

## 6.0 WATER QUALITY

### 6.1 Introduction

This section describes the baseline aqueous geochemistry and stable isotope data compiled as part of the hydrogeological evaluation of groundwater in parts of Clark, Lincoln, and White Pine counties, Nevada. Data were compiled for hydrographic basins in four regional flow systems (Figure 2-1) and are provided electronically on the attached CD-ROM. Data in the Project Basins of Spring, Snake, Cave, Dry Lake, Delamar, and Coyote Spring valleys are briefly discussed in the following sections.

### 6.2 Geochemical Characterization of Groundwater

The chemical composition of most natural waters is controlled by the mineralogic composition of the surrounding rocks. Rock-water reactions play a significant role in the chemical characteristics of groundwater. The equilibrium water chemistry is a function of the bedrock type and contact time between water and the rock.

Processes of mineral dissolution, alteration, and genesis exert strong controls on the chemical species in natural waters. The chemistry of groundwater in carbonate-rock (limestone or dolomite) aquifers is typically a calcium-bicarbonate-type water with varying amounts of magnesium and sulfate, depending on the amounts of dolomite and gypsum or anhydrite present (White, 1988; Macpherson and Townsend, 1998). Barium, strontium, iron, and manganese are some of the common trace elements in carbonate-rock aquifers.

The groundwater chemistry of alluvial aquifers typically reflects the chemistry of the dominant rock type in the surrounding mountains. Calcium-bicarbonate-type water is found in valley-fill aquifers that are composed chiefly of carbonate-rock detritus. Sodium, chloride, sulfate, and trace constituents such as bromide, lithium, and boron are prevalent in valley-fill aquifers dominated by volcanic rocks.

Groundwater in volcanic rocks sometimes has relatively higher sodium and potassium concentrations and a relatively lower pH than those found in carbonate-rock aquifers. Where the depositional environment is saline or brackish, especially for Tertiary lacustrine deposits, evaporite minerals such as gypsum and halite are common, and groundwater flowing in such a medium usually has high concentrations of sulfates and chlorides with very high total dissolved solids (TDS).

Major-ion concentrations of groundwater have been used to distinguish the different types of water in the study area and in parts of the carbonate-rock aquifer province in Nevada. Schoff and Moore (1964) distinguished three chemical types of groundwater at the Nevada Test Site. They related a calcium-magnesium water to carbonate rocks, a sodium-potassium water to volcanic rocks, and a mixed cation type to water flowing through the two types of rocks or undergoing cation exchange

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reactions. These three hydrochemical facies were confirmed by Winograd and Thordarson (1975), who also identified a playa facies and a sodium-sulfate-bicarbonate facies that occur in parts of the Death Valley Flow System. These hydrochemical facies guide the interpretation of the chemistry of the different waters in the study area for this report.

### **6.3 Data Compilation**

Over 400 analytical results of groundwater and surface water were compiled for springs and creeks in the mountain blocks, and from wells and springs in the valley floor. Many of these sources have been sampled multiple times. The water chemistry and site data are provided as Microsoft Excel® spreadsheet files and are found on the CD-ROM attached to the back page of this report. Also included on the CD-ROM is a 2006 letter report from the DRI on stable isotopes and major-ion geochemistry for East, Central, and Southeastern Nevada.

Data compiled for this report include most of the published and unpublished work on aqueous geochemistry for the hydrographic basins in southern and eastern Nevada. The major sources include data collected by SNWA in the 1990s and from 2003 through 2007. These include data collected on 18 wells drilled in WRFS by SNWA from 2003 to 2005 and wells drilled in Spring Valley in 2006 and 2007. Other sources of data include the USGS NWIS website (USGS, 2007), the Division of Hydrologic Sciences of the DRI, Nevada Bureau of Mines and Geology (NBMG), wells drilled by the Utah Geological Survey in 2007, and other miscellaneous drilling and consulting reports completed by independent consulting firms. The USGS NWIS database contains data compiled from the USGS Regional Aquifer-System Analysis studies, data from the USGS Professional Papers series on the Basin and Range physiographic area (e.g., Thomas et al., 1996; Plume, 1996), the MX Missile-Siting Investigation Program of the early 1980s (Ertec Western, Inc., 1981a to 1981e), the USGS National Water-Quality Assessment Program, the DRI and USGS Basin and Range Carbonate Aquifer System (BARCAS) study (e.g. Hershey et al., 2007), and data from the co-operative work between USGS and the Nevada Department of Conservation and Natural Resources.

#### **6.3.1 Data Limitations**

Numerous sources of data were used for this study. The data were typically collected in support of other studies with different purposes and objectives. The majority of the data is from springs because they are easily accessible for sampling. Most of the data from deep wells were collected during drilling, or shortly thereafter. Generally, there is a paucity of wells tapping the carbonate-rock aquifer in the study area. For example, in their study of the water quality in the carbonate-rock aquifer of the Great Basin in Nevada and Utah, USGS sampled only 18 deep wells in 8 regional flow systems (Schaefer et al., 2005). The spring data complement the data collected from wells in representing groundwater resources in the study area, although it is not known how well the springs represent the deep carbonate-rock aquifer. In many instances, the sample suites were limited, making a determination of the hydrochemical facies more difficult.

A great effort was made to evaluate most of these data for completeness and quality; however, the precision and accuracy of all the data could not be ascertained. At a minimum, reaction error calculations were made to assess the quality of water chemistry data. Reaction errors occur because

of analytical errors for the individual parameters or because not all possible ions are commonly measured. Reaction error determination is based on the assumption that the sum of the cation charge in a solution is equal to the sum of the anion charge. Normally, the criterion for acceptability is a maximum reaction error between 2 and 5 percent (Mazor, 1991); however, due to the varied nature of the data sources used for this report, a maximum reaction error of 10 percent was used in some few instances.

### **6.3.2 Data Collection and Analysis**

#### **6.3.2.1 Sample Collection**

Data collection by SNWA for this study was conducted in the summers of 2003, 2004, 2005, 2006, and through 2007 at wells, creeks, and spring sites within the study area. Field water-quality parameters were collected at each of the sites during sampling. Water temperatures were measured with either a hand-held mercury thermometer or with a temperature probe attached to a Beckman 255 pH/temperature meter. Electrical conductivity measurements were made using an Orion 130A portable conductivity meter. Dissolved oxygen measurements were made using a YSI 550A meter. All measurement equipment were calibrated according to the manufacturers' calibration procedures. The coordinates of the sample sites were also determined using Trimble GEOXH hand-held Geographic Positioning System.

At all sites, samples were collected for analysis of major ions, trace metals, and light stable isotopes after the field parameters (pH, electrical conductivity, and temperature) had stabilized for at least 5 minutes.

Samples for analysis of major ions and trace metals were collected in high-density polyethylene bottles. Samples were collected using the procedures described by Koterba et al. (1995) and stored at a temperature of approximately 4°C for shipment to the appropriate laboratories for analysis. Trace metal samples were preserved with reagent-grade nitric acid.

Samples for deuterium and oxygen-18 analysis were collected in 25 ml glass bottles with polysealed lids.

#### **6.3.2.2 Documentation and Shipping**

A sample collection log was completed for each sampling event, documenting measurement of the parameters described in [Section 6.3.2.1](#). A chain-of-custody record was completed, and chain of custody was maintained for each sample at all times. Each chain-of-custody record was completed based on the type of sample and for the laboratory to which the sample was shipped. A copy of the SNWA sample collection log and the original copy of the chain-of-custody record were shipped with the samples to each laboratory.

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### **6.3.2.3 Sample Analysis**

The samples collected by SNWA for major ions and trace elements were analyzed by the Weck Laboratories, Inc. (a State of Nevada-licensed laboratory in California), the Water Chemistry Laboratory of DRI in Reno, or the Southern Nevada Water System Laboratory. Some of the spring and well samples collected in 2004 and 2005 were analyzed by MWH Laboratories at their facilities in Monrovia, California. All the analyses were performed using standard U.S. Environmental Protection Agency (EPA) methods.

Stable isotopes samples were analyzed at the Environmental Isotope Laboratory of the University of Waterloo, Canada.

## **6.4 Analytical Results and Discussion**

The characteristics of the water chemistry in the SNWA Project Basins are briefly discussed in this section.

### **6.4.1 Great Salt Lake Desert Flow System**

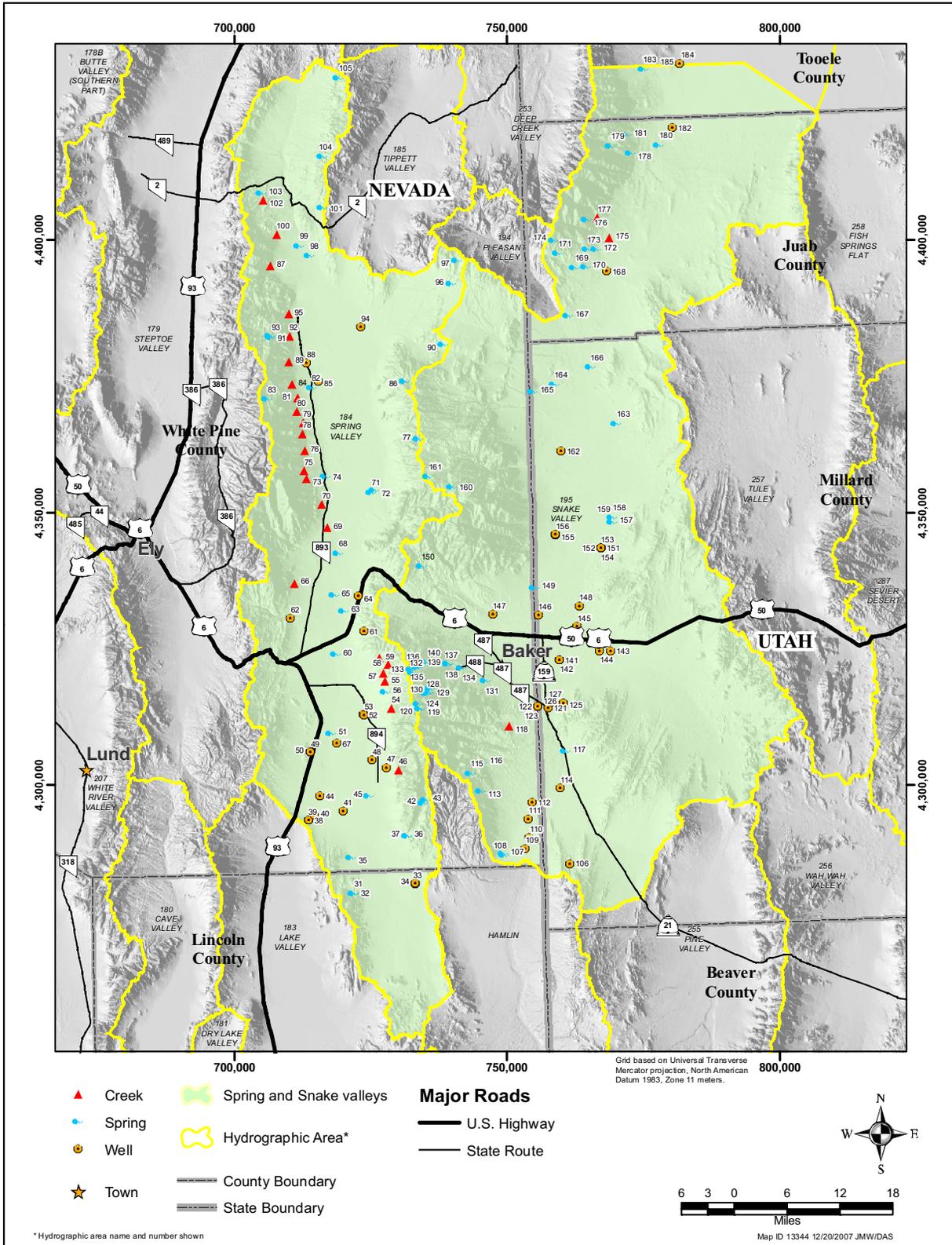
Data for Spring and Snake valleys in GSLDFS were compiled for this report, and are found on the attached CD-ROM. The sample sites within the SNWA project basins in the GSLDFS (Spring and Snake valleys) whose data were used for the analysis are shown on [Figure 6-1](#). The site data are provided in the Site Information Worksheet, and the major-ion data are provided in the Microsoft Excel® “Majors” worksheet described in [Appendix A](#) and attached on the CD-ROM.

#### **6.4.1.1 Chemical Composition of Spring Valley Waters**

A Piper diagram of samples collected in Spring and Snake valleys is shown on [Figure 6-2](#). The water type is mainly Ca-Mg-HCO<sub>3</sub> for all the springs, creeks, and wells sampled in Spring Valley with the exception of a few which have a Ca-Na-HCO<sub>3</sub>-Cl, Ca-Mg-Na-HCO<sub>3</sub> and Ca-Mg-Na-HCO<sub>3</sub>-SO<sub>4</sub> facies. The water chemistry of most of the springs reflects the chemistry of the carbonate rocks that underlie most of the valley. The chemical makeup of a majority of the springs and creeks suggests that the weathering of ferromagnesian minerals and carbonate rocks (dolomite and limestone) is the dominant process controlling the chemistry of the springs and creeks in Spring Valley. The Ca-Mg-Na-HCO<sub>3</sub> waters suggest contact with some sodium-rich rocks. The SO<sub>4</sub> facies water probably results from the dissolution of evaporites within the carbonates, or from dissolution of sulfide or sulfate minerals in altered carbonate rocks. The distribution of hydrochemical facies within the aquifers in Spring Valley appears to be controlled by the mineralogy of the aquifer material. In [Figure 6-2](#), most of the samples in Spring Valley are clustered in the Ca-Mg-HCO<sub>3</sub> facies of the Piper diagram.

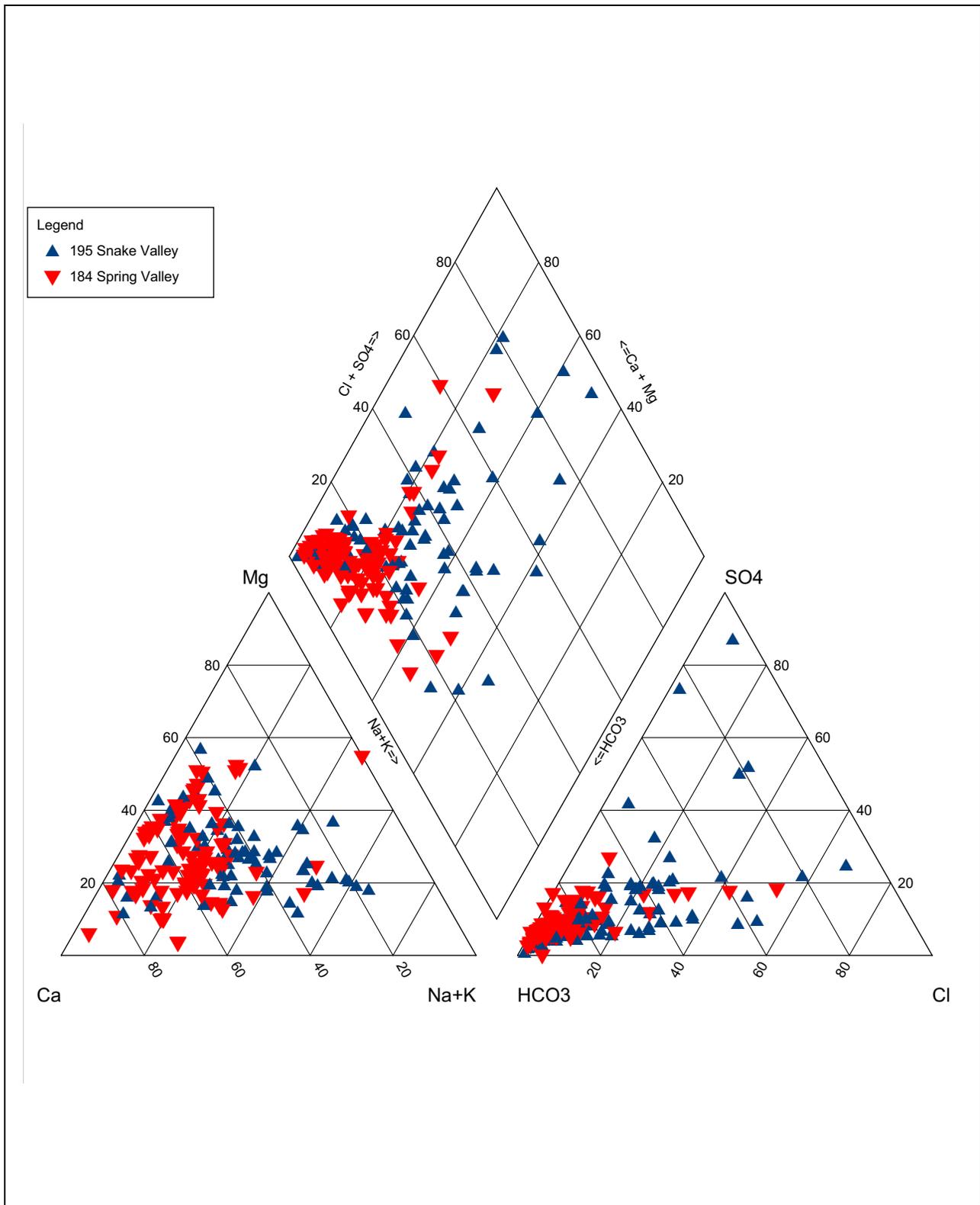
#### **6.4.1.2 Chemical Composition of Snake Valley Waters**

The major-ion chemistry data for Snake Valley waters are provided in the Microsoft Excel® worksheet entitled “Majors” described in [Appendix A](#) and attached on the CD-ROM. The dominant



Note: Numbers beside points correspond to the Map ID assigned with the data set provided on the CD-ROM.

**Figure 6-1**  
**Locations of Sample Sites in Spring and Snake Valleys, Nevada and Utah**



**Figure 6-2**  
**Piper Diagram of Spring, Creek, and Well Water Samples Collected in**  
**Parts of the Great Salt Lake Desert Flow System**

cation for these samples is calcium, and the dominant anions are bicarbonate and chloride. The samples range from Ca-HCO<sub>3</sub> facies through Ca-Mg-Na-HCO<sub>3</sub> to Ca-Mg-Na-HCO<sub>3</sub>-Cl to Na-Ca-HCO<sub>3</sub>-Cl facies. The increase in sodium could be due to contact with some sodium-rich minerals, cation exchange reactions, or albite weathering. Carbonate and ferromagnesian mineral weathering appears to dominate the chemistry of the Ca-Mg-HCO<sub>3</sub> facies waters.

From [Figure 6-2](#), the hydrochemical facies suggest that there is a greater variation in the chemical composition of basin-fill aquifers in Snake Valley than in Spring Valley. The number of wells tapping the carbonate-rock aquifer was not enough to make any meaningful observations.

#### **6.4.1.3 Trace Element Concentration of Spring and Snake Valley Waters**

Trace element concentrations of the waters in Spring and Snake valleys are provided in the Microsoft Excel<sup>®</sup> worksheet entitled “Traces” described in [Appendix A](#) and attached on the CD-ROM. These include springs in the mountain-block areas and the valley floor. The minimum and maximum concentrations of selected trace elements and other parameters regulated by the EPA observed in both valleys are shown in [Table 6-1](#). With the exception of arsenic, the maximum concentrations of the parameters in both valleys were less than the EPA maximum contaminant level (MCL) values. The maximum concentrations of chloride and TDS in both valleys were however, greater than the EPA secondary maximum contaminant level (SMCL) values. The maximum pH and concentrations of aluminum and iron in Spring Valley were also greater than the EPA SMCL values.

#### **6.4.1.4 Deuterium and Oxygen-18 Composition of Spring and Snake Valley Waters**

The stable isotope data for Spring and Snake valleys are provided in the Microsoft Excel<sup>®</sup> worksheet entitled “Stable Isotopes” described in [Appendix A](#) and attached on the CD-ROM. A plot of the isotopic composition of the springs, creeks, and wells in Spring and Snake valleys is depicted in [Figure 6-3](#). Also shown is the global meteoric water line (GMWL), available precipitation data, and the local meteoric water line (LMWL) developed using the current data set. The slope of the LMWL is 7.7 and is not significantly different from that of the GMWL (Craig, 1961), which is 8. Samples plotting below the GMWL suggest the water underwent some form of evaporation prior to recharging. There is no remarkable difference between the isotopic composition of the springs, creeks, and wells in Spring and Snake valleys; they all plot around the GMWL. The lack of isotopic difference between the springs, creeks, and wells implies the same source for all of them.

Winter snowmelt and local summer storms produce the runoff and recharge to the area. Summer precipitation is relatively more enriched in isotopic composition than winter precipitation as a result of more partial evaporation during the summer ([Figure 6-3](#)). Contribution by summer rainfall to the recharge appears to be small. Using a mass balance analysis of the mean isotopic compositions of summer rainfall, winter snow, and shallow groundwater in Great Basin National Park (GBNP), Acheampong (1992) observed that the shallow groundwater in GBNP was a mixture of about 20 percent summer rainfall, and about 80 percent winter snow. The wells, creeks, and springs sampled for the study are also more depleted in isotopic composition than the volume-weighted precipitation. Thus, based on the isotopic composition, present-day winter precipitation is the major source of recharge to the springs, wells, and creeks in Spring and Snake valleys.

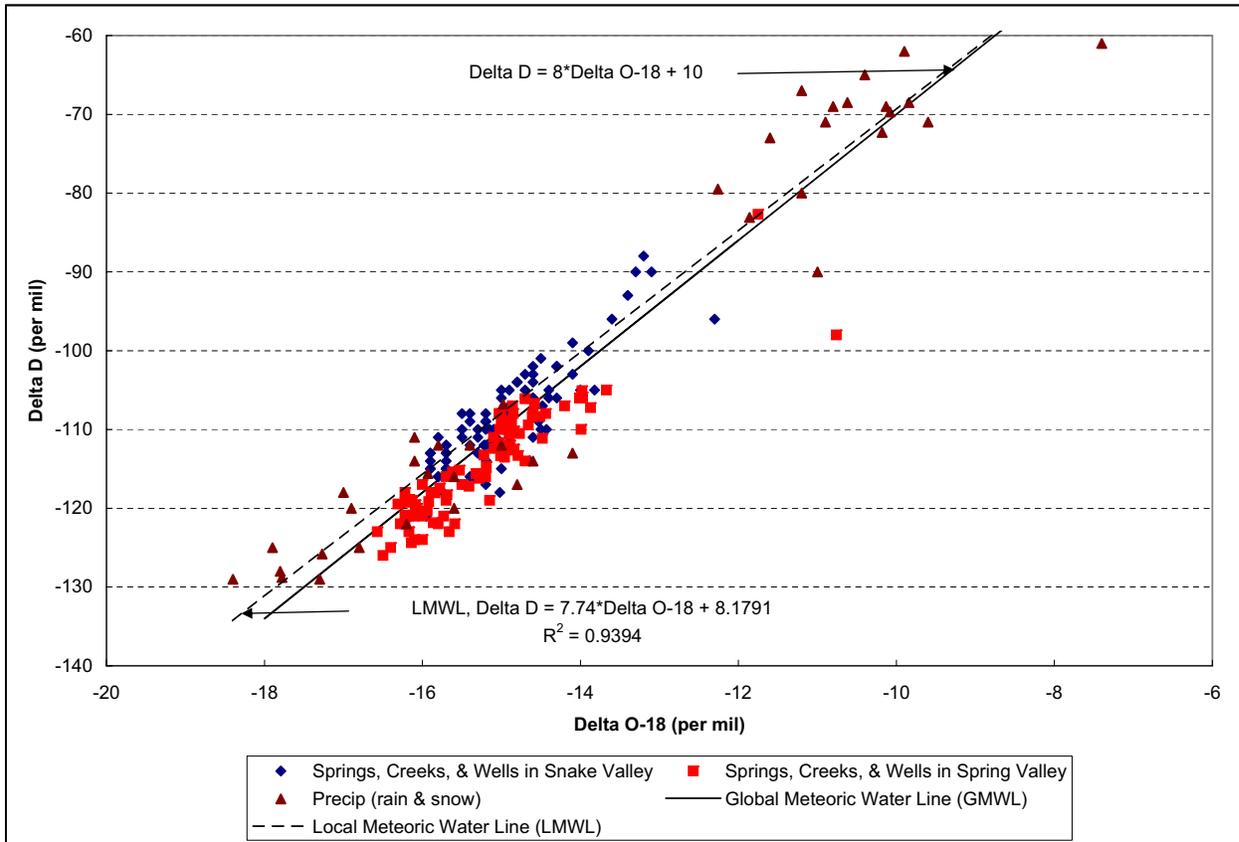
**Table 6-1**  
**Range of Concentrations of Selected Parameters for Water Samples Collected in Snake and Spring Valleys, Great Salt Lake Desert Flow System, Nevada and Utah**

Constituent	EPA Maximum Contaminant Level	EPA Secondary Maximum Contaminant Level	Minimum Value (Snake)	Maximum Value (Snake)	Minimum Value (Spring)	Maximum Value (Spring)
Antimony	6 µg/L	---	ND	0.38	ND	0.67
Arsenic	10 µg/L	---	ND	30.1	ND	10
Barium	2,000 µg/L	---	ND	120	ND	360
Beryllium	4 µg/L	---	ND	ND	ND	ND
Cadmium	5 µg/L	---	ND	ND	ND	0.17
Chromium	100 µg/L	---	ND	5.7	ND	9
Copper	1,300 µg/L	---	ND	6	ND	5
Fluoride	4 mg/L	2 mg/L	ND	2.9	ND	0.96
Lead	15 µg/L	---	ND	0.5	ND	3.6
Mercury	2 µg/L	---	ND	0.2	ND	ND
Selenium	50 µg/L	---	ND	18	ND	8
Thallium	2 µg/L	---	ND	0.2	ND	0.39
Uranium	30 µg/L	---	0.42	17.6	ND	21.5
Nitrite (as nitrogen)	1 mg/L	---	ND	ND	ND	ND
Nitrate (as nitrogen)	10 mg/L	---	ND	0.93	ND	2.41
Aluminum	---	50 to 200 µg/L	ND	160	ND	1,200
Chloride	---	250 mg/L	ND	490	ND	352
Iron	---	300 µg/L	ND	208	ND	5,700
Manganese	---	50 µg/L	ND	30	ND	88
Silver	---	100 µg/L	ND	ND	ND	ND
Sulfate	---	250 mg/L	ND	1060	ND	162
Zinc	---	5,000 µg/L	ND	11.3	ND	56
pH	---	6.5 to 8.5	6.43	8.4	6.03	9.92
Total Dissolved Solids	---	500 mg/L	198	1794	ND	660

ND = non-detect; NTU = nephelometric turbidity unit

### 6.4.2 White River Flow System

Groundwater flow and water-quality data have been compiled for the WRFS since the early 1900s. However, there is still a paucity of water chemistry data for many of the valleys within the WRFS. Major-ion chemistry data compiled for WRFS are provided in the Microsoft Excel worksheet entitled “Majors” described in [Appendix A](#) and attached on the CD-ROM.



GBNP = Great Basin National Park

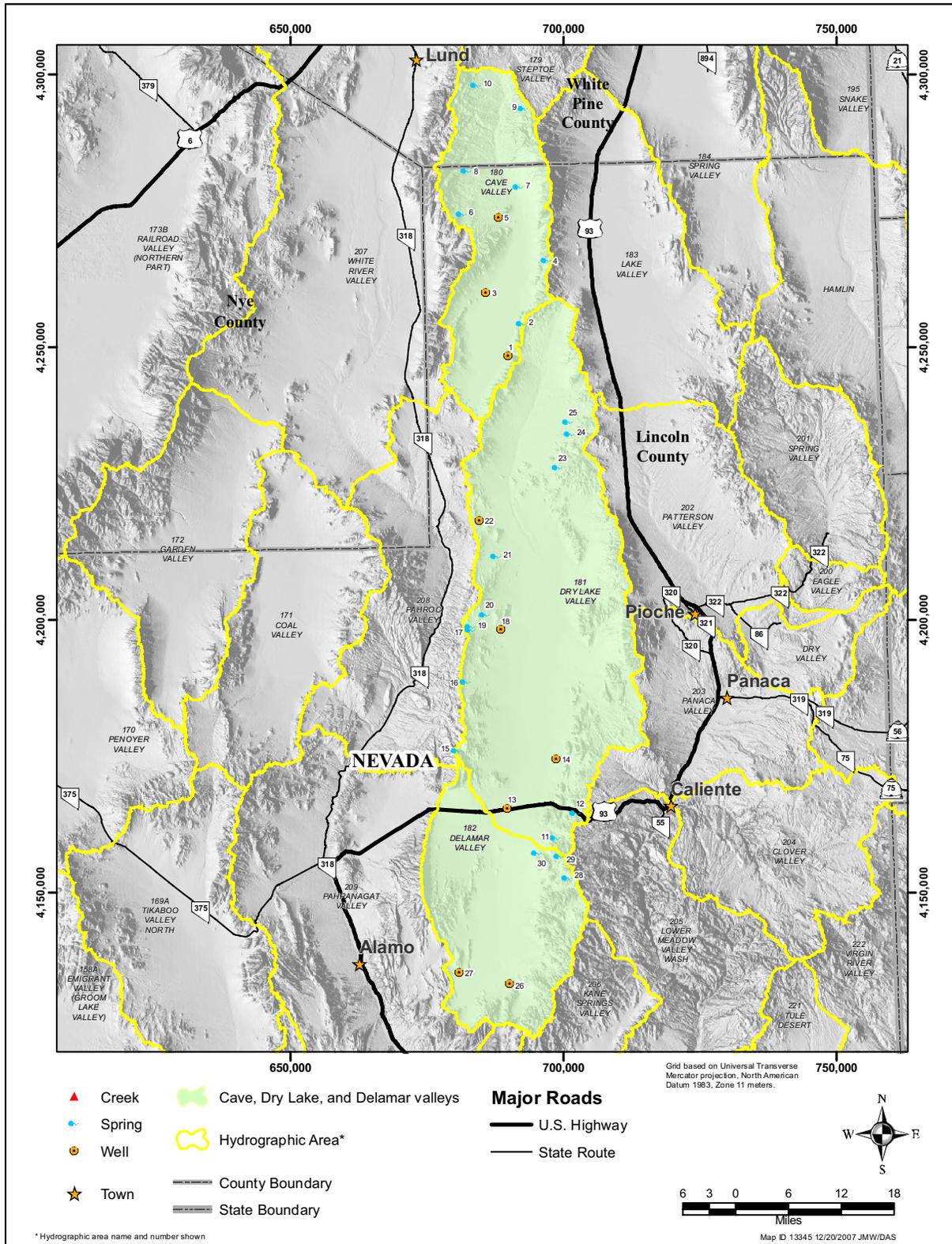
**Figure 6-3**  
 $\delta D$  Versus  $\delta^{18}O$  Plot of Springs, Creeks, and Wells  
 in Spring and Snake Valleys, Nevada and Utah

**6.4.2.1 Chemical Composition of Cave, Dry Lake, Delamar, and Coyote Spring Valleys Waters**

Sample locations in Cave, Delamar, and Dry Lake valleys are shown on [Figure 6-4](#), and those in Coyote Spring Valley are shown on [Figure 6-5](#).

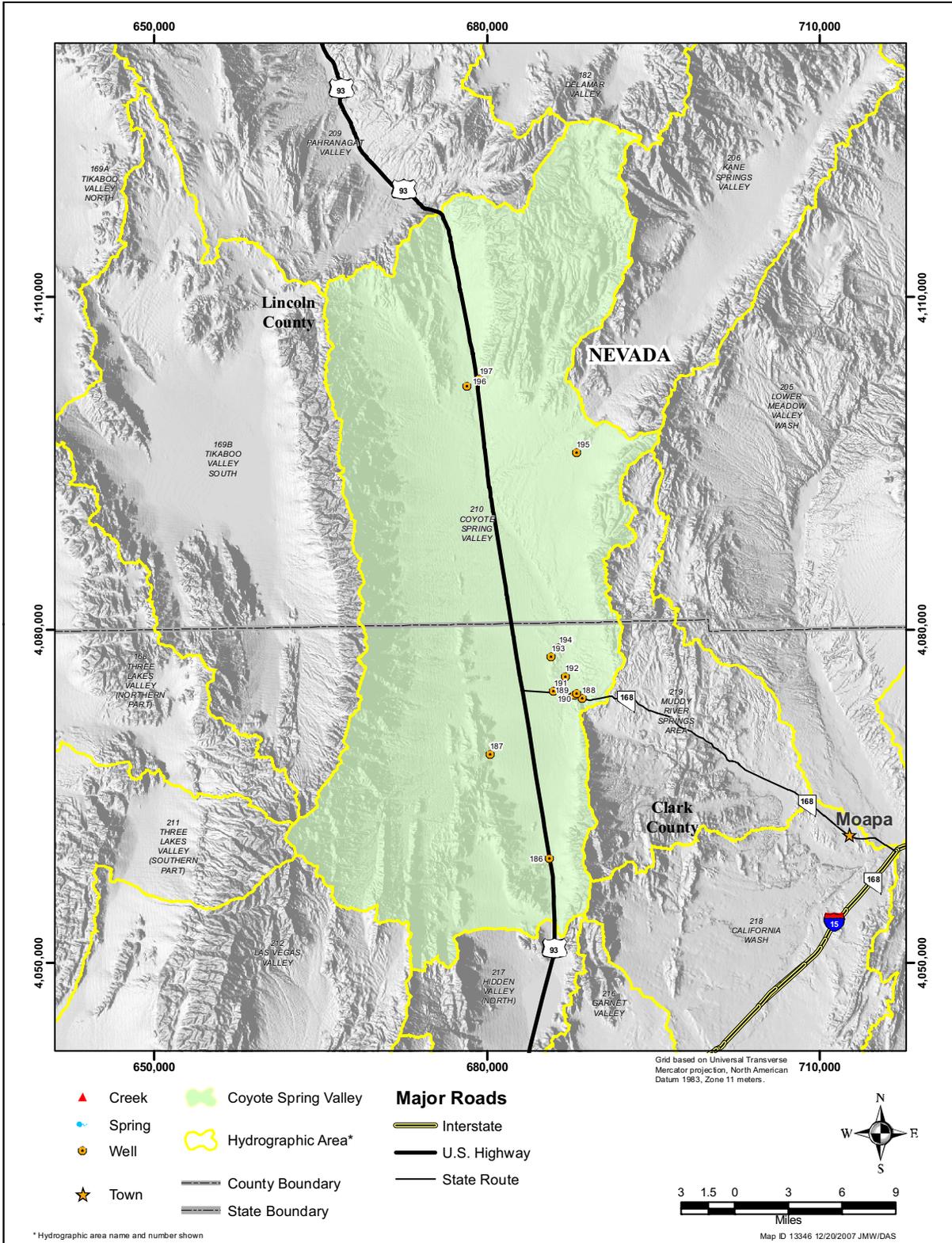
[Figure 6-6](#) is the Piper diagram for groundwater in WRFS. The diagram shows the relationship of the chemical composition of the springs and their positions along the flow path. With a few exceptions of samples in Coyote Spring Valley where some sulfate and chloride salts are encountered, the dominant anion in the majority of the samples in the area is bicarbonate. The dominance of the bicarbonate ion is mainly due to the strong influence of the regional carbonate-rock aquifer that underlies much of the area. Sodium is prevalent in parts of Coyote Spring Valley. The dominant cations in the remaining parts of the area are calcium and magnesium.

Water from the springs and wells in Cave Valley are generally  $Ca-HCO_3$  and  $Ca-Mg-HCO_3$  type and suggest the weathering of limestone and dolomite. The water types in Delamar Valley are  $Na-Ca-HCO_3$  and  $Ca-Na-HCO_3$ . These water types result from mineral weathering and suggest the



Note: Numbers beside points correspond to the Map ID assigned with the data set provided on the CD-ROM.

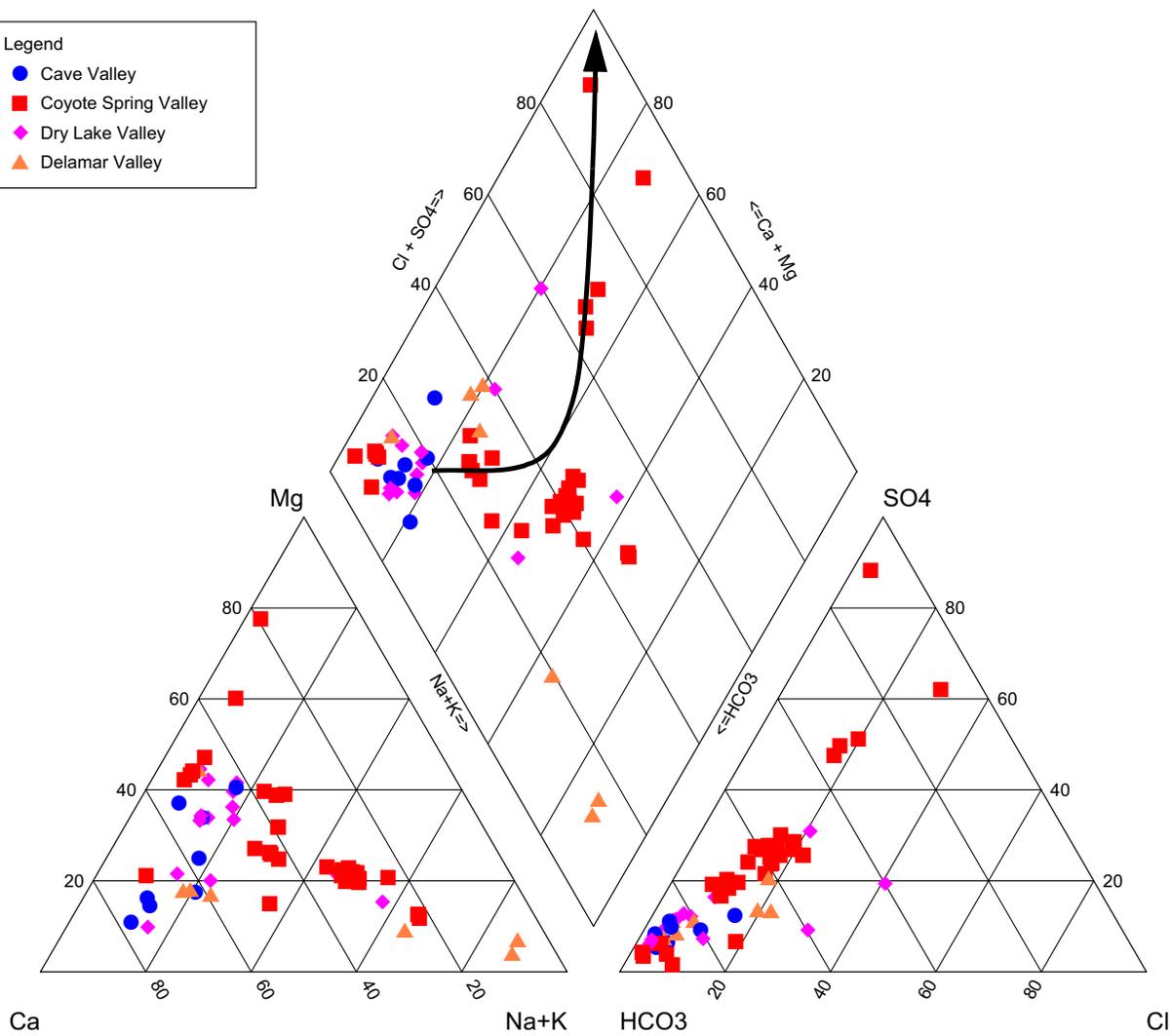
**Figure 6-4**  
**Locations of Sample Sites in Cave, Delamar, and Dry Lake Valleys, Nevada**



Note: Numbers beside points correspond to the Map ID assigned with the data set provided on the CD-ROM.

**Figure 6-5**  
**Locations of Sample Sites in Coyote Spring Valley, Nevada**

- Legend
- Cave Valley
  - Coyote Spring Valley
  - ◆ Dry Lake Valley
  - ▲ Delamar Valley



Note: The arrow indicates the evolution of water chemistry.

**Figure 6-6**  
**Piper Diagram of Spring, Creek, and Well Water Samples**  
**Collected in the White River Flow System, Nevada**

influence of both the carbonate rocks near the range front of the Delamar Mountains and the volcanic rocks related to the Caliente Caldera Complex. The water types in Dry Lake Valley are mainly Ca-Mg-HCO<sub>3</sub> and Ca-Na-HCO<sub>3</sub>. These water types result from the weathering of carbonate and volcanic rocks. Jacobs Well 7b, which is located at the southern part of Dry Lake Valley, has Na-Ca-mixed anion type water. The water chemistry of the well appears to be affected to a greater degree by evaporite mineral dissolution and interaction with volcanic rocks.

Coyote Spring Valley waters have higher TDS values than those in the other Project Basins. The increase in TDS may result from the dissolution of evaporite minerals in the Muddy Creek Formation, which is known to occur in parts of the valley (Thomas et al., 1996). The water types in Coyote Spring Valley are Na-Ca-Mg-HCO<sub>3</sub>-SO<sub>4</sub> and Ca-Na-Mg-SO<sub>4</sub>-HCO<sub>3</sub> (Figure 6-6).

Groundwater chemistry in WRFS shows an evolutionary trend from the northern valleys to the southern valleys. The water evolves from Ca-HCO<sub>3</sub> and Ca-Mg-HCO<sub>3</sub> type to Ca-Na-Mg-HCO<sub>3</sub> and Na-Ca-Mg-HCO<sub>3</sub>-SO<sub>4</sub> type close to the end of the flow system.

#### **6.4.2.2 Trace Element Data for Cave, Dry Lake, Delamar, and Coyote Spring Valleys Waters**

The trace element data compiled for WRFS are provided in the Microsoft Excel<sup>®</sup> worksheet entitled “Traces” described in Appendix A and attached on the CD-ROM. Most of the trace elements in the four valleys were generally lower than the EPA MCL and SMCL values. Arsenic concentrations in Coyote Spring Valley, however, were generally higher than the EPA MCL of 10 µg/L in some locations. Concentrations of ten of the seventeen samples were in exceedance of the EPA MCL value. The arsenic concentrations of two of the five samples in Dry Lake Valley exceeded the EPA MCL value, and one of the four samples in Delamar Valley was in exceedance of the EPA MCL. None of the 12 samples collected in Cave Valley had arsenic concentrations in excess of the EPA MCL. The range of concentrations of selected parameters in water samples collected from Cave, Dry Lake, Delamar, and Coyote Spring valleys is listed in Table 6-2.

With the exception of maximum concentration of antimony in Coyote Spring Valley which exceeded the EPA MCL, the maximum concentrations of barium, beryllium, cadmium, chromium, copper, lead, mercury, uranium, and zinc were less than the EPA MCL and SMCL values. Two of the five samples in Delamar Valley had fluoride concentrations in excess of the EPA MCL, and concentrations of three of the sixteen samples in Coyote Spring Valley exceeded the EPA MCL value. None of the fluoride concentrations of samples collected in Cave and Dry Lake valleys exceeded the EPA MCL.

Aluminum concentrations of all the samples measured in Coyote Spring Valley were less than the EPA SMCL value. The concentration of one of the twelve samples measured in Cave Valley exceeded the EPA SMCL; one of the four samples each in Dry Lake and Delamar valleys had aluminum concentration in excess of the EPA SMCL.

The maximum concentration of iron in each of the four valleys was higher than the EPA SMCL. Eight of the seventeen samples in Coyote Spring Valley had concentrations in excess of the EPA SMCL, and one of the four samples measured in Delamar Valley exceeded the EPA SMCL. In Dry Lake valley, the concentrations of three of the four samples exceeded the EPA SMCL, and only one of the

**Table 6-2  
Range of Concentrations of Selected Parameters for Water Samples Collected in Cave, Dry Lake,  
Delamar, and Coyote Spring Valleys, White River Flow System, Nevada**

Constituent	EPA Maximum Contaminant Level	EPA Secondary Maximum Contaminant Level	Min. Value (Cave)	Max. Value (Cave)	Min. Value (Dry Lake)	Max. Value (Dry Lake)	Min. Value (Delamar)	Max. Value (Delamar)	Min. Value (Coyote Spring)	Max. Value (Coyote Spring)
Antimony	6 µg/L	---	ND	1	ND	0.5	ND	ND	ND	6.6
Arsenic	10 µg/L	---	ND	3.8	ND	11.5	ND	17	ND	23
Barium	2,000 µg/L	---	ND	220	ND	198	ND	5.9	29	430
Beryllium	4 µg/L	---	ND	ND	ND	0.11	ND	ND	ND	ND
Cadmium	5 µg/L	---	ND	1	ND	0.02	ND	ND	ND	1.79
Chromium	100 µg/L	---	ND	6	ND	2	ND	4	ND	5.2
Copper	1,300 µg/L	---	ND	6	ND	1.4	ND	6.3	ND	5.6
Fluoride	4 mg/L	2 mg/L	ND	0.21	0.18	0.6	0.2	5.9	0.1	4.7
Lead	15 µg/L	---	ND	10	ND	1.3	ND	3.8	ND	9.6
Mercury	2 µg/L	---	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	50 µg/L	---	ND	2.1	ND	0.8	ND	2	ND	20
Thallium	2 µg/L	---	ND	2.2	ND	2.55	ND	ND	ND	0.35
Uranium	30 µg/L	---	0.13	3.64	2.1	5.65	2.1	4.7	1	3.91
Nitrite (as nitrogen)	1 mg/L	---	ND	ND	ND	0.06	ND	ND	ND	ND
Nitrate (as nitrogen)	10 mg/L	---	ND	1.9	ND	3.94	0.36	3.5	ND	12.2
Aluminum	---	50 to 200 µg/L	ND	430	ND	990	ND	430	ND	180
Chloride	---	250 mg/L	ND	16	2.5	70.3	4.8	70.7	2.1	58
Iron	---	300 µg/L	ND	650	ND	2,400	ND	1,300	ND	3,000
Manganese	---	50 µg/L	ND	120	4.0	94	ND	38	ND	190
Zinc	---	5,000 µg/L	ND	262	ND	25.8	ND	3.2	ND	4,000
pH	---	6.5 to 8.5	6.11	7.81	6.76	9.68	7.01	8.52	6.98	8.25
Total Dissolved Solids	---	500 mg/L	72	260	268	402	210	481	300	630

ND = non-detect; NTU = nephelometric turbidity unit

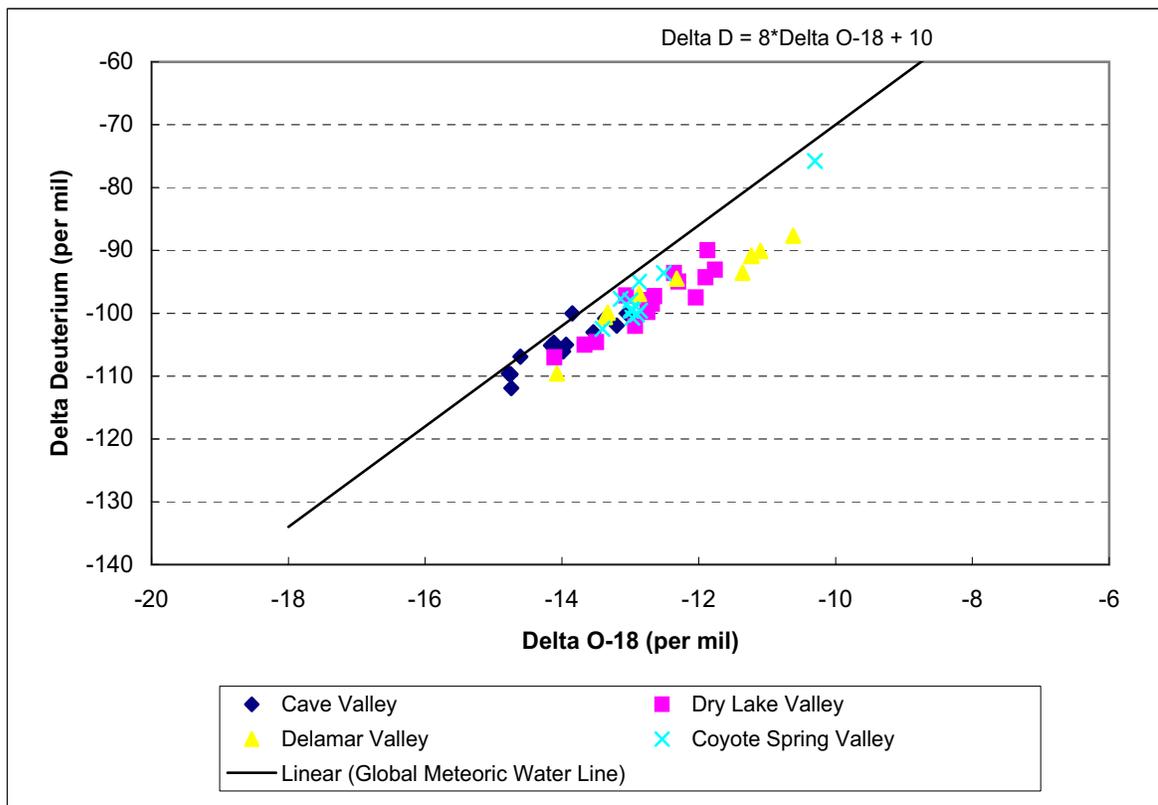
thirteen samples in Cave Valley had a concentration in excess of the EPA SMCL value of 300 µg/L (Traces Worksheet; Table 2).

**6.4.2.3 Stable Isotope Data for Cave, Dry Lake, Delamar, and Coyote Spring Valleys Waters**

The stable isotope data for Cave, Dry Lake, Delamar, and Coyote Spring valleys are provided in the Microsoft Excel® worksheet entitled “Stable Isotopes” described in Appendix A and attached on the CD-ROM. Stable isotopic data for the Project Basins in WRFS are plotted on Figure 6-7. The waters are of meteoric origin. Almost all the samples plot to the right of the GMWL, suggesting that water in the Project Basins in WRFS underwent a small amount of evaporation prior to recharging into the underlying aquifers.

**6.4.2.4 Nutrient and Radiochemical Concentrations**

Very limited data on nutrients and radiochemicals are available for each of the flow systems covered in this report. SNWA is in the process of gathering these types of data in the basins where it has groundwater rights applications. The available data compiled for WRFS is listed in Tables 6-3 and 6-4.



**Figure 6-7**  
 $\delta D$  Versus  $\delta^{18}O$  Plot of Water Samples Collected  
 in Parts of the White River Flow System, Nevada

**Table 6-3**  
**Concentrations of Nutrients in Well and Spring Water Samples**  
**in Selected Hydrographic Areas in White River Flow System, Nevada**  
 (Page 1 of 2)

Sample ID	Hydrographic Area	HA No.	Site Type	Sample Date	Source <sup>a</sup>	mg/L				µg/L	
						Nitrate as NO <sub>3</sub>	Nitrate as N	Nitrite as N (Dissolved)	NO <sub>3</sub> + NO <sub>2</sub> as N	Phosphorous as Total P	O-phosphates as Total P
180W501M	Cave	180	Well	05/17/2006	SNWA06	8.60	1.90	---	---	ND	ND
180W902M	Cave	180	Well	05/18/2006	SNWA06	4.00	0.91	ND	---	ND	7.7
Cave Valley MX	Cave	180	Well	07/10/2003	USGS	---	1.38	E 0.004	1.38	---	E 10
181M-1	Dry Lake	181	Well	05/31/2006	SNWA06	0.93	0.21	ND	---	ND	ND
181W909M	Dry Lake	181	Well	06/05/2006	SNWA06	4.70	1.10	ND	---	39	ND
N. Dry Lake MX	Dry Lake	181	Well	06/19/2003	USGS	---	0.05	ND	0.05	---	E 10
182M-1	Delamar	182	Well	05/23/2006	SNWA06	5.2	1.20	ND	---	30	ND
182W906M	Delamar	182	Well	06/20/2006	SNWA06	---	0.89	ND	---	13	10
209M-1	Pahranaगत	209	Well	06/07/2006	SNWA06	2.40	0.54	ND	---	ND	ND
Ash Springs	Pahranaगत	209	Spring	05/25/2004	SNWA04	---	0.24	ND	---	---	10
Crystal Springs	Pahranaगत	209	Spring	06/03/2003	USGS	---	0.26	ND	---	---	ND
CSI-1	Coyote Spring	210	Well	05/31/2005	SNWA05	1.20	0.27	---	0.27	---	---
CSI-3	Coyote Spring	210	Well	09/13/2006	SNWA06	1.10	0.25	---	---	ND	6.5
CSV M-2	Coyote Spring	210	Well	01/10/2006	SNWA06	ND	ND	ND	---	ND	10
CSV M-2	Coyote Spring	210	Well	01/10/2006	SNWA06	ND	0.12	ND	---	ND	10
CSV M-3	Coyote Spring	210	Well	01/06/2006	SNWA06	2.80	---	---	---	ND	ND
CSV M-3	Coyote Spring	210	Well	01/05/2006	SNWA06	---	0.60	ND	---	---	---
CSV M-4	Coyote Spring	210	Well	01/16/2006	SNWA06	ND	ND	ND	ND	ND	2.8
CSV M-4	Coyote Spring	210	Well	01/16/2006	SNWA06	---	0.14	ND	---	<10	2.8
CSV M-5	Coyote Spring	210	Well	01/08/2006	SNWA06	4.90	1.11	ND	---	ND	ND

**Table 6-3  
Concentrations of Nutrients in Well and Spring Water Samples  
in Selected Hydrographic Areas in White River Flow System, Nevada  
(Page 2 of 2)**

Sample ID	Hydrographic Area	HA No.	Site Type	Sample Date	Source <sup>a</sup>	mg/L					µg/L	
						Nitrate as NO <sub>3</sub>	Nitrate as N	Nitrite as N (Dissolved)	NO <sub>3</sub> + NO <sub>2</sub> as N	Phosphorous as Total P	O-phosphates as Total P	
CSV-M-5	Coyote Spring	210	Well	01/08/2006	SNWA06	---	1.10	ND	...	ND	<10	
CSV-M-6	Coyote Spring	210	Well	01/11/2006	SNWA06	0.95	0.21	---	---	---	8.1	
CSV-M-6	Coyote Spring	210	Well	01/11/2006	SNWA06	---	0.26	ND	---	ND	8.1	
CSV-M-7	Coyote Spring	210	Well	01/23/2006	SNWA06	5.90	1.33	---	---	---	---	
MX-5	Coyote Spring	210	Well	02/16/2005	SNWA05	---	ND	---	---	---	<20	
CSV-2	Coyote Spring	210	Well	07/08/2003	USGS	---	---	ND	0.48	---	<20	
MX-5	Coyote Spring	210	Well	05/28/2003	USGS	---	---	ND	0.29	---	<20	
RW-2	Coyote Spring	210	Well	03/06/2002	NPC	---	<1	<1	1.20	---	---	
Mirant	Garnet	216	Well	06/04/2003	USGS	---	0.10	ND	0.10	---	ND	
Arrow Canyon	MRSA	219	Well	03/15/2006	SNWA06	4.50	---	---	---	---	---	
Pederson Spring	MRSA	219	Spring	07/08/2003	USGS	---	---	0.008	0.4	---	ND	

<sup>a</sup>References:  
 NPC: Unpublished data collected by the Nevada Power Company in 2002.  
 SNWA04: Unpublished data collected by SNWA in 2004; SNWA05: Unpublished data collected by SNWA in 2005; SNWA06: Unpublished data collected by SNWA in 2006.  
 USGS: Published data by USGS for the National Water-Quality Assessment Program.  
 MRSA = Muddy River Springs Area; ND = non-detect; E = Reported value is an estimate

Table 6-4

Radiochemical Activities (in pCi/L) in Well and Spring Water Samples in Selected Hydrographic Areas in White River Flow System, Nevada<sup>a</sup>

Sample ID	Hydrographic Area	HA No.	Sample Date	Alpha		Beta		Radium-226 Error	Radium-226	Radium-228 Error	Radium-228	Radium Total Gross	Combined Radium Total Error	Radon	Radon Error	Strontium-90	Uranium	Tritium
				Gross	2 $\sigma$ Error	Gross	2 $\sigma$ Error											
180W501M	Cave	180	05/17/2006	6.20	1.30	3.00	0.92	2.40	ND	N/A	ND	2.40	0.20	269	29	ND	0.67	ND
180W902M	Cave	180	05/18/2006	3.40	1.20	1.70	0.76	0.70	ND	N/A	ND	0.70	0.10	237	26	ND	1.30	ND
Cave Valley MX	Cave	180	07/10/2003	---	---	---	---	---	---	---	---	---	---	360	23	---	---	ND
181M-1	Dry Lake	181	05/31/2006	10.50	1.07	3.60	0.92	1.20	ND	N/A	ND	1.20	0.10	213	23	ND	2.70	ND
181W909M	Dry Lake	181	06/05/2006	8.17	0.97	5.00	0.83	ND	ND	N/A	ND	ND	N/A	373	39	ND	3.10	ND
N. Dry Lake MX	Dry Lake	181	06/19/2003	---	---	---	---	---	---	---	---	---	---	400	23	---	---	0.3
182M-1	Delamar	182	05/23/2006	2.10	1.10	7.00	0.78	ND	ND	N/A	ND	ND	N/A	696	71	ND	2.10	ND
182W906M	Delamar	182	06/20/2006	7.40	1.30	0.56	0.61	ND	ND	N/A	ND	ND	N/A	445	46	ND	4.70	ND
KPW-1	Kane Springs	206	12/15/2005	6.30	2.20	16.00	1.90	---	---	---	---	---	---	---	---	---	---	---
209M-1	Pahrnagat	209	06/07/2006	6.33	0.88	5.20	0.75	0.80	ND	N/A	ND	0.80	0.10	99	12	ND	1.50	ND
Crystal Springs	Pahrnagat	209	06/03/2003	---	---	---	---	---	---	---	---	---	---	60	17	---	---	---
CSI-3	Coyote Spring	210	09/13/2006	2.95	0.82	13.00	1.00	0.60	ND	N/A	ND	0.60	0.10	227	24	ND	2.60	ND
CSV-2	Coyote Spring	210	01/10/2006	6.00	1.60	3.30	2.40	0.80	0.60	0.30	0.60	1.40	0.30	226	29	ND	0.74	ND
CSV-3	Coyote Spring	210	01/06/2006	9.60	2.10	11.00	1.00	0.30	ND	N/A	ND	0.30	0.10	---	---	ND	3.50	ND
CSV-4	Coyote Spring	210	01/16/2006	0.57	2.30	11.00	1.50	0.30	ND	N/A	ND	0.30	0.10	192	21	ND	1.80	ND
CSV-5	Coyote Spring	210	01/08/2006	10.00	1.40	5.40	0.57	0.20	ND	N/A	ND	0.20	0.10	486	50	ND	1.70	ND
CSV-6	Coyote Spring	210	01/11/2006	4.70	1.90	10.00	0.98	0.50	ND	N/A	ND	0.50	0.10	192	21	ND	2.10	ND
MX-5	Coyote Spring	210	02/16/2005	3.40	1.90	9.40	1.60	---	---	---	---	---	---	---	---	1.44	1.54	ND
CSV-2	Coyote Spring	210	07/08/2003	---	---	---	---	---	---	---	---	---	---	740	29	---	---	---
MX-5	Coyote Spring	210	05/28/2003	---	---	---	---	---	---	---	---	---	---	480	25	---	---	---
Mirant	Garnet	216	06/04/2003	---	---	---	---	---	---	---	---	---	---	530	26	---	---	---
Pederson Springs	MRSA	219	07/30/2003	---	---	---	---	---	---	---	---	---	---	550	26	---	---	---

<sup>a</sup> Source: Acheampong et al. (2007)  
 MRSA = Muddy River Springs Area; ND = non-detect  
 N/A = Not applicable

## 6.5 Summary

Calcium and bicarbonate are the dominant cation and anion within all of the four flow systems for which chemistry data have been compiled. The data suggest that chemical composition of groundwater within Spring and Snake valleys within the GSLDFS is controlled by the mineralogy of the aquifer materials. The chemical composition of groundwater in WRFS shows an evolutionary trend evolving from Ca-Mg-HCO<sub>3</sub> water in the mountainous recharge areas to Na-Ca-Mg-SO<sub>4</sub> water close to the end of the flow system.

Most of the trace elements are in very minute concentrations in the creeks, springs, and well water samples compiled for the study. Concentrations of antimony, beryllium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, thallium, vanadium, and zinc are generally very low and are non-detect in most of the samples analyzed in Spring and Snake valleys within GSLDFS and also in Cave, Delamar, Dry Lake, and Coyote Spring valleys in the WRFS. Arsenic concentrations in parts of Coyote Spring Valley are, however, greater than the EPA MCL of 10 µg/L. Despite the numerous mining activities that have taken place in Nevada over the past several decades, it appears that the generally low concentrations of trace elements in the study area are a natural occurrence and their abundances lie within values expected in natural systems. No anthropogenic sources are identified.

The stable isotope compositions of all the types of water in the flow systems studied show that the waters are of meteoric origin. The stable isotopic data also suggest that modern-day precipitation is a major source of recharge to the groundwater in Spring and Snake valleys.

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