

Nitrate and Emerging Contaminants Evaluation of Springdale, Idaho: Cassia County Nitrate Priority Area



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Cover photo: Marsh Creek in October 2008 (looking east)

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Executive Summary

This study presents water quality data from the community of Springdale, Idaho, which is located within the Cassia County Nitrate Priority Area (NPA). The objective of the study was to characterize ground water quality and determine the sources of nitrate and emerging contaminants found in wells in the Springdale area, with the help of the West Cassia County Soil and Water Conservation District (SWCD). Previous studies by the Idaho State Department of Agriculture (ISDA) concluded that agricultural land practices may be contributing constituents of concern to the shallow aquifer system in the Springdale area.

A sampling network consisting of 13 domestic wells, two surface water sites, and two drain sites was established in the Springdale area to evaluate impacts to the aquifer and their potential sources. Samples were collected in October 2008 and April 2009 to investigate seasonal variations in ground water quality. The domestic wells sampled include shallow, intermediate, and deep wells (all less than 200 feet deep) that are completed in the shallow alluvial aquifer. Water chemistry of the wells was compared to that of surface water and drain sites to determine if hydraulic connectivity between surface water and ground water exists.

The community of Springdale lies at the northern edge of an alluvial fan (Oakley Fan) that is situated between the Albion Mountain Range to the south and the Snake River to the north. Ground water flow direction in the Springdale area is generally southeast to northwest, following the natural drainage of the Oakley Fan. The aquifer is overlain by sandy soils which allow dissolved constituents of concern to reach the aquifer through infiltrating surface runoff.

Inorganic chemicals (IOCs), such as nitrate, sulfate, and chloride, were analyzed to determine if constituents of concern were elevated in the shallow aquifer. Nitrate concentrations in this area commonly exceed the maximum contaminant level (MCL) of 10 milligrams per liter (mg/L). To further identify what sources are impacting ground water, this study also analyzed wells and surface water samples for emerging contaminants (contaminants over which concern is just emerging, particularly personal care products and pharmaceuticals (PCPPs)). Analytical results suggest these emerging contaminants are ubiquitous in the study area but still below human health concerns.

The presence of emerging contaminants in surface water suggests surface water is being impacted by agricultural runoff and land practices up-gradient from the Springdale area. This study concluded that while Springdale is within a county-wide NPA, the local land practices, including agricultural activities and confined animal feeding operations (CAFOs), may be contributing to the elevated nitrate and emerging contaminant concentrations in the community of Springdale. Also, poor well construction and subsequent inadequate well maintenance may be creating conditions of upper shallow (impacted) aquifer leakage to the deeper aquifer systems in select Springdale wells. These conclusions are consistent with previous water quality studies in Cassia County (Young and Newton, 1989; Tesch et al., 2003; Carlson et al., 2005).

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1 Introduction

This study was developed to characterize the ground water quality and to determine whether current land practices in the Springdale area could be identified as potential sources of nitrate and emerging contaminants to the aquifer. Possible sources of nitrate and emerging contaminants in this area include commercial fertilizer application, confined animal feeding operations (CAFOs) (dairies and feedlots), septic tank effluent, and legume crop residues. The Springdale area is within the Cassia County Nitrate Priority Area (NPA), established by the Idaho Department of Environmental Quality (DEQ).

Springdale is located at the southern edge of the Eastern Snake River Plain (ESRP) Aquifer, one of the most voluminous aquifers in the United States. It was designated a sole source aquifer by the U.S. Environmental Protection Agency (EPA) because it is the only source of drinking water for 200,000 people in southern Idaho (Environmental Protection Agency, 2009).

1.1 Delineation of the Cassia County NPA

The Cassia County NPA was delineated using nitrate concentration data from 384 wells. This area extends over approximately 300 square miles of northern Cassia County, south of the Snake River, and encompasses the city of Burley and the community of Springdale. Ground water in the eastern part of the priority area, south of the community of Springdale, has higher mean nitrate ($\text{NO}_2 + \text{NO}_3\text{-N}$) concentrations than the area as a whole. Data from 112 wells south of Springdale have a mean nitrate concentration of 8.15 mg/L (Idaho Department of Environmental Quality, 2008).

To identify the major sources of nitrate within the Springdale area, including human, animal, or agricultural sources, the results of this study were combined with data from two Idaho State Department of Agriculture (ISDA) regional ground water monitoring projects in the Springdale area. The first of the ISDA regional studies was initiated in 1998 and included monitoring nitrate concentrations in ground water in northern Cassia County (Project #790; Carlson et al., 2005). The second regional study (Project #930; Tesch et al., 2003) was established in 2000 as a response to [dairy well] nitrate concentrations exceeding the maximum contaminant level (MCL) of 10 mg/L established by the EPA. The ISDA sampled ground water from wells in the Springdale area during one sampling event each year from 1998 to 2008.

The results from the ISDA studies suggest a connection between agricultural land use and ground water quality (Tesch et al., 2003; Carlson et al., 2005). ISDA identified the Springdale area as having the highest nitrate concentrations, with the majority of the wells they sampled having nitrate concentrations greater than the MCL. Most wells were completed less than 250 feet below ground surface (bgs). They concluded that nitrate impacts to the shallow aquifer are widespread, and that leaching of animal waste and the use of commercial fertilizers is the likely source of nitrate to ground water (Tesch et al., 2003).

1.2 Objectives

The objectives of the study were as follows:

- Delineate the ground water flow direction in the Springdale area

- Characterize the ground water quality in the Springdale area
- Evaluate the influence of surface water bodies (H and J Canals, Marsh Creek) on ground water contamination in the Springdale area
- Identify wells with elevated nitrate and emerging contaminant concentrations
- Determine the sources of elevated constituents of concern to ground water

2 Study Area

The Springdale study area, located southeast of Burley, Idaho, south of the Snake River, and north of the H and J Canal systems, is within the Cassia County Nitrate Priority Area (Figure 1). Springdale lies at the edge of the Oakley Fan area, a broad crescent-shaped area that originates in the Albion Mountain Range and slopes to the north. This fan is bounded in the north by the Snake River. The gently sloping fan is punctuated by broad volcanic domes, which rise several hundred feet above the plain (Young and Newton, 1989).

The H and J canal systems transport water from the Snake River to irrigate agricultural land. The main agricultural crops in northern Cassia County are barley, potatoes, sugar beets, wheat, alfalfa, and legumes (Idaho State Department of Agriculture, 2009).

There are several CAFOs within the Springdale study area, including dairies and feedlots. According to DEQ databases, there are approximately 14,000 confined animals within the 22,000 acre Springdale study area and approximately 60,000 cattle in Cassia County in 2009.

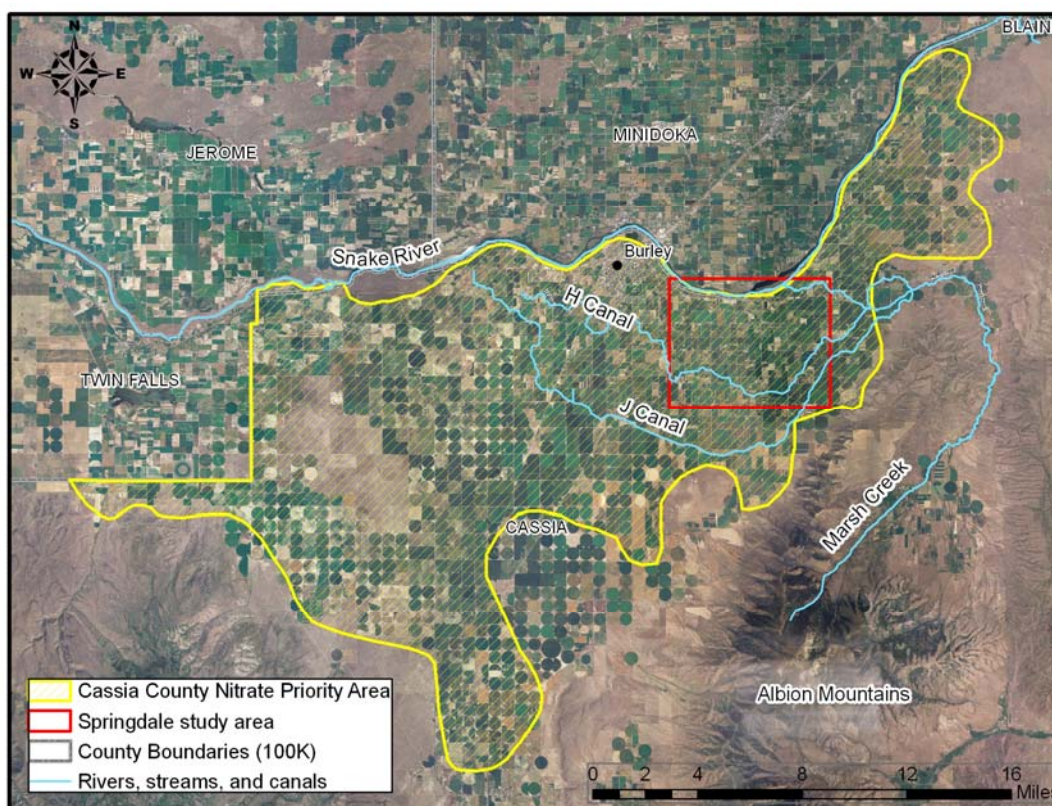


Figure 1. Springdale study area.

Of the approximately 112 domestic wells within the Springdale study area, a total of 14 domestic wells were selected for this study. In addition to domestic wells, two surface water sites (Marsh Creek) and two spring drain sites (Spring Creek Drain) were selected to be sampled. There were two sampling events, once in October 2008 (10 wells and two surface water sites) and again in April 2009 (13 wells, two surface water sites, and two spring drain sites). The domestic well suite for the sampling event in October 2008 consisted of 10 sites: SC-1 through SC-11, with no SC-8 (SC-8 sample identification was used to collect a duplicate sample from SC-7). The sampling suite was expanded for the April 2009 sampling event in response to preliminary chemistry results and consisted of the same sites, with the exception that SC-7 was omitted, plus the additional sites SC-10A, SC-12, SC-13, and SC-14. Figure 2 shows sample site locations for this study and for the two ISDA studies. The well site SC-10A was added to the sample suite due to the presence of historical data collected by ISDA, where as SC-10 has no corresponding historical data.

The Spring Creek Drain is a surface water body, called a spring drain, that transports surface runoff (mostly irrigation runoff) during the irrigation season (late April to October). Before the irrigation season, the flow in Spring Creek Drain is coincident with the shallow water table and considered to represent shallow ground water chemistry. Therefore, in order to characterize the chemistry of the shallow water table, samples were collected from the Spring Creek Drain during the April sampling event before irrigation season.

The ISDA collected historical nitrate data for 11 of the 14 domestic wells included in this study as part of two of their regional ground water monitoring projects (790 and 930).

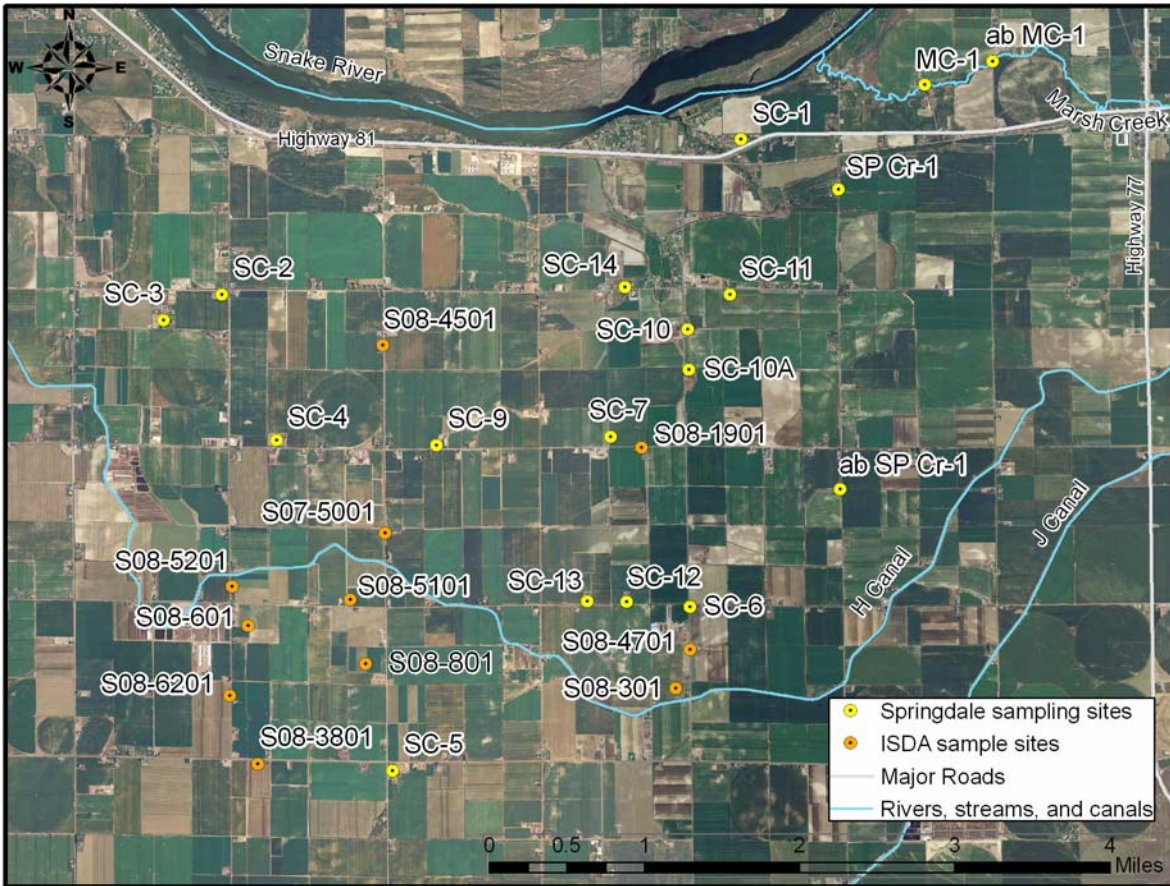


Figure 2. Springdale sample sites, including ground water wells (SC-1 through SC-14), surface water sites (MC-1, ab* MC-1), spring drain sites (SP Cr-1, ab SP Cr-1), and ISDA samples (sites beginning with S07- and S08-).

***ab signifies a site that is upstream of the site with the otherwise identical number.**

2.1 Climate

The climate in Cassia County is semi-arid with an average annual precipitation rate between 9 and 11 inches per year recorded at the Burley, Idaho weather station (DEQ databases). Precipitation is a minor source of recharge to the Springdale area aquifer system. The topography in the area influences the climate: the mountains receive more rainfall compared to the low lying area, where Springdale is located.

2.2 Geologic Setting

Springdale lies on the southern edge of the Eastern Snake River Plain (ESRP), which is an elongate, down-warped basin consisting of late-Tertiary and Quaternary basalt flows overlying Tertiary silicic volcanism related to the North American plate overriding the Yellowstone Hotspot (Leeman, 1982; Morgan et al., 1984; Smith, 2004). Tectonic and sedimentary processes also shaped the ESRP before, during, and after pulses of volcanism.

The local geology in the Springdale area is dominated by four major rock types: (1) pre-Tertiary sedimentary units, (2) Tertiary rhyolite, (3) Tertiary and Quaternary basalt, and (4) Quaternary alluvium (Young and Newton, 1989). Pre-Tertiary sedimentary rocks comprise the Albion Mountains to the southeast of the Springdale area and include units of limestone, sandstone, and

shale. The overlying Tertiary volcanic units consist of welded ash tuffs and lava flows of rhyolitic composition. Tertiary and Quaternary mafic volcanism resulted in basalt flows ranging in thickness from tens of feet to hundreds of feet. Springdale area well logs note evidence of cinders and “rubbly” basalt near the top of individual flows that are in contact with alluvial units above. The wells in the Springdale area are screened in this alluvium and in some instances, encounter the underlying basalt flows.

The Quaternary alluvium consists of glaciofluvial deposits, fanglomerate deposits, lacustrine deposits (prehistoric Burley Lake), and terrace deposits (Bonneville flood). These alluvial deposits include clay, silt, sand, and gravel that are locally interfingered with one another and are not laterally extensive (Figure 3) (Young and Newton, 1989).

The Burley lake deposits were identified by well cuttings and well logs in the Rupert-Burley-Paul area. The Burley lake deposits consist of clay, silt, sand, and gravel that range from unconsolidated to well-compacted (Crosthwaite and Scott, 1956). There are approximately 15 to 150 feet of prehistoric Burley Lake deposits overlying successive basalt flows (Crosthwaite and Scott, 1956). The Springdale area lies near the southern extent of the Burley Lake sediments (Figure 4, page 8).

The glaciofluvial alluvium was transported from the Albion Mountain range to the ancestral Snake River by glacial outwash streams. These stream deposits consist of bedded clay, sand, and gravel units, deposited as the streams drained active glacial ice. The fanglomerate deposits consist of various sized fragments deposited within the Oakley Fan that were later cemented into competent rock. This depositional environment may describe the cemented gravels noted in the Springdale well logs for SC-6 and SC-7 (Idaho Department of Water Resources, 1975; 1996).

Well logs from the Springdale area document this complex geology, identifying intercalated basalt flows and varying thicknesses of alluvial deposits from various depositional environments. The well logs for wells SC-11 and SC-10A describe upper clay and gravel units in contact with basalt at depths of approximately 21-23 feet (Idaho Department of Water Resources, 1971; 2002a). Well logs for wells SC-6 and SC-7 identify more than 150 feet of alternating clay, sand, and gravel, with no apparent contact with the underlying basalt units (Idaho Department of Water Resources, 1975; 1996). In the western extent of the study area, wells SC-2 and SC-3 draw water from shallow (less than 50 feet) sand and gravel units with no documentation of contact with basalt (Idaho Department of Water Resources, 1972; 2002b). The subsurface geology hydraulically below H canal and above J canal is documented in the well log for SC-5, which describes alternating alluvial units to approximately 60 feet (Idaho Department of Water, Resources 1970).

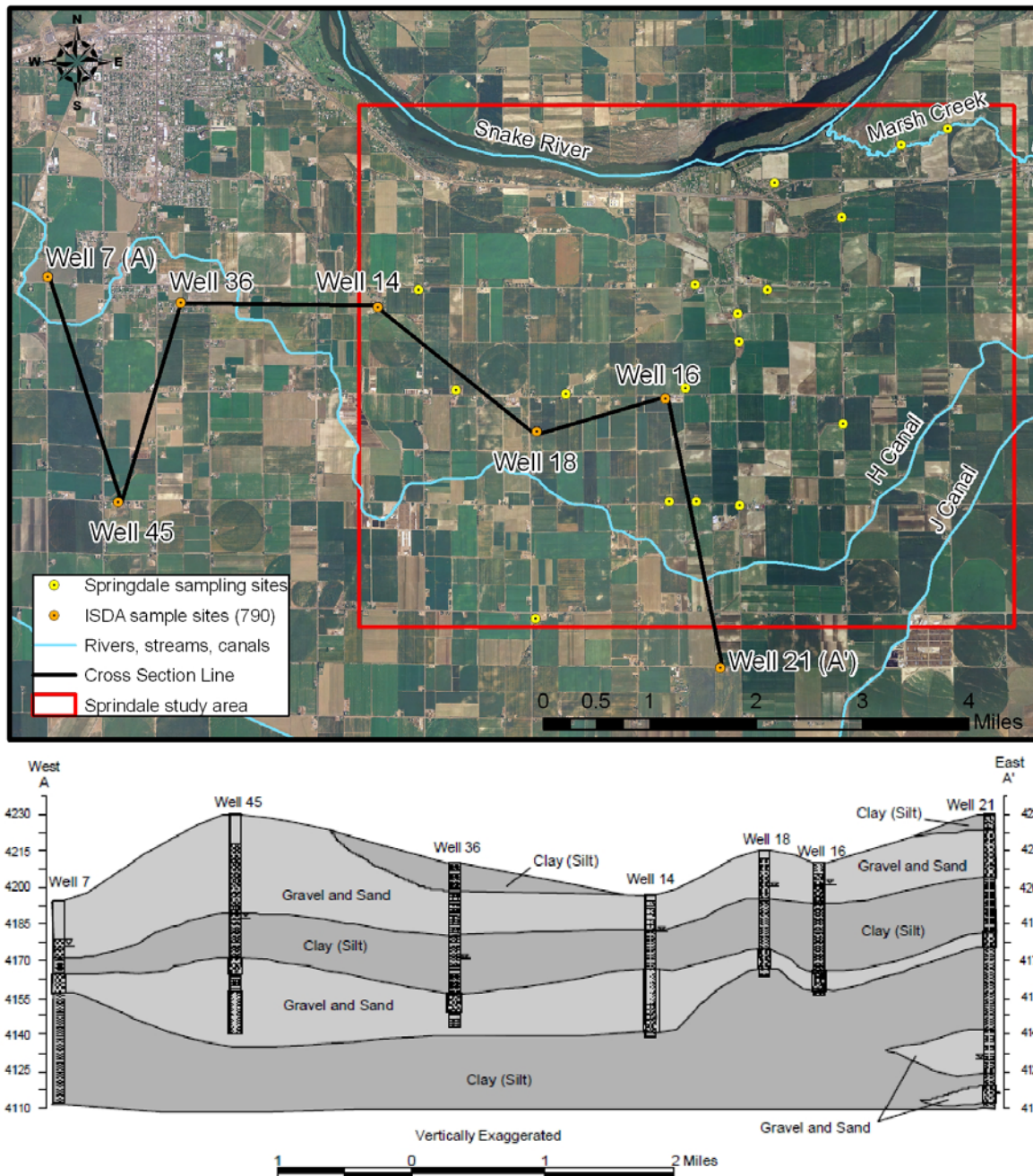


Figure 3. Cross section of shallow alluvial aquifer in the Springdale area (modified after Tesch et al., 2003).

2.3 Hydrogeology

Four aquifers have been identified in the Springdale area. The four aquifer bearing units include 1) limestone, 2) rhyolite, 3) basalt, and 4) alluvium. The two major aquifers in the Springdale area important to this study are the basalt aquifer and overlying alluvial aquifer.

Ground water is unconfined in the basalt and perched zones within the alluvium (Young and Newton, 1989). The average depth to water in the basalt aquifer in the study area is greater than

150 feet. The shallow unconfined aquifer in the Springdale area is coincident with areas underlain by alluvial deposits (i.e., Burley Lake beds and Bonneville Flood deposits). Water from the alluvial aquifer likely contributes recharge to the deeper aquifer system in the area, but the amount of recharge is difficult to quantify. Based on well logs in the Springdale area, the average depth to ground water in the shallow alluvial system is less than 50 feet below ground surface (bgs), and ranges locally from 5 to 144 feet bgs (Idaho Department of Water Resources, 1971; 1996).

Possible sources of leachable contaminants to the shallow aquifer include commercial fertilizers, cattle manure, legume crops, wastewater lagoons, and septic systems (Tesch et al., 2003). The shallow alluvial aquifer system in the study area is used for domestic and irrigation water supply and is particularly susceptible to contamination leaching due to the unconfined, shallow nature of the deposits.

The main sources of recharge in the Springdale area are infiltration of surface water (Snake River, canal systems, streams) and precipitation, and to a lesser degree, deep percolation of irrigation water. The main irrigation method in this area is sprinkler application of surface water by hand lines, wheel lines, and pivots. The Snake River north of Springdale likely gains ground water contributions from the shallow ground water system underlying the study area.

The general direction of ground water flow inferred from potentiometric water level measurements from the alluvial aquifer (Figure 4) is generally southeast to northwest in the study area (Young and Newton, 1989). The J canal represents the up-gradient hydrologic boundary, and the Snake River is the down-gradient hydrologic boundary of the system.

Several perennial stream systems drain the Oakley Fan area. Marsh Creek drains the eastern portion of the Albion Mountain Range and enters the Snake River near Springdale. The headwaters of Marsh Creek are a combination of springs and surface runoff from the peak of Mount Harrison as well as runoff contributions from the Cotterel Mountains to the east. Marsh Creek appears to lose water to the deeper regional aquifers near its headwaters but the creek gains ground water in the Springdale study area, based on discharge measurements taken by the Cassia County Soil and Water Conservation District (SWCD).

The velocity of ground water in Springdale's shallow aquifer can be estimated using the following parameters: effective porosity, or the void spaces within the aquifer available to hold water; hydraulic conductivity, or the interconnectivity of those void spaces; and the hydraulic gradient, or the ground water surface elevation change. Using published values for these parameters, ground water flow velocities in the shallow aquifer range from 0.5 to 3.5 ft/day, suggesting the time required for a particle of ground water at the southern boundary of the Springdale study area to travel to the Snake River (~6 miles) could take from tens to hundreds of years.

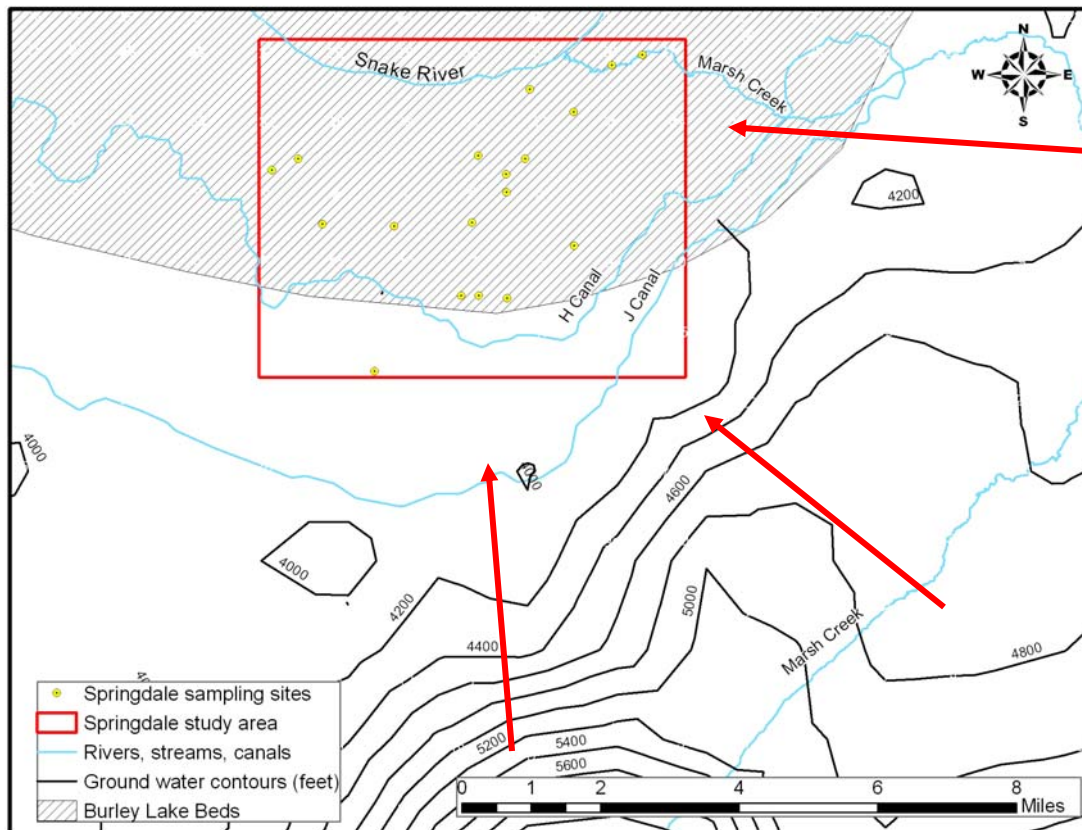


Figure 4. Ground water contours and flow direction for the alluvial aquifer system (developed with IDWR domestic well GIS shapefile). The red arrows denote the ground water flow direction (modified after Malde, 1991).

3 Methodology

The sampling protocol included a suite of wells and constituents in October 2008 (at the end of the irrigation and growing season) and April 2009 (before irrigation and the growing season). During both the October 2008 and April 2009 sampling events, field parameters (pH, temperature, dissolved oxygen, and specific conductivity) were measured with a Horiba Water Checker U-10. For both events, samples were analyzed for inorganic chemicals (IOCs) (nitrate, chloride, sulfate, and total dissolved solids (TDS)), nitrogen isotopes, and emerging contaminants (those only recently recognized as potentially being of concern, including PCPPs [pharmaceutical and personal care products])—with the exception that the April 2009 samples were not analyzed for steroids and hormones. In addition to the constituents analyzed during both sampling events, the October 2008 samples were analyzed for major ions (calcium, magnesium, potassium, sodium, and alkalinity) and for oxygen and deuterium isotopes.

The PCPP sample collected for SC-6 in October 2008 was compromised during transport to the University of Iowa; therefore, an additional sample was collected for SC-6 in December 2008. See Table 6 on page 24.

The parameters measured and constituents analyzed and the corresponding EPA methods and preservation techniques are provided in Table 1. Permission was granted by landowners before

samples were collected from their domestic wells. The results from these analyses can be found in Appendices A, B, and C.

Analysis for major ions and inorganic chemicals was performed at the Idaho State Laboratory in Boise, Idaho. Analysis for the stable isotopes of oxygen (^{18}O), hydrogen (deuterium; ^2H), and nitrogen (^{15}N) was performed at the University of Arizona's Laboratory of Isotope Geochemistry. The PCPPs were analyzed at the University of Iowa Hygienic Laboratory.

Table 1. Suite of analytes, EPA analytical methods, and preservation techniques.

Sampling Event	Analyte	Analytical Method	Preservative	Holding Time
October 2008; April 2009	$\text{NO}_2+\text{NO}_3\text{-N}^1$	EPA 300.0	$4^\circ\text{C} \pm 2^\circ\text{C}$, H_2SO_4^2	28 Days
October 2008; April 2009	Chloride, Sulfate	EPA 300.0	$4^\circ\text{C} \pm 2^\circ\text{C}$	28 Days
October 2008	Metals ³ (Ca, Mg, K, Na)	EPA 200.7	$4^\circ\text{C} \pm 2^\circ\text{C}$, HNO_3^4	6 months
October 2008	Alkalinity (HCO_3) ⁵	EPA 2320 B	$4^\circ\text{C} \pm 2^\circ\text{C}$	14 days
October 2008; April 2009	Total Dissolved Solids (TDS)	EPA 160.1	$4^\circ\text{C} \pm 2^\circ\text{C}$	28 days
October 2008; April 2009	$^{15}\text{N}^6$	TP11	Freeze samples	Unlimited if frozen
October 2008	$^{18}\text{O}^7$	TP13	None	None
October 2008	$^2\text{H}^8$	TP04	None	None

1. $\text{NO}_2+\text{NO}_3\text{-N}$ – nitrite plus nitrate as nitrogen; 2. H_2SO_4 – sulfuric acid; 3. Metals: Ca – calcium; Mg – magnesium; K – potassium; Na – sodium; 4. HNO_3 – nitric acid; 5. HCO_3 – bicarbonate; 6. ^{15}N – nitrogen isotope; 7. ^{18}O – oxygen isotope; 8. ^2H – (deuterium) hydrogen isotope

3.1 PCPP Sample Collection Method

Sampling for PCPPs requires careful sample collection and handling procedures, as summarized below (from Nicholas, 2009). PCPP sample collection was performed using EPA Method 1669 (i.e., “clean hands/dirty hands” procedures) for *Sampling Ambient Water for Trace Metals*. The sample procedures were designed to minimize the potential for contamination of the samples.

Using these procedures, roles and responsibilities for each member of the sampling team are established before they don personal protective equipment (PPE) and/or obtaining any sample. One member of the two-person sampling team was designated as “dirty hands” and the other “clean hands.” The person assuming the “dirty hands” role wore powder-less nitrile laboratory gloves and a surgical mask. This PPE reduces the possibility of any PCPP contamination from the samplers. Gloves were changed between samples and sample sites by the “dirty hands” member of the sampling team. The “clean hands” member of the team was responsible for handling the sample after it was collected by the “dirty hands” member. Samples were collected as quickly as was reasonably possible, while carefully preventing any contact between the containers and any surface other than the sampling surface.

Springdale samples were taken directly from designated sample locations (Figure 2, page 4). The stream samples were collected as surface water, and wells were sampled according to the guidelines outlined in the quality assurance project plan (QAPP). Duplicates and blanks were collected and submitted as outlined in the QAPP. Samples were stored in coolers with freezer packs, after collection, to maintain 4 °C from the time of the sampling event until sample custody was transferred to the appropriate laboratory among those used for this study.

4 Water Chemistry

The major ions (chloride [Cl], sulfate [SO₄], alkalinity [HCO₃], and the metals calcium [Ca], magnesium [Mg], potassium [K], sodium [Na]) were analyzed in samples from the October 2008 sampling event to characterize the ground water chemistry in the Springdale area. This major ion analysis was done to characterize the “type” of ground water in the shallow aquifer. The plotted values (Figure 5) are relative to the percentage of major dissolved anions and cations in the water. The major ion water chemistry of the ground water is not markedly different from the water chemistry of the surface water samples from Marsh Creek. The ground water in the Springdale area can be characterized as calcium bicarbonate-type water. The water chemistry of the aquifer systems identified in the Springdale area was compared by Young and Newton (1989), and the major ion concentrations from the alluvial Springdale aquifer system are consistent with the water chemistry of the alluvial aquifer system in the [1989] study. Given the consistent results, the major ion metals (calcium, magnesium, potassium, sodium, and alkalinity) were not repeated for the April 2009 sampling event.

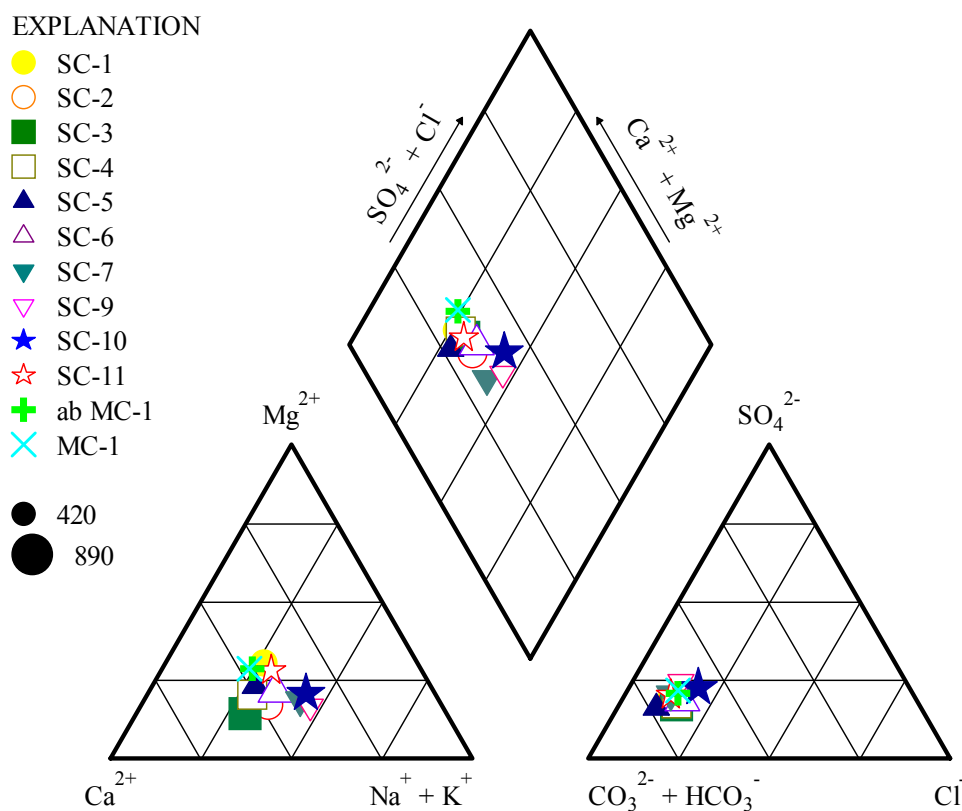


Figure 5. Piper trilinear diagram for Springdale wells (October 2008) (after Piper 1944). The symbol size is determined by the TDS concentration for each sample.

The major ion chemistry is dependent on total well depth for the Springdale wells. The major ions calcium, magnesium, and sodium were summed to evaluate whether the well depth was correlated with dissolved ion concentrations. Figure 6 shows the correlation between the summed ion concentration and the depth for each well and, for comparison, each of the surface water sites. Wells SC-6, SC-7, and SC-10 had the highest dissolved ion concentrations and are the three deepest wells sampled for this study at 155 feet bgs, 195 feet bgs, and 205 feet bgs, respectively (Idaho Department of Water Resources 1975; 1987; 1996). Calcium and sodium contributions in these deep wells are markedly higher than for the shallower wells (averaging 64 feet bgs). These ions are likely derived from parent material and equilibrium reactions between ground water and the sedimentary units encountered in these deeper wells.

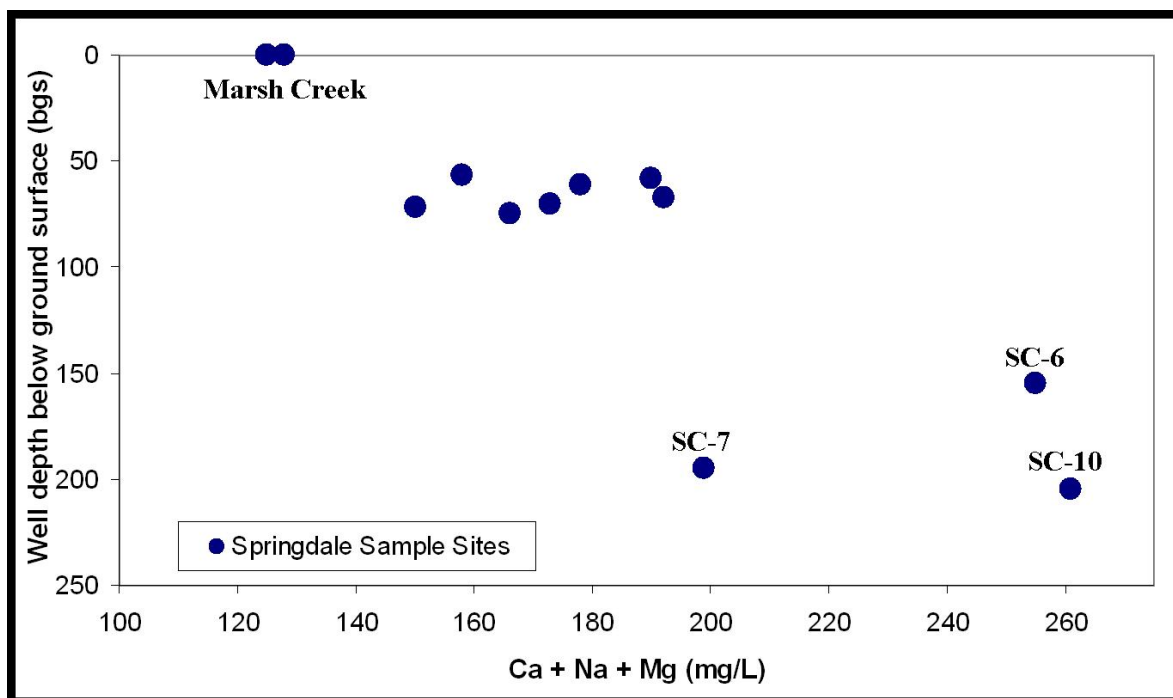


Figure 6. Well depth versus major ion chemistry for selected Springdale wells.

4.1 Inorganic Chemical Results

Samples were analyzed for a suite of inorganic chemicals to characterize ground water quality in the Springdale area. The inorganic constituents analyzed included nitrate, chloride, sulfate, and total dissolved solids (TDS). These constituents, along with field parameters including pH, temperature, dissolved oxygen, and specific conductance define the water quality in the Springdale area. ISDA also collected samples that were analyzed for inorganic constituents for their 790 and 930 projects and a comparison of their resulting data is included.

Nitrate concentrations exceeded the maximum contaminant level (MCL) of 10 mg/L in nine of the 10 wells included in the October 2008 sampling event and total dissolved solids (TDS) exceeded the MCL of 500 mg/L in all 10 of the wells. Nitrate and TDS concentrations exceeded the MCL in 12 of the 13 wells included in the April 2009 sampling event. Concentrations at the surface water sites did not exceed the nitrate or TDS MCLs in either the October or April sampling events. The Spring Creek drain did not have concentrations that exceeded the MCL for nitrate or TDS throughout the year. However, compared to the Marsh Creek samples, the Spring

Creek Drain samples had significantly higher TDS, nitrate, chloride, and sulfate concentrations that are more consistent with the chemistry of the shallow ground water in the area.

Nitrate versus TDS concentrations for DEQ's October 2008 and April 2009 sampling events are plotted in Figure 7. Because the ISDA sampling procedures included calculating TDS values from specific conductivity values in the field, their data is therefore not included in this analysis. There is a linear relationship ($R^2 = 0.92$) between nitrate and TDS in the Springdale area. The surface water samples from Marsh Creek sites MC-1 and ab MC-1, had the lowest measured nitrate and TDS concentrations. Wells SC-6 and SC-10 had the highest measured nitrate and TDS concentrations. These two wells appear to be influenced by processes that contribute dissolved solids to the aquifer, independently or in addition to nitrate contributions.

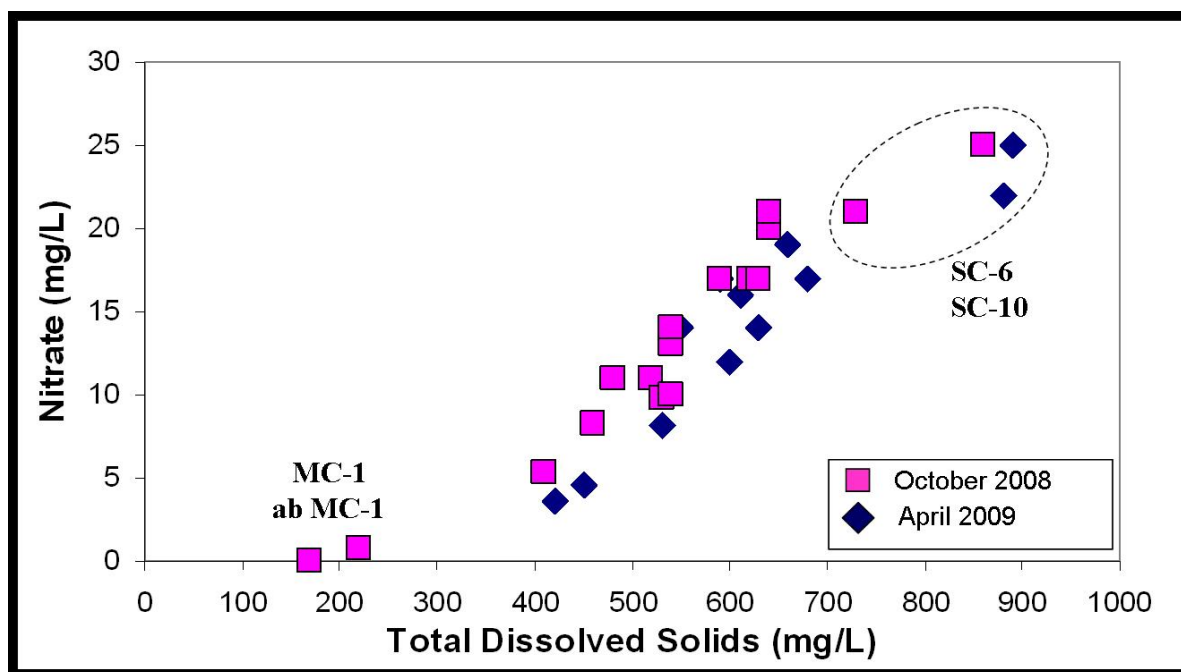


Figure 7. Total dissolved solids versus nitrate concentrations for Springdale wells.

The nitrate versus chloride discrimination plot (Figure 8) presents data collected for this project and auxiliary data collected by ISDA during the summers of 2007 and 2008. The ground water samples from wells SC-6, SC-10, S08-301, and S08-601 exhibit an increased chloride contribution relative to the remainder of the data. Because the chloride and nitrate data are correlated, the source of the increases could be related as well. This chloride contribution in wells SC-6 and SC-10 is also evident in Figure 9, where sulfate and chloride are compared.

Sources of chloride include natural chloride from geologic units, septic tank effluent, or CAFO effluent. In general, igneous rocks (basalt-hosted aquifers) do not contribute high concentrations of chloride to circulating ground water. However, sedimentary rocks deposited in drainage basins (i.e., Burley lake beds) can contribute high concentrations of leachable chloride to ground water. While the source of chloride could be from naturally occurring sedimentary units, the nitrogen isotope values ($\delta^{15}\text{N} > 9\text{‰}$) indicate that the additional source of chloride could be from human or animal waste sources.

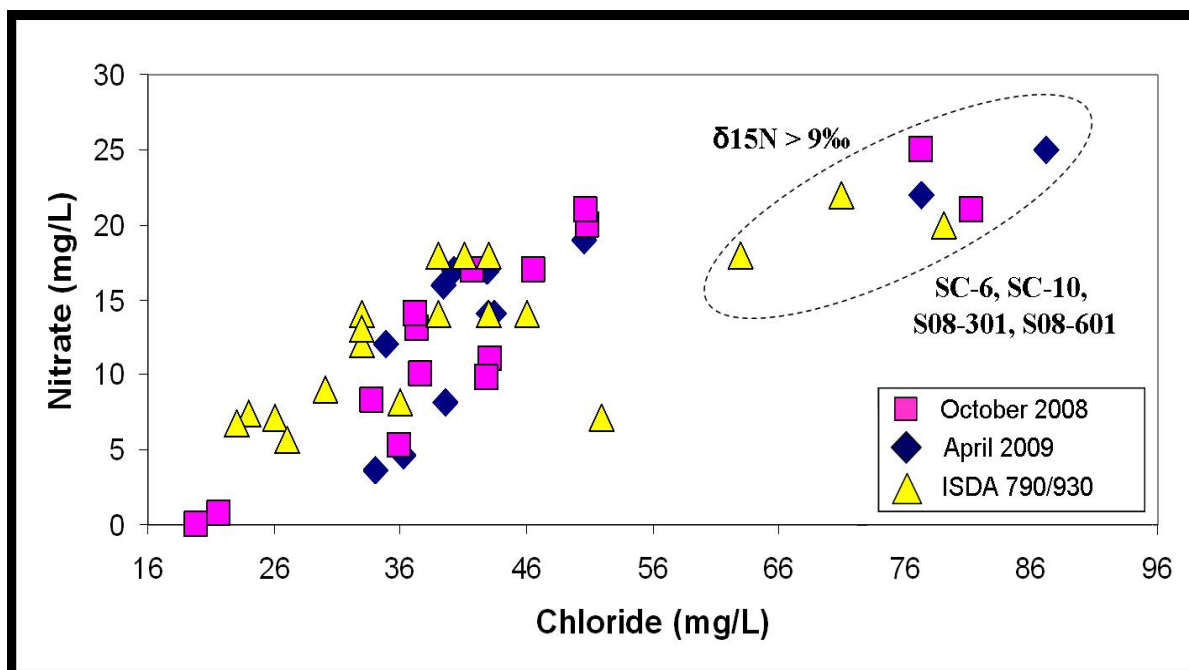


Figure 8. Chloride versus nitrate concentrations for Springdale wells. ISDA 930 project data were collected during the summer of 2007 and 2008.

In areas of irrigation and low rainfall, the shallow ground water (recharged irrigation water) leaches solutes (dissolved salts) from the vadose zone at an accelerated rate. This accelerated leaching will increase the total dissolved solid concentration and nutrient loads in the aquifer. Water affected by irrigation generally has higher sulfate and chloride concentrations than the original recharged water supply, due to evapotranspiration (Hem, 1986).

The sulfate/chloride mass ratio (after Townsend and Whittemore, 2005) is plotted against chloride concentration in Figure 9. The samples from wells SC-6 and SC-10, and ISDA samples S08-301 and S08-601, all exhibit an increased chloride contribution relative to sulfate (data circled to the right on Figure 9); however, the sulfate/chloride ratio falls within a small range. The Marsh Creek sites show significant variation in sulfate concentrations between the spring and fall, where the April 2009 samples had much lower sulfate concentrations than the October 2008 samples, on average 15.6 mg/L and 72.5 mg/L, respectively.

Naturally occurring sulfate can be found in high concentrations where ground water is in contact with evaporative units (i.e., Burley lake beds), including gypsum. Human-caused sources of sulfate could be from application of fertilizers containing sulfur (personal communication, Cassia County SWCD).

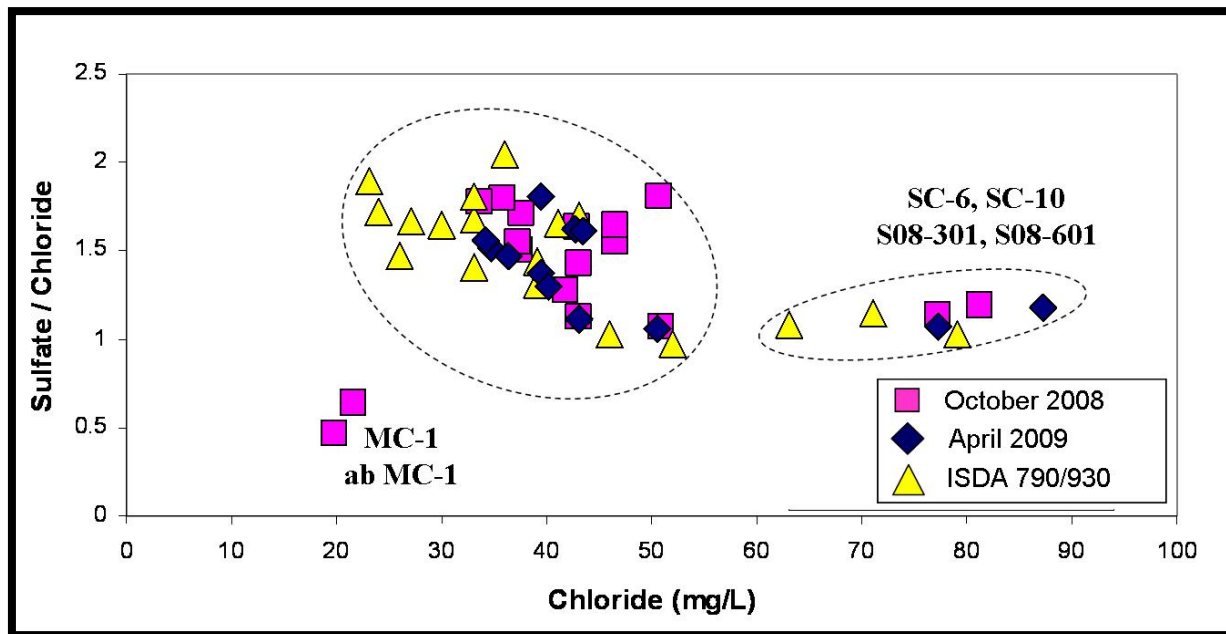


Figure 9. Sulfate/chloride mass ratio versus chloride concentration (mg/L).

Table 2 provides a trend analysis of nitrate data for select wells, and Figure 10 displays the spatial distribution of nitrate concentrations across the Springdale study area. This figure illustrates the localized nature of high nitrate values, where wells in close proximity have significantly different nitrate concentrations (wells SC-10 and SC-14, for instance). The surface water sites have the lowest nitrate concentrations during both the October and April sampling events. The Spring Creek drain sites (SP Cr-1 is hydraulically down-gradient from ab SP Cr-1), which were sampled during April 2009, are thought to represent the top of the water table during low water flow. There seems to be no correlation between depth of water sample and nitrate concentration, because the nitrate values at these drain sites (and at the two Marsh Creek surface water sites) are lower than in all of the wells sampled, and it is generally believed that nitrate concentrations are highest at the top of the water table.

Wells SC-6 and SC-10 had the highest nitrate concentrations observed during this study. In both the October 2008 and April 2009 sampling events, both SC-6 and SC-10 had nitrate concentrations greater than 20 mg/L. During the April sampling event, nitrate in SC-3 was greater than 20 mg/L. In many agricultural areas, nitrate concentrations are thought to increase during the fall, due to cumulative effects of irrigation recharge and fertilizer use during the growing season. However, in most instances in the Springdale area, nitrate concentrations were higher in April compared to October, suggesting dilution effects from increased recharge are occurring during the fall that decrease the overall nitrate concentration observed.

Sampling location SC-7 was not sampled in the April 2009 event; sampling locations SC-10A, SC-12, SC-13, SC-14, SP Cr-1, and ab SP Cr-1 were only sampled during the April 2009 event.

Table 2. Mann-Kendall trend analysis of nitrate data for Springdale study wells with corresponding historical data provided by ISDA (790 and 930 projects). The sample sites SC-1 and SC-10 were not previously sampled by ISDA, therefore a trend analysis could not be conducted.

ISDA Site ID	DEQ Site ID	Trend Analysis	Confidence Level	Number of Analyses	Average Nitrate (mg/L)	Standard Deviation
9303701	SC-2	Stable		8	17.68	0.79
7901401	SC-3	Increasing	90%	9	15.83	2.67
9300201	SC-4	Decreasing	80%	9	13.31	1.54
7901901	SC-5	Increasing	90%	9	11.06	1.6
9304601	SC-6	Stable		9	23.08	1.75
9306101	SC-7	Increasing	90%	9	15.96	2.07
9301201	SC-10A	Increasing	80%	8	12.88	5.18
9303401	SC-11	Stable		9	16.72	2.93
9304801	SC-12	Increasing	80%	8	13.75	1.67
9304901	SC-13	Increasing	90%	8	13.55	2.06
9301501	SC-14	Decreasing	90%	8	6.33	5.02

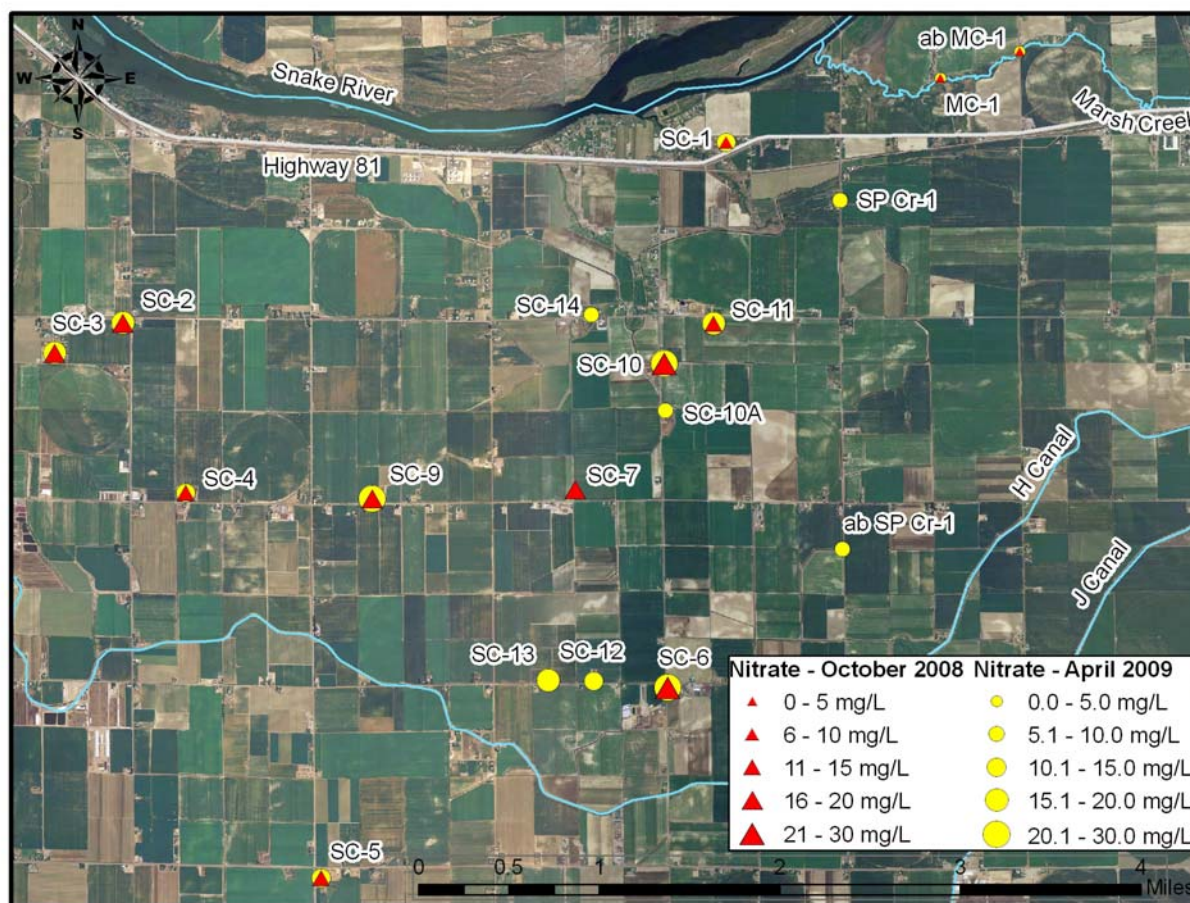


Figure 10. Well locations and nitrogen concentrations.

Nitrate analyses (~1,200) from domestic and monitoring wells sampled by DEQ, ISDA, IDWR, and the USGS were combined to produce a contour map of nitrate concentrations for the Springdale area (Figure 11). Historical nitrate data in this area extends back to 1975. Each sample site that had more than one nitrate data concentration collected was averaged. The Kriging tool in ArcGIS allows the user to interpolate data to produce a “contour map” of nitrate concentrations. Figure 11 shows a contour map of nitrate concentrations in northern Cassia County. (A similar method was used to delineate the DEQ nitrate priority areas, including the Cassia County Nitrate Priority Area.) This map is intended to provide a conceptualization of the nitrate “hotspots” in the Springdale area (represented by the pink areas in Figure 11). These high-nitrate areas are localized and correspond to the locations of the wells with the highest recorded nitrate concentrations (in this study). These localized areas of high nitrate concentrations may be controlled by the extent of the shallow aquifer system, the extent of the alluvial deposits that control the hydrogeology in this area, and the local land uses.

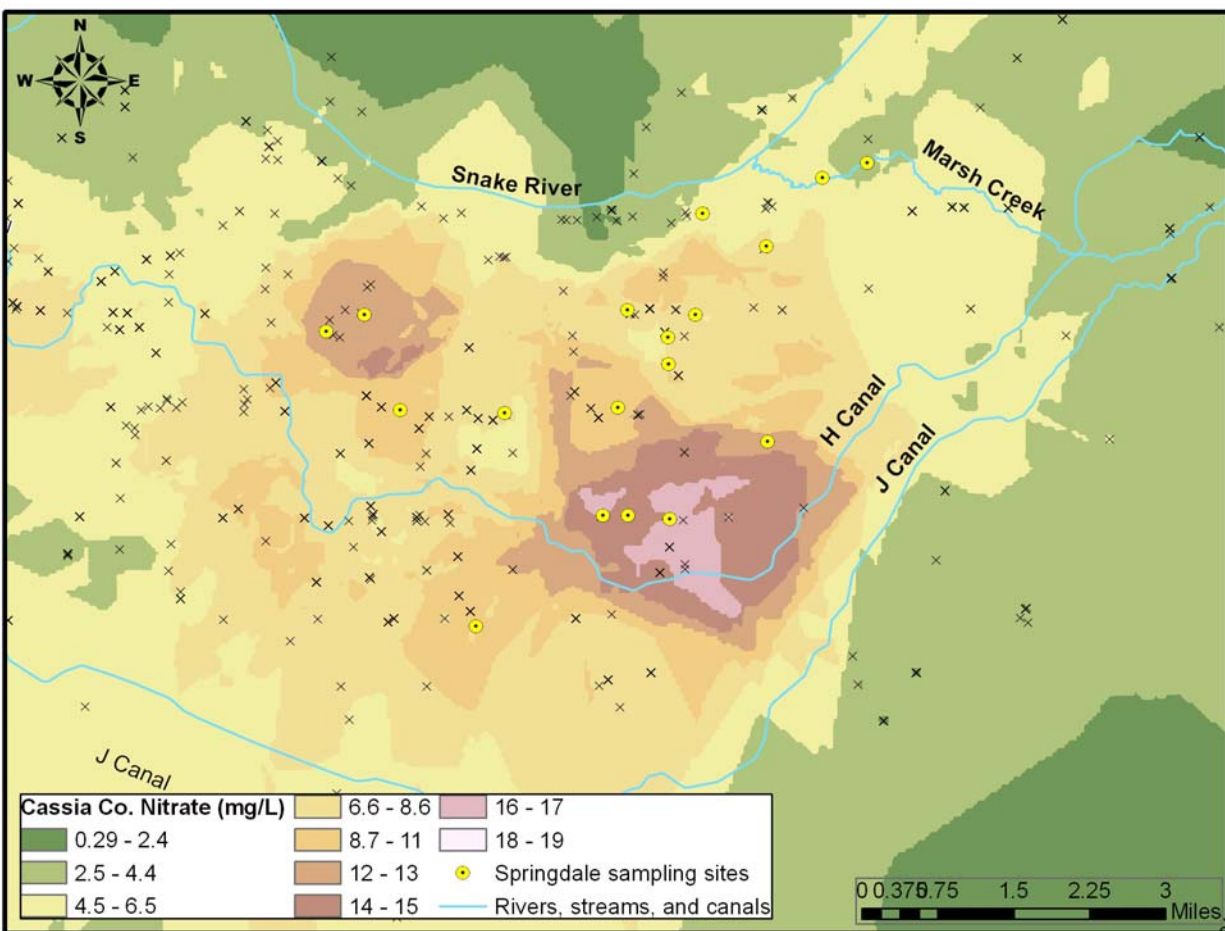


Figure 11. Contour map of nitrate concentrations from wells included in the Cassia County Nitrate Priority Area delineation.

4.2 Stable Isotope Results

Stable isotopes can provide information about the relative age, provenance, and environment of ground water recharge (Young and Newton, 1989). The stable isotope systems analyzed for this project include ^{18}O (oxygen), ^2H (deuterium), and ^{15}N (nitrogen).

4.2.1 Oxygen and Deuterium

Analyses of the oxygen and deuterium isotope system can help determine the isotope partitioning behavior (fractionation) that occurs from natural processes such as ground water and surface water mixing, evaporation, precipitation, and recharge. This isotopic system is sensitive to the temperature and elevation of water condensation. The ratios of stable isotopes within a particular air mass vary with temperature during condensation or evaporation (Clark and Fritz, 1997). Oxygen and deuterium values decrease (become more negative) with decreasing temperature. Therefore, climatic conditions at the time of water droplet formation can be inferred for that sample of water. Similarly, water formed at higher elevations results in isotope depletion (becomes more negative).

Studies of freshwater worldwide have shown that cold meteoric water has isotopic compositions related by the equation $D = (8)^{18}\text{O} + 10$ (Craig, 1961). This line is referred to as the global meteoric water line (GMWL). A local meteoric water line (LMWL) was identified for southeastern Idaho to better represent the isotopic compositions of water at these elevations. Freshwater in the Eastern Snake River Plain Aquifer has isotopic compositions related by the equation $D = (6.4)^{18}\text{O} - 21$ (Benjamin et al., 2004).

The isotopic compositions of the water from the Oakley Fan area (southwest of and including the Springdale area) are displayed in Figure 12. Isotopic values for most of the samples from this area cluster near the GMWL but vary up-slope or down-slope. Isotopic values for water influenced by evaporation lie off of the meteoric water line (Young and Newton, 1989). The isotopic results from Springdale are compared with Oakley Fan isotope results to determine the origin of the water in the Springdale area.

The samples that plot down-slope and to the left in the figure represent depleted isotopic values, suggesting this water has been recharged from areas of higher elevation (and cooler temperature conditions). These samples correspond to water derived from the deeper aquifers in the Springdale area (limestone, basalt, and rhyolite aquifers). The samples up-slope and to the right (including Springdale data) represent water that has undergone fractionation (i.e., evaporation) prior to recharge and is derived from the shallow alluvial aquifer system (Young and Newton, 1989).

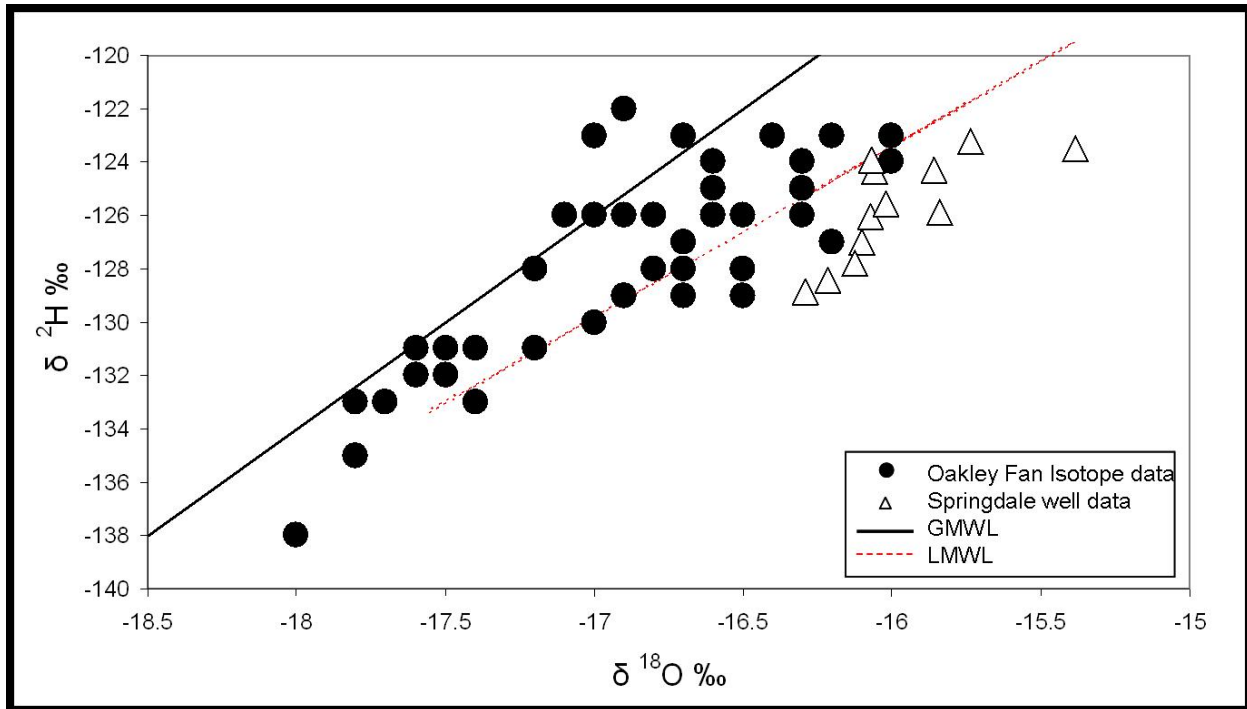


Figure 12. Isotope data for the Oakley Fan area (Young and Newton, 1989) and Springdale area (this study).

The oxygen and deuterium isotope results for wells in the Springdale area are shown in Figure 13. The isotopic signature of the surface water samples from MC-1 and ab MC-1, and the average isotopic signature of the Snake River (near King Hill), are plotted for comparison. Isotopic signatures in these surface water samples are consistent with the isotopic signature of the LMWL. The wells that plot to the left of the surface water samples are isotopically depleted (light), while the wells that plot to the right of the surface water samples are isotopically enriched (heavy). When the value is “enriched” isotopically, it means that the heavy ^{18}O molecules are concentrated in the water, which occurs by evaporation (Kendall and McDonnell, 1998).

The wells SC-6, SC-9, SC-10, and SC-11 exhibit isotopic signatures that are consistent with water that has undergone extensive evaporation prior to recharge. Because the water from these wells is more isotopically enriched than surface water, the provenance of this water is not consistent with recharge that comes only from river or canal waters.

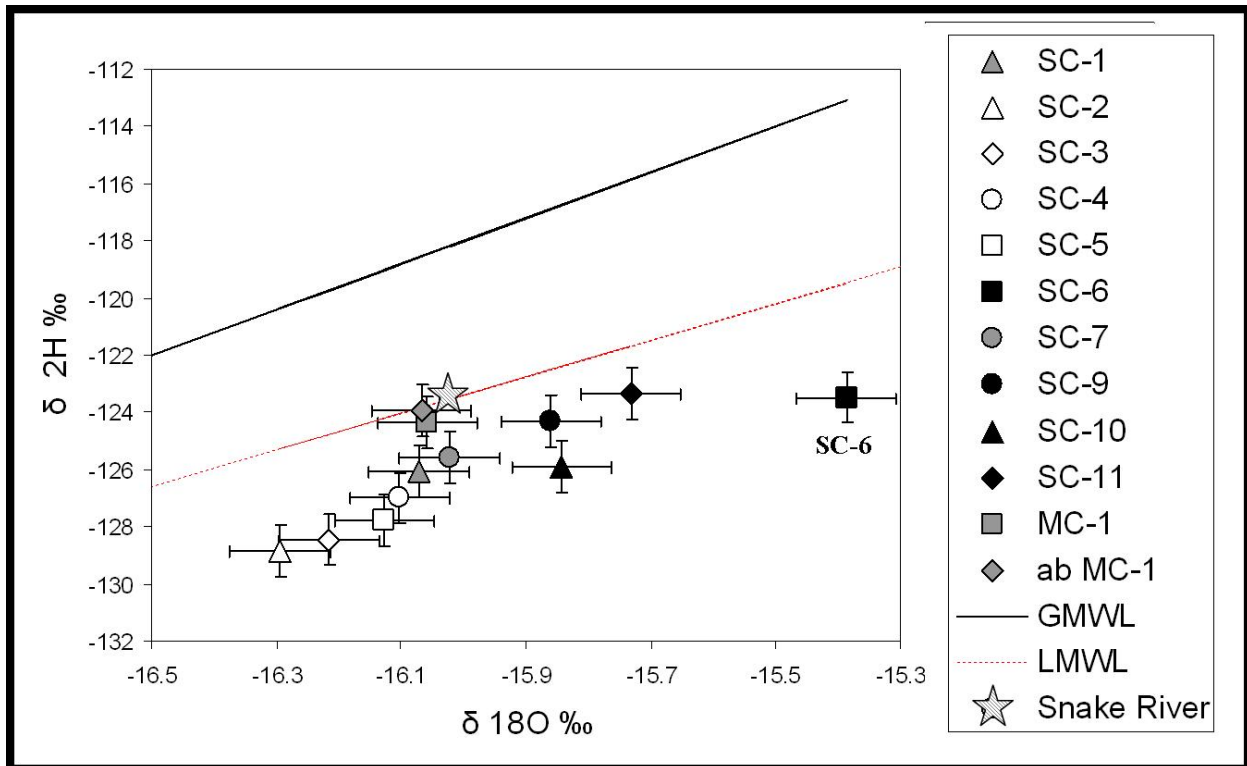


Figure 13. Oxygen and deuterium data for the Springdale area from the October 2008 sampling event. The Snake River isotopic value is provided by USGS (Coplan and Kendall, 2000).

Correlations have been identified between oxygen and deuterium isotopic compositions and the direction of ground water flow in the Oakley Fan area as described by Young and Newton (1989). These authors showed that contours of deuterium values (‰) were consistent with potentiometric water level contours across the study area. Results from this Springdale study indicate a similar spatial relationship with oxygen isotopes, where the isotopic value decreases with distance from the H and J canal systems. The oxygen isotope values in the Springdale area range from -15.4 to -16.5‰ with an analytical precision of 0.08‰. The most isotopically enriched sample (SC-6), defines the upper bound (most-enriched value) of the oxygen isotopes in the contours displayed (Figure 14) and is from the southeastern extent of the study area. The sample from SC-2 is the most isotopically depleted and is from the western extent of the study area. The oxygen isotope values decrease (or become isotopically depleted) moving from southeast to northwest across the study area. This shift from isotopically enriched to depleted oxygen signatures is consistent with the direction of ground water flow and may correspond to the relative amount of evaporated surface water (canal) recharge to the shallow aquifer system.



Figure 14. Oxygen isotope $\delta^{18}\text{O}$ (‰) values are plotted to show spatial distribution of relatively depleted isotopic signatures across the study site.

4.2.2 Nitrogen Isotopes

Analysis of nitrogen isotopes can be a useful method in determining sources of nitrogen to ground water. The isotopic method involves measuring the ratio of heavy (^{15}N) to light (^{14}N) nitrogen on the nitrate compound, compared to the ratio observed in the atmosphere (Kendall and McDonnell, 1998). Fractionation of nitrogen isotopes can occur by several processes in the hydrologic cycle (e.g., nitrification, denitrification, plant uptake, and volatilization), which can modify the $\delta^{15}\text{N}$ values of ground water and soil (Kendall and McDonnell, 1998).

Analysis of the stable isotope of nitrogen (^{15}N) can be a useful tool for determining water provenance. The two major sources of nitrate in agricultural areas are commercial fertilizer application and leaching of nitrate from animal manure into ground water. These sources have distinct $\delta^{15}\text{N}$ values. However, isotope results that fall within the organic nitrogen range (+4 to +9 ‰) can indicate a mixture of commercial fertilizer and animal or human sources, or nitrogen derived from soil organic matter. Nitrogen isotope analysis, in conjunction with other chemical analyses, can be used to identify potential sources of nitrate to the ground water.

Analyses of nitrogen isotopes were performed by DEQ and ISDA. Forty-nine nitrogen isotope analyses were produced using data from 30 wells in the study area that were sampled over the course of two years, including sampling during spring, summer, and fall. For comparison, typical nitrogen isotope values for potential contaminants are shown in Table 3. A histogram of the nitrogen isotope values for the Springdale area is shown in Figure 15. Results are reported in parts per thousand (per mil or ‰) relative to a standard.

When commercial fertilizers containing nitrogen are applied to cropland, the nitrate concentrations and the $\delta^{15}\text{N}$ values of soils are altered. Commercial (anthropogenic) fertilizers are produced by the fixation of atmospheric N_2 and have a corresponding low isotopic range of -4 to +4 ‰ (Kendall and McDonnell, 1998).

Table 3. Typical $\delta^{15}\text{N}$ values from Seiler (1996).

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

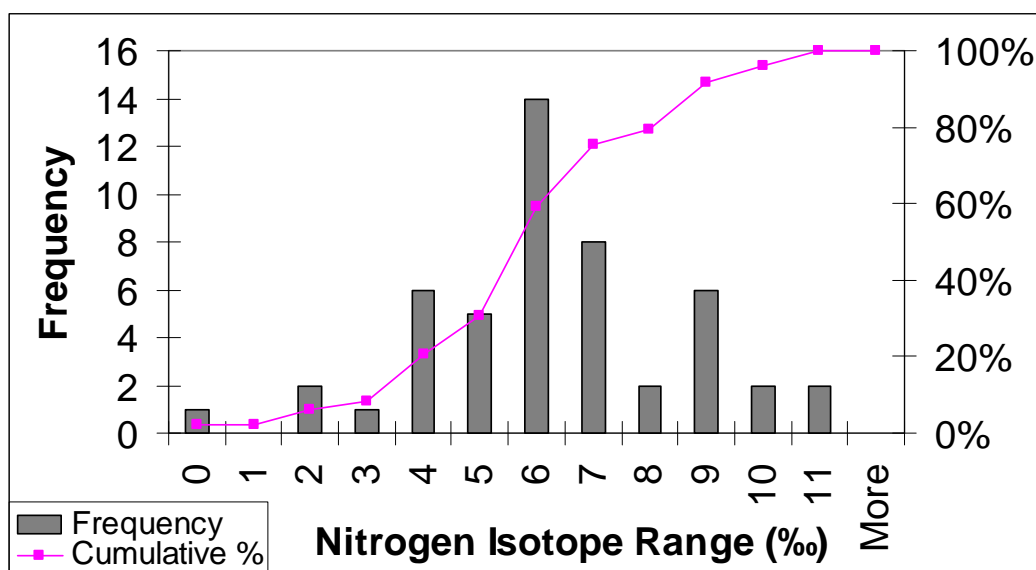


Figure 15. Cumulative frequency of nitrogen isotope values for the Springdale area. Data provided by ISDA (2009).

Samples from several wells in this study (SC-7, 9, 14), ISDA wells (S08-5201, -6201, -3801, -5101, and -4501) and one surface water site (ab MC-1) exhibit $\delta^{15}\text{N}$ values (< +4‰) that are consistent with a commercial fertilizer source (Figure 15 and Figure 16). Ground water samples from wells SC-3 and SC-6 show a nitrogen isotope signature consistent with human or animal waste sources (> +9‰). Well SC-4, located on an active dairy, exhibits a high nitrogen isotope value as well ($\delta^{15}\text{N}$ = 8.7‰). The remainder of the samples show a mixed nitrogen source signature, which may be from mixing of water from more than one source. There is no apparent spatial distribution of similar $\delta^{15}\text{N}$ values within the entire study area. There is also no consistent increase or decrease in $\delta^{15}\text{N}$ values between spring, summer, and fall. The variable nitrogen signatures across the study area suggest local land use (e.g., fertilizer loading, CAFOs) plays a significant role in resulting nitrogen signatures.

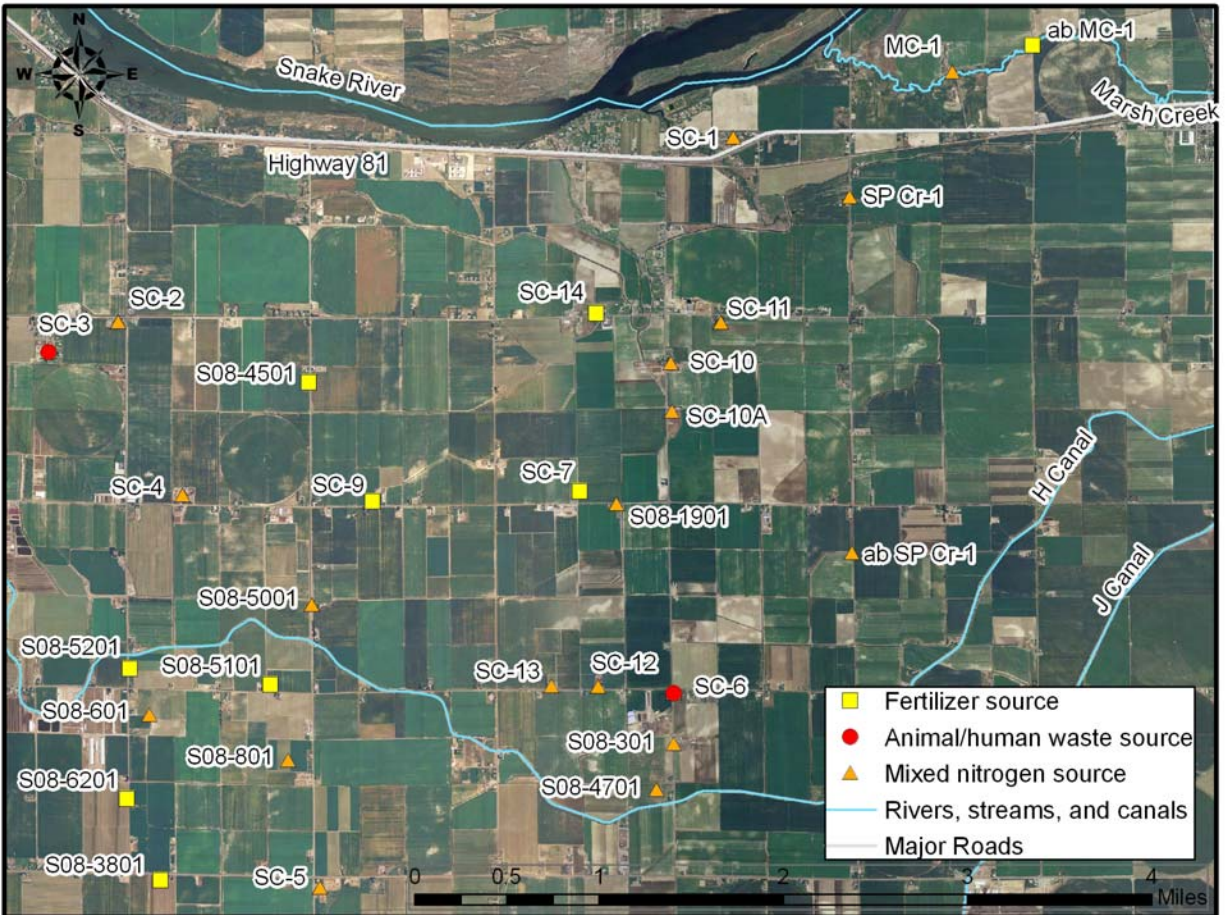


Figure 16. Potential sources of nitrogen (based on isotope signature) to wells and surface water sites.

The ISDA regional agricultural ground water quality monitoring program characterized degradation of ground water in northern Cassia County (Carlson et al., 2005). As part of this program, ISDA measured nitrogen isotopes in wells in northern Cassia County that had nitrate concentrations greater than 10 mg/L. They found that a majority of the sampled wells exhibited $\delta^{15}\text{N}$ values consistent with fertilizer sources (2001: 56%; 2002: 65%; 2003: 31%). ISDA concluded fertilizer sources may be the dominant source of nitrate found in ground water in northern Cassia County (Carlson et al., 2005).

4.3 Personal Care Products and Pharmaceuticals (PCPPs)

This study included sampling for a list of selected PCPPs in ground water wells and surface water sites near Springdale. The presence of these analytes can provide information about the fate of these chemicals in ground water as well as potential pathways for contamination. A list of the selected PCPPs can be found in Table 4 and Table 5.

Table 4. List of PCPPs (antibiotics and personal care products) analyzed by LC/MS (liquid chromatography/mass spectrometry)

Analyte	Description	LOQ* (ng/L)	Test Method
Sulfadimethoxine	Antibiotic, animal	1	LC/MS
Sulfamethazine	Antibiotic, animal	1	LC/MS

Analyte	Description	LOQ* (ng/L)	Test Method
Sulfamethoxazole	Antibiotic, animal	1	LC/MS
Sulfathiazole	Antibiotic, animal	1	LC/MS
Lincomycin	Antibiotic, animal	1	LC/MS
Tylosin	Antibiotic, animal	1	LC/MS
Carbamazepine	Anti-seizure drug	1	LC/MS
Trimethoprim	Antibiotic, human	1	LC/MS
Acetaminophen	Analgesic	2	LC/MS
Ibuprofen	Analgesic	2	LC/MS
Cotinine	Nicotine metabolite	1	LC/MS
Caffeine	Stimulant	1	LC/MS
1,7-Dimethylxanthine	Caffeine metabolite	2	LC/MS
N,N-dimethyl-m-toluamide (DEET)	Insect repellent	1	LC/MS
Triclosan	Antibacterial in soap	2	LC/MS

* LOQ = limit of quantitation, ng/L = nanograms per liter.

Table 5. List of PCPPs (steroids and hormones) analyzed by GC/MS (gas chromatography/mass spectrometry)

Analyte	Description	LOQ* (ng/L)	Test Method
Coprostanol	Fecal steroid	50	GC/MS
Cholesterol	Plant and animal steroid	50	GC/MS
Dihydrocholesterol	Fecal steroid	50	GC/MS
Estriol	Reproductive hormone	250	GC/MS
Testosterone	Reproductive hormone	50	GC/MS
Progesterone	Reproductive hormone	50	GC/MS
Equilenin	Estrogen replacement hormone	50	GC/MS
Stigmastanol	Plant steroid	50	GC/MS
Sitosterol	Plant steroid	50	GC/MS
Stigmastarol	Plant steroid	50	GC/MS

* LOQ = limit of quantitation, ng/L = nanograms per liter.

Samples for analysis of PCPPs in Springdale were collected during two events. The first round of PCPP occurred during the October 2008 sampling event and the second round was conducted during the April 2009 sampling event. These sampling windows were selected to capture seasonality of ground water flow and the possible corresponding variations in PCPP concentrations. Sample results are given in Table 6 and Table 7. Cholesterol detections in wells during the October 2008 sampling event are considered to reflect background concentrations for ground water in this area. Therefore, after review of the October 2008 sampling results, cholesterol, and all other steroids and hormones, were not included in the analyte suite for the April 2009 event.

Caffeine, found in caffeinated beverages, was detected at a concentration of 12 ng/L in the sample from well SC-10 during the October 2008 sampling event and from wells SC-6, SC-14, MC-1, and SP Cr-1 during the April 2009 sampling event. The human anti-seizure medication carbamazepine was found in low concentrations in well SC-7 and the duplicate of that sample, SC-8, during the October 2008 sampling event.

Relatively large concentrations of the sterols sitosterol and stigmastarol were detected in Marsh Creek during the October 2008 sampling event. These sterols were not analyzed for during the

April sampling event (see discussion about cholesterol above). These compounds are plant-derived sterols from crop residues, or the decay of agricultural crops such as legumes. The combination of nitrogen isotope values and detections of plant sterols in the Marsh Creek samples suggests Marsh Creek is being impacted by agricultural practices.

Table 6. PCPP analyses for samples collected in October 2008 (and one December 2008 resample). All sample results are given in nanograms per liter (ng/L). SC-8 is a duplicate sample collected from the SC-7 well site.

Sample Site	Cholesterol	Sitosterol	Caffeine	Sulfa-methoxazole	Sulfa-dimethoxine	Carbamazepine	Stigmasterol
SC-1	910	ND	ND	3.9	ND	ND	ND
SC-2	800	ND	ND	ND	ND	ND	ND
SC-3	910	ND	ND	1.6	ND	ND	ND
SC-4	1000	ND	ND	1.2	ND	ND	ND
SC-5	840	ND	ND	1.2	ND	ND	ND
SC-6	640	ND	ND	56	1	ND	ND
SC-7	1100	ND	ND	1.2	ND	6.6	ND
SC-8 (Dup)	1100	340	ND	1.5	ND	7.0	ND
SC-9	1000	ND	ND	ND	ND	ND	ND
SC-10	1100	ND	12	26	ND	ND	ND
SC-11	970	ND	ND	1.1	ND	ND	ND
MC-1	1300	980	ND	1.9	ND	ND	140
ab MC-1	1200	820	ND	ND	ND	ND	160

ND= analyte was not detected above the laboratory quantitation limit.

Table 7. PCPP analyses for samples collected in April 2009. All sample results are given in nanograms per liter (ng/L). SC-20 is a duplicate sample of SC-6.

Sample Site	Caffeine	Sulfa-methoxazole	Sulfa-dimethoxine	Carbamazepine	Trimethoprim	Acetaminophen
SC-1	ND	ND	ND	ND	ND	ND
SC-2	27	ND	ND	ND	ND	ND
SC-3	ND	1.7	ND	ND	ND	ND
SC-4	ND	3.6	ND	ND	ND	ND
SC-5	ND	1.1	ND	ND	ND	ND
SC-6	6.8	19	1.4	ND	ND	ND
SC-20 (Dup)	9.8	20	1.5	ND	ND	ND
SC-9	ND	ND	ND	ND	ND	ND
SC-10	ND	36	ND	ND	ND	ND
SC-10A	ND	4	ND	1.4	ND	ND
SC-11	ND	1.2	ND	ND	ND	ND
SC-12	ND	2.3	ND	ND	ND	ND
SC-13	ND	ND	ND	ND	ND	ND
SC-14	11	1.2	ND	ND	8.4	ND
MC-1	14	ND	ND	ND	ND	ND
ab MC-1	ND	ND	ND	ND	ND	ND
SP Cr-1	6.7	ND	ND	ND	ND	5.2
ab SP Cr-1	ND	ND	ND	ND	ND	ND

ND= analyte was not detected above the laboratory quantitation limit.

Sulfamethoxazole (SMX) is a member of the sulfonamide family of antimicrobials used mainly for veterinary practices (Lee et al., 2007). In October (and December) 2008, SMX was detected in 8 out of 10 sampled wells and in one out of two sampled surface water sites (Marsh Creek), with the highest concentration, at 56 nanograms per liter (ng/L or parts per trillion), found in the sample from well SC-6 in December 2008 (Figure 17). Repeat detections of SMX were confirmed in samples from wells SC-3, SC-4, SC-5, SC-6, SC-10, and SC-11 from the April 2009 sampling event. Throughout the Springdale area SMX was detected in highly variable concentrations, with no apparent relationship to well depth. In general, the concentration of SMX was lower in April. Ground water levels in the fall are higher due to increased inputs by irrigation recharge. Therefore, you might expect the concentrations of PCPPs to be lower in the fall (due to dilution), if you assume the source of PCPPs are constant. However, the concentrations are higher in the fall than in the spring, suggesting the sources of PCPPs are greater in the fall, or that irrigation recharge facilitates the transport of PCPPs to the aquifer.

Well SC-6 had elevated SMX concentrations compared to the other wells in the Springdale area, during both the October and April sampling events. The combination of PCPP detections along with nitrogen isotope evidence and elevated chloride concentrations, suggests this well is being directly influenced by animal or human waste source(s).

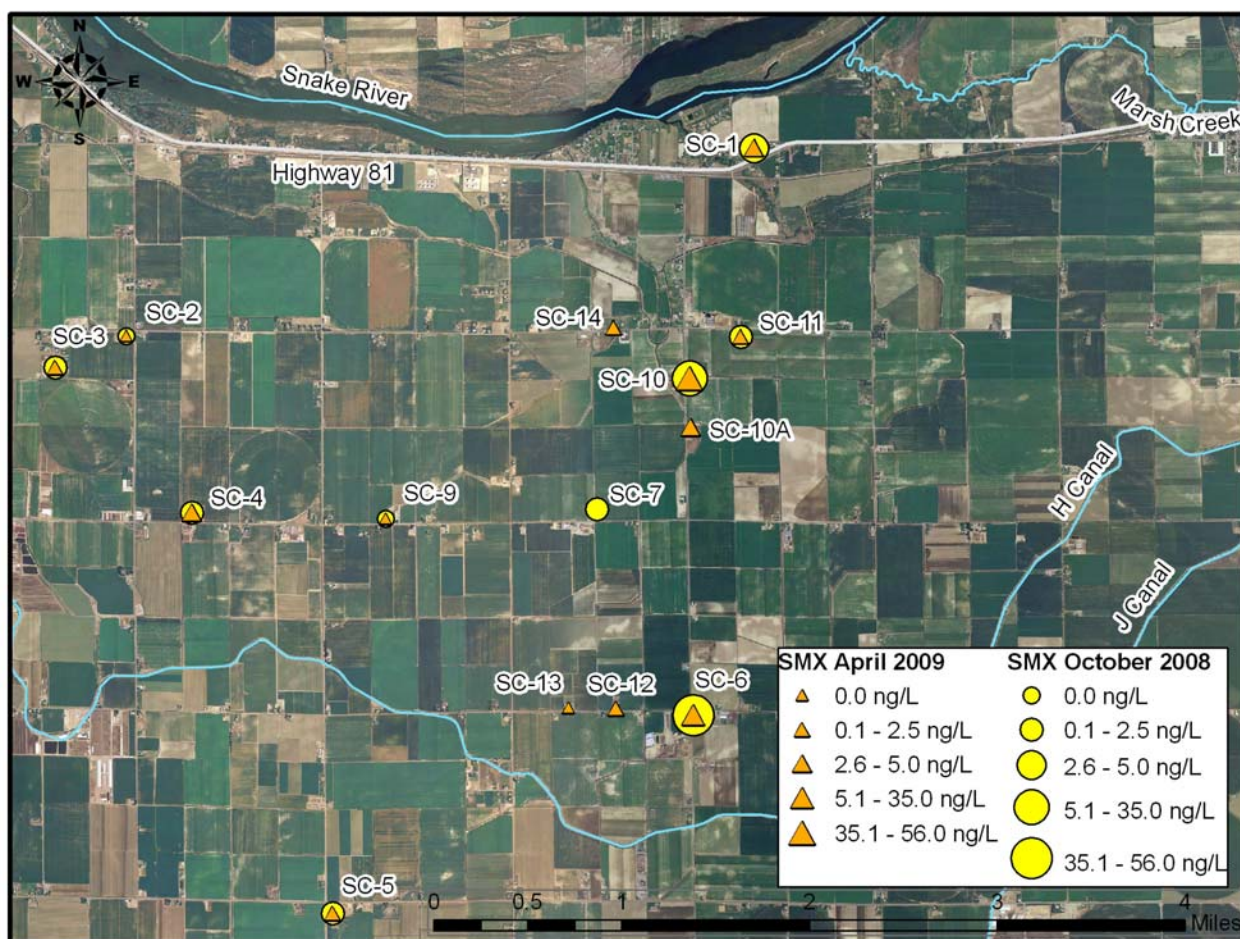


Figure 17. SMX concentrations for the October and April sampling events.

Although PCPP compounds were detected at relatively low concentrations, the frequency and distribution of the compounds, together with the fact that they were also detected in the duplicate samples, appears to represent a real occurrence of these PCPPs in ground water. While the detection of these constituents does not identify a point source of pollution, it does indicate that PCPPs are detectable in the shallow aquifer and in surface water and that a pathway exists from sources of these and other constituents to the ground water.

The ISDA has documented numerous pesticide detections in the shallow ground water system underlying the Springdale area. Pesticide results from 2002 suggested the concentrations of pesticides, as well as the variety of pesticides detected in the ground water, were declining (Carlson et al., 2005).

5 Possible Sources of Constituents of Concern

Possible sources of nitrate include commercial fertilizer application, CAFOs (dairies and feedlots), septic tank effluent, and legume crop residues. There is evidence of impact from fertilizer and animal or human waste sources from the analysis of nitrogen isotopes in the study area. While agriculture has been occurring in the area for decades, the number of cattle in confined operations in the area has increased only recently (Figure 18). Yearly nitrate concentrations for wells sampled by DEQ, ISDA, IDWR, and USGS were averaged to determine if an increasing trend was present in Springdale. Based on 171 nitrate values from wells in the Springdale area, an increasing trend (90% confidence level) was identified between the years 1993 and 2001, with an average nitrate concentration of 4.8 mg/L. The trend is stable for the years from 2001 to 2009 based on 432 nitrate values, with an average nitrate concentration of 8.5 mg/L.

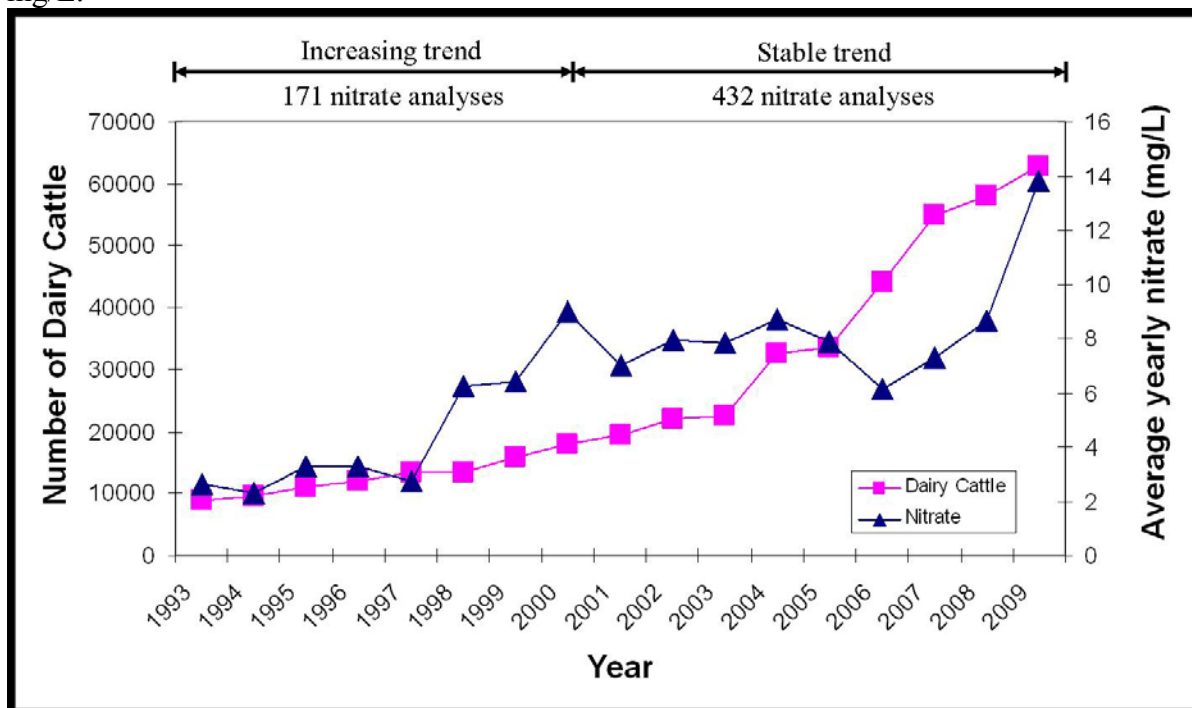


Figure 18. Number of dairy cattle versus nitrate concentrations from 1993 to present (DEQ databases).

Wells SC-6 and SC-7 are two of the deepest completed wells included in this Springdale study, completed to 155 feet bgs and 195 feet bgs, respectively (Idaho Department of Water Resources, 1975; 1996). Well SC-6 exhibits the highest measured nitrate concentrations during the summer of 2007 and 2008 (ISDA monitoring), October 2008, and April 2009 (this study) by several mg/L above the next highest well nitrate measurement. Both wells, SC-6 and SC-7, had very low (< 2 mg/L) dissolved oxygen concentrations, which is significantly lower than in the other wells in the area (on average, 5.8 mg/L). Although these wells are screened at different depths, both are screened in “cemented coarse sand” and “cemented gravel,” respectively. There may be chemical reactions occurring in these wells between the ground water and the lithology. Causes for low dissolved oxygen levels in the wells may include variations in flow causing stagnant water, changes in the oxidizing environment (by possible inputs of ammonia), or an excess in anthropogenic nutrients.

The water level (the average depth to ground water) in SC-6 and SC-7 is more than 50 feet lower than in the remainder of the wells. Neither well is drilled into the underlying basalt units. In both wells there is more than 40 feet of clay, indicating that the upper aquifer may be perched and isolated from the deeper water-bearing units. The clay units are not laterally continuous, as evidenced by nearby well logs (refer to Figure 3 on page 6).

Well SC-10 is located at an active dairy with approximately 500 confined animals. Duck Creek Drain carries water from the H Canal north to Duck Creek and flows along the south, east, and north of the dairy. This well was drilled to a depth of 46 feet and has a static water level of 5 feet bgs (Idaho Department of Water Resources, 1971). The nitrogen isotopic value suggests the nitrate source could possibly from animal or human waste.

6 Conclusions

The ground water in the Springdale area appears to flow from the higher elevations to the valley, towards the Snake River, in a north by northwest direction. Local variations occur due to the influence of canals and agriculture-related holding ponds that may change local seasonal flow directions. The complex geological setting of the Springdale area makes it difficult to determine shallow ground water flow directions.

Shallow ground water in the Springdale area is being negatively impacted from land use practices as evidenced by elevated nitrate, TDS, chloride, sulfate, and PCPP concentrations. Analytical results suggest the local land use practices in northern Cassia County influence the concentrations of these constituents of concern in domestic wells and surface water.

Oxygen and deuterium isotopic analyses suggest some wells are impacted by recharged ground water from evaporated sources (i.e. holding ponds, such as irrigation ponds or wastewater lagoons). The spatial relationship between oxygen isotope values and well location suggest that ground water is recharged by less-evaporated water in the down-gradient direction of ground water flow (northwest). This relationship could be a result of distance from the H and J canal system, which recharge the shallow aquifer system through leakage.

There is no apparent relationship between well depth and nitrate concentrations in the Springdale area. One might expect the shallower wells to exhibit the highest levels of contaminants, owing to shallow recharge events; however, this is not evident in Springdale. The deepest wells (SC-6, SC-7, and SC-10) have some of the highest recorded nitrate concentrations recorded for this

study. However, there are major ion chemistry and dissolved oxygen differences in these wells that appear to be related to depth. The annular casing seals at these wells may have failed, allowing shallow, contaminated water to move downward.

The range of nitrogen isotope values observed in the Springdale area indicates a mixture of nitrogen from commercial fertilizer and animal or human sources, and organic nitrogen in soil. The nitrogen isotope values for SC-3, SC-6, (and likely SC-10A) are indicative of animal or human waste.

The field parameters and concentrations of IOCs, isotopes, and PCPPs together suggest that an area-wide land use-related contamination problem exists independent of well depth or construction. These measurements and analysis results also suggest that well construction and on-site land use practices are important factors determining the water quality at individual well locations.

The persistence of PCPPs in analyzed wells and surface water suggests that pathways exist between human and animal waste sources, ground water, and surface water. A wide variety of PCPPs were detected in both the April and October sampling events, meaning these constituents are present in water sources year-round. The fact that PCPPs were found throughout the study area suggests there is an area-wide persistence of PCPPs in northern Cassia County.

7 Recommendations

Due to current data gaps, it is recommended that additional sampling events be performed in 2010 to analyze ground water for the following constituents: nitrate, chloride, sulfate, total dissolved solids, nitrogen and oxygen isotopes, and PCPPs in selected wells. Measuring the isotopic signature of the oxygen that comprises the nitrate compound (NO_3), along with the nitrogen isotope signature, will be useful in further fingerprinting the wells impacted by commercial fertilizer application, and/or animal or human waste sources.

The additional data will be analyzed to identify sources of nitrogen in the area. The data will be used to help develop a ground water quality management plan for the Springdale area. Employing best management practices will ensure that the potential over-application of commercial and animal fertilizers is minimized. Public outreach would be beneficial to educate the citizens of the community of Springdale about the quality of ground water in their area and how they can protect their domestic drinking water wells.

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Appendix A: Geochemical Data for wells: Springdale, Idaho

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-1	10/14/2008	11:15	Field Parameter	Temperature	12.6	C
SC-1	10/14/2008	11:15	Field Parameter	pH	7.7	
SC-1	10/14/2008	11:15	Field Parameter	Specific Conductance	812.0	µS/cm
SC-1	10/14/2008	11:15	Field Parameter	Dissolved Oxygen	5.7	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Calcium	75.0	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Magnesium	33.0	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Potassium	10.0	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Sodium	50.0	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Chloride	39.5	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Sulfate	73.6	mg/L
SC-1	10/14/2008	11:15	Idaho State Health Laboratory	Nitrate	8.2	mg/L
SC-1	10/14/2008	12:00	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-1	10/14/2008	12:00	Idaho State Health Laboratory	Alkalinity	278.0	mg/L
SC-1	10/14/2008	12:00	Idaho State Health Laboratory	Total Dissolved Solids	530.0	mg/L
SC-1	10/14/2008	12:00	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Carbamazepine	<1.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Caffeine	<25	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Cotanine	<1.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	DEET	<15	µg/L
SC-1	10/14/2008	12:00	University of Iowa	Ibuprofen	<2.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Lincomycin	<5.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Sulfamethoxazole	3.9	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-1	10/14/2008	12:00	University of Iowa	Triclosan	<5.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Trimethoprim	<1.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Tylosin	<2.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Testosterone	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Equilenin	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Estriol	<250	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Progesterone	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Coprostanol	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Cholesterol	910.0	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Stigmasterol	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Sitosterol	<100	ng/L
SC-1	10/14/2008	12:00	University of Iowa	Stigmastanol	<100	ng/L
SC-1	4/6/2009	12:25	Field Parameter	Temperature	13.3	C
SC-1	4/6/2009	12:25	Field Parameter	pH	5.1	
SC-1	4/6/2009	12:25	Field Parameter	Specific Conductance	849.0	µS/cm
SC-1	4/6/2009	12:25	Field Parameter	Dissolved Oxygen	8.8	mg/L

SC-1	4/6/2009	12:25	Idaho State Health Laboratory	Chloride	43.1	mg/L
SC-1	4/6/2009	12:25	Idaho State Health Laboratory	Sulfate	83.2	mg/L
SC-1	4/6/2009	12:25	Idaho State Health Laboratory	Nitrate	11.0	mg/L
SC-1	4/6/2009	12:25	Idaho State Health Laboratory	Total Dissolved Solids	520.0	mg/L
SC-1	4/6/2009	12:25	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Carbamazepine	<1.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Caffeine	<5.6	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Cotanine	<2.1	ng/L
SC-1	4/6/2009	12:25	University of Iowa	DEET	<0.0079	µg/L
SC-1	4/6/2009	12:25	University of Iowa	Ibuprofen	<1.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Lincomycin	<1.1	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Sulfamethoxazole	4.4	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-1	4/6/2009	12:25	University of Iowa	Triclosan	<5.3	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Trimethoprim	<1.0	ng/L
SC-1	4/6/2009	12:25	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-2	10/14/2008	13:45	Field Parameter	Temperature	12.4	C
SC-2	10/14/2008	13:45	Field Parameter	pH	7.7	
SC-2	10/14/2008	13:45	Field Parameter	Specific Conductance	920.0	µS/cm
SC-2	10/14/2008	13:45	Field Parameter	Dissolved Oxygen	3.5	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Calcium	83.0	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Magnesium	18.0	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Potassium	8.7	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Sodium	65.0	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Chloride	40.2	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Sulfate	70.5	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Nitrate	17.0	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Alkalinity	267.0	mg/L
SC-2	10/14/2008	13:45	Idaho State Health Laboratory	Total Dissolved Solids	590.0	mg/L
SC-2	10/14/2008	13:45	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Carbamazepine	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Caffeine	<25	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Cotanine	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	DEET	<15	µg/L
SC-2	10/14/2008	13:45	University of Iowa	Ibuprofen	<2.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Lincomycin	<5.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Sulfamethoxazole	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-2	10/14/2008	13:45	University of Iowa	Triclosan	<5.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Trimethoprim	<1.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Tylosin	<2.0	ng/L

SC-2	10/14/2008	13:45	University of Iowa	Testosterone	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Equilenin	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Estriol	<250	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Progesterone	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Coprostanol	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Cholesterol	800.0	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Stigmasterol	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Sitosterol	<100	ng/L
SC-2	10/14/2008	13:45	University of Iowa	Stigmastanol	<100	ng/L
SC-2	4/7/2009	11:58	Field Parameter	Temperature	12.4	C
SC-2	4/7/2009	11:58	Field Parameter	pH	7.9	
SC-2	4/7/2009	11:58	Field Parameter	Specific Conductance	950.0	µS/cm
SC-2	4/7/2009	11:58	Field Parameter	Dissolved Oxygen	3.5	mg/L
SC-2	4/7/2009	11:58	Idaho State Health Laboratory	Chloride	41.8	mg/L
SC-2	4/7/2009	11:58	Idaho State Health Laboratory	Sulfate	72.6	mg/L
SC-2	4/7/2009	11:58	Idaho State Health Laboratory	Nitrate	17.0	mg/L
SC-2	4/7/2009	11:58	Idaho State Health Laboratory	Total Dissolved Solids	590.0	mg/L
SC-2	4/7/2009	11:58	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Carbamazepine	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Caffeine	27.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Cotanine	<2.1	ng/L
SC-2	4/7/2009	11:58	University of Iowa	DEET	<0.007 9	µg/L
SC-2	4/7/2009	11:58	University of Iowa	Ibuprofen	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Lincomycin	<1.1	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Sulfamethoxazole	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Sulfathiazole	<0.001 1	µg/L
SC-2	4/7/2009	11:58	University of Iowa	Triclosan	<5.3	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Trimethoprim	<1.0	ng/L
SC-2	4/7/2009	11:58	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-3	10/14/2008	14:30	Field Parameter	Temperature	13.3	C
SC-3	10/14/2008	14:30	Field Parameter	pH	7.7	
SC-3	10/14/2008	14:30	Field Parameter	Specific Conductance	1040.0	µS/cm
SC-3	10/14/2008	14:30	Field Parameter	Dissolved Oxygen	3.6	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Calcium	110.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Magnesium	17.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Potassium	9.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Sodium	63.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Chloride	50.6	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Sulfate	73.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Nitrate	19.0	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Alkalinity	301.0	mg/L

SC-3	10/14/2008	14:30	Idaho State Health Laboratory	Total Dissolved Solids	660.0	mg/L
SC-3	10/14/2008	14:30	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Carbamazepine	<1.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Caffeine	<25	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Cotanine	<1.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	DEET	<15	µg/L
SC-3	10/14/2008	14:30	University of Iowa	Ibuprofen	<2.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Lincomycin	<5.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Sulfamethoxazole	1.6	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-3	10/14/2008	14:30	University of Iowa	Triclosan	<5.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Trimethoprim	<1.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Tylosin	<2.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Testosterone	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Equilenin	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Estriol	<250	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Progesterone	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Coprostanol	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Cholesterol	910.0	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Stigmasterol	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Sitosterol	<100	ng/L
SC-3	10/14/2008	14:30	University of Iowa	Stigmasterol	<100	ng/L
SC-3	4/7/2009	12:10	Field Parameter	Temperature	13.0	C
SC-3	4/7/2009	12:10	Field Parameter	pH	7.8	
SC-3	4/7/2009	12:10	Field Parameter	Specific Conductance	1100.0	µS/cm
SC-3	4/7/2009	12:10	Field Parameter	Dissolved Oxygen	3.2	mg/L
SC-3	4/7/2009	12:10	Idaho State Health Laboratory	Chloride	50.9	mg/L
SC-3	4/7/2009	12:10	Idaho State Health Laboratory	Sulfate	74.0	mg/L
SC-3	4/7/2009	12:10	Idaho State Health Laboratory	Nitrate	20.0	mg/L
SC-3	4/7/2009	12:10	Idaho State Health Laboratory	Total Dissolved Solids	640.0	mg/L
SC-3	4/7/2009	12:10	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Carbamazepine	<1.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Caffeine	<5.6	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Cotanine	<2.1	ng/L
SC-3	4/7/2009	12:10	University of Iowa	DEET	<0.0079	µg/L
SC-3	4/7/2009	12:10	University of Iowa	Ibuprofen	<1.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Lincomycin	<1.1	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Sulfamethoxazole	1.7	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-3	4/7/2009	12:10	University of Iowa	Triclosan	<5.3	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Trimethoprim	<1.0	ng/L
SC-3	4/7/2009	12:10	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-4	10/14/2008	15:05	Field Parameter	Temperature	14.4	C
SC-4	10/14/2008	15:05	Field Parameter	pH	7.7	
SC-4	10/14/2008	15:05	Field Parameter	Specific Conductance	816.0	µS/cm
SC-4	10/14/2008	15:05	Field Parameter	Dissolved Oxygen	3.7	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Calcium	82.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Magnesium	20.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Potassium	9.7	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Sodium	48.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Chloride	43.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Sulfate	64.7	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Nitrate	14.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Alkalinity	258.0	mg/L
SC-4	10/14/2008	15:05	Idaho State Health Laboratory	Total Dissolved Solids	550.0	mg/L
SC-4	10/14/2008	15:05	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Carbamazepine	<1.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Caffeine	<25	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Cotanine	<1.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	DEET	<15	µg/L
SC-4	10/14/2008	15:05	University of Iowa	Ibuprofen	<2.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Lincomycin	<5.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Sulfamethoxazole	1.2	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-4	10/14/2008	15:05	University of Iowa	Triclosan	<5.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Trimethoprim	<1.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Tylosin	<2.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Testosterone	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Equilenin	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Estriol	<250	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Progesterone	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Coprostanol	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Cholesterol	1000.0	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Stigmasterol	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Sitosterol	<100	ng/L
SC-4	10/14/2008	15:05	University of Iowa	Stigmastanol	<100	ng/L
SC-4	4/7/2009	11:15	Field Parameter	Temperature	13.7	C
SC-4	4/7/2009	11:15	Field Parameter	pH	8.1	
SC-4	4/7/2009	11:15	Field Parameter	Specific Conductance	826.0	µS/cm
SC-4	4/7/2009	11:15	Field Parameter	Dissolved Oxygen	3.8	mg/L
SC-4	4/7/2009	11:15	Idaho State Health Laboratory	Chloride	43.1	mg/L
SC-4	4/7/2009	11:15	Idaho State Health Laboratory	Sulfate	65.8	mg/L
SC-4	4/7/2009	11:15	Idaho State Health Laboratory	Nitrate	11.0	mg/L
SC-4	4/7/2009	11:15	Idaho State Health Laboratory	Total Dissolved Solids	480.0	mg/L
SC-4	4/7/2009	11:15	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Carbamazepine	<1.0	ng/L

SC-4	4/7/2009	11:15	University of Iowa	Caffeine	<5.6	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Cotanine	<2.1	ng/L
SC-4	4/7/2009	11:15	University of Iowa	DEET	<0.0079	µg/L
SC-4	4/7/2009	11:15	University of Iowa	Ibuprofen	<1.0	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Lincomycin	<1.1	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Sulfamethoxazole	3.6	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-4	4/7/2009	11:15	University of Iowa	Triclosan	<5.3	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Trimethoprim	<1.0	ng/L
SC-4	4/7/2009	11:15	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-5	10/14/2008	16:00	Field Parameter	Temperature	12.2	C
SC-5	10/14/2008	16:00	Field Parameter	pH	7.8	
SC-5	10/14/2008	16:00	Field Parameter	Specific Conductance	970.0	µS/cm
SC-5	10/14/2008	16:00	Field Parameter	Dissolved Oxygen	7.9	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Calcium	94.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Magnesium	27.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Potassium	11.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Sodium	57.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Chloride	34.9	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Sulfate	71.4	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Nitrate	12.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Phosphorus	0.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Alkalinity	332.0	mg/L
SC-5	10/14/2008	16:00	Idaho State Health Laboratory	Total Dissolved Solids	600.0	mg/L
SC-5	10/14/2008	16:00	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Carbamazepine	<1.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Caffeine	<25	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Cotanine	<1.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	DEET	<15	µg/L
SC-5	10/14/2008	16:00	University of Iowa	Ibuprofen	<2.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Lincomycin	<5.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Sulfamethoxazole	1.2	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-5	10/14/2008	16:00	University of Iowa	Triclosan	<5.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Trimethoprim	<1.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Tylosin	<2.0	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Testosterone	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Equilenin	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Estriol	<250	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Progesterone	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Coprostanol	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Cholesterol	840.0	ng/L

SC-5	10/14/2008	16:00	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Stigmasterol	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Sitosterol	<100	ng/L
SC-5	10/14/2008	16:00	University of Iowa	Stigmastanol	<100	ng/L
SC-5	4/6/2009	16:50	Field Parameter	Temperature	12.5	C
SC-5	4/6/2009	16:50	Field Parameter	pH	5.4	
SC-5	4/6/2009	16:50	Field Parameter	Specific Conductance	1000.0	µS/cm
SC-5	4/6/2009	16:50	Field Parameter	Dissolved Oxygen	11.4	mg/L
SC-5	4/6/2009	16:50	Idaho State Health Laboratory	Chloride	37.4	mg/L
SC-5	4/6/2009	16:50	Idaho State Health Laboratory	Sulfate	76.3	mg/L
SC-5	4/6/2009	16:50	Idaho State Health Laboratory	Nitrate	13.0	mg/L
SC-5	4/6/2009	16:50	Idaho State Health Laboratory	Total Dissolved Solids	540.0	mg/L
SC-5	4/6/2009	16:50	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Carbamazepine	<1.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Caffeine	<5.6	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Cotanine	<2.1	ng/L
SC-5	4/6/2009	16:50	University of Iowa	DEET	<0.0079	µg/L
SC-5	4/6/2009	16:50	University of Iowa	Ibuprofen	<1.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Lincomycin	<1.1	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Sulfamethoxazole	1.1	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-5	4/6/2009	16:50	University of Iowa	Triclosan	<5.3	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Trimethoprim	<1.0	ng/L
SC-5	4/6/2009	16:50	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-6	10/15/2008	9:45	Field Parameter	Temperature	12.4	C
SC-6	10/15/2008	9:45	Field Parameter	pH	7.6	
SC-6	10/15/2008	9:45	Field Parameter	Specific Conductance	1410.0	µS/cm
SC-6	10/15/2008	9:45	Field Parameter	Dissolved Oxygen	1.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Calcium	120.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Magnesium	35.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Potassium	15.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Sodium	100.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Chloride	77.3	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Sulfate	112.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Nitrate	22.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Alkalinity	413.0	mg/L
SC-6	10/15/2008	9:45	Idaho State Health Laboratory	Total Dissolved Solids	880.0	mg/L
SC-6	10/15/2008	9:45	University of Iowa	Testosterone	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Equilenin	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Estriol	<250	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Progesterone	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Coprostanol	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Cholesterol	640.0	ng/L

SC-6	10/15/2008	9:45	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Stigmasterol	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Sitosterol	<100	ng/L
SC-6	10/15/2008	9:45	University of Iowa	Stigmastanol	<100	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Carbamazepine	<1.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Caffeine	<25	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Cotanine	<1.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	DEET	<15	µg/L
SC-6	12/4/2008	11:23	University of Iowa	Ibuprofen	<2.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Lincomycin	<5.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Sulfadimethoxine	1.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Sulfamethoxazole	56.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-6	12/4/2008	11:23	University of Iowa	Triclosan	<5.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Trimethoprim	<1.0	ng/L
SC-6	12/4/2008	11:23	University of Iowa	Tylosin	<2.0	ng/L
SC-6	4/6/2009	12:00	Field Parameter	Temperature	12.6	C
SC-6	4/6/2009	12:00	Field Parameter	pH	4.9	
SC-6	4/6/2009	12:00	Field Parameter	Specific Conductance	1380.0	µS/cm
SC-6	4/6/2009	12:00	Field Parameter	Dissolved Oxygen	1.6	mg/L
SC-6	4/6/2009	12:00	Idaho State Health Laboratory	Chloride	77.3	mg/L
SC-6	4/6/2009	12:00	Idaho State Health Laboratory	Sulfate	119.0	mg/L
SC-6	4/6/2009	12:00	Idaho State Health Laboratory	Nitrate	25.0	mg/L
SC-6	4/6/2009	12:00	Idaho State Health Laboratory	Total Dissolved Solids	860.0	mg/L
SC-6	4/6/2009	12:00	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Carbamazepine	<1.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Caffeine	6.8	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Cotanine	<2.1	ng/L
SC-6	4/6/2009	12:00	University of Iowa	DEET	<0.0079	µg/L
SC-6	4/6/2009	12:00	University of Iowa	Ibuprofen	<1.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Lincomycin	<1.1	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Sulfadimethoxine	1.4	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Sulfamethoxazole	19.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-6	4/6/2009	12:00	University of Iowa	Triclosan	<5.3	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Trimethoprim	<1.0	ng/L
SC-6	4/6/2009	12:00	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-7	10/15/2008	10:15	Field Parameter	Temperature	11.7	C
SC-7	10/15/2008	10:15	Field Parameter	pH	7.8	
SC-7	10/15/2008	10:15	Field Parameter	Specific Conductance	1080.0	µS/cm
SC-7	10/15/2008	10:15	Field Parameter	Dissolved Oxygen	1.8	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Calcium	79.0	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Magnesium	23.0	mg/L

SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Potassium	11.0	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Sodium	97.0	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Chloride	42.8	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Sulfate	94.2	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Nitrate	17.0	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Alkalinity	327.0	mg/L
SC-7	10/15/2008	10:15	Idaho State Health Laboratory	Total Dissolved Solids	680.0	mg/L
SC-7	10/15/2008	10:15	University of Iowa	Acetomenophin	<5.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Carbamazepine	6.6	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Caffeine	<25	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Cotanine	<1.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	DEET	<15	µg/L
SC-7	10/15/2008	10:15	University of Iowa	Ibuprofen	<2.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Lincomycin	<5.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Sulfamethoxazole	1.2	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-7	10/15/2008	10:15	University of Iowa	Triclosan	<5.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Trimethoprim	<1.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Tylosin	<2.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Testosterone	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Equilenin	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Estriol	<250	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Progesterone	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Coprostanol	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Cholesterol	1100.0	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Stigmasterol	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Sitosterol	<100	ng/L
SC-7	10/15/2008	10:15	University of Iowa	Stigmastanol	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Carbamazepine	7.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Caffeine	<25	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Cotanine	<1.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	DEET	<15	µg/L
SC-7	10/15/2008	14:15	University of Iowa	Ibuprofen	<2.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Lincomycin	<5.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Sulfamethoxazole	1.5	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-7	10/15/2008	14:15	University of Iowa	Triclosan	<5.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Trimethoprim	<1.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Tylosin	<2.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Testosterone	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Equilenin	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Estriol	<250	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Progesterone	<100	ng/L

SC-7	10/15/2008	14:15	University of Iowa	Coprostanol	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Cholesterol	1100.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Stigmasterol	<100	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Sitosterol	340.0	ng/L
SC-7	10/15/2008	14:15	University of Iowa	Stigmastanol	<100	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-9	10/15/2008	11:00	Field Parameter	Temperature	11.9	C
SC-9	10/15/2008	11:00	Field Parameter	pH	8.0	
SC-9	10/15/2008	11:00	Field Parameter	Specific Conductance	886.0	µS/cm
SC-9	10/15/2008	11:00	Field Parameter	Dissolved Oxygen	8.8	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Calcium	65.0	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Magnesium	18.0	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Potassium	9.8	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Sodium	90.0	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Chloride	39.4	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Sulfate	96.5	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Nitrate	16.0	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Alkalinity	258.0	mg/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory	Total Dissolved Solids	610.0	mg/L
SC-9	10/15/2008	11:00	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Carbamazepine	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Caffeine	<25	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Cotanine	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	DEET	<15	µg/L
SC-9	10/15/2008	11:00	University of Iowa	Ibuprofen	<2.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Lincomycin	<5.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Sulfamethoxazole	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-9	10/15/2008	11:00	University of Iowa	Triclosan	<5.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Trimethoprim	<1.0	ng/L
SC-9	10/15/2008	11:00	University of Iowa	Tylosin	<2.0	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Testosterone	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Equilenin	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Estrilol	<250	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Progesterone	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Coprostanol	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Cholesterol	1000.0	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Dihydrocholesterol	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Stigmasterol	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Sitosterol	<100	ng/L
SC-9	10/15/2008	11:00	Idaho State Health Laboratory5	Stigmastanol	<100	ng/L
SC-9	4/7/2009	10:45	Field Parameter	Temperature	12.2	C
SC-9	4/7/2009	10:45	Field Parameter	pH	8.1	

SC-9	4/7/2009	10:45	Field Parameter	Specific Conductance	11.5	µS/cm
SC-9	4/7/2009	10:45	Field Parameter	Dissolved Oxygen	9.2	mg/L
SC-9	4/7/2009	10:45	Idaho State Health Laboratory	Chloride	50.7	mg/L
SC-9	4/7/2009	10:45	Idaho State Health Laboratory	Sulfate	124.0	mg/L
SC-9	4/7/2009	10:45	Idaho State Health Laboratory	Nitrate	21.0	mg/L
SC-9	4/7/2009	10:45	Idaho State Health Laboratory	Total Dissolved Solids	640.0	mg/L
SC-9	4/7/2009	10:45	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Carbamazepine	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Caffeine	<5.6	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Cotanine	<2.1	ng/L
SC-9	4/7/2009	10:45	University of Iowa	DEET	<0.0079	µg/L
SC-9	4/7/2009	10:45	University of Iowa	Ibuprofen	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Lincomycin	<1.1	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Sulfamethoxazole	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-9	4/7/2009	10:45	University of Iowa	Triclosan	<5.3	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Trimethoprim	<1.0	ng/L
SC-9	4/7/2009	10:45	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-10	10/15/2008	11:20	Field Parameter	Temperature	12.6	C
SC-10	10/15/2008	11:20	Field Parameter	pH	7.7	
SC-10	10/15/2008	11:20	Field Parameter	Specific Conductance	1430.0	µS/cm
SC-10	10/15/2008	11:20	Field Parameter	Dissolved Oxygen	6.1	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Calcium	97.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Magnesium	34.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Potassium	11.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Sodium	130.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Chloride	97.2	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Sulfate	140.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Nitrate	25.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Alkalinity	376.0	mg/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory	Total Dissolved Solids	890.0	mg/L
SC-10	10/15/2008	11:20	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Carbamazepine	<1.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Caffeine	12.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Cotanine	<1.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	DEET	<15	µg/L
SC-10	10/15/2008	11:20	University of Iowa	Ibuprofen	<2.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Lincomycin	<5.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Sulfamethoxazole	26.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-10	10/15/2008	11:20	University of Iowa	Triclosan	<5.0	ng/L

SC-10	10/15/2008	11:20	University of Iowa	Trimethoprim	<1.0	ng/L
SC-10	10/15/2008	11:20	University of Iowa	Tylosin	<2.0	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Testosterone	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Equilenin	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Estriol	<250	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Progesterone	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Coprostanol	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Cholesterol	1100.0	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Dihydrocholesterol	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Stigmasterol	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Sitosterol	<100	ng/L
SC-10	10/15/2008	11:20	Idaho State Health Laboratory5	Stigmastanol	<100	ng/L
SC-10	4/6/2009	16:00	Field Parameter	Temperature	12.9	C
SC-10	4/6/2009	16:00	Field Parameter	pH	4.9	
SC-10	4/6/2009	16:00	Field Parameter	Specific Conductance	13.5	µS/cm
SC-10	4/6/2009	16:00	Field Parameter	Dissolved Oxygen	7.8	mg/L
SC-10	4/6/2009	16:00	Idaho State Health Laboratory	Chloride	81.3	mg/L
SC-10	4/6/2009	16:00	Idaho State Health Laboratory	Sulfate	131.0	mg/L
SC-10	4/6/2009	16:00	Idaho State Health Laboratory	Nitrate	21.0	mg/L
SC-10	4/6/2009	16:00	Idaho State Health Laboratory	Total Dissolved Solids	730.0	mg/L
SC-10	4/6/2009	16:00	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Carbamazepine	<1.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Caffeine	<5.6	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Cotanine	<2.1	ng/L
SC-10	4/6/2009	16:00	University of Iowa	DEET	<0.0079	µg/L
SC-10	4/6/2009	16:00	University of Iowa	Ibuprofen	<1.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Lincomycin	<1.1	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Sulfamethoxazole	36.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-10	4/6/2009	16:00	University of Iowa	Triclosan	<5.3	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Trimethoprim	<1.0	ng/L
SC-10	4/6/2009	16:00	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-10A	4/6/2009	16:40	Field Parameter	Temperature	12.2	C
SC-10A	4/6/2009	16:40	Field Parameter	pH	5.1	
SC-10A	4/6/2009	16:40	Field Parameter	Specific Conductance	1000.0	µS/cm
SC-10A	4/6/2009	16:40	Field Parameter	Dissolved Oxygen	5.9	mg/L
SC-10A	4/6/2009	16:40	Idaho State Health Laboratory	Chloride	42.9	mg/L
SC-10A	4/6/2009	16:40	Idaho State Health Laboratory	Sulfate	95.0	mg/L
SC-10A	4/6/2009	16:40	Idaho State Health Laboratory	Nitrate	9.8	mg/L
SC-10A	4/6/2009	16:40	Idaho State Health Laboratory	Total Dissolved Solids	530.0	mg/L
SC-10A	4/6/2009	16:40	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Carbamazepine	1.4	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Caffeine	<5.6	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Cotanine	<2.1	ng/L

SC-10A	4/6/2009	16:40	University of Iowa	DEET	<0.0079	µg/L
SC-10A	4/6/2009	16:40	University of Iowa	Ibuprofen	<1.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Lincomycin	<1.1	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Sulfamethoxazole	4.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-10A	4/6/2009	16:40	University of Iowa	Triclosan	<5.3	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Trimethoprim	<1.0	ng/L
SC-10A	4/6/2009	16:40	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-11	10/15/2008	12:30	Field Parameter	Temperature	11.8	C
SC-11	10/15/2008	12:30	Field Parameter	pH	7.8	
SC-11	10/15/2008	12:30	Field Parameter	Specific Conductance	1050.0	µS/cm
SC-11	10/15/2008	12:30	Field Parameter	Dissolved Oxygen	7.5	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Calcium	88.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Magnesium	36.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Potassium	12.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Sodium	68.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Chloride	43.4	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Sulfate	94.6	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Nitrate	14.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Phosphorus	0.1	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Alkalinity	324.0	mg/L
SC-11	10/15/2008	12:30	Idaho State Health Laboratory	Total Dissolved Solids	630.0	mg/L
SC-11	10/15/2008	12:30	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Carbamazepine	<1.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Caffeine	<25	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Cotanine	<1.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	DEET	<15	µg/L
SC-11	10/15/2008	12:30	University of Iowa	Ibuprofen	<2.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Lincomycin	<5.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Sulfamethoxazole	1.1	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Sulfathiazole	<2.0	µg/L
SC-11	10/15/2008	12:30	University of Iowa	Triclosan	<5.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Trimethoprim	<1.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Tylosin	<2.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Testosterone	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Equilenin	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Estriol	<250	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Progesterone	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Coprostanol	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Cholesterol	970.0	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Dihydrocholesterol	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Stigmasterol	<100	ng/L

SC-11	10/15/2008	12:30	University of Iowa	Sitosterol	<100	ng/L
SC-11	10/15/2008	12:30	University of Iowa	Stigmastanol	<100	ng/L
SC-11	4/6/2009	15:15	Field Parameter	Temperature	12.0	C
SC-11	4/6/2009	15:15	Field Parameter	pH	4.9	
SC-11	4/6/2009	15:15	Field Parameter	Specific Conductance	1080.0	µS/cm
SC-11	4/6/2009	15:15	Field Parameter	Dissolved Oxygen	7.1	mg/L
SC-11	4/6/2009	15:15	Idaho State Health Laboratory	Chloride	46.5	mg/L
SC-11	4/6/2009	15:15	Idaho State Health Laboratory	Sulfate	97.2	mg/L
SC-11	4/6/2009	15:15	Idaho State Health Laboratory	Nitrate	17.0	mg/L
SC-11	4/6/2009	15:15	Idaho State Health Laboratory	Total Dissolved Solids	620.0	mg/L
SC-11	4/6/2009	15:15	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Carbamazepine	<1.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Caffeine	<5.6	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Cotanine	<2.1	ng/L
SC-11	4/6/2009	15:15	University of Iowa	DEET	<0.0079	µg/L
SC-11	4/6/2009	15:15	University of Iowa	Ibuprofen	<1.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Lincomycin	<1.1	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Sulfamethoxazole	1.2	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-11	4/6/2009	15:15	University of Iowa	Triclosan	<5.3	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Trimethoprim	<1.0	ng/L
SC-11	4/6/2009	15:15	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-12	4/6/2009	12:45	Field Parameter	Temperature	12.4	C
SC-12	4/6/2009	12:45	Field Parameter	pH	5.2	
SC-12	4/6/2009	12:45	Field Parameter	Specific Conductance	940.0	µS/cm
SC-12	4/6/2009	12:45	Field Parameter	Dissolved Oxygen	6.7	mg/L
SC-12	4/6/2009	12:45	Idaho State Health Laboratory	Chloride	37.2	mg/L
SC-12	4/6/2009	12:45	Idaho State Health Laboratory	Sulfate	78.2	mg/L
SC-12	4/6/2009	12:45	Idaho State Health Laboratory	Nitrate	14.0	mg/L
SC-12	4/6/2009	12:45	Idaho State Health Laboratory	Total Dissolved Solids	540.0	mg/L
SC-12	4/6/2009	12:45	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Carbamazepine	<1.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Caffeine	<5.6	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Cotanine	<2.1	ng/L
SC-12	4/6/2009	12:45	University of Iowa	DEET	<0.0079	µg/L
SC-12	4/6/2009	12:45	University of Iowa	Ibuprofen	<1.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Lincomycin	<1.1	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Sulfamethoxazole	2.3	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-12	4/6/2009	12:45	University of Iowa	Triclosan	<5.3	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Trimethoprim	<1.0	ng/L
SC-12	4/6/2009	12:45	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-13	4/6/2009	13:20	Field Parameter	Temperature	12.5	C
SC-13	4/6/2009	13:20	Field Parameter	pH	5.1	
SC-13	4/6/2009	13:20	Field Parameter	Specific Conductance	992.0	µS/cm
SC-13	4/6/2009	13:20	Field Parameter	Dissolved Oxygen	8.8	mg/L
SC-13	4/6/2009	13:20	Idaho State Health Laboratory	Chloride	46.6	mg/L
SC-13	4/6/2009	13:20	Idaho State Health Laboratory	Sulfate	104.0	mg/L
SC-13	4/6/2009	13:20	Idaho State Health Laboratory	Nitrate	17.0	mg/L
SC-13	4/6/2009	13:20	Idaho State Health Laboratory	Total Dissolved Solids	630.0	mg/L
SC-13	4/6/2009	13:20	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Carbamazepine	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Caffeine	<5.6	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Cotanine	<2.1	ng/L
SC-13	4/6/2009	13:20	University of Iowa	DEET	<0.0079	µg/L
SC-13	4/6/2009	13:20	University of Iowa	Ibuprofen	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Lincomycin	<1.1	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Sulfamethoxazole	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-13	4/6/2009	13:20	University of Iowa	Triclosan	<5.3	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Trimethoprim	<1.0	ng/L
SC-13	4/6/2009	13:20	University of Iowa	Tylosin	<1.1	ng/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SC-14	4/7/2009	10:15	Field Parameter	Temperature	13.8	C
SC-14	4/7/2009	10:15	Field Parameter	pH	8.1	
SC-14	4/7/2009	10:15	Field Parameter	Specific Conductance	970.0	µS/cm
SC-14	4/7/2009	10:15	Field Parameter	Dissolved Oxygen	7.5	mg/L
SC-14	4/7/2009	10:15	Idaho State Health Laboratory	Chloride	37.6	mg/L
SC-14	4/7/2009	10:15	Idaho State Health Laboratory	Sulfate	86.9	mg/L
SC-14	4/7/2009	10:15	Idaho State Health Laboratory	Nitrate	10.0	mg/L
SC-14	4/7/2009	10:15	Idaho State Health Laboratory	Total Dissolved Solids	540.0	mg/L
SC-14	4/7/2009	10:15	University of Iowa	Acetomenaphin	<5.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Carbamazepine	<1.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Caffeine	11.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Cotanine	<2.1	ng/L
SC-14	4/7/2009	10:15	University of Iowa	DEET	<0.0079	µg/L
SC-14	4/7/2009	10:15	University of Iowa	Ibuprofen	<1.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Lincomycin	<1.1	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Sulfadimethoxine	<1.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Sulfamethazine	<1.0	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Sulfamethoxazole	1.2	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Sulfathiazole	<0.0011	µg/L
SC-14	4/7/2009	10:15	University of Iowa	Triclosan	<5.3	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Trimethoprim	8.4	ng/L
SC-14	4/7/2009	10:15	University of Iowa	Tylosin	<1.1	ng/L

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Appendix B: Geochemical Data for surface water sites: Springdale, Idaho

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
MC-1	10/14/2008	9:15	Field Parameter	Temperature	8.40	C
MC-1	10/14/2008	9:15	Field Parameter	pH	7.92	
MC-1	10/14/2008	9:15	Field Parameter	Specific Conductance	647.00	µS/cm
MC-1	10/14/2008	9:15	Field Parameter	Dissolved Oxygen	11.08	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Calcium	67	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Magnesium	25	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Potassium	36	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Sodium	7.2	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Chloride	36.3	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Sulfate	72.5	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Nitrate	4.6	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Phosphorus	0.086	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Alkalinity	234	mg/L
MC-1	10/14/2008	9:15	Idaho State Health Laboratory	Total Dissolved Solids	450	mg/L
MC-1	4/6/2009	9:53	Field Parameter	Temperature	6.6	C
MC-1	4/6/2009	9:53	Field Parameter	pH	6.28	
MC-1	4/6/2009	9:53	Field Parameter	Specific Conductance	370	µS/cm
MC-1	4/6/2009	9:53	Field Parameter	Dissolved Oxygen	17.9	mg/L
MC-1	4/6/2009	9:53	Idaho State Health Laboratory	Chloride	21.7	mg/L
MC-1	4/6/2009	9:53	Idaho State Health Laboratory	Sulfate	18.8	mg/L
MC-1	4/6/2009	9:53	Idaho State Health Laboratory	Nitrate	0.77	mg/L
MC-1	4/6/2009	9:53	Idaho State Health Laboratory	Total Dissolved Solids	220	mg/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
ab MC-1	10/14/2008	9:30	Field Parameter	Temperature	7.20	C
ab MC-1	10/14/2008	9:30	Field Parameter	pH	8.18	
ab MC-1	10/14/2008	9:30	Field Parameter	Specific Conductance	681.00	µS/cm
ab MC-1	10/14/2008	9:30	Field Parameter	Dissolved Oxygen	9.17	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Calcium	66	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Magnesium	24	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Potassium	35	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Sodium	35	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Chloride	34.1	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Sulfate	71.8	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Nitrate	3.6	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Phosphorus	0.098	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Alkalinity	222	mg/L
ab MC-1	10/14/2008	9:30	Idaho State Health Laboratory	Total Dissolved Solids	420	mg/L

ab MC-1	4/6/2009	10:30	Field Parameter	Temperature	7.2	C
ab MC-1	4/6/2009	10:30	Field Parameter	pH	4.9	
ab MC-1	4/6/2009	10:30	Field Parameter	Specific Conductance	293	µS/cm
ab MC-1	4/6/2009	10:30	Field Parameter	Dissolved Oxygen	17.38	mg/L
ab MC-1	4/6/2009	10:30	Idaho State Health Laboratory	Chloride	19.9	mg/L
ab MC-1	4/6/2009	10:30	Idaho State Health Laboratory	Sulfate	12.6	mg/L
ab MC-1	4/6/2009	10:30	Idaho State Health Laboratory	Nitrate	0	mg/L
ab MC-1	4/6/2009	10:30	Idaho State Health Laboratory	Total Dissolved Solids	170	mg/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
SP Cr-1	4/6/2009	10:55	Field Parameter	Temperature	10.7	C
SP Cr-1	4/6/2009	10:55	Field Parameter	pH	6.15	
SP Cr-1	4/6/2009	10:55	Field Parameter	Specific Conductance	663	µS/cm
SP Cr-1	4/6/2009	10:55	Field Parameter	Dissolved Oxygen	19.9	mg/L
SP Cr-1	4/6/2009	10:55	Idaho State Health Laboratory	Chloride	35.9	mg/L
SP Cr-1	4/6/2009	10:55	Idaho State Health Laboratory	Sulfate	87.3	mg/L
SP Cr-1	4/6/2009	10:55	Idaho State Health Laboratory	Nitrate	5.3	mg/L
SP Cr-1	4/6/2009	10:55	Idaho State Health Laboratory	Total Dissolved Solids	410	mg/L

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Constituent or Parameter	Result	Unit of Measure
ab SP Cr-1	4/6/2009	11:40	Field Parameter	Temperature	12.3	C
ab SP Cr-1	4/6/2009	11:40	Field Parameter	pH	5.78	
ab SP Cr-1	4/6/2009	11:40	Field Parameter	Specific Conductance	771	µS/cm
ab SP Cr-1	4/6/2009	11:40	Field Parameter	Dissolved Oxygen	19.99	mg/L
ab SP Cr-1	4/6/2009	11:40	Idaho State Health Laboratory	Chloride	33.7	mg/L
ab SP Cr-1	4/6/2009	11:40	Idaho State Health Laboratory	Sulfate	81	mg/L
ab SP Cr-1	4/6/2009	11:40	Idaho State Health Laboratory	Nitrate	8.3	mg/L
ab SP Cr-1	4/6/2009	11:40	Idaho State Health Laboratory	Total Dissolved Solids	460	mg/L

Appendix C: Isotope Data for all sites: Springdale, Idaho

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Compound	Result	Unit of Measure
SC-1	10/14/2008	11:15	University of Arizona	Oxygen isotope	-16.1	per mil
SC-1	10/14/2008	11:15	University of Arizona	Hydrogen isotope	-126	per mil
SC-1	10/14/2008	11:15	University of Arizona	Nitrogen isotope	5	per mil
SC-1	4/6/2009	14:50	University of Arizona	Nitrogen isotope	5.1	per mil
SC-2	10/14/2008	14:15	University of Arizona	Oxygen isotope	-16.3	per mil
SC-2	10/14/2008	14:15	University of Arizona	Hydrogen isotope	-129	per mil
SC-2	10/14/2008	14:15	University of Arizona	Nitrogen isotope	6.7	per mil
SC-2	4/6/2009	12:00	University of Arizona	Nitrogen isotope	6.4	per mil
SC-3	10/14/2008	14:50	University of Arizona	Oxygen isotope	-16.2	per mil
SC-3	10/14/2008	14:50	University of Arizona	Hydrogen isotope	-128	per mil
SC-3	10/14/2008	14:50	University of Arizona	Nitrogen isotope	10	per mil
SC-3	4/6/2009	12:40	University of Arizona	Nitrogen isotope	9.9	per mil
SC-4	10/14/2008	15:25	University of Arizona	Oxygen isotope	-16.1	per mil
SC-4	10/14/2008	15:25	University of Arizona	Hydrogen isotope	-127	per mil
SC-4	10/14/2008	15:25	University of Arizona	Nitrogen isotope	8.7	per mil
SC-4	4/6/2009	11:30	University of Arizona	Nitrogen isotope	8.7	per mil
SC-5	10/14/2008	16:00	University of Arizona	Oxygen isotope	-16.1	per mil
SC-5	10/14/2008	16:00	University of Arizona	Hydrogen isotope	-128	per mil
SC-5	10/14/2008	16:00	University of Arizona	Nitrogen isotope	5.1	per mil
SC-5	4/6/2009	17:15	University of Arizona	Nitrogen isotope	4.7	per mil
SC-6	10/15/2008	10:15	University of Arizona	Oxygen isotope	-15.4	per mil
SC-6	10/15/2008	10:15	University of Arizona	Hydrogen isotope	-123	per mil
SC-6	10/15/2008	10:15	University of Arizona	Nitrogen isotope	9.4	per mil
SC-6	4/6/2009	12:15	University of Arizona	Nitrogen isotope	8.5	per mil
SC-7	10/15/2008	10:35	University of Arizona	Oxygen isotope	-16	per mil
SC-7	10/15/2008	10:35	University of Arizona	Hydrogen isotope	-126	per mil
SC-7	10/15/2008	10:35	University of Arizona	Nitrogen isotope	5.9	per mil
SC-9	10/15/2008	11:25	University of Arizona	Oxygen isotope	3.5	per mil
SC-9	10/15/2008	11:25	University of Arizona	Hydrogen isotope	-15.9	per mil
SC-9	10/15/2008	11:25	University of Arizona	Nitrogen isotope	-124	per mil
SC-9	4/6/2009	10:50	University of Arizona	Nitrogen isotope	3.4	per mil
SC-10	10/15/2008	11:50	University of Arizona	Oxygen isotope	-15.8	per mil
SC-10	10/15/2008	11:50	University of Arizona	Hydrogen isotope	-126	per mil
SC-10	10/15/2008	11:50	University of Arizona	Nitrogen isotope	7.2	per mil
SC-10	4/6/2009	16:00	University of Arizona	Nitrogen isotope	6.8	per mil
SC-11	10/15/2008	12:35	University of Arizona	Oxygen isotope	-15.7	per mil
SC-11	10/15/2008	12:35	University of Arizona	Hydrogen isotope	-123	per mil
SC-11	10/15/2008	12:35	University of Arizona	Nitrogen isotope	5.6	per mil
SC-11	4/6/2009	15:15	University of Arizona	Nitrogen isotope	5.7	per mil
SC-10A	4/6/2009	16:40	University of Arizona	Nitrogen isotope	5.2	per mil

DEQ Sample ID	Sample Date	Sample Time	Laboratory	Compound	Result	Unit of Measure
SC-12	4/6/2009	12:45	University of Arizona	Nitrogen isotope	5.1	per mil
SC-13	4/6/2009	13:20	University of Arizona	Nitrogen isotope	4.4	per mil
SC-14	4/6/2009	10:15	University of Arizona	Nitrogen isotope	3.6	per mil
MC-1	10/14/2008	9:15	University of Arizona	Oxygen isotope	-16.1	per mil
MC-1	10/14/2008	9:15	University of Arizona	Hydrogen isotope	-124	per mil
MC-1	10/14/2008	9:15	University of Arizona	Nitrogen isotope	5.8	per mil
MC-1	4/6/2009	9:53	University of Arizona	Nitrogen isotope	5.9	per mil
ab MC-1	10/14/2008	9:30	University of Arizona	Oxygen isotope	-16.1	per mil
ab MC-1	10/14/2008	9:30	University of Arizona	Hydrogen isotope	-124	per mil
ab MC-1	10/14/2008	9:30	University of Arizona	Nitrogen isotope	1.2	per mil
ab MC-1	4/6/2009	10:30	University of Arizona	Nitrogen isotope	4.9	per mil
SP Cr-1	4/6/2009	10:55	University of Arizona	Nitrogen isotope	8.3	per mil
ab SP Cr-1	4/6/2009	11:40	University of Arizona	Nitrogen isotope	6.5	per mil