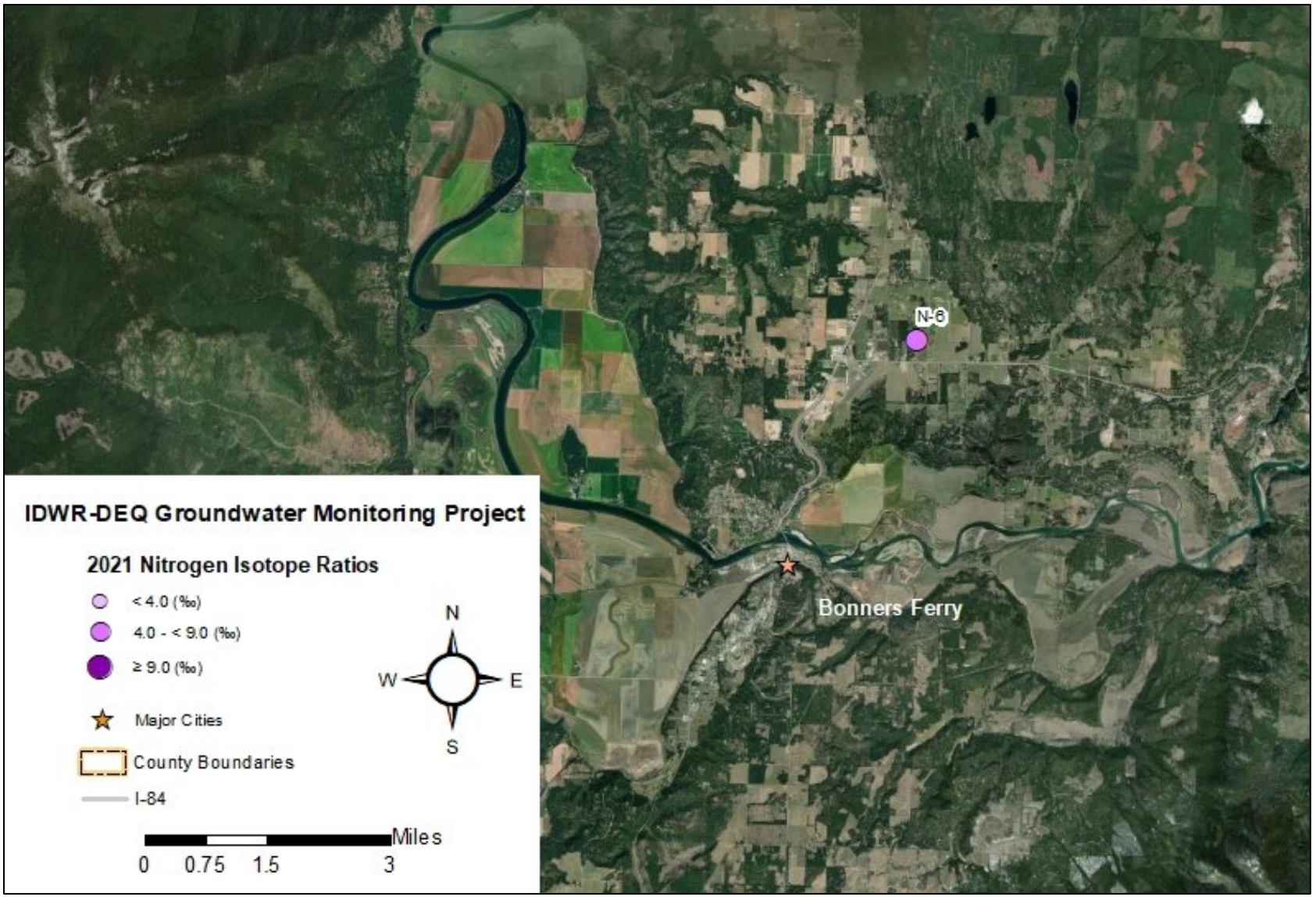


Figure A-2. 2021 north Idaho nitrogen isotope ratios—DEQ-IDWR Joint Groundwater Monitoring Project.

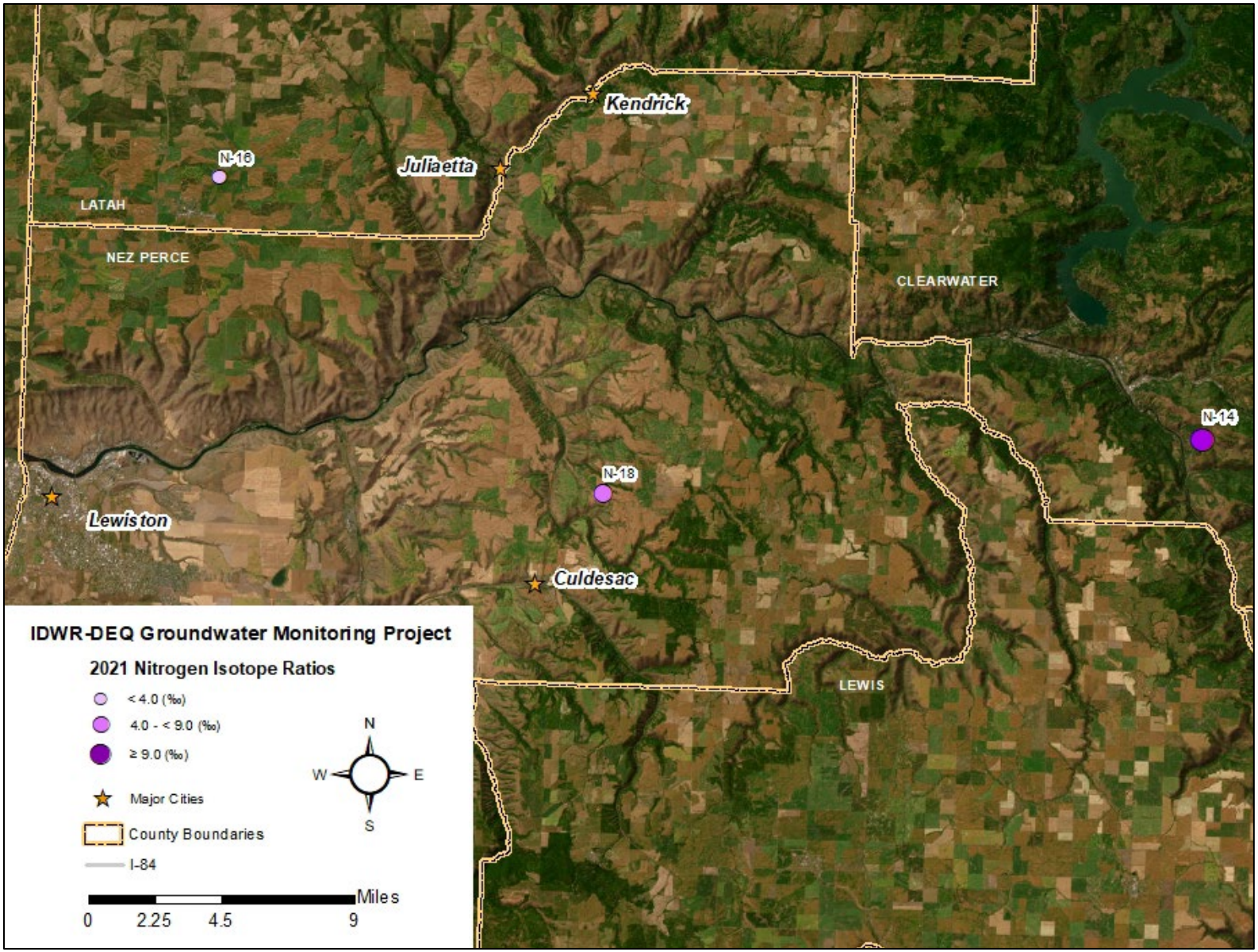


Figure A-3. 2021 north Idaho nitrogen isotope ratios—DEQ-IDWR Joint Groundwater Monitoring Project.

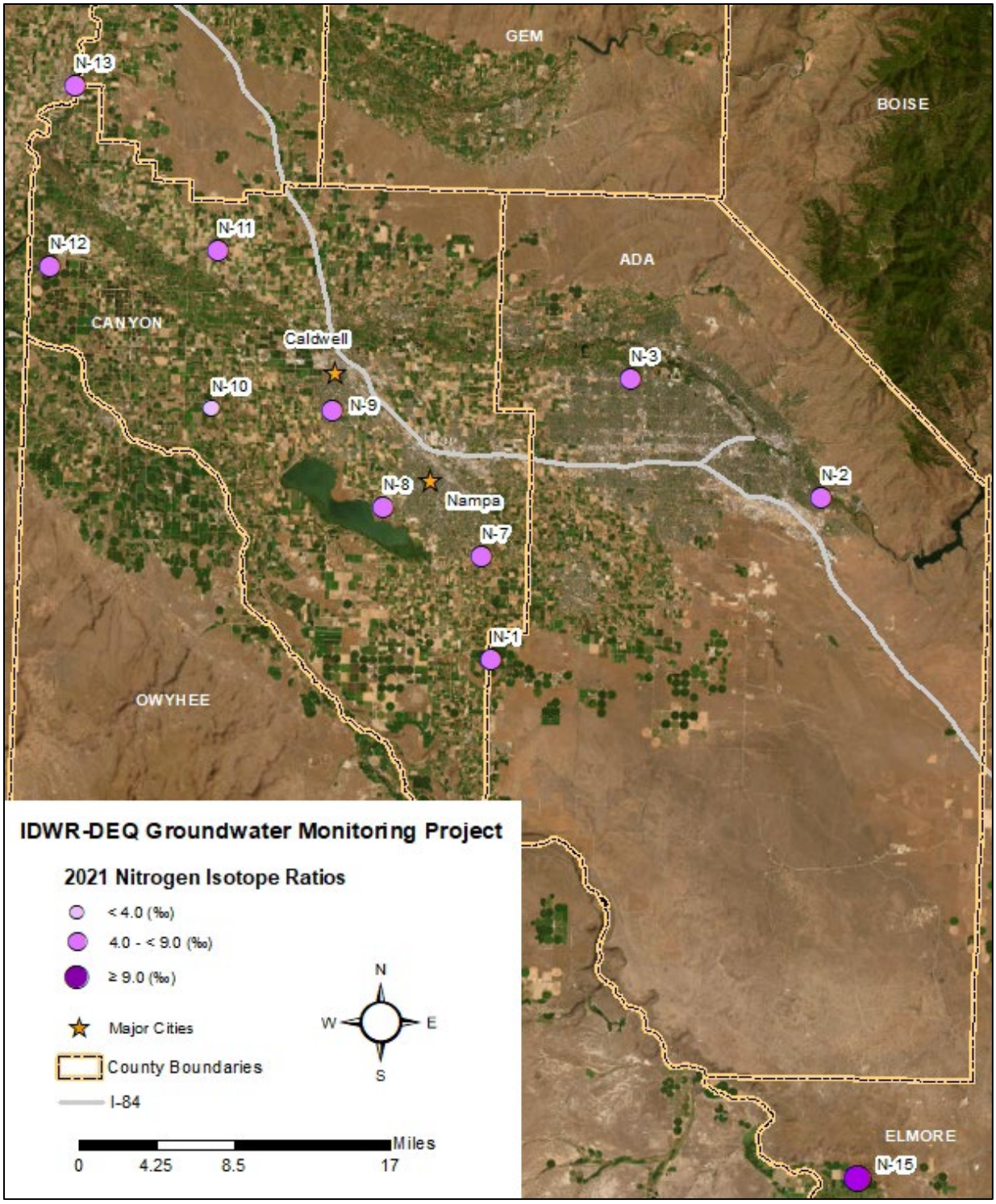


Figure A-4. 2021 southwest Idaho nitrogen isotope ratios—DEQ-IDWR Joint Groundwater Monitoring Project.

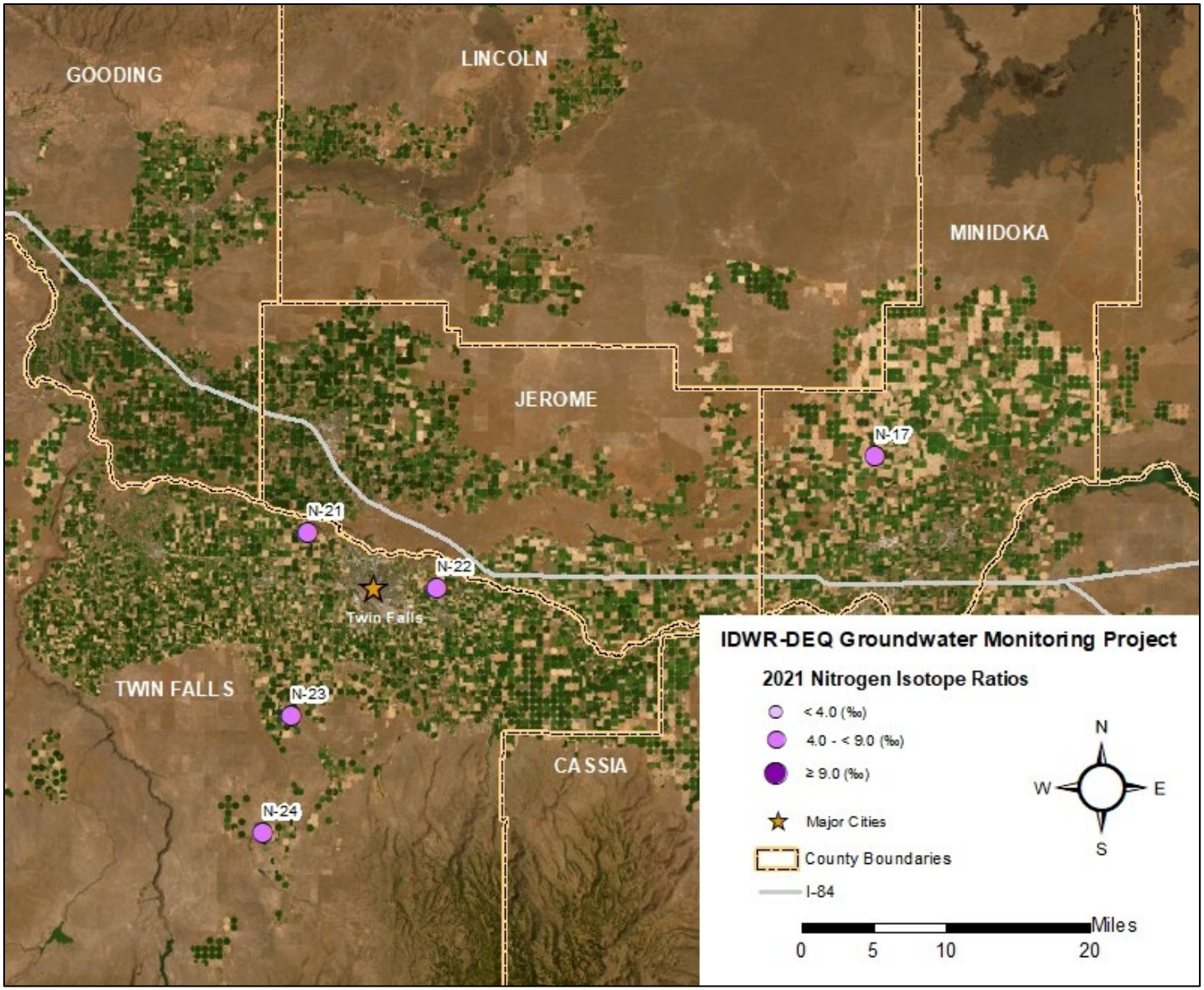


Figure A-5. 2021 southcentral Idaho nitrogen isotope ratios—DEQ-IDWR Joint Groundwater Monitoring Project.

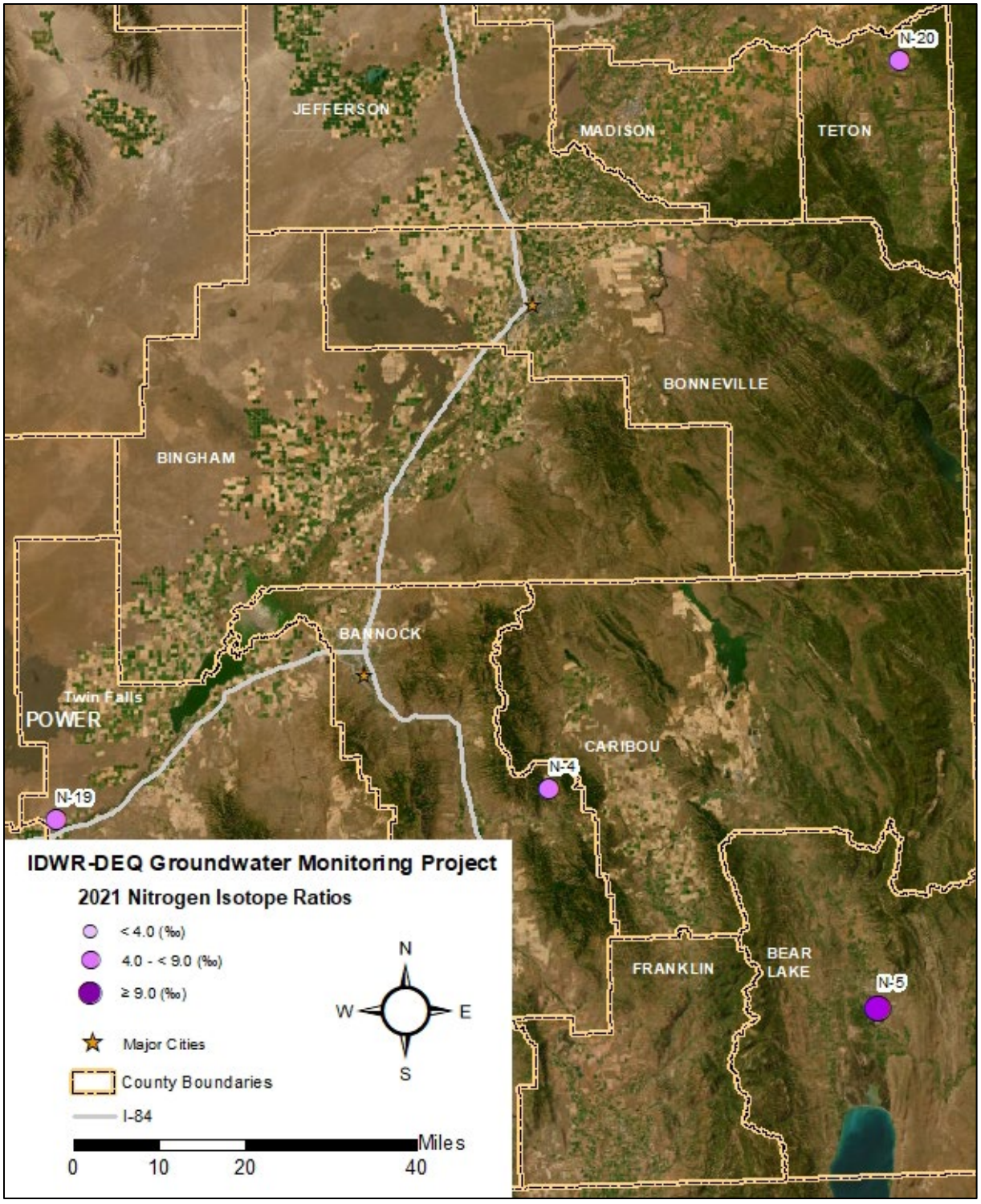


Figure A-6. 2021 east Idaho nitrogen isotope ratios—DEQ-IDWR Joint Groundwater Monitoring Project.

Appendix B. Idaho State Department of Agriculture Collected Data–2021

Table B-1. 2021 ISDA-collected analytical results.

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
Water Quality Standard:				No Standard	6.5-8.5	No Standard	10	No Standard	10	30	No Standard
2200301	220	6/8/2021	Ada/Canyon	14.4	7.65	795.7	**15**	–	**17**	10	2.5
2201301	220	6/7/2021	Ada/Canyon	14.9	7.93	1403.0	6.9	–	**23**	7.4	4.8
2201701	220	6/8/2021	Ada/Canyon	17.9	7.22	391.3	3.8	–	**26**	5.4	–
2201801	220	6/7/2021	Ada/Canyon	14.0	7.59	1193.0	8.4	–	5.8	8.4	1.5
2201901	220	6/7/2021	Ada/Canyon	15.7	7.55	1301.0	4.9	–	2.6	17	4.7
2203001	220	6/9/2021	Ada/Canyon	13.9	7.12	579.3	5.8	–	0.51J[c]	**34**	4.0
2203101	220	6/9/2021	Ada/Canyon	13.5	7.33	829.1	8.7	–	1.0J[c]	**67**	4.6
2204701	220	6/8/2021	Ada/Canyon	15.0	7.38	751.4	5.7	–	**12**	11	5.4
2204801	220	6/8/2021	Ada/Canyon	16.4	7.58	2159.0	**12**	–	**13**	**62**	3.8
2206401	220	6/8/2021	Ada/Canyon	17.3	7.75	436.1	1.4	–	2.7	4.6	–
2206601	220	6/7/2021	Ada/Canyon	15.1	7.34	1133.0	2.0	–	1.1J[c]	25	–
2206701	220	6/9/2021	Ada/Canyon	15.5	7.13	1539.0	0.15	–	1.6J[c]	**52**	–
2207101	220	6/7/2021	Ada/Canyon	16.2	7.88	1028.0	1.0	–	2.5	15	–
3003101	300	5/11/2021	Latah	12.2	7.06	342.1	4.7	–	–	–	–
3003601	300	5/11/2021	Latah	9.2	*6.40*	208.3	8.8	–	–	–	0.7
3003701	300	5/11/2021	Latah	11.4	7.02	219.9	2.6	–	–	–	–
3100201	310	6/14/2021	Owyhee	22.0	7.80	1886.0	<0.010	6.8	–	–	–
3100401	310	6/14/2021	Owyhee	21.7	7.82	1953.0	<0.010	8.9	–	–	–
3100601	310	6/14/2021	Owyhee	19.6	7.46	2020.0	4.4	4.8	–	–	–
3100701	310	6/14/2021	Owyhee	16.7	7.57	1822.0	<0.010	7.9	–	–	–
3101001	310	6/14/2021	Owyhee	18.2	7.61	2815.0	0.026	11	–	–	–
3101101	310	6/14/2021	Owyhee	18.4	7.58	2510.0	0.22	10	–	–	–
3101601	310	6/14/2021	Owyhee	20.1	7.78	2426.0	0.83	9.7	–	–	–
3400101	340	6/22/2021	Payette	15.8	7.45	831.6	9.7	–	**11**	13	2.9
3400701	340	6/22/2021	Payette	15.8	7.58	749.2	**11**	–	**14**	13	–
3400801	340	6/22/2021	Payette	15.7	7.52	925.9	8.7	–	9.2	22	6.3
3401501	340	6/22/2021	Payette	14.3	7.72	793.3	**12**	–	**36**	21	3.2
3500101	350	6/1/2021	Ada	14.5	7.13	661.5	3.8	–	7.6	8.6	–
3500201	350	6/1/2021	Ada	13.9	6.61	452.9	4.4	–	4.6	3.6	–
3500501	350	6/2/2021	Ada	15.2	6.89	239.1	1.9	–	1.2J[c]	1.9	–
3500701	350	6/2/2021	Ada	15.1	6.73	530.0	7.1	–	5.6	5.9	6.0

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
3501401	350	6/1/2021	Ada	15.6	6.96	398.0	2.5	—	4.2	1.9	—
3503001	350	6/2/2021	Ada	14.8	7.08	360.2	1.8	—	5.5	9.1	—
3503101	350	6/1/2021	Ada	14.4	6.81	251.8	2.8	—	0.56J[c]	1.4	—
5302701	530	6/16/2021	Ada	13.2	7.02	716.3	**46**	—	5.1	4.3	3.9
5303401	530	6/16/2021	Ada	13.8	7.14	764.2	**43**	—	—	—	5.1[d]
5303801	530	6/16/2021	Ada	13.6	6.91	730.0	**48**	—	5.8	4.2	4.0
5304001	530	6/16/2021	Ada	14.7	7.33	387.2	1.7	—	8.7	**34**	—
7100501	710	6/28/2021	Washington	13.7	7.55	779.0	**15**	—	—	—	0.2
7100601	710	6/28/2021	Washington	14.1	7.51	1281.0	**12**	—	—	—	2.9
7100901	710	6/29/2021	Washington	15.2	7.27	1044.0	**15**	—	—	—	3.4
7101101	710	6/23/2021	Washington	13.8	7.23	2924.0	**43**	—	—	—	—
7101701	710	6/29/2021	Washington	15.2	7.55	834.5	**12**	—	—	—	2.0
7102101	710	6/28/2021	Washington	15.4	7.36	1051.0	5.0	—	—	—	6.48
7102501	710	6/29/2021	Washington	15.3	7.04	1828.0	**24**	—	—	—	6.9
7103801	710	6/29/2021	Washington	13.9	7.48	1253.0	5.8	—	—	—	1.2
7103901	710	6/29/2021	Washington	16.2	7.30	750.7	6.0	—	—	—	—
7104101	710	6/28/2021	Washington	13.4	7.36	1384.0	**24**	—	—	—	4.7
7104201	710	6/28/2021	Washington	14.3	7.30	726.9	**18**	—	—	—	2.5
7104401	710	6/23/2021	Washington	14.8	7.51	870.2	5.5	—	—	—	7.1
7104601	710	6/28/2021	Washington	15.2	7.20	822.7	**12**	—	—	—	1.7
7104801	710	6/29/2021	Washington	14.7	7.60	874.4	**18**	—	—	—	0.3
7105101	710	6/28/2021	Washington	15.2	7.37	829.3	**12**	—	—	—	2.4
7105801	710	6/29/2021	Washington	13.7	7.57	917.7	**16**	—	—	—	0.1
7300201	730	5/4/2021	Minidoka (Shallow)	13.2	7.32	935.2	9.4	—	—	—	4.6
7300501	730	5/4/2021	Minidoka (Shallow)	15.8	7.68	649.4	1.3	—	—	—	—
7300801	730	5/4/2021	Minidoka (Shallow)	12.2	7.40	1805.0	**30**	—	—	—	4.2
7300901	730	5/4/2021	Minidoka (Shallow)	13.5	7.43	1012.0	8.3	—	—	—	19.6
7301101	730	5/5/2021	Minidoka (Shallow)	14.6	7.53	682.0	6.4	—	—	—	—
7301601	730	5/4/2021	Minidoka (Shallow)	12.0	7.46	931.6	**11**	—	—	—	5.1
7302001	730	5/4/2021	Minidoka (Shallow)	15.9	7.54	640.1	3.2	—	—	—	—
7302801	730	5/4/2021	Minidoka (Shallow)	13.1	7.40	3448.0	**13**	—	—	—	11.9
7303201	730	4/29/2021	Minidoka (Shallow)	12.6	7.19	3252.0	**43**	—	—	—	10.4
7303401	730	5/4/2021	Minidoka (Shallow)	11.8	7.64	663.3	0.094	—	—	—	—
7303901	730	5/5/2021	Minidoka (Shallow)	14.1	7.60	582.9	5.3	—	—	—	—
7304101	730	5/4/2021	Minidoka (Shallow)	14.0	7.58	748.2	8.0	—	—	—	—

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
7304301	730	5/5/2021	Minidoka (Shallow)	14.6	7.50	679.5	8.0	—	—	—	—
7304501	730	5/4/2021	Minidoka (Shallow)	11.7	7.44	963.4	9.9	—	—	—	4.4
7305401	730	5/4/2021	Minidoka (Shallow)	13.3	7.92	517.8	<0.010	—	—	—	—
7305501	730	5/4/2021	Minidoka (Shallow)	13.3	7.93	530.7	<0.010	—	—	—	—
7401501	740	4/19/2021	Minidoka (Deep)	14.8	7.51	799.0	7.1	—	—	—	4.0
7401701	740	4/15/2021	Minidoka (Deep)	13.3	7.56	966.4	8.4	—	—	—	6.2
7401801	740	4/15/2021	Minidoka (Deep)	13.2	7.62	847.0	5.2	—	—	—	3.7
7403201	740	4/19/2021	Minidoka (Deep)	14.5	7.60	1214.0	3.4	—	—	—	—
7404801	740	4/19/2021	Minidoka (Deep)	13.5	7.48	918.8	8.3	—	—	—	4.8
7404901	740	4/19/2021	Minidoka (Deep)	19.4	8.08	461.3	0.95	—	—	—	—
7405101	740	4/15/2021	Minidoka (Deep)	13.4	7.70	825.6	6.3	—	—	—	4.4
7500601	750	4/8/2021	Jerome/Gooding/Lincoln	14.9	7.62	686.0	2.9	—	—	—	—
7502401	750	4/8/2021	Jerome/Gooding/Lincoln	14.7	7.62	783.7	3.3	—	—	—	—
7504701	750	4/7/2021	Jerome/Gooding/Lincoln	14.8	7.58	1031.0	6.6	—	—	—	—
7504801	750	4/7/2021	Jerome/Gooding/Lincoln	14.4	7.39	715.0	3.4	—	—	—	—
7505601	750	4/7/2021	Jerome/Gooding/Lincoln	14.8	7.33	669.7	3.7	—	—	—	—
7505801	750	4/7/2021	Jerome/Gooding/Lincoln	14.6	7.25	666.2	2.4	—	—	—	—
7506601	750	4/7/2021	Jerome/Gooding/Lincoln	16.1	7.72	718.6	8.4	—	—	—	—
7506701	750	4/7/2021	Jerome/Gooding/Lincoln	14.3	7.00	462.8	2.1	—	—	—	—
7507001	750	4/7/2021	Jerome/Gooding/Lincoln	13.8	7.44	1132.0	**14**	—	—	—	—
7507401	750	4/8/2021	Jerome/Gooding/Lincoln	15.9	7.57	696.4	3.9	—	—	—	—
7700801	770	6/23/2021	Payette	14.2	7.47	637.1	2.8	—	6.5	13	—
7701701	770	6/23/2021	Payette	13.4	7.55	1042.0	1.9	—	7.8	25	—
7702001	770	6/23/2021	Payette	15.1	7.44	1161.0	**12**	—	5.9	10	8.6[e]
7702501	770	6/23/2021	Payette	14.5	7.69	687.1	5.5	—	**14**	14	—
7702801	770	6/22/2021	Payette	17.1	7.19	371.0	4.4	—	5.4	3.8	—
7705301	770	6/22/2021	Payette	14.2	7.71	904.1	**21**	—	**31**	22	6.6
7800201	780	4/27/2021	Twin Falls	13.7	7.60	858.2	5.3	—	—	—	6.8
7800301	780	4/27/2021	Twin Falls	14.0	7.84	864.8	5.4	—	—	—	—
7801701	780	4/27/2021	Twin Falls	13.7	7.85	982.9	8.3	—	—	—	3.4
7803601	780	4/20/2021	Twin Falls	12.6	7.79	984.3	8.6	—	—	—	6.2
7803701	780	4/20/2021	Twin Falls	13.3	7.53	900.3	6.8	—	—	—	4.7
7804201	780	4/26/2021	Twin Falls	13.0	7.50	882.0	2.3	—	—	—	—
7804301	780	4/26/2021	Twin Falls	12.4	7.48	930.5	7.8	—	—	—	7.2
7804401	780	4/26/2021	Twin Falls	14.1	7.32	958.1	4.0	—	—	—	—

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
7804501	780	4/26/2021	Twin Falls	15.7	*9.05*	809.3	0.84	—	—	—	—
7805501	780	4/20/2021	Twin Falls	13.4	7.56	889.3	8.5	—	—	—	5.2
7805601	780	4/20/2021	Twin Falls	13.6	7.62	887.2	6.5	—	—	—	5.6
7805701	780	4/20/2021	Twin Falls	13.6	7.56	883.0	7.5	—	—	—	7.1
7806401	780	4/20/2021	Twin Falls	14.0	7.53	911.5	4.6	—	—	—	—
7806601	780	4/26/2021	Twin Falls	11.5	7.47	874.0	4.4	—	—	—	—
7807701	780	4/26/2021	Twin Falls	13.8	NA	1244.0	6.8	—	—	—	4.0
7807801	780	4/27/2021	Twin Falls	11.8	7.65	1182.0	**12**	—	—	—	4.6
7810101	780	4/20/2021	Twin Falls	12.8	7.76	1371.0	6.0	—	—	—	4.8
7810201	780	4/20/2021	Twin Falls	15.2	7.79	794.9	3.8	—	—	—	—
7900101	790	4/28/2021	Cassia	16.2	7.83	908.1	5.4	—	—	—	4.1
7900601	790	4/29/2021	Cassia	12.4	7.67	944.1	**10**	—	—	—	5.7
7900701	790	4/29/2021	Cassia	12.5	7.18	867.6	**10**	—	—	—	5.7
7900901	790	4/28/2021	Cassia	13.3	7.45	667.5	5.0	—	—	—	5.0
7901101	790	4/28/2021	Cassia	15.5	7.68	590.4	3.3	—	—	—	—
7901401	790	4/29/2021	Cassia	12.8	7.40	925.1	**15**	—	—	—	8.5
7901501	790	4/28/2021	Cassia	13.9	7.58	926.0	9.0	—	—	—	—
7901701	790	4/28/2021	Cassia	12.3	7.66	758.8	6.8	—	—	—	2.5
7901901	790	4/28/2021	Cassia	12.2	7.49	1060.0	**16**	—	—	—	5.0
7902201	790	4/27/2021	Cassia	13.5	7.10	782.1	2.4	—	—	—	—
7903501	790	4/28/2021	Cassia	12.1	7.50	1092.0	**19**	—	—	—	5.9
7903601	790	4/29/2021	Cassia	12.9	7.53	830.2	**11**	—	—	—	7.3
7903801	790	4/29/2021	Cassia	10.8	7.49	757.7	5.4	—	—	—	4.7
7904001	790	4/28/2021	Cassia	13.4	7.39	887.2	8.1	—	—	—	2.8
7907401	790	4/27/2021	Cassia	12.0	7.53	926.1	**14**	—	—	—	2.9
8050301	805	7/14/2021	Madison/Fremont/Teton	10.7	7.65	623.7	**13**	—	—	—	3.3
8050801	805	7/14/2021	Madison/Fremont/Teton	12.5	7.57	461.5	7.7	—	—	—	2.6
8050901	805	7/14/2021	Madison/Fremont/Teton	11.3	7.47	486.1	6.6	—	—	—	3.3
8051301	805	7/13/2021	Madison/Fremont/Teton	10.0	7.53	531.2	5.2	—	—	—	7.6
8051401	805	7/14/2021	Madison/Fremont/Teton	11.5	7.49	461.0	8.2	—	—	—	2.9
8052801	805	7/13/2021	Madison/Fremont/Teton	8.8	7.51	570.5	9.8	—	—	—	4.6
8053401	805	7/13/2021	Madison/Fremont/Teton	10.6	7.72	365.9	1.5	—	—	—	—
8053501	805	7/13/2021	Madison/Fremont/Teton	8.5	7.41	563.2	**10**	—	—	—	3.5
8053901	805	7/14/2021	Madison/Fremont/Teton	15.0	7.72	430.9	7.3	—	—	—	2.5
8054101	805	7/13/2021	Madison/Fremont/Teton	11.3	7.87	549.0	**12**	—	—	—	2.1

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
8070101	807	7/21/2021	Teton	7.8	7.79	363.7	0.41	—	—	—	—
8070201	807	7/21/2021	Teton	7.6	7.76	395.3	1.1	—	—	—	—
8070301	807	7/21/2021	Teton	7.8	7.72	423.0	1.4	—	—	—	—
8070401	807	7/21/2021	Teton	7.7	7.85	352.0	0.41	—	—	—	—
8070501	807	7/21/2021	Teton	6.8	7.82	348.1	0.086	—	—	—	—
8070601	807	7/21/2021	Teton	7.3	7.99	290.1	0.16	—	—	—	—
8070701	807	7/21/2021	Teton	10.8	7.77	393.9	2.2	—	—	—	—
8070801	807	7/21/2021	Teton	8.0	8.10	307.9	<0.010	—	—	—	—
8070901	807	7/20/2021	Teton	9.1	7.72	403.4	2.2	—	—	—	—
8071001	807	7/20/2021	Teton	8.4	7.88	334.1	3.9	—	—	—	—
8071101	807	7/20/2021	Teton	7.9	7.89	312.8	1.3	—	—	—	—
8071201	807	7/20/2021	Teton	8.1	7.69	783.2	3.9	—	—	—	—
8071301	807	7/20/2021	Teton	8.5	7.42	354.3	0.18	—	—	—	—
8071401	807	7/20/2021	Teton	7.8	7.24	374.6	1.0	—	—	—	—
8071501	807	7/20/2021	Teton	8.1	7.61	524.2	4.6	—	—	—	—
8071601	807	7/20/2021	Teton	7.1	7.70	482.1	2.2	—	—	—	—
8100401	810	4/8/2021	Owyhee	13.3	7.69	1379.0	**16**	—	—	—	—
8100601	810	4/8/2021	Owyhee	13.2	7.52	1418.0	**27**	—	—	—	—
8101601	810	4/8/2021	Owyhee	11.4	6.84	545.0	8.1	—	—	—	—
8101701	810	4/8/2021	Owyhee	12.9	7.09	621.1	7.2	—	—	—	—
8104801	810	4/8/2021	Owyhee	17.8	8.40	360.6	2.0	—	—	—	—
8201201	820	5/10/2021	Kootenai	9.1	8.08	298.5	4.3	—	—	—	—
8202901	820	5/11/2021	Kootenai	16.1	7.84	367.0	3.9	—	—	—	—
8204501	820	5/10/2021	Kootenai	9.4	7.98	363.2	2.0	—	—	—	—
8204601	820	5/10/2021	Kootenai	9.5	8.09	322.8	1.5	—	—	—	—
8204801	820	5/10/2021	Kootenai	9.0	8.01	329.2	0.8	—	—	—	—
8204901	820	5/10/2021	Kootenai	9.0	7.86	416.1	2.4	—	—	—	—
8205101	820	5/10/2021	Kootenai	8.2	7.93	384.0	2.5	—	—	—	—
8300301	830	7/13/2021	Jefferson	11.9	7.86	376.4	5.5	—	—	—	—
8300401	830	7/7/2021	Jefferson	13.4	8.07	317.1	4.2	—	—	—	—
8300501	830	7/7/2021	Jefferson	13.3	8.06	335.1	4.5	—	—	—	—
8302001	830	7/7/2021	Jefferson	12.0	8.24	307.6	<0.010	—	—	—	—
8303001	830	7/7/2021	Jefferson	11.4	7.53	749.2	7.2	—	—	—	—
8303201	830	7/7/2021	Jefferson	11.8	7.95	394.3	5.3	—	—	—	—
8401601	840	7/14/2021	Bonneville/Jefferson/Madison	11.3	7.57	487.8	0.94	—	—	—	—

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a,]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
8404201	840	7/28/2021	Bonneville/Jefferson/Madison	12.0	7.61	486.3	1.3	—	—	—	—
8404301	840	7/28/2021	Bonneville/Jefferson/Madison	13.1	7.70	419.9	0.76	—	—	—	—
8404401	840	7/28/2021	Bonneville/Jefferson/Madison	12.7	7.54	510.4	1.9	—	—	—	—
8404801	840	7/27/2021	Bonneville/Jefferson/Madison	12.5	7.46	552.3	1.8	—	—	—	—
8404901	840	7/27/2021	Bonneville/Jefferson/Madison	12.3	7.57	484.1	0.78	—	—	—	—
8405001	840	7/27/2021	Bonneville/Jefferson/Madison	12.3	7.66	453.7	2.0	—	—	—	—
8405301	840	7/28/2021	Bonneville/Jefferson/Madison	9.7	7.76	484.7	0.57	—	—	—	—
8405801	840	7/28/2021	Bonneville/Jefferson/Madison	11.6	7.58	499.7	0.94	—	—	—	—
8406101	840	7/28/2021	Bonneville/Jefferson/Madison	13.0	7.49	517.4	1.4	—	—	—	—
8406501	840	7/13/2021	Bonneville/Jefferson/Madison	12.6	7.48	312.9	7.0	—	—	—	4.4
8406601	840	7/27/2021	Bonneville/Jefferson/Madison	12.0	7.66	499.3	1.6	—	—	—	—
8407501	840	7/28/2021	Bonneville/Jefferson/Madison	11.8	7.50	523.6	1.4	—	—	—	—
8420101	842	9/28/2021	Bingham/Bonneville	12.6	7.41	613.5	0.72	—	—	—	—
8420201	842	9/28/2021	Bingham/Bonneville	13.2	7.52	559.2	1.5	—	—	—	—
8420301	842	9/28/2021	Bingham/Bonneville	13.5	7.56	574.4	1.4	—	—	—	—
8420401	842	9/28/2021	Bingham/Bonneville	15.1	7.66	736.8	2.2	—	—	—	—
8420501	842	9/27/2021	Bingham/Bonneville	13.4	7.67	601.1	2.9	—	—	—	—
8420601	842	9/29/2021	Bingham/Bonneville	12.4	7.59	590.6	2.7	—	—	—	—
8420701	842	9/28/2021	Bingham/Bonneville	13.0	7.54	661.5	1.8	—	—	—	—
8420801	842	9/29/2021	Bingham/Bonneville	13.8	7.57	470.2	0.7	—	—	—	—
8420901	842	9/28/2021	Bingham/Bonneville	13.4	7.46	546.9	1.8	—	—	—	—
8421001	842	9/29/2021	Bingham/Bonneville	12.9	7.56	572.0	3.4	—	—	—	—
8421201	842	9/28/2021	Bingham/Bonneville	13.2	7.47	578.5	3.3	—	—	—	—
8421301	842	9/28/2021	Bingham/Bonneville	13.3	7.48	578.1	3.2	—	—	—	—
8421501	842	9/27/2021	Bingham/Bonneville	13.0	7.52	580.8	3.4	—	—	—	—
8421601	842	9/29/2021	Bingham/Bonneville	13.3	7.57	584.9	2.6	—	—	—	—
8421701	842	9/29/2021	Bingham/Bonneville	12.7	7.61	545.1	1.9	—	—	—	—
8421901	842	9/27/2021	Bingham/Bonneville	13.1	7.56	570.6	3.0	—	—	—	—
8422001	842	9/29/2021	Bingham/Bonneville	13.5	7.69	464.8	1.6	—	—	—	—
8450301	845	7/6/2021	Bingham	15.4	7.38	532.9	0.8	—	—	—	—
8450601	845	7/6/2021	Bingham	12.5	7.59	420.9	1.1	—	—	—	—
8450801	845	7/7/2021	Bingham	13.4	7.57	488.1	1.8	—	—	—	—
8450901	845	7/6/2021	Bingham	13.2	7.48	501.1	0.98	—	—	—	—
8452101	845	7/6/2021	Bingham	13.6	8.19	461.0	<0.010	—	—	—	—
8452501	845	7/7/2021	Bingham	13.6	7.57	481.8	1.7	—	—	—	—

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
8452701	845	7/6/2021	Bingham	14.1	7.74	449.9	0.88	—	—	—	—
8452801	845	7/6/2021	Bingham	13.0	7.43	478.8	0.62	—	—	—	—
8453101	845	7/6/2021	Bingham	12.2	7.69	486.9	1.8	—	—	—	—
8453301	845	7/7/2021	Bingham	12.9	7.53	477.7	1.7	—	—	—	—
8453801	845	7/6/2021	Bingham	12.5	7.61	424.0	0.8	—	—	—	—
8601101	860	6/15/2021	Owyhee	14.9	7.31	2189.0	5.5	<0.050	—	—	3.0
8601401	860	6/15/2021	Owyhee	15.2	7.28	1339.0	9.8	<0.050	—	—	5.2
8601801	860	6/15/2021	Owyhee	16.2	7.89	940.0	<0.010	5.7	—	—	—
8602001	860	6/15/2021	Owyhee	15.1	7.26	1532.0	6.0	0.77	—	—	6.1
8602901	860	6/15/2021	Owyhee	16.1	7.65	1967.0	0.041	9.9	—	—	—
8603001	860	6/15/2021	Owyhee	17.1	7.41	1292.0	<0.010	9.0	—	—	—
8650101	865	4/7/2021	Owyhee	15.3	7.45	1057.0	**11**	—	—	—	4.8
8650201	865	4/7/2021	Owyhee	15.9	7.56	1109.0	**15**	—	—	—	1.9
8650301	865	4/7/2021	Owyhee	14.8	7.13	2638.0	**79**	—	—	—	5.9
8650501	865	4/7/2021	Owyhee	16.9	7.13	2262.0	**18**	—	—	—	7.1
8652501	865	4/7/2021	Owyhee	17.1	7.91	794.7	8.6	—	—	—	3.0
8700501	870	4/6/2021	Gooding	12.0	7.70	782.8	7.3	—	—	—	4.1
8700601	870	4/6/2021	Gooding	15.2	7.71	934.4	**15**	—	—	—	3.1
8701201	870	4/6/2021	Gooding	14.7	7.67	907.9	**10**	—	—	—	2.0
8701801	870	4/6/2021	Gooding	15.5	7.44	836.4	3.3	—	—	—	—
8706201	870	4/6/2021	Gooding	11.6	7.39	1215.0	**17**	—	—	—	5.6
8900501	890	4/14/2021	Elmore	17.4	7.59	875.1	4.1	—	—	—	—
8900601	890	4/14/2021	Elmore	15.8	7.53	814.3	3.0	—	—	—	—
8900801	890	4/14/2021	Elmore	15.7	7.45	1662.0	**57**	—	—	—	1.9
8901801	890	4/14/2021	Elmore	16.2	7.57	1147.0	6.9	—	—	—	3.3
8902201	890	4/14/2021	Elmore	17.2	7.68	1091.0	**14**	—	—	—	3.5
9500201	950	8/9/2021	Clearwater/Lewis/Nez Perce	12.7	7.45	656.8	9.8	—	—	—	3.7
9501201	950	4/21/2021	Clearwater/Lewis/Nez Perce	10.8	7.28	392.3	4.2	—	—	—	—
9501401	950	8/9/2021	Clearwater/Lewis/Nez Perce	13.0	7.24	1081.0	**36**	—	—	—	12.3
9501901	950	8/9/2021	Clearwater/Lewis/Nez Perce	15.5	7.74	476.1	3.3	—	—	—	—
9502001	950	8/11/2021	Clearwater/Lewis/Nez Perce	15.5	8.09	348.6	0.23	—	—	—	—
9502201	950	5/12/2021	Clearwater/Lewis/Nez Perce	11.2	7.70	536.3	**12**	—	—	—	3.2
9502701	950	4/21/2021	Clearwater/Lewis/Nez Perce	11.7	7.73	467.5	4.6	—	—	—	—
9502801	950	5/12/2021	Clearwater/Lewis/Nez Perce	12.0	7.84	494.1	1.7	—	—	—	—
9503701	950	8/9/2021	Clearwater/Lewis/Nez Perce	17.8	7.68	357.6	<0.010	—	—	—	—

ISDA Well ID	Project Number	Sample Date	Project County	Temperature (°C)	pH[a,]	Specific Conductance (uS/cm)	Nitrate-Nitrite as N[b]	Ammonia	Arsenic[b]	Uranium[b]	δN^{15} Isotope
							(mg/L)		(µg/L)		(‰)
9504501	950	4/21/2021	Clearwater/Lewis/Nez Perce	8.3	7.07	288.9	4.2	–	–	–	–
9505401	950	8/11/2021	Clearwater/Lewis/Nez Perce	13.2	7.69	666.7	**17**	–	–	–	1.2
9505701	950	4/21/2021	Clearwater/Lewis/Nez Perce	10.6	7.34	678.6	6.7	–	–	–	–
9506001	950	5/12/2021	Clearwater/Lewis/Nez Perce	10.7	7.05	240.2	7.1	–	–	–	1.9
9506401	950	5/12/2021	Clearwater/Lewis/Nez Perce	12.2	7.77	360.5	<0.010	–	–	–	–
9507201	950	4/21/2021	Clearwater/Lewis/Nez Perce	8.9	7.45	515.2	6.5	–	–	–	1.9
9507301	950	8/8/2021	Clearwater/Lewis/Nez Perce	13.3	7.78	530.5	<0.010	–	–	–	–
9507601	950	4/21/2021	Clearwater/Lewis/Nez Perce	10.2	7.73	528.4	8.6	–	–	–	–
9507701	950	8/11/2021	Clearwater/Lewis/Nez Perce	14.5	7.35	509.6	**13**	–	–	–	4.7
9507901	950	8/9/2021	Clearwater/Lewis/Nez Perce	12.2	7.78	398.8	3.7	–	–	–	–

Notes: (–) = Not Analyzed. Italicized numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was exceeded. Bolded numbers with gray shading indicate EPA's NPDWR standard, expressed as a maximum contaminant level (MCL), was reached or exceeded.

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

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

c. Data qualified with a J flag is an estimated value..

d. Result was reported for Site ID "5302139". This was identified as a lab transcription error. Data result match date and time for 5302134 and no data was collected under 5302139.

e. Result was reported for Site ID "7102120". This was identified as a lab transcription error. Data result match date and time for 7702120 and no data was collected under 7102120.

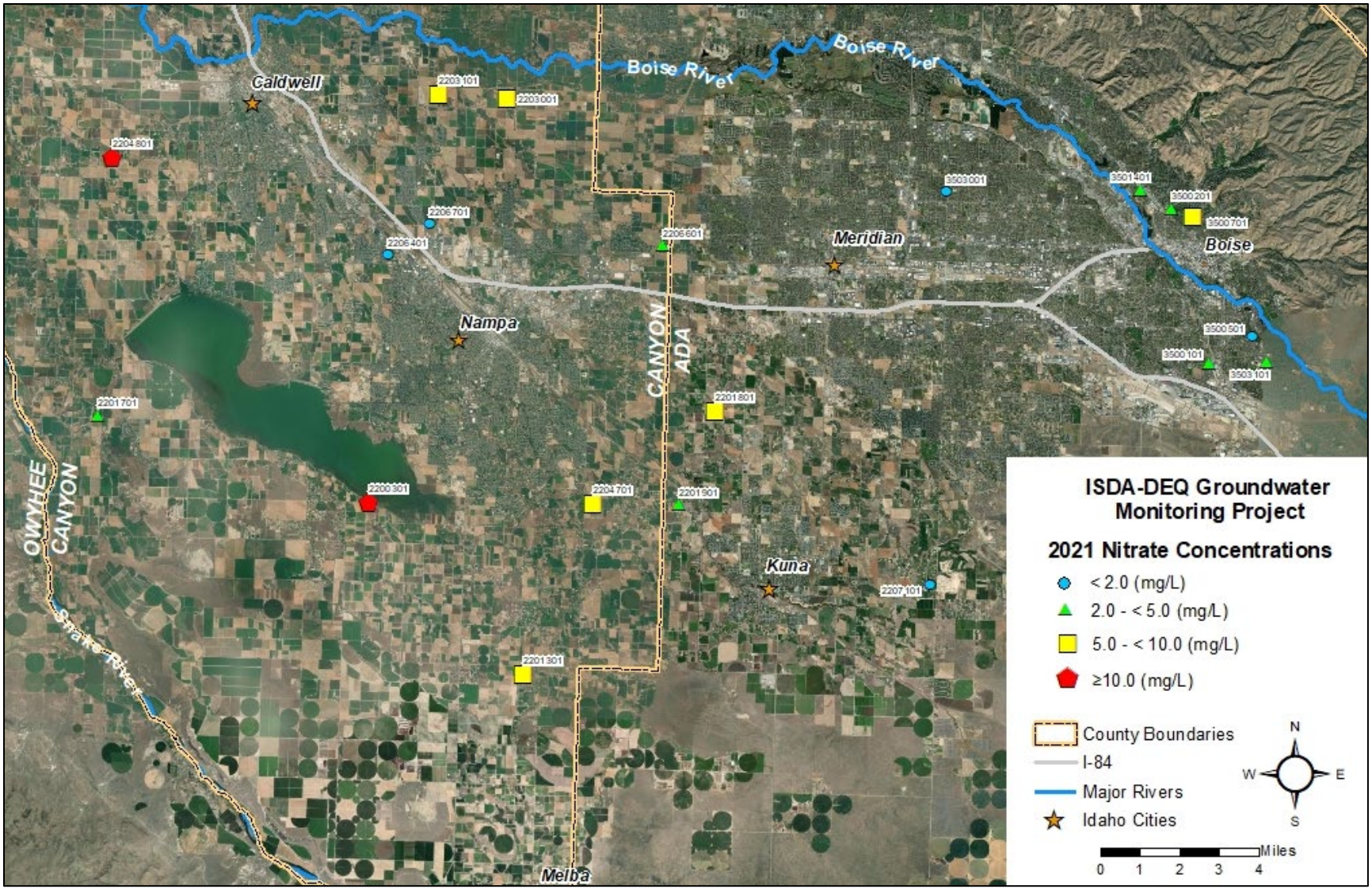


Figure B-1. Projects 220 and 350 (Ada and Canyon Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.



Figure B-2. Project 300 (Latah County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

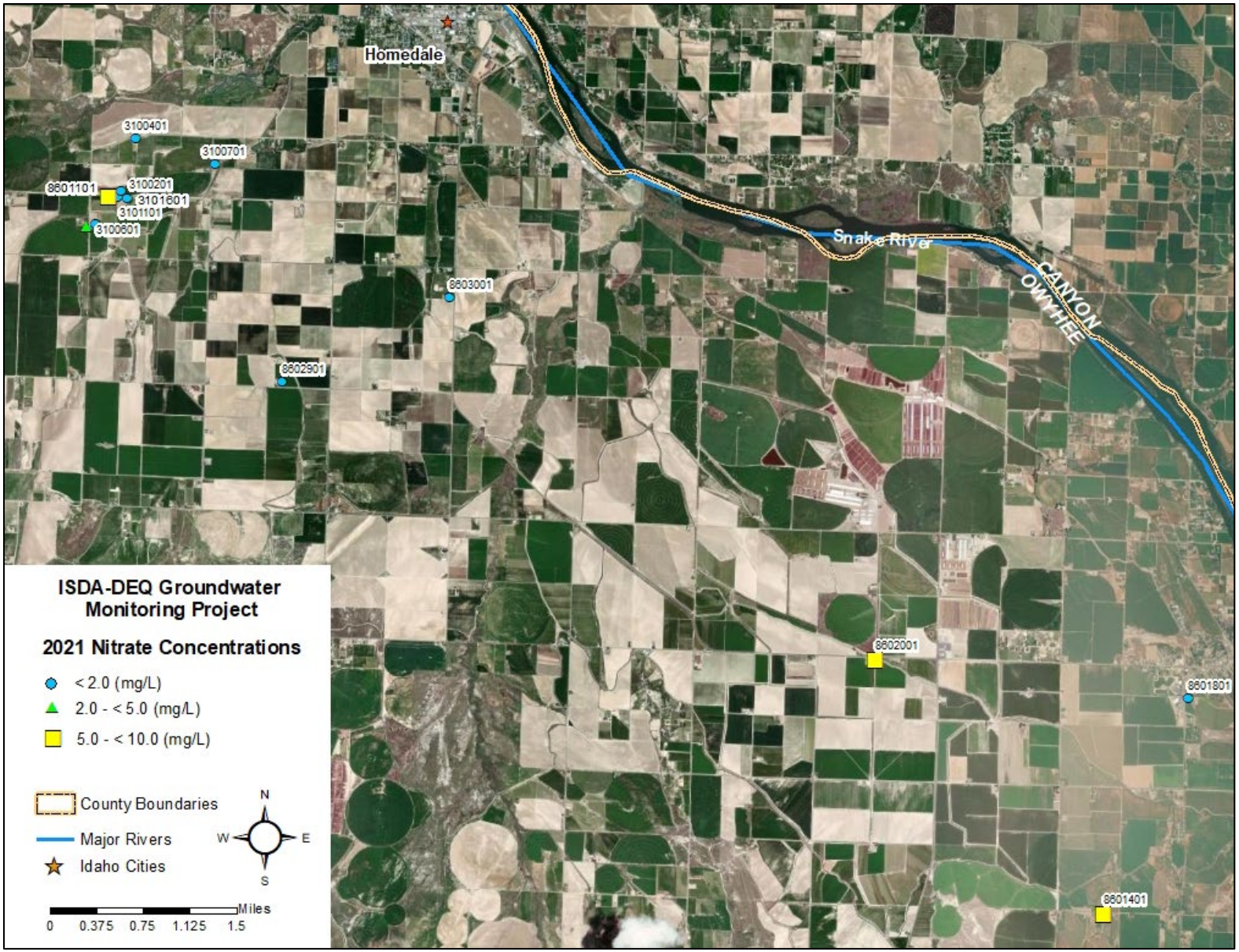


Figure B-3. Projects 310 and 860 (Owyhee County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

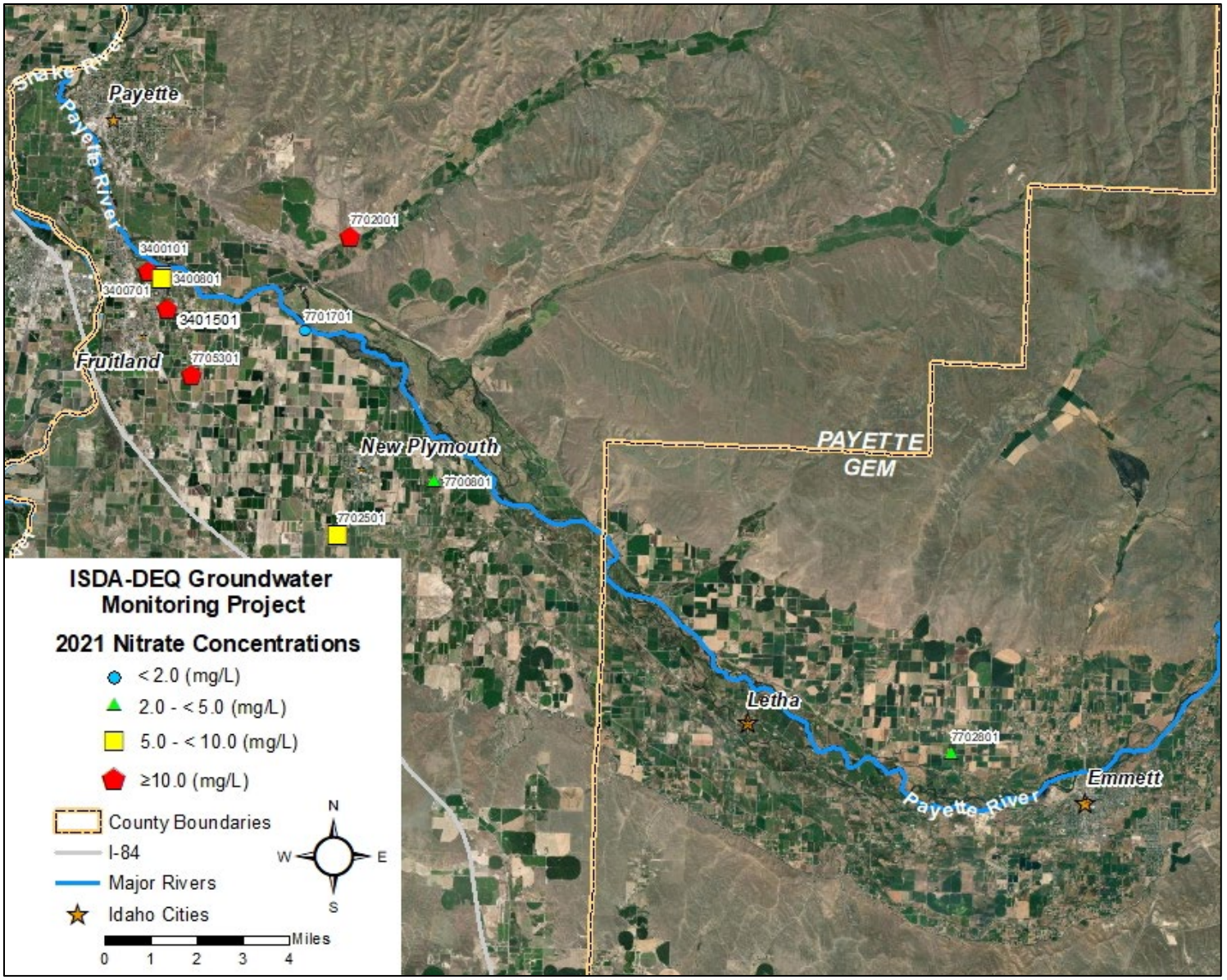


Figure B-4. Projects 340 and 770 (Payette and Gem Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.



Figure B-5. Project 530 (Ada County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

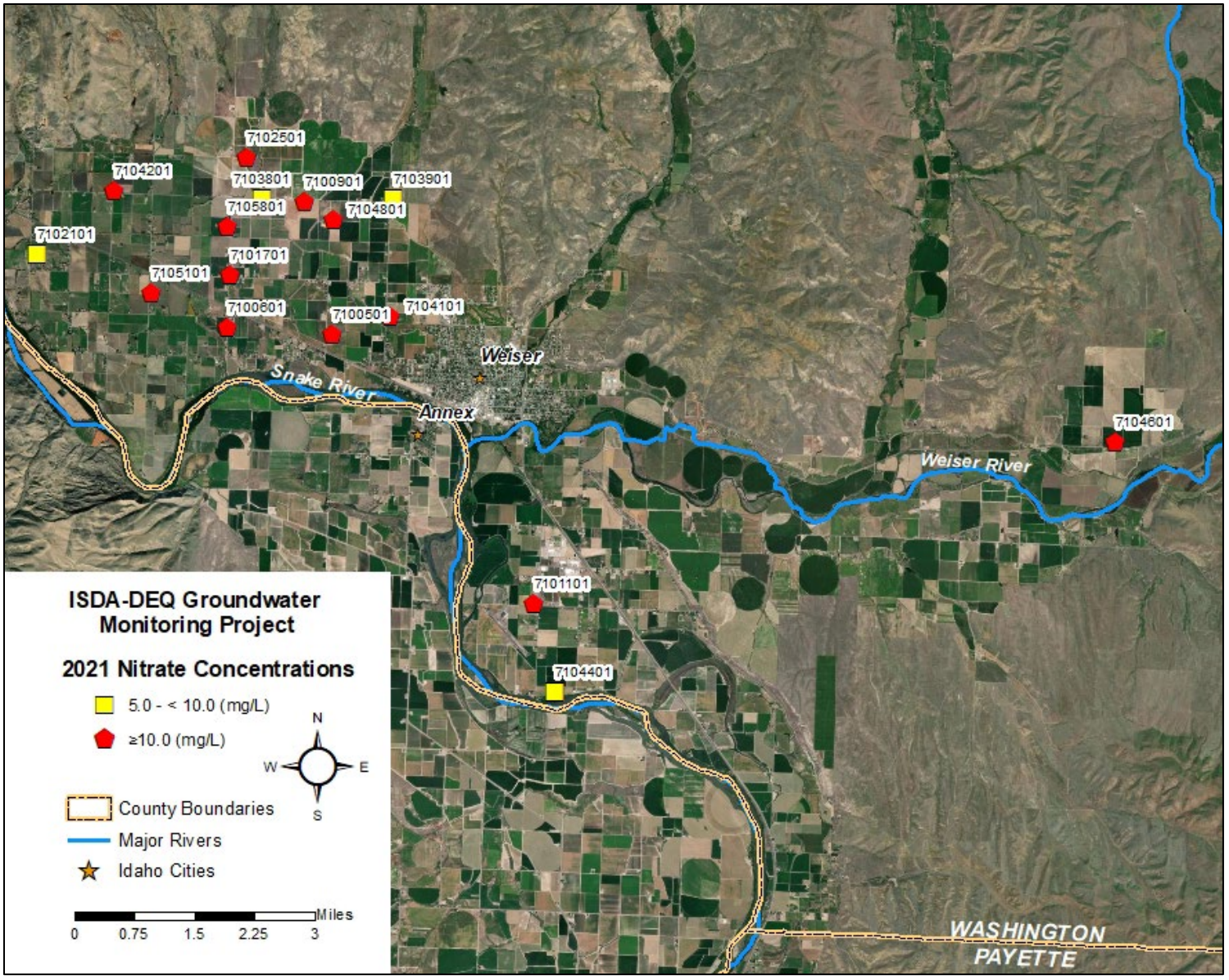


Figure B-6. Project 710 (Washington County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

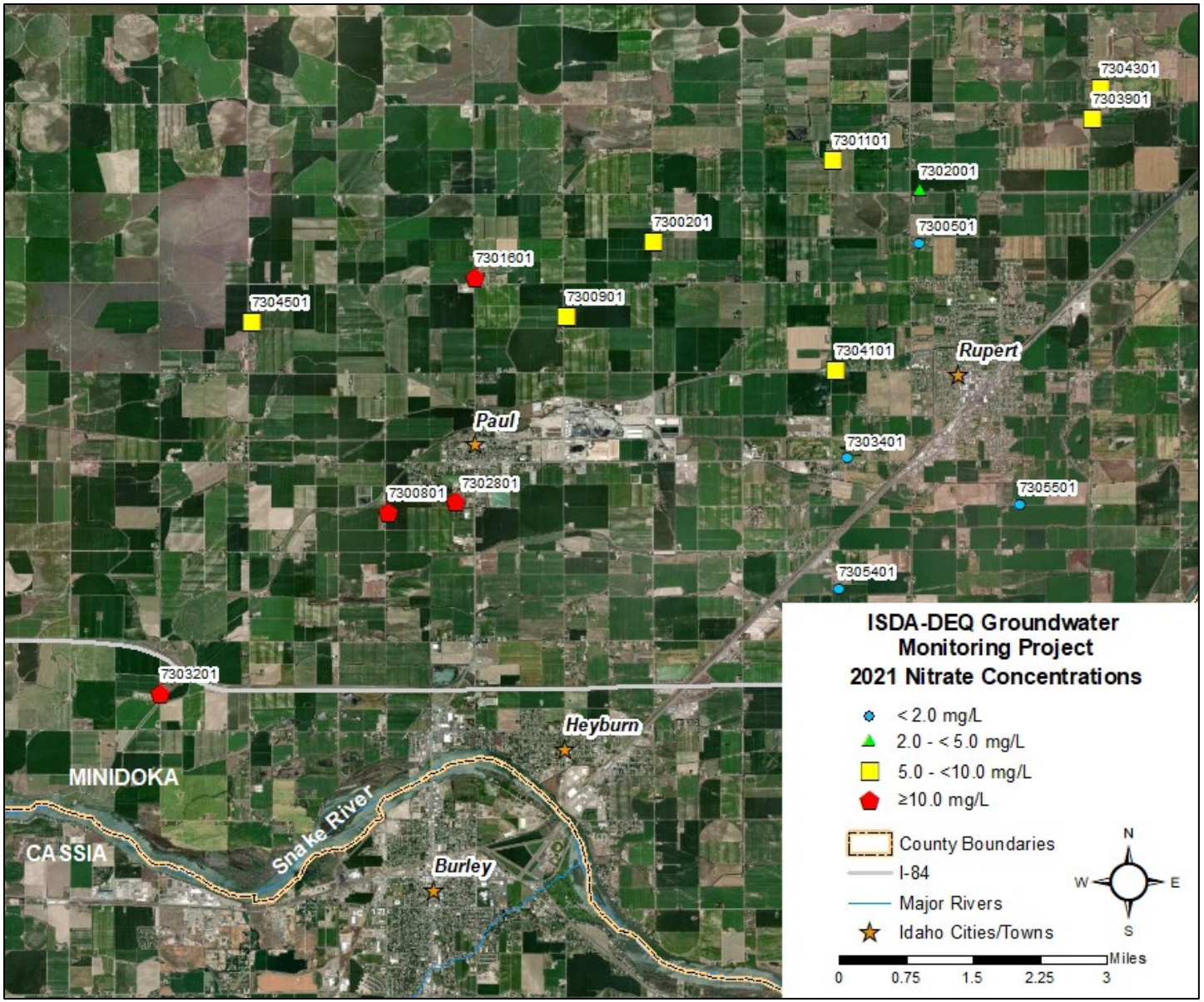


Figure B-7. Project 730 (Minidoka County) (shallow aquifer) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

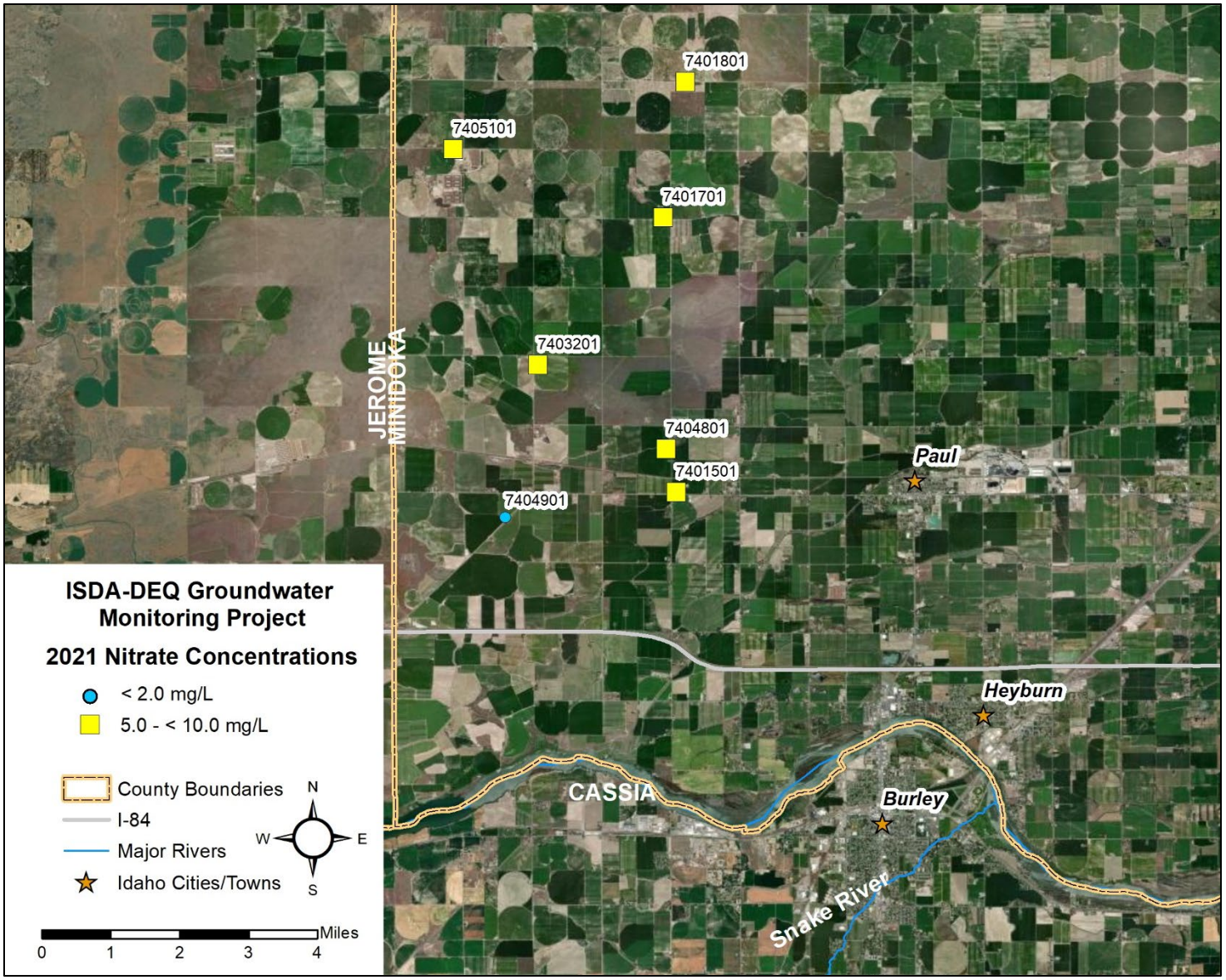


Figure B-8. Project 740 (Minidoka County) (deep aquifer) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

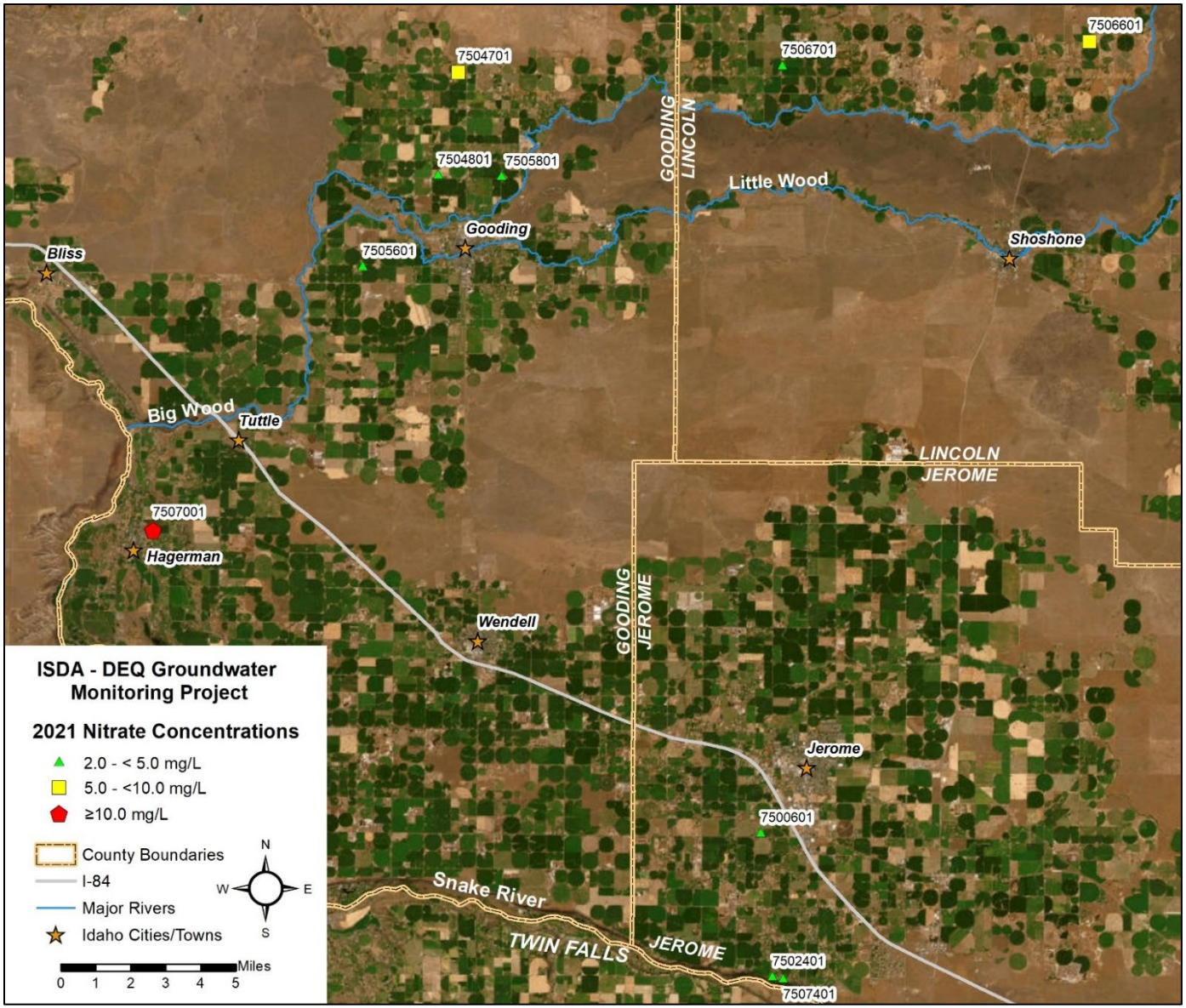


Figure B-9. Project 750 (Gooding, Jerome, and Lincoln Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

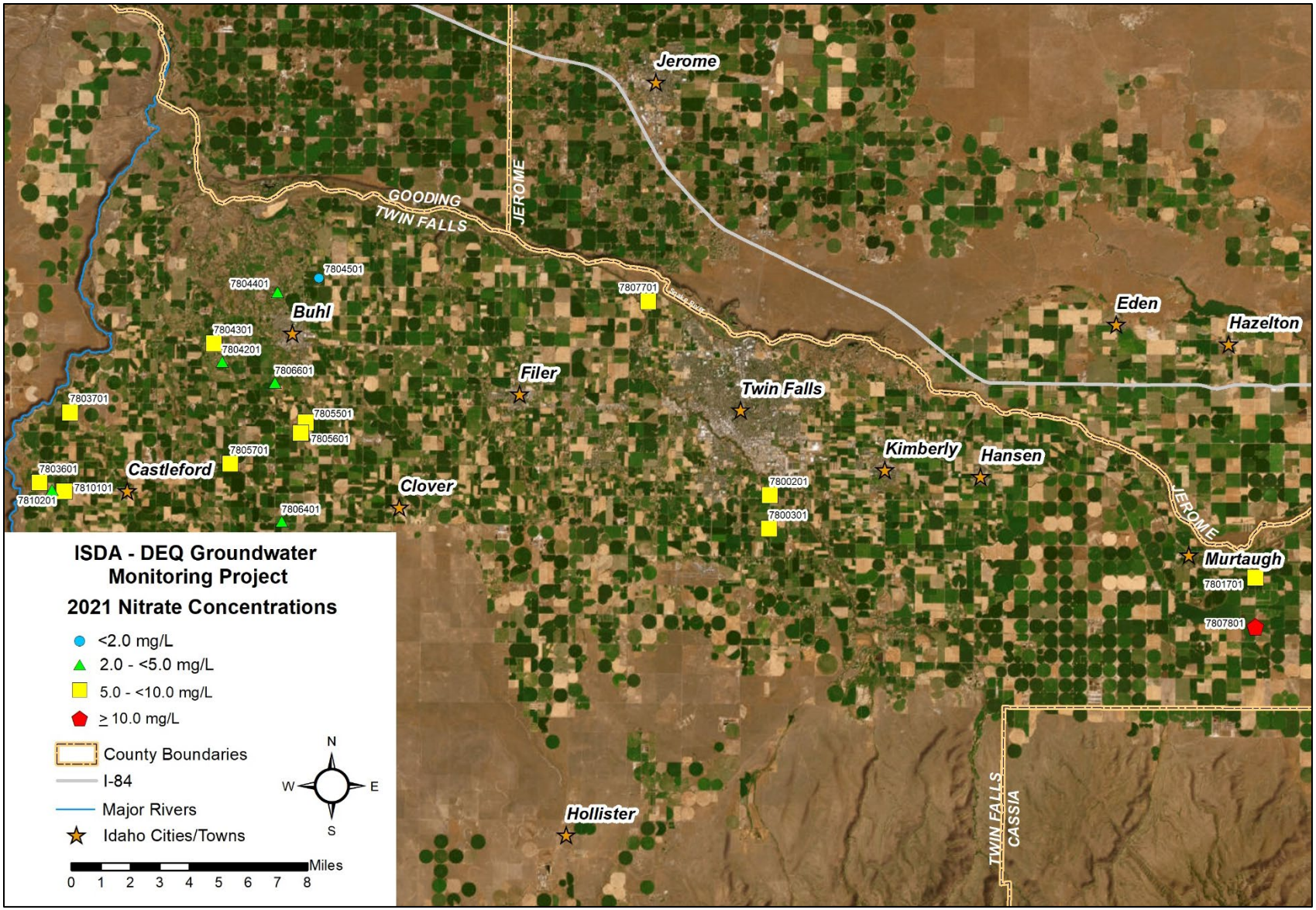


Figure B-10. Projects 780 and 781 (Twin Falls County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

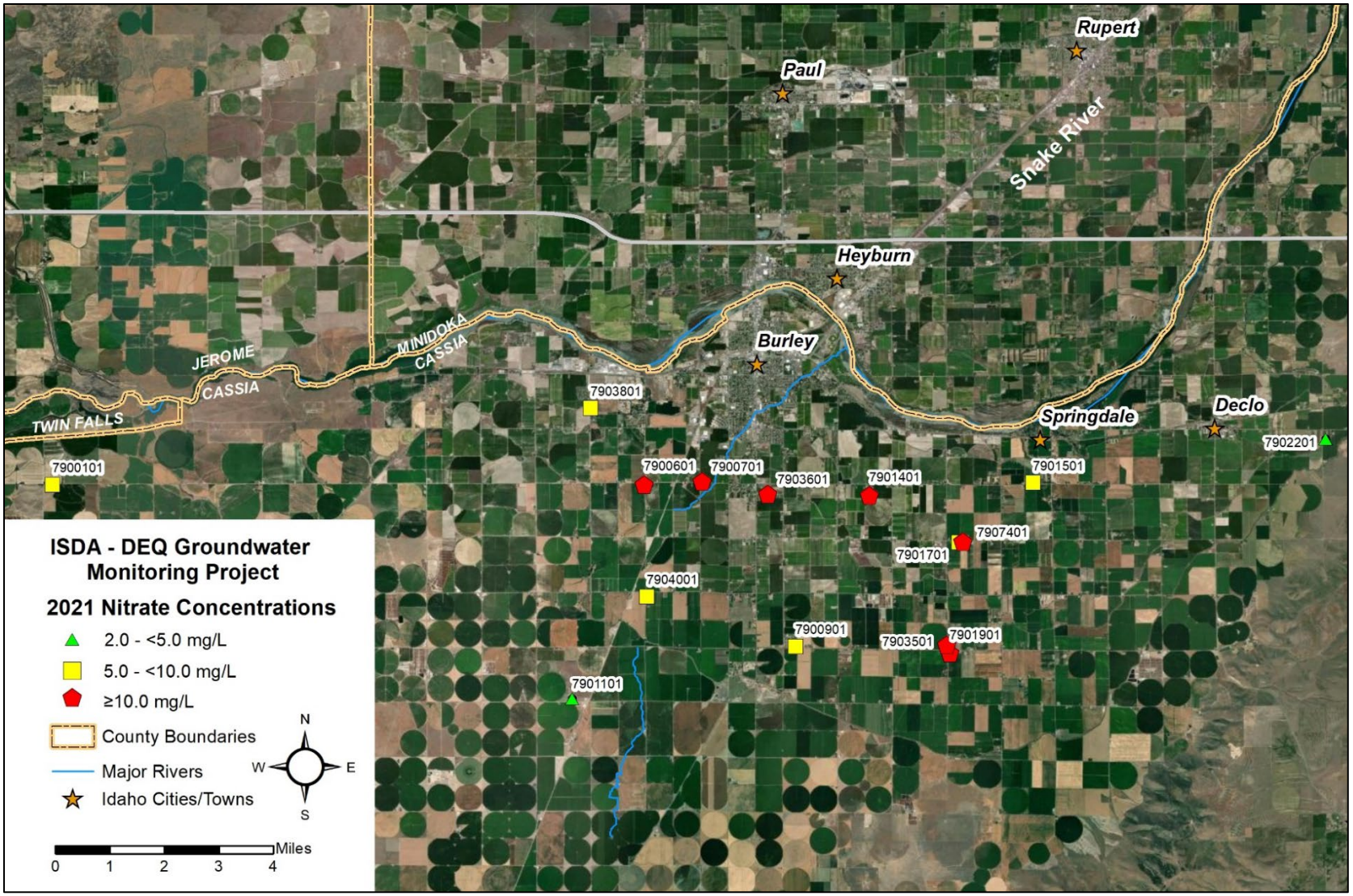


Figure B-11. Project 790 (Cassia County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

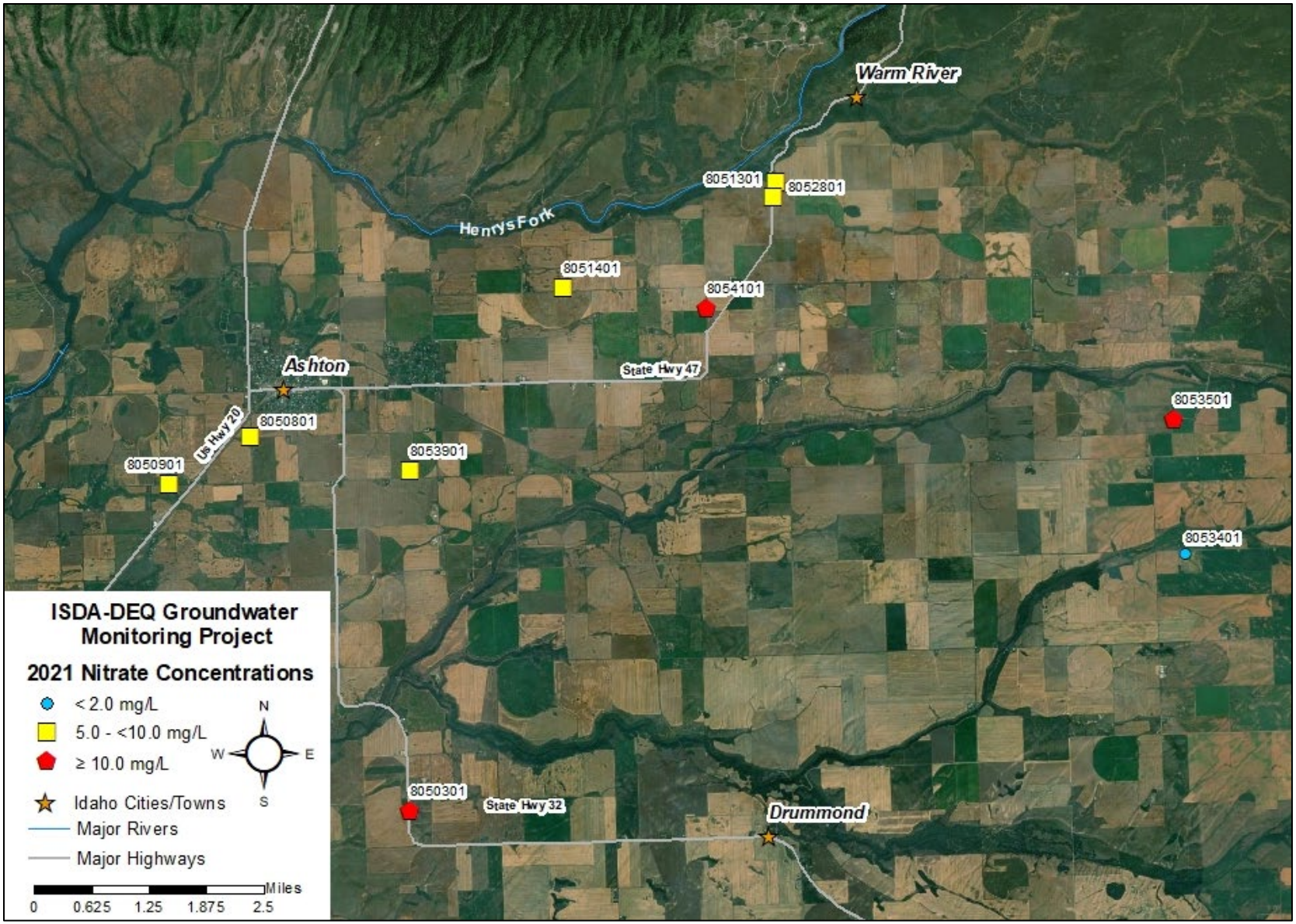


Figure B-12. Project 805 (Fremont County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

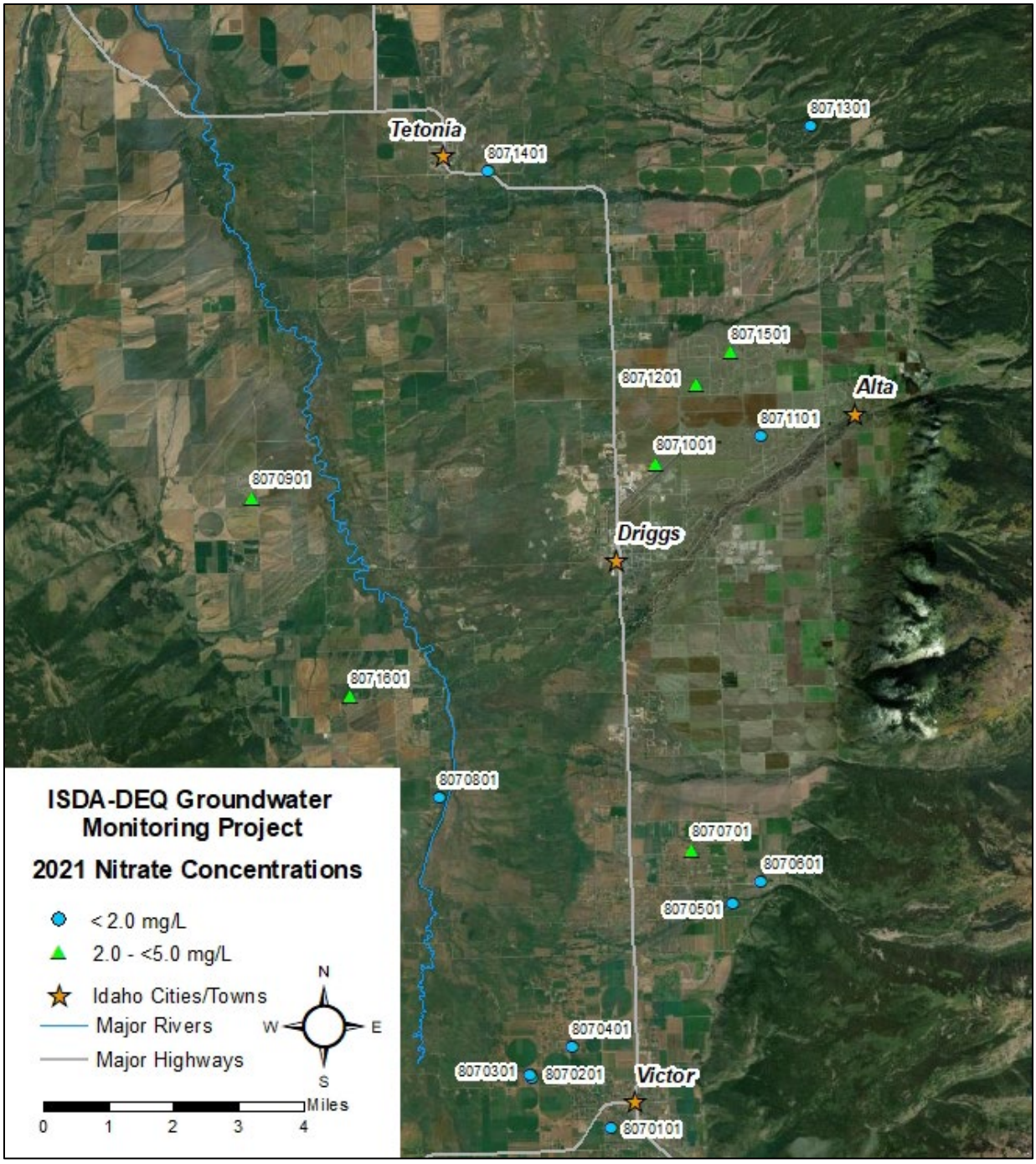


Figure B-13. Project 807 (Teton County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

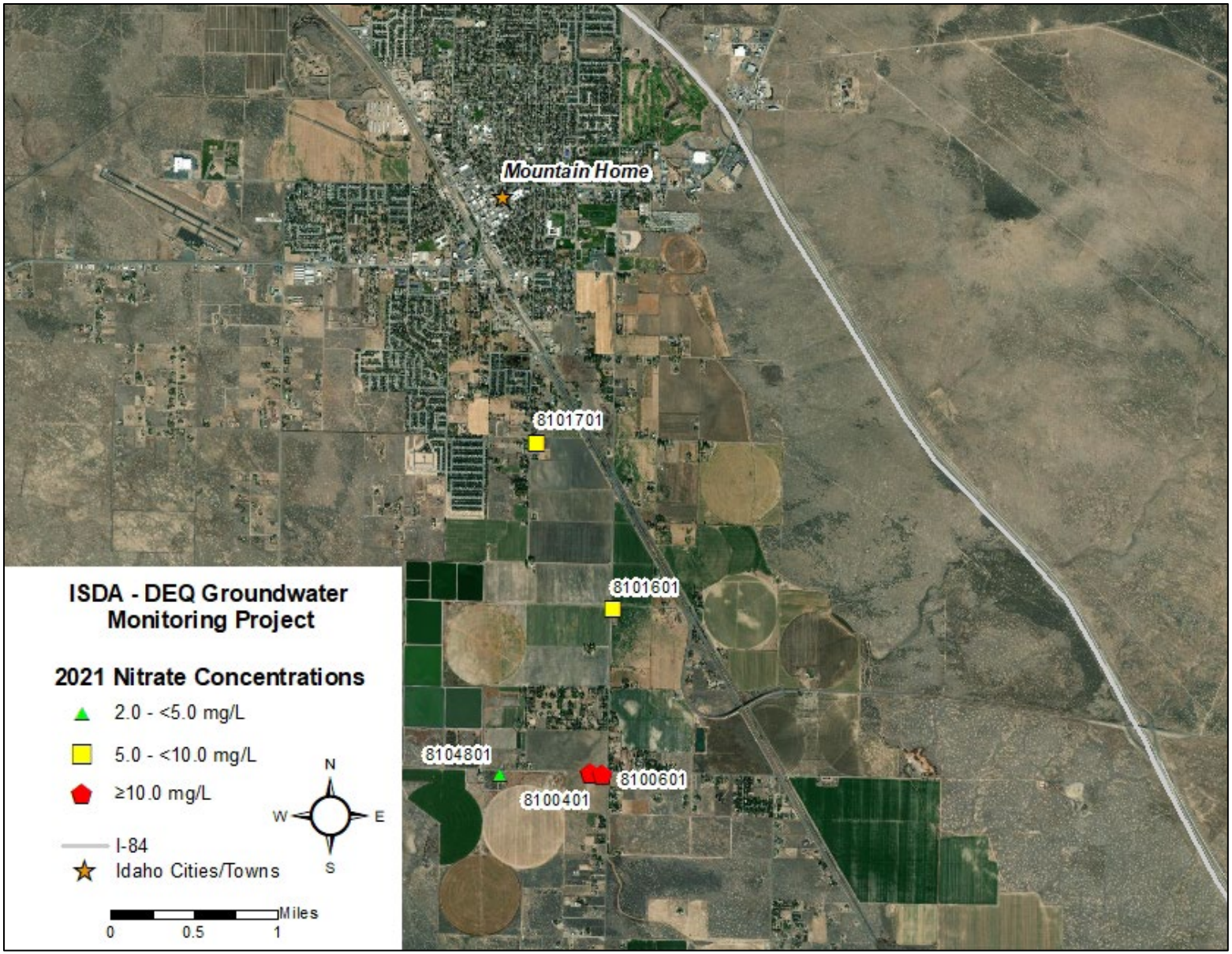


Figure B-14. Project 810 (Elmore County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

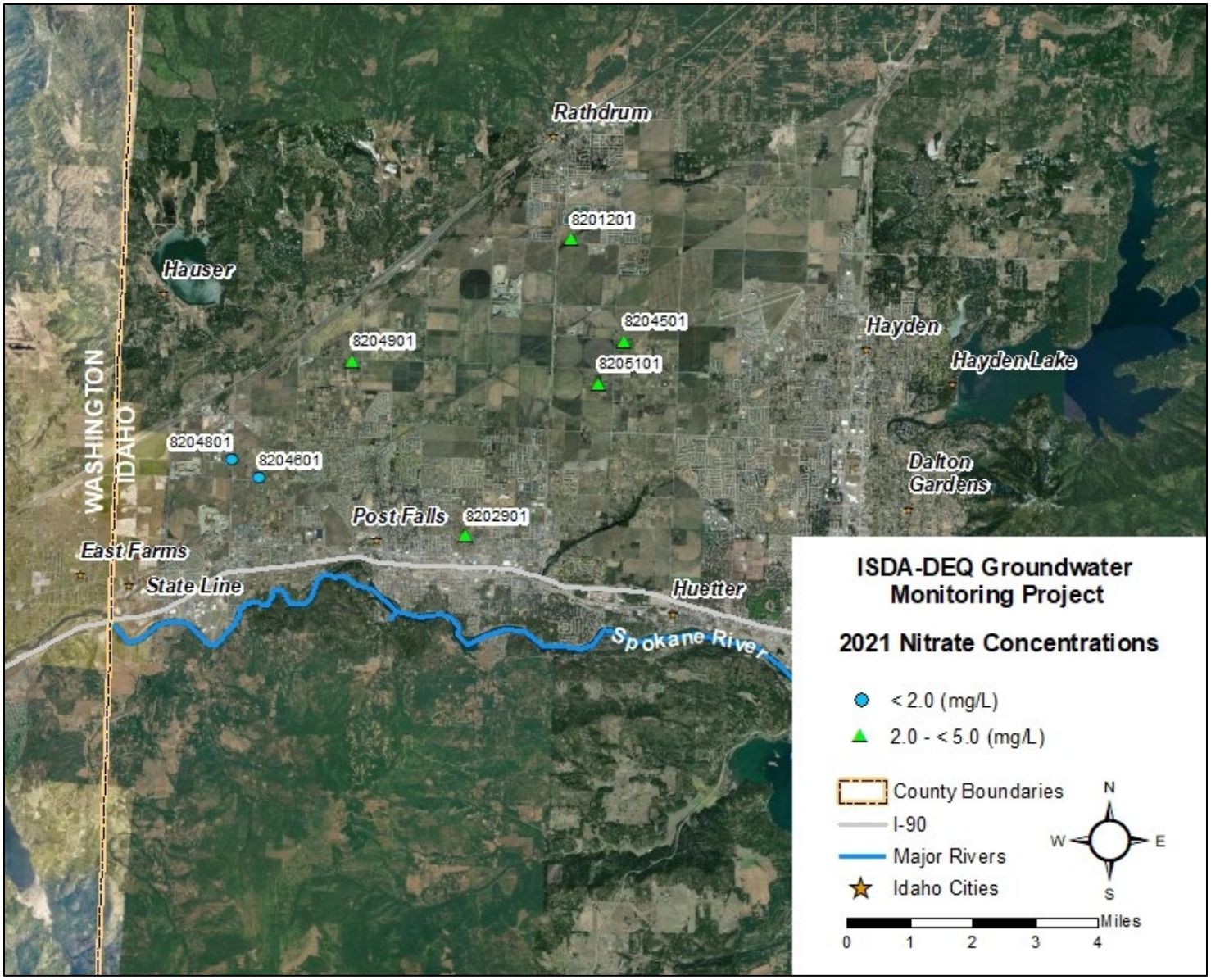


Figure B-15. Project 820 (Kootenai County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

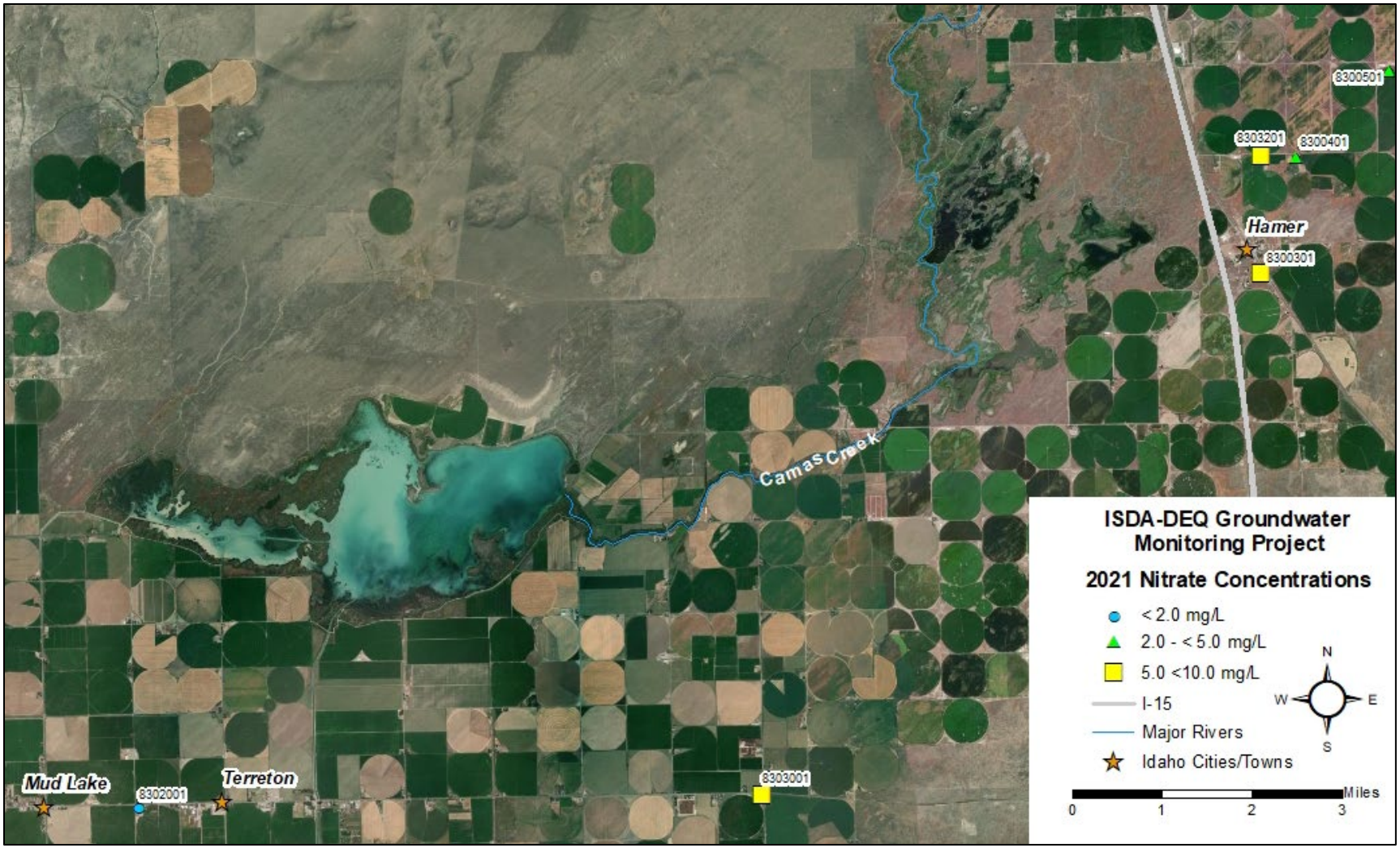


Figure B-16. Project 830 (Jefferson County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

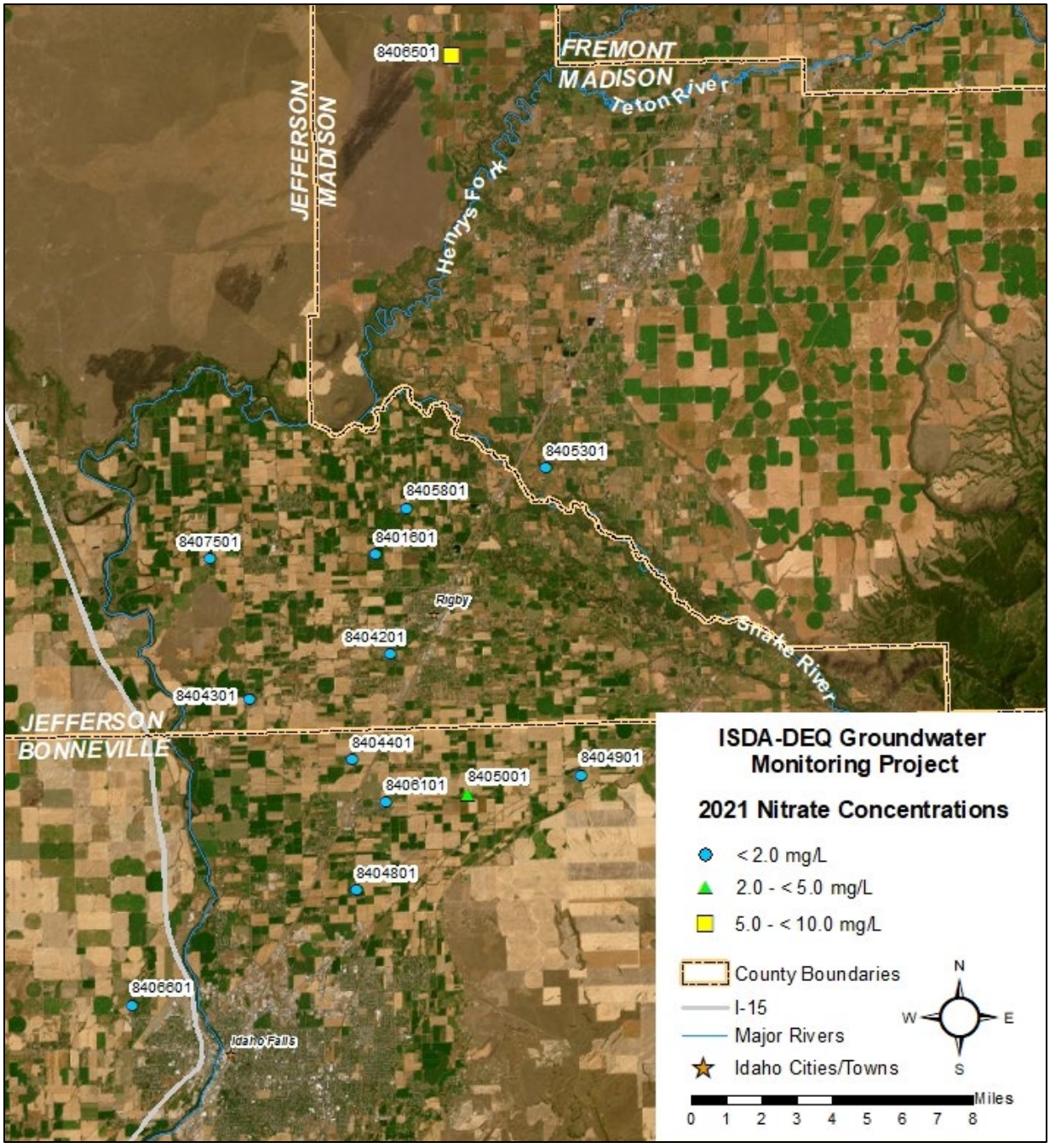


Figure B-17. Project 840 (Bonneville, Jefferson, and Madison Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

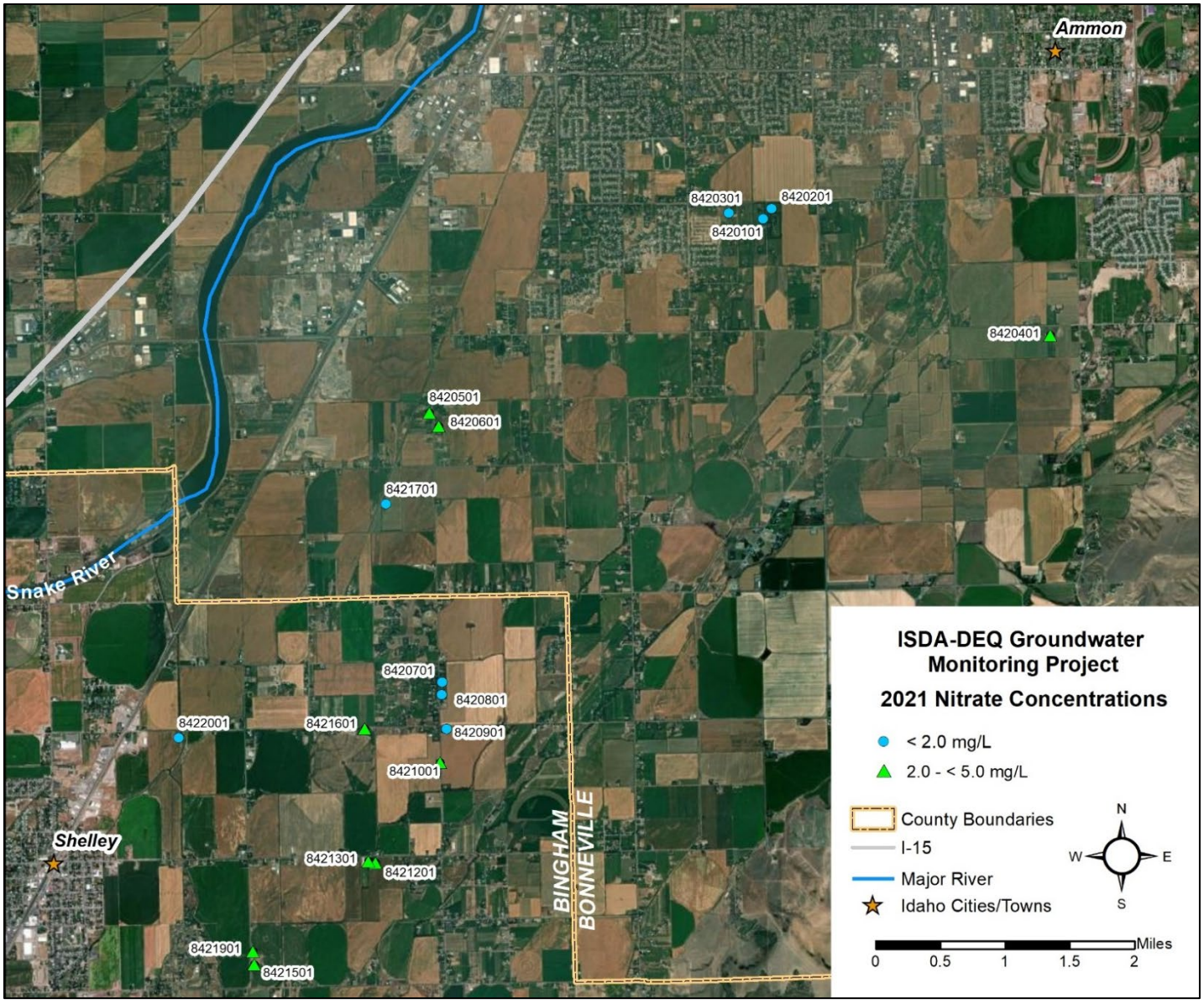


Figure B-18. Project 842 (Bingham and Bonneville Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

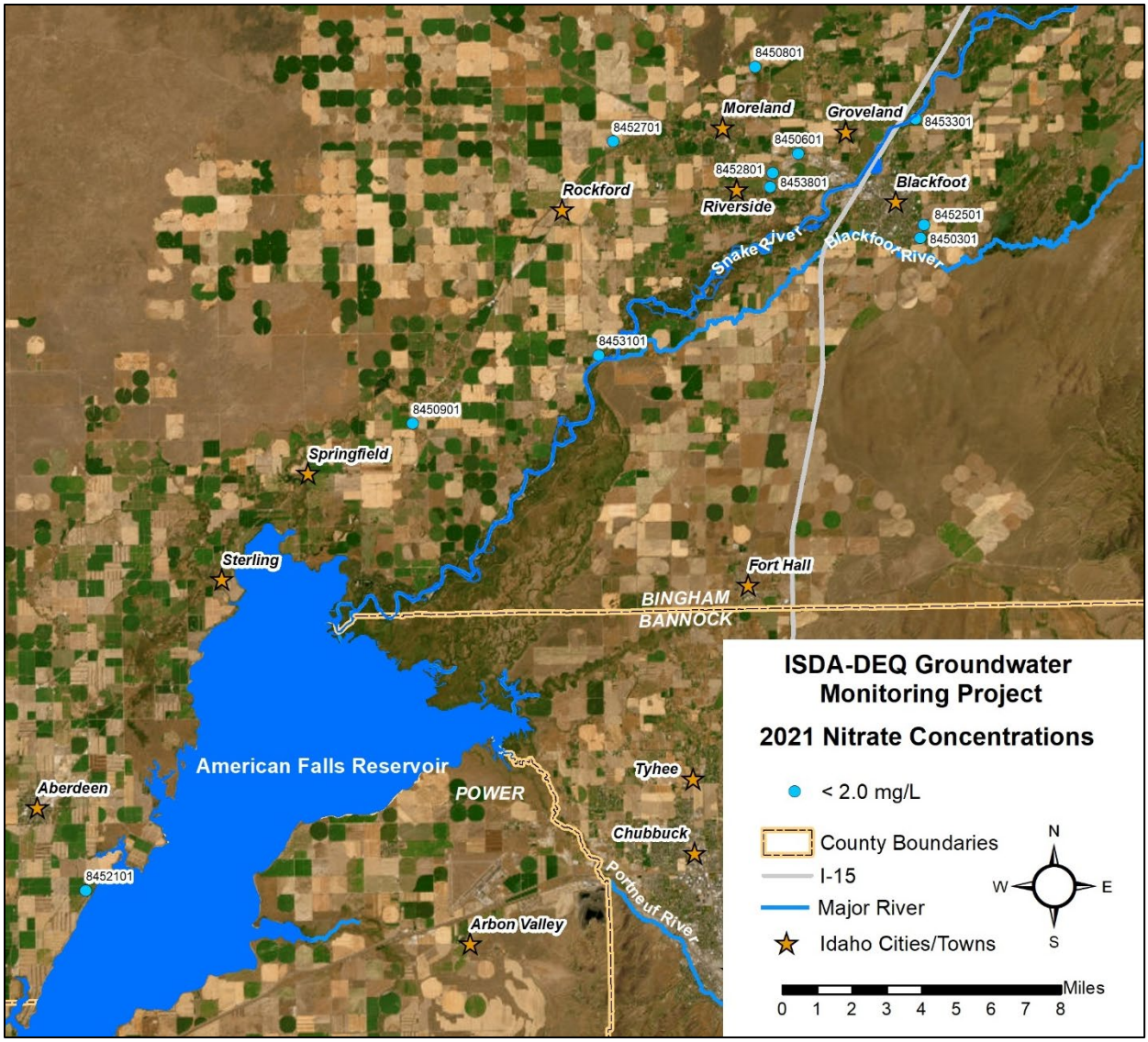


Figure B-19. Project 845 (Bingham County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

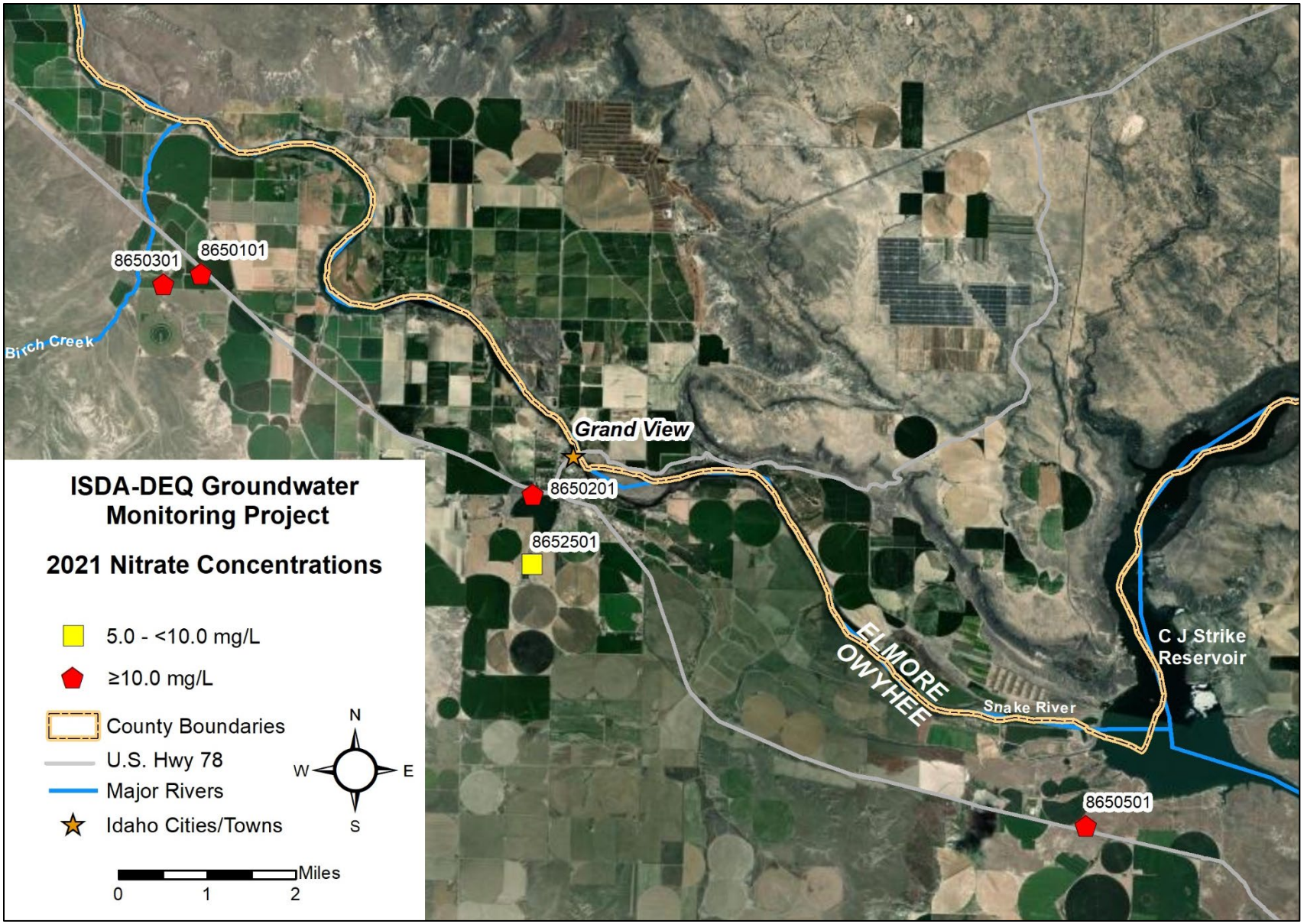


Figure B-20. Project 865 (Owyhee County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

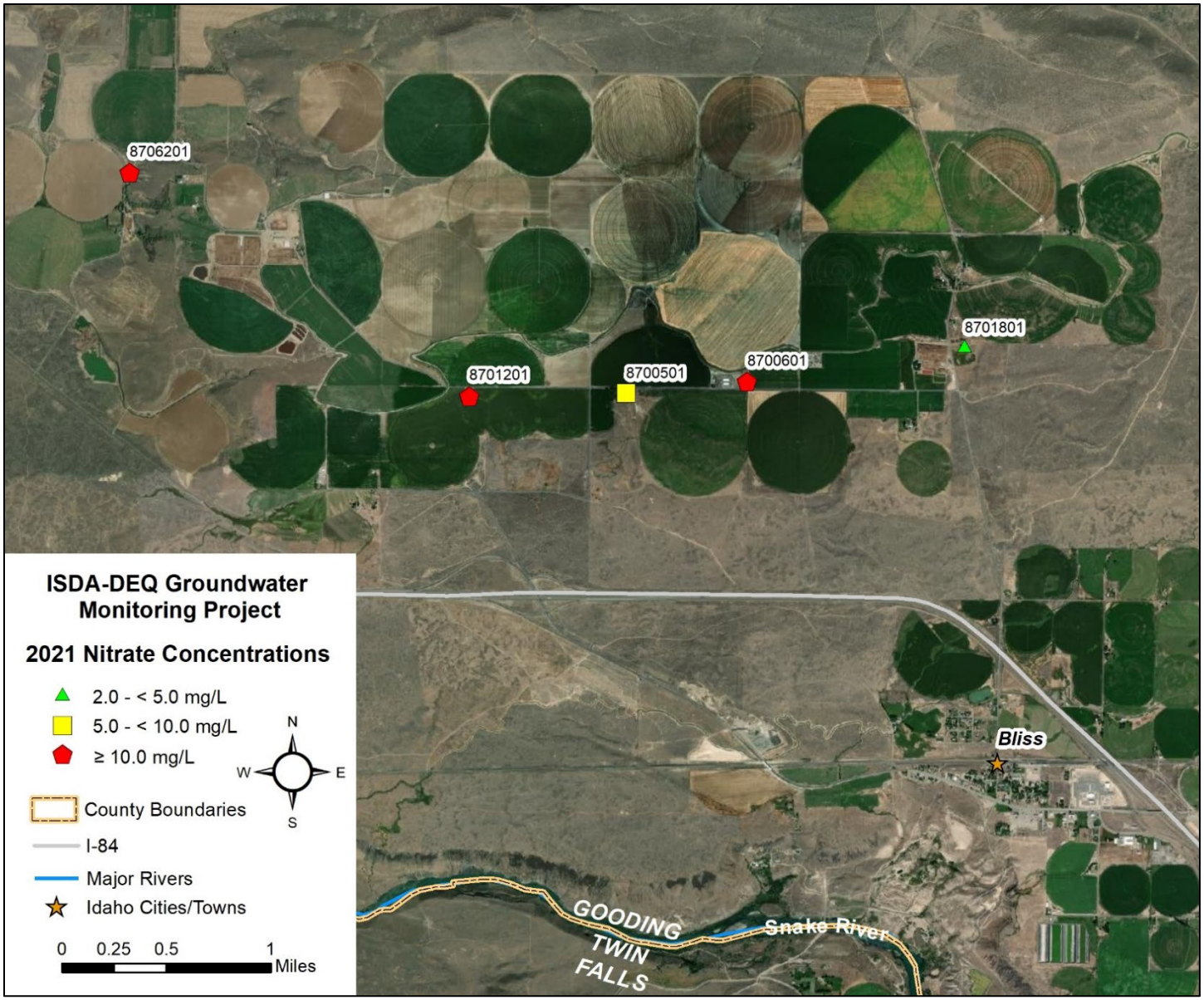


Figure B-21. Project 870 (Gooding County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

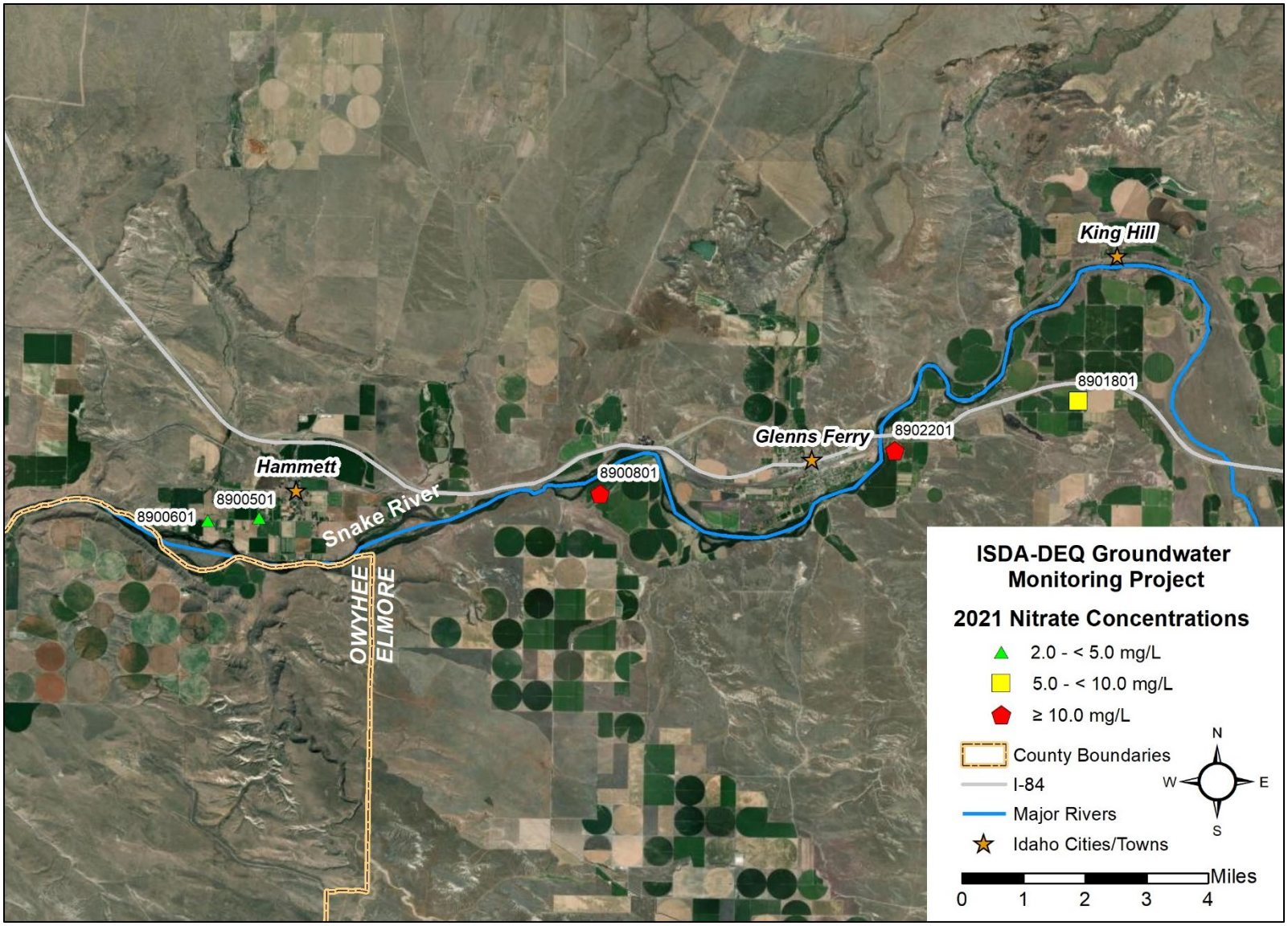


Figure B-22. Project 890 (Elmore County) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.

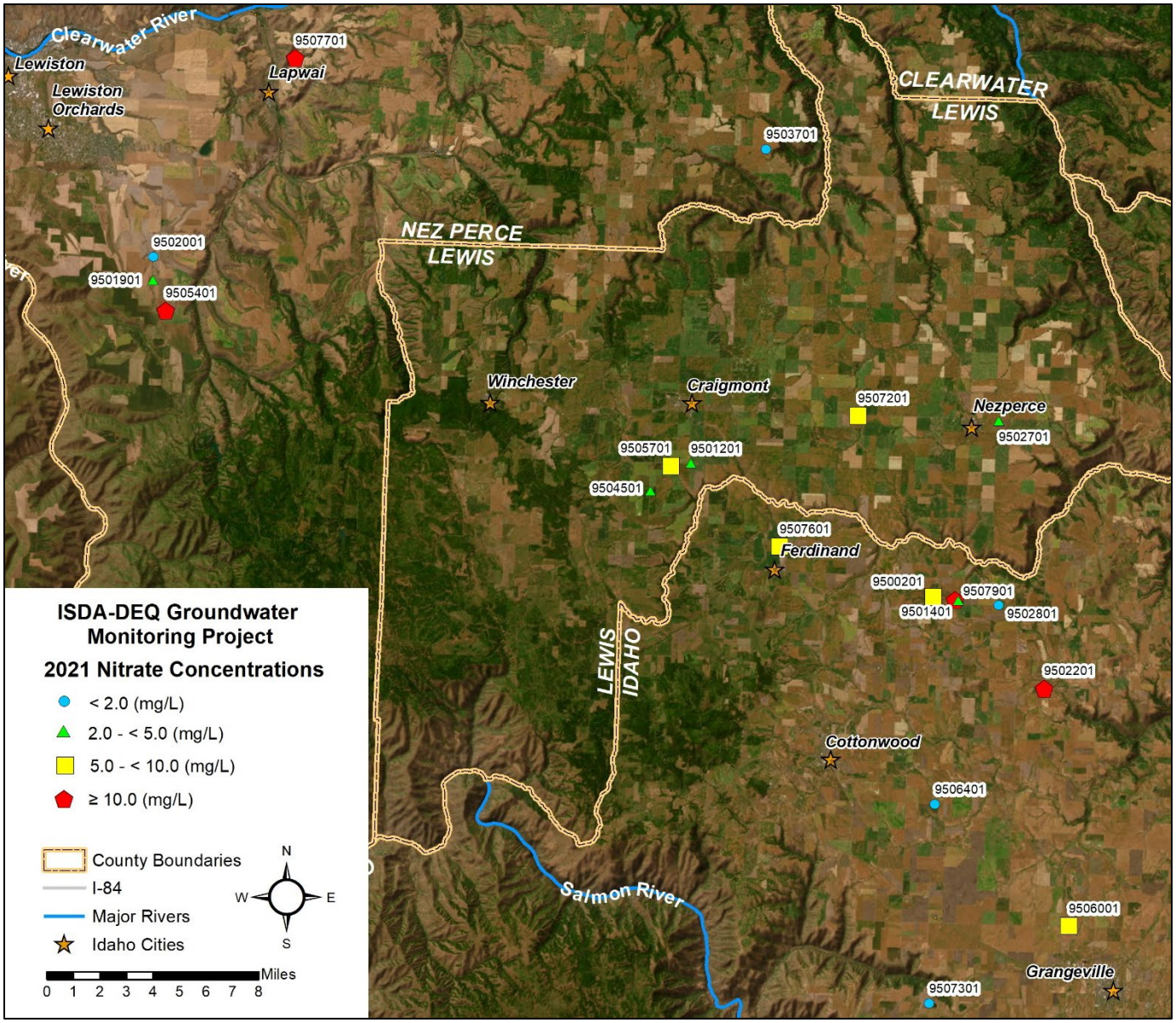


Figure B-23. Project 950 (Clearwater, Lewis, and Nez Perce Counties) nitrate results—DEQ-ISDA Joint Groundwater Monitoring Project, 2021.