AQUIFER STORAGE AND RECOVERY IN MILLVILLE, CACHE COUNTY, UTAH

by Paul Inkenbrandt

REPORT OF INVESTIGATION 275
UTAH GEOLOGICAL SURVEY
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Cover photo: *Millville and Providence, Cache County, Utah.*

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ABSTRACT

The Utah Geological Survey in cooperation with Millville City, Utah, investigated the feasibility of an aquifer storage and recovery project using Millville's existing water supply infrastructure. The project involved injecting and pumping with the Glenridge well, a public water supply well with elevated nitrate concentrations of about 8 mg/L, and using Garr spring, a public water supply spring, as the injection source. Millville City conducted two injection and pumping tests. The first test consisted of a week-long injection period immediately followed by a week of pumping, and the second test consisted of five months of injection, two months of storage, and three months of pumping.

I used various modeling techniques and analyses of geochemical samples to investigate the effects of the project. Aquifer test modeling indicates that the aquifer around the Glenridge well has a transmissivity of 135,000 ft^2/day (12,500 m^2/day). Three-dimensional finite-difference modeling shows the injected spring water flows slowly from the injection well to the northwest at a rate of approximately 1 m per day. Geochemical modeling indicates that the spring water would increase oxidation state of water in the aquifer, potentially causing mobilization of some metals. However, the change due to oxidation is expected to be minute, since geochemical analysis indicates that the major ion chemistry of the spring water is very similar to that of the principal aquifer. Geochemical analysis also indicates that septic systems are contributing significant amounts of nitrate to the water in the principal aquifer.

If this project continues, Millville City should establish a monitoring plan to ensure that metal concentrations do not approach regulatory standards. Also, the city should consider taking steps to remediate identified sources of nitrate, as nitrate contamination unrelated to the aquifer storage and recovery program will continue to increase with population density.

INTRODUCTION

Study Area

The area of study includes and surrounds the city of Millville in southeast Cache Valley, Utah (figure 1). The area of review (AOR) for this study, a two-mile radius around Millville's Glenridge well (figures 1 and 2), is based on state and federal regulatory requirements of underground injection (U.S. Code of Federal Regulations, 2014; Utah Administrative Code, 2015).

This study was conducted using Millville City's public drinking water system, which supplies water to 572 connections and serves 1900 people (Utah Division of Water Rights, 2015). The Utah Division of Drinking Water (DDW) has assigned system number 03012 to Millville's system. Garr spring and Glenridge well (table 1) are important public water sources in Millville's system.

Goals

Millville City, with assistance from the Utah Geological Survey (UGS), is testing the application of a small-scale aquifer storage and recovery (ASR) program in Cache Valley. Millville proposes to inject water from Garr spring into the Glenridge well from October to March of each year, store the water in Cache Valley's principal basin fill aquifer (figure 1) until late June, and then extract the injected water from June to September when public demand for water is greatest.

The ASR program would (1) provide Millville with a method to store Garr spring water during the winter months, when Millville's water rights for the spring are active and when demand is low, (2) assist in artificially decreasing relatively high measured nitrate concentrations in the Glenridge well, and (3) further utilize existing water rights. Nitrate concentrations at the Glenridge well have increased 4 mg/L over the past 15 years, and positively correlate to Millville's population increase (figure 3). The nitrate concentrations are approaching the federal maximum contaminant level (MCL) of 10 mg/L (nitrate as nitrogen) (U.S. Environmental Protection Agency, 2014).

This study consisted of two phases, a short term injection and pumping cycle conducted during March 2014, and a long term injection, storage, and pumping cycle conducted from October 2014 to October 2015. The goals of this study were to (1) determine how injection of Garr spring water would affect the Cache Valley principal aquifer system, (2) characterize the efficiency and viability of Millville's proposed ASR program, and (3) describe the source, distribution, and possible remediation methods of the nitrate contamination in the aquifer in the Millville area.

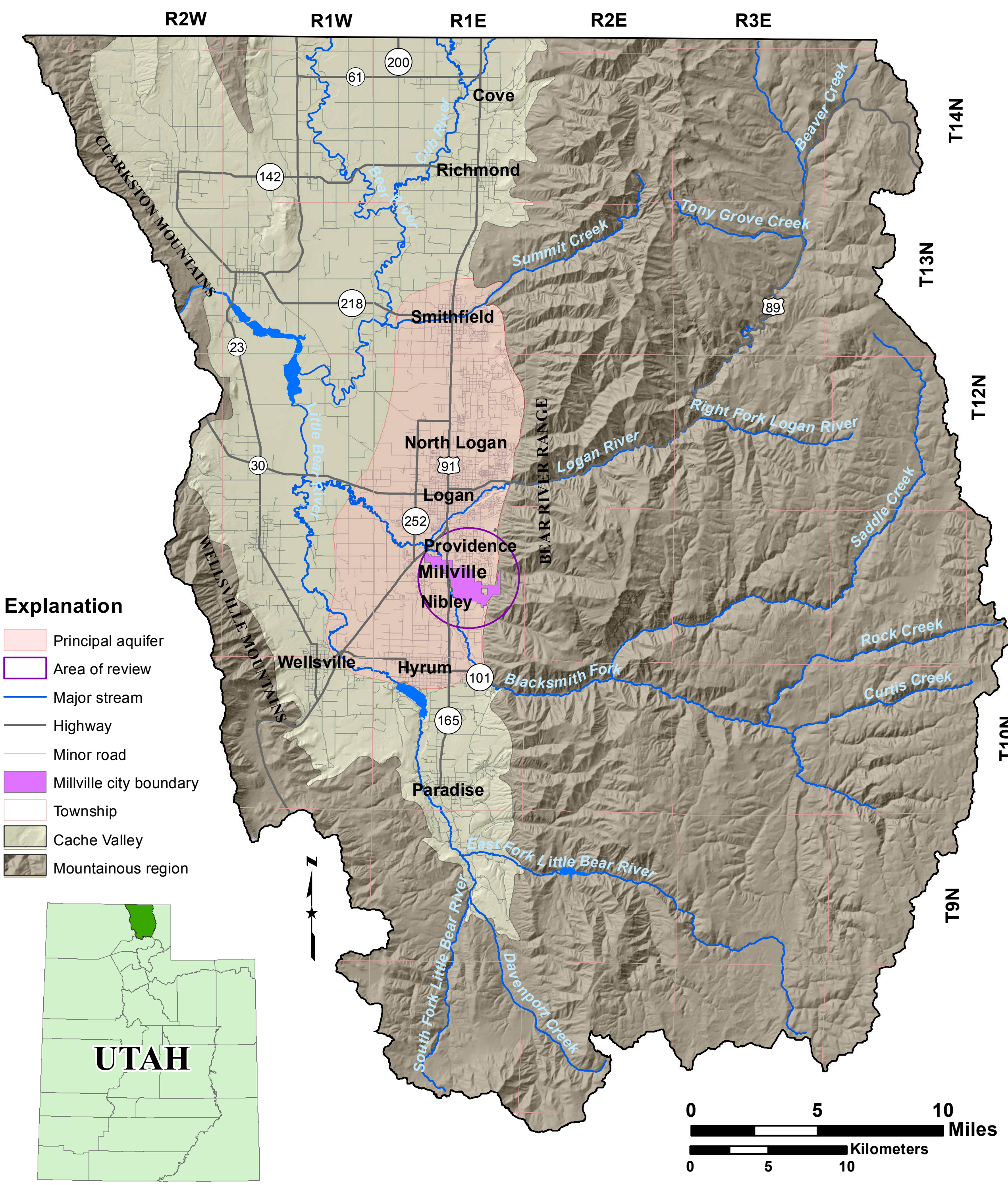

Figure 1. Location of the study area in Cache County, Utah.

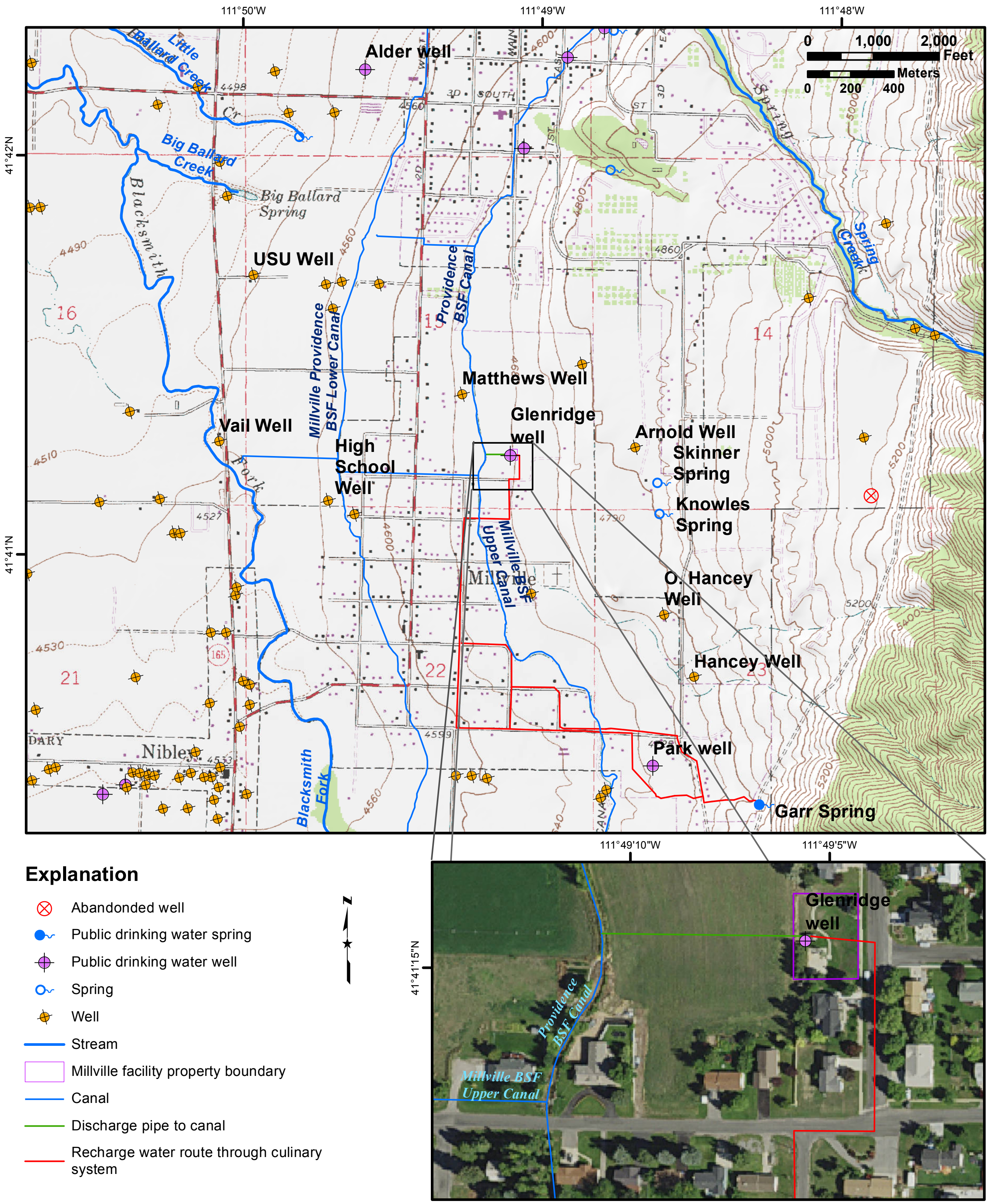

Figure 2. Location of Millville aquifer storage and recovery facility and well.

Table 1. *Millville water sources used in the Millville ASR program.*

Station Name	Station ID	Elev. (ft)	Lat.*	Long.*	Station Type	WIN	PLSS Location	Source Code	Water Rights
Garr Spring	414024111481101	4848	41.6730	-111.8039	Spring		N 690 ft W 2650 ft SE Cor Sec 23 T11N R1E SLB&M	03012-01	25-3510, 25-3069, 25-5170, 25-8394
Glenridge Well	414115111490301	4682	41.6877	-111.8181	Well	2722	N 790 ft W 1260 ft SE Cor Sec 15 T11N R1E SLB&M	03012-02	25-5171

*North American Datum 1983

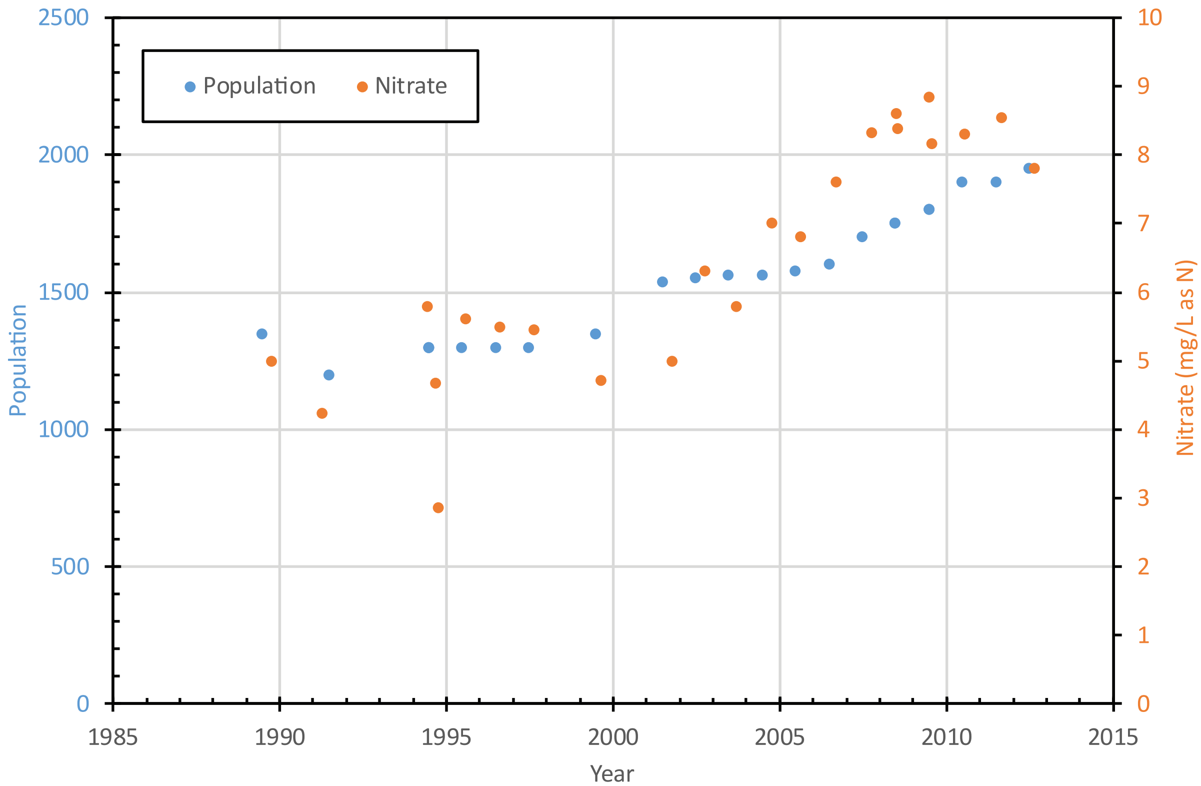

Figure 3. *Millville's population and Glenridge well nitrate concentrations both increase over time.*

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is the method of artificially recharging water into an aquifer, storing the water, and then recovering the water at a later time. In many cases, as is the case for Millville, ASR effectively uses aquifers as subsurface water storage reservoirs. The volumes of water injected and recovered can be managed to balance or change groundwater levels. For this study, the artificially recharged water is referred to as the injectate and the water in the aquifer is the host water.

The recharge aspect of ASR is an attempt to expedite and increase the natural groundwater recharge process through a human intervention process known as managed aquifer recharge, where the water is either injected via well or infiltrated at the ground surface via an infiltration gallery (Pyne, 1995). Thomas and others (2011) and Inkenbrandt and others (2013) investigated the use of surface infiltration to induce groundwater recharge near North Logan in Cache Valley (figure 1). For this study, the applied recharge method is injection into the Glenridge well, which is also used to extract the water. Injection of water into an aquifer system creates an effective "bubble" of injectate surrounded by the host water of the aquifer (figure 4). Diffusion and groundwater flow slowly disperse

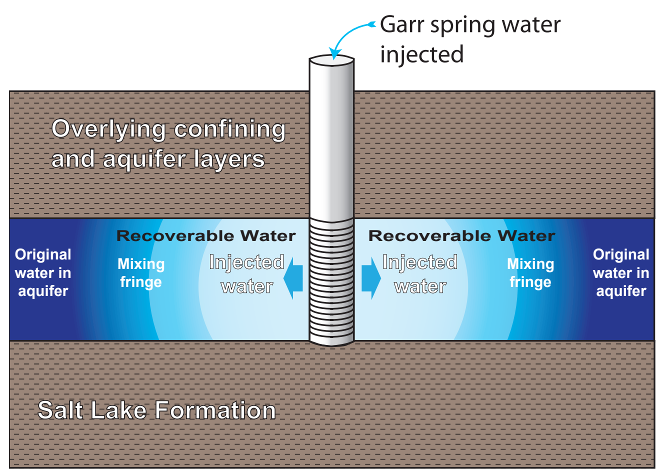

Figure 4. *Conceptual diagram of storage of injected water in the Cache Valley principal aquifer (modified from Pyne, 1995).*

the bubble, but pumping recovers some quantity of injectate. The ratio of the volume of injectate retrieved to the total volume of injected water is known as recovery efficiency.

During ASR, the injectate and the host water can chemically interact with each other and with minerals in the aquifer. The level of interaction depends on relative differences between the chemistries of the two waters—mainly pH, temperature, oxygen concentrations, and oxidation state. Water near or at the land surface is generally oxygen rich and creates oxidizing (high Eh) conditions in the upper portion of an aquifer system (figure 5a). Low oxygen (low Eh) reducing conditions are more likely to dominate deeper in an aquifer system, especially if the aquifer is confined (figure 6). Oxygen-rich injectate introduced into an aquifer dominated by low oxygen reducing conditions could change the oxidation state of ions in the host water, resulting in the potential mobilization of ions (Pyne, 1995). For the case of the water surrounding the Glenridge well, a primary concern is mobilizing nitrate via the oxidation of nitrite and ammonium (nitrification) (figure 5b). Oxidation can mobilize metals, including arsenic, uranium, mercury, nickel, chromium, cobalt, lead, and zinc. Microbiota often play an important role in the mobilization and demobilization of these and other ions, especially in the case of nitrate (Canter, 1997).

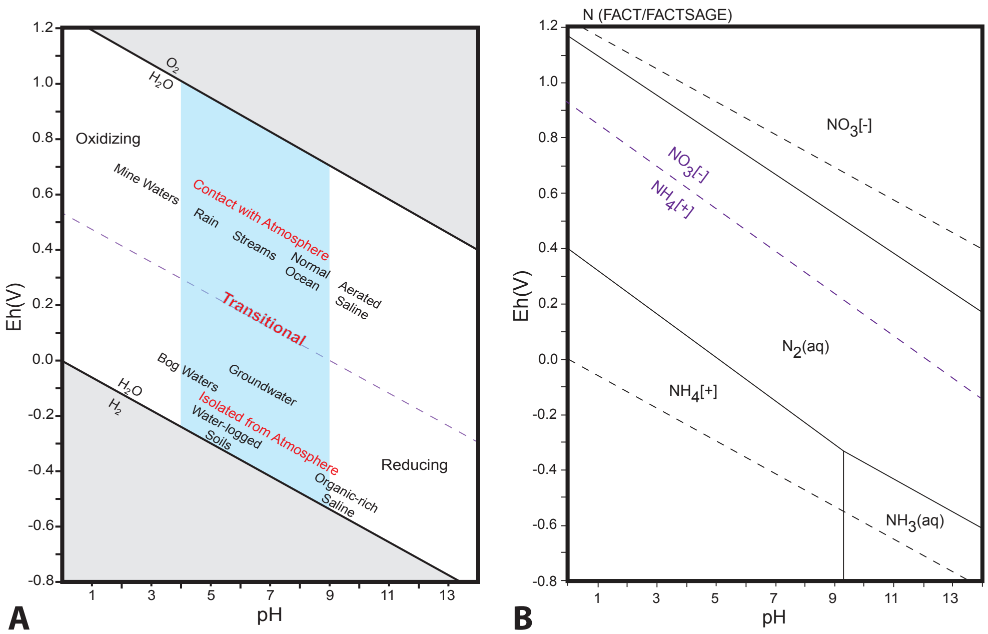

***Figure 5.** Pourbaix (Eh-pH) diagrams of (A) natural waters (Garrels and Christ, 1965) and (B) nitrogen (Takeno, 2005).*

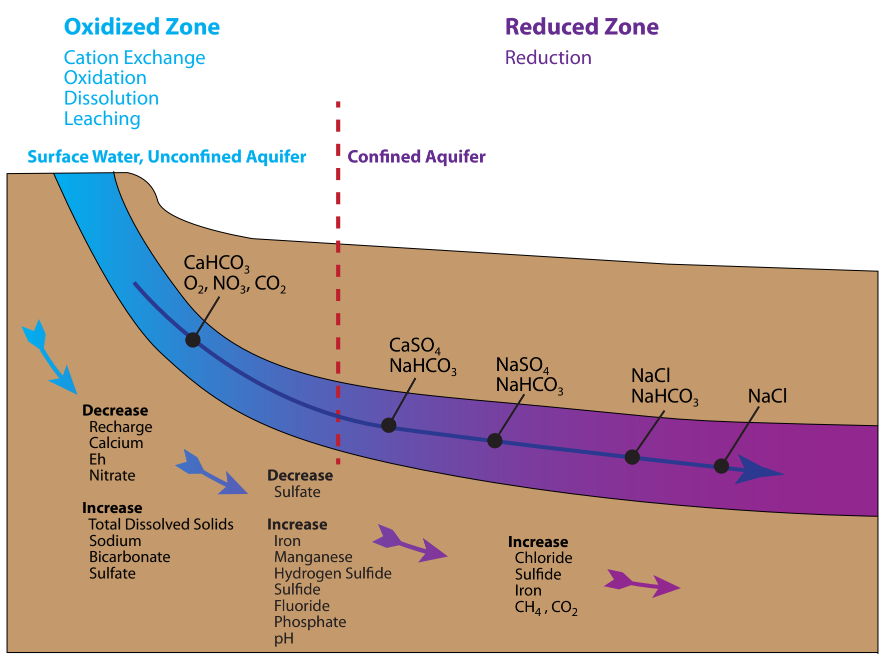

***Figure 6.** Common geochemical evolution of water as depth, confinement, and residence time increase (Pyne, 1995).*

Another concern during ASR injection periods is raising the water table of an unconfined aquifer to the point that nitrate in the previously unsaturated zone is entrained and mobilized, as observed by Nishikawa and others (2003) in a basin-fill aquifer system very similar to that of Cache Valley (figure 4). Raising the groundwater level in an unconfined aquifer that has a nitrate source near the water table would result in higher concentrations of nitrate in the aquifer water.

A similar concern to raising the water table is entraining nitrate in water infiltrating through the ground surface. In an ASR project using a surface-based infiltration gallery, the recharge water travels through the potentially contaminated unsaturated zone before reaching the saturated zone (figure 7), picking up nitrate along its path of travel. If a nitrate source is near or on the ground surface, then the infiltrating water can capture and transport the nitrate as it travels to the saturated zone.

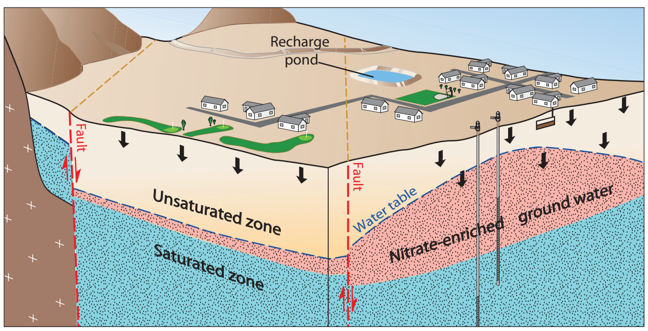

Figure 7. *Conceptual model of surface-based infiltration. Water is recharged at the recharge pond, infiltrates through an area with a high density of septic systems, creates a recharge mound, and mobilizes nitrate in the previously unsaturated part of the aquifer (Nishikawa and others, 2003).*

Regulation

Injection of water into a drinking water aquifer via Millville's Glenridge well is subject to regulation by the Underground Injection Control (UIC) Program of the Utah Division of Water Quality, the Utah Division of Water Rights, and the Utah Division of Drinking Water (Utah Administrative Code, 2015). The UIC Program classifies all ASR wells as Class 5B4 injection wells, which are wells used to replenish water in an aquifer for subsequent use (Utah Administrative Code, 2015). In order for an entity to inject water into and recover water from a Class 5B4 well, applications must be filed with the UIC Program and the Utah Division of Water Rights (Utah Administrative Code, 2015; Utah Division of Water Rights, 2016a; Utah Division of Water Rights, 2016b). The applications require a hydrogeologic study defining (1) the area of the aquifer potentially impacted by injection (AOR), (2) the implications of injecting foreign water into the groundwater system, (3) the hydrogeology of the area, and (4) the capabilities of the entity injecting water. Regulations require that water sources are regularly sampled for a suite of parameters on a regular basis (table 2).

Hydrogeology

The Cache Valley principal aquifer system (figure 1) is the primary aquifer for drinking-water supplies in Cache County and consists of a complex multiple-aquifer system (figure 8) composed of basin-fill sediment under both unconfined and confined conditions (Bjorklund and McGreevy, 1971; Kariya and others, 1994; Robinson, 1999). The basin-fill sediment consists of multiple layers of silt, sand, and gravel deposited in fluvial, alluvial fan, landslide, and near-shore lacustrine environments, separated by silt and clay layers primarily deposited in offshore lacustrine environments (Bjorklund and McGreevy, 1971; Lowe, 1987). Robinson (1999) defined two predominant and fairly continuous confining layers (B1 and B2) in the Cache Valley principal aquifer, as well as two major water bearing zones (A1 and A2) (figure 8; table 3). The basin fill is more than several hundred feet thick in the valley center (figure 9) and is thickest on the east side of the valley center (Evans and Oaks, 1996; Robinson, 1999).

Most near-surface confinement and recharge areas are dictated by the lacustrine stratigraphy of Pleistocene Lake Bonneville. In the area of Millville, gravel-rich deposits of the Provo and Bonneville shorelines are located near and east of the Glenridge well, respectively (figures 10 and 11) (Evans and others, 1996). Finer lacustrine sediments, some of which have been eroded and reworked by streams and mass movements, are more common west of the well (figures 10 and 11).

Evidence from aquifer tests in the Logan area (figure 1) suggests that the East Cache fault, the basin-bounding normal fault on the east side of the AOR, acts as a barrier to groundwater flow (Inkenbrandt, 2010). The Bear River Range east of the East Cache fault is a broad syncline of Paleozoic carbonates and siliceous meta-sedimentary rocks (figures 10 and 11). The connection between the older strata of the Bear River Range and the valley fill of Cache Valley has yet to be well established, although some have suggested that there is underflow from the range to the valley (Robinson, 1999; Myers, 2003), the focus of which could be coincident with streams entering the valley from the range.

The distribution of confining layers and the vertical hydrologic gradient dictate where groundwater recharges and discharges (Anderson and others, 1994). Groundwater in the principal aquifer is unconfined along the margins of Cache Valley, but is confined in many areas toward the center of the valley where many flowing wells exist (figure 8) (Bjorklund and McGreevy, 1971; Robinson, 1999). Confining conditions in the principal aquifer gradate from confined to leaky to unconfined as one moves from the center of the valley to the margins of the basin, the east side of which is defined by the East Cache fault (Robinson, 1999). Recharge occurs mainly at the margins of Cache Valley, and discharge is predominantly near the center of the valley, with exception of springs flowing from perched zones along the base of deltaic deposits (Anderson and others, 1994; Olsen, 2007) (figures 10 and 11).

Table 2. *Constituents analyzed in the injectate and injection well, as mandated by regulatory agencies.*

ANALYTE	CAS #	UNITS	MCL	Secondary Regulations	Once per 5 Year Permit Cycle for Established Injectate Source	Annually for Each New Injection Source (1)	Baseline Groundwater	Recovered Groundwater
Inorganics:								
Aluminum	7429-90-5	mg/L		0.05 to 0.2	X	X	X	
Antimony	7440-36-0	mg/L	0.006		X	X	X	
Arsenic	7440-38-2	mg/L	0.01		X	X	X	
Barium	7440-39-3	mg/L	2		X	X	X	
Beryllium	7440-41-7	mg/L	0.004		X	X	X	
Cadmium	7440-43-9	mg/L	0.005		X	X	X	
Chloride	7647-14-5	mg/L		250	X	X	X	
Chromium (Total)	7440-47-3	mg/L	0.1		X	X	X	
Copper	7440-50-8	mg/L		1	X	X	X	
Cyanide (as free Cyanide)	143-33-9	mg/L	0.2		X	X	X	
Fluoride	7681-49-4	mg/L	4	2	X	X	X	
Iron	7439-89-6	mg/L		0.3	X	X	X	
Manganese	7439-96-5	mg/L		0.05	X	X	X	
Mercury (inorganic)	7487-94-7	mg/L	0.002		X	X	X	
Nickel	7440-02-0	mg/L			X	X	X	
Selenium	7782-49-2	mg/L	0.05		X	X	X	
Silver	7440-22-4	mg/L		0.1	X	X	X	
Sodium						X	X	
Sulfate (2)	7757-82-6	mg/L	1,000	250	X	X	X	
Thallium	7440-28-0	mg/L	0.002		X	X	X	
Total Dissolved Solids (3)		mg/L	2000	500	X	X	X	
Zinc	7440-66-6	mg/L		5	X	X	X	
Nitrate/Nitrite:								
Nitrate (as Nitrogen)	14797-55-8	mg/L	10		X	X	X	
Nitrite (as Nitrogen)	14797-65-0	mg/L	1		X	X	X	
Total Nitrate and Nitrite (as N)		mg/L	10		X	X	X	
Asbestos:								
Asbestos (4)	1332-21-4	million fibers/l longer than 10 microns	7		X	X	X	
Volatile Organic Contaminants (VOC):								
Benzene	71-43-2	mg/L	0.005		X	X	X	
Carbon tetrachloride	56-23-5	mg/L	0.005		X	X	X	
Dichlorobenzene o-	95-50-1	mg/L	0.6		X	X	X	
Dichlorobenzene p-	106-46-7	mg/L	0.075		X	X	X	
Dichloroethane (1,2-)	107-06-2	mg/L	0.005		X	X	X	
Dichloroethylene (1,1-)	75-35-4	mg/L	0.007		X	X	X	
Dichloroethylene (cis-1,2-)	156-59-2	mg/L	0.07		X	X	X	
Dichloroethylene (trans-1,2-)	156-60-5	mg/L	0.1		X	X	X	
Dichloromethane	75-09-2	mg/L	0.005		X	X	X	
Dichloropropane (1,2-)	78-87-5	mg/L	0.005		X	X	X	
Ethylbenzene	100-41-4	mg/L	0.7		X	X	X	
Monochlorobenzene	108-90-7	mg/L	0.1		X	X	X	
Styrene	100-42-5	mg/L	0.1		X	X	X	
Tetrachloroethylene	127-18-4	mg/L	0.005		X	X	X	
Toluene	108-88-3	mg/L	1		X	X	X	
Trichlorobenzene (1,2,4-)	120-82-1	mg/L	0.07		X	X	X	
Trichloroethane (1,1,1-)	71-55-6	mg/L	0.2		X	X	X	
Trichloroethane (1,1,2-)	79-00-5	mg/L	0.005		X	X	X	
Trichloroethylene	79-01-6	mg/L	0.005		X	X	X	
Vinyl chloride	75-01-4	mg/L	0.002		X	X	X	
Xylenes	1330-20-7	mg/L	10		X	X	X	

Table 2. Continued.

ANALYTE	CAS #	UNITS	MCL	Secondary Regulations	Once per 5 Year Permit Cycle for Established Injectate Source	Annually for Each New Injection Source (1)	Baseline Groundwater	Recovered Groundwater
Pesticides:								
2,4 - D (2,4 - dichlorophenoxyacetic acid)	94-75-7	mg/L	0.07		X	X	X	
2,4,5-TP (Silvex)	93-72-1	mg/L	0.05		X	X	X	
Alachlor	15972-60-8	mg/L	0.002		X	X	X	
Aldicarb	116-06-3	mg/L	0.003		X	X	X	
Aldicarb sulfone	1646-88-4	mg/L	0.003		X	X	X	
Aldicarb sulfoxide	1646-87-3	mg/L	0.004		X	X	X	
Atrazine	1912-24-9	mg/L	0.003		X	X	X	
Benzo(a)pyrene (PAH)	50-32-8	mg/L	0.0002		X	X	X	
Carbofuran	1563-66-2	mg/L	0.04		X	X	X	
Chlordane	57-74-9	mg/L	0.002		X	X	X	
Dalapon (sodium salt)	75-99-0	mg/L	0.2		X	X	X	
Di(2-ethylhexyl) adipate	103-23-1	mg/L	0.4		X	X	X	
Di(2-ethylhexyl) phthalate	117-81-7	mg/L	0.006		X	X	X	
Dinoseb	88-85-7	mg/L	0.007		X	X	X	
Endrin	72-20-8	mg/L	0.002		X	X	X	
Heptachlor	76-44-8	mg/L	0.0004		X	X	X	
Heptachlor epoxide	1024-57-3	mg/L	0.0002		X	X	X	
Hexachlorobenzene	118-74-1	mg/L	0.001		X	X	X	
Hexachlorocyclopentadiene	77-47-4	mg/L	0.05		X	X	X	
Lindane	58-89-9	mg/L	0.0002		X	X	X	
Methoxychlor	72-43-5	mg/L	0.04		X	X	X	
Oxamyl (Vydate)	23135-22-0	mg/L	0.2		X	X	X	
Pentachlorophenol	87-86-5	mg/L	0.001		X	X	X	
Picloram	1918-2-1	mg/L	0.5		X	X	X	
Polychlorinated biphenyls (PCBs)	1336-36-3	mg/L	0.0005		X	X	X	
Simazine	122-34-9	mg/L	0.004		X	X	X	
Toxaphene	8001-35-2	mg/L	0.003		X	X	X	
Radionuclides:								
Gross alpha particle activity (Radium 226; excluds Radon & Uranium)		pCi/l	15		X	X	X	
Radium-226 (only required if gross alpha is >= 5pCi/L)	7440-14-4	pCi/l	5					
Radium-228	7440-14-4	pCi/l	5					
Uranium (only if gross alpha MCL is exceeded)	7440-61-1	mg/L	0.03		X	X	X	
Gross beta particle and photon emitters *(5)*		mrem/yr	4		X	X	X	
Tritium (only if gross beta exceeds 50 pCi/L)		pCi/l	20,000		X	X	X	
Strontium-90 (only if gross beta exceeds 50 pCi/L)		pCi/l	8		X	X	X	
Radon	10043-92-2	pCi/l			X	X	X	
Total Trihalomethanes (TTHMs): (6) ***(if Chlorine used as disinfectant)***		mg/L	0.08		X	X	X	
Chloroform	67-66-3	mg/L			X	X	X	
Bromodichloromethane	75-27-4	mg/L			X	X	X	
Dibromochloromethane	124-48-1	mg/L			X	X	X	
Bromoform	75-25-2	mg/L			X	X	X	
Haloacetic acids (HAA5): (7)		mg/L	0.06		X	X	X	X
(if Chlorine used as disinfectant)								
Trihaloacetic acids (THAAs)								
Trichloroacetic acid (TCAA)	76-03-9	mg/L			X	X	X	X
Dihaloacetic acids (DHAAs)								
Dichloroacetic acid (DCAA)	76-43-6	mg/L			X	X	X	X
Dibromoacetic acid (DBAA)	631-64-1	mg/L			X	X	X	X
Monohaloacetic acids (MHAAs)								
Monochloroacetic acid (MCAA)	79-11-8	mg/L			X	X	X	X
Monobromoacetic acid (MBAA)	79-08-3	mg/L			X	X	X	X

Table 2. *Continued.*

ANALYTE	CAS #	UNITS	MCL	Secondary Regulations	Once per 5 Year Permit Cycle for Established Injectate Source	Annually for Each New Injection Source (1)	Baseline Groundwater	Recovered Groundwater
Disinfectants and Their By-Products: *(8)*								
Chloramine (if used as a disinfectant)	10599-90-3	mg/L	4		X	X	X	X
Chlorine	7782-50-5	mg/L	4		X	X	X	X
Chlorine Dioxide (if used as a disinfectant)	10049-04-4	mg/L	0.8		X	X	X	X
Chlorite (if Chlorine Dioxide is used as a disinfectant)	7758-19-2	mg/L	1		X	X	X	X
Bromide / Bromate (if Ozone is used as a disinfectant) *(9)*	24959-67-9	mg/L			X	X	X	X
Turbidity:		NTU	*(10)*		X	X	X	
Total Coliform:			*(11)*		X	X	X	
Additional Parameters:								
Color		Color Units		15		X	X	
Corrosivity				Non-Corr.		X	X	
Foaming Agents		mg/L		0.5		X	X	
Odor		Threshhold		3		X	X	
pH		pH units		6.5 – 8.5		X	X	
Ammonia, as N		mg/L				X	X	
Boron		mg/L				X	X	
Calcium		mg/L				X	X	
Lead		mg/L				X	X	
Magnesium		mg/L				X	X	
Potassium		mg/L				X	X	
Specific Conductivity at 25º C		µmhos/cm				X	X	
Bicarbonate		mg/L				X	X	
Carbon Dioxide		mg/L				X	X	
Carbonate		mg/L				X	X	
Hydroxide		mg/L				X	X	
Phosphorous, Ortho as P		mg/L				X	X	
Silica, dissolved as SIO_2		mg/L				X	X	
Surfactant as MBAS		mg/L				X	X	
Total Hardness as $CaCO_3$		mg/L				X	X	
Alkalinity as $CaCO_3$		mg/L				X	X	
Total Organic Carbon (TOC) *(12)*		mg/L				X	X	

(1) Permittee shall analyze any new injection source annually for the permit cycle. This is to comply with the Division of Drinking Water's requirement for new source monitoring.

(2) According to Utah DDW, if Sulfate is greater than 500 mg/L the water management must demonstrate that no better water is available.

(3) DDW has TDS limits of 2,000 mg/L but because of the Ground Water/UIC Rules, injection of water with TDS concentrations greater than the TDS limit of the Ground Water Class of the receiving aquifer is not permitted.

(4) Asbestos monitoring is not required unless the new source is located in area of natural deposits of asbestos or the distribution system contains any asbestos cement piping.

(5) See R309-200-5(4) (d) for actual MCL of 4 millirem/year. Use 50 pCi/L as a screening level for further analysis.

(6) According to Utah DDW, the maximum contaminant level for community water systems serving a population of 10,000 or more and utilizing chlorine as a disinfectant is 80 µg/l as a location based running annual average.

(7) HAA5 includes MCAA, DCAA, TCAA, MBAA, and DBAA.

(8) The permit limits for disinfectants are maximum residual disinfectant levels (MRDLs) and not MCLs.

(9) DWQ has added bromide to the analytical parameter list with an analytical method reporting limit not to exceed 0.02 mg/L. If the bromide concentration exceeds 0.04 mg/L, permittee will be required to analyze for bromate concentrations.

(10) The turbidity limit for surface water sources or ground water sources under the direct influence of surface water is 0.3 NTU in at least 95% of the samples per month. The turbidity limit for slow sand filtration and diatomaceous earth filtration is 1.0 NTU in at least 95% of the samples per month. The turbidity level for ground water sources not under the direct influence of surface water is 5.0 NTU.

(11) For a system which collects less than 40 samples per month, no more than one sample per month may be total coliform-positive. For a system which collects 40 or more samples per month, no more than 5.0 % of the samples collected during a month may be total coliform-positive. Any fecal coliform-positive or Escherichia coliform (E. coli)-positive repeat sample or any total coliform-positive repeat sample following a fecal coliform-positive or E.coli-positive routine sample constitutes an acute MCL violation for total coliforms. This applies to samples taken throughout the distribution system. For the injection wells, no more than 5% of the monthly samples collected of the plant effluent may be total coliform-positive.

(12) If surface water is the source of the injectate, total organic carbon (TOC) shall be included for analysis.

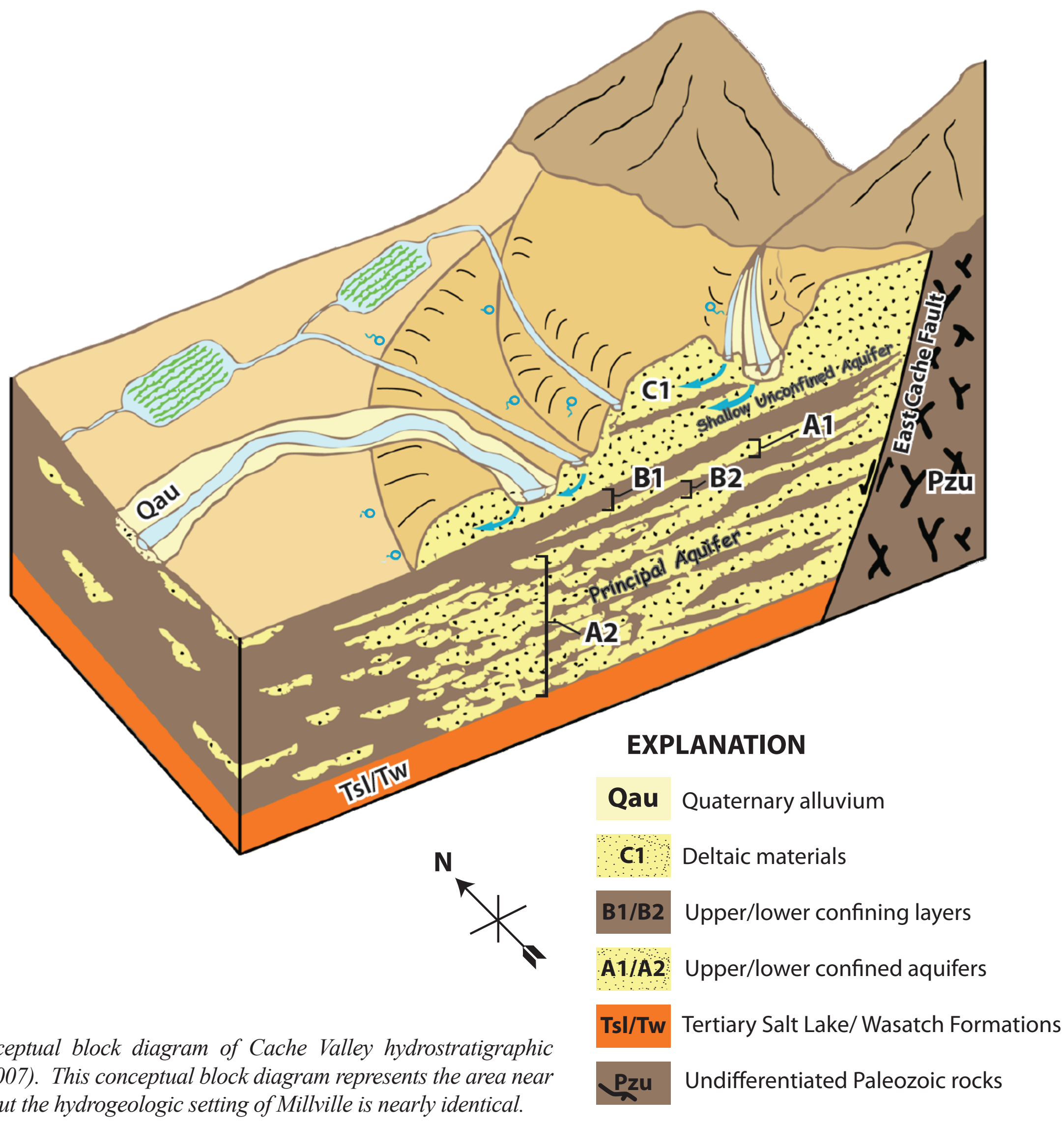

Figure 8. *Conceptual block diagram of Cache Valley hydrostratigraphic units (Olsen, 2007). This conceptual block diagram represents the area near Logan, Utah, but the hydrogeologic setting of Millville is nearly identical.*

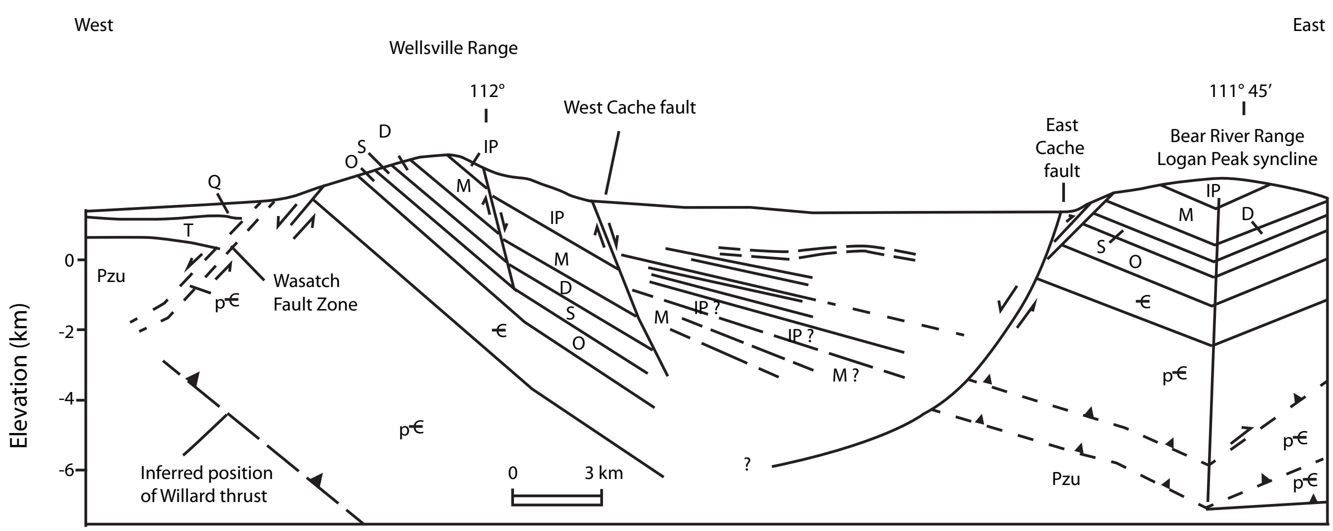

Figure 9. *West-east cross section through Cache Valley at Millville's latitude (Evans and Oaks, 1996). Abbreviations: Pzu—undifferentiated, Paleozoic, pC—Proterozoic, C—Cambrian, O—Ordovician, S—Silurian, D—Devonian, M—Mississippian, IP—Pennsylvanian, T—Tertiary, Q—Quaternary.*

Table 3. *Hydrostratigraphic units in Cache Valley as defined by Robinson (1999).*

Unit (Avg. thickness, ft)	Description	Water-Bearing Properties
Qau (50)	Quaternary alluvium undifferentiated Cobbles, gravel, sand, and silt; well to poorly sorted; unconsolidated; eolian sand and spring tufa	Generally highly to moderately conductive; unconfined; transmissivities generally adequate for stock wells
B1 (60)	Upper confining layer Clay grading to silt, sand, and gravel near the valley margins	Considered to be a highly impermeable aquitard; vertical gradients as great as 0.5
C1 (>200)	Deltaic deposits Cobbles, gravel, sand, and silt; well to poorly sorted; unconsolidated	Transmissivities are generally the highest in the valley; unconfined to confined; high water quality
A1 (30)	Upper confined aquifer Gravels to cobbles interbedded with sand and silt; clay beds present in discontinuous lenses	Moderately conductive but relatively low thickness gives low transmissivities; water generally contains much iron; well confined
B2 (30)	Lower confining layer Thickly bedded clay containing thin gravel lenses near the valley margins	Considered to be a highly impermeable aquitard; vertical gradients as great as 0.5
A2 (1340)	Lower confined aquifer Unconsolidated to semiconsolidated, thickly bedded gravels and sands; discontinuous lenses of silt, clay and marl; woody debris, peat, and shells sometimes present	Conductivities very low to very high; these sediments compose the major aquifer of the valley
Tsl (9000)	Tertiary Salt Lake Fm, undifferentiated Tuff, and mostly tuffaceous and calcareous siltstone, sandstone, and conglomerate, limestone and marl	Conductivities generally low, but may be high locally in solution cavities or fanglomerate facies; water quality is highly variable
Tw (150)	Tertiary Wasatch Fm, undifferentiated Poorly consolidated red-colored cobble- to boulder-bearing conglomerate	Conductivities generally low to moderate; low well discharges possible; source of some springs
Pz (>>10,000)	Paleozoic, undifferentiated Well consolidated to slightly metamorphosed sandstone, shale, dolomite, and limestone; possibly containing solution cavities	Permeability is predominately due to fractures and solution cavities, ranging from very low to locally quite high

Recharge and discharge zones for Utah basin-fill aquifers are organized into three categories: (1) primary recharge – less than 20 feet (ft) (<6 m) of clay and a downward hydraulic gradient, (2) secondary recharge – confining layers (greater than 20 ft [6 m]) and a downward hydraulic gradient, and (3) discharge areas – upward hydraulic gradient (Anderson and others, 1994).

Transmissivity for the principal aquifer is high relative to many aquifers, having values as high as 135,000 feet squared per day (ft^2/day) (12,500 m^2/day) (Inkenbrandt, 2010; Inkenbrandt, 2012; Inkenbrandt, 2014). Some of the highest transmissivity values are near the Millville area (Inkenbrandt, 2010). Distribution of transmissivity in the principal aquifer follows a pattern similar to the confining zones. Transmissivity decreases to the west, as valley fill material becomes finer. Vertically, the lower water bearing stratum of the principal aquifer (A2) has relatively higher transmissivity (Inkenbrandt, 2012). High transmissivities increase the rate of travel for contaminants. In aquifers with high transmissivities, cones of depression as well as their inverse, artificial recharge mounds, show much smaller changes in head, but over a much larger area than in aquifers with smaller transmissivities (Kruseman and Ridder, 1990).

Horizontal hydraulic gradient in the principal aquifer in the area of the Glenridge well is 0.002 from generally east to west (Inkenbrandt, 2014). This value agrees with ranges reported for the principal aquifer of 0.0004 to 0.004 (Bjorklund and McGreevy, 1971). The gradient generally follows the land surface, starting out steep near the mountains and becoming more gentle towards the center of the valley. Based on a gradient of 0.002, a transmissivity of 135,000 ft^2/day (12,500 m^2/day), and an aquifer thickness of 100 ft (30.5 m) (Inkenbrandt, 2014), the estimated Darcy velocity (Fetter, 2000) for the principal aquifer in the area of the Glenridge well is 2.7 ft/day (0.8 m/day). However, this value will likely decrease towards the center of the valley and transmissivity and hydraulic gradient decrease.

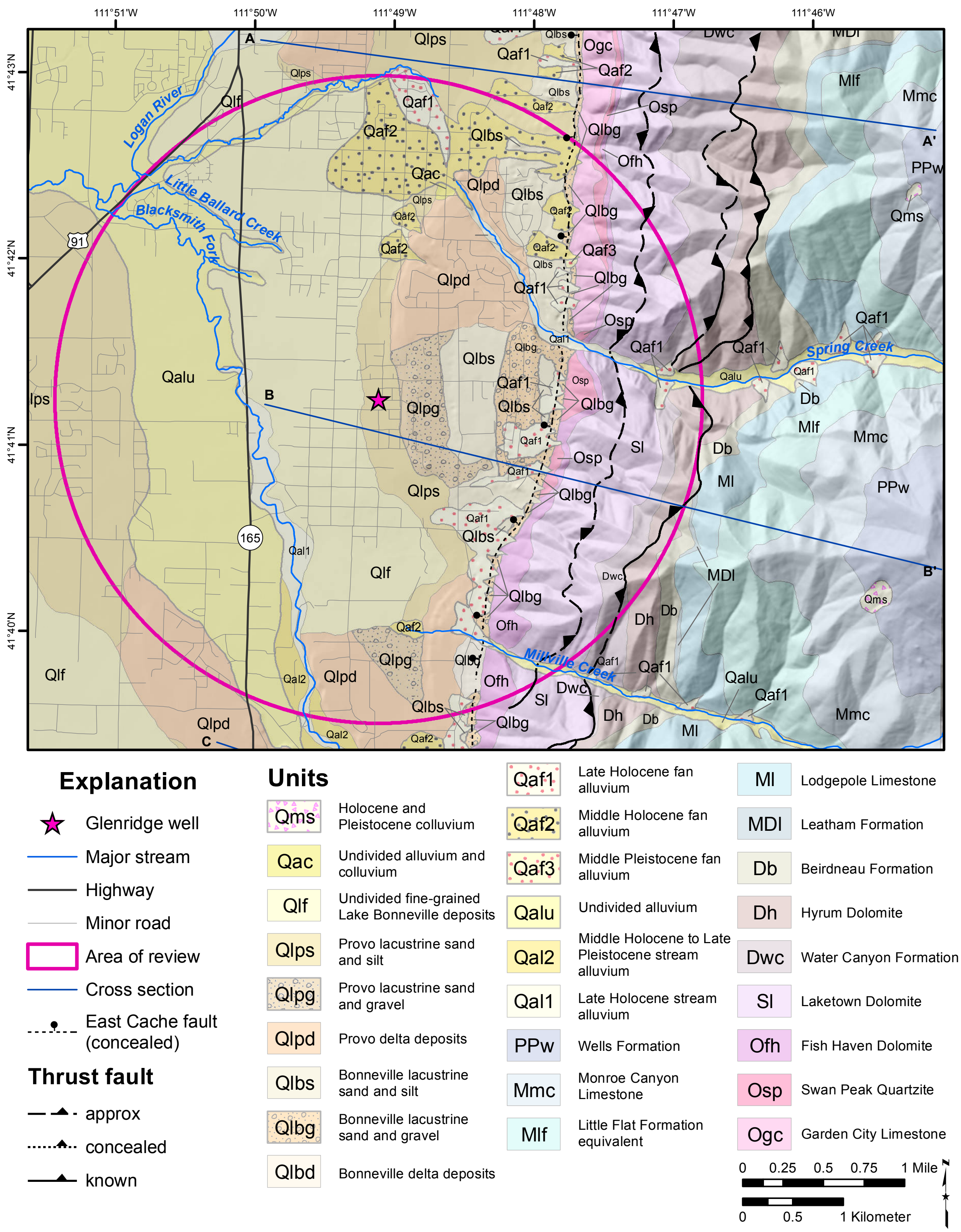

Figure 10. Geologic map of study area (modified from Evans and others, 1996).

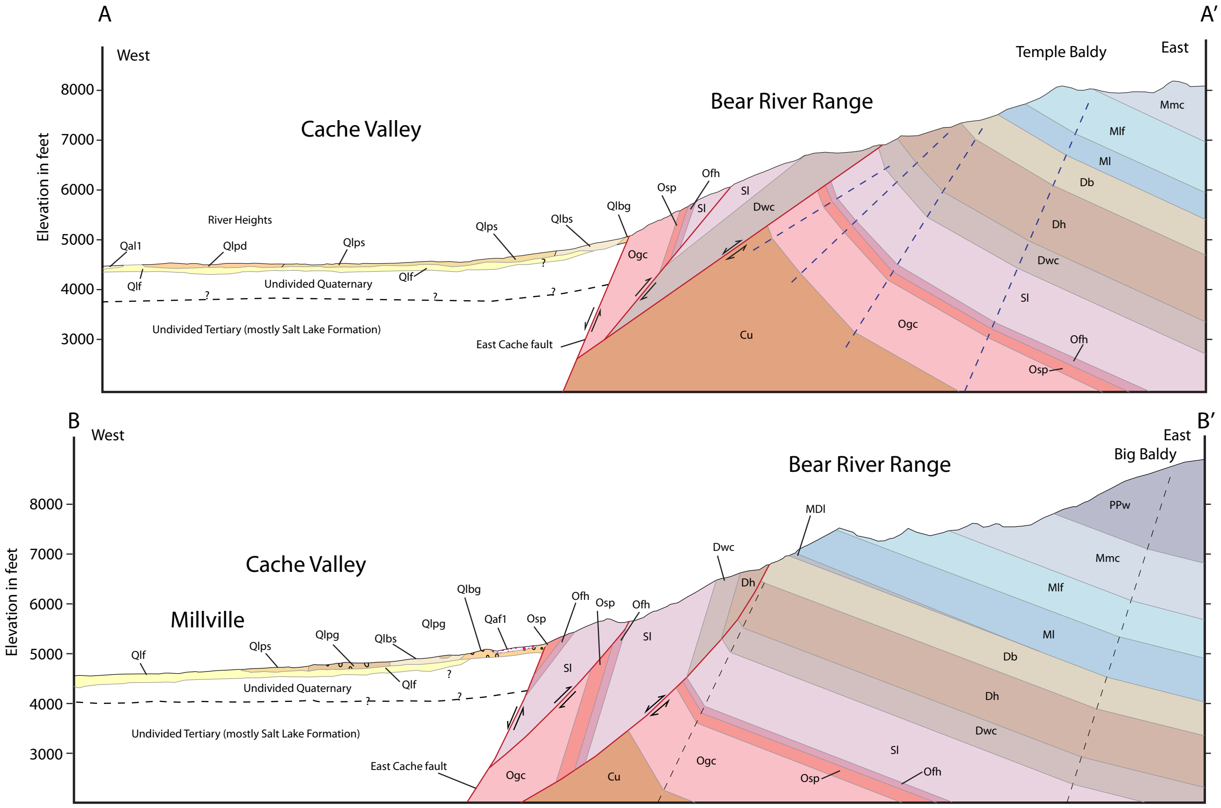

Figure 11. Cross sections A-A' and B-B' through the study area (modified from Evans and others, 1996). See figure 10 for location and an explanation of units.

METHODS

The goals of (1) determining how Garr spring water would affect the Cache Valley principal aquifer system, (2) characterizing ASR efficiency and viability, and (3) describing the source, distribution, and remediation methods of the nitrate required a multi-faceted approach. To accomplish the goals, I: (1) examined the preexisting physical conditions of the aquifer system by compiling well logs and geochemical data and creating cross sections and potentiometric maps, (2) conducted two ASR tests where water was injected, stored and pumped, and (3) modeled the conditions of the tests using a variety of techniques.

Potentiometric Surface

Using compiled well water-level data and land-surface elevations, I created a high-resolution potentiometric surface map to determine groundwater flow direction and gradient. Groundwater flow direction and gradient can be applied for modeling Drinking Water Source Protection (DWSP) zones, contaminant transport, and water injection. I used a combination of compiled and field-collected data to generate the map. I used 1/3 arc-second digital elevation models (DEM) (U.S. Geological Survey, 2015) to assign land-surface elevations to wells that I did not measure in the field. The DEMs have an average root-mean square error of 1.55 m, where the error increases with slope and amount of land cover (Gesch and others, 2014).

I supplemented field measurements with compiled data from the U.S. Geological Survey (USGS) and the Utah Division of Water Rights, and compiled existing data from the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2014). For wells having multiple measurements, I calculated an average depth-to-water value. Averaging measurements is appropriate in this situation because, although there is a downward long-term trend in groundwater levels for parts of Cache Valley (Burden and others, 2015), I wanted to represent the average long-term static groundwater level. I also compiled data from the Utah Division of Water Rights Water Rights Points of Diversion (WRPOD) shapefile and associated tables.

I created a potentiometric surface map using DEM data (U.S. Geological Survey, 2015) and 645 groundwater-level measurements compiled from 576 wells in the principal aquifer area. I used the entire principal aquifer area to better model spatial relationships between groundwater levels. I interpolated the groundwater level elevation data using cokriging. Cokriging is a geostatistical method that assumes one can improve estimates of a value of a variable in space if it is spatially dependent on other variables (ESRI, 2015). One advantage of using a geostatistical method is that it allows for error estimates in interpolation (ESRI, 2015).

Table 4. *Grouping method used to interpret well drillers' records.*

Drillers' Description	Group	Simplification	Assumed Permeability
gravel-cobbles gravel-cobbles-boulders boulders gravel-boulders cobbles-boulders gravel cobbles	gravel	1	high
sand-gravel-cobbles-boulders sand-gravel-boulders sand-boulders silt-sand-gravel sand-gravel-cobbles	sand-gravel		
clay-hardpan	hardpan	2	low
clay-silt-sand clay-silt	clay-sand	3	medium-Low
silt-sand	sand	4	medium
clay-gravel-boulders clay-cobbles clay-boulders clay-cobbles-boulders clay-sand-gravel-cobbles clay-silt-gravel-cobbles clay-gravel-cobbles-boulders clay-gravel-cobbles clay-silt-gravel clay-sand-gravel	clay-gravel	5	medium
other	other	6	low
clay-conglomerate gravel-conglomerate clay-silt-sand-gravel-conglomerate	conglomerate	7	high

I determined gradient and flow direction by generating slope and aspect rasters of the groundwater level interpolation. I averaged the aspect and slope orientations within a two-mile radius of the well and west of the East Cache fault.

Cross Sections

Using well logs compiled from the Utah Division of Water Rights, I generated several geologic cross sections to investigate the distribution of coarse and fine-grained sediments in the aquifer. For each well in the AOR, I tabulated the lithologic, depth, and screen interval information into spreadsheets. Then, using Python (van Rossum, 2014), I standardized the raw information into groups (table 4) based on permeability using the Robinson (1999) nomenclature and conceptual model (figure 8). The data were then mapped in ArcGIS (ESRI, 2015) and plotted in cross sections.

Geochemical Background

General Chemistry

To characterize the typical baseline geochemical conditions of the Cache Valley principal basin fill aquifer, I compiled geochemical data for the aquifer then statistically summarized and analyzed the data. I compiled the field data and water sample data collected during the ASR tests with data from the U.S. Environmental Protection Agency Water Quality Exchange database (WQX; formerly STORET) (U.S. Environmental Protection Agency, 2015), the U.S. Geological Survey National Water Information System (NWIS) (U.S. Geological Survey, 2014), the Utah Department of Food and Agriculture (UDAF), and the Utah Division of Drinking Water Safe Drinking Water Information System (SDWIS) (Utah Division of Drinking Water, 2015). To compile the data into one table, I standardized all of the column names and field types, as well as recalculating common nutrients and reported concentration units.

All of the modifications made to the raw data were done using Python (van Rossum, 2014), an open programming language capable of data analysis and manipulation. Using Python (van Rossum, 2014) scripts allow for complete documentation of how each dataset was queried and manipulated, as well as reproducibility if one has the necessary dependencies. The Python scripts are available at GitHub.com to improve reproducibility (Inkenbrandt, 2016).

After compiling the various geochemical datasets, I selected a subset of the data that best represented the geochemistry of the principal aquifer. I used a rectangular area that encompassed the boundaries of the principal aquifer system (Robinson, 1999; Inkenbrandt, 2010), and selected only samples collected from wells. While some springs are sourced from the principal aquifer system (Olsen, 2007), they were not included in this compilation.

Potential Nitrate Sources

I created a potential contaminant map showing the location of septic systems and animal operations using the Cache County parcel map of Millville (Utah Automated Geographic Reference Center, 2015). I created points representing the approximate location of septic systems by using the centroid of each parcel and also included a few older parcels in Providence suspected of having septic systems, as reported in informal communications with Providence City personnel. I then generated a point density map from the centroid points. To include animal-related potential sources of nitrate, Nathan Payne (UGS) used aerial photographs (Utah Geological Survey, 2015) and water-related land use maps (Utah Automated Geographic Reference Center, 2015) to determine land use change over time.

Aquifer Storage and Recovery Tests

Aquifer storage and recovery (ASR) testing consisted of two phases. The first test lasted two weeks, and the second test lasted one year. The objective of the second test was to recreate the typical operating conditions Millville would employ if their ASR program was fully operational. Before conducting the ASR tests, spring flow and water rights were assessed and the Glenridge well was configured for injection. The tests followed the three general phases typical of an ASR system (Pyne, 1995): (1) injection of Garr spring water into the principal aquifer via the Glenridge well, (2) storage of the injected water in the principal aquifer, and (3) pumping of the Glenridge well. Gary Larsen (Millville City) and I measured water levels and collected water quality samples from the Glenridge and surrounding wells during the tests. Exact constituents, sites sampled, and sample times are summarized in the laboratory reports of appendix A as well as tables 5 and 6.

Table 5. *Sites sampled for this study.*

Station Name	Station ID	Elev (m)	Lat.[1]	Long.[1]	Station Type	Depth (ft)	Screen Depth (ft)	WIN[2]	Diam. (in)	WL[3] (ft)	WL[3] Date	Screen Bottom (ft)
Garr spring	414024111481101	4848	41.6730	-111.8039	Spring							
Park well	414029111483501	4698	41.6731	-111.8111	Well	398	264	2721	1	188	3/8/78	365
Skinner spring	414112111483101	4828	41.6862	-111.8103	Spring							
Glenridge well	414115111490301	4682	41.6877	-111.8181	Well	385	269	2722	10	180	9/6/73	369
USU well	414143111495501	4522	41.6951	-111.8326	Well	230	195	437364	12	17	5/11/74	230
Alder well	414213111493101	4534	41.7037	-111.8265	Well	220	180	2815	8	41	8/15/78	215
Postma well	414018111483001	4757	41.6716	-111.8082	Well	340	277	20761	6	150	3/22/00	340
Arnold well	414023111484101	4823	41.6880	-111.8113	Well	450	450	436207	6	315	7/16/16	450
Hancey well	414042111483501	4783	41.6786	-111.8084	Well	356	250	33886	8	270	4/10/72	315
O. Hancey well	414052111484301	4793	41.6811	-111.8091	Well	355		32975	6	256	9/17/75	
Cox well	414055111490101	4695	41.6819	-111.8170	Well	295	222	33155	6	185	4/4/74	290
Knowles spring	414107111483501	4823	41.6853	-111.8096	Spring							
Arnold well	414117111494101	4823	41.6880	-111.8113	Well	450	450	436207	6	315	7/16/16	450
Vail well	414117111500401	4522	41.6881	-111.8345	Well	220	170		8	37	10/9/81	205
Matthews well	414125111491601	4655	41.6903	-111.8217	Well	351	97	33877	8	156	8/30/72	350
High School well	414108111494201	4564	41.6857	-111.8284	Well	433	260	438792	8	72	10/1/15	420

[1]North American Datum 1983
[2]Utah Division of Water Rights well identification number
[3]Depth to water below ground surface

Table 6. *Dates and times that wells were sampled by the UGS for this study.*

Station Name	Station ID	Sample ID	Sample Date
Garr Spring	414024111481101	201400737	02/28/2014 09:15
Glenridge Well	414115111490301	201400738	02/28/2014 11:15
O. Hancey Well	UT4140521114843201	201400739	02/28/2014 12:50
USU Well	414143111495501	201400740	02/28/2014 14:06
Glenridge Well	414115111490301	UTGl04170847	03/10/2014 11:15
Glenridge Well	414115111490301	UTGl04170861	03/10/2014 14:45
Glenridge Well	414115111490301	UTGl04170975	03/11/2014 18:00
Glenridge Well	414115111490301	UTGl04171329	03/15/2014 06:55
Glenridge Well	414115111490301	201401103	03/19/2014 10:35
Glenridge Well	414115111490301	UTGl04171744	03/19/2014 10:38
Glenridge Well	414115111490301	UTGl04171745	03/19/2014 10:48
Glenridge Well	414115111490301	UTGl04171940	03/21/2014 09:33
Arnold Well	UT414023111484101	UTAr04171941	03/21/2014 09:55
Glenridge Well	414115111490301	UTGl04171953	03/21/2014 12:47
Glenridge Well	414115111490301	UTGl04172240	03/24/2014 09:37
Glenridge Well	414115111490301	201401120	03/24/2014 09:37
Garr Spring	414024111481101	201405201	10/15/2014 10:30
Arnold Well	UT414023111484101	201405247	10/15/2014 14:00
USU Well	414143111495501	201405248	10/16/2014 10:00
Knoll Spring	UT4141071111483501	201405249	10/16/2014 11:00
Glenridge Well	414115111490301	201405679	11/04/2014 10:15
Garr Spring	414024111481101	201405679	11/04/2014 11:15
Arnold Well	UT414023111484101	UTAr04197738	12/04/2014 09:00
Glenridge Well	414115111490301	UTGl04197743	12/04/2014 10:25
USU Well	414143111495501	UTUS04197745	12/04/2014 10:55
USU Well	414143111495501	UTUS04202541	01/21/2015 09:45
Glenridge Well	414115111490301	UTGl04202544	01/21/2015 10:35
Arnold Well	UT414023111484101	UTAr04202548	01/21/2015 11:30
Glenridge Well	414115111490301	201501600	04/01/2015 11:08
Arnold Well	UT414023111484101	201501598	04/01/2015 12:00
USU Well	414143111495501	201501599	04/01/2015 14:25
USU Well	414143111495501	UTUS04215842	06/03/2015 10:09
Alder Well	414213111493101	201503254	06/09/2015 10:00
USU Well	414143111495501	UTUS04216444	06/09/2015 10:30
Glenridge Well	414115111490301	201504075	07/16/2015 09:45
USU Well	414143111495501	201504076	07/16/2015 10:45
Alder Well	414213111493101	201504077	07/16/2015 11:15
Arnold Well	UT414023111484101	201504078	07/16/2015 13:15
Glenridge Well	414115111490301	201504075	09/03/2015 09:48

Aquifer Storage and Recovery System Configuration

Many potential ASR sites in Cache Valley are contingent upon water availability (Thomas and others, 2011). Millville has the water necessary for injection. Garr spring discharge measurements range between 3.5 and 5 cubic feet per second (cfs) (Peterson, 1946; Beer, 1967; Mundorff, 1971), which is equivalent to between 2530 to 3620 acre-feet per year (ac-ft/yr [312-447 ha-m/yr]). In 2013, about 12% (61.6 ac-ft [7.6 ha-m/yr]) of Millville's total water use came from the Glenridge well and about 36% (191 ac-ft [24 ha-m]) came from Garr spring (Utah Division of Water Rights, 2015). Water right number 25-5171 allots 2 cfs (1449 ac-ft/yr [179 ha-m/yr]) of water to Millville from the Glenridge and Park wells (Utah Division of Water Rights, 2015). Millville has 1.139 cfs (825 ac-ft/yr [102 ha-m/yr]) in water rights from the spring extending from October 1 to March 31 (181 days). The other water right holder on Garr spring is Garr Spring Water Company (water right number 25-4528), which has 4.133 cfs (2994 ac-ft/yr [369 ha-m/yr]). Millville City owns shares in the Garr Spring Water Company.

To inject of water from Garr spring to the Glenridge well, Millville routed the water through existing pressurized culinary water lines. The Garr spring collection box is in the foothills of the Bear River Range, at a higher elevation than the Glenridge well, allowing for pressurized gravity flow. Millville operates a storage tank and chlorination building immediately west and downhill of the spring collection area. Water moving through the system, including the Garr spring water, was treated with chlorine. Before using Millville's culinary system for injection delivery, Millville's cross connection control policy was verified to ensure that water in the city's culinary lines would not contaminate the water in the aquifer.

Millville modified the configuration of the Glenridge well to accommodate their ASR program. During the first phase of the ASR project, water was gravity-fed into the well at a constant pressure through the pump column (Inkenbrandt, 2014). For the second phase, water was injected using a 2-inch (5 cm) diameter polyethylene pipe extending more than 20 ft (6 m) below the static water level (figure 12). The Glenridge well is 385 ft (117 m) deep, with a static water level of about 180 ft (55 m) below land surface (figure 12; appendix B). The 10-inch (25 cm) diameter casing of the well houses a 4-inch (10 cm) diameter pumping column in addition to the injection pipe. In-line volumetric totalizers (discharge meters) on both the injection line and the pumping line were used to measure volumes of water injected and pumped, as well as the rates of pumping and injection (figure 13).

Phase I

Preinjection: Before injection began, I sampled wells and springs to determine geochemical background conditions of the principal aquifer and to use later for mixing calculations. I sampled three wells (Glenridge, Hancey, and USU) and Garr spring (figure 2; table 5) for nitrate, and Glenridge and USU wells and Garr Spring for stable oxygen and hydrogen isotopes in water, arsenic, metals, and general chemistry. The Utah State University Water Laboratory conducted a preliminary analysis on a water sample from the Glenridge well for caffeine and a suite of other chemicals commonly sourced from septic tanks. The presence of these chemicals could indicate septic tank contribution. Prior to conducting the injection test, I was required by the Utah Department of Environmental Quality to sample for a wide variety of constituents (table 2). Prior to the project, Gary Larsen (Millville City public works director) collected nitrate data from several sites over several years. The Chemical and Environmental Laboratory of the Utah Public Health Laboratory analyzed samples collected by the Utah Geological Survey, except for stable isotopes which were analyzed at the Utah State University (USU) Geology Department Isotope Lab and the University of Utah SIRFER Laboratory. Samples collected by Gary Larsen (Millville) were analyzed by Ecosystems Research Institute.

Stable isotopes of nitrogen and oxygen in nitrate can be used to narrow down potential sources of nitrate in groundwater. Different sources plot in different regions on a graph of the ratios of oxygen and nitrogen isotopes, with some overlap (Clark and Fritz, 1997). The locations of the samples on the graph give some indication as to the source of nitrate. If the samples fall into the overlap areas, the source is mixed or ambiguous (Clark and Fritz, 1997). Waterloo Laboratory analyzed a water sample from the Glenridge well for nitrogen and oxygen isotope ratios in nitrate to determine a possible nitrate source.

I also used stable isotopes of oxygen and hydrogen in water, as well as nitrate concentrations, to determine the "make-up" of the post-injection water extracted from the Glenridge well. Based on ratios of source-water concentrations to pumped-

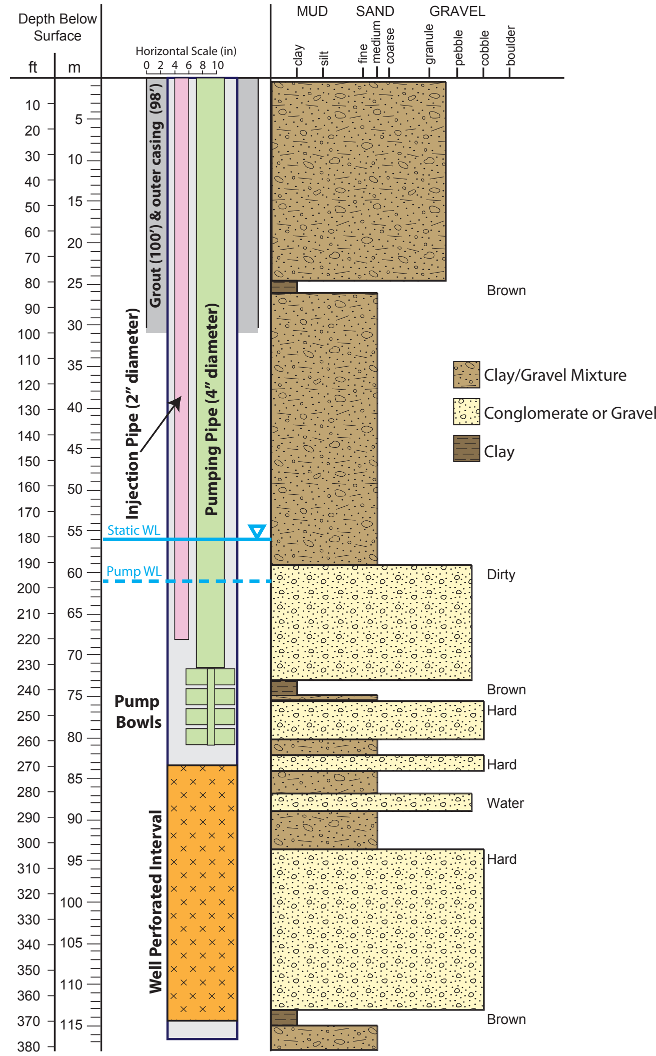

Figure 12. *Scale drawing and lithologic record of Glenridge well. Construction data and lithology from appendix B.*

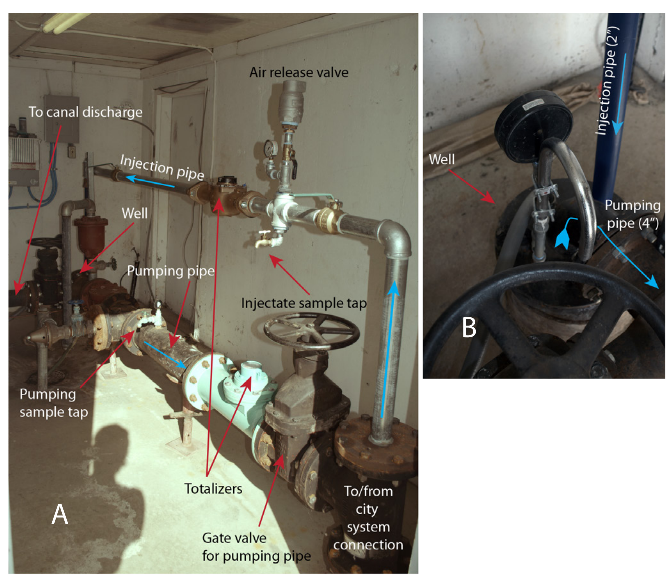

Figure 13. *Configuration of the Glenridge well house for Millville's ASR program. A) View of inside of Glenridge well house. Connection to Millville's culinary system is in foreground and the well is in the background. B) Close-up view of well head.*

water concentrations, assuming nitrate and stable isotopes are conservative, I determined the percentage of pumped water that is original to the Cache Valley principal aquifer (host water) relative to the amount of water pumped.

I created a nitrate concentration map to determine the extent and orientation of the nitrate plume. I used Empirical Bayesian Kriging, a geostatistical interpolation method used to generate localized geostatistical models that approximate spatial variation in a variable (ESRI, 2015), and the most recent nitrate values as input for the interpolation of concentrations for the nitrate map.

Injection: Phase I injection began at 10:45 a.m. on March 10, 2014, and continued until March 17, 2014, at 10:51 (table 7) at a mean rate of 476 gallons per minute (gpm) (1800 L/min). I measured the injection rate and volume using an in-pipe volume meter. The meter requires the pipe to be full to be accurate, which was the case during the injection test. Millville injected a total of 4,987,000 gallons (15.3 ac-ft [1.9 ha-m]) of Garr Spring water into the Glenridge well over a period of 7 days (table 7).

Pumping: After injection was complete, the pump was placed back into the well with the pump intake at 231 feet (70 m) below ground surface. Pumping began at 9:15 a.m. on March 19, 2014, and continued until March 24, 2014, at 10:56 a.m. at a mean rate of 290 gpm (18 liters per second [L/sec]). I measured the pumping rate and volume using the same flowmeter used for injection. Millville pumped a total of 2,117,000 gallons (6.5 ac-ft; 0.8 ha-m) from Glenridge well over a period of 5 days (table 7). The well sat idle until May 5, 2014, when the pump was turned on to purge and sample the well. The well pump was turned on for extended municipal use on July 1, 2014 (table 7).

Table 7. *Injection and pumping rates for the Glenridge well.*

Phase	Date-time	Avg Rate (gpm)	Total Water Injected (ac-ft)	Total Water Pumped (ac-ft)	Volume Pumped / Volume Injected	Percent Garr of Water	Percent GR Water	Volume of Injectate Recovered (gal)	Volume of Host Pumped (gal)	Cumulative Volume of Injectate Recovered (ac-ft)	Cumulative Volume of Host Recovered (ac-ft)	Ratio of Host to Injectate	Percent Recovered	Operation Stage
1	2/28/14 11:15		0.00	0.00										off
1	3/10/14 10:51	0	0.00	0.00				0		0.00	0			Injection
1	3/10/14 11:02	411	0.01	-0.01				0		-0.01	0			Injection
1	3/11/14 11:43	496	2.27	-2.27				0		-2.27	0			Injection
1	3/15/14 10:30	495	10.92	-10.92				0		-10.92	0			Injection
1	3/17/14 10:51	429	15.31	-15.31				0		-15.31	0			Injection
1	3/17/14 10:51		0.00	0.00						0.00	0			Storage
1	3/19/14 9:15	0	0.00	0.00				0		0.00	0.00			Storage
1	3/19/14 10:18	0	0.00	0.00				0		0.00	0.00			Pumping
1	3/19/14 10:24	-293	-0.01	0.01	0.0%	99.0%	1.0%	1935	20	0.01	0.00	0.01	0%	Pumping
1	3/20/14 9:16	-294	-1.24	1.24	8.1%	93.3%	6.7%	176490	12731	1.18	0.06	0.05	8%	Pumping
1	3/22/14 7:46	-293	-3.74	3.74	24.5%	81.7%	18.3%	80	18	3.32	0.42	0.13	22%	Pumping
1	3/24/14 10:56	-48	-6.50	6.50	42.5%	68.9%	31.1%	90	40	5.22	1.27	0.24	34%	Pumping
1	3/24/14 10:56		-6.50	6.50	42.5%	68.9%	31.1%			0.00	0.00	0.00	34%	Storage
1	6/30/14 14:30		-9.63	9.63	62.9%	17.5%	82.5%	175	825	0.00	0.00	4.71	34%	Pumping
1	7/10/14 14:20		-11.34	11.34	74.1%	17.0%	83.0%	94491	461509	0.29	1.42	4.88	36%	Pumping
1	7/28/14 9:00		-26.39	26.39	172.4%	12.3%	87.7%	604127	4302873	2.14	14.62	6.82	48%	Pumping
1	9/30/14 0:00	0	-43.08	43.08	281.5%	7.1%	92.9%	387264	5050606	3.33	30.12	9.04	56%	Pumping
1	9/30/14 0:00		0.00	0.00	0.0%	0.0%	100.0%	0	0	0.00	0.00	0.00	0%	Storage
2	11/4/14 11:16	0	0.00	0.00				0	0	0.00	0.00			Injection
2	1/21/15 10:35	158	54.58	-54.58				-17785600	0	-54.58	0.00			Injection
2	4/1/15 9:56	163	104.84	-104.84				-16375200	0	-104.84	0.00			Injection
2	4/1/15 10:47	0	0.00	0.00				0	0	0.00	0.00			Storage
2	5/20/15 10:45	0	-0.04	0.04	0.0%			0	1000	0.00	0.04			Storage
2	6/10/15 11:20	0	-0.05	0.05	0.0%			0	2000	0.00	0.00			Storage
2	6/25/15 9:00	0	-0.05	0.05	0.0%	64.4%	35.6%	644	356	0.00	0.00		0%	Pumping
2	6/29/15 15:00	-161	-2.84	2.84	2.7%	62.4%	37.6%	192958	116042	1.76	1.03	0.58	2%	Pumping
2	7/2/15 7:30	-141	-4.52	4.52	4.3%	61.3%	38.7%	334471	211529	2.79	1.68	0.60	3%	Pumping
2	8/3/15 8:00	-177	-26.39	26.39	25.2%	45.8%	54.2%	571991	678009	14.27	12.06	0.85	14%	Pumping
2	9/2/15 14:30	-189	-46.93	46.93	44.8%	31.2%	68.8%	443006	976994	22.00	24.88	1.13	21%	Pumping
2	9/14/15 9:30	-137	-53.51	53.51	51.0%	26.5%	73.5%	314219	869781	23.82	29.64	1.24	23%	Pumping
2	9/25/15 8:30	-80	-57.57	57.57	54.9%	23.7%	76.3%	54179	174821	24.83	32.69	1.32	24%	Pumping
2	9/28/15 8:00	-78	-58.59	58.59	55.9%	22.9%	77.1%	76373	256627	25.06	33.48	1.34	24%	Pumping
2	9/29/15 11:00	-101	-59.09	59.09	56.4%	22.6%	77.4%	36806	126194	25.18	33.87	1.35	24%	off

Phase II

Preinjection: On October 15 and 16, 2014, the Glenridge well, Garr spring, the Arnold well, and the USU well were sampled to determine baseline conditions of the system prior to injection and storage. Analysis included major ion general chemistry and nutrients (appendix A). Glenridge well and Garr spring were also sampled for a variety of other constituents whose concentrations were required by State regulatory guidelines (table 2). The Vail well, Matthews well, and Knowles spring were also monitored for nutrients (ammonia, nitrate plus nitrate, and phosphorous). Stable isotope samples were collected and field parameters (specific conductance, temperature, pH, dissolved oxygen, oxidation-reduction potential) were measured at all sites. I sampled Knowles spring and the Glenridge well for chemicals associated with personal care products and prescriptions, which are commonly associated with septic system effluents.

Groundwater levels for the Arnold well, the USU well, and the Glenridge well were recorded in advance of injection. Non-vented submersible pressure transducers were installed in the Glenridge well, the Arnold well, and the USU well and set to measure pressure and temperature every 20 minutes for the duration of the ASR project. The transducer in the Arnold well also measured specific conductance.

Injection: Injection for phase II began on November 4, 2014, at 11:16 a.m. Millville injected treated Garr spring water into the principal aquifer via the Glenridge well through the 2-inch diameter injection pipe at a constant rate of about 160 gpm (10 L/sec) until April 1, 2015, at 9:56 a.m. A total of 104.8 ac-ft (12.9 ha-m) were injected over a period of 147.95 days (213,040 min). During that time, the USU well was sampled on January 1, 2015, for nutrients. At the end of injection, the USU well, Glenridge well, and the Arnold well were all sampled for general chemistry and nutrients (appendix A), as well as field parameters and stable isotopes.

Storage: The injectate was allowed to remain in storage in the principal aquifer from April 1, 2015, to June 25, 2015, at 9:00 a.m. Millville City pumped the Glenridge well on multiple occurrences over the course of the storage interval, but the pumping duration of each instance was only long enough to purge and sample the well for nitrate plus nitrite. I sampled the USU well for general chemistry, nutrients, and metals, as well as stable isotopes on June 9, 2015, and Gary Larsen collected a sample from the Matthews well for nitrate.

During the storage period, Providence City contacted Millville City regarding elevated nitrate recorded in their Alder well. While this well was originally not part of the sample regime for this project, it was immediately included as a sample site and sampled for major ions, metals, and nutrients on June 9, 2015.

Pumping: On June 25, 2015, at 9:00 a.m., Millville turned on the pump to the Glenridge well. The well was pumped at regular 4–6 hour cycles until September 29, 2015, at 11:00 a.m. The well pumped 59.09 ac-ft (69 ha-m) of water at a rate of about 280 gpm (18 L/sec). The total (non-continuous) pumping time was about 48 days. On July 16, 2015, the Glenridge well, the USU well, the Alder well, and the Arnold well were all sampled for major ions, nutrients and metals to determine post-storage end-member chemistry of the system.

Models

For this study, I used geochemical modeling and digital flow modeling to determine the behavior of the injectate in the principal aquifer system. Aquifer test modeling and simple forward modeling were conducted using AQTESOLV (Duffield, 2007). A preexisting MODFLOW (Harbaugh, 2005) model created for Cache Valley (Kariya and others, 1994) was adapted for the physical modeling. Water quality results from sampling were used in PHREEQC (Parkhurst and Appelo, 2013) software to conduct the geochemical modeling.

AQTESOLV

Aquifer test analyses: I used AQTESOLV (Duffield, 2007) computer software to determine aquifer transmissivity from test data collected during the pumping period. I did not analyze the injection data. I applied a Theis (1935) / Hantush (1961) solution for a confined aquifer. Variation in the groundwater level data prevented a more precise analysis and model of the drawdown and recovery curves. I applied alternate solutions that produced results within an order of magnitude of the Theis (1935) / Hantush (1961) approximation.

Injection model: I used AQTESOLV (Duffield, 2007) to determine maximum potentiometric surface changes due to injection. Using the parameters determined from aquifer test analyses conducted during this study, the groundwater level map, and geologic cross sections, I modeled the magnitude of potentiometric changes in the aquifer that various rates of injection would induce. For injection, I assumed that Millville would inject water into the aquifer system at 300 gpm (19 L/sec) for 181 days per year for a total of 240 ac-ft/ yr (29.6 ha-m/yr), and then pump out about 60 ac-ft (7.4 ha-m) of that water during June, July, August, and September of each year. This model included pumping influence from wells operated by Providence (figure 1).

MODFLOW

MODFLOW (Harbaugh, 2005) is a three-dimensional finite-difference groundwater modeling software. To conduct the MODFLOW analysis, I adapted an existing model by the U.S. Geological Survey (Kariya and others, 1994).

While some argue that this model inadequately represents the complex aquifer system in Cache Valley (Robinson, 1999; Myers, 2003; Olsen, 2007), it is functional and adaptable for use with the modeling software available at the UGS. Other models (Clyde and others, 1984; Myers, 2003) show similar hydraulic head, porosity, and horizontal hydraulic conductivity in the Millville area to the model applied. Note that a newer and improved model was available (Myers, 2003) at the time that this report was written, but it was not compatible with the modeling interface used at the UGS. Myers (2003) noted several limitations associated with the model used for this study (Kariya and others, 1994), most of which involve water balances and aquifer confinement, which should be considered when reviewing the results of this report.

I densified the grid of the transient MODFLOW model (Kariya and others, 1994) in the Millville area to increase the resolution of results. I also added wells in the Millville and Providence areas, including Millville's Glenridge well and the municipal wells in Providence (figure 2). I modified the modeled time intervals and number of stress periods to match the different stages of the ASR test. I used reported pumping values and water rights information (Utah Division of Water Rights, 2015) to set the pumping rates and intervals of the added wells.

After the modified MODFLOW (Harbaugh, 2005) model processed the updated grid and wells, I ran MODPATH (Pollock, 2012) and MT3DMS (Zheng, 2010) models to determine the flow paths and diffusion of injectate, respectively, under the conditions of the Millville ASR test. For the MODPATH model, I generated a dense network of particles in the vicinity of Millville and forward-traced their paths to see where a particle in the groundwater of the principal aquifer would travel over time. For the MT3DMS model, I used the Source/Sink Mixing Package to simulate mass loading of an arbitrary concentration (1000 mg/L) of a chemical species at the screen depth and location of the Glenridge well. This mass loading source was used to simulate the injectate bubble and determine how it dissipates over time and space. The concentration of 1000 mg/L provides contrast with the native aquifer water and for rapid assessment of dissolution in the aquifer.

I also used MT3DMS to model the transport of high-nitrate water from sources in Millville to visualize dissipation and travel direction of the contaminant over time. I selected areas thought to be the centroid of septic tank nitrate contributions, based on septic tank density distribution (figure 14), and treated the points as mass loading sources in the top layer of the model.

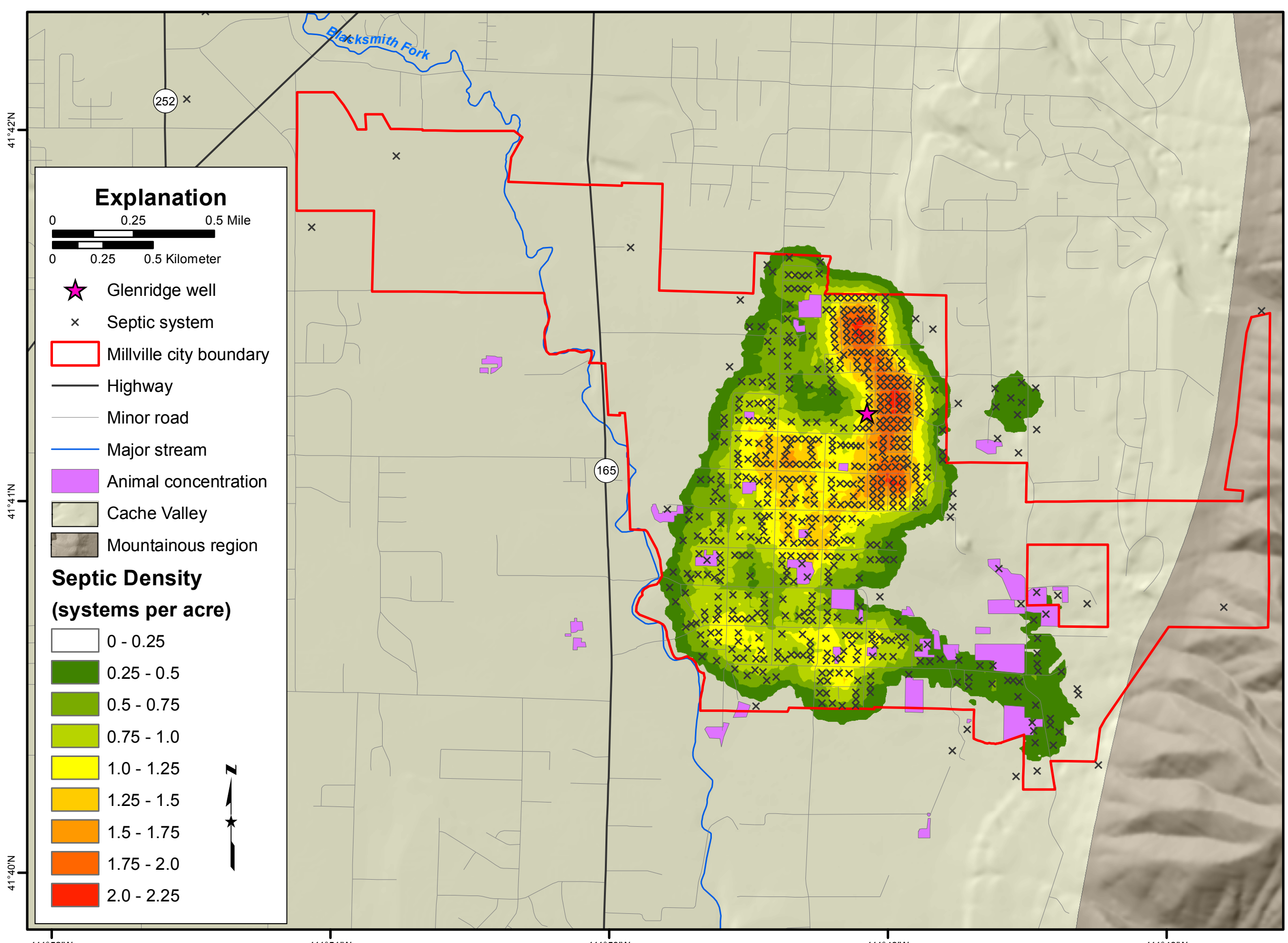

Figure 14. *Septic tank locations, septic tank density, and locations of animal concentrations.*

Drinking Water Source Protection Zones

I reevaluated the drinking water source protection (DWSP) zones based on recalculated aquifer properties and the presence of the East Cache fault. Using the particle tracking option in MODPATH (Pollock, 2012) and the USGS MODFLOW (Harbaugh, 2005) model (Kariya and others, 1994), I traced particles from the Glenridge well backward in time to determine a capture zone. The capture zone extends to the east edge of the model, which is noted by Kariya and others (1994) as being an area of greater uncertainty. Because of the limitations of the model, the eastward extent of the capture zone is limited to the East Cache fault. However, it should be noted that cross-fault flow is possible, as hypothesized by previous investigators (Bjorklund and McGreevy, 1971; Robinson, 1999; Myers, 2003; Olsen, 2007).

GIS Particle Tracking

I modeled and calculated groundwater and particle flow in the principal aquifer over the duration of the test to determine the fate and dispersion of the injectate over time. Groundwater tools in ArcGIS (ESRI, 2015) were used to model dispersive advective flow in the principal aquifer. Using the parameter estimates of transmissivity and steady state potentiometric surface from the Kariya and others (1994) MODFLOW model of the valley, I determined the Darcy velocity of groundwater in the vicinity of the Glenridge well. I assumed an effective porosity of 0.3 and a uniform saturated thickness of 100 feet (30.5 m), based on the open screen interval of the Glenridge well. The saturated thickness is supported by thicknesses determined from cross-section measurements (Robinson, 1999; Inkenbrandt, 2014). My models produced similar results to the model produced by Kariya and others (1994).

PHREEQC

PHREEQC (Parkhurst and Appelo, 2013) is freeware produced by the USGS to model aqueous geochemistry. I used PHREEQC to model the potential for mobilizing metals in the aquifer and the effects of mixing injectate with host water. I created an input file that mixed the host and injectate at different ratios. To model mixing, I used analysis results from samples collected from Garr spring and Glenridge well on October 15, 2014.

I also created an inverse model in PHREEQC, which uses end-member (starting and ending) water chemistries and assumed aquifer mineral phases to determine the possible reactions that occurred to lead to a specific water chemistry. For the initial water, I input Garr Spring and Glenridge well water collected on October 15, 2014. For the final water, I used Glenridge well water collected on July 16, 2015. For the reactive mineral phases, I chose common carbonate and sulfite minerals, as well as nutrient phases, that would be possible for basin-fill material. The script used to run the PHREEQC model can be found in appendix C.

Calculating Volumes

As in Phase I of Millville's ASR program, nitrate was used as a conservative tracer (Inkenbrandt, 2014). In Phase I, nitrate values produced mixing ratios that matched mixing ratios produced using stable oxygen and hydrogen isotopes of water (Inkenbrandt, 2014). To calculate the percentage of host water in a sample, I used the following equation:

$$V_h = 1 - \frac{(H_i - I_0)}{(H_o - I_0)} \tag{1}$$

where:

V_h = percent injectate

H_i = host tracer concentration at time i

H_o = host tracer concentration immediately prior to injection

I_0 = injectate tracer concentration immediately prior to injection

The above equation treats nitrate as a conservative tracer, which assumes that there is no loss or gain of nitrate due to chemical reactions, and does not account for contribution of additional nitrate from septic systems during the time of the test.

Using the resulting mixing percentages, I calculated the ratio between the volume of water pumped and the total volume of water injected. I then linearly interpolated the percentages calculated from equation 1 using that ratio as the determinant variable ($m = -0.7430$, $b = 0.6446$). I used the linear relationship to interpolate injectate returned over time, which I then discretized to calculate the total volume of injectate water recovered over the duration of the tests.

RESULTS AND DISCUSSION

Groundwater Chemistry

The various water samples have very similar concentrations of major ions. The injectate water from Garr spring is very similar to the host water from Glenridge well. Both are calcium-magnesium-bicarbonate water types, plotting very near each other on a rectangular Piper diagram (figure 15). A sample collected from the Glenridge well in 1989 by the USGS had major ion chemistry that was more similar to the post injection Glenridge water (with some injectate still remaining) than the pre-injection Glenridge water (figure 16). A greater similarity between the 1989 host sample and the modern injectate than modern host water containing injectate could signify changes in the host water chemistry over time, but more than

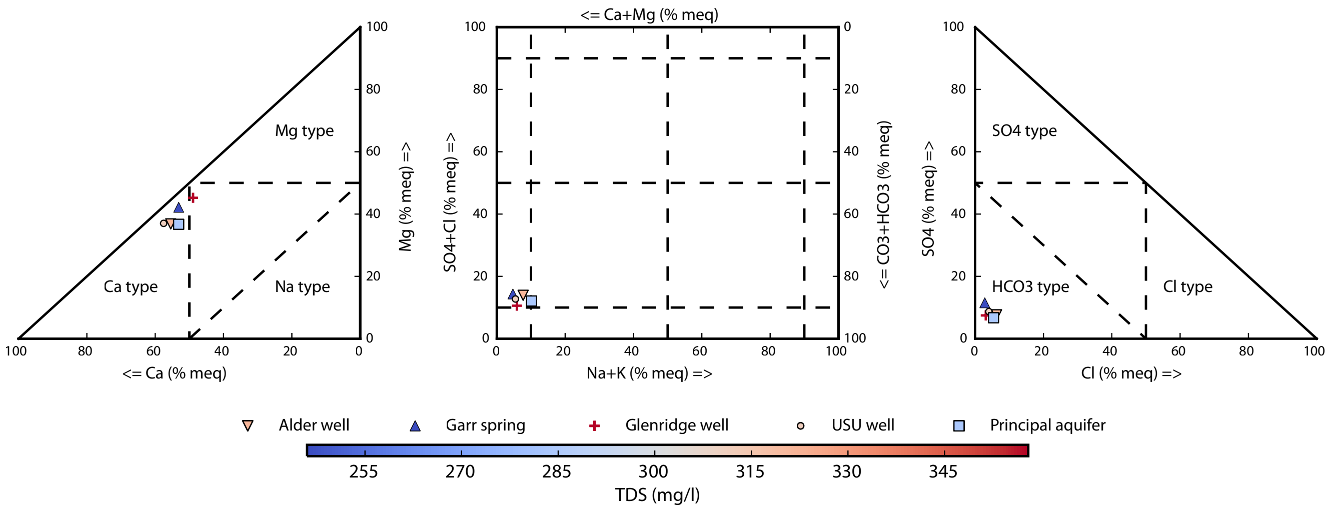

Figure 15. Rectangular piper diagram (Ranjan Kumar Ray, 2008) of important water chemistries in the Millville area.

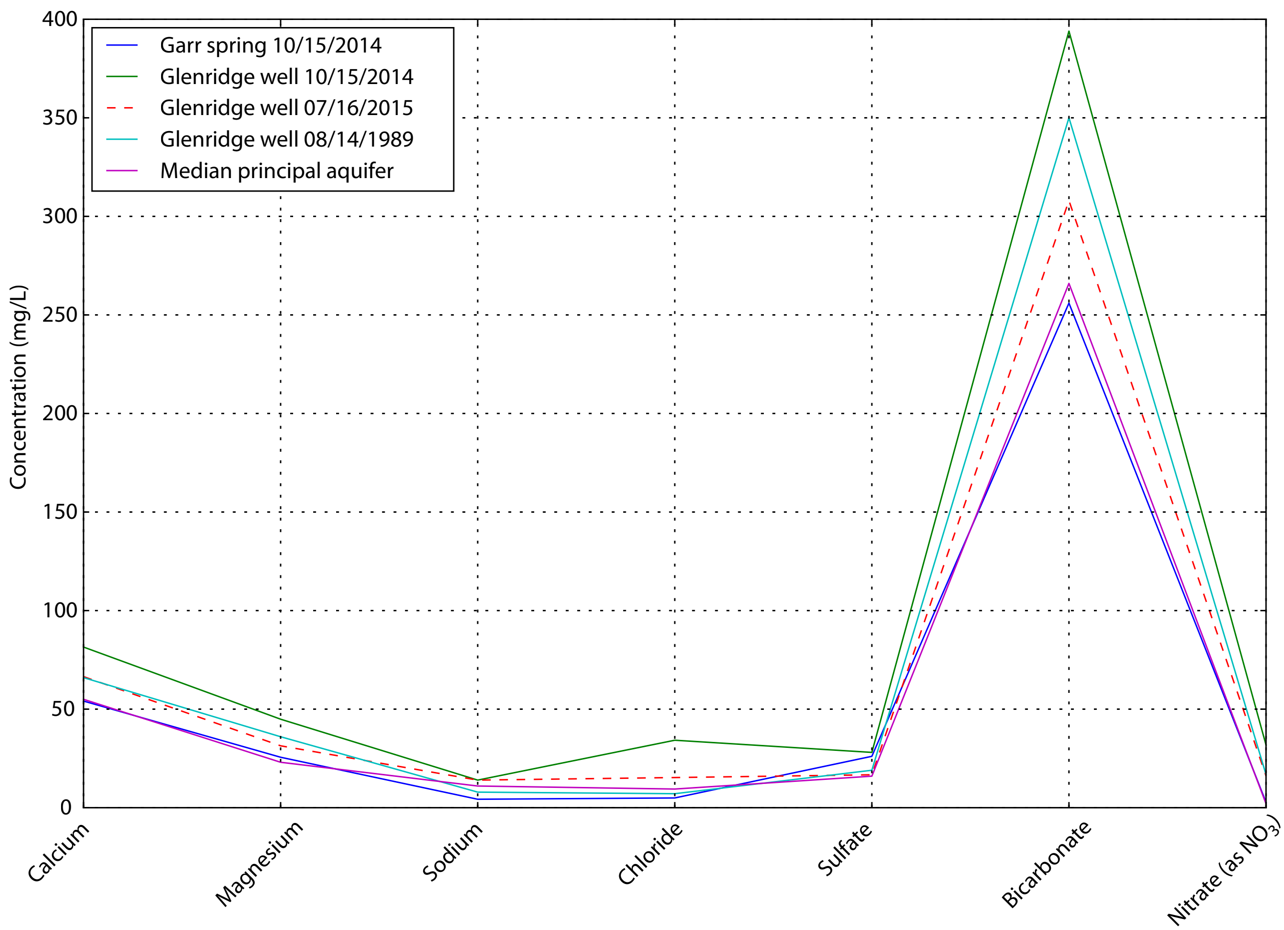

Figure 16. *Schoeller plot of major ion concentrations in Glenridge well and Garr spring water.*

likely signifies that variation in the chemistry of the three water sources is within natural variation and analytical error.

Statistics for various constituents found in principal aquifer water are in table 8. Statistics calculated for the principal aquifer include all samples prior to March of 2014, meaning that samples collected for this study were intentionally excluded from the principal aquifer statistics. Recent samples of the Glenridge and Alder wells are significantly different than ranges determined for the principal aquifer (figure 17). The two wells have calcium, magnesium, and nitrate concentrations that are higher than the 95-percentile for the principal

Table 8. *Summary statistics of chemistry of the Cache Valley principal acquifer. These statistics do not account for non-detects.*

Parameter	Units	n	Range	Std. Dev.	Max.	95%-tile	75%-tile	50%-tile	Mean	25%-tile	5%-tile	Min.
Arsenic	mg/L	122	0.0235	0.0041	0.0235	0.0100	0.0017	0.0006	0.0021	0.0	0.0	0.0
Boron	mg/L	70	0.8000	0.1225	0.8000	0.2078	0.1038	0.0400	0.0822	0.0200	0.0001	0.00
Barium	mg/L	33	0.27	0.08	0.27	0.19	0.13	0.05	0.07	0.00	0.00	0.00
Bromide	mg/L	37	0.06	0.01	0.07	0.06	0.02	0.02	0.02	0.02	0.01	0.01
Carbon Dioxide	mg/L	180	234	48	234	190	18	9	25	5	2	0
Carbonate	mg/L	58	12	1.95	12.00	2.30	1.00	0.00	0.71	0.00	0.00	0.00
Calcium	mg/L	214	202	19	225	82	66	55	57	46	37	23
Chloride	mg/L	214	475	66	475	51	16	9	26	7	4	0
Spec. Cond.	µS/cm	190	1430	197	1710	744	561	496	542	451	382	280
Hex. Chromium	mg/L	66	0.006	0.002	0.006	0.005	0.003	0.0	0.001	0.0	0.0	0.0
Chromium	mg/L	95	0.030	0.005	0.030	0.013	0.001	0.0	0.002	0.0	0.0	0.0
Dissolved Copper	mg/L	64	0.47	0.060	0.470	0.059	0.001	0.0	0.014	0.0	0.0	0.0
Total Copper	mg/L	36	1.0	0.183	1.000	0.176	0.020	0.004	0.051	0.0	0.0	0.0
Floride	mg/L	192	0.90	0.113	0.900	0.400	0.220	0.150	0.176	0.100	0.047	0.0
Iron	mg/L	147	3.0	0.482	3.000	0.982	0.161	0.030	0.210	0.007	0.0	0.0
Bicarbonate	mg/L	161	395	59	561	380	307	266	281	245	202	166
Potassium	mg/L	185	16.2	2.3	16.2	7.2	2.7	1.8	2.4	1.0	0.3	0.0
Alkalinity	mg/L	110	355	52	355	312	253	235	235	208	174	0
Hardness	mg/L	208	810	136	810	335	257	200	161	0	0	0
Magnesium	mg/L	214	56.07	7	65	38	28	23	25	21	17	9
Manganese	mg/L	73	0.22	0.05	0.22	0.15	0.06	0.01	0.03	0.0002	0.0	0.0
Molybdinum	mg/L	35	0.0097	0.0022	0.0100	0.0045	0.0008	0.0007	0.0012	0.0005	0.0004	0.0003
Nitrogen	mg/L	117	5.78	1.29	5.78	4.21	1.70	0.80	1.24	0.36	0.13	0.0
Ammonium	mg/L	67	2.82	0.36	2.82	0.48	0.005	0.0	0.10	0.0	0.0	0.0
Nitrite	mg/L	70	13.8	1.68	13.80	1.44	0.0	0.0	0.33	0.0	0.0	0.0
Nitrate	mg/L	154	33.65	6.1	33.6	17.7	4.7	2.0	4.4	0.5	0.1	0.0
Sodium	mg/L	219	203	28	204	52	24	11	20	7	4	1
Phosphate	mg/L	127	2.34	0.25	2.34	0.20	0.06	0.03	0.09	0.0	0.0	0.0
Lead	mg/L	105	0.020	0.0040	0.0200	0.0094	0.0004	0.0000	0.0016	0.0	0.0	0.0
Sulfate	mg/L	214	223	21	223	56	24	16	21	11	2	0.0
Selenium	mg/L	108	0.0018	0.00044	0.00181	0.00130	0.00031	0.00000	0.00025	0.0	0.0	0.0
Silica	mg/L	196	56.4	9.0	60.0	33.0	14.0	11.0	14.1	9.0	7.0	3.6
TDS	mg/L	197	1024	121	1180	450	325	284	308	254	201	156
Temperature	mg/L	102	19.8	3.6	27.8	20.9	14.9	12.7	13.6	11.1	10.0	8.0
Zinc	mg/L	115	1.08	0.18	1.08	0.29	0.024	0.010	0.062	0.0	0.0	0.0
Field pH	mg/L	176	3.70	0.39	8.50	8.20	7.90	7.65	7.63	7.40	7.10	4.80
Lab. pH	mg/L	79	1.60	0.27	8.80	8.30	7.80	7.70	7.75	7.60	7.40	7.20

aquifer. Samples from Garr spring all fall within the upper and lower quartiles of principal aquifer statistics for calcium, magnesium, potassium, bicarbonate, and nitrate, and were between the 5th and 95th percentiles for all major ions (figure 17). The biggest deviances for Garr spring from principal aquifer water was sodium and chloride—Garr spring has less sodium and chloride than the typical principal aquifer sample.

Geochemical Modeling

PHREEQC (Parkhurst and Appelo, 2013) modeling shows what type of water will result from a mix of host and injectate waters and how that mix will interact with the aquifer. Introduction of the injectate into the host water tends to decrease the saturation of metals and increase the saturation of calcium carbonate. Inverse models suggest that to produce the water sampled on July 16, 2015, from the Glenridge well, galena and sphalerite (lead and zinc sulphide minerals) would have to be dissolved, and ammonia, oxygen, halite, and gypsum would have to be precipitated (table 9). Dissolution of sulfides suggests that the water is oxidizing. While the observed increase in lead concentration was comparable to the range of potential measurement error, the observed increase of zinc concentration was significant. However, iron, arsenic, and manganese levels did not increase to detectible/measurable concentration between samples (appendix C).

Nitrate Contamination

Nitrate distribution in wells (figure 18; table 10; appendix A) indicates that an extensive nitrate plume covers most of the central part of Millville. The contamination extends in both the unconfined and confined aquifers in the principal aquifer system, as observed by measured values of nitrate in both springs and deeper wells.

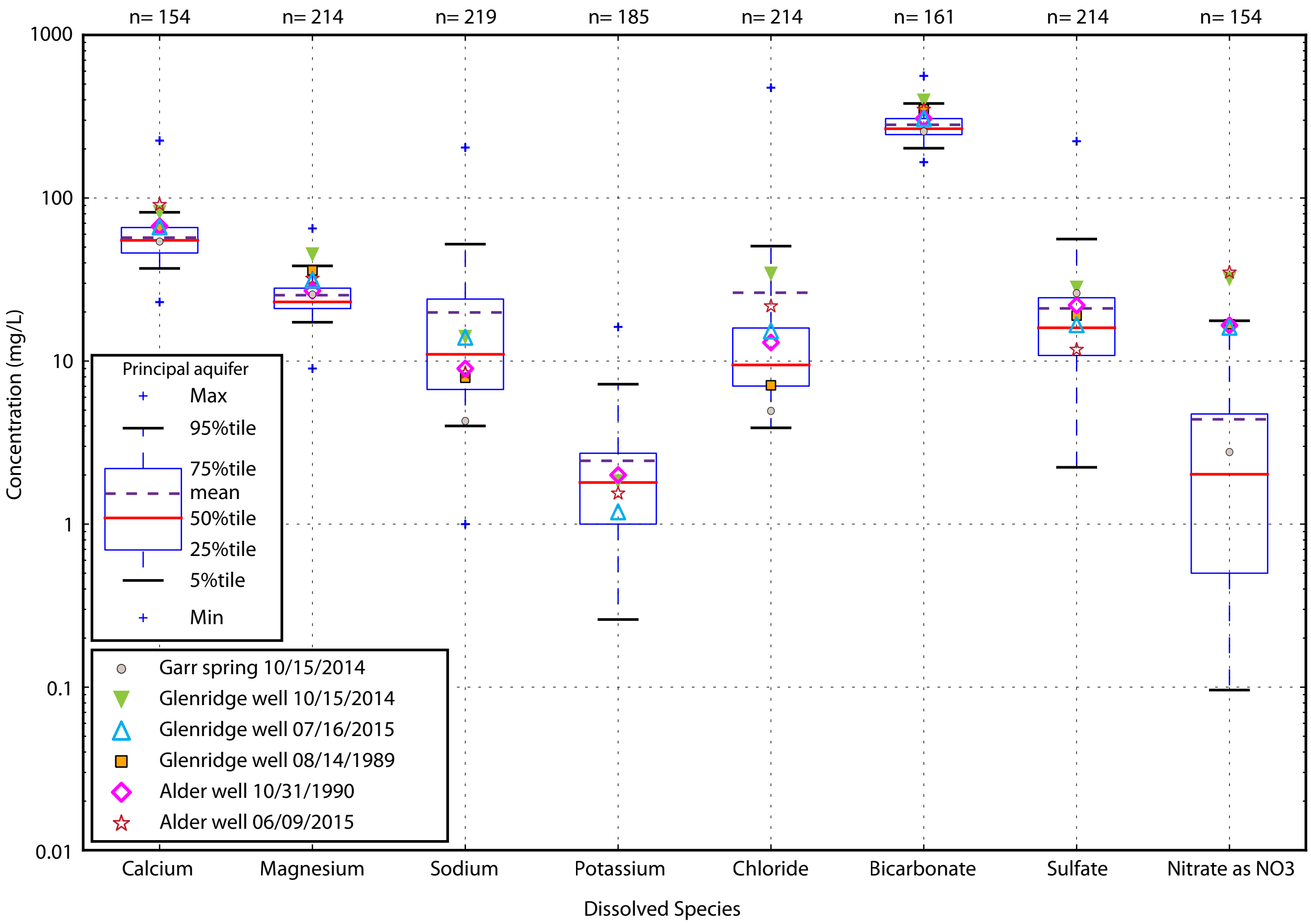

Figure 17. *Box and whisker plot showing the distributions of major ion concentrations in Glenridge well, Alder well, and Garr spring water as compared to the principal aquifer.*

Table 9. *Results of PHREEQ Modeling.*

	Glenridge 10/15/2014			Garr 10/15/2014			Glenridge 7/16/2015		
	Input	Delta	Total	Input	Delta	Total	Input	Delta	Total
Alkalinity	6.5E-03	-1.9E-04	6.3E-03	4.2E-03		4.2E-03	5.1E-03	2.5E-04	5.3E-03
As(5)	6.7E-09		6.7E-09	6.7E-09		6.7E-09	6.7E-09		6.7E-09
Ca	2.0E-03		2.0E-03	1.4E-03	-3.0E-05	1.3E-03	1.7E-03	-8.3E-05	1.6E-03
Cl	9.7E-04		9.7E-04	1.4E-04		1.4E-04	4.3E-04		4.3E-04
K	4.7E-05		4.7E-05	1.3E-05		1.3E-05	3.0E-05		3.0E-05
Mg	1.8E-03	-4.7E-05	1.8E-03	1.1E-03	-1.2E-05	1.0E-03	1.3E-03	-1.6E-05	1.3E-03
N(-3)	1.6E-06		1.6E-06	1.6E-06		1.6E-06	9.2E-07		9.2E-07
N(5)	5.1E-04		5.1E-04	4.5E-05		4.5E-05	2.6E-04		2.6E-04
Na	6.1E-04		6.1E-04	1.9E-04		1.9E-04	6.1E-04		6.1E-04
O(0)	0.0E+00		0.0E+00	2.9E-04		2.9E-04	2.4E-04		2.4E-04
Pb	1.3E-08		1.3E-08	4.8E-10		4.8E-10	1.8E-08		1.8E-08
S(-2)	0.0E+00		0.0E+00	0.0E+00		0.0E+00	0.0E+00		0.0E+00
S(6)	2.9E-04		2.9E-04	2.7E-04		2.7E-04	1.7E-04		1.7E-04
Zn	4.1E-07		4.1E-07	7.7E-08		7.7E-08	2.1E-06		2.1E-06

Solution fractions

Glenridge	51%
Garr	49%

Phase mole transfers

Gypsum	$CaSO_4:2H_2O$	-1.1E-04	Precipitation
NH_4X	NH_4X	-2.6E-05	Precipitation
Halite	NaCl	-1.3E-04	Precipitation
MgX_2	MgX_2	-1.6E-04	Precipitation
NaX	NaX	3.4E-04	Dissolution
Galena	PbS	1.1E-08	Dissolution
Sphalerite	ZnS	1.9E-06	Dissolution

Redox mole transfers

Ammonia	-2.5E-05	Precipitation
Dissolved Oxygen	-9.4E-05	Precipitation
Sulfide	1.9E-06	Dissolution

Table 10. *Data used to make the nitrate map in figure 18.*

Map ID	Org. ID[1]	Nitrate-N (mg/L)	Sample Date	Station ID	Depth (ft)	Elev. (ft)	Latitude	Longitude	Station Name	WIN[2]
536	MVC	0.7	6/20/12	414018111483001		4740	41.6716	-111.8082	Postma Well	
539	MVC	3.5	6/20/12	414042111483501		4763	41.6786	-111.8084	Hancey Well	
542	MVC	7.2	4/2/15	414052111484301		4800	41.6811	-111.8091	O. Hancey Well	32975
543	MVC	5.4	6/20/09	414055111490101		4683	41.6819	-111.8170	Cox Well	
553	MVC	7.2	8/27/15	414125111491601		4640	41.6903	-111.8217	Matthews Well	
9	UDAF	1.5	9/6/00	UDAF-01489		4555	41.6732	-111.8382		
7	UDAF	0.9	10/10/00	UDAF-01494		4544	41.6757	-111.8456		
10	UDAF	2.0	8/1/02	UDAF-01501		4514	41.6747	-111.8617		
6	UDAF	0.8	8/1/02	UDAF-01503		4662	41.6458	-111.8168		
8	UDAF	1.2	9/6/00	UDAF-01511		4554	41.6736	-111.8370		
3	UDAF	0.5	9/6/00	UDAF-01569		4465	41.7336	-111.8553		28327
11	UDAF	3.8	6/27/01	UDAF-01572		4473	41.7236	-111.8574		
5	UDAF	0.8	9/6/00	UDAF-02823		4434	41.7192	-111.8853		
13	UDAF	0.9	9/13/06	UDAF-03162		4456	41.7279	-111.8602		434818
12	UDAF	0.8	9/13/06	UGS-106.5		4465	41.6931	-111.8734		
230	UDDW	0.5	8/18/14	SDWIS3088.0WS004		4604	41.6586	-111.8315	4000 S Main Well	2741
361	UDDW	0.4	8/18/14	SDWIS3090.0WS006		4585	41.6654	-111.8392	Nelson Well	
222	UDDW	0.5	11/12/14	SDWIS3110.0WS003		4541	41.7306	-111.8289	200 E Center Well	
333	UDDW	0.5	11/12/14	SDWIS3112.0WS005		4487	41.7197	-111.8486	Willow Park	2694
271	UDDW	3.0	5/6/99	SDWIS3128.0WS004		4657	41.7005	-111.8176	400 S Well	18590
112	UDDW	2.0	12/13/05	SDWIS3132.0WS002		4593	41.7247	-111.8205	RH Upper Well	
228	UDDW	2.3	8/5/14	SDWIS3133.0WS004		4589	41.7233	-111.8178	RH Well	2848
60	UDDW	1.3	6/23/81	SDWIS3143.0WS001		4481	41.7030	-111.8495	Zollinger Warehouse	
46	UDDW	3.0	11/30/98	SDWIS3146.0WS001		4483	41.7018	-111.8548	Buttars Tractor	
220	UDDW	0.8	7/28/14	414029111483501		4711	41.6753	-111.8093	Park Well	2721
132	UDDW	2.7	8/15/07	414216111485201		4653	41.7046	-111.8143	100E 200S Well	
18	UDDW	1.6	8/5/14	414328111493001		4569	41.7236	-111.8253	Lower Well	2823
464	UGS	0.9		UGS-0083	137	4555	41.6469	-111.8795	Miller, Richard L.	
465	UGS	0.2		UGS-0089		4471	41.6921	-111.8726	Kunsman, Lisa	
468	UGS	0.3		UGS-0092	127	4484	41.6926	-111.8642	Hansen, Kay D.	
470	UGS	0.3		UGS-0093	80	4510	41.6752	-111.8634	Floyd, W.D.	
474	UGS	0.0		UGS-0096	98	4454	41.7317	-111.8605	Clark, Darala	
478	UGS	0.7		UGS-0099	191	4493	41.7102	-111.8371	Weston, Todd G.	
481	UGS	0.1		UGS-0101	140	4539	41.6556	-111.8639	Miller, E.A. - Corp.	
482	UGS	0.0		UGS-0102	205	4493	41.7029	-111.8366	Alder, Seth L.	426853
483	UGS	2.2		UGS-0105	143	4576	41.6955	-111.8267	Olsen, David	
486	UGS	0.2		UGS-0108	127	4525	41.7158	-111.8206	Smith, Arthur D.	
489	UGS	0.9		UGS-0411		4497	41.6746	-111.8716	Zollinger, Sid	
490	UGS	7.8		UGS-0416	24	4505	41.6601	-111.8848	Mangum Mink Ranch	
480	UGS	0.1		UGS-100.5	232	4644	41.6476	-111.8352	Larsen, Kent	
487	UGS	0.3		UGS-108.5	131	4488	41.6930	-111.8630	Isaacson, Merle	
488	UGS	0.3		UGS-109.5	131	4524	41.6647	-111.8624	Wright, Steven	
462	UGS	0.1		UGS-69.5	183	4436	41.7254	-111.8794	Potter, Charles	
463	UGS	0.3		UGS-70.5	125	4440	41.7087	-111.8838	Thompson, Leslie	
466	UGS	0.8		UGS-90.5	191	4636	41.7213	-111.8060	Andrews, Ronald	
467	UGS	0.0		UGS-91.5	154	4562	41.7204	-111.8155	Rounds, Arlyn	28647
469	UGS	0.3		UGS-92.5	155	4488	41.6979	-111.8583	Russell, Bert	
471	UGS	0.5		UGS-93.5	145	4443	41.7226	-111.8734	Jensen, Robert L.	
472	UGS	0.3		UGS-94.5	140	4455	41.7017	-111.8730	Isaacson, Merl	
473	UGS	0.1		UGS-95.5	151	4529	41.7059	-111.8264	Gustaveson, Rex	35814

Table 10. Continued

Map ID	Org. ID[1]	Nitrate-N (mg/L)	Sample Date	Station ID	Depth (ft)	Elev. (ft)	Latitude	Longitude	Station Name	WIN[2]
491	UGS	0.5		UGS-96.5B		4482	41.7013	-111.8567	Hyclone	
476	UGS	0.4		UGS-97.5	139	4502	41.6923	-111.8538	Smith, Claine	
477	UGS	0.2		UGS-98.5	138	4484	41.6852	-111.8744	Hansen, Hal	
479	UGS	0.5		UGS-99.5	164	4563	41.6621	-111.8459	Peterson, Steve	
492	UGS	7.2	10/15/14	414115111490301		4682	41.6877	-111.8181	Glenridge Well	2722
495	UGS	1.1	10/16/14	414143111495501		4521	41.6952	-111.8327	(A-11- 1)15bcb- 1	
503	UGS	7.0	7/16/15	414213111493101		4538	41.7032	-111.8260	Alder Well	
494	UGS	4.2	10/15/14	414023111484101		4822	41.6880	-111.8113	Arnold Well	
497	UGS	1.5	10/16/14	414117111500401		4521	41.6881	-111.8345	Vail Well	
372	USGS	0.1	3/28/68	413838111513501		4617	41.6438	-111.8605	(A-11- 1)32dcb- 1	
374	USGS	0.4	7/4/68	413924111493501	596	4607	41.6566	-111.8272	(A-11- 1)27cdc- 1	
455	USGS	0.8	10/6/98	413958111485901	290	4650	41.6658	-111.8173	(A-11- 1)27adb- 1	
459	USGS	1.1	8/22/90	414032111514400		4511	41.6755	-111.8630	(A-11- 1)20cad- 1	
376	USGS	0.7	7/4/68	414054111510601		4527	41.6816	-111.8524	(A-11- 1)20ada- 1	
377	USGS	0.3	8/31/62	414109111522101		4484	41.6858	-111.8733	(A-11- 1)18ddd- 1	
450	USGS	3.9	8/17/11	414141111493601	145	4569	41.6947	-111.8275	(A-11- 1)15bdb- 1 S29	
382	USGS	1.4	8/2/89	414206111512001	139	4482	41.7016	-111.8563	(A-11- 1) 8ddc- 1	
461	USGS	1.0	8/21/14	414211111510902	87	4478	41.7030	-111.8533	(A-11- 1) 8dda- 2	
453	USGS	0.4	8/22/13	414216111511001	85	4475	41.7044	-111.8536	(A-11- 1) 8dda- 3	
393	USGS	1.7	7/20/60	414237111502701		4485	41.7102	-111.8416	(A-11- 1) 9acb- 2	
394	USGS	1.2	8/2/89	414243111495801	385	4498	41.7119	-111.8336	(A-11- 1) 9aad- 1	
397	USGS	0.3	8/15/89	414344111523301	230	4424	41.7288	-111.8766	(A-11- 1) 6aab- 1	
454	USGS	0.5	8/24/12	414409111523502		4435	41.7358	-111.8772	(A-12- 1)31dab- 2	
404	USGS	0.3	2/6/63	414410111521101	107	4441	41.7360	-111.8705	(A-12- 1)32cbb- 1	

[1] Organization ID - UGS: Utah Geological Survey, USGS-UT: U.S. Geological Survey, UDDW: Utah Division of Water Rights, UDAF: Utah Department of Food and Agriculture, MVC: Millville City

[2]Utah Division of Water Rights well identification number

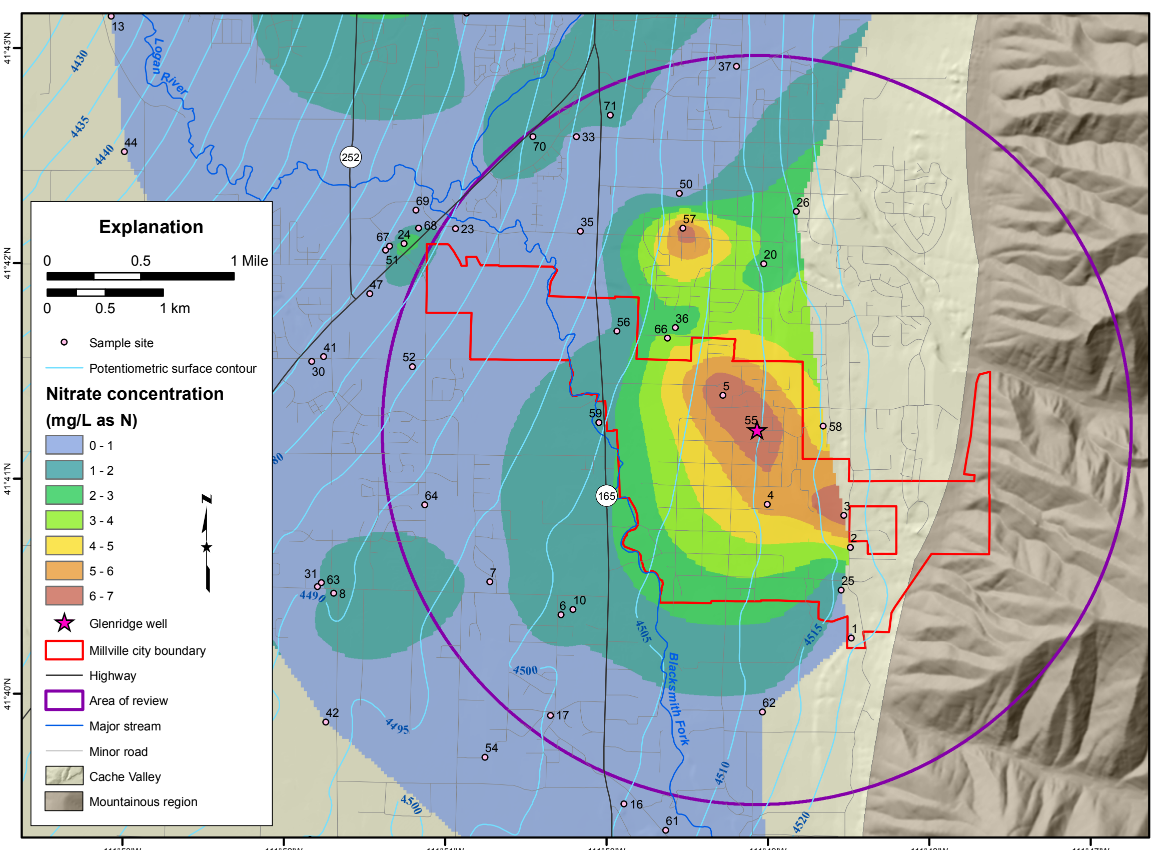

Figure 18. Nitrate concentrations in the Millville area. Numbers adjacent to sample sites are the nitrate sample numbers listed in table 10.

Source of nitrate: Millville has four major potential sources of nitrate, none of which is exclusive of the others: (1) septic tank effluent from on-site wastewater treatment (septic) systems, (2) fertilizer, (3) livestock excrement, and (4) geologic sources (Canter, 1997; Lowe and Wallace, 2001). Like most communities in Cache Valley, Millville was historically an agricultural community (Millville History Book Committee, 1990), and animal operations that are still active include dairies, a mink farm, and livestock corrals. Millville, unlike the neighboring municipalities of Providence and Hyrum, does not have a municipal sewer system and disposes of wastewater through individual home septic systems. Lot size is typically one acre or less, contributing to a high density of septic systems (figure 14). Lowe and others (2003) characterized mass loading of nitrate into groundwater in Cache Valley and recommended a maximum of one system per three acres for the Millville area. Nitrate contamination near the Glenridge well has increased over time and recent nitrate values in the well are approaching the U.S. EPA MCL of 10 mg/L (nitrate as nitrogen) (figure 3). Nitrate concentrations in water from the Glenridge well are relatively high compared to those at Garr spring and the Park well, which are both at or near 1 mg/L.

A map of septic tank density of the Millville area (figure 14) indicates a large quantity of septic systems upgradient of the Glenridge well. After carefully reviewing historical aerial photography and land-use maps, I determined that there are not and have not been any major livestock or agricultural activities upgradient of the Glenridge well. However, a small farm east of the well has some llamas and evidence of historical manure piles, which could potentially contribute to nitrate observed in the Glenridge well. The plume-shaped and areally discontinuous distribution of the nitrate contamination also suggests that nitrate derived from geologic sources is unlikely, although nitrogen and oxygen isotopes in nitrate do not discount this possibility.

Chemical analyses for anthropogenic influence imply that septic systems are significant contributors to nitrate contamination in the Glenridge well area. Water from the Glenridge well, the Arnold well, and Knowles spring was tested for a number of organic chemicals associated with septic tank effluent, including caffeine, sulfamethoxazole, carbamazepine, and diethyltoluamide (DEET). Caffeine and sulfamethoxazole were detected in minute but verifiable concentrations (appendix D) in the Glenridge well and Knowles spring. DEET was detected in a more informal, earlier sample from the Glenridge well (Inkenbrandt, 2014).

Nitrogen and oxygen isotopes from nitrate also indicate septic systems as a possible explanation for high nitrate in the Glenridge well (Inkenbrandt, 2014). The average nitrogen and oxygen isotope concentration ratios in nitrate from Glenridge well water were -5.75 and -5.78 ‰, respectively, which are values that fall into the range expected for several possible sources, including septic, geologic, and animal operation sources. The measured isotope ratios exclude nitrate from precipitation and manufactured nitrate (figure 19).

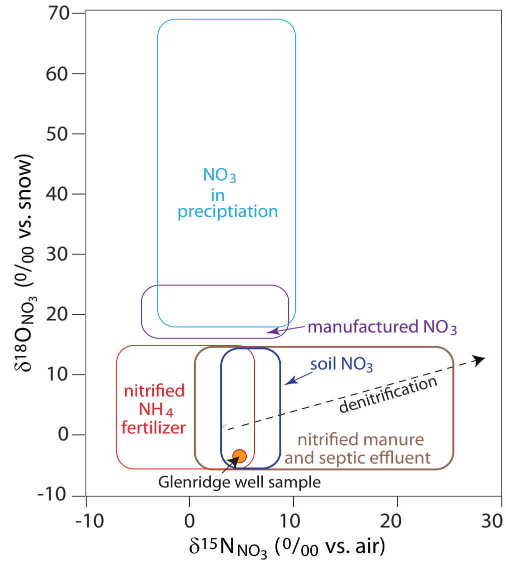

Figure 19. Standard ranges for isotope concentrations of nitrate-15 and oxygen-18 for various nitrate sources. Nitrate from water in the Glenridge well falls within several categories. Modified from Kendall (1998).

While septic system contribution has been verified by the presence of minute concentrations of pharmaceuticals, there is evidence to support that some nitrate contamination could be sourced upgradient and east of the Millville city limits, within the municipal boundaries of the sewered community of Providence. Evidence to support nitrate contributions from the southeastern portion of Providence includes high nitrate concentrations found in two springs (Knowles and Skinner springs) and one well (Arnold well) east of the Millville city line. The O. Hancey (shop) well to the southeast of the Glenridge well also has elevated nitrate concentrations (figure 18, site 4). While the two springs and the Hancey and Arnold wells do show elevated nitrate concentrations, they are in the range of 4 to 6 mg/L, which is measurably lower than concentrations measured in the Glenridge well, suggesting additional contributions downgradient of the Arnold well. Rudimentary MT3DMS (Zheng, 2010) modeling suggests that the sources of nitrate are diffuse and the observed distribution of concentrations would be hard to create with a single point source.

The source of nitrate, most likely septic systems east and south of the Glenridge well, should be mitigated or the nitrate concentrations in the aquifer will continue to rise. The ASR injection only slightly dilutes the groundwater and does not actually remediate the nitrate issue. Regular maintenance of septic systems can ensure proper function, allowing for a reduction in nitrate. Connecting all developments up gradient of the Glenridge well to the Providence sewer system would limit contamination.

Wells previously considered downgradient (west) of the Glenridge well, including the new high-school well and the Vail well, do not show elevated nitrate values, which could be most likely be explained by: (1) groundwater not flowing due west and/or (2) nitrate being reduced as it moves west.

Cross sections indicate that most of the wells in the area are screened in the main gravel section of the principal aquifer, though the high school well (not mapped in sections) is much deeper than the other wells. Preliminary geochemistry does not indicate that the Vail well has reducing water, and particle tracking modeling shows that the groundwater flow direction shifts northward as depth increases, suggesting that the first explanation is most likely.

Nitrification: In relation to Millville's ASR operation, the biggest concerns for the Millville area are nitrification of ammonium via the movement of an induced oxidation front created by the injection of oxygen-rich spring water. Based on existing measurements of nitrate in the area (figure 20), injecting spring water does not appear to be increasing nitrate contamination in the principal aquifer, likely because the spring water has lower a nitrate concentration, in effect, diluting the nitrate in the host water. Geochemical modeling using PHREEQC (Parkhurst and Appelo, 2013) shows an increase in dissolved oxygen in the groundwater around the Glenridge well after injection; however, the increase is not large enough to transition the aquifer from a reducing state to an oxidizing state, which could mobilize nitrate.

Adler Well Influence

During the later stages of the second phase of the study, Providence detected a significant increase of nitrate concentrations in the Alder well, one of their public water supply wells. Nitrate concentrations in the Alder well ranged from 0.387 to 3.94 mg/L in 26 samples collected before September 3, 2013 (Utah Division of Drinking Water, 2015). The September 3, 2013, sample prior to Millville's ASR tests, showed a nitrate concentration of 4.5 mg/L (figure 20). In the months during Millville's ASR tests nitrate concentrations in the Alder well increased to a range of 6 to 8 mg/L (Utah Division of Drinking Water, 2015).

One major concern of injecting oxygen-rich Garr spring water into the Glenridge well is the advancement of an oxidation front in the aquifer system. Oxidation can mobilize metals in siderite and sulfide minerals (pyrite, marcasite, arsenopyrite, etc.). Oxidation is the process that converts ammonium to nitrite to nitrate. Based on an understanding of the Cache Valley principal aquifer system, the dominant geochemical environment of the confined portions of the Cache Valley principal aquifer could become more reducing as water flows from the margins of Cache Valley to greater depths the center of the valley (figure 6).

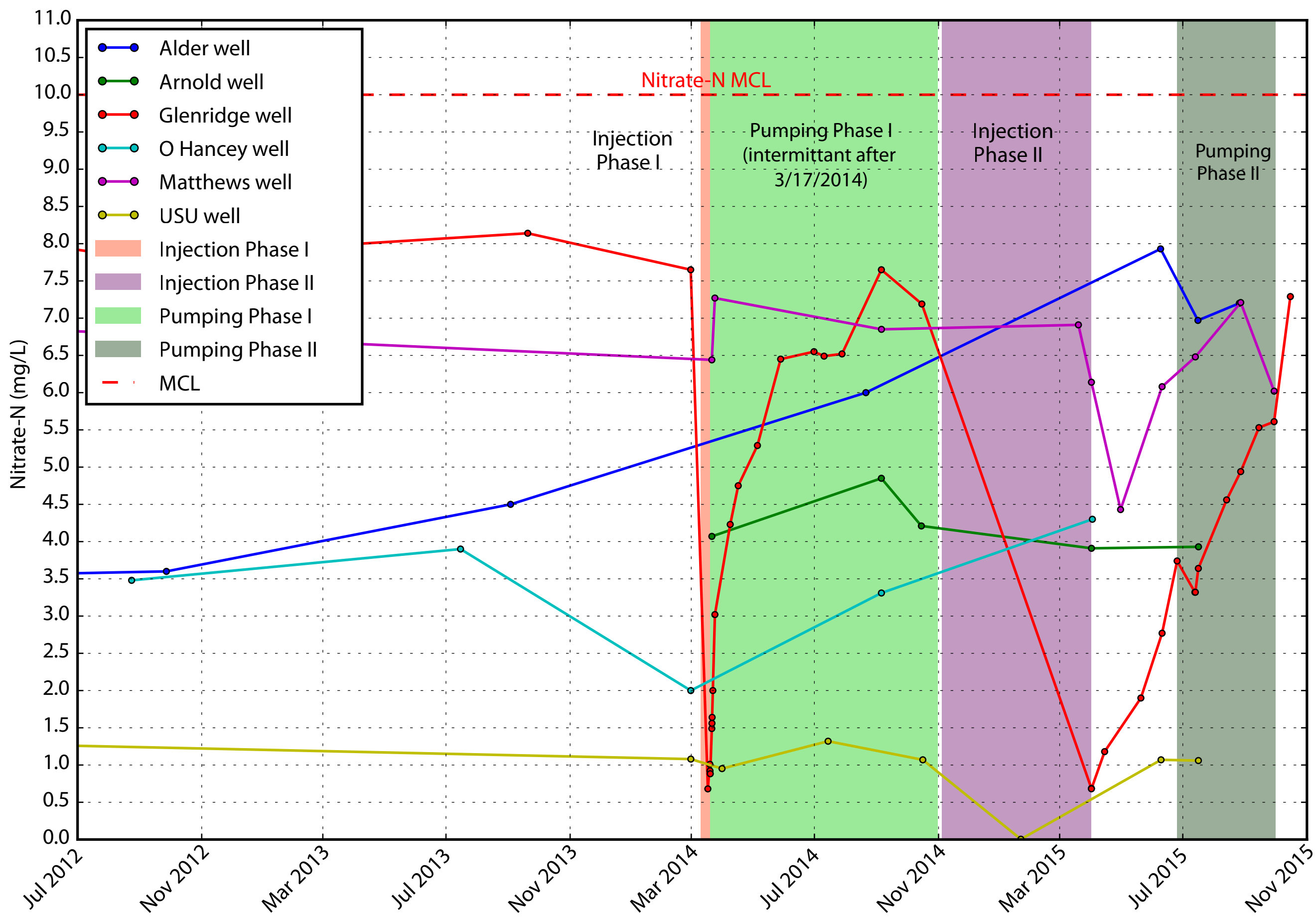

Figure 20. *Nitrate concentrations at various wells over time.*

Based on available water chemistry data from the Utah Division of Drinking Water's Safe Drinking Water Information System (SDWIS) database, there is no evidence to support a transition from reducing conditions to oxidizing conditions at the Alder well. Previous water samples at the well indicate that the well has always had a calcium bicarbonate type water indicative of oxygen-rich water. Most notably, the well has never had detectable quantities of ammonia (as nitrogen) or nitrite, which would be present in high nitrogen water in a reducing setting.

It is also unlikely that the nitrate was transported to the Alder well via an induced gradient from injection at the Glenridge well, where increased pressures displace water in the region, because the increase in the hydraulic gradient around the well is minimal relative to the general natural groundwater gradient of the area. The aquifer has a very high transmissivity, allowing for a widespread but relatively small increase in the potentiometric pressure head around the well during injection.

While high transmissivity could allow for rapid movement of the injectate bubble, monitoring data do not support this. Water chemistry data from the Matthews and Arnold wells indicate delayed incomplete mixing of the injectate with the host water (table 10), which could be explained by limited dispersion of the spring water into the aquifer. Modeling and calculations of groundwater flow and dispersion indicate that it is very unlikely that the injected bubble of water was ever near any of the Providence wells.

MODFLOW (Harbaugh, 2005) and MODPATH (Pollock, 2012) modeling of the Millville and Providence region suggests that the high concentrations of nitrate at Providence's Adler well would have to originate in groundwater east of Millville. The models show that most particles are moving in a north-west to north direction. The flow path tracing accounted for the influence on the hydraulic gradient, including pumping from Providence wells, injection from the Glenridge well and different starting potentiometric surfaces and hydraulic conductivities.

One possible explanation for the observed increase in nitrate at the Providence Alder well is the arrival of the Glenridge nitrate plume or the introduction of a new source of nitrate upgradient of the well in the Providence area. The nitrate source could by verified and potentially distinguished from the Glenridge nitrate source by testing for stable nitrogen and oxygen isotopes and analyzing the water for indicator chemicals of septic tank sources.

Alternative explanations for elevated nitrate at the Alder well include dispersion of the nitrate plume at a rate faster than I calculated for groundwater flow or other point sources of nitrate in the area, including in the areas of Providence near the Adler well and to the east of the Glenridge well.

Biofouling

The Glenridge well is at some risk of biofouling, a process where bacteriological growth partially clogs the well screen and pore spaces in the aquifer surrounding the well, reducing permeability. Conditions favorable for biofouling are pH values ranging from 7.8 to 8.6, nitrate-nitrogen concentrations greater than 1.0 mg/L, phosphorous greater than 0.1mg/L, dissolved oxygen greater than 3 mg/L, and iron concentrations greater than 1.0 mg/L (Pyne, 1995). The pH range of the well (7-8), relatively high nitrate and dissolved oxygen concentration (9 mg/L), and detectable concentrations of phosphorous (0.017 mg/L) can all contribute to pore-clogging bacteriological growth in the vicinity of the well screen. Using water from Millville's municipal water system reduces the probability of biofouling, as it contains small amounts of disinfectants that kill bio-film-producing organisms.

Disinfectant Byproducts

Using municipal drinking water as an injectate causes concerns for the creation of disinfectant byproducts, including trihalomethanes (THMS), haloacetic acids (HAAS), and chlorite, which are created by reactions between organic matter and drinking water disinfectants. However, no disinfectant byproducts were measured in any of the samples retrieved after injection, and no measureable quantities of dissolved organic carbon were detected in the injected or host waters. The Glenridge well also has relatively low temperatures of around 14 degrees Celsius, which is lower than a more problematic range of 20 to 40 degrees Celsius (Pyne, 1995).

Scaling

The Ryznar stability and Langelier saturation indices are measures of the potential for water scaling or corrosivity. The Ryznar indices I calculated for water from Garr spring, Glenridge well, and mixes of the two waters indicate a balance of corrosion and scaling, with some pitting possible (table 9). The Langelier indices suggest slight to moderate corrosion, as opposed to scaling (table 9).

Percent Recovered

In neither phase of the ASR pilot project was the injectate completely recaptured. As expected, recapturing the injectate was more effective when the storage time was shorter because the injectate had less time to drift and disperse. During the first phase of the ASR pilot project in March 2014, Millville injected 15.3 ac-ft (1.9 ha-m) of Garr spring water into the Glenridge well and pumped 6.5 ac-ft (0.8 ha-m), of which 5.2 ac-ft (0.64 ha-m) was injectate (table 11). The well was then allowed to sit until its typical startup time of July, when it was switched on for normal operation. Over that time, more injectate was recovered (figure 21), but less efficiently than during the initial pumping. See (Inkenbrandt, 2014) for the details regarding this phase. During the second phase of the ASR pilot project, Millville injected 104.8 ac-ft (12.9 ha-m) of Garr spring water into the Glenridge well over 148 days (table 11). After the injectate resided in the aquifer for 3 months, Millville pumped 59.1 ac-ft (7.3 ha-m) of water from the Glenridge well, 25.2 ac-ft (3.1 ha-m) of which was injectate based on mixing ratios established using nitrate concentrations (equation [1], methods section); the recovery for phase II was 24%.

Table 11. *Summary of volumes of water in the Millville aquifer storage and recovery tests. See figure 21 and table 7 for more detail.*

	Phase I	Phase II
Volume Injected (ac-ft)	15.3	104.8
Volume Pumped[1] (ac-ft)	6.5	59.1
Volume of injectate recovered (ac-ft)	5.2	25.2
Injectate Recovered	34.1%	24.0%
Volume Pumped / Volume Injected	42.5%	56.4%
Volume Recovered / Volume Pumped	80.4%	42.6%
Injection Period (days)	7.0	147.9
Main Storage Period (days)	2.0	85.0[2]
Main Pumping Period (days)	5.0[1]	96.1

[1] In Phase I, Millville pumped the well for one week during the study and then shut it down until July 2014, for its regular pumping operation. The numbers provided are specifically for the two weeks of study in March 2014.

[2] In the Phase II storage period, the well was pumped periodically to collect samples.

Using nitrate as a conservative tracer does not account for the creation of new nitrate from nitrification or the addition of new nitrate via septic system leachate. However, the results of mixing calculations using nitrate concentrations (table 12) matched those of mixing calculations from measured stable oxygen and deuterium isotopes (Inkenbrandt, 2014). A few measured spikes of nitrate observed during both phases. The two most notable spikes in nitrate were on June 25, 2015, and October 15, 2015 (figure 22). The latter could be caused by sample error, as the sample was delivered to the analytical laboratory past its holding time. The spikes could have been caused by higher nitrate water flushing through the aquifer system after rain events or by lab error. While I did plot nitrate against precipitation for the duration of both phases of the pilot project (figure 22), two issues limited my ability to observe a relationship between nitrate concentration and precipitation: (1) lag time between precipitation and recharge to the aquifer, and (2) the changes in nitrate caused by the test masked smaller changes that could have been caused by the introduction of new nitrate.

Modeling of bubble drift shows that water injected that was not recovered will likely travel to the center of Cache Valley, which eventually contributes to water discharging in springs and wetlands connected to the Little Bear River and Logan

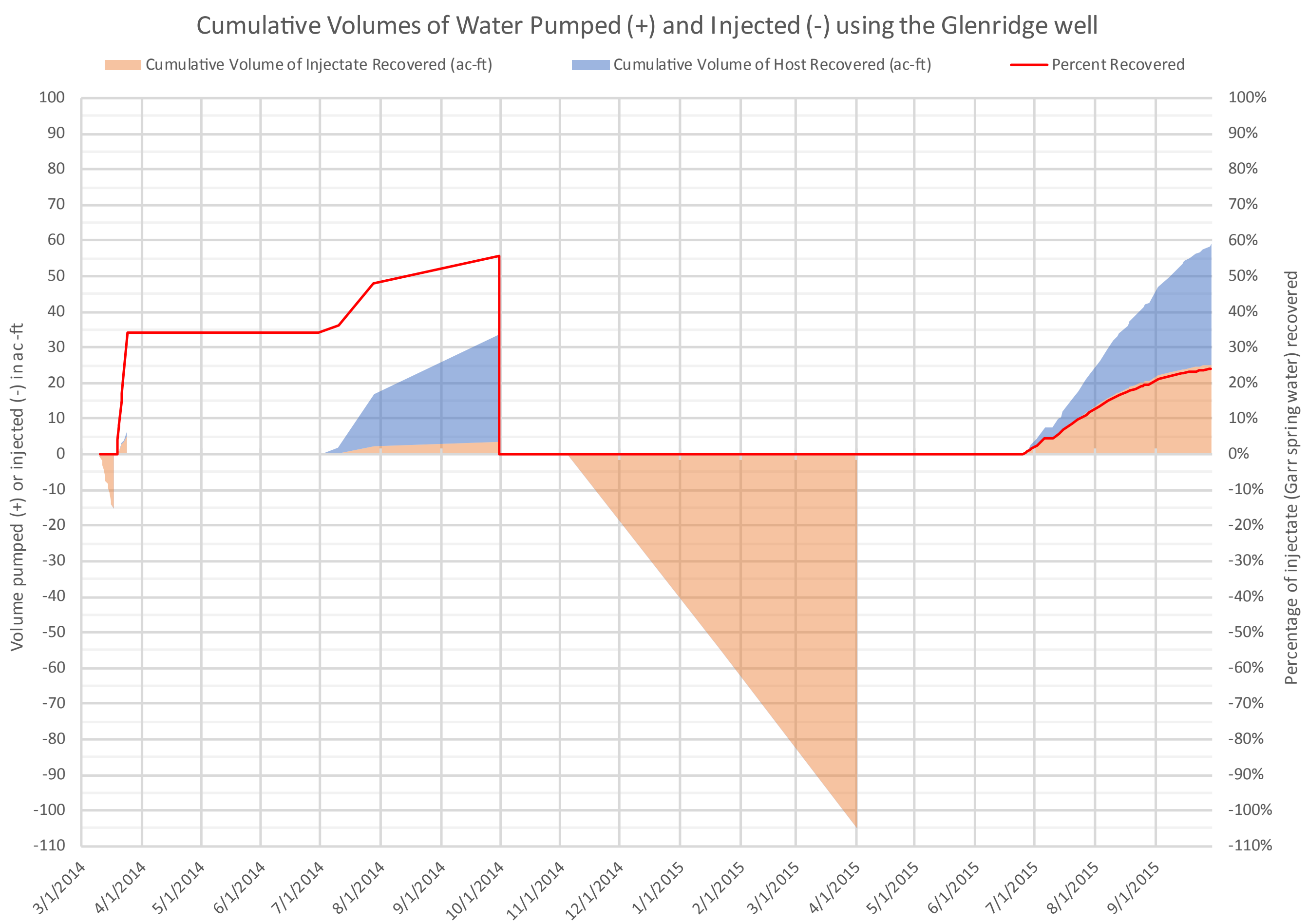

Figure 21. *Hydrograph of phase I injection and pumping test of the Glenridge well.*

River (Robinson, 1999). If not captured for injection, winter overflow water from Garr Spring travels as surface water via a ditch to Millville BSF Upper Canal and to Blacksmith Fork (figure 2), which contribute to the Little Bear River. The ASR activities are essentially storing water that would otherwise flow to the Bear River system, and water not recaptured by wells in the principal aquifer would eventually end up in the Bear River, although the time of travel would likely be much greater.

Recovery Efficiency

During phase I post-injection pumping, Millville pumped out 42.5% of the total volume of water that was injected. However, the extracted water did not have the same composition as the injectate. I used ratios of nitrate concentrations (table 8; equation [1]) and oxygen and deuterium isotopes to determine how much of the pumped water was injectate.

Table 12. *Nitrate-N concentrations and mixing percentages based on those concentrations.*

Phase	Station	Date	Nitrate-N (mg/L)	Time from injection start (days)[1]	Time from pumping start (days)[1]	Host Water (%)	Injectate Water (%)	Volume Pumped / Volume Injected (%)
1	Garr (injectate)	2/28/14 9:15	0.728				100%	
		3/17/14 10:30	0.68	6.98			100%	
	Glenridge	2/28/14 11:15	7.65			100%	0%	
		3/19/14 10:40	1.01	8.98	0.02	4%	96%	0.1%
		3/19/14 14:00	0.922	9.12	0.15	3%	97%	1.3%
		3/19/14 20:00	0.883	9.37	0.40	2%	98%	3.4%
		3/21/14 9:00	1.49	10.92	1.95	11%	89%	16.4%
		3/21/14 12:47	1.56	11.07	2.10	12%	88%	17.8%
		3/21/14 16:18	1.64	11.22	2.25	13%	87%	19.0%
		3/22/14 9:37	2	11.94	2.97	18%	82%	25.1%
		3/24/14 10:30	3.02	13.98	5.01	33%	67%	42.3%
		4/8/14 14:30	4.23	29.14	20.17	51%	49%	42.5%
		4/16/14 13:00	4.75	37.08	28.11	58%	42%	42.7%
		5/5/14 13:30	5.29	56.10	47.13	66%	34%	42.8%
		5/28/14 13:45	6.45	79.11	70.14	83%	17%	62.9%
		6/30/14 14:30	6.55	112.14	103.17	84%	16%	62.9%
		7/10/14 14:20	6.49	122.14	113.17	83%	17%	74.1%
		7/28/14 9:00	6.52	139.92	130.95	84%	16%	172.4%
		8/20/14 11:30	7.31	163.02	154.05	95%	5%	287.1%
2	Garr (injectate)	10/15/14 10:30	0.625				100%	
	Matthews	3/24/14 10:00	7.27			100.00%	0.00%	
		3/19/15 13:45	6.91	135.1	0.0	94.58%	5.42%	
		4/1/15 11:30	6.14	148.0	0.1	82.99%	17.01%	
		6/10/15 11:35	6.08	218.0	70.1	82.09%	17.91%	6%
		7/13/15 10:15	6.48	251.0	103.0	88.11%	11.89%	28%
		8/27/15 9:15	7.21	295.9	148.0	99.10%	0.90%	57%
	Glenridge	10/15/14 11:30	7.19	-20.0		100.00%	0.00%	
		4/1/15 10:45	0.686	148.0		0.93%	99.07%	
		4/14/15 13:30	1.18	161.1		8.45%	91.55%	
		5/20/15 11:15	1.9	197.0		19.42%	80.58%	
		6/10/15 11:20	2.77	218.0		32.67%	67.33%	0.04%
		6/25/15 9:00	3.74	232.9	0.0	47.45%	52.55%	0.05%
		7/13/15 10:00	3.32	250.9	18.0	41.05%	58.95%	9.6%
		7/16/15 9:45	3.64	253.9	21.0	45.93%	54.07%	12.2%
		8/13/15 10:15	4.56	282.0	49.1	59.94%	40.06%	32.3%
		8/27/15 8:45	4.94	295.9	63.0	65.73%	34.27%	40.4%
		9/14/15 10:00	5.53	313.9	81.0	74.71%	25.29%	51.0%
		9/29/15 11:10	5.61	329.0	96.1	75.93%	24.07%	56.4%
		10/15/15	7.29	345.1	112.2	101.52%	-1.52%	60.9%
	Arnold	3/21/14	4.07	-228.5	-376.4	100.00%	0.00%	
		10/15/14	4.21	-20.5	-168.4	100.00%	0.00%	
		4/1/15 12:30	3.91	148.1	0.1	91.63%	8.37%	
		7/16/15 13:15	3.93	254.1	106.1	92.19%	7.81%	30%
	USU	10/16/14 10:00	1.07	-19.1				
		1/21/15 13:45	0.00	78.1				
		6/9/15 10:30	1.07	217.0	69.0			6%
		7/16/15 10:45	1.06	254.0	106.0			30%

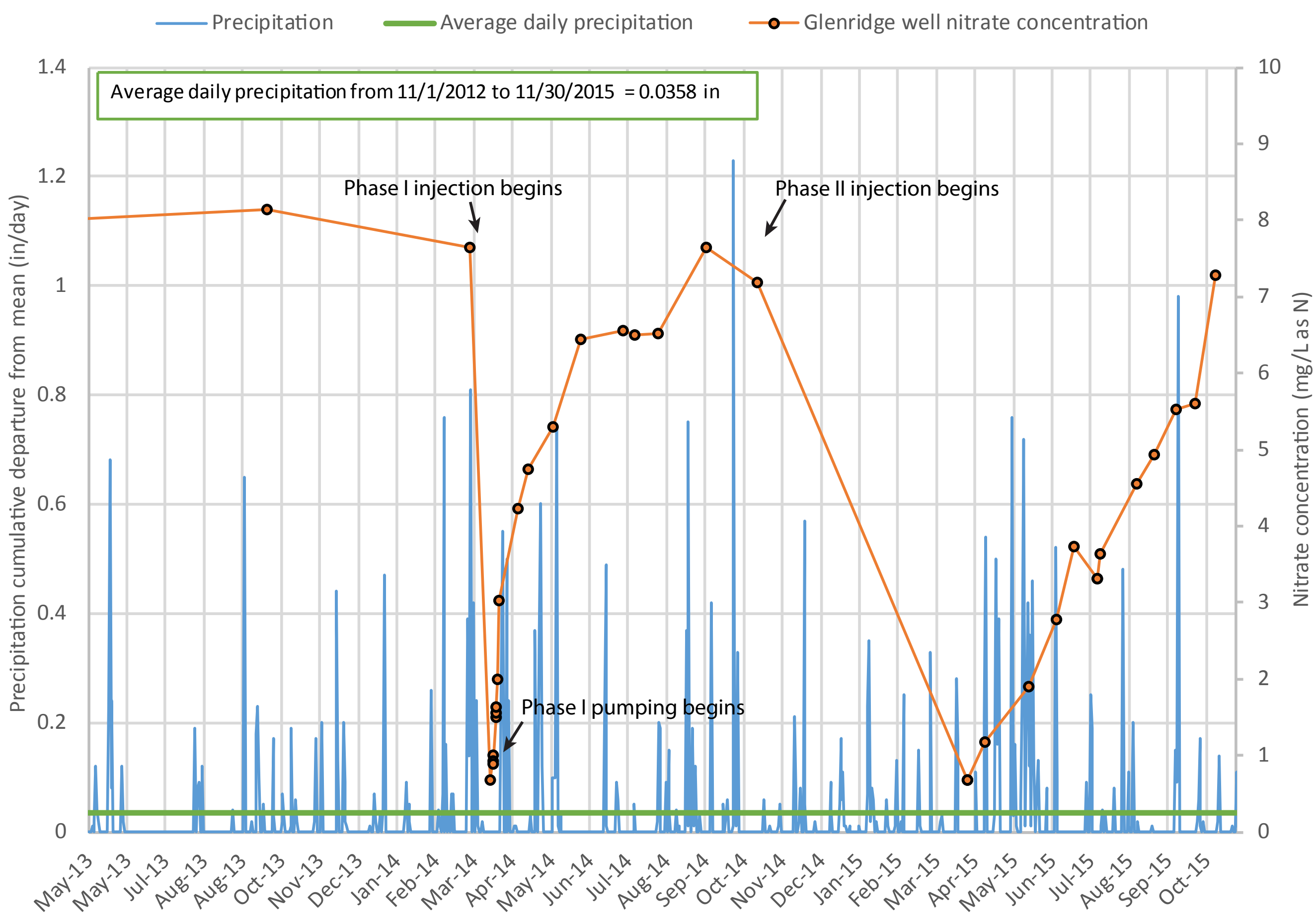

Figure 22. *Nitrate concentrations at the Glenridge well over time plotted with cumulative departure from mean precipitation. Influence from precipitation (if any) has been masked by ASR activities and probable lag time associated with recharge, though some spikes in nitrate appear to correlate with precipitation.*

Isotope and nitrate concentrations show that the water extracted from the Glenridge well was 95% Garr Spring water up to 10.75 hours after post-injection pumping began (figure 21). For the first five days of pumping, nitrate concentration increased in a near-linear fashion at a rate of about 0.5 mg/L for every acre-foot of water pumped. At the end of the first week of phase I pumping, on March 24, 2014, at 10:30 a.m., the water extracted from the well was 68% Garr spring water (figure 21). Nitrate values increased logarithmically during the remainder of the post-injection pumping period (figure 21). This is best explained by diffusion of the Garr spring water into and mixing with host water. Relatively fast-flowing groundwater is likely near the well, allowing for further mixing of the two waters. The asymptote of the nitrate trend approaches 7 mg/L, which is a relatively high value, but lower than the initial value. Millville recovered 5.2 ac-ft (34.1%; 0.6 ha-m) of the 15.3 ac-ft (1.9 ha-m) injected, and 80.4% of the water pumped was injectate.

Nitrate concentrations show the water from Glenridge well was 64% Glenridge water when phase II pumping started on June 25, 2015, indicating diffusion and bubble drift over the duration of storage (figure 21). At the end of phase II pumping, pumped water contained 23% injectate. Millville pumped 59.1 ac-ft (7.3 ha-m) of water, to recover 25.2 ac-ft (24%; 3.1 ha-m) of the 104.8 ac-ft (12.9 ha-m) injected. The relative proportion of injectate in the pumped water decreased over time, requiring more pumping for a smaller return of injectate. Longer storage periods decrease the volume recovered per volume pumped, meaning that complete recovery of injectate is more difficult as storage time increases.

Aquifer Properties

The aquifers vary in thickness depending on location. Based on the cross sections (figure 23) and the Glenridge well driller's log, the aquifer is about 100 ft (30.5 m) thick near the Glenridge well. Most of the clay within 0.25 mile (0.4 km) of the Glenridge well is greater than 80-feet (24 m) thick (figure 23). The aquifer in the region of Millville coincides well with the conceptual model presented by (Robinson, 1999) for Cache Valley (figure 8). Clay thickness calculations (figure 24) substantiate the recharge areas designated in the map from Anderson and others (1994). Clay layers thin substantially upgradient (east) of the Glenridge well, where Provo-level Lake Bonneville gravels are predominant at the surface (figure 10) (Evans and others, 1996). There may be some thin, discontinuous clay layers east of the Glenridge well, allowing for the flow observed at Skinner and Knowles springs (figure 2).

I analyzed aquifer test data (figure 25) and determined that the transmissivity of the principal aquifer near the Glenridge well is 135,000 ft^2/day (12,540 m^2/day), which, based on an aquifer thickness of 100 ft (30.5 m), equals a hydraulic conductivity of 1350 ft/day (411 m/day). The hydraulic conductivity is extremely high and would be an appropriate value for gravel. The transmissivity from the test fits well with other values interpolated from data presented in Inkenbrandt (2010) (figure 26).

I could not analyze injection test data because of the water-level disruption during injection (figure 27) and loss of the well transducer during phase II. During the injection portion of the test, the apparent water level in the Glenridge well dropped about 6 ft (2 m) immediately after injection began and stayed at the depressed level until injection stopped (figure 27). This apparent depressed water level (i.e., lower pressure head) is likely due to jetting of water from the injection column (pipe) into the well. A significant change in fluid velocity from the port of the injection column can lead to a Venturi (Bernoulli) effect in the well casing, which manifests as lower fluid pressure and gives the impression of depressed water levels. Some of this jetting was likely alleviated when the permanent injection pipe was installed, as a lower injection rate was applied and there was not an orifice plate on the permanent injection pipe.

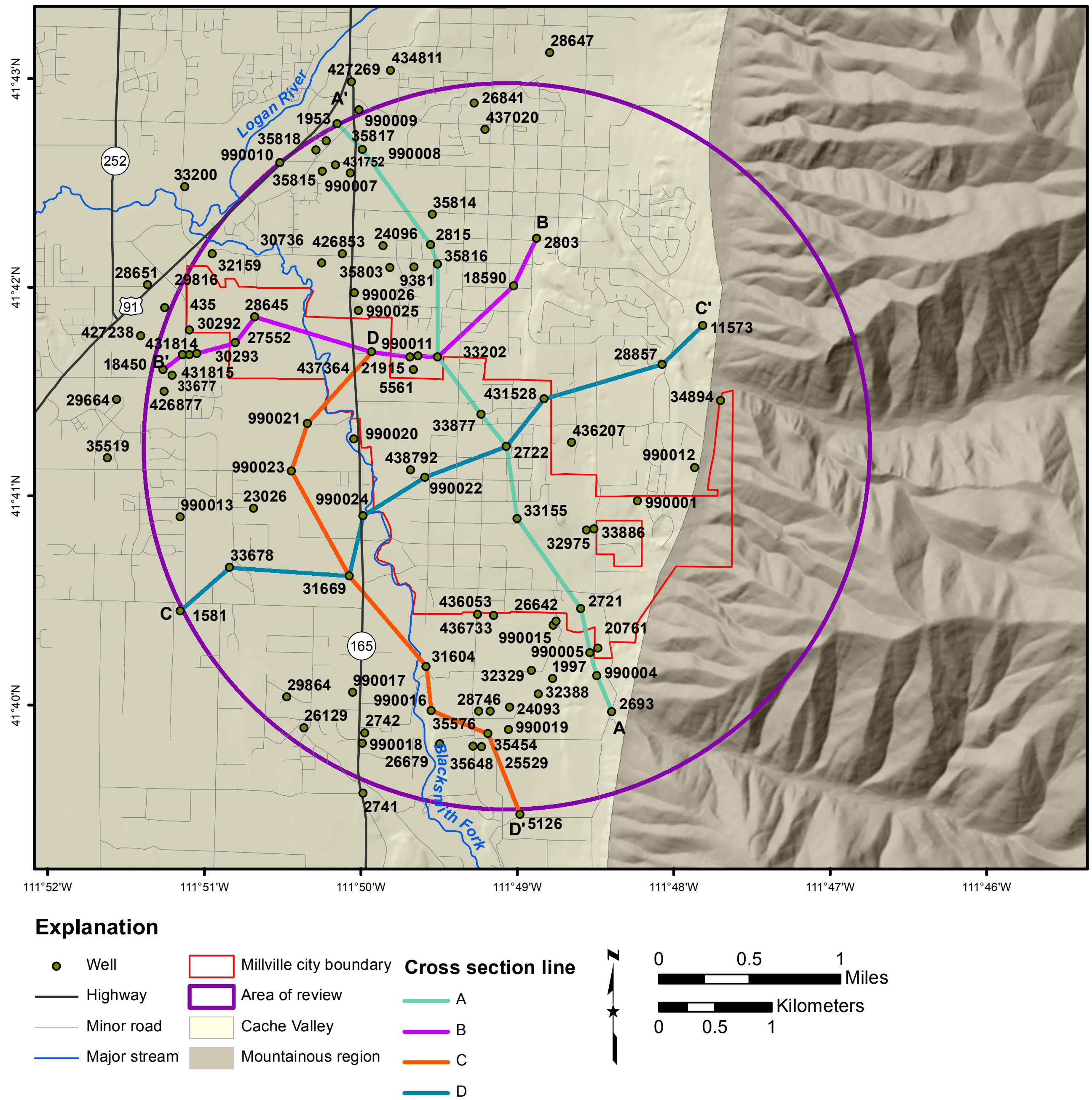

Figure 23. Map and cross sections of Millville area. Well labels are Utah Division of Water Rights Well Identification Numbers (WIN). The Glenridge well is WIN 2722.

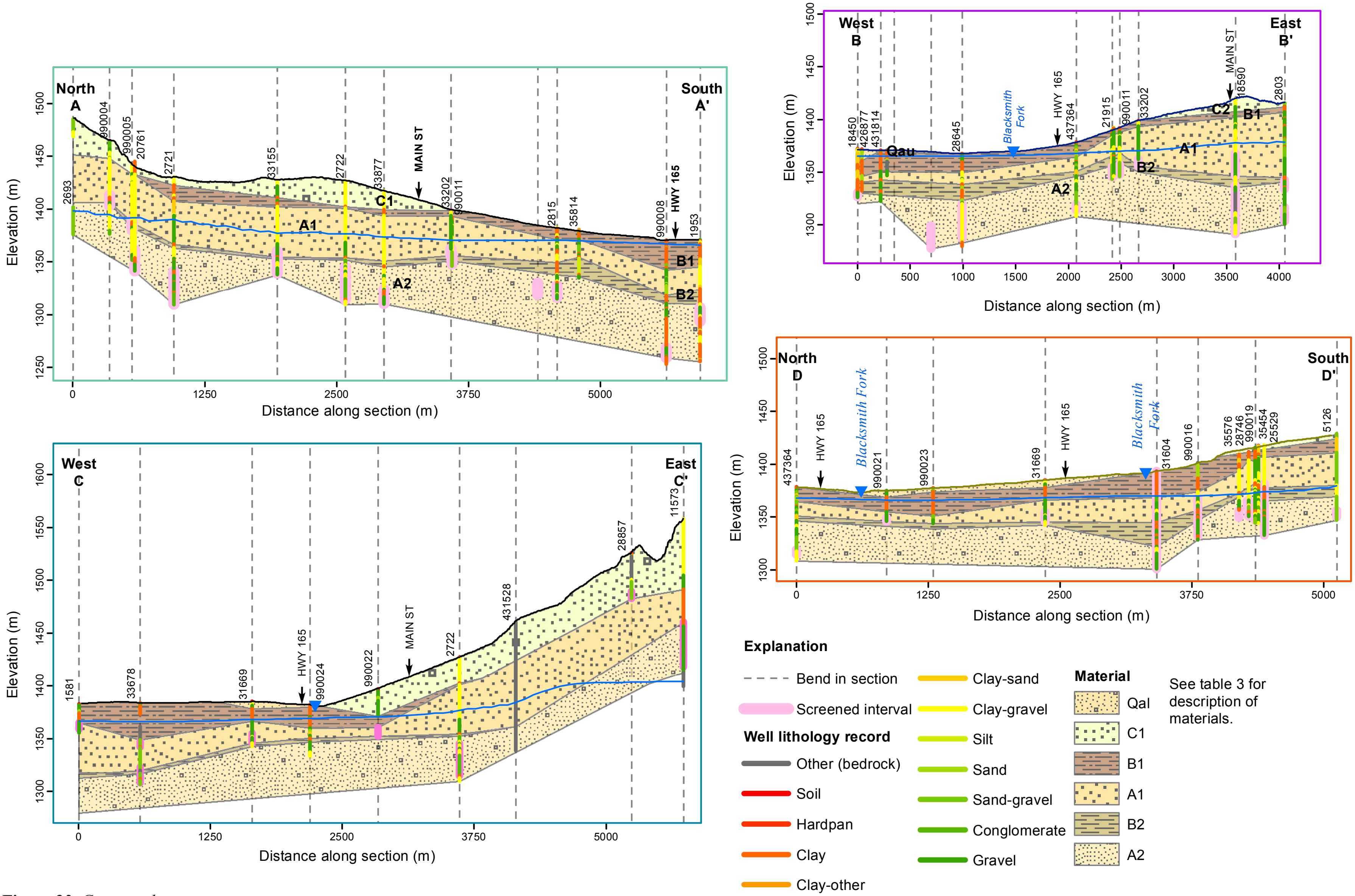

Figure 23. Continued

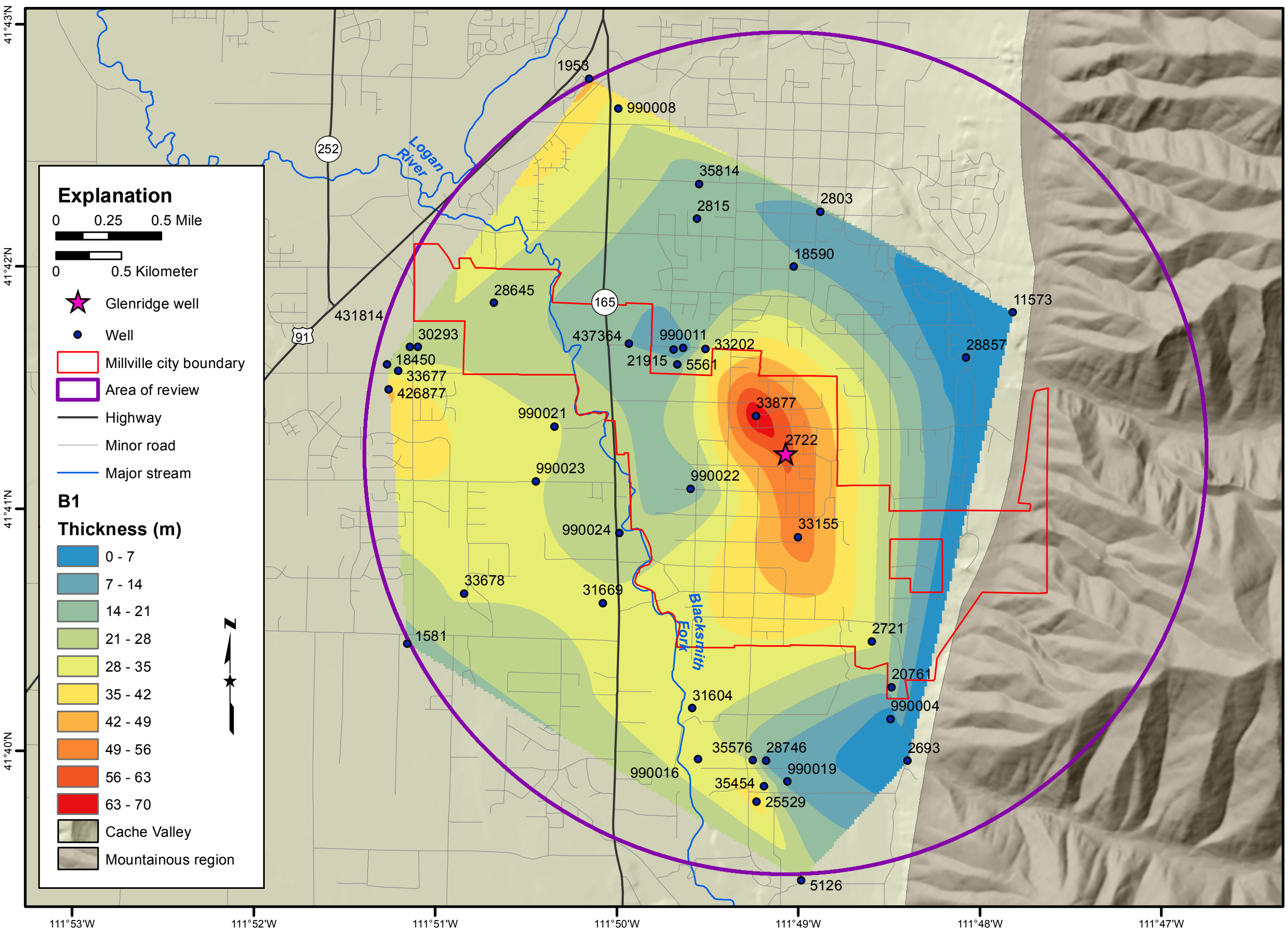

Figure 24. *Thickness of the upper confining unit in the principal aquifer based on interpretation of well logs and cross sections.*

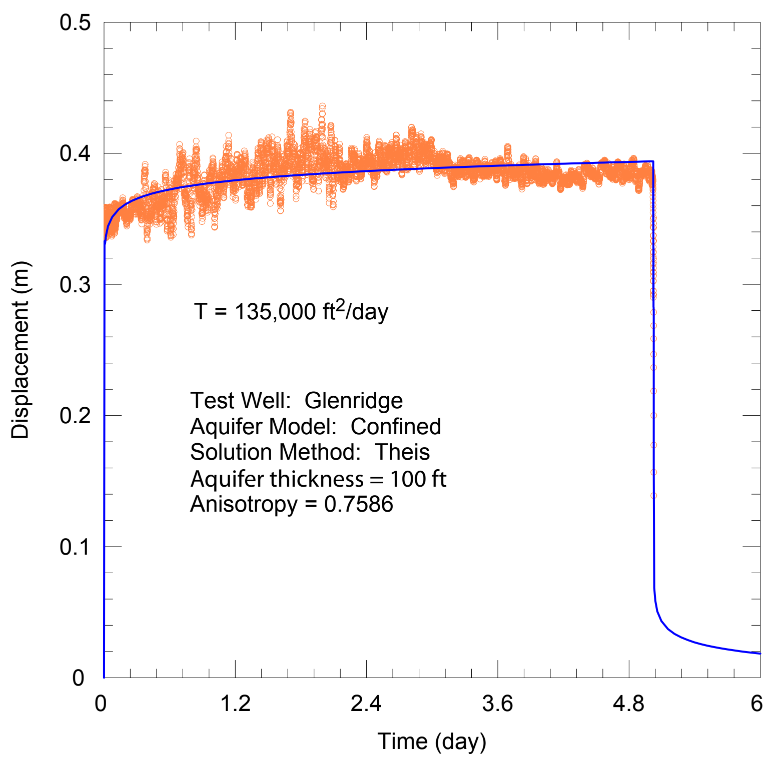

Figure 25. *Aquifer test analysis of post-injection pumping data.*

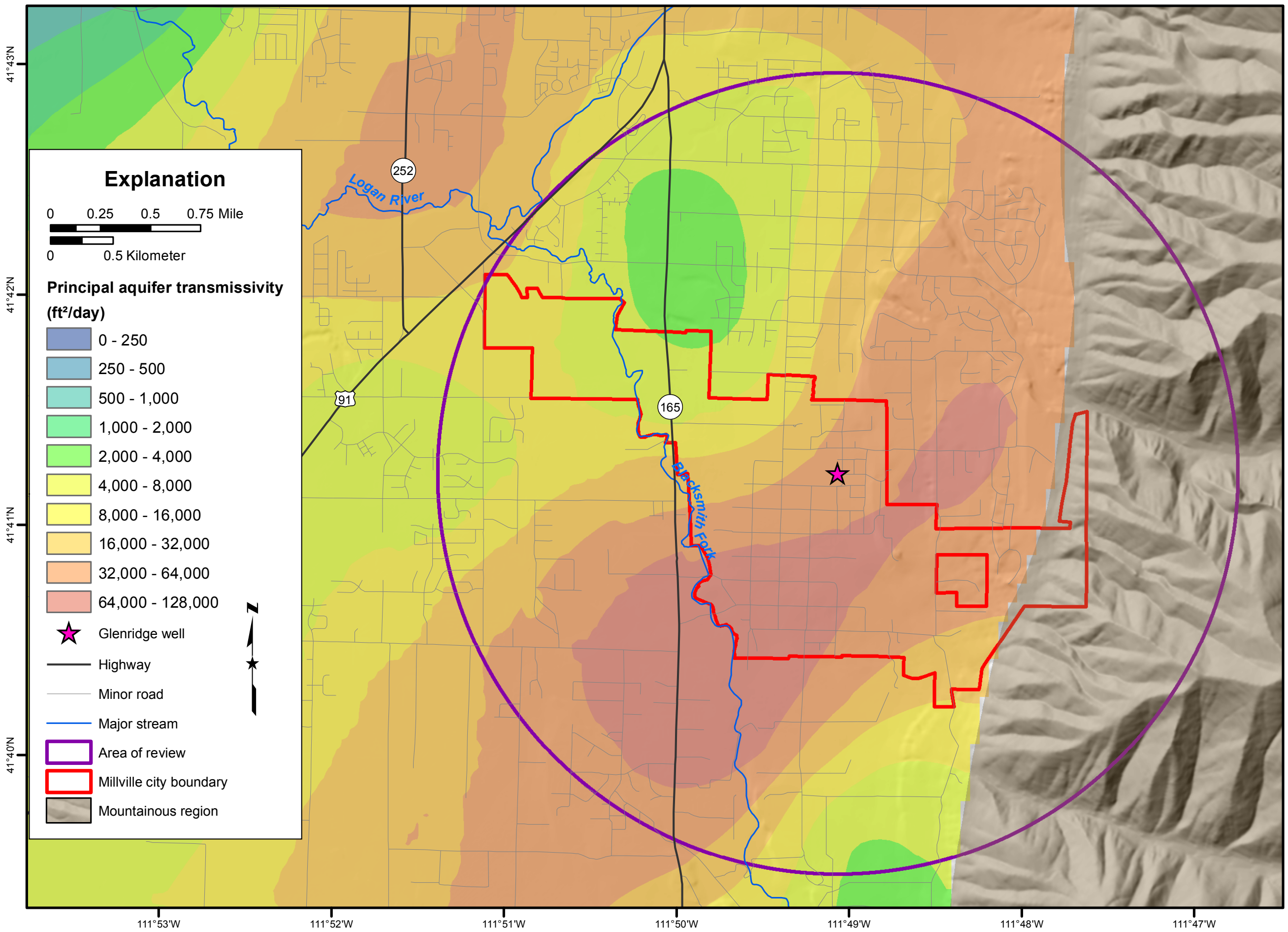

Figure 26. *Transmissivity of the Cache Valley principal aquifer (modified from Inkenbrandt, 2010).*

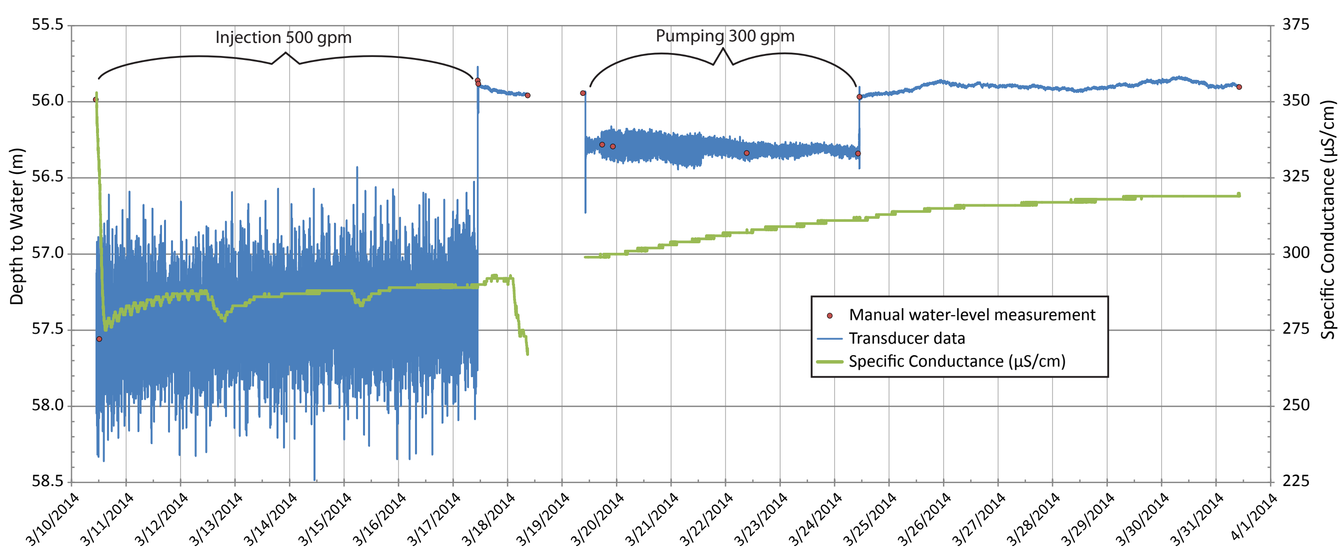

Figure 27. *Hydrograph of phase I injection and pumping test of the Glenridge well.*

A cone of depression or recharge mound created by a well in a high transmissivity aquifer will exhibit small amounts of potentiometric surface change over a very large area. Based on the transmissivity from the aquifer test using the Glenridge well, injection modeling displays a wide swath of influence. The inference of a relatively small increase in groundwater levels based on high transmissivity is supported by the surrounding monitoring wells, where measured increases where smaller than the noise at the site and precision of the transducers. For Millville to inject its full winter water-right allowance at the current maximum injection rate of 300 gpm (19 L/sec), injection would need to occur from the beginning of October to the end of May the following year (181 days). The maximum increase in potentiometric surface level (i.e., height above the static groundwater level) would be about 0.3 ft near the well after an injection cycle and that increase would be negligible after a post-injection pumping cycle.

Groundwater Flow

Based on the rudimentary modeling, I determined the mean groundwater flow velocity in the vicinity of the Glenridge well to be about 3.3 ft/day (1 m/day) to the northwest. Average velocity for 97 particles surrounding the Glenridge well was a little less than 9.8 ft/day (3 m/day). The combined duration of the pumping and storage of phase II was 233 days, which would put the bulk of the injectate at less than 2300 ft (700 m) from the Glenridge well (not counting dispersion). MODPATH (Pollock, 2012) modeling verified these calculations. The USGS groundwater model (Kariya and others, 1994) indicated that the centroid (high concentration point) of the bubble drifted about 520 ft (158 m) over the duration of storage during phase II, and total bubble drift by October 1, 2015, was 740 ft (226 m) (figure 28).

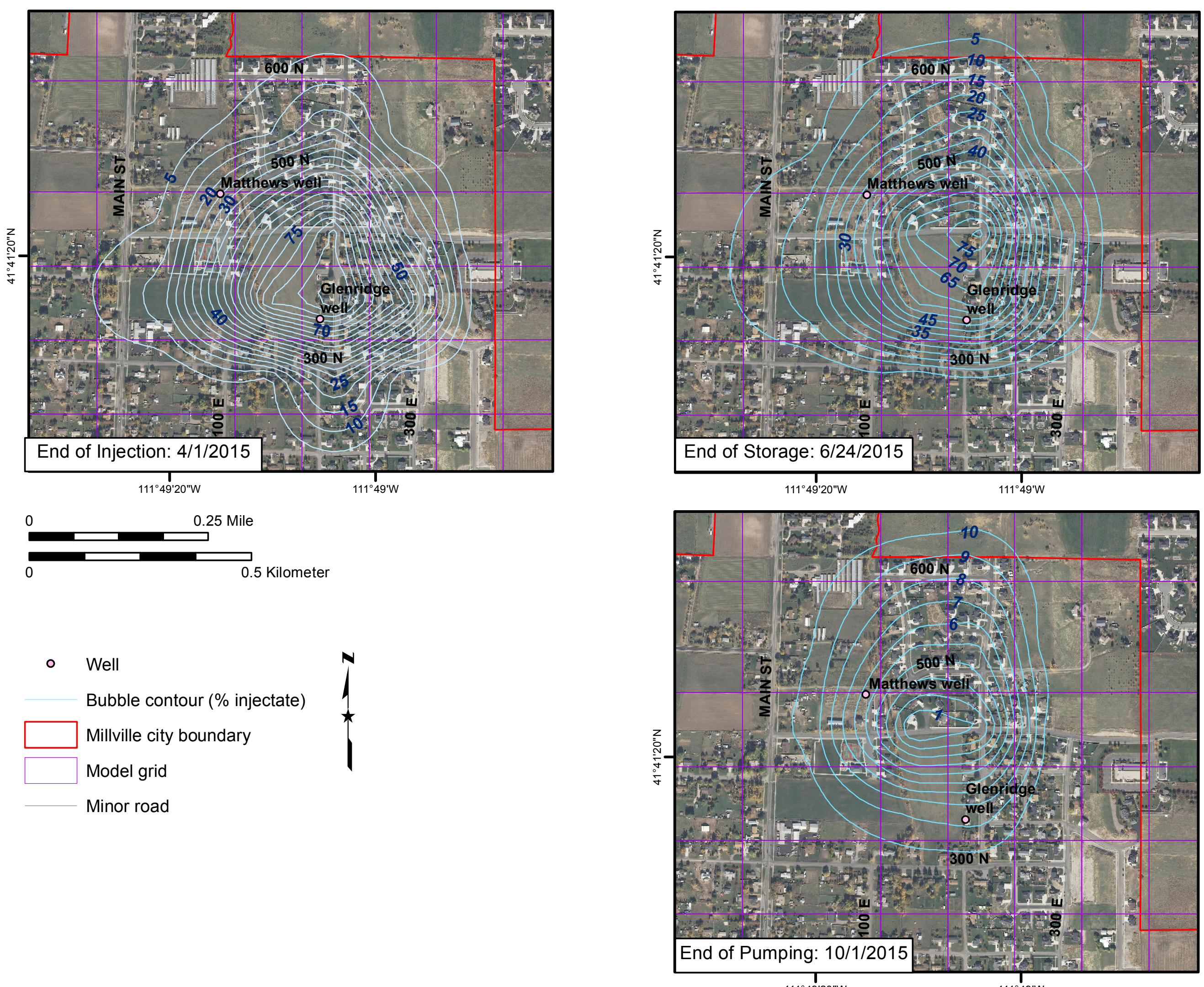

Figure 28. *Modeled injectate bubble at different times during phase II. The contours represent percent injectate. Note that the contours are not exactly aligned with the Glenridge well due to offset of the grid cell center from the actual well location.*

The direction and magnitude of groundwater flow are dependent on the potentiometric surface. The potentiometric surface map constructed for this study (figure 29; appendix E) indicates a southeast to northwest flow of groundwater (280° ± 35° from north) having a horizontal gradient of 0.002 at the Glenridge well. The potentiometric surface generated from layer one of the USGS model (Kariya and others, 1994) indicates a northwest groundwater flow direction (311°) having a gradient of 0.008. The difference between the two surfaces may be due to pumping influence from Providence City's municipal wells and injection by the Glenridge well, which were not accounted for in the steady state MODFLOW model. Pathlines generated by MODFLOW modeling show that the flow of particles traveling through the aquifer system shift to the north as depth increases, where shallow particles at about 200 feet (61 m) deep have a much more east-west trend than do deeper particles at about 600 feet (183 m) deep.

Because of the high transmissivity of the principal aquifer, induced gradients created by pumping should be small relative to the natural gradient of the aquifer. The maximum drawdown observed in the Glenridge well from the aquifer test was about 1.3 ft (0.4 m). Based on forward modeling of maximum seasonal pumping of all of Providence's wells and injection of the Glenridge well, the additional induced gradient would be 0.0001-0.0004 to the north (figure 30). This modeled gradient is an order of magnitude smaller than the natural gradient of the principal aquifer, and therefore, large amounts of pumping only shift particle tracks slightly to the north.

Induced Seismicity

In some instances, injection of water, especially near active faults, can create induced seismicity (Ellsworth, 2013). Based on examination of quarterly epicenter reports (University of Utah Seismograph Stations, 2015), no measured earthquakes were detected along the East or West Cache faults over the duration of the study (figure 31). There were several small (M<2.0) quakes in the Bear River Range to the east, but they did not correlate to the timing of injection.

SUMMARY

The following summarizes my significant conclusions based on the results of the Millville ASR project.

1. Potentiometric contours, the modified USGS model, and measured nitrate concentrations all suggest that groundwater in the Millville area is flowing from southeast to northwest.
2. The capacity of storage in the Millville ASR system is limited by the diameter of the injection pipe in the Millville well and the volume of water that Millville will pump during periods of demand.
3. Injection does not appear to create a significant/measurable rise in groundwater elevations in wells near the Glenridge well.
4. The geochemical nature of the major ions of the Garr spring water, median principal aquifer water, and Glenridge well are all very similar.
5. Mixing injectate with host water causes minute but detectible increases in lead and zinc concentrations, likely from oxidation of the sulfide minerals galena and sphalerite in the aquifer.
6. Due to the limited differences in groundwater chemistry, the mobilization of metals is small relative to their concentrations in the samples.
7. Groundwater travel times and geochemical modeling suggest that recently observed increases of nitrate concentrations in the Providence Alder well are not related to Millville's ASR activities.
8. While they are not related, changes observed in nitrate concentration of the Alder well coincide with different stages of Millville's pilot project, warranting a suggested monitoring regime for nutrients in the Alder well to verify that there is no influence from Millville's ASR project.
9. Nitrate contamination is still a problem in the area and will continue to increase as population and septic tank density and age increases.
10. Recapture of the injectate bubble decreases as storage time increases.
11. The maximum quantity of water that Millville can inject in one season (October to March) is about 15 ac-ft (2 ha-m).
12. The principal aquifer has a much greater capacity than was tested in this study for storage of artificially recharged water.

Overall, the pilot tests conducted by Millville did not show detriment to the principal aquifer. Nitrate in the Millville area is a problem that should be addressed. The principal aquifer has significant storage abilities beyond the capacity of Millville's water system.

RECOMMENDATIONS

Monitoring Plan

Regulation requires Millville to initiate a monitoring plan if they chose to pursue ASR. Below, I recommend a monitoring plan that will assess changes in the aquifer and well. The recommended monitoring plan includes biyearly, regular (weekly to monthly), and periodic (monthly) measurements. I recommend that Millville sample the Glenridge well at least twice during each cycle (once at the end of injection, once at the end of pumping) for nitrate plus nitrite as nitrogen, disinfectant byproducts, general chemistry, and some metals. Nitrate plus nitrite as nitrogen should be monitored because of the proximity of the current nitrate concentrations to the drinking water source. Disinfectant byproducts should be

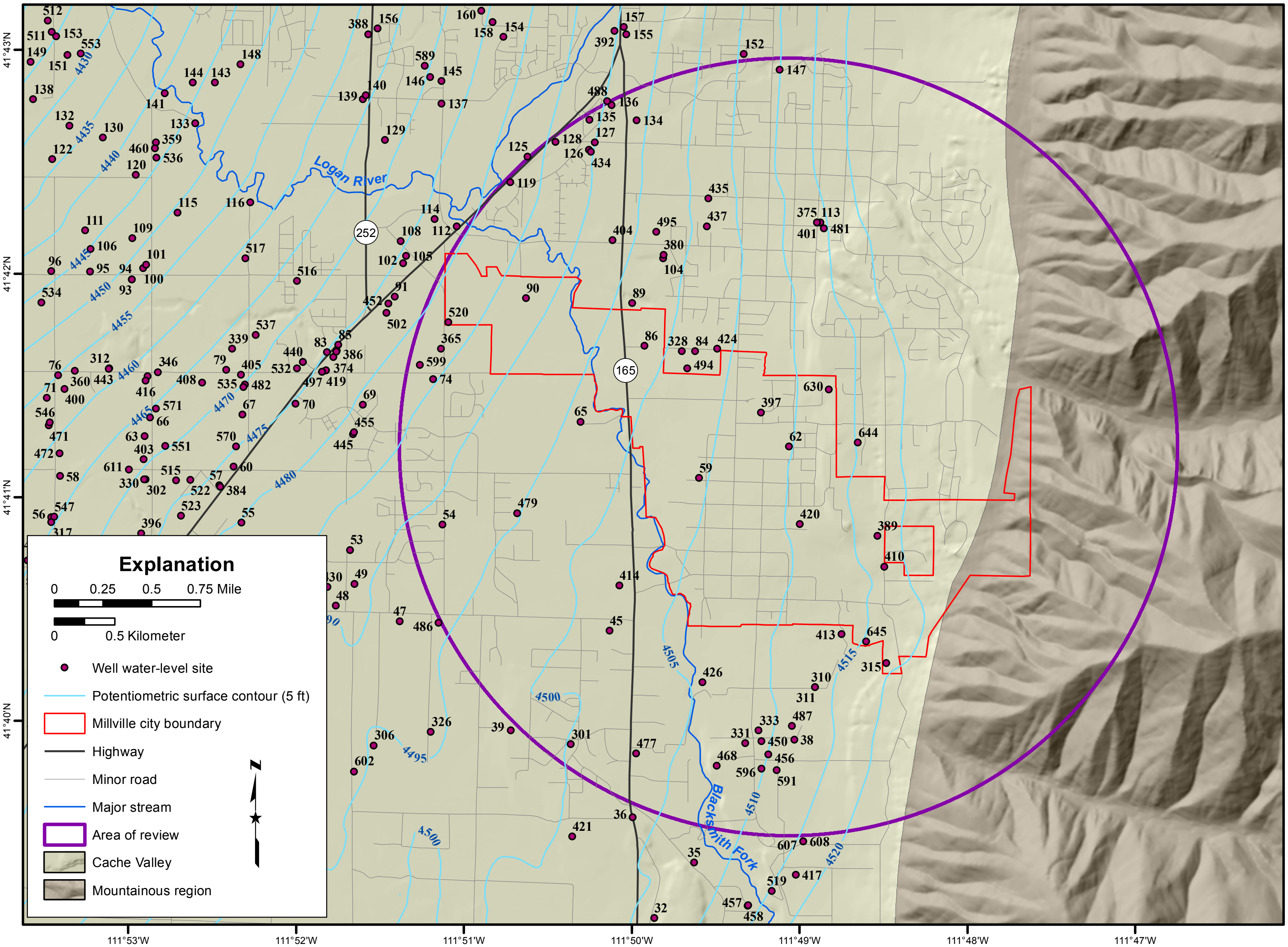

Figure 29. *Potentiometric surface contours created using cokriging interpolation of groundwater levels and elevation data in the Millville area. Numbers adjacent to sample sites are sample numbers listed in appendix E. Contour interval is 5 feet.*

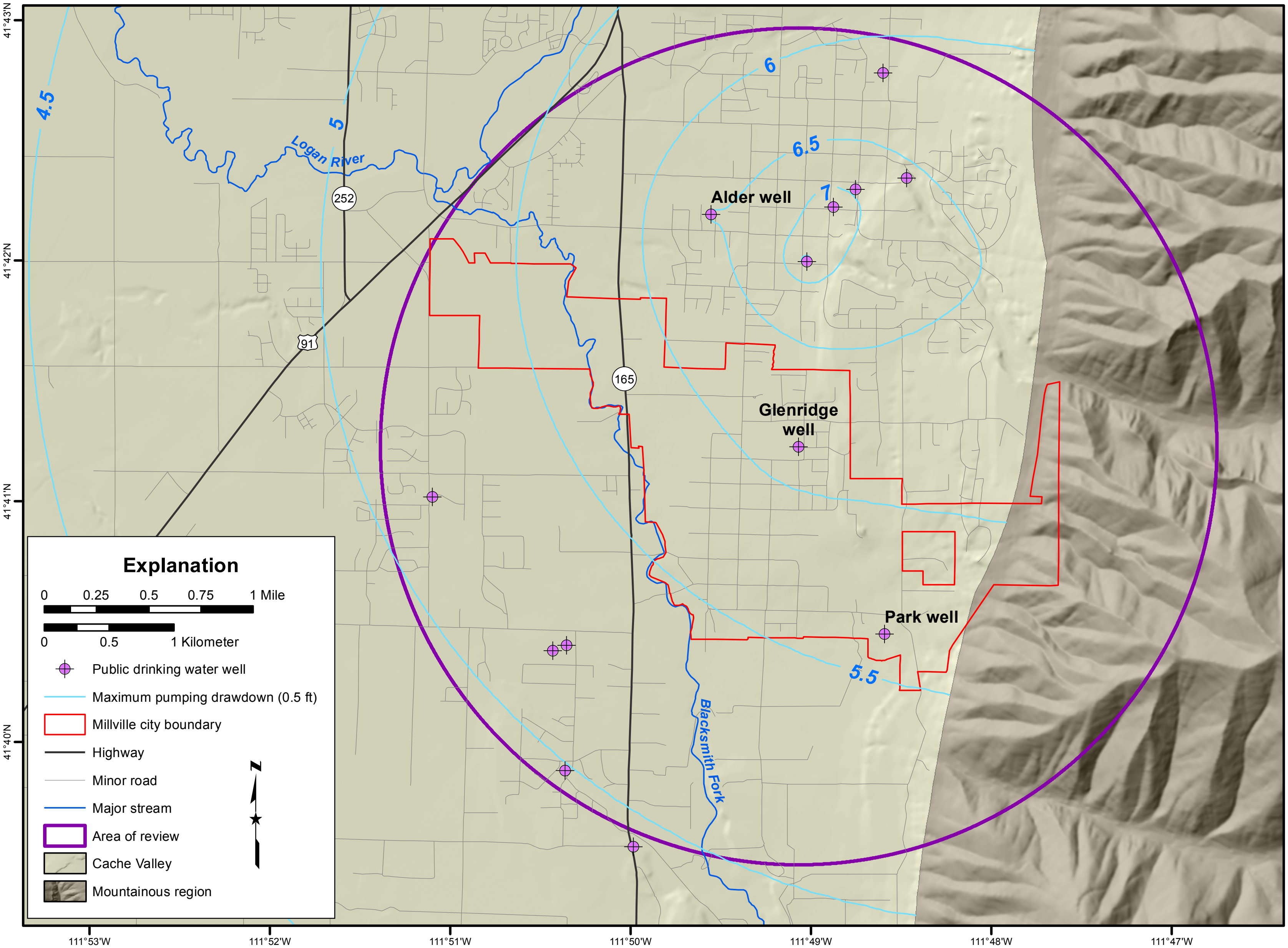

Figure 30. Drawdown contours created using AQTESOLV model of the Millville area. The contours represent maximum pumping conditions, treating the East Cache fault as a barrier to flow. Contour interval is 0.5 feet.

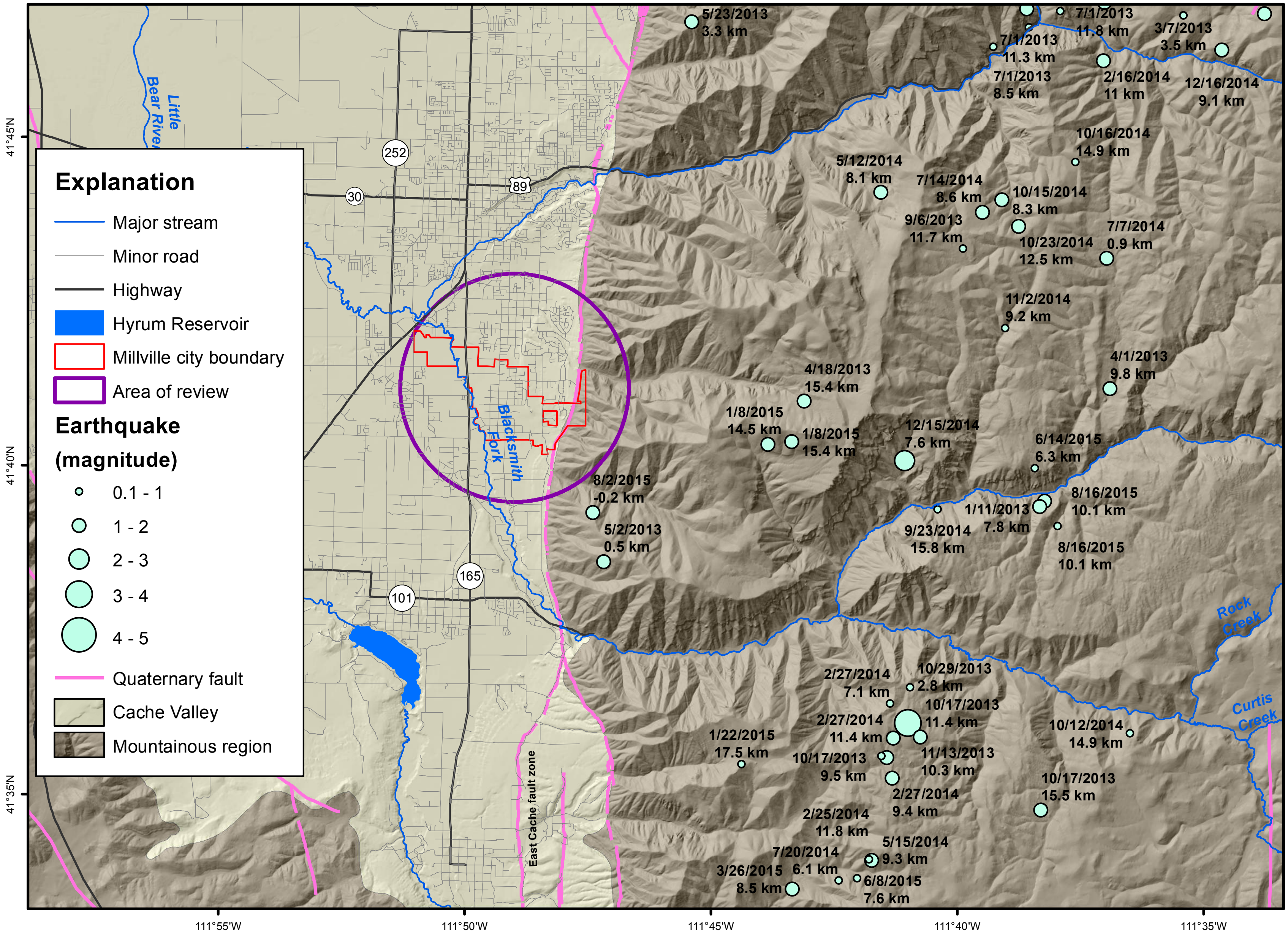

Figure 31. *Earthquakes in the Millville area from January 2013 to October 2015. The label for each earthquake is the date it was measured and the approximate hypocenter elevation.*

monitored to ensure that these are not building up over time. General chemistry includes calcium, magnesium, bicarbonate, sodium, and chloride and should be monitored to observe geochemical changes in the aquifer over time. Recommended metals to monitor twice per cycle include arsenic, iron, zinc, and lead, which will allow observation of ongoing oxidation reactions. I recommend that Millville conduct regularly (weekly to monthly) monitoring of the Glenridge well during each cycle for field dissolved oxygen and/or field Eh and field pH. Field-based measurements of dissolved oxygen and field Eh allow for monitoring ongoing changes in the oxidation state and general geochemistry of the aquifer. Millville should conduct periodic monitoring (monthly) of two nearby downgradient wells for nitrate, pH, and dissolved oxygen.

I also recommend that Millville conduct inspections and tests to ensure that the Glenridge well structure maintains its integrity. Millville should measure specific capacity (based on pumping rate, drawdown, and pumping duration) in the Glenridge on a yearly basis to determine if clogging/biofouling is occurring. A specific capacity test consists of pumping the well for a given duration while measuring discharge and water levels to determine how efficiently the well is operating. To maintain screen efficiency, I recommend regular inspection and service of the Glenridge well perforated intervals.

Monitoring of ambient groundwater levels at the Glenridge well, the new high school well, and one well to the north of the Glenridge well—the USU Farm well would work well for this, but other area wells (Arnold or Matthews) could be an option—could also be useful, but should not be necessary. Groundwater level monitoring would ensure that injection activities are not excessively raising local groundwater levels.

Injection and Pumping Schedule

Due to dispersion and bubble drift, Millville should plan to pump more total volume than they inject. To prevent excessive loss of injectate, the storage interval should be minimized. Based on these parameters, injection would start in January and proceed to the end of March, and pumping would begin sometime in June and end in October to match demand and water right access.

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APPENDICES

APPENDIX A
WATER CHEMISTRY

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
06/09/2015 10:00	Alder well	414213111493101		Sp. Cond.	648	umhos/cm	UGS
06/09/2015 10:00	Alder well	414213111493101		T. Sus. Solids	<4	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Turbidity	0.157	NTU	UGS
06/09/2015 10:00	Alder well	414213111493101		pH	6.915	units	UGS
06/09/2015 10:00	Alder well	414213111493101		Bicarbonate	350	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Carbon Dioxide	68	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Carbonate	0	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Hydroxide	0	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		T. Alk/CaCO3	287	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		TDS @ 180 C	376	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Nitrate + Nitrite as N	7.93	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Phosphate, Tot. Dig. (as P)	0.01	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Sulfate	11.8	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Ammonia as N	<0.02	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101		Chloride	21.8	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Boron	<30	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Calcium	91.2	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Iron	<0.02	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Magnesium	32.2	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Potassium	1.55	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Sodium	8.47	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Arsenic	<1	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Barium	0.1308	mg/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Cadmium	<0.1	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Chromium	<2	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Copper	7.727	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Lead	1.166	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Manganese	<5	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Nickel	<5	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Selenium	<1	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Silver	<0.5	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Zinc	25.784	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Aluminum	<10	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Mercury	<0.2	ug/L	UGS
06/09/2015 10:00	Alder well	414213111493101	Total	Selenium	0	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Sp. Cond.	653	umhos/cm	UGS
07/16/2015 11:15	Alder well	414213111493101		T. Sus. Solids	<4	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Turbidity	0.122	NTU	UGS
07/16/2015 11:15	Alder well	414213111493101		pH	7.471	units	UGS
07/16/2015 11:15	Alder well	414213111493101		Bicarbonate	342	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Carbon Dioxide	18	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Carbonate	0	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Hydroxide	0	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		T. Alk/CaCO3	280	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		TDS @ 180 C	400	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Nitrate + Nitrite as N	6.97	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Phosphate, Tot. Dig. (as P)	0.01	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Sulfate	<7.545	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Ammonia as N	<0.02	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Chloride	22.5	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101		Bromide	<0.02	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Boron	<30	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Calcium	84.9	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Iron	<20	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Magnesium	28.6	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Potassium	1.44	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Sodium	7.95	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Hardness (from D-CA and D-MG)	329.5	mg/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Arsenic	<1	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Barium	148.35	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Cadmium	<0.1	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Chromium	2.016	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Copper	11.512	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Lead	2.321	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Manganese	<5	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Nickel	<5	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Selenium	<1	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Silver	<0.5	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Zinc	52.242	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Aluminum	<10	ug/L	UGS
07/16/2015 11:15	Alder well	414213111493101	Dissolved	Mercury	<0.2	ug/L	UGS
09/05/2014 08:30	Arnold well	414023111484101		Nitrate + Nitrite as N	4.85	mg/L	Millville City
10/15/2014 00:00	Arnold well	414023111484101		Sp. Cond.	474	umhos/cm	UGS
10/15/2014 00:00	Arnold well	414023111484101		T. Sus. Solids	6.4	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Turbidity	2.35	NTU	UGS
10/15/2014 00:00	Arnold well	414023111484101		pH	7.575	units	UGS
10/15/2014 00:00	Arnold well	414023111484101		Bicarbonate	244	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Carbon Dioxide	10	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Carbonate	0	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Hydroxide	0	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		T. Alk/CaCO3	200	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		TDS @ 180 C	262	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Nitrate + Nitrite as N	4.21	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Phosphate, Tot. Dig. (as P)	0.018	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Silica D/SIO2	9.6	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Sulfate	18.2	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Ammonia as N	<0.035	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101		Chloride	12.2	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Calcium	50	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Magnesium	27.9	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Potassium	<1	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Sodium	11.1	mg/L	UGS
10/15/2014 00:00	Arnold well	414023111484101	Dissolved	Hardness (from D-CA and D-MG)	239.5	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Sp. Cond.	429	umhos/cm	UGS
04/01/2015 12:30	Arnold well	414023111484101		T. Sus. Solids	218	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Turbidity	91.4	NTU	UGS
04/01/2015 12:30	Arnold well	414023111484101		pH	7.698	units	UGS
04/01/2015 12:30	Arnold well	414023111484101		Bicarbonate	222	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Carbon Dioxide	7	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Carbonate	0	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Hydroxide	0	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		T. Alk/CaCO3	182	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		TDS @ 180 C	230	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Nitrate + Nitrite as N	3.91	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Phosphate, Tot. Dig. (as P)	0.219	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Silica D/SIO2	9.42	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Sulfate	24.7	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Ammonia as N	0.055	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101		Chloride	8.67	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Calcium	49.8	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Iron	28.1	ug/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Magnesium	28.5	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Potassium	2.63	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Sodium	12	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Hardness (from D-CA and D-MG)	241.5	mg/L	UGS
04/01/2015 12:30	Arnold well	414023111484101	Dissolved	Arsenic	<1	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Sp. Cond.	516	umhos/cm	UGS
07/16/2015 13:15	Arnold well	414023111484101		T. Sus. Solids	17.6	mg/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
07/16/2015 13:15	Arnold well	414023111484101		Turbidity	3.21	NTU	UGS
07/16/2015 13:15	Arnold well	414023111484101		pH	7.657	units	UGS
07/16/2015 13:15	Arnold well	414023111484101		Bicarbonate	292	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Carbon Dioxide	10	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Carbonate	0	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Hydroxide	0	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		T. Alk/CaCO3	239	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		TDS @ 180 C	306	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Nitrate + Nitrite as N	3.93	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Phosphate, Tot. Dig. (as P)	0.019	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Sulfate	<7.545	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Ammonia as N	<0.02	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Chloride	12.3	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101		Bromide	<0.02	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Boron	36	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Calcium	53.7	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Iron	<20	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Magnesium	29.7	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Potassium	3.73	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Sodium	12.7	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Hardness (from D-CA and D-MG)	256.2	mg/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Arsenic	<1	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Barium	123.45	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Cadmium	0.195	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Chromium	2.356	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Copper	20.792	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Lead	0.577	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Manganese	7.201	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Nickel	<5	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Selenium	<1	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Silver	<0.5	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Zinc	91.035	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Aluminum	<10	ug/L	UGS
07/16/2015 13:15	Arnold well	414023111484101	Dissolved	Mercury	<0.2	ug/L	UGS
08/24/2012 07:20	Garr spring	414024111481101		Nitrate + Nitrite as N	0.778	mg/L	Millville City
02/28/2014 09:15	Garr spring	414024111481101		Turbidity	<0.1	NTU	UGS
02/28/2014 09:15	Garr spring	414024111481101		TDS @ 180 C	254	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Fluoride	0.09	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Sulfate	27	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Cyanide	<0.01	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Nitrate as N	0.728	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Nitrite as N	<0.035	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Nitrate + Nitrite as N	0.764	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Phosphate, Tot. Dig. (as P)	0.008	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Ammonia as N	<0.035	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Sodium	4.28	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Arsenic	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Barium	<0.1	mg/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Cadmium	0.202	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Chromium	9.7	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Copper	2.19	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Lead	0.115	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Nickel	<5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Selenium	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Beryllium	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Thallium	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Antimony	<3	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Uranium 238	1.22	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101	Total	Mercury	<0.2	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
02/28/2014 09:15	Garr spring	414024111481101		Dalapon	<2.2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dicamba	<0.4	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		2,4-D	<0.22	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Pentachlorophenol	<0.08	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		2,4,5-TP (Silvex)	<0.44	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Picloram	<0.22	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dinoseb	<0.44	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1-Dichloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1,1-Trichloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1,2-Trichloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1,1,2-Tetrachloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,1,2,2-Tetrachloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2-Dibromo-3-chloropropane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2-Dichloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		2-Chlorotoluene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2,3-Trichloropropane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2,4-Trichlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,3-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,3-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,4-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		4-Chlorotoluene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		2,2-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Benzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromodichloromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2,3-Trichlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,2,4-Trimethylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,3,5-Trimethylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		1,4-Isopropyltoluene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromochloromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dichlorodifluoromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Hexachlorobutadiene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromomethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromoform	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chlorobenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chlorodibromomethane	0.44	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chloroethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chloroform	0.32	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chloromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Carbon Tetrachloride	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		cis-1,2-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		cis-1,3-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dibromomethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Ethylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Ethylene Dibromide	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Methylene Chloride	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Styrene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Tetrachloroethene (PCE)	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Toluene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Total Xylene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		trans-1,2-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		trans-1,3-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Trichloroethene (TCE)	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Vinyl Chloride	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Isopropylbenzene	<0.5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
02/28/2014 09:15	Garr spring	414024111481101		Methyl T-Butyl Ether (MTBE)	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Napthalene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		n-Butylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		n-Propylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Sec-butyl benzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Tert-butylbenzene	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Trichlorofluoromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chloroform	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromodichloromethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chlorodibromomethane	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromoform	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Total THM	<0.5	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Aldicarb sulfone	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Aldicarb sulfoxide	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Aldicarb	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Carbofuran	<2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Oxamyl	<2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Carbaryl	<2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		3-Hydroxycarbofuran	<2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Methomyl	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Alachlor	<0.2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Atrazine	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Benzo (a) pyrene	<0.05	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bis (2-ethylhexyl) adipate	<0.6	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bis (2-ethylhexyl) phthalate	<0.6	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Endrin	<0.01	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Heptachlor	<0.04	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Heptachlor Epoxide	<0.02	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Hexachlorobenzene	<0.12	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Hexachlorocyclopentadiene	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Lindane	<0.02	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Methoxychlor	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Pentachlorophenol	<0.04	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Simazine	<0.07	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Toxaphene	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Aldrin	<0.21	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Alpha-Chlordane	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Gamma-Chlordane	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Trans-Nonachlor	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Chlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dichlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Heptachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Hexachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Octachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Pentachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Tetreachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Trichlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Monochloroacetic Acid	<2	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dichloroacetic Acid	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Trichloroacetic Acid	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Monobromoacetic Acid	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Dibromoacetic Acid	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Bromochloroacetic Acid	<1	ug/L	UGS
02/28/2014 09:15	Garr spring	414024111481101		Nitrate + Nitrite as N	0.728	mg/L	Millville City
10/15/2014 10:30	Garr spring	414024111481101		Alpha, gross	0.19	pc/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Beta, gross	1.7	pc/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Radium 228	6.2	pc/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Color	0	ccu	UGS
10/15/2014 10:30	Garr spring	414024111481101		Sp. Cond.	449	umhos/cm	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 10:30	Garr spring	414024111481101		Odor	0	T.O.N.	UGS
10/15/2014 10:30	Garr spring	414024111481101		pH	7.752	units	UGS
10/15/2014 10:30	Garr spring	414024111481101		T. Sus. Solids	<4	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Turbidity	<0.1	NTU	UGS
10/15/2014 10:30	Garr spring	414024111481101		pH	7.784	units	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bicarbonate	256	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Carbon Dioxide	7	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Carbonate	0	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Hydroxide	0	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		T. Alk/CaCO3	210	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		TDS @ 180 C	246	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chloride	4.9446	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Fluoride	0.0782	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Sulfate	26.071	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Cyanide	<0.01	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Nitrate + Nitrite as N	0.625	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Phosphate, Tot. Dig. (as P)	0.008	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Silica D/SIO2	7.45	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Total Organic Carbon	<0.5	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Corrosivity	0.271	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Ammonia as N	<0.035	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Boron	<30	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Calcium	54.1	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Iron	<0.02	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Magnesium	25.6	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Potassium	<1	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Sodium	4.29	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Dissolved	Hardness (from D-CA and D-MG)	240.3	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Arsenic	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Barium	<0.1	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Cadmium	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Chromium	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Copper	1.049	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Lead	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Manganese	<5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Nickel	<5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Selenium	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Silver	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Zinc	<10	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Aluminum	<10	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Beryllium	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Thallium	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Antimony	<3	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Uranium 238	1.2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101	Total	Mercury	<0.2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Surfactant/MBAS	0	mg/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dalapon	<2.2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dicamba	<0.4	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		2,4-D	<0.22	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Pentachlorophenol	<0.08	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		2,4,5-TP (Silvex)	<0.44	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Picloram	<0.22	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dinoseb	<0.44	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1-Dichloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1,1-Trichloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1,2-Trichloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,1,1,2-Tetrachloroethane	<0.5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 10:30	Garr spring	414024111481101		1,1,2,2-Tetrachloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2-Dibromo-3-chloropropane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2-Dichloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		2-Chlorotoluene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2,3-Trichloropropane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2,4-Trichlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,3-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,3-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,4-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		4-Chlorotoluene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		2,2-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Benzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromodichloromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2,3-Trichlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,2,4-Trimethylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,3,5-Trimethylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		1,4-Isopropyltoluene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromochloromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dichlorodifluoromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Hexachlorobutadiene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromomethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromoform	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chlorobenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chlorodibromomethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chloroethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chloroform	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chloromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Carbon Tetrachloride	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		cis-1,2-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		cis-1,3-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dibromomethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Ethylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Ethylene Dibromide	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Methylene Chloride	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Styrene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Tetrachloroethene (PCE)	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Toluene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Total Xylene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		trans-1,2-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		trans-1,3-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Trichloroethene (TCE)	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Vinyl Chloride	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Isopropylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Methyl T-Butyl Ether (MTBE)	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Napthalene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		n-Butylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		n-Propylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Sec-butyl benzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Tert-butylbenzene	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Trichlorofluoromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chloroform	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromodichloromethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chlorodibromomethane	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromoform	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Total THM	<0.5	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Aldicarb sulfone	<1	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 10:30	Garr spring	414024111481101		Aldicarb sulfoxide	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Aldicarb	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Carbofuran	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Oxamyl	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Carbaryl	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		3-Hydroxycarbofuran	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Methomyl	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Alachlor	<0.2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Atrazine	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Benzo (a) pyrene	<0.05	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bis (2-ethylhexyl) adipate	<0.6	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bis (2-ethylhexyl) phthalate	<0.6	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Endrin	<0.01	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Heptachlor	<0.04	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Heptachlor Epoxide	<0.02	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Hexachlorobenzene	<0.12	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Hexachlorocyclopentadiene	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Lindane	<0.02	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Methoxychlor	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Pentachlorophenol	<0.04	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Simazine	<0.07	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Toxaphene	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Aldrin	<0.21	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Alpha-Chlordane	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Gamma-Chlordane	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Trans-Nonachlor	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Chlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dichlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Heptachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Hexachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Octachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Pentachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Tetreachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Trichlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Monochloroacetic Acid	<2	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dichloroacetic Acid	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Trichloroacetic Acid	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Monobromoacetic Acid	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Dibromoacetic Acid	<1	ug/L	UGS
10/15/2014 10:30	Garr spring	414024111481101		Bromochloroacetic Acid	<1	ug/L	UGS
11/04/2014 11:30	Garr spring	414024111481101		Surfactant/MBAS	<0.015	mg/L	UGS
08/24/2012 08:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.81	mg/L	Millville City
07/16/2013 10:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	8.45	mg/L	Millville City
09/20/2013 08:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	8.14	mg/L	Millville City
02/28/2014 11:15	Glenridge well	414115111490301		Turbidity	<0.1	NTU	UGS
02/28/2014 11:15	Glenridge well	414115111490301		TDS @ 180 C	426	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Fluoride	0.11	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Sulfate	23.3	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Cyanide	<0.01	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Nitrate as N	7.65	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Nitrite as N	<0.035	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.65	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.021	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Ammonia as N	<0.035	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Sodium	12.6	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Arsenic	1.09	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Barium	0.222	mg/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Cadmium	0.128	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Chromium	15.9	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
02/28/2014 11:15	Glenridge well	414115111490301	Total	Copper	1.63	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Lead	0.483	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Nickel	<5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Selenium	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Beryllium	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Thallium	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Antimony	<3	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Uranium 238	1.74	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301	Total	Mercury	<0.2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dalapon	<2.2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dicamba	<0.4	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		2,4-D	<0.22	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Pentachlorophenol	<0.08	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		2,4,5-TP (Silvex)	<0.44	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Picloram	<0.22	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dinoseb	<0.44	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1-Dichloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1,1-Trichloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1,2-Trichloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1,1,2-Tetrachloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,1,2,2-Tetrachloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2-Dibromo-3-chloropropane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2-Dichloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		2-Chlorotoluene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2,3-Trichloropropane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2,4-Trichlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,3-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,3-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,4-Dichlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		4-Chlorotoluene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		2,2-Dichloropropane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Benzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromodichloromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2,3-Trichlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,2,4-Trimethylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,3,5-Trimethylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		1,4-Isopropyltoluene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromochloromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dichlorodifluoromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Hexachlorobutadiene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromomethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromoform	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chlorobenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chlorodibromomethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chloroethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chloroform	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chloromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Carbon Tetrachloride	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		cis-1,2-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		cis-1,3-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dibromomethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Ethylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Ethylene Dibromide	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Methylene Chloride	<0.5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
02/28/2014 11:15	Glenridge well	414115111490301		Styrene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Tetrachloroethene (PCE)	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Toluene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Total Xylene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		trans-1,2-Dichloroethene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		trans-1,3-Dichloropropene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Trichloroethene (TCE)	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Vinyl Chloride	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Isopropylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Methyl T-Butyl Ether (MTBE)	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Napthalene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		n-Butylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		n-Propylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Sec-butyl benzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Tert-butylbenzene	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Trichlorofluoromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chloroform	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromodichloromethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chlorodibromomethane	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bromoform	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Total THM	<0.5	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Aldicarb sulfone	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Aldicarb sulfoxide	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Aldicarb	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Carbofuran	<2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Oxamyl	<2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Carbaryl	<2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		3-Hydroxycarbofuran	<2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Methomyl	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Alachlor	<0.2	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Atrazine	0.24	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Benzo (a) pyrene	<0.05	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bis (2-ethylhexyl) adipate	<0.6	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Bis (2-ethylhexyl) phthalate	<0.6	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Endrin	<0.01	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Heptachlor	<0.04	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Heptachlor Epoxide	<0.02	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Hexachlorobenzene	<0.12	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Hexachlorocyclopentadiene	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Lindane	<0.02	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Methoxychlor	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Pentachlorophenol	<0.04	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Simazine	<0.07	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Toxaphene	<1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Aldrin	<0.21	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Alpha-Chlordane	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Gamma-Chlordane	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Trans-Nonachlor	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Chlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Dichlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Heptachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Hexachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Octachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Pentachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Tetreachlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Trichlorobiphenyl	<0.1	ug/L	UGS
02/28/2014 11:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.65	mg/L	Millville City
03/01/2014 11:15	Glenridge well	414115111490301		Monochloroacetic Acid	<2	ug/L	UGS
03/02/2014 11:15	Glenridge well	414115111490301		Dichloroacetic Acid	<1	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
03/03/2014 11:15	Glenridge well	414115111490301		Trichloroacetic Acid	<1	ug/L	UGS
03/04/2014 11:15	Glenridge well	414115111490301		Monobromoacetic Acid	<1	ug/L	UGS
03/05/2014 11:15	Glenridge well	414115111490301		Dibromoacetic Acid	<1	ug/L	UGS
03/06/2014 11:15	Glenridge well	414115111490301		Bromochloroacetic Acid	<1	ug/L	UGS
03/17/2014 10:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.68	mg/L	Millville City
03/19/2014 10:40	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.01	mg/L	Millville City
03/19/2014 14:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.922	mg/L	Millville City
03/19/2014 14:05	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.767	mg/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.009	mg/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Ammonia as N	<0.035	mg/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Monochloroacetic Acid	<2	ug/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Dichloroacetic Acid	<1	ug/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Trichloroacetic Acid	<1	ug/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Monobromoacetic Acid	<1	ug/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Dibromoacetic Acid	<1	ug/L	UGS
03/19/2014 14:05	Glenridge well	414115111490301		Bromochloroacetic Acid	<1	ug/L	UGS
03/19/2014 16:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.799	mg/L	UGS
03/19/2014 20:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.883	mg/L	Millville City
03/19/2014 22:15	Glenridge well	414115111490301		Nitrate as N	0.854	mg/L	UGS
03/19/2014 22:15	Glenridge well	414115111490301		Nitrite as N	<0.007	mg/L	UGS
03/20/2014 08:50	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.04	mg/L	UGS
03/21/2014 09:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.49	mg/L	Millville City
03/21/2014 10:06	Glenridge well	414115111490301		Nitrate + Nitrite as N	4.07	mg/L	Millville City
03/21/2014 12:47	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.56	mg/L	Millville City
03/21/2014 16:18	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.64	mg/L	Millville City
03/22/2014 09:37	Glenridge well	414115111490301		Nitrate + Nitrite as N	2	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Sp. Cond.	562	umhos/cm	UGS
03/24/2014 10:15	Glenridge well	414115111490301		T. Sus. Solids	<4	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Turbidity	<0.1	NTU	UGS
03/24/2014 10:15	Glenridge well	414115111490301		pH	7.683	units	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Bicarbonate	302	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Carbon Dioxide	10	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Carbonate	0	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Hydroxide	0	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		T. Alk/CaCO3	248	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		TDS @ 180 C	332	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.0531	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.015	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Sulfate	25.1	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Ammonia as N	<0.035	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301		Chloride	11.7	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Boron	<30	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Dissolved	Calcium	59.9	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Calcium	60.9	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Iron	<0.02	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Dissolved	Magnesium	30.3	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Magnesium	31.1	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Dissolved	Potassium	1.16	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Potassium	1.15	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Dissolved	Sodium	7.51	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Sodium	7.62	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Dissolved	Hardness (from D-CA and D-MG)	274.1	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Arsenic	<1	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Barium	0.12511	mg/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Cadmium	<0.1	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Chromium	<2	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Copper	1.402	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Lead	0.263	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Manganese	<5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
03/24/2014 10:15	Glenridge well	414115111490301	Total	Nickel	<5	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Silver	<0.5	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Zinc	<10	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Aluminum	<10	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Mercury	<0.2	ug/L	UGS
03/24/2014 10:15	Glenridge well	414115111490301	Total	Selenium	<1	ug/L	UGS
03/24/2014 10:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	3.02	mg/L	Millville City
04/08/2014 14:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	4.23	mg/L	Millville City
04/16/2014 13:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	4.75	mg/L	Millville City
05/05/2014 13:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	5.29	mg/L	Millville City
05/28/2014 13:45	Glenridge well	414115111490301		Nitrate + Nitrite as N	6.45	mg/L	Millville City
06/30/2014 14:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	6.55	mg/L	Millville City
07/10/2014 14:20	Glenridge well	414115111490301		Nitrate + Nitrite as N	6.49	mg/L	Millville City
07/28/2014 09:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	6.52	mg/L	Millville City
08/20/2014 11:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.31	mg/L	Millville City
09/05/2014 09:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.65	mg/L	Millville City
10/15/2014 11:30	Glenridge well	414115111490301		Alpha, gross	1.1	pc/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Beta, gross	0.76	pc/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Radium 228	1.6	pc/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Color	0	ccu	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Sp. Cond.	779	umhos/cm	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Odor	0	T.O.N.	UGS
10/15/2014 11:30	Glenridge well	414115111490301		pH	7.514	units	UGS
10/15/2014 11:30	Glenridge well	414115111490301		T. Sus. Solids	<4	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Turbidity	0.116	NTU	UGS
10/15/2014 11:30	Glenridge well	414115111490301		pH	7.604	units	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bicarbonate	394	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Carbon Dioxide	16	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Carbonate	0	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Hydroxide	0	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		T. Alk/CaCO3	323	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		TDS @ 180 C	440	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chloride	34.227	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Fluoride	0.1012	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Sulfate	28.058	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Cyanide	<0.01	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Nitrate + Nitrite as N	7.19	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.017	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Silica D/SIO2	13.8	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Total Organic Carbon	<0.5	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Corrosivity	0.364	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Ammonia as N	<0.035	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Boron	37.7	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Calcium	81.5	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Iron	<0.02	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Magnesium	44.9	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Potassium	1.82	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Sodium	14	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Dissolved	Hardness (from D-CA and D-MG)	388.1	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Arsenic	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Barium	0.22227	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Cadmium	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Chromium	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Copper	12.591	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Lead	2.608	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Manganese	<5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Nickel	<5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Selenium	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Silver	<0.5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 11:30	Glenridge well	414115111490301	Total	Zinc	26.686	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Aluminum	<10	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Beryllium	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Thallium	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Antimony	<3	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Uranium 238	1.84	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301	Total	Mercury	<0.2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Surfactant/MBAS	0	mg/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dalapon	<2.2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dicamba	<0.4	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		2,4-D	<0.22	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Pentachlorophenol	0.092	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		2,4,5-TP (Silvex)	<0.44	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Picloram	<0.22	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dinoseb	<0.44	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1-Dichloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1,1-Trichloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1,2-Trichloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1,1,2-Tetrachloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,1,2,2-Tetrachloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2-Dibromo-3-chloropropane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2-Dichloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		2-Chlorotoluene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2,3-Trichloropropane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2,4-Trichlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,3-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,3-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,4-Dichlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		4-Chlorotoluene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		2,2-Dichloropropane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Benzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromodichloromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2,3-Trichlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,2,4-Trimethylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,3,5-Trimethylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		1,4-Isopropyltoluene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromochloromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dichlorodifluoromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Hexachlorobutadiene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromomethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromoform	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chlorobenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chlorodibromomethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chloroethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chloroform	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chloromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Carbon Tetrachloride	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		cis-1,2-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		cis-1,3-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dibromomethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Ethylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Ethylene Dibromide	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Methylene Chloride	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Styrene	<0.5	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 11:30	Glenridge well	414115111490301		Tetrachloroethene (PCE)	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Toluene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Total Xylene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		trans-1,2-Dichloroethene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		trans-1,3-Dichloropropene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Trichloroethene (TCE)	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Vinyl Chloride	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Isopropylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Methyl T-Butyl Ether (MTBE)	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Napthalene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		n-Butylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		n-Propylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Sec-butyl benzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Tert-butylbenzene	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Trichlorofluoromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chloroform	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromodichloromethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chlorodibromomethane	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromoform	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Total THM	<0.5	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Aldicarb sulfone	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Aldicarb sulfoxide	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Aldicarb	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Carbofuran	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Oxamyl	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Carbaryl	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		3-Hydroxycarbofuran	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Methomyl	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Alachlor	<0.2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Atrazine	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Benzo (a) pyrene	<0.05	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bis (2-ethylhexyl) adipate	<0.6	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bis (2-ethylhexyl) phthalate	<0.6	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Endrin	<0.01	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Heptachlor	<0.04	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Heptachlor Epoxide	<0.02	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Hexachlorobenzene	<0.12	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Hexachlorocyclopentadiene	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Lindane	<0.02	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Methoxychlor	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Pentachlorophenol	<0.04	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Simazine	<0.07	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Toxaphene	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Aldrin	<0.21	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Alpha-Chlordane	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Gamma-Chlordane	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Trans-Nonachlor	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Chlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dichlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Heptachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Hexachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Octachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Pentachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Tetreachlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Trichlorobiphenyl	<0.1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Monochloroacetic Acid	<2	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Dichloroacetic Acid	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Trichloroacetic Acid	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Monobromoacetic Acid	<1	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
10/15/2014 11:30	Glenridge well	414115111490301		Dibromoacetic Acid	<1	ug/L	UGS
10/15/2014 11:30	Glenridge well	414115111490301		Bromochloroacetic Acid	<1	ug/L	UGS
11/04/2014 10:00	Glenridge well	414115111490301		Surfactant/MBAS	<0.015	mg/L	UGS
04/01/2015 10:45	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.686	mg/L	Millville City
04/01/2015 11:00	Glenridge well	414115111490301		Sp. Cond.	451	umhos/cm	UGS
04/01/2015 11:00	Glenridge well	414115111490301		T. Sus. Solids	<4	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Turbidity	0.108	NTU	UGS
04/01/2015 11:00	Glenridge well	414115111490301		pH	7.833	units	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Bicarbonate	258	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Carbon Dioxide	6	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Carbonate	0	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Hydroxide	0	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		T. Alk/CaCO3	212	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		TDS @ 180 C	252	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	0.681	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.008	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Silica D/SIO2	7.46	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Sulfate	29.5	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Ammonia as N	<0.02	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301		Chloride	5.01	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Calcium	55.9	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Iron	<20	ug/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Magnesium	26.9	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Potassium	<1	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Sodium	4.13	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Hardness (from D-CA and D-MG)	250.2	mg/L	UGS
04/01/2015 11:00	Glenridge well	414115111490301	Dissolved	Arsenic	<1	ug/L	UGS
05/20/2015 11:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	1.9	mg/L	Millville City
06/25/2015 09:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	3.74	mg/L	Millville City
07/13/2015 10:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	3.32	mg/L	Millville City
07/16/2015 09:45	Glenridge well	414115111490301		Sp. Cond.	580	umhos/cm	UGS
07/16/2015 09:45	Glenridge well	414115111490301		T. Sus. Solids	<4	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Turbidity	0.123	NTU	UGS
07/16/2015 09:45	Glenridge well	414115111490301		pH	7.589	units	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Bicarbonate	308	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Carbon Dioxide	13	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Carbonate	0	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Hydroxide	0	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		T. Alk/CaCO3	253	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		TDS @ 180 C	342	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Nitrate + Nitrite as N	3.64	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Phosphate, Tot. Dig. (as P)	0.013	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Sulfate	16.7	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Ammonia as N	<0.02	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Chloride	15.3	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Bromide	0.0656	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Boron	<30	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Calcium	66.5	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Iron	<20	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Magnesium	31.4	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Potassium	1.19	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Sodium	14	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Hardness (from D-CA and D-MG)	295.1	mg/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Arsenic	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Barium	128.62	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Cadmium	0.148	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Chromium	<2	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Copper	9.639	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Lead	3.639	ug/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Manganese	<5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Nickel	<5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Selenium	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Silver	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Zinc	137.06	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Aluminum	<10	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301	Dissolved	Mercury	<0.2	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Chloroform	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Bromodichloromethane	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Chlorodibromomethane	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Bromoform	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Total THM	<0.5	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Monochloroacetic Acid	<2	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Dichloroacetic Acid	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Trichloroacetic Acid	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Monobromoacetic Acid	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Dibromoacetic Acid	<1	ug/L	UGS
07/16/2015 09:45	Glenridge well	414115111490301		Bromochloroacetic Acid	<1	ug/L	UGS
08/13/2015 10:15	Glenridge well	414115111490301		Nitrate + Nitrite as N	4.56	mg/L	Millville City
08/27/2015 08:45	Glenridge well	414115111490301		Nitrate + Nitrite as N	4.94	mg/L	Millville City
09/14/2015 10:00	Glenridge well	414115111490301		Nitrate + Nitrite as N	5.53	mg/L	Millville City
09/29/2015 11:10	Glenridge well	414115111490301		Nitrate + Nitrite as N	5.61	mg/L	Millville City
08/23/2012 13:30	Hancey well	414042111483501		Nitrate + Nitrite as N	3.48	mg/L	Millville City
07/15/2013 10:15	Hancey well	414042111483501		Nitrate + Nitrite as N	3.9	mg/L	Millville City
02/28/2014 12:50	Hancey well	414042111483501		Nitrate + Nitrite as N	2	mg/L	Millville City
02/28/2014 12:50	Hancey well	414042111483501		Nitrate as N	2	mg/L	UGS
02/28/2014 12:50	Hancey well	414042111483501		Nitrite as N	<0.035	mg/L	UGS
03/19/2014 16:00	Hancey well	414042111483501		Nitrate + Nitrite as N	1.82	mg/L	UGS
09/05/2014 09:45	Hancey well	414042111483501		Nitrate + Nitrite as N	3.31	mg/L	Millville City
04/02/2015 10:20	Hancey well	414042111483501		Nitrate + Nitrite as N	4.3	mg/L	Millville City
09/21/2015 13:40	High School well	414108111494201		Nitrate + Nitrite as N	1.71	mg/L	Millville City
10/16/2014 11:00	Knowles spring	414107111483501		Nitrate + Nitrite as N	5.87	mg/L	UGS
10/16/2014 11:00	Knowles spring	414107111483501		Phosphate, Tot. Dig. (as P)	0.012	mg/L	UGS
10/16/2014 11:00	Knowles spring	414107111483501		Ammonia as N	<0.035	mg/L	UGS
08/23/2012 13:45	Knowles spring	414107111483501		Nitrate + Nitrite as N	6.89	mg/L	Millville City
07/15/2013 10:15	Knowles spring	414107111483501		Nitrate + Nitrite as N	7.72	mg/L	Millville City
09/05/2014 09:20	Knowles spring	414107111483501		Nitrate + Nitrite as N	6.54	mg/L	Millville City
04/02/2015 12:00	Knowles spring	414107111483501		Nitrate + Nitrite as N	5.41	mg/L	Millville City
07/16/2013 10:15	Matthews well	414125111491601		Nitrate + Nitrite as N	6.5	mg/L	Millville City
03/21/2014 09:30	Matthews well	414125111491601		Nitrate + Nitrite as N	6.44	mg/L	Millville City
03/24/2014 10:00	Matthews well	414125111491601		Nitrate + Nitrite as N	7.27	mg/L	Millville City
09/05/2014 11:00	Matthews well	414125111491601		Nitrate + Nitrite as N	6.85	mg/L	Millville City
03/19/2015 13:45	Matthews well	414125111491601		Nitrate + Nitrite as N	6.91	mg/L	Millville City
04/01/2015 11:30	Matthews well	414125111491601		Nitrate + Nitrite as N	6.14	mg/L	Millville City
04/30/2015 08:30	Matthews well	414115111490301		Nitrate + Nitrite as N	4.43	mg/L	Millville City
06/10/2015 11:20	Matthews well	414125111491601		Nitrate + Nitrite as N	2.77	mg/L	Millville City
06/10/2015 11:35	Matthews well	414125111491601		Nitrate + Nitrite as N	6.08	mg/L	Millville City
07/13/2015 10:15	Matthews well	414125111491601		Nitrate + Nitrite as N	6.48	mg/L	Millville City
08/27/2015 09:15	Matthews well	414125111491601		Nitrate + Nitrite as N	7.21	mg/L	Millville City
09/29/2015 11:45	Matthews well	414125111491601		Nitrate + Nitrite as N	6.02	mg/L	Millville City
07/15/2013 10:15	O. Hancey well	414052111484301		Nitrate + Nitrite as N	1.79	mg/L	Millville City
09/05/2014 09:30	O. Hancey well	414052111484301		Nitrate + Nitrite as N	2.3	mg/L	Millville City
04/02/2015 11:00	O. Hancey well	414052111484301		Nitrate + Nitrite as N	7.15	mg/L	Millville City
08/24/2012 07:20	Park well	414029111483501		Nitrate + Nitrite as N	0.821	mg/L	Millville City
09/20/2013 08:00	Park well	414029111483501		Nitrate + Nitrite as N	0.765	mg/L	Millville City
07/13/2015 10:30	Park well	414029111483501		Nitrate + Nitrite as N	0.795	mg/L	Millville City
08/23/2012 13:30	Postma well	414018111483001		Nitrate + Nitrite as N	0.77	mg/L	Millville City
07/15/2013 10:00	Postma well	414018111483001		Nitrate + Nitrite as N	1.79	mg/L	Millville City
04/02/2015 10:10	Postma well	414018111483001		Nitrate + Nitrite as N	0.666	mg/L	Millville City

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
07/16/2013 10:15	Skinner spring	414112111483101		Nitrate + Nitrite as N	5.75	mg/L	Millville City
04/14/2015 13:30	Skinner spring	414112111483101		Nitrate + Nitrite as N	1.18	mg/L	Millville City
02/28/2014 14:06	USU well	414143111495501		Nitrate as N	1.08	mg/L	UGS
02/28/2014 14:06	USU well	414143111495501		Nitrite as N	<0.035	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501		Nitrate + Nitrite as N	0.952	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501		Phosphate, Tot. Dig. (as P)	0.013	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Boron	<30	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Calcium	66	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Iron	0.62	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Magnesium	25.4	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Potassium	1.47	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Sodium	6.66	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Arsenic	<1	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Barium	<0.1	mg/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Cadmium	<0.1	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Chromium	<2	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Copper	<1	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Lead	<0.1	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Manganese	7.401	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Nickel	<5	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Silver	<0.5	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Zinc	98.646	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Aluminum	<10	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Mercury	<0.2	ug/L	UGS
03/31/2014 11:55	USU well	414143111495501	Total	Selenium	<1	ug/L	UGS
10/16/2014 10:00	USU well	414143111495501		Sp. Cond.	548	umhos/cm	UGS
10/16/2014 10:00	USU well	414143111495501		T. Sus. Solids	<4	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Turbidity	2.25	NTU	UGS
10/16/2014 10:00	USU well	414143111495501		pH	7.535	units	UGS
10/16/2014 10:00	USU well	414143111495501		Bicarbonate	318	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Carbon Dioxide	15	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Carbonate	0	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Hydroxide	0	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		T. Alk/CaCO3	261	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		TDS @ 180 C	310	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Nitrate + Nitrite as N	1.07	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Phosphate, Tot. Dig. (as P)	0.014	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Silica D/SIO2	11	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Sulfate	27.5	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Ammonia as N	<0.035	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501		Chloride	9.1	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Calcium	69.7	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Magnesium	26.6	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Potassium	1.19	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Sodium	6.4	mg/L	UGS
10/16/2014 10:00	USU well	414143111495501	Dissolved	Hardness (from D-CA and D-MG)	283.3	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Sp. Cond.	528	umhos/cm	UGS
04/01/2015 13:30	USU well	414143111495501		T. Sus. Solids	<4	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Turbidity	1.46	NTU	UGS
04/01/2015 13:30	USU well	414143111495501		pH	7.507	units	UGS
04/01/2015 13:30	USU well	414143111495501		Bicarbonate	300	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Carbon Dioxide	15	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Carbonate	0	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Hydroxide	0	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		T. Alk/CaCO3	246	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		TDS @ 180 C	280	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Silica D/SIO2	9.82	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Sulfate	25	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501		Chloride	8.52	mg/L	UGS

Sample Date-time	Station Name	Station ID	Matrix Description	Parameter Description	Result	Units	Sampled by
04/01/2015 13:30	USU well	414143111495501	Dissolved	Calcium	70.3	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Iron	210	ug/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Magnesium	27.2	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Potassium	1.46	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Sodium	6.62	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Hardness (from D-CA and D-MG)	287.3	mg/L	UGS
04/01/2015 13:30	USU well	414143111495501	Dissolved	Arsenic	<1	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501		Sp. Cond.	529	umhos/cm	UGS
07/16/2015 10:45	USU well	414143111495501		T. Sus. Solids	<4	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Turbidity	0.102	NTU	UGS
07/16/2015 10:45	USU well	414143111495501		pH	7.083	units	UGS
07/16/2015 10:45	USU well	414143111495501		Bicarbonate	316	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Carbon Dioxide	42	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Carbonate	0	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Hydroxide	0	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		T. Alk/CaCO3	259	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		TDS @ 180 C	326	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Nitrate + Nitrite as N	1.06	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Phosphate, Tot. Dig. (as P)	0.013	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Sulfate	16.7	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Ammonia as N	<0.02	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Chloride	8.42	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501		Bromide	<0.02	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Boron	<30	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Calcium	67.9	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Iron	<20	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Magnesium	25.8	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Potassium	1.63	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Sodium	6.9	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Hardness (from D-CA and D-MG)	275.6	mg/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Arsenic	<1	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Barium	<100	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Cadmium	<0.1	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Chromium	<2	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Copper	6.809	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Lead	1.172	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Manganese	<5	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Nickel	<5	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Selenium	<1	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Silver	<0.5	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Zinc	267.44	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Aluminum	<10	ug/L	UGS
07/16/2015 10:45	USU well	414143111495501	Dissolved	Mercury	<0.2	ug/L	UGS
10/16/2014 09:15	Vail well	414117111500401	Dissolved	Nitrate + Nitrite as N	1.45	mg/L	UGS
10/16/2014 09:15	Vail well	414117111500401	Dissolved	Ammonia as N	<0.03	mg/L	UGS

APPENDIX B
WELL LOGS

Form 113—3M—12-60

no card

15-5768

Examined 9/16/75 WQ
Recorded: B. C. 9/16/75 T. B. WQ
Inspection Sheet
Copied

1975

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 41887
Claim No.
Coordinate No. (A-11-1) 15 ddc

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Glen W. Hancey
Address 2033 N. 10th East Logan, Utah

(2) LOCATION OF WELL:
County Cache Ground Water Basin (leave blank)
North 510 feet, ~~East~~ West 675 feet from SE Corner
of Section 15, T. 11 N, R. 1 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☒
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☒ Industrial ☐ Municipal ☐ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☒
16" Diam. from 0 feet to 98 feet Gage .312
10" Diam. from 0 feet to 386 feet Gage .365
" Diam. from feet to feet Gage
New ☒ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☒ No ☐
Type of perforator used Mills Blade Type
Size of perforations 1/4 inches by 1 1/2 inches
1200 perforations from 269 feet to 369 feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☒ Size of gravel:
Gravel placed from feet to feet
Was a surface seal provided? Yes ☒ No ☐
To what depth? 100 feet
Material used in seal: Cement Grout
Did any strata contain unusable water? Yes ☐ No ☒
Type of water: Depth of strata
Method of sealing strata off:

Was surface casing used? Yes ☒ No ☐
Was it cemented in place? Yes ☒ No ☐

(10) WATER LEVELS:
Static level 180 feet below land surface Date 9-6-73
Artesian pressure feet above land surface Date

LOG RECEIVED:

DIVISION OF WATER RIGHTS 1975

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☒ No ☐ If so, by whom? J. S. Lee & Sons
Yield: 440 gal./min. with 2.5 feet drawdown after 10 hours
" " " "
" " " "
Bailer test gal./min. with feet drawdown after hours
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? No ☐ Yes ☒

(13) WELL LOG: Diameter of well 10 inches
Depth drilled 385 feet. Depth of completed well 385 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	1											Top Soil
1	80	x			x		x					
80	85	x										Brown
85	193	x			x							
193	239				x							Dirty
239	245	x										Brown
245	247	x			x							
247	262								x			Hard
262	268	x			x							
268	274								x			Hard
274	283	x			x							
283	290				x							Water
290	305	x			x							
305	369								x			Hard
369	375	x										Brown
375	385	x			x							

Work started 7-31-73, 19 Completed 9-6-73, 19

(14) PUMP:
Manufacturer's Name
Type: H. P.
Depth to pump or bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name J. S. Lee & Sons (Person, firm, or corporation) (Type or print)
Address 1313 So. Hwy 89-91, Logan, Utah
(Signed) Robert E. Lee (Well Driller)
License No. 11 Date 9-10-73, 19

USE OTHER SIDE FOR ADDITIONAL REMARKS

PUMP INSTALLATION REPORT (PUMP LOG)

State of Utah Division of Water Rights
PO Box 146300, SLC, UT 84114-6300
(801) 538-7240; (801) 538-7467 fax; waterrights.utah.gov

Well Identification (e.g., Water Right or Non-production Well Number) 25-5171 a16185

Owner Info (Name and Address): Millville City WIN 2721

Well Location:

Physical Street Address 200E 350S

Point of Diversion (Public Land Survey): North/South ____ feet, East/West ____ feet from the ____ Corner of Section ____, Township ____, Range ____, SLB&M/USB&M

GPS (UTM or Lat-Long, incl. Map Datum): 0431973 4615178

Existing Well Details (if known)

Is a Well Driller's Report Available? ☐ Yes ☑ No; Well Depth 388 feet; Well Diameter 10 inches
Nature of Use: ☑ Dom. ☐ Irr. ☐ Stock ☐ Industrial ☐ Commercial ☑ Municipal ☐ Provisional ☐ Monitor
Casing Type: ☑ Steel ☐ Stainless Steel ☐ PVC ☐ Fiberglass ☐ ABS ☐ SR ☐ Other ____
Depth of Surface Seal ____; Other details (if known): ____

RECEIVED
MAR 19 2014 KH
WATER RIGHTS
SALT LAKE

Pump Installation Details:

Type of Installation: [ ] *New;* [ ] *Replacement;* [✓] *Repair;* [✓] *Other* ____
Date of Installation (single date or range as applicable): 3-18-14
Type of Pump: [✓] *Submersible;* [ ] *Lineshaft;* [ ] *Jet;* [ ] *Other* ____
Pump Manufacturer: Simmons ; *Pump Model:* SS8LL-4
Number of Stages: 4 ; *Riser/Discharge Pipe Type/Size:* 4" Galv ; *Shaft Size (in):* ____
Height of Casing Above Ground Surface (inches): 12 *Pump Intake Depth Below Top of Casing (ft):* 231
Pump Size (hp): 30 ; *Pump Capacity (gpm):* 385 ; *Static Water Level (ft below top of casing):* 183
Pumping Water Level (ft below top of casing): ____; *Shut-in Head for Flowing Wells (ft or psi):* ____
Artesian Flow (gpm): — ; *Drawdown at End of Test (ft):* —
Pitless Installation: [ ] *Yes;* [✓] *No Manufacturer:* ____; *Model:* ____
Pitless Type: [ ] *Pitless Adapter;* [ ] *Pitless Unit;* [ ] *Screw On;* [ ] *Welded;* [ ] *Compression*
Method of Cutting Hole in Casing: — ; *Depth of Pitless (ft BGS):* —
Pump Testing? [ ] *Yes;* [✓] *No; Test Pumping Rate (gpm):* — ; *Test Pump Duration (hrs):* ____
Water Level Measurement Method: [ ] *Airline;* [✓] *Electric Sounder;* [ ] *Steel Tape;* [ ] *Other* ____
Discharge Measure Method: [ ] *Bailer;* [ ] *Bucket/Barrel/Stopwatch'* [ ] *Current;* [ ] *Air Lift;* [ ] *Gauge;* [ ] *Meter;* [ ] *Orifice;* [ ] *Volume;* [ ] *Weir – Flume;* [ ] *Other* ____
Down-hole Camera Survey? [ ] *Yes;* [✓] *No* *Water Quality Sample Taken?* [ ] *Yes;* [✓] *No*
Well and Pump Works Disinfected Upon Completion in accordance with R655-4? [✓] *Yes;* [ ] *No*
Comments by Installer: Pull Pump For Test + install 2" CTS Poly Pipe For Injection

Licensee Statement This pump work was conducted under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name: Robert Dunn / Glenns Electric License No. 778
(Person, Firm, or Corporation - Print or Type)

Signature of Licensee: [signature] Date 3-18-14
(Licensed Well Driller or Pump Installer)

Note: All Pump work shall be performed in accordance with the provisions of the State of Utah Administrative Rules for Water Wells (Section R655-4 UAC).

Pump Log

Form 113—5M—12-60

Examined JUL 1 9 1978 7115
Recorded: B. C. .... T. B. 7115
Inspection Sheet.
Copied

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 9610
Claim No.
Coordinate No. (A-11-1) 23cad

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

Loc. 23

(1) WELL OWNER:
Name Millville City
Address Millville, Utah

(2) LOCATION OF WELL:
County Cache Ground Water Basin .... (leave blank)
North 1830 feet. East 2070 feet from SW Corner
of Section 22, T. 11 N, R. 1 E SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☒ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☒ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☐
12 " Diam. from 0 feet to 398 feet Gage .375
" Diam. from ...... feet to ...... feet Gage
" Diam. from ...... feet to ...... feet Gage
New ☒ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☒ No ☐
Type of perforator used Mills
Size of perforations 3/8 inches by 3 inches
372 perforations from 264 feet to 295 feet
228 perforations from 308 feet to 327 feet
348 perforations from 331 feet to 339 feet
408 perforations from 364 feet to 398 feet
perforations from ...... feet to ...... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size. Set from ...... ft. to ......
Diam. Slot size. Set from ...... ft. to ......

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☒ Size of gravel.
Gravel placed from ...... feet to ...... feet
Was a surface seal provided? Yes ☒ No ☐
to what depth? 100' feet
Material used in seal: Cement Grout
Did any strata contain unusable water? Yes ☐ No ☒
Type of water. Depth of strata.
Method of sealing strata off.

Was surface casing used? Yes ☒ No ☐
Was it cemented in place? Yes ☐ No ☒

(10) WATER LEVELS:
Static level 158 feet below land surface Date 3-9-78
Artesian pressure feet above land surface Date

LOG RECEIVED: RECEIVED APR 07 1978 WATER RIGHTS

(11) FLOWING WELL:
Controlled by (check) Valve ☐ Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☒ No ☐ If so, by whom? Rhodes Bros.
Yield: 1412 gal. min with 16 feet drawdown after 30 hours
Bailer test gal. min. with feet drawdown after hours
Artesian flow g.p.m. Date
Temperature of water 44 F. Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 12 inches
Depth drilled 398 feet. Depth of completed well 398 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

From	To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	2										X	Top Soil
2	17	X			X							Brown
17	21	X			X							"
21	26	X			X							Blue
26	58	X										"
58	65	X					X					"
65	78	X										"
78	117	X		X								Brown
117	120	X			X							"
120	209				X							Gry
209	221	X										Brown
221	225	X			X							Alternating Strata (water)
225	261				X							Water
261	264	X										Brown
264	295				X							Water
295	308	X										Brown
308	327				X							Water
327	331	X										Brown
331	339				X							Lightly Cemented (water)
339	364	X										Brown
364	?								X			Water

Work started 2-1-78, 19 ... Completed 3-8-78, 19

(14) PUMP:
Manufacturer's Name
Type H. P.
Depth to pump or bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Wright Drilling Co. (Person, firm, or corporation) (Type or print)
Address 45 So. Main Ripley, Utah
(Signed) [signature] (Well Driller)
License No. 333 Date 3-9-78, 19

USE OTHER SIDE FOR ADDITIONAL REMARKS

MICROFILMED

APPENDIX C
PHREEQ MODEL

```
#
# Input File:E:\PROJECTS\UMAR\Data\InSamplesMillville_v3.pqi
# Output File:E:\PROJECTS\UMAR\Data\InSamplesMillville_v3.pqo
# Input File:C:\Program Files (x86)\AquaChem\PHREEQC\wateq4f.dat
# Author/timestamp:paulinkenbrandt / 10/5/2015 4:29:25 PM


SELECTED_OUTPUT
-file    E:\PROJECTS\UMAR\Data\InSamplesMillvilleOut.pqo
-reset   true
-activities      Al+3 Ba+2 Ca+2 Cl- Fe+2 Mg+2 Mn+2 Na+ SO4-2
-saturation_indices      Calcite Anhydrite Gypsum Aragonite Talc
Albite Fluorite Halite Siderite Chalcedony Quartz Hematite Goethite
Pyrite Barite Witherite Willemite Dolomite
SOLUTION 15 Garr 10/15/2014
    temp      11
    pH        7.76
    pe        8.073259
    redox     pe
    units     mg/l
    density   1
    Ag        0.25 ug/l
    Al        5 ug/l
    Alkalinity 210 as CaCO3
    As        0.5 ug/l
    B         0.015
    Ba        0.05
    Ca        54.1
    Cl        4.9446
    Cu        1.049 ug/l
    Fe        0.01
    K         0.5
    Mg        25.6
    Mn        0.0025
    N(-3)     0.0225 as N
    N(5)      2.767 as NO3
    Na        4.29
    O(0)      9.36 as O2
    P         0.008
    Pb        0.1 ug/l
    S(6)      26.071 as SO4
    Si        7.45 as SiO2
    U(3)      1.2 ug/l       as U
    Zn        5 ug/l
    C(4)      0
    -water    1 # kg
SOLUTION 13 Glenridge 10/15/2014
    temp      11.7
    pH        6.96
```

```
    pe        3.416062
    redox     pe
    units     mg/l
    density   1
    Ag        0.25 ug/l
    Al        5 ug/l
    Alkalinity 323 as CaCO3
    As        0.5 ug/l
    B         0.0377
    Ba        0.22227
    Ca        81.5
    Cl        34.227
    Cu        12.591 ug/l
    Fe        0.01
    K         1.82
    Mg        44.9
    Mn        0.0025
    N(-3)     0.02254 as N
    N(5)      31.829 as NO3
    Na        14
    P         0.017
    Pb        2.608 ug/l
    S(6)      28.058 as SO4
    Si        13.8 as SiO2
    U(3)      1.84 ug/l       as U
    Zn        26.686 ug/l
    C(4)      0
    -water    1 # kg
SOLUTION 16 Arnold 10/15/2014
    temp      9.8
    pH        7.74
    pe        4
    redox     pe
    units     mg/l
    density   1
    Alkalinity 200 as CaCO3
    Ca        50
    Cl        12.2
    K         0.5
    Mg        27.9
    N(-3)     0.0225 as N
    N(5)      18.637 as NO3
    Na        11.1
    O(0)      8.51 as O2
    P         0.018
    S(6)      18.2 as SO4
    Si        9.6 as SiO2
    -water    1 # kg
SOLUTION 22 Glenridge 7/16/2015
    temp      10.5
```

```
    pH        7.6
    pe        2.719532
    redox     pe
    units     mg/l
    density   1
    Ag        0.25 ug/l
    Al        5 ug/l
    Alkalinity 253 as CaCO3
    As        0.5 ug/l
    B         0.015
    Ba        0.12862
    Br        0.0656
    Ca        66.5
    Cl        15.3
    Cu        9.639 ug/l
    Fe        0.01
    K         1.19
    Mg        31.4
    Mn        0.0025
    N(-3)     0.01288 as N
    N(5)      16.114 as NO3
    Na        14
    O(0)      7.57 as O2
    P         0.013
    S(6)      16.7 as SO4
    Zn        137.06 ug/l
    Pb        3.639 ug/L
    -water    1 # kg
SOLUTION 23 Arnold 7/15/2015
    temp      14.5
    pH        7.76
    pe        3.347737
    redox     pe
    units     mg/l
    density   1
    Ag        0.25 ug/l
    Al        5 ug/l
    Alkalinity 239 as CaCO3
    As        5 ug/l
    Ba        0.12345
    C(4)      0
    Ca        53.7
    Cl        12.3
    Cu        20.792 ug/l
    Fe        0.01
    K         3.73
    Mg        29.7
    Mn        0.007201
    N(5)      17.397 as NO3
    Na        12.7
```

```
    P         0.058
    S(6)      3.7725 as SO4
    -water    1 # kg
SOLUTION 21 Alder 7/16/2015
    temp      11.4
    pH        7.67
    pe        3.313354
    redox     pe
    units     mg/l
    density   1
    Al        5 ug/l
    Alkalinity 280 as CaCO3
    As        0.5 ug/l
    Ba        0.14835
    Br        0.01
    Ca        84.9
    Cl        22.5
    Cu        11.512 ug/l
    Fe        0.005
    K         1.44
    Mg        28.6
    Mn        0.0025
    N(5)      30.855 as NO3
    Na        7.95
    P         0.01
    S(6)      3.7725 as SO4
    -water    1 # kg
SOLUTION 33 Glenridge 4/1/2015
    temp      11.3
    pH        7.2
    pe        10.35123
    redox     pe
    units     mg/l
    density   1
    Alkalinity 212 as CaCO3
    Ca        55.9
    Cl        5.01
    K         0.5
    Mg        26.9
    N(-3)     0.0129 as N
    N(5)      3.014787 as NO3
    Na        4.13
    O(0)      7.52 as O2
    P         0.008
    S(6)      29.5 as SO4
    Si        7.46 as SiO2
    -water    1 # kg
SOLUTION 34 Arnold 4/1/2015
    temp      11.8
    pH        7.89
```

```
    pe        6.405078
    redox     pe
    units     mg/l
    density   1
    Alkalinity 182 as CaCO3
    As        0.5 ug/l
    C(4)      0
    Ca        49.8
    Cl        8.67
    Fe        0.0281
    K         2.63
    Mg        28.5
    N(-3)     0.055 as N
    N(5)      3.91 as N
    Na        12
    P         0.219
    S(6)      24.7 as SO4
    Si        9.42 as SiO2
    -water    1 # kg
SOLUTION 26 USU 6/9/2015
    temp      11.6
    pH        7.59
    pe        3.806794
    redox     pe
    units     mg/l
    density   1
    Al        50 ug/l
    Alkalinity 279 as CaCO3
    As        0.5 ug/l
    B         0.05
    Ca        70.6
    Cl        8.41
    Cu        5 ug/l
    Fe        0.05
    K         1.79
    Mg        28.4
    Mn        0.001
    N(-3)     0.016 as N
    N(3)      0.008 as NO2
    N(5)      4.737 as NO3
    Na        7.28
    O(0)      7.18 as O2
    P         0.0075
    S(6)      19.5 as SO4
    -water    1 # kg
SOLUTION 17 USU 10/16/2014
    temp      11.3
    pH        7.48
    pe        -4.431176
    redox     pe
```

```
        units     mg/l
        density   1
        Alkalinity 261 as CaCO3
        Ca        69.7
        Cl        9.1
        K         1.19
        Mg        26.6
        N(-3)     0.0225 as N
        N(5)      4.73689 as NO3
        Na        6.4
        O(0)      5.64 as O2
        P         0.014
        S(6)      27.5 as SO4
        Si        11 as SiO2
        -water    1 # kg
    SOLUTION 29 USU 7/14/2014
        temp      20
        pH        7
        pe        4
        redox     pe
        units     mg/l
        density   1
        Al        50 ug/l
        Alkalinity 262 as CaCO3
        As        2 ug/l
        B         0.05
        Ba        0.0888
        Ca        66.2
        Cl        8.51
        K         2.06
        Mg        28.4
        Mn        0.0055
        N(3)      0.008 as NO2
        N(5)      5.843 as NO3
        Na        7.49
        P         0.157
        S(6)      21.3 as SO4
        -water    1 # kg
    SOLUTION 35 USU 4/1/2015
        temp      11.1
        pH        7.32
        pe        4
        redox     pe
        units     mg/l
        density   1
        Alkalinity 246 as CaCO3
        As        0.5 ug/l
        Ca        70.3
        Cl        8.52
        Fe        210
```

```
    K         1.46
    Mg        27.2
    Na        6.62
    O(0)      7.58 as O2
    S(6)      25 as SO4
    Si        9.82 as SiO2
    -water    1 # kg
SOLUTION 20 Alder 6/9/2015
    temp      12.1
    pH        7.24
    pe        3.923843
    redox     pe
    units     mg/l
    density   1
    Ag        0.25 ug/l
    Al        5 ug/l
    Alkalinity 287 as CaCO3
    As        0.5 ug/l
    B         0.015
    Ba        0.1308
    Ca        91.2
    Cl        21.8
    Fe        0.01
    K         1.55
    Mg        32.2
    Mn        0.0025
    N(-3)     0.01288 as N
    N(5)      35.104 as NO3
    Na        8.47
    O(0)      7.2 as O2
    P         0.01
    S(6)      11.8 as SO4
    Zn        25.784 ug/l
    -water    1 # kg
SELECTED_OUTPUT 2
    -file                 selected_output_5.txt
    -high_precision       true
    -reset                true
    -totals               Alkalinity  As(3)  As(5)  As  Cu  Cu(1)
Cu(2)
                          Fe  Fe(3)  Fe(2)  Mn  Mn(2)  Mn(3)  Mn(6)
                          Mn(7)  N  N(0)  N(3)  N(-3)  N(5)  Ca
                          C  Ba  O(0)  P  Pb  S  S(-2)
                          S(6)  Si  U  U(3)  U(4)  U(5)  U(6)
                          Zn
    -molalities           Ba+2  BaCO3  BaSO4  Br-
                          Ca+2  CaCO3  CaPO4-  CH4
                          Cu+  Cu+2  CO2  CO3-2
                          F-  Fe+2  Fe+3  FeOH+
                          FeOH+2  H2S  HCO3-  K+
```

```
                          Mg+2  Mn+2  Mn+3  Na+
                          N2  Pb+2  O2  OH-
                          NO3-  NO2-  NH4X  NH4+
                          NH3  SO4-2  Zn+2
    -saturation_indices   Anhydrite  Aragonite  Arsenolite  Barite
                          Ba3(AsO4)2  Calcite  Ca3(AsO4)2:4w
Chalcopyrite
                          Chalcocite  CO2(g)  Covellite  Cu(OH)2
                          Cu2(OH)3NO3  Cu2SO4  Cu3(AsO4)2:6w
Cu3(PO4)2
                          Cu3(PO4)2:3H2O  CuCO3  Cuprite  CuSO4
                          Fe3(OH)8  FeS(ppt)  Galena  Gibbsite
                          Goethite  Gypsum  H2S(g)  Halite
                          Mn2(SO4)3  MnSO4  Manganite  N2(g)
                          NH3(g)  O2(g)  Orpiment  Pb(OH)2
                          Pb2O3  Pb4(OH)6SO4  PbMetal  SiO2(a)
                          Siderite  Sphalerite  Zincite(c)  Witherite
                          Zn2(OH)2SO4  Zn(OH)2-a  ZnCl2  ZnO(a)
                          ZnS(a)  ZnSO4:H2O  Acanthite  Adularia
                          AgMetal  Alunite  Analcime  Anglesite
                          Artinite  As_native  As2O5(cr)  As2S3(am)
                          Atacamite  Autunite  Bixbyite  Bassetite
                          Brucite  Cerrusite  CH4(g)  Chalcedony
                          CuF  Cristobalite  CuMetal  CupricFerrite
                          CuprousFerrite  Fluorapatite  Fluorite
Massicot
                          Millerite  Montmorillonite-Ca  Illite
PbSiO3
                          PbO:0.3H2O  Pyrolusite  Pyrophyllite
Realgar
                          Sulfur  Uraninite(c)  Wurtzite  Willemite
    -inverse_modeling     true
end

TITLE 10% Injectate 90% Host
MIX 1
    13    0.9
    15    0.1
SAVE solution 41
END
TITLE 20% Injectate 80% Host
MIX 2
    15    0.2
    13    0.8
SAVE solution 42
END
TITLE 30% Injectate 70% Host
MIX 3
    15    0.3
    13    0.7
```

```
SAVE solution 43
END
TITLE 40% Injectate 60% Host
MIX 4
    15    0.4
    13    0.6
SAVE solution 44
END
TITLE 50% Injectate 50% Host
MIX 5
    15    0.5
    13    0.5
SAVE solution 45
END
TITLE 60% Injectate 40% Host
MIX 6
    15    0.6
    13    0.4
SAVE solution 46
END
TITLE 70% Injectate 30% Host
MIX 7
    15    0.7
    13    0.3
SAVE solution 47
END
TITLE 80% Injectate 20% Host
MIX 8
    15    0.8
    13    0.2
SAVE solution 48
END
TITLE 90% Injectate 10% Host
MIX 9
    15    0.9
    13    0.1
SAVE solution 49

END
```

```
TITLE Glenridge (33) to Glenridge (22) Major
INVERSE_MODELING 1
    -solutions      13       15       22
    -uncertainty    0.05     0.05     0.05
    -phases
        Gypsum
        NH4X
        As_native
        Halite
        NH3(g)
        N2(g)
        H2S(g)
        Sylvite
        MgX2
        NaX
        Galena
        Sphalerite
    -balances
        Ca          0.05     0.05     0.05
        Cl          0.05     0.05     0.05
        S(6)        0.05     0.05     0.05
        Mg          0.05     0.05     0.05
        K           0.05     0.05     0.05
        N(5)        0.05     0.05     0.05
        Na          0.05     0.05     0.05
        Alkalinity  0.05     0.05     0.05
        Pb          0.05     0.05     0.05
        As          0.05     0.05     0.05
        Zn          0.05     0.05     0.05
    -range             1000
    -minimal
    -tolerance         1e-10
    -mineral_water     false
    -multiple_precision     true
    -mp_tolerance 1e-12
    -censor_mp 1e-20
PHASES
Sylvite
    KCl = Cl- + K+
    log_k     0.8797
    delta_h   4.165 kcal
end
TITLE Glenridge (33) to Glenridge (22) Major
INVERSE_MODELING 1
    -solutions      13       15       22
    -uncertainty    0.03     0.03     0.04
```

```
    -phases
        Gypsum
        NH4X
        As_native
        Halite
        NH3(g)
        N2(g)
        H2S(g)
        Sylvite
        MgX2
        NaX
        Galena
        Sphalerite
        CuSO4
        Pyrite
        Sulfur
    -balances
        Ca          0.03     0.03     0.04
        Cl          0.03     0.03     0.04
        S(6)        0.03     0.03     0.04
        Mg          0.03     0.03     0.04
        K           0.03     0.03     0.04
        N(5)        0.03     0.03     0.04
        Na          0.03     0.03     0.04
        Alkalinity  0.03     0.03     0.04
        Pb          0.03     0.03     0.04
        As          0.03     0.03     0.04
        Zn          0.03     0.03     0.04
        Cu          0.03     0.03     0.04
    -range              1000
    -minimal
    -tolerance          1e-10
    -mineral_water      false
    -multiple_precision     true
    -mp_tolerance 1e-12
    -censor_mp 1e-20
PHASES
Sylvite
    KCl = Cl- + K+
    log_k     0.8797
    delta_h   4.165 kcal
end
```

APPENDIX D
USU WATER LAB RETURN

Results table for groundwater samples collected October 15 and 16, 2014

Sample	caffeine (ng/L)	sulfamethoxazole (ng/L)	carbamazepine (ng/L)	DEET (ng/L)
Reagent water* blank	< 5 ng/L	< 1 ng/L	< 1 ng/L	< 2 ng/L
S1	< 5 ng/L	10.46	< 1 ng/L	< 2 ng/L
S2	8.34	10.38	< 1 ng/L	< 2 ng/L
S3	8.57	< 1 ng/L	< 1 ng/L	< 2 ng/L
S4	< 5 ng/L	12.55	< 1 ng/L	< 2 ng/L
S5	< 5 ng/L	< 1 ng/L	< 1 ng/L	3.94
S5 duplicate	< 5 ng/L	< 1 ng/L	< 1 ng/L	4.10
S3 Matrix Spike	117	106	109	97
S3 Matrix Spike Dup	142	128	136	118
Lab Control Sample**	105.83	91.97	94.36	94.09

*Burdick and Jacson High Purity Water, Lot: DG-761-C
**Lab control sample = 50 ng spike in 250 mL reagent water

QA/QC results table

LCS (ng/L)	105.8	92.0	94.4	94.1
% recovery	53%	46%	47%	47%

Matrix Spike Data				
	caffeine (ng/L)	sulfamethoxazole (ng/L)	carbamazepine (ng/L)	DEET (ng/L)
S3 (unspiked)	8.57	< 1 ng/L	< 1 ng/L	< 2 ng/L
S3 matrix spike	117	106	109	97
S3 matrix spike duplicate	142	128	136	118
recovery, %				
matrix spike	58%	53%	54%	48%
matrix spike duplicate	71%	64%	68%	59%
RPD	20%	19%	22%	20%

Sample Duplicate Data				
	caffeine (ng/L)	sulfamethoxazole (ng/L)	carbamazepine (ng/L)	DEET (ng/L)
S5	< 5 ng/L	< 1 ng/L	< 1 ng/L	3.94
S5 duplicate	< 5 ng/L	< 1 ng/L	< 1 ng/L	4.10
RPD				4%

Samples S1, S2, S3 were collected on October 15, 2014
Samples S4 and S5 were collected on October 16, 2014
Samples received at UWRL on October 16, 2014
Samples extracted on October 22, 2014
Samples analyzed on October 23, 2014

Extraction: 250 mL sample through Oasis HLB (500 mgx 6cc), 20 mL DI wash, elute 10 mL methanol
Analysis: Agilent 1290 ultra HPLC with a 6490 triple quadrupole MS
Column: Agilent Eclipse+ C18 (5 cm x 1.8 um)
Mobile phase: A = 0.1% Formic acid in water, B = 90/10 Acetonitrile/water with 0.1% formic acid
Gradent elution: isocratic 0-1 min at 5%B, linear increase to 5 min, isocratic 5-6 min at B = 98%

APPENDIX E
WATER LEVEL DATA

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
1	103		4828	4815	USGS	8151	19620813	(A-10- 1)21aab- 1	413550111500601	430348	4605388	19	8/13/62	3/6/91	13.5	13.9	1.3	11.0	15.5
2	18	80	4820	4810	USGS	438519	1967	(A-10- 1)16ddb- 1	413601111500801	430305	4605727	1	5/20/15	5/20/15	10.0	10.0		12.0	12.0
3	16		4820	4811	USGS		1967	(A-10- 1)16dad- 1	413609111495701	430562	4605972	170	9/26/68	3/10/15	9.3	10.1	1.5	4.1	10.7
12	178		4684	4667	USGS	427236	19800605	(B-10- 1)11dad- 1	413704111543801	424075	4607734	10	6/5/80	3/6/91	16.8	17.8	5.1	3.0	20.8
14	187		4645	4649	USGS	28975	195508	(A-10- 1) 6ccc	413738111532601	425821	4608733	1	3/22/67	3/22/67	-4.0	-4.0		-4.0	-4.0
16	630		4803	4499	USGS	31570	19750308	(A-10- 1) 3ccc	413738111495701	430681	4608715	1	2/19/78	2/19/78	304.0	304.0		301.0	301.0
17	472		4794	4496	USGS	31571	19630511	(A-10- 1) 4daa	413802111500001	430596	4609457	1	5/19/63	5/19/63	298.0	298.0		298.0	298.0
19	85		4813	4752	USGS	7380	19940923	(A-10- 1) 3bdd- 1	413805111492201	431399	4609532	98	5/1/96	8/19/15	61.6	62.8	3.4	54.0	66.0
22	129		4584	4489	USGS	10600	19860517	(B-10- 1) 1aaa	413824111533001	425791	4610177	7	9/17/98	10/23/09	94.8	94.8	2.7	91.3	99.6
24	134		4581	4574	USGS	18341	36120	(B-10- 1) 1aaa- 3	413827111532501	425791	4610276	1	10/31/68	10/31/68	7.0	7.0		7.0	7.0
25	355		4616	4492	USGS	25776	19680215	(A-11- 1)32dcc	413838111513901	428339	4610589	1	8/20/02	8/20/02	124.0	124.0		107.0	107.0
26	186		4663	4505	USGS	427493	1968	(A-11- 1)34dca- 1	413841111490401	431833	4610647	1	8/6/68	8/6/68	158.0	158.0		158.0	158.0
33	195		4504	4492	USGS	6677	19831005	(B-11- 1)36abb	413916111535901	425113	4611825	1	10/19/83	10/19/83	12.0	12.0		12.0	12.0
36	441		4620	4500	USGS	2741	19760417	(A-11- 1)28dad	413936111496001	430624	4612355	1	4/14/76	4/14/76	120.0	120.0		120.0	120.0
38	290		4651	4496	USGS	32329	19790424	(A-11- 1)27adb- 1	413958111485901	431958	4612998	6	5/17/79	9/15/08	155.1	153.8	4.6	149.8	162.4
42	55		4444	4455	USGS	1719	1921	(B-11- 1)26abd	414007111545801	423765	4613381	1	3/11/91	3/11/91	-11.4	-11.4		-11.4	-11.4
44			4460	4477	USGS	7489	34609	(B-11- 1)24ccc- 1	414017111542701	424392	4613683	1	12/12/67	12/12/67	-17.0	-17.0		-17.0	-17.0
49	150		4516	4494	USGS	31670	19780307	(A-11- 1)20dbb- 1	414038111513701	428323	4614287	79	3/16/78	3/10/15	22.2	22.7	2.6	15.2	27.7
56	105		4460	4479	USGS	21751	20000328	(B-11- 1)24ada	414053111532901	425815	4614840	1	11/5/68	11/5/68	-19.0	-19.0		-19.0	-19.0
57			4485	4494	USGS	427939	19680525	(A-11- 1)19aab	414103111522801	427205	4615103	1	5/19/68	5/19/68	-9.0	-9.0		-2.0	-2.0
61	112		4443	4478	USGS	18190	36060	(B-11- 1)13cdd- 1	414109111540301	424964	4615281	1	1/4/68	1/4/68	-35.0	-35.0		-35.0	-35.0
62	385		4680	4500	USGS	2722	19730731	(A-11- 1)15ddb	414116111490701	431914	4615424	1	9/6/73	9/6/73	180.0	180.0		180.0	180.0
71	115		4447	4478	USGS	28862		(B-11- 1)13daa- 1	414127111532801	425779	4615827	1	1/19/68	1/19/68	-31.0	-31.0		-31.0	-31.0
72	113		4439	4474	USGS	438008	1934	(B-11- 1)13dbb- 1	414128111535801	425086	4615865	1	1/4/68	1/4/68	-35.0	-35.0		-35.0	-35.0
73	136		4434	4460	USGS	28634	19520619	(B-11- 1)14dba	414133111545701	423746	4616003	1	6/19/52	6/19/52	-26.0	-26.0		-26.0	-26.0
74	139		4502	4501	USGS	33677	19730416	(A-11- 1)17daa- 1	414133111511001	428971	4615980	2	4/16/73	3/7/91	1.0	1.0	1.4	0.0	2.0
75	102		4452	4425	USGS	10647	19520511	(A-11- 1)18caa	414132111525601	426613	4616004	1	4/29/68	4/29/68	27.0	27.0		27.0	27.0
79	146		4464	4488	USGS	426854	19671116	(A-11- 1)18add- 1	414135111522401	427261	4616059	1	11/17/67	11/17/67	-24.0	-24.0		-24.0	-24.0
84	145		4570	4500	USGS	5561	19910314	(A-11- 1)15bdb- 1	414141111493601	431140	4616211	28	3/27/91	8/22/12	69.9	71.3	3.8	61.6	77.4
85	136		4486	4491	USGS	20512	19680930	(A-11- 1)17bda	414142111514601	428188	4616265	1	10/8/68	10/8/68	-5.0	-5.0		-5.0	-5.0
95	96		4436	4470	USGS	6121	19240601	(A-11- 1) 7ccd- 2	414201111531301	426137	4616872	1	4/12/68	4/12/68	-34.0	-34.0		-34.0	-34.0
96	104		4435	4466	USGS	26753	19860610	(B-11- 1)12ddc	414159111533001	425813	4616876	1	3/19/91	3/19/91	-31.0	-31.0		-31.0	-31.0
97	97		4434	4466	USGS	27749	1936	(B-11- 1)12dcd	414160111534801	425397	4616880	1	4/21/36	4/21/36	-32.0	-32.0		-32.0	-32.0
104	186		4508	4486	USGS	35803	19660920	(A-11- 1)10cca	414207111495101	430876	4616979	1	9/19/66	9/19/66	22.0	22.0		9.0	9.0
105	138		4482	4497	USGS	427238	19801128	(A-11- 1) 8ddc- 2	414206111512001	428750	4617000	1	11/28/80	11/28/80	-15.0	-15.0		-15.0	-15.0
106			4438	4471	USGS	33878	26451	(A-11- 1) 7ccd- 1	414207111531301	426138	4617057	1	4/14/68	4/14/68	-33.0	-33.0		-33.0	-33.0
107	220		4424	4452	USGS	18049	19540804	(B-11- 1)12ccb	414208111543801	424267	4617108	1	10/7/68	10/7/68	-28.0	-28.0		-28.0	-28.0
110	150		4424	4404	USGS	9474	1916	(B-11- 1)11dda	414210111544101	424221	4617201	1	9/19/84	9/19/84	20.0	20.0		-39.0	-39.0
112			4476	4492	USGS	32159	28412	(A-11- 1) 9cbc- 1	414214111510201	429168	4617243	1	10/20/67	10/20/67	-16.0	-16.0		-16.0	-16.0
113	366		4643	4509	USGS	2803	19651102	(A-11- 1)10dad	414216111485601	432174	4617275	1	10/19/65	10/19/65	134.0	134.0	5.2	138.0	145.4
121	200		4425	4458	USGS	26677	19520604	(B-11- 1)12bcc	414228111543701	424297	4617755	1	10/7/68	10/7/68	-33.0	-33.0		-33.0	-33.0
123	227	201	4424	4447	USGS	1578	19920805	(B-11- 1)11add	414230111544301	424159	4617818	1	8/19/92	8/19/92	-23.1	-23.1		-37.0	-37.0
126	195		4490	4506	USGS	35815	19780206	(A-11- 1) 9adb	414234111501701	430261	4617880	1	2/19/78	2/19/78	-16.0	-16.0		-7.0	-7.0
129	136		4465	4482	USGS	33618	19730611	(A-11- 1) 8aca- 1	414237111512801	428575	4617958	1	6/11/73	6/11/73	-17.0	-17.0		-17.0	-17.0
135			4491	4483	USGS	35817		(A-11- 1) 9aac	414243111501601	430263	4618126	1	6/20/68	6/20/68	8.0	8.0		8.0	8.0
136			4497	4486	USGS	1953		(A-11- 1) 9aab- 1	414247111500701	430449	4618248	1	2/19/92	2/19/92	11.0	11.0		-4.0	-4.0
142	195		4424	4396	USGS	26069	1962	(B-11- 1)12bbb	414250111543801	424280	4618403	1	7/20/10	7/20/10	28.0	28.0		-30.0	-30.0
149	190		4434	4464	USGS	3347	34156	(B-11- 1) 1ddc- 1	414257111533501	425646	4618605	1	4/6/43	4/6/43	-30.0	-30.0		-30.0	-30.0
152	127		4531	4494	USGS	26841	19620413	(A-11- 1) 3dcb	414301111492201	431540	4618669	1	6/16/66	6/16/66	37.0	37.0		37.0	37.0
153	155	159	4436	4438	USGS	433615	1925	(A-11- 1) 6ccb	414303111532901	425856	4618818	1	2/19/92	2/19/92	-2.3	-2.3	4.5	-30.0	-23.7
159	240	270	4424	4381	USGS	16201	19970711	(B-11- 1) 2dad	414310111544201	424194	4619021	1	7/19/97	7/19/97	43.0	43.0		-14.0	-14.0
160	970		4487	4490	USGS	2694	19790910	(A-11- 1) 4cba	414312111505601	429371	4619030	2	6/20/80	3/21/91	-3.0	-3.0	2.8	-4.9	-1.0
165	154		4451	4483	USGS	433883	19750708	(A-11- 1) 5cbb	414315111521401	427593	4619201	1	10/9/54	10/9/54	-32.0	-32.0		-32.0	-32.0
172	70		4430	4471	USGS	29328	1920	(B-11- 1) 1bdd	414319111540701	425006	4619290	1	11/8/67	11/8/67	-41.0	-41.0	36.9	-41.0	-41.0
176	335		4589	4496	USGS	2848	19800729	(A-11- 1) 3adc	414323111490801	431870	4619375	2	8/21/80	4/3/91	92.5	92.5	29.0	72.0	113.0

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
181	140		4547	4512	USGS	2823	1934	(A-11- 1) 3bda	414329111493301	431317	4619504	65	10/13/36	4/3/91	35.4	34.7	4.3	29.1	52.0
185	192		4598	4460	USGS	2836	1934	(A-11- 1) 3abd	414332111491201	431780	4619623	2	10/24/67	4/3/91	138.0	138.0	48.1	104.0	172.0
191	130		4456	4489	USGS	434624	1900	(A-11- 1) 5aba	414340111513501	428455	4619902	1	10/16/67	10/16/67	-33.0	-33.0		-33.0	-33.0
192	180		4433	4450	USGS	35632	20060818	(A-11- 1) 6bba	414343111531401	426169	4620049	1	8/7/68	8/7/68	-17.0	-17.0		-17.0	-17.0
194	1000		4551	4496	USGS	2677	19630301	(A-12- 1)34cca	414353111494501	431093	4620277	1	3/1/91	3/1/91	55.0	55.0		55.0	55.0
195	123		4447	4463	USGS	427266	19730712	(A-12- 1)32cac- 1	414402111515101	428069	4620585	1	7/12/73	7/12/73	-16.0	-16.0		-16.0	-16.0
200	119		4454	4470	USGS	434625	19500418	(A-12- 1)32dba	414405111513501	428486	4620673	37	8/7/62	3/13/91	-15.9	-16.1	2.3	-18.7	-3.7
201	108		4442	4470	USGS	35586	19560504	(A-12- 1)32bba- 1	414405111520601	427724	4620681	1	6/6/68	6/6/68	-28.0	-28.0		-28.0	-28.0
210	150		4442	4464	USGS	31603	19781121	(A-12- 1)32bcd	414411111521001	427679	4620835	1	5/1/44	5/1/44	-22.0	-22.0		-22.0	-22.0
211	107		4441	4411	USGS	35587	19590702	(A-12- 1)32bcc	414411111521301	427610	4620836	1	7/19/59	7/19/59	30.0	30.0		-11.0	-11.0
216	206		4441	4401	USGS	35589	19590000	(A-12- 1)32bcd	414413111521101	427680	4620928	1	8/19/59	8/19/59	40.0	40.0		-12.0	-12.0
222	110		4444	4471	USGS	25940		(A-12- 1)32bda- 1	414419111514801	428144	4621108	1	3/27/68	3/27/68	-27.0	-27.0		-27.0	-27.0
228	137		4469	4488	USGS	4320	34227	(A-12- 1)32ada- 2	414423111511401	428930	4621224	1	4/14/43	4/14/43	-19.0	-19.0		-19.0	-19.0
233	434		4785	4505	USGS	433990	19831202	(A-12- 1)35bab	414437111483401	432676	4621588	1	12/2/83	12/2/83	280.0	280.0		280.0	280.0
235	470		4634	4470	USGS	2679	196110	(A-12- 1)27dcd	414441111491001	431869	4621750	2	2/28/67	3/1/91	164.0	164.0	22.6	148.0	180.0
237	60		4486	4494	USGS	7602	193406	(A-12- 1)28cca	414445111505801	429353	4621898	1	8/23/67	8/23/67	-8.0	-8.0		-8.0	-8.0
243	800		4553	4490	USGS	2675	19630506	(A-12- 1)27cab	414460111493901	431205	4622312	2	3/7/68	3/1/91	63.0	63.0	12.7	54.0	72.0
248	150		4487	4496	USGS	29006		(A-12- 1)28bdc- 1	414509111504501	429614	4622636	1	6/6/68	6/6/68	-9.0	-9.0		-9.0	-9.0
255	147		4489	4536	USGS	10698	19860715	(A-12- 1)28baa	414526111504001	429804	4623127	1	7/19/86	7/19/86	-46.2	-46.2		-10.0	-10.0
259	161		4437	4458	USGS	427651	19670405	(A-12- 1)30aaa	414528111522801	427334	4623245	1	4/19/67	4/19/67	-21.0	-21.0		-21.0	-21.0
266	57		4494	4499	USGS	28093	1957	(A-12- 1)21dbd	414543111502401	430225	4623678	1	10/1/57	10/1/57	-5.0	-5.0		-5.0	-5.0
278	134		4433	4449	USGS	427178	19831017	(A-12- 1)19bdc	414558111531301	426304	4624149	1	3/26/91	3/26/91	-16.2	-16.2		-16.2	-16.2
281			4445	4453	USGS	438211		(A-12- 1)20bda- 1	414607111514601	428223	4624438	1	5/1/68	5/1/68	-8.0	-8.0		-8.0	-8.0
288	210		4486	4474	USGS	426884	26180	(A-12- 1)15ccb- 1	414634111495501	430794	4625246	1	4/16/69	4/16/69	12.0	12.0		12.0	12.0
300	313	133	4684	4594	UDWR	24679	20020310	(B-10- 1) 1cdc	413738111541701	424647	4608793	1	3/20/02	3/20/02	90.0	90.0			
301	506		4586	4485	UDWR	26129	20030307	(A-11- 1)28aca	413955111502201	430112	4612960	1	3/20/03	3/20/03	101.0	101.0			
302	145		4474	4472	UDWR	27396		(A-11- 1)19baa	414105111525501	426597	4615153	1	6/20/03	6/20/03	1.5	1.5			
303	490	320	4801	4501	UDWR	27876	20031110	(A-10- 1)10bcc	413713111495401	430720	4607952	1	11/20/03	11/20/03	300.0	300.0			
304	100		4752	4694	UDWR	33497	20050216	(A-11- 1)34cad	413843111492801	431353	4610727	1	2/20/05	2/20/05	58.2	58.2			
305	100		4792	4724	UDWR	33498	20050219	(A-11- 1)34dcb	413838111492301	431463	4610555	1	2/20/05	2/20/05	67.2	67.2			
306	150		4528	4497	UDWR	428550	20061217	(A-11- 1)29acd	413954111513301	428480	4612950	1	6/20/08	6/20/08	31.0	31.0			
307	66	36	4793	4752	UDWR	7379	19940919	(A-10- 1) 3bdc	413809111493801	431113	4609672	1	9/19/94	9/19/94	41.0	41.0			
309	661		4577	4477	UDWR	22493	20010420	(A-12- 1)35cba	414407111483901	432582	4620698	1	6/20/01	6/20/01	100.5	100.5			
312	118		4445	4445	UDWR	6620	19940629	(A-11- 1)18bdc	414135111530901	426293	4616068	1	6/29/94	6/29/94				0.0	0.0
313	330		4704	4529	UDWR	19826	19990230	(A-10- 1) 2bbc	413822111484701	432289	4610056	1	8/19/99	8/19/99	175.0	175.0			
314	369		4423	4380	UDWR	34222	20050706	(B-11- 1) 2dab	414316111544901	424003	4619229	1	7/20/05	7/20/05	43.0	43.0			
315	340		4740	4590	UDWR	20761	20000322	(A-11- 1)23cdc	414018111483001	432721	4613633	1	3/20/00	3/20/00	150.0	150.0			
316	160		4535	4486	UDWR	20835	19991021	(B-10- 1) 1bab	413828111541801	424637	4610318	1	10/19/99	10/19/99	49.0	49.0			
318	329		4831	4616	UDWR	21445	20000211	(A-10- 1)15bac	413634111493601	431121	4606756	1	2/20/00	2/20/00	215.0	215.0			
320	285		4816	4772	UDWR	34430	20050908	(A-10- 1)21bad	413540111503401	429757	4605094	1	9/20/05	9/20/05	44.0	44.0			
321	160		4435	4435	UDWR	24048	20010808	(B-11- 1)13bac	414147111540401	425014	4616458	1	8/8/01	8/8/01				0.0	0.0
322	159		4514	4486	UDWR	24047	20010820	(A-11- 1)29bcd	413951111520701	427688	4612846	1	8/20/01	8/20/01	28.0	28.0			
323	179		4656	4611	UDWR	25158	20020511	(A-10- 1) 6ccd	413738111531401	426096	4608765	1	5/20/02	5/20/02	45.0	45.0			
324	200	156	4573	4515	UDWR	25310	20020610	(B-10- 1) 1dbd	413754111534801	425323	4609269	1	6/20/02	6/20/02	58.0	58.0			
325	169		4451	4432	UDWR	27530	20030528	(B-11- 1)23dab	414040111545201	423893	4614406	1	5/20/03	5/20/03	18.5	18.5			
326	86		4534	4497	UDWR	430671	20071026	(A-11- 1)29ada	413958111511201	428952	4613062	1	11/20/07	11/20/07	37.0	37.0			
327	421		4714	4707	UDWR	34453	20050727	(A-10- 1) 7bcc	413713111532601	425799	4608005	1	7/20/05	7/20/05	7.0	7.0			
328	152	115	4557	4549	UDWR	21915	20000516	(A-11- 1)15bca	414141111494401	431030	4616210	1	5/20/00	5/20/00	8.0	8.0			
329	246		4797	4687	UDWR	427270	19690905	(A-10- 1)16abb	413645111502501	429992	4607087	1	9/19/69	9/19/69	110.0	110.0			
331	199		4632	4491	UDWR	35648	20060526	(A-11- 1)27acb	413956111492001	431552	4612969	1	8/20/06	8/20/06	141.0	141.0			
332	140		4575	4487	UDWR	434134				425228	4609745	1	9/20/10	9/20/10	88.0	88.0			
333	200		4625	4491	UDWR	35576	20060511	(A-11- 1)27aca	413959111491501	431662	4613073	1	5/20/06	5/20/06	134.0	134.0			
335	130		4480	4480	UDWR	428817	20070203	(A-11- 1)19bcc	414042111532001	426014	4614434	1	9/4/08	9/4/08				0.0	0.0
336	198		4777	4635	UDWR	429614	20070508	(A-10- 1) 9cdd	413645111504801	429462	4607108	1	6/20/07	6/20/07	142.0	142.0			
338	326		4860	4640	UDWR	428388	20061103	(A-10- 1) 8cdc	413650111515801	427835	4607271	1	11/20/06	11/20/06	220.0	220.0			

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
339	136		4453	4453	USGS	427467	20060924	(A-11- 1)18ada	414140111522501	427311	4616231	1	10/6/06	10/6/06				0.0	0.0
340	200	180	4953	4795	UDWR	17490	19980602	(A-10- 1)14bbb	413642111484501	432306	4606992	1	6/19/98	6/19/98	158.0	158.0			
341	321		4788	4725	UDWR	12123	19960624	(A-10- 1) 7dbd	413660111523801	426911	4607583	1	6/19/96	6/19/96	63.0	63.0			
342	166		4552	4499	UDWR	432055	20081002	(A-11- 1) 3abc	414332111491801	431666	4619653	1	11/20/08	11/20/08	53.0	53.0			
343	240	253	4428	4427	UDWR	7515	19941003	(B-11- 1) 1bdd	414320111541201	424894	4619303	1	10/19/94	10/19/94	1.0	1.0			
344	340		4423	4423	UDWR	34218	20050616	(B-12- 1)36ccc	414345111543401	424362	4620122	1	6/25/05	6/25/05				0.0	0.0
345	140		4575	4481	UDWR	434359	20110601	(B-10- 1) 1adb	413811111534001	425506	4609790	1	6/20/11	6/20/11	94.0	94.0			
346	112		4454	4454	USGS	431554	20080703	(A-11- 1)18acc	414134111525001	426695	4616039	1	7/9/08	7/9/08				0.0	0.0
347	585		4729	4706	UDWR	431371	20080922	(B-10- 1)14aaa	413640111544001	424077	4607008	1	10/20/08	10/20/08	23.0	23.0			
348	127		4454	4486	UDWR	431274	20080424	(B-11- 1)24abd	414058111535101	425306	4614956	1	9/20/08	9/20/08	-32.0	-32.0			
349	215		4776	4617	UDWR	431990	20081018	(A-10- 1) 9cdd	413647111504701	429475	4607172	1	11/20/08	11/20/08	159.0	159.0			
350	137		4805	4784	UDWR	432681				425641	4607168	1	4/20/09	4/20/09	21.0	21.0			
351	200	155	4804	4774	UDWR	21754	20000327	(A-10- 1) 7ddb	413652111523201	427054	4607343	1	3/20/00	3/20/00	30.0	30.0			
352	237		4552	4486	UDWR	23341	20010326	(B-10- 1) 1aba	413829111534701	425356	4610345	1	6/20/01	6/20/01	66.0	66.0			
353	219		4426	4451	USGS	24271	20010928	(B-11- 1)11dda	414208111544101	424169	4617113	1	10/20/01	10/20/01	-25.4	-25.4			
354	205		4434	4438	UDWR	10620	19951101	(B-11- 1)14acd	414134111550401	423636	4616078	1	11/19/95	11/19/95	-4.6	-4.6			
355	161		4434	4402	USGS	434098	20100819	(B-11- 1)14dab	414132111544901	423975	4616015	1	8/20/10	8/20/10	32.0	32.0			
356	179		4457	4467	UDWR	131		(B-11- 1)23adc	414042111545101	423900	4614478	1	4/19/92	4/19/92	-10.0	-10.0			
357	168	168	4493	4490	UDWR	9664	19840209	(A-11- 1)19dbb	414035111525201	426655	4614221	1	2/19/84	2/19/84	3.0	3.0			
359	110		4442	4459	UDWR	432854	19690201	(A-11- 1) 7acb	414236111525301	426679	4617940	1	2/19/69	2/19/69	-17.0	-17.0			
360	110		4443	4443	UDWR	4421		(A-11- 1)18bcc	414134111532101	426011	4616051	1	10/6/93	10/6/93				0.0	0.0
363	354	180	4778	4756	UDWR	5506	19941020	(A-10- 1)11aad	413729111474301	433752	4608430	1	10/19/94	10/19/94	22.0	22.0			
364	242		4424	4429	UDWR	10822	19951108	(B-11- 1) 1ccb	414303111543801	424256	4618820	1	11/19/95	11/19/95	-4.6	-4.6			
365	158		4497	4489	USGS	431815		(A-11- 1)16bcb	414141111511001	429037	4616232	1	11/20/08	11/20/08	8.0	8.0			
366	151		4454	4454	USGS	2066		(A-12- 1)16cbd	414640111505601	429463	4625450	1	3/4/93	3/4/93				0.0	0.0
367	220		4438	4418	UDWR	435386		(A-11- 1) 6bab	414338111531001	426336	4619877	1	11/20/11	11/20/11	20.0	20.0			
372	195		4442	4533	USGS	10191		(A-12- 1)32bcd	414415111520501	427803	4620992	1	11/19/86	11/19/86	-90.1	-90.1			
374	144		4485	4479	USGS	428337	19630910	(A-11- 1)17bdd	414138111514901	428146	4616162	1	9/19/63	9/19/63	6.0	6.0			
376	140		4486	4470	UDWR	32309		(A-12- 1)28bdb	414514111504901	429591	4622793	1	4/19/77	4/19/77	16.0	16.0			
383	232		4665	4665	UDWR	426995	19700330	(A-11- 1)33daa	413851111500301	430546	4610979	1	3/27/70	3/27/70				158.0	158.0
386	140		4486	4495	USGS	427495	19680927	(A-11- 1)17bda	414140111514701	428177	4616215	1	9/19/68	9/19/68	-9.0	-9.0			
387	21		4506	4496	USGS	427502	19681104	(A-11- 1) 4aca	414325111502401	430140	4619434	1	11/19/68	11/19/68	10.0	10.0			
388	230	210	4467	4451	USGS	26728		(A-11- 1) 5dbc	414305111513701	428437	4618836	1	4/20/03	4/20/03	16.0	16.0			
390	115		4830	4768	UDWR	427267	19690418	(B-10- 1)13bdb	413626111541401	424690	4606574	1	4/19/69	4/19/69	62.0	62.0			
391	67		4488	4486	USGS	427268	19690728	(A-12- 1)28baa	414528111504101	429769	4623242	1	7/19/69	7/19/69	2.0	2.0			
392	45		4504	4495	USGS	427269		(A-11- 1) 4dad	414307111500901	430473	4618861	1	7/19/69	7/19/69	9.0	9.0			
393	102		4837	4805	UDWR	8157	196911	(A-10- 1)21aac	413539111501401	430234	4605061	1	11/19/69	11/19/69	32.0	32.0			
394	334		4825	4530	UDWR	33156	19740600	(A-10- 1)10cdd	413645111492901	431295	4607094	1	6/19/74	6/19/74	295.0	295.0			
395	232		4535	4491	UDWR	426990	19700310	(B-11- 1)36cdc	413830111541801	424637	4610390	1	3/19/70	3/19/70	44.0	44.0			
396	170		4485	4486	UDWR	426991	19700702	(A-11- 1)19bda	414051111525701	426559	4614703	1	7/19/70	7/19/70	-1.0	-1.0			
398	140		4437	4417	UDWR	426994	19701121	(A-12- 1)32cca	414354111520901	427706	4620348	1	11/19/70	11/19/70	20.0	20.0			
400	140		4443	4443	UDWR	435051		(A-11- 1)18cbb	414129111532401	425926	4615900	1	11/17/11	11/17/11				0.0	0.0
402	219		4803	4618	UDWR	34026	19710609	(A-10- 1)16baa	413645111503401	429782	4607090	1	6/19/71	6/19/71	185.0	185.0			
403	130		4466	4466	UDWR	426852	19710611	(A-11- 1)18cdd	414110111525601	426579	4615317	1	6/11/71	6/11/71				0.0	0.0
404	207		4493	4493	UDWR	426853	19710920	(A-11- 1) 9dda	414210111500901	430456	4617130	1	9/20/71	9/20/71				0.0	0.0
406	120		4471	4471	UDWR	426876	19711009	(B-11- 1)24add	414046111532901	425805	4614585	1	10/9/71	10/9/71				0.0	0.0
408	141		4461	4461	UDWR	426882	19710804	(A-11- 1)18dab	414131111523501	427064	4615954	1	8/4/71	8/4/71				0.0	0.0
409	300	150	4703	4565	UDWR	6279		(A-10- 1) 2bcd	413804111483801	432493	4609518	1	4/19/83	4/19/83	138.0	138.0			
410	356	250	4762	4492	UDWR	33886	19720410	(A-11- 1)23bdc	414044111483101	432703	4614430	1	4/19/72	4/19/72	270.0	270.0			
412	275		4809	4807	UDWR	33723	19720425	(A-10- 1) 8cbc	413703111521301	427497	4607666	1	4/19/72	4/19/72	2.0	2.0			
413	216	176	4672	4494	UDWR	26642		(A-11- 1)23ccb	414025111484601	432351	4613869	1	1/20/03	1/20/03	178.0	178.0			
414	140		4544	4502	UDWR	31669	19780302	(A-11- 1)21daa	414038111500501	430513	4614273	1	3/19/78	3/19/78	42.0	42.0			
415	147	147	4818	4765	UDWR	8165		(A-10- 1)16add	413620111500001	430555	4606306	1	7/19/70	7/19/70	53.0	53.0			
417	343		4697	4492	UDWR	33433	19731214	(A-11- 1)34aab	413921111490101	431973	4611880	1	12/19/73	12/19/73	205.0	205.0			
419	160		4484	4480	UDWR	35650	19770826	(A-11- 1)17bdd	414135111515101	428086	4616053	1	8/19/77	8/19/77	4.0	4.0			

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
420	295		4684	4499	UDWR	33155	19740400	(A-11- 1)22aac	414055111490101	432005	4614780	1	4/19/74	4/19/74	185.0	185.0			
421	230		4604	4555	UDWR	33111	19740607	(A-11- 1)28dca	413930111502101	430124	4612197	1	6/19/74	6/19/74	49.0	49.0			
422	137		4563	4488	UDWR	33148	19740517	(A-11- 1)31dbc	413844111524701	426739	4610790	1	5/19/74	5/19/74	75.0	75.0			
423	289		4419	4419	UDWR	16706		(B-12- 1)13ccc	414625111543901	424303	4625053	1	3/3/00	3/3/00				0.0	0.0
424	140		4592	4512	UDWR	33202	19741017	(A-11- 1)15bda	414142111493101	431324	4616234	1	10/19/74	10/19/74	80.0	80.0			
425	300		4803	4782	UDWR	31174	19790627	(A-10- 1) 7ccd	413647111531001	426161	4607180	1	6/19/79	6/19/79	21.0	21.0			
426	303		4571	4481	UDWR	31604	19780208	(A-11- 1)27bab	414012111493501	431199	4613471	1	2/19/78	2/19/78	90.0	90.0			
427	113		4697	4657	UDWR	32874	19750708	(A-10- 1) 7bab	413734111530501	426294	4608638	1	7/19/75	7/19/75	40.0	40.0			
428	276		4729	4531	UDWR	32945	19751028	(A-10- 1) 2cac	413751111482401	432803	4609112	1	10/19/75	10/19/75	198.0	198.0			
429	130		4480	4479	UDWR	23170		(A-11- 1)19cbb	414035111532601	425877	4614239	1	1/20/01	1/20/01	1.5	1.5			
431	160		4571	4511	UDWR	34709	19760914	(B-10- 1) 1aca	413816111534701	425348	4609960	1	9/19/76	9/19/76	60.0	60.0			
432	183	183	4809	4691	UDWR	8163	19810420	(A-10- 1)16bdd	413619111503601	429725	4606295	1	4/19/81	4/19/81	118.0	118.0			
433	140	115	4493	4483	UDWR	23035		(A-11- 1)19dbb	414036111525001	426715	4614246	1	11/20/00	11/20/00	10.0	10.0			
435	151		4529	4494	UDWR	35814	19770513	(A-11- 1)10caa	414222111493501	431250	4617477	1	5/19/77	5/19/77	35.0	35.0			
436	256		4424	4424	UDWR	12723		(B-11- 1) 1bcc	414319111543801	424264	4619318	1	8/15/96	8/15/96				0.0	0.0
437	220		4533	4492	USGS	35816	19770815	(A-11- 1)10cac	414214111493501	431235	4617244	1	8/19/78	8/19/78	41.0	41.0			
438	160	133	4827	4808	UDWR	371		(A-10- 1)15ccb	413560111495301	430706	4605697	1	2/19/92	2/19/92	19.0	19.0			
439			4691	4531	UDWR	9642	19950728	(A-11- 1)34dda	413841111485701	432071	4610653	1	7/19/95	7/19/95	160.0	160.0			
440	139		4480	4480	UDWR	10572	19951013	(A-11- 1)17bdc	414137111515901	427896	4616121	1	10/13/95	10/13/95				0.0	0.0
441	375		4824	4819	UDWR	31674	19780221	(A-10- 1)18bdd	413620111525301	426550	4606348	1	2/19/78	2/19/78	5.0	5.0			
442	158		4448	4426	UDWR	35590	19780115	(A-11- 1) 5bcb	414325111521301	427605	4619457	1	1/19/78	1/19/78	22.0	22.0			
444	194		4803	4663	UDWR	8162	19781107	(A-10- 1)16abc	413632111502801	429904	4606703	1	11/19/78	11/19/78	140.0	140.0			
445	166		4492	4490	UDWR	35519	19790504	(A-11- 1)17dcb	414118111514101	428309	4615526	1	5/19/79	5/19/79	2.0	2.0			
447	320		4921	4772	UDWR	6126	20000929	(A-10- 1)15aac	413636111490101	431934	4606798	1	9/20/00	9/20/00	149.0	149.0			
448	282	267	4804	4788	UDWR	8152	19791002	(A-10- 1)16bbd	413632111505101	429374	4606690	1	10/19/79	10/19/79	16.0	16.0			
449	336		4424	4399	UDWR	433427		(B-11- 1) 1bcb	414325111543801	424259	4619498	1	5/20/10	5/20/10	25.0	25.0			
450	234		4633	4483	UDWR	35454	19810107	(A-11- 1)27aca	413957111491401	431687	4612987	1	1/19/80	1/19/80	150.0	150.0			
453	287	214	4773	4761	UDWR	2084	19920714	(A-10- 1)11aac	413728111475301	433501	4608422	1	7/19/92	7/19/92	12.5	12.5			
454	67		4464	4460	USGS	30211	19820527	(A-12- 1)16dbc	414641111503401	429951	4625465	1	5/19/82	5/19/82	4.0	4.0			
457	32		4620	4612	UDWR	35019		(A-11- 1)34abc	413912111491801	431573	4611624	1	12/20/05	12/20/05	8.0	8.0			
459	210		4424	4424	UDWR	11482	19831227	(B-11- 1)11dad	414218111544201	424151	4617415	1	3/1/96	3/1/96				0.0	0.0
462	181	128	4426	4381	UDWR	6675	19830901	(B-12- 1)25cab	414459111541901	424734	4622379	1	9/19/83	9/19/83	45.0	45.0			
463	130		4471	4513	UDWR	7229	19830806	(A-12- 1)21ccd	414536111510101	429321	4623468	1	8/19/83	8/19/83	-41.6	-41.6			
465	199	191	4604	4514	UDWR	7266	19830730	(A-12- 1)14cba	414642111484101	432577	4625481	1	7/19/83	7/19/83	90.0	90.0			
467	125		4792	4777	UDWR	27196		(B-10- 1)14adb	413625111545301	423770	4606547	1	8/19/86	8/19/86	15.0	15.0			
468	260		4647	4497	UDWR	26679	19870706	(A-11- 1)27bdd	413950111493001	431319	4612783	1	7/19/87	7/19/87	150.0	150.0			
469	261		4427	4427	UDWR	8706	19840422	(B-12- 1)36acb	414423111535801	425207	4621263	1	3/27/95	3/27/95				0.0	0.0
470	163		4424	4394	UDWR	9663	19840415	(B-11- 1)12cbd	414213111542801	424473	4617259	1	9/20/13	9/20/13	30.0	30.0			
471	100	100	4443	4466	UDWR	7249	19840706	(B-11- 1)13dda	414119111533001	425793	4615598	1	9/19/94	9/19/94	-23.1	-23.1			
472	95	95	4454	4414	UDWR	32830	19750313	(A-11- 1)18ccc	414113111532701	425885	4615368	1	9/19/84	9/19/84	40.0	40.0			
474	220	165	4818	4768	UDWR	9671	19840706	(A-10- 1)16dcc	413553111502801	429914	4605483	1	7/19/84	7/19/84	50.0	50.0			
475	50		4820	4790	UDWR	2094	19921114	(B-10- 1)13bcc	413625111543401	424231	4606522	1	11/19/92	11/19/92	30.0	30.0			
476	50		4823	4793	UDWR	2115	19921114	(B-10- 1)13bcc	413624111543101	424283	4606512	1	11/19/92	11/19/92	30.0	30.0			
477	62	14	4587	4573	UDWR	2742	19930430	(A-11- 1)27bcc	413953111495901	430652	4612883	1	4/19/93	4/19/93	14.0	14.0			
478	216		4458	4458	UDWR	33730		(B-11- 1)25bbb	414011111543101	424353	4613492	1	4/20/05	4/20/05				0.0	0.0
479	58	58	4524	4494	UDWR	23026	20001125	(A-11- 1)21bad	414057111504201	429668	4614871	1	11/20/00	11/20/00	30.0	30.0			
482	163	163	4473	4491	UDWR	17809	19980802	(A-11- 1)18daa	414131111522001	427415	4615936	1	7/19/98	7/19/98	-18.5	-18.5			
484	200		4834	4831	UDWR	24043	19871028	(A-10- 1)18bcd	413619111531101	426144	4606323	1	10/19/87	10/19/87	3.0	3.0			
485	159	150	4592	4485	UDWR	417	19920506	(A-11- 1)31ccd	413835111531101	426185	4610532	1	5/19/92	5/19/92	107.0	107.0			
486	79	59	4536	4482	UDWR	1581	19921028	(A-11- 1)20dda	414027111511001	429017	4613965	1	10/19/92	10/19/92	54.0	54.0			
487	211	174	4645	4490	UDWR	24093	19870615	(A-11- 1)27adb	414001111490301	431938	4613109	1	6/19/87	6/19/87	155.0	155.0			
491	179	169	4564	4490	UDWR	15521	19970405	(B-10- 1) 1aab	413829111533801	425561	4610344	1	4/19/97	4/19/97	74.0	74.0			
493	225		4684	4526	UDWR	2143	19910415	(B-10- 1) 1cdd	413738111541001	424790	4608797	1	4/19/91	4/19/91	158.0	158.0			
495	182		4512	4493	UDWR	24096	19871128	(A-11- 1)10cbc	414213111495301	430817	4617201	1	11/19/87	11/19/87	19.0	19.0			
496	69		4716	4716	UDWR	14420	19881125	(A-10- 1) 2bdc	413808111483001	432674	4609632	1	11/25/88	11/25/88				20.0	20.0

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
498	249	230	4801	4671	UDWR	2888	19930615	(A-10- 1)16bad	413636111504101	429626	4606831	1	6/19/93	6/19/93	130.0	130.0			
501	80	14	4636	4624	UDWR	9602	19950622	(A-11- 1)34acb	413906111492301	431455	4611421	1	6/19/95	6/19/95	12.0	12.0			
503	220		4424	4422	UDWR	10977	19951121	(B-11- 1) 1ccc	414253111543901	424233	4618496	1	11/19/95	11/19/95	2.0	2.0			
505	180	150	4804	4687	UDWR	6955	19940812	(A-10- 1)16cba	413615111505701	429235	4606165	1	8/19/94	8/19/94	117.0	117.0			
508	159		4634	4634	UDWR	12248	19960713	(B-10- 1) 1ddc	413739111534201	425449	4608807	1	7/13/96	7/13/96				0.0	0.0
509	230		4640	4624	UDWR	431983		(B-10- 1)12aad	413737111533101	425696	4608746	1	11/20/08	11/20/08	16.0	16.0			
510	300	255	4765	4556	UDWR	1583	19921113	(A-10- 1) 9cbd	413705111505301	429348	4607714	1	11/19/92	11/19/92	209.0	209.0			
511	159	159	4436	4439	USGS	1866	19920203	(B-11- 1) 1dad	414305111533001	425818	4618855	1	2/19/92	2/19/92	-2.3	-2.3			
512	164	145	4436	4461	UDWR	11767	19960510	(B-11- 1) 1dad	414308111533201	425786	4618948	1	5/19/96	5/19/96	-24.3	-24.3			
513	271	271	4694	4682	UDWR	31925	20041211	(A-10- 1) 7bcb	413718111532401	425815	4608150	1	4/19/92	4/19/92	12.0	12.0			
514	150	139	4554	4488	UDWR	416	19920421	(B-10- 1) 1aba	413824111535101	425263	4610190	1	4/19/92	4/19/92	66.0	66.0			
515	138		4478	4478	UDWR	16074	19970702	(A-11- 1)19aba	414105111524401	426845	4615145	1	7/2/97	7/2/97				0.0	0.0
516	120		4472	4472	UDWR	8248	19910513	(A-11- 1)17bab	414159111520201	427848	4616794	1	5/13/91	5/13/91				0.0	0.0
517	140		4458	4458	UDWR	785	19920803	(A-11- 1) 7ddd	414205111522001	427421	4616978	1	8/3/92	8/3/92				0.0	0.0
518	206	150	4717	4576	UDWR	782	19920720	(A-10- 1) 2cbb	413802111484101	432414	4609450	1	7/19/92	7/19/92	141.0	141.0			
519	269		4668	4480	UDWR	1585	19920309	(A-11- 1)34aba	413916111491001	431772	4611746	1	3/19/92	3/19/92	188.0	188.0			
520	89	69	4494	4489	UDWR	435	19920610	(A-11- 1)16bbc	414148111510701	429099	4616453	1	6/19/92	6/19/92	5.0	5.0			
521	200		4484	4476	UDWR	9639	19950706	(B-11- 1)25aca	413959111534801	425353	4613132	1	7/19/95	7/19/95	8.0	8.0			
522	140		4480	4480	UDWR	11614	19960524	(A-11- 1)19aba	414105111523901	426964	4615149	1	5/24/96	5/24/96				0.0	0.0
523	146		4484	4484	UDWR	21702	20000316	(A-11- 1)19abd	414055111524201	426889	4614852	1	3/16/00	3/16/00				0.0	0.0
524	300	172	4618	4601	UDWR	19245	19990518	(B-10- 1) 1ddb	413747111534201	425460	4609040	1	5/19/99	5/19/99	17.0	17.0			
525	140	100	4821	4789	UDWR	436	19920608	(A-10- 1)18bcc	413620111532301	425853	4606356	1	4/19/92	4/19/92	32.0	32.0			
527	140		4646	4552	UDWR	24102	20010830	(A-11- 1)34dba	413855111490901	431783	4611075	1	8/20/01	8/20/01	94.0	94.0			
529	455	440	4841	4486	UDWR	2009	19930323	(A-12- 1)13cab	414648111472001	434446	4625647	1	3/19/93	3/19/93	355.0	355.0			
533	176		4433	4433	USGS	9570	19950627	(A-11- 1) 6cba	414316111531601	426152	4619189	1	6/23/95	6/23/95				0.0	0.0
534	110		4434	4434	UDWR	6705	19940707	(B-11- 1)13aad	414152111533301	425732	4616614	1	7/7/94	7/7/94				0.0	0.0
536	141		4442	4442	UDWR	7925	19941212	(A-11- 1) 7acc	414231111525201	426686	4617814	1	12/12/94	12/12/94				0.0	0.0
537	134	107	4463	4462	UDWR	7842	19941201	(A-11- 1)17bcb	414144111521601	427506	4616346	1	12/19/94	12/19/94	1.0	1.0			
539	273	253	4891	4723	UDWR	6639	19940728	(A-10- 1) 8ccb	413653111521201	427518	4607380	1	7/19/94	7/19/94	168.0	168.0			
540	145	145	4469	4474	UDWR	7126	19940829	(B-11- 1)24cdc	414019111542001	424626	4613749	1	8/19/94	8/19/94	-4.6	-4.6			
543	180	173	4580	4495	UDWR	7322	19940912	(A-12- 1)15dda	414629111485801	432172	4625074	1	9/19/94	9/19/94	85.0	85.0			
548	154		4432	4432	USGS	15347	19970328	(B-11- 1)14aaa	414156111544101	424177	4616752	1	3/28/97	3/28/97				0.0	0.0
549	207	194	4433	4449	UDWR	26165	20021029	(B-11- 1)14aaa	414153111544201	424145	4616658	1	10/20/02	10/20/02	-16.2	-16.2			
551	138		4468	4468	UDWR	23285	20010309	(A-11- 1)18dcb	414114111524801	426756	4615430	1	3/9/01	3/9/01				0.0	0.0
552	78	62	4493	4485	UDWR	6782		(B-11- 1)25aad	414003111532901	425783	4613252	1	7/19/94	7/19/94	8.0	8.0			
553	161		4436	4401	UDWR	30057	19830801	(A-11- 1) 6cca	414259111532001	426057	4618675	1	8/19/83	8/19/83	35.0	35.0			
554	166		4842	4827	UDWR	9601	19950706	(A-10- 1)21acd	413529111501601	430186	4604747	1	7/19/95	7/19/95	15.0	15.0			
555	115		4471	4494	UDWR	9684	19950713	(B-11- 1)24daa	414041111533401	425685	4614407	1	7/19/95	7/19/95	-23.1	-23.1			
556	266	266	4683	4639	UDWR	9820	19960305	(B-10- 1)12bbb	413735111543001	424333	4608689	1	3/19/96	3/19/96	44.0	44.0			
557	113	85	4494	4490	UDWR	10706	19951026	(A-11- 1)19dcb	414027111525201	426646	4613965	1	10/19/95	10/19/95	4.0	4.0			
558	188		4442	4442	UDWR	10023	19950816	(B-11- 1)23adb	414051111545401	423853	4614756	1	8/16/95	8/16/95				0.0	0.0
560	400	295	4591	4589	UDWR	25679	20020814	(B-10- 1) 1cca	413748111542201	424534	4609098	1	8/20/02	8/20/02	2.0	2.0			
561	258	248	4424	4414	UDWR	28908		(B-11- 1) 2dad	414306111544201	424171	4618908	1	5/19/96	5/19/96	10.0	10.0			
562	156		4435	4442	UDWR	11942	19960619	(B-11- 1) 1daa	414315111533601	425703	4619173	1	6/19/96	6/19/96	-6.9	-6.9			
563	315	315	4802	4647	UDWR	20799	19991015	(A-10- 1) 8cca	413655111520001	427788	4607421	1	10/19/99	10/19/99	155.0	155.0			
564	340	260	4838	4659	UDWR	19412	19990521	(A-10- 1) 8cdb	413652111515701	427861	4607336	1	5/19/99	5/19/99	179.0	179.0			
566	213		4818	4795	UDWR	12176	19960703	(A-10- 1)16dad	413609111500601	430426	4605975	1	7/19/96	7/19/96	23.0	23.0			
567	240	200	4818	4803	UDWR	19686	19990716	(A-10- 1) 7ddc	413648111523101	427065	4607203	1	7/19/99	7/19/99	15.0	15.0			
569	386	370	4896	4722	UDWR	17574	19980612	(A-10- 1) 7dda	413654111521901	427343	4607394	1	6/19/98	6/19/98	174.0	174.0			
570	78		4480	4480	UDWR	13883	19961008	(A-11- 1)18dda	414114111522301	427341	4615424	1	10/8/96	10/8/96				0.0	0.0
571	120		4459	4457	USGS	13748	19960920	(A-11- 1)18dbc	414124111525201	426682	4615738	1	9/19/96	9/19/96	2.0	2.0			
573	283	263	4671	4671	UDWR	12445	19960719	(B-10- 1)12ada	413723111532901	425736	4608309	1	7/19/96	7/19/96	0.3	0.3			
574	220	150	4798	4675	UDWR	19031	19990524	(A-10- 1)17abc	413643111512701	428543	4607060	1	5/19/99	5/19/99	123.0	123.0			
575	285		4876	4626	UDWR	13006	19960906	(A-10- 1)15bad	413633111492701	431329	4606724	1	9/19/96	9/19/96	250.0	250.0			
576	207	198	4809	4781	UDWR	14502	19970118	(A-10- 1)16ada	413629111500301	430502	4606611	1	1/19/97	1/19/97	28.0	28.0			

Map ID	Well Depth (ft)	Screen Depth (ft)	Elev. (ft)	Mean Water Level Elev.(ft)	Agency	Well ID Number	Date Drilled	PLSS	USGS ID Number	UTM X (m)	UTM Y (m)	n	Depth to Water Statistics (ft)						
													First Measured	Last Measured	Mean	Median	Standard Dev.	Min.	Max.
577	135		4809	4779	UDWR	15043	19970409	(A-10- 1)16adb	413626111500801	430372	4606520	1	4/19/97	4/19/97	30.0	30.0			
578	155	155	4814	4784	UDWR	15419	19970321	(A-10- 1)16add	413623111500201	430512	4606423	1	3/19/97	3/19/97	30.0	30.0			
579	180	143	4576	4484	UDWR	16241	19970904	(B-10- 1) 1ada	413811111533601	425605	4609794	1	9/19/97	9/19/97	92.0	92.0			
581	222	222	4436	4450	UDWR	14887	19970515	(B-11- 1) 1daa	414316111533301	425773	4619203	1	5/19/97	5/19/97	-13.9	-13.9			
582	139	59	4839	4803	UDWR	25528	20020717	(B-10- 1)13dad	413610111533001	425708	4606068	1	7/20/02	7/20/02	36.0	36.0			
583	525		4834	4834	UDWR	23396	20010416	(B-10- 1)13daa	413612111533501	425591	4606120	1	4/16/01	4/16/01				0.0	0.0
584	460	411	4856	4815	UDWR	25639	20020816	(B-10- 1)13dba	413616111535301	425159	4606238	1	7/20/02	7/20/02	41.0	41.0			
585	180	180	4571	4491	UDWR	21105	19991208	(B-10- 1) 1aac	413822111534201	425456	4610128	1	12/19/99	12/19/99	80.0	80.0			
586	270	180	4681	4663	UDWR	16026	19970815	(B-10- 1)12bbb	413732111543401	424231	4608600	1	8/19/97	8/19/97	18.0	18.0			
587	180		4536	4487	UDWR	15623	19970610	(B-11- 1)36dcc	413832111535801	425084	4610431	1	6/19/97	6/19/97	49.0	49.0			
588	395		4821	4807	UDWR	31320	19790803	(B-10- 1)13bdc	413622111541401	424688	4606452	1	8/19/79	8/19/79	14.0	14.0			
589	152		4474	4474	UDWR	18293	19990524	(A-11- 1) 5ddd	414257111511701	428903	4618572	1	5/24/99	5/24/99				0.0	0.0
590	200		4578	4488	UDWR	17832	19980731	(B-10- 1) 1aad	413819111533101	425716	4610040	1	7/19/98	7/19/98	90.0	90.0			
591	210	179	4655	4494	UDWR	15957	19970619	(A-11- 1)27acd	413949111490901	431812	4612744	1	6/19/97	6/19/97	161.0	161.0			
593	323		4803	4510	UDWR	33203	19740724	(A-10- 1)10bcc	413713111495101	430792	4607941	1	7/19/74	7/19/74	293.0	293.0			
595	140		4430	4430	UDWR	17398	19980515	(B-11- 1)14aaa	414157111544401	424092	4616789	1	5/15/98	5/15/98				0.0	0.0
596	280		4653	4477	UDWR	25529	20030619	(A-11- 1)27acd	413949111491401	431689	4612758	1	6/20/03	6/20/03	176.0	176.0			
597	341	327	4684	4634	UDWR	18537	19990127	(B-10- 1) 1ccd	413738111542701	424397	4608779	1	1/19/99	1/19/99	50.0	50.0			
598	120		4485	4480	UDWR	18592	19990518	(A-11- 1)19acd	414042111524201	426883	4614443	1	5/19/99	5/19/99	5.0	5.0			
599	147		4499	4499	UDWR	18450	19981203	(A-11- 1)17add	414137111511801	428862	4616100	1	12/3/98	12/3/98				0.0	0.0
600	180		4424	4424	UDWR	17918	19980817	(B-11- 1)14aba	414154111545801	423763	4616698	1	8/17/98	8/17/98				0.0	0.0
602	140		4529	4484	UDWR	18328				428318	4612735	1	11/19/98	11/19/98	45.0	45.0			
604	240	240	4542	4482	UDWR	23564	20010504	(B-10- 1) 1aba	413829111535101	425213	4610368	1	5/20/01	5/20/01	60.0	60.0			
606	450		4812	4512	USGS	5023	19940209	(A-10- 1)10cdb	413654111494001	431026	4607370	1	2/19/94	2/19/94	300.0	300.0			
607	259		4687	4497	UDWR	5126	19931220	(A-11- 1)27ddb	413930111485901	432031	4612157	1	12/19/93	12/19/93	190.0	190.0			
611	138	122	4466	4493	UDWR	23094	20001206	(A-11- 1)18cdd	414108111530101	426455	4615232	1	12/20/00	12/20/00	-26.6	-26.6			
612	199	148	4445	4471	UDWR	20778	19850326	(A-11- 1) 5bcc	414322111522101	427461	4619384	1	11/20/00	11/20/00	-25.4	-25.4			
613	219	200	4426	4456	UDWR	24357	20011031	(B-11- 1)11ddd	414205111544101	424166	4617013	1	10/20/01	10/20/01	-30.0	-30.0			
616	400		4881	4801	UDWR	34165	20050527	(A-10- 1)22bbb	413549111495801	430599	4605375	1	5/20/05	5/20/05	80.0	80.0			
617	415		4790	4502	UDWR	35583	20070102	(A-12- 1)26cdc	414439111482701	432868	4621674	1	7/20/07	7/20/07	288.0	288.0			
619	147		4465	4455	UDWR	34412	20051202	(B-11- 1)24add	414043111533701	425621	4614483	1	12/20/05	12/20/05	10.0	10.0			
620	97		4601	4587	UDWR	431876	20081006	(B-10- 1) 1cda	413748111541001	424798	4609091	1	10/20/08	10/20/08	14.0	14.0			
621	200		4798	4743	UDWR	435676	20120310	(B-10- 1)12dcd	413647111535001	425250	4607192	1	3/20/12	3/20/12	54.5	54.5			
622	102		4629	4583	UDWR	433796	20100430	(A-10- 1) 6ccc	413743111532301	425889	4608929	1	5/20/10	5/20/10	46.0	46.0			
623	120		4490	4486	UDWR	429150	20070428	(A-11- 1)30bbb	414008111532501	425886	4613399	1	5/20/07	5/20/07	4.0	4.0			
624	320		4820	4565	UDWR	430692	20071018	(A-10- 1)15bab	413643111493701	431110	4607030	1	10/20/07	10/20/07	255.0	255.0			
625	240		4769	4733	UDWR	431572	20090210	(B-10- 1)12dcb	413651111540101	425003	4607333	1	3/20/09	3/20/09	36.0	36.0			
626	157		4477	4489	UDWR	430624	20071203	(A-11- 1)19bcc	414042111532501	425907	4614437	1	9/20/08	9/20/08	-12.0	-12.0			
627	268		4767	4717	UDWR	435049	20110818	(B-10- 1)12cdd	413650111540401	424916	4607314	1	8/20/11	8/20/11	50.0	50.0			
628	180		4746	4701	UDWR	431615	20080721	(B-10- 1)12cda	413652111541001	424791	4607375	1	7/20/08	7/20/08	45.0	45.0			
629	265		4828	4798	UDWR	432987	20090807	(A-10- 1)21bdd	413529111503401	429757	4604757	1	8/20/09	8/20/09	30.0	30.0			
630	400		4795	4489	UDWR	431528	20080825	(A-11- 1)14cbb	414131111485101	432245	4615896	1	9/20/08	9/20/08	306.0	306.0			
631	220		4724	4561	UDWR	432347	20090204	(A-10- 1) 2cdb	413749111482801	432715	4609033	1	2/20/09	2/20/09	163.0	163.0			
632	159		4665	4547	UDWR	433380				430379	4610751	1	12/20/09	12/20/09	118.0	118.0			
633	157		4806	4786	USGS	433929	20100707	(B-10- 1)12ddd	413646111533001	425716	4607158	1	7/20/10	7/20/10	20.0	20.0			
634	301		4855	4695	UDWR	435551	20120111	(A-10- 1) 8cca	413653111520801	427619	4607371	1	1/20/12	1/20/12	160.0	160.0			
635	189	189	4592	4587	UDWR	22563	20000908	(B-10- 1) 2ddc	413739111544601	423970	4608809	1	9/20/00	9/20/00	5.0	5.0			
636			4821	4791	UDWR	12570		(A-10- 1)18cba	413617111531001	426166	4606264	1	7/19/96	7/19/96	30.0	30.0			
643			4890	4809	UDWR	22492	20000731	(A-10- 1)21add	413529111500601	430401	4604752	1	7/20/00	7/20/00	81.0	81.0			