Evaluation of Groundwater Origins, Flow Paths, and Ages in East-Central and Southeastern Nevada

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EXECUTIVE SUMMARY

This report evaluates groundwater sources and flow paths in the Delamar, Dry Lake, and Cave valleys (DDC) area using deuterium (δD) and oxygen-18 ($\delta^{18}O$) data combined with hydrogeologic information. The DDC area is part of the larger White River Flow System (WRFS), so this report also evaluates groundwater flow from the DDC area to other adjacent valleys in the WRFS. Carbon-14 corrected groundwater ages were also estimated for the regional warm spring areas of the WRFS to provide information on recharge timing and groundwater travel times within the WRFS.

Evaluation of isotopic variability of recharge area springs and regional warm springs shows that variability is small over a period of several years up to 40 years, for samples collected throughout all four seasons. Variability of four recharge area monitoring springs have standard deviations that range from 0.7 to 1.1 permil (‰) and 0.07 to 0.11‰ (except for one site with a value of 0.33), for δD and $\delta^{18}O$, respectively. This range in variability is for flows ranging from about 100 to 5,000 gallons per minute and with one site having 7 years of data and two of the three sites having 6 years of data. Isotopic variability of 10 regional warm springs had a standard deviation ranging from 0.5 to 1.9‰ for δD and 0.05 to 0.21‰ (except for one site with a value of 0.67) for $\delta^{18}O$. Spatial variability of recharge area sites was larger than the temporal variation, with standard deviations ranging from 1.8 to 4.2‰ and 0.35 to 0.70‰ for δD and $\delta^{18}O$, respectively. Thus, this low variability of δD and $\delta^{18}O$ groundwater data shows that they are an appropriate tool to evaluate sources and flow paths of groundwater in eastern and southeastern Nevada.

The δD and $\delta^{18}O$ data combined with mountain block recharge rates show that groundwater in the DDC area is supplied by local recharge from the mountain block recharge areas of the valleys. There is little, if any, interbasin flow into the most upgradient of these three valleys, Cave Valley. Groundwater flows out of Cave Valley into southeastern White River Valley and northeastern Pahroc Valley. Potentially a small amount (up to 2,000 acre-feet per year) of groundwater may flow into northwest Dry Lake Valley from northeast Pahroc Valley. Groundwater in Dry Lake Valley flows south into Delamar Valley. Groundwater flows south, or southwest, out of Delamar Valley to Coyote Springs Valley, although some groundwater may flow through the very southern part of Pahranagat Valley along the Pahranagat Valley Shear Zone before entering Coyote Springs Valley.

Isotopic data show that groundwater originating in the DDC area supplies little, if any, water to the warm springs in southern White River Valley. These data also show that groundwater discharging from warm springs in Pahranagat Valley are a mixture of waters recharged in numerous valleys north of Pahranagat Valley, which likely includes Cave Valley.

The δD and $\delta^{18}O$ data, tritium data, and carbon-14 corrected groundwater ages show that groundwater in the WRFS, which includes Delamar, Dry Lake, and Cave valleys, is recharged under current climatic conditions. Carbon-14 corrected groundwater ages also show that it can take thousands of years for groundwater from mountainous recharge areas to flow through numerous basins and discharge in warm spring areas throughout the WRFS.

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INTRODUCTION

This report focuses on groundwater flow through the Delamar, Dry Lake, and Cave valleys (DDC) area in east central Nevada. These three valleys are part of the larger White River Flow System (WRFS), which is a regional groundwater flow system in east-central Nevada (Figure 1). The primary objectives of this report are to: 1) evaluate groundwater sources and flow paths of the DDC area, with particular interest in potential flow from the DDC area to springs in adjacent valleys of the WRFS, primarily regional warm springs in White River and Pahranagat valleys; and 2) evaluate recharge timing to the WRFS, which also provides information on groundwater travel times within the WRFS.

This report is based on the Thomas and Mihevc (2007) report, but includes significant revisions. The revisions include: (1) the inclusion of new data collected since the 2007 report and additional data from the SNWA geochemical and isotopic database; (2) the addition of the calculation of carbon-14 corrected groundwater ages, which provides information on recharge timing and groundwater travel times within the WRFS; and (3) this report only focuses on groundwater sources and flow paths for the DDC area, so the isotope mass-balance model for the WRFS presented by Thomas and Mihevc (2007) was not updated or included in this study. Although this report focuses on the DDC area and does not include a discussion of the entire WRFS, carbon-14 corrected groundwater ages are presented for the regional warm springs in White River, Pahranagat, and Upper Moapa valleys of the WRFS.

The stable isotopes deuterium ($^{2}H/^{1}H$) and oxygen-18 ($^{18}O/^{16}O$), reported as δD and $\delta^{18}O$ in permil (parts per thousand; ‰), respectively, are used to evaluate groundwater sources and flow paths for the DDC area. This evaluation includes potential groundwater flow from the DDC area to adjacent valleys within the WRFS. δD and $\delta^{18}O$ are ideal natural tracers to evaluate water sources and flow paths of groundwater because they are part of the water molecule, rather than being dissolved in the water like all other potential tracers. Thus, δD and $\delta^{18}O$ values are only affected by physical processes, such as evaporation, and are unchanged under low to moderate temperatures by geochemical processes such as dissolution or precipitation, which affects other potential groundwater tracers. The ratio of the mass difference of ^{2}H as compared to ^{1}H (2/1) is significantly greater than that of ^{18}O to ^{16}O (18/16), so the change in deuterium values is greater than the change in oxygen-18 values during physical processes. Water that has undergone any significant evaporation is easily identified because of this mass-ratio difference. A change in δD and $\delta^{18}O$ values that result from the mass differences during physical processes is called isotopic fractionation. This fractionation is known and can be easily calculated for physical processes.

The timing of groundwater recharge and the travel time of groundwater along flow paths in the WRFS were evaluated using: (1) stable isotopes of water that is recharged and discharged all along the WRFS from its headwaters in Long Valley to the Muddy Springs discharge area in Upper Moapa Valley (Thomas and Mihevc, 2007); and (2) carbon-13 and carbon-14 data for dissolved inorganic carbon in groundwater of the WRFS. δD and $\delta^{18}O$ data provide information on the timing of recharge to the WRFS, as indicated by both recharge and regional spring isotopic values. Carbon-14 and carbon-13 data are used to estimate groundwater ages that are corrected for reactions involving solid and gas phases that contain carbon [such as calcite ($CaCO_3$) with no carbon-14 (rock sources) or atmospheric or soil zone CO_2 gas with modern or elevated carbon-14 values].

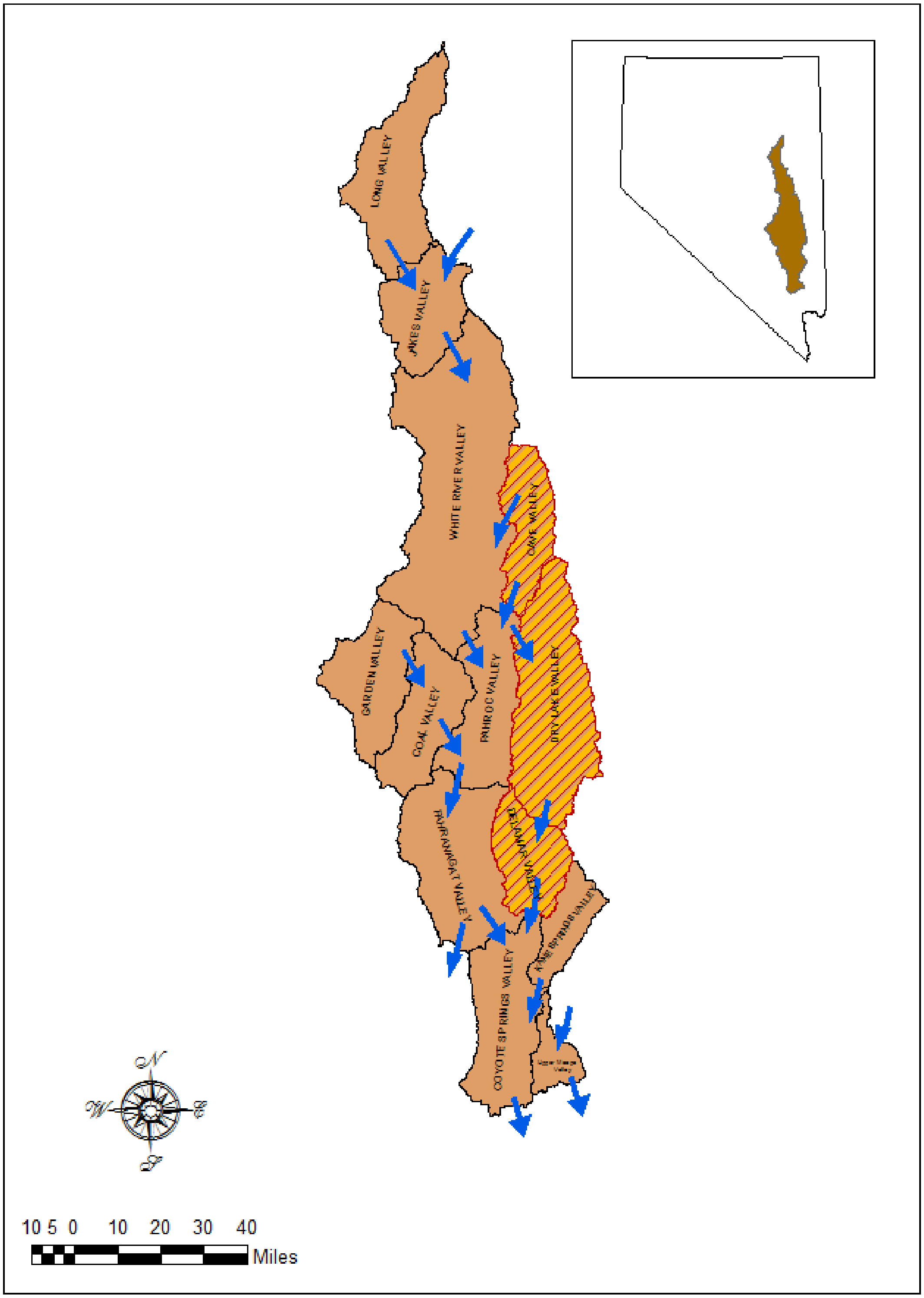

Figure 1. Study area location showing the White River Flow System (WRFS), which includes Delamar, Dry Lake, and Cave valleys (DDC area is shaded). General groundwater flow directions are from Burns and Drici (2011) and are shown by arrows.

Study Area Description

The focus area of this project is the DDC area, but it also includes the WRFS because groundwater flows from the DDC area to other valleys of the WRFS (Figure 1). The regional WRFS extends from Long Valley in the north to the Muddy River Springs area in Upper Moapa Valley in the south, with the DDC valleys located in the eastern middle part of the WRFS. A groundwater hydraulic gradient extends from Long Valley in the north to the Muddy River Springs area of Upper Moapa Valley in the south (Eakin, 1966; Mifflin, 1968; Thomas et al. 1986; 1996; 2001; Kirk and Campana, 1990; Thomas and Mihevc, 2007). Groundwater flow directions for the entire WRFS, including the DDC area, are shown in Figure 1.

Groundwater flows from north to south down the WRFS primarily in carbonate rock aquifers that underlie the area (Eakin, 1966; Mifflin, 1968; Thomas et al. 1986; 1996; Kirk and Campana, 1990; Plume and Carlton, 1988; Plume, 1996; Welch et al., 2007). Groundwater flows between valleys along the hydraulic gradient, and this interbasin flow is discharged from regional warm (> 20^{o}C) springs in White River, Pahranagat, and Upper Moapa valleys (Eakin, 1966; Mifflin, 1968; Kirk and Campana, 1990; Thomas et al., 1996; 2001; Thomas and Mihevc, 2007). Groundwater is recharged in mountains of the WRFS, which are generally along the eastern and western sides of the valleys, and this local recharge mixes with interbasin flow as it passes from one topographic valley to the next. Groundwater is discharged from local springs supplied by water from the adjacent mountain block recharge areas and from regional warm spring areas that include a mixture of groundwater from many recharge areas and valleys. Groundwater is also discharged in phreatophytic areas in some valleys of the WRFS, some of which are associated with warm spring discharge areas and others that are not part of the regional warm spring discharge areas but instead are supplied by recharge to that valley.

Water Chemistry and Isotope Data

Most of the water chemistry and isotopic data used in this report were collected by Desert Research Institute (DRI), U.S. Geological Survey (USGS), and Southern Nevada Water Authority (SNWA) personnel. Most of the water chemistry samples were analyzed at the DRI Water Quality Laboratory, in Reno, Nevada, or the USGS Central Water Quality Laboratory, in Denver, Colorado. Recent δD and $\delta^{18}O$ samples were analyzed at the University of Nevada, Reno Isotope Laboratory. Historic δD and $\delta^{18}O$ data used in this report are from samples analyzed at the DRI Isotope Laboratory in Las Vegas, Nevada; the USGS Isotope Laboratories in Reston, Virginia and Menlo Park, California; and the Waterloo Isotope Laboratory in Waterloo, Canada. Recent carbon-13 and carbon-14 isotopic data are from samples analyzed at the University of Arizona Accelerator Facility in Tucson, Arizona. Historic carbon isotope data are from samples analyzed at the DRI Isotope Laboratory in Las Vegas, Nevada, and the USGS Isotope Laboratories in Reston, Virginia and Menlo Park, California. All data used in this report are provided in Appendix 1. Appendix 1 was developed for isotopic and chemical studies for east-central and southeastern Nevada, so it also contains data outside of the area of this study that were not used in this report.

USING STABLE ISOTOPE DATA TO EVALUATE GROUNDWATER SOURCES AND FLOW PATHS

δD and $\delta^{18}O$ have been used to evaluate groundwater sources and flow paths because they are part of the water molecule. Once water recharges an aquifer, its isotopic signature (δD and $\delta^{18}O$ values) travels with the water and remains unchanged unless the water mixes with water from another source(s) with different δD and $\delta^{18}O$ values, or the groundwater undergoes evaporation (Kirk and Campana, 1990; Thomas et al., 1996; 2001; Clark and Fritz, 1997; Lundmark et al., 2007; Thomas and Mihevc, 2007). Thus, if the isotopic values of the recharge waters are known, and they differ for different recharge areas, then the source(s) of water in an aquifer can be identified. δD and $\delta^{18}O$ are conservative, so that they can also be used to evaluate amounts of groundwater mixing from different sources along a groundwater flow path.

In this study, the stable isotopes of water (δD and $\delta^{18}O$) are used to evaluate sources of groundwater in Delamar, Dry Lake, and Cave valleys and groundwater discharging from springs in adjacent valleys of the WRFS. As noted above, the δD and $\delta^{18}O$ values change only during evaporation and are not involved in chemical reactions that could change their values. Any groundwater that has undergone significant evaporation is not included in the isotope evaluations of water sources and flow paths and is not included in Appendix 1. A groundwater sample is assumed to have undergone significant evaporation if the predicted δD value as calculated from the measured $\delta^{18}O$ value of the sample is 10‰, or more, positive than the measured deuterium value. These samples are easily identified on a δD versus $\delta^{18}O$ plot because they plot 10‰ below (to the right of) of the global meteoric water line defined by the equation $\delta D = 8\delta^{18}O + 10$ (Craig, 1961). The global meteoric water line is a regression line that represents un-evaporated precipitation from all over the world, ranging from the equator to the Arctic and Antarctica. A local meteoric water line is sometimes developed for studies in Nevada, but these lines generally include groundwater samples that have undergone some evaporation or sublimation prior to recharge, thus they are highly influenced by the evaporated less negative samples. A study of isotopic values of precipitation in southern Nevada showed that precipitation values plot close to the global meteoric line, except for the lightest storms (<0.25 cm) which were highly evaporated, and snow samples plot along the global meteoric water line (Benson and Klieforth, 1989).

Groundwater sources and flow paths were evaluated by calculating the average δD and $\delta^{18}O$ values of mountain block recharge areas in a valley. Valleys in east-central and southeastern Nevada generally have two main recharge areas, a mountain block on the east side and a mountain block on the west side of the valley. However, no matter if there are two, or more than two, recharge areas within a topographic basin (valley), they are treated separately and assigned their own average δD and $\delta^{18}O$ values. δD and $\delta^{18}O$ values are assigned to recharge areas by taking the average stable isotope values of all the springs sampled in a recharge area. If a spring site contains more than one sample, then the average δD and $\delta^{18}O$ values for the site is used in calculating the average stable isotope value of the recharge area.

Recharge-area springs are used to represent the isotopic composition of groundwater recharge to a mountain block because they represent an integration of many recharge events and generally integrate recharge over large areas. Recharge-area springs are great integrators and represent precipitation that becomes groundwater recharge because they: (1) average the isotopic composition of all precipitation events that become recharge, (2) do not contain water, and its isotopic signature, that is lost by sublimation, evaporation, and transpiration, and (3) represent a larger area than a single measurement point, such as precipitation collected at a single location.

The δD and $\delta^{18}O$ values of groundwater discharging from springs, or in wells, on the valley floor can be used to evaluate the source(s) of water supplying them. Springs and wells on valley floors that contain cool (< $20^{o}C$) groundwater can be used to evaluate sources of water recharging a basin. The source(s) of this cool water is generally local recharge to the adjacent mountain blocks, as indicated by the average isotopic composition of springs in mountain-block recharge areas weighted by the amount of recharge to each individual mountain block. If the δD and $\delta^{18}O$ values of water in a spring or well on a valley floor are similar to the average δD and $\delta^{18}O$ values of the recharge to the valley (within 2‰ δD and 0.2‰ $\delta^{18}O$) then the most likely groundwater source(s) is the local recharge to the mountain blocks within the valley. If the groundwater isotopic values are significantly different than the average recharge values, then the groundwater may include interbasin flow from an upgradient valley(s). Springs and wells on valley floors that contain warm groundwater [> $20^{o}C$, which represents an average flow depth of several thousand feet (Acheampong et al., 2005)] can be used to evaluate water sources and interbasin flow. The warm springs usually include flow from an upgradient basin(s) that flows at depth into the valley. The δD and $\delta^{18}O$ values of groundwater flowing out of an upgradient basin(s), along with δD and $\delta^{18}O$ values of local recharge, are used to identify the source(s) of groundwater discharging from warm spring areas. All four warm spring areas in White River, Pahranagat, and Upper Moapa valleys of the WRFS are isotopically much lighter (more negative) than local recharge in the adjacent mountain block recharge areas, supporting interbasin groundwater flow to these springs from upgradient basins (Plate 2; Appendix 1).

Deuterium and Oxygen-18 Variability

An important consideration in using δD and $\delta^{18}O$ values to evaluate the source(s) of water discharging from valley springs, or in wells, is their natural variability. This variability includes; (1) changes in recharge area spring isotopic values over time; (2) potential stable isotope differences with altitude in recharge areas; (3) the spatial distribution of stable isotope values of springs in mountain block recharge areas; and (4) changes in regional warm spring isotopic values over time. Ideally, isotopic variability will be small so that isotope values for springs in recharge areas and for springs and wells on the valley floor do not have a large uncertainty associated with them. If uncertainty of isotopic values for these springs and wells is small, then the measured isotopic values are appropriate indicators for determining present day recharge sources, as well as, historic recharge sources for springs and wells on valley floors. The analytical (measurement) precision for δD is +/– 1.0‰ and for $\delta^{18}O$ is +/– 0.10‰. (Analytical precision values represent one standard deviation; Simon Poulson, University of Nevada, Reno Isotope Laboratory, oral communication, 2007.)

Isotopic Variability Over Time of Springs in Recharge Areas

A large amount of isotopic data has been collected in recharge areas of the WRFS, including the DDC area (Figure 1; Plates 1 and 2; Appendix 1). Three springs in major recharge areas of the WRFS [Monitoring Spring WR1 in the White Pine Range (site 320), Upper Terrace Spring WR2 in the Egan Range (site 270), and Patterson Pass Spring WR3 in the Schell Creek Range (site 305)] have been continuously monitored for flow, water temperature, and electrical conductance. These springs have also been sampled on an approximately quarterly basis (access permitting) for δD, $\delta^{18}O$, pH, and major-ion chemistry from October of 2003 to November 2009, with WR1 also having a sample collected in June 2010. In addition, one recharge area spring [Upper Riggs Spring, WR4 in the Delamar Mountains (site 105)] was monitored and sampled from April 2004 to February 2005 until the monitoring site was destroyed by a flood. This monitoring site also has a sample from February 1984. Bulk precipitation amount was also measured at the spring monitoring sites and precipitation samples were collected for δD and $\delta^{18}O$ analysis. These data are presented in Appendix 2. Numerous recharge-area springs were also sampled for stable isotopes and major-ion chemistry to provide information for recharge areas that had little or no isotopic data in the Thomas et al. (2001) study and to provide more data for all recharge areas throughout the WRFS (Plates 1 and 2; Appendix 1).

Continuous flow and approximately quarterly deuterium data for recharge-area monitoring springs are shown in Figures 2, 3, and 4 ($\delta^{18}O$ is not shown on the plots because it is strongly correlated with δD and follows the same trend as δD). As is observed in all three figures, the δD composition of the springs varies little with change in flow or season. For example, δD values for Monitoring Spring WR1 in the White Pine Range only varies between -116.2 and -111.2‰ for a range in flow of about 100 to 5,000 gallons per minute and for the time period October 2003 to June 2010 (Figure 2; Table 1). Oxygen-18 for these same samples varies between -15.90 and -15.32‰. During this period, 25 samples were collected with an average δD value of -114.0‰ and a standard deviation of 1.1‰ and an average $\delta^{18}O$ value of -15.63‰ with a standard deviation of 0.11‰ (Table 1). A similar pattern is observed for the other three recharge-area monitoring springs in the WRFS (Figures 3 and 4; Table 1). Table 1 presents a summary of the data in Figures 2, 3, and 4 and data for the shorter record at Upper Riggs Spring WR4 in the Delamar Range, with minimum, maximum, median, mean, and standard deviation values for the isotopic data for all four recharge area monitoring sites. The greatest range in δD values that was observed for all four sites is 5.0‰ for the Monitoring Spring WR1 in the White Pine Range and the smallest range is 1.8‰ for five samples for the Upper Riggs Spring WR4 monitoring site in the Delamar Mountains (Table 1). All of the standard deviations of the spring δD data are about 1‰ with the highest standard deviation being 1.1‰ for Monitoring Spring WR1 and the lowest being 0.7‰ for Upper Riggs Spring. $\delta^{18}O$ data follows a similar pattern with the standard deviation ranging from 0.07 to 0.11‰ (except for Upper Riggs Spring with a value of 0.33‰) for the four recharge-area monitoring sites (Table 1). These standard deviations are about the same as the analytical uncertainty of the δD and $\delta^{18}O$ water analysis.

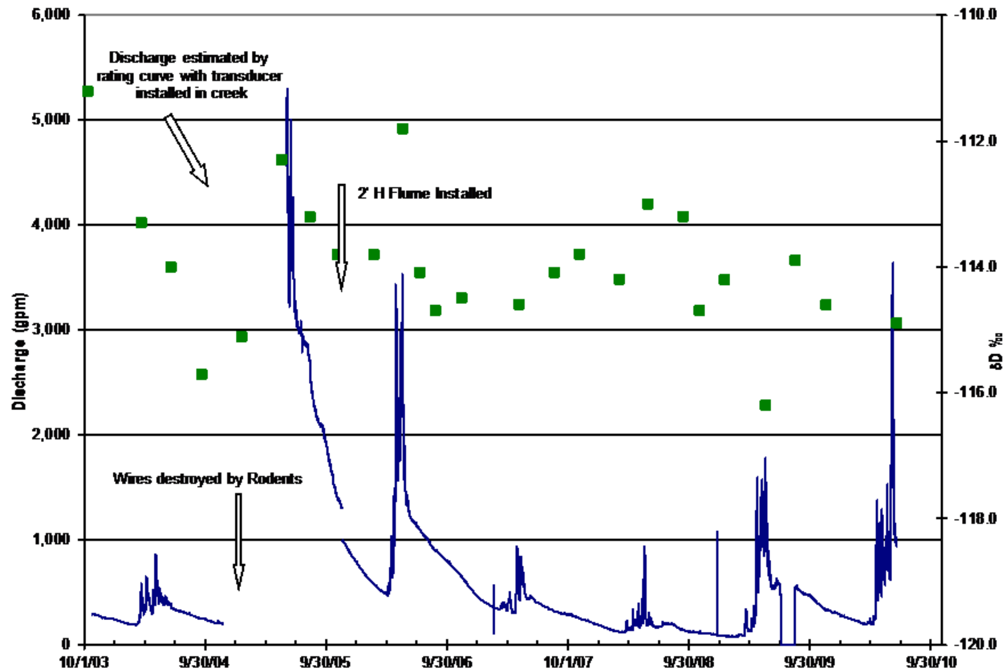

Figure 2. Deuterium and flow data for Monitoring Spring WR1 in the White Pine Range in northwestern White River Valley. Green squares are the deuterium data, which have an analytical uncertainty of +/- 1.0‰. Blue line is spring flow. The high spring flows in the spring of 2005 are estimated from a rating curve developed from continuous stream-height data and flow measurements (flow exceeded the flume capacity).

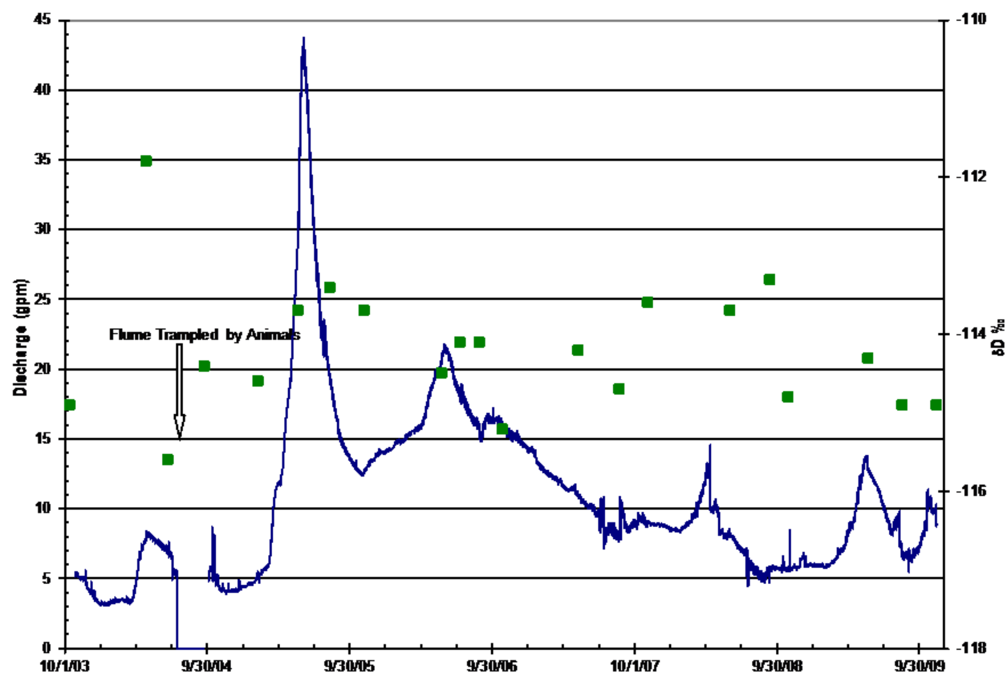

Figure 3. Deuterium and flow data for Upper Terrace Spring WR2 in the Egan Range in northeastern White River Valley. Green squares are the deuterium data, which have an analytical uncertainty of +/- 1.0‰. Blue line is spring flow.

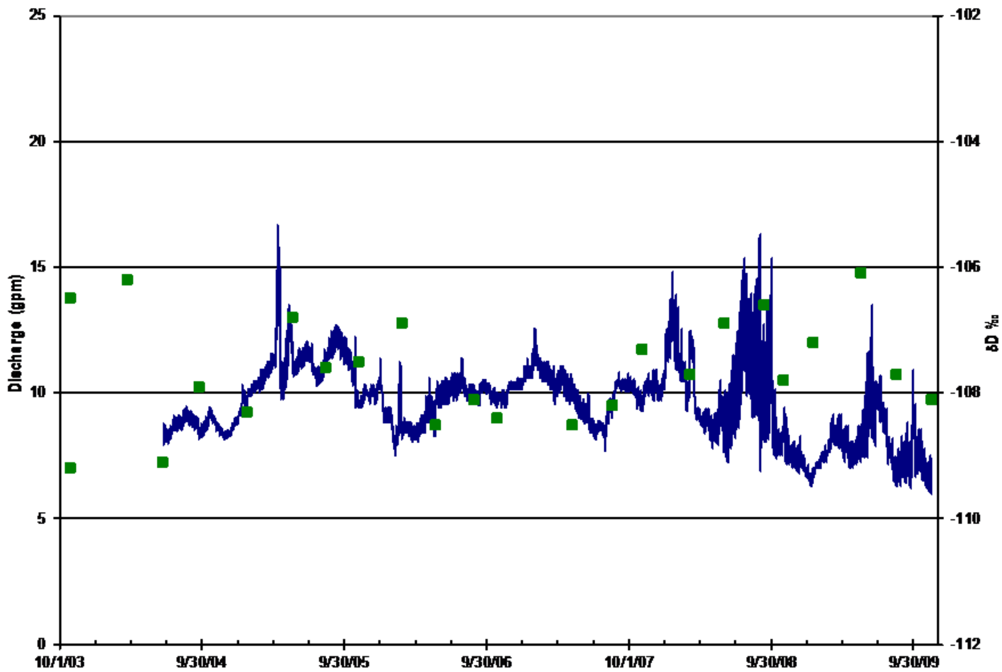

Figure 4. Deuterium and flow data for Patterson Pass Spring WR3 in the Schell Creek Range in western Lake Valley. Green squares are the deuterium data, which have an analytical uncertainty of +/- 1.0‰. Blue line is spring flow.

Table 1. Variability of δD and $\delta^{18}O$ in recharge-area springs of the WRFS. Values are reported in permil.

Site Name		Number of Samples	Minimum	Maximum	Median	Mean	Standard Deviation
			White Pine Range				
Monitoring Spring WR1	δD	25	-116.2	-111.2	-114.1	-114.0	1.1
Monitoring Spring WR1	$\delta^{18}O$	25	-15.90	-15.32	-15.64	-15.63	0.11
			Egan Range				
Upper Terrace Spring WR2	δD	21	-115.6	-111.8	-114.3	-114.2	0.8
Upper Terrace Spring WR2	$\delta^{18}O$	21	-15.64	-15.24	-15.46	-15.45	0.08
			Schell Creek Range				
Patterson Pass Spring WR3	δD	24	-109.1	-106.1	-107.8	-107.6	0.8
Patterson Pass Spring WR3	$\delta^{18}O$	24	-14.96	-14.71	-14.90	-14.88	0.07
			Delamar Mountains				
Upper Riggs Spring WR4	δD	5	-88.0	-86.2	-87.0	-87.0	0.7
Upper Riggs Spring WR4	$\delta^{18}O$	5	-12.46	-11.55	-11.90	-11.95	0.33

Isotopic Variability with Altitude of Springs in Recharge Areas

The potential for variability of stable isotope values with altitude also needs to be considered, because if stable isotope values become more depleted (more negative) with increasing altitude in the recharge areas, this would need to be accounted for in assigning average stable isotope values to recharge areas (the amount of precipitation and the percent of precipitation that becomes recharge increases with increasing altitude). The altitudes of the springs were used in these evaluations, although the average recharge altitude of the source of the spring water would be a better altitude value to use than the spring altitude (Russell et al., 2007). One could estimate the average altitude of recharge represented by the spring using the methods of Russell et al. (2007), or by simply taking the average altitude of the catchment above the spring because according to Russell et al. (2007), page 48 “Uncertainty in the actual elevation of the recharge basin tended to pull the mean elevation toward the middle of that slope.” In the Russell et al. (2007) report “that slope” was the slope between the spring and the highest point in the watershed above the spring. However, this approach was not taken in this study because of the unknown source of recharge to the springs (they could be derived from recharge to the mountain block anywhere above the spring) and precipitation amounts for the elevation gradients within the watershed would have to be known to correctly estimate the average recharge altitude based on a precipitation weighted altitude relationship (because of the increase in precipitation with altitude in mountainous recharge areas of Nevada). Finally, using the average altitude of the spring catchment would have little effect on the trends of the plots presented in Figures 5 through 8, and any effect would likely be to increase the lower-spring altitudes relative to the higher-spring altitudes (since many of the springs would have a similar ridge line altitude for their catchments). Incorporating average recharge altitudes for springs would likely reduce any potential altitude-stable isotope relationship.

The relationship between δD and altitude was evaluated for four major recharge areas in the study area that contained 14, or more, springs. In the northern part of the WRFS, the White Pine Range and Central Egan Range δD data were plotted as a function of altitude (Figures 5 and 6). There are very weak relationships (R^2 values of 0.066 and 0.018) of δD as a function of altitude in these plots and the strongest relationship, which is for the White Pine Range, shows a negative slope for δD as a function of altitude (δD values increase with increasing altitude). In the central and southern part of the WRFS, δD data were plotted as a function of altitude for the Fairview and Bristol Ranges and the Delamar Mountains (Figures 7 and 8). There is a very weak relationship of δD with altitude for the Fairview and Bristol Ranges (R^2 value of 0.026). There is a stronger observed relationship for the Delamar Range (R^2 value of 0.366) than the other three recharge areas, with δD values becoming more positive with decreasing altitude (Figures 5-8). Using the average value of all the springs may result in a more positive δD recharge value for the Delamar Range than the actual δD recharge value, so this relationship could shift the average isotopic recharge value for the Delamar Range to an isotopic value that is 2 to 3‰ more negative. This shift would have no effect on the interpretations in this report. Although a decrease in δD values with increasing altitude is observed on the western side of the Sierra Nevada, as storm tracks originating from the Pacific Ocean move inland and ascend to the Sierra crest (Smith et al., 1979), this effect is not assumed to occur in eastern and southeastern Nevada because cloud

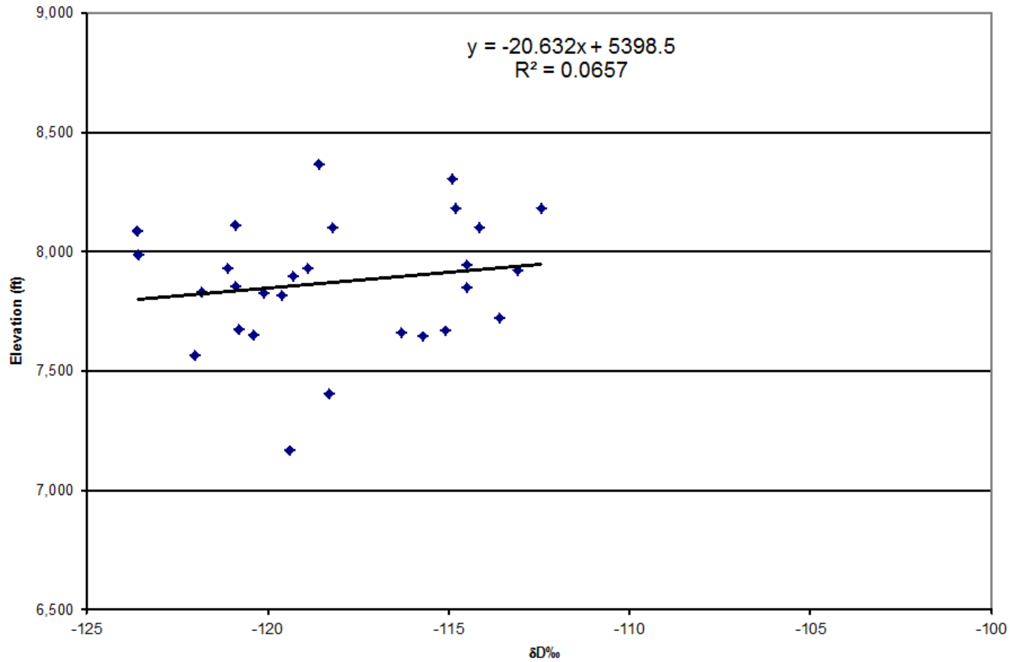

Figure 5. Deuterium as a function of altitude in the White Pine Range. δD data have an analytical uncertainty of +/- 1.0‰.

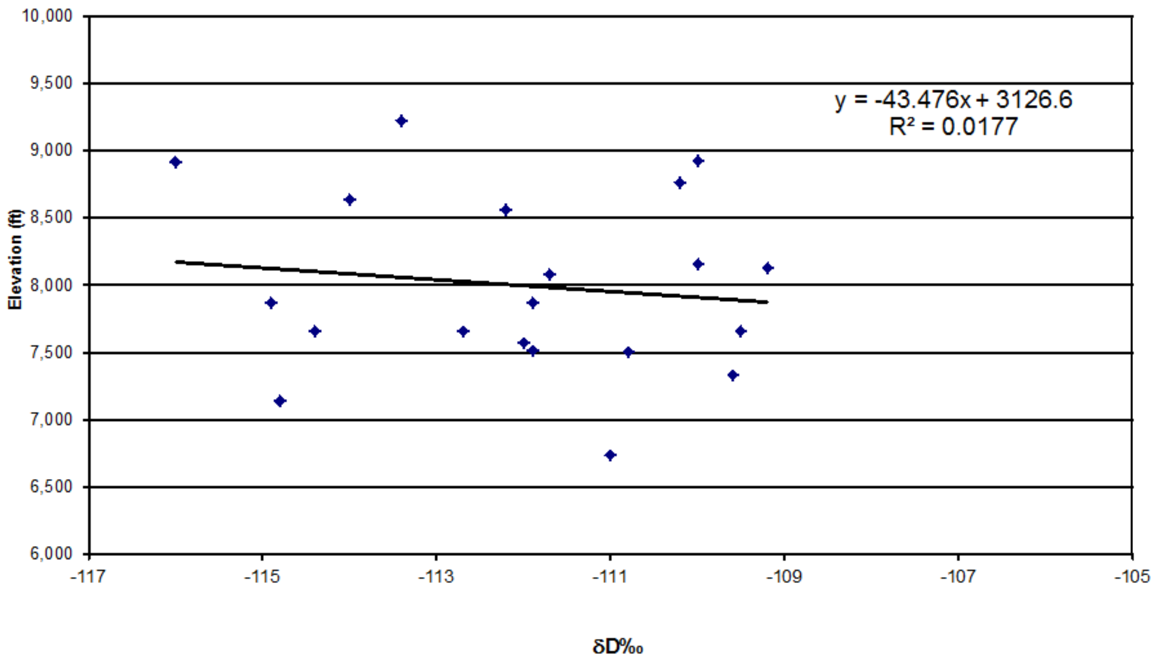

Figure 6. Deuterium as a function of altitude in the Central Egan Range. δD data have an analytical uncertainty of +/- 1.0‰.

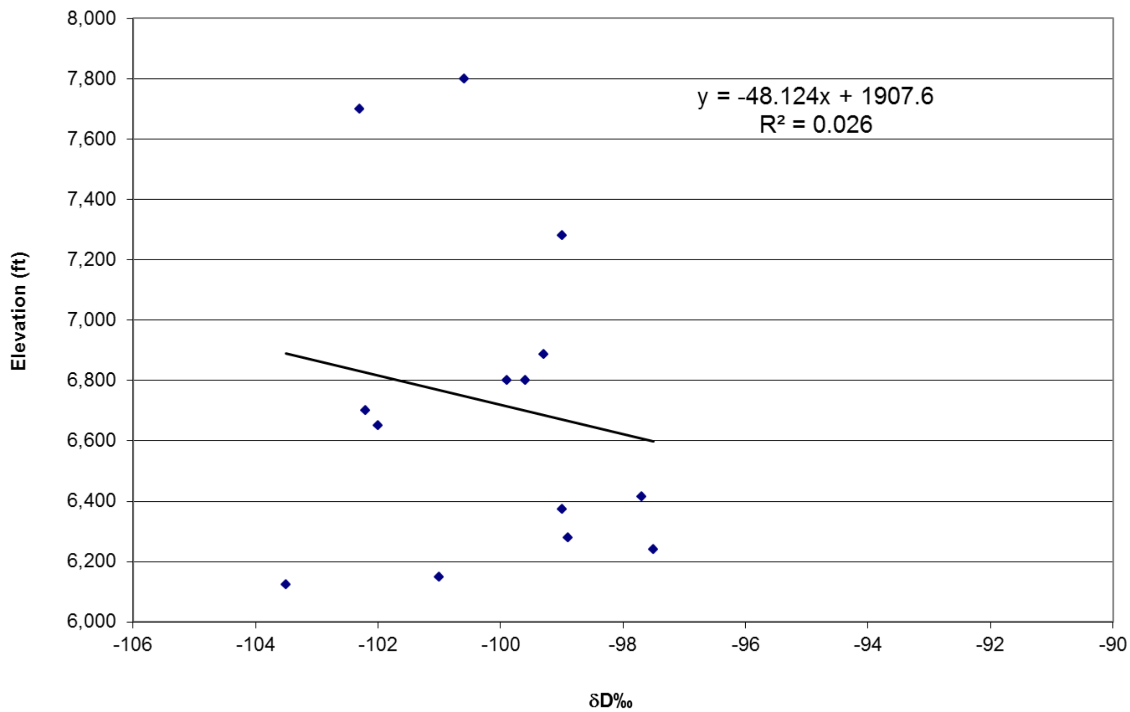

Figure 7. Deuterium as a function of altitude in the Highland and Fairview Ranges. δD data have an analytical uncertainty of +/- 1.0‰.

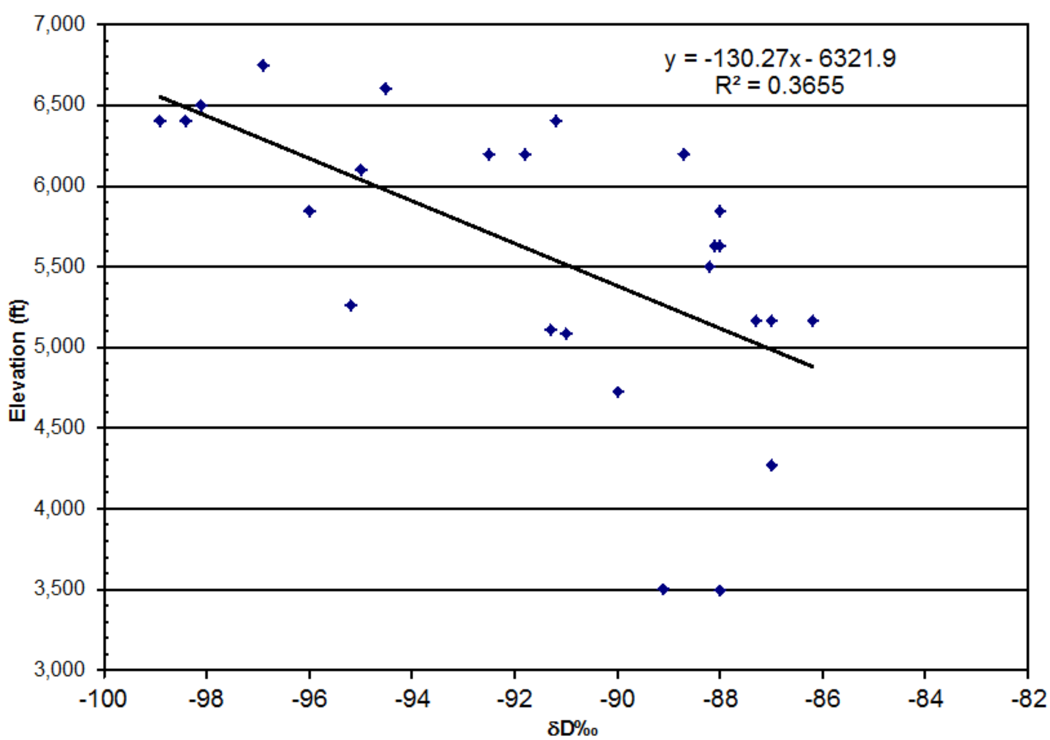

Figure 8. Deuterium as a function of altitude in the Delamar Mountains. δD data have an analytical uncertainty of +/- 1.0‰.

base levels may be similar across the Great Basin. The lack of an apparent δD with altitude relationship in all but the Delamar Range in the four WRFS recharge areas is consistent with the results of Thomas et al. (1996; Figure 21) for the Spring Mountains in southern Nevada. They found no δD-altitude relationship for samples ranging in altitude from about 4,400 to 10,300 feet in the Spring Mountains. The significance of a lack of a δD-altitude relationship is that isotopic values in recharge areas can simply be averaged to obtain the recharge isotopic signature for a mountain block recharge area.

Spatial Isotopic Variability of Springs in Recharge Areas

The spatial variability of δD values in recharge areas is presented in Table 2. The range in δD values for the recharge areas is 4.8 to 11.9‰ and the standard deviations of these recharge area springs range from 1.8 to 4.2‰ (Table 2). These ranges in δD and standard deviation values are greater than the range in spring δD temporal values presented in Table 1. Given that δD values of groundwater in valleys adjacent to these recharge areas, that have cool temperatures (< 20^{o}C) and variable flow rates indicating that they are derived from local recharge, have similar δD values to that of the average value of springs in the adjacent recharge areas indicates that they are appropriate values to represent recharge in the mountain block recharge areas (see discussion later in this report in section titled "Isotopic Evaluation of Groundwater Sources and Flow Paths"). This similarity of the average δD value of springs in recharge areas with that of locally derived groundwater in adjacent valleys, combined with the small variability of spring δD values over time and large flow fluctuations, shows that springs in mountain block recharge areas provide good representative δD values for DDC recharge areas.

Isotopic Variability of Regional Warm Springs

Regional warm (> 20^{o}C) springs in the WRFS have consistent isotopic values and flow rates over time, have average flow depths of several thousand feet (Acheampong et al., 2005), and contain significantly more negative isotopic values than local recharge to the basin that they are in, so they provide valuable information needed to evaluate interbasin groundwater flow in the WRFS. Thus, it is important that isotopic variability of these springs is known, and if this variability is large, then the water sources supplying regional warm springs would need to be considered under transient, rather than steady-state, conditions. Table 3 presents minimum, maximum, median, mean, and standard deviation values for δD and δ^{18}O for the warm spring provinces (discharge areas) of the WRFS. Analysis of data are presented for individual springs within a warm spring province if three or more analyses are available and for the average of all warm springs in a warm spring province (Table 3). For example, in northern White River Valley, Preston Big Spring (Appendix 1 and Plate 1; site 231) is a warm spring in the Preston warm spring province that has 13 samples, so the variability of stable isotopic data for this spring was analyzed. Additionally, there are two other warm springs in the warm spring province, Nicholas (Appendix 1 and Plate 1; site 227) and Cold (Appendix 1 and Plate 1; site 230) springs. Cold Spring is a warm (21.8^{o}C) spring despite its name. So, the statistical values for Preston Big Spring data and also for the average values of the three springs in the Preston warm spring

Table 2. Spatial variability of δD and $\delta^{18}O$ in mountain block recharge areas of the DDC area. Values are reported in permil. NA: not applicable.

Site Name		Number of Samples	Minimum	Maximum	Median	Mean	Standard Deviation
			Cave Valley				
South Schell Creek Range	δD	6	-109.5	-99.5	-106.2	-105.0	4.0
South Schell Creek Range	$\delta^{18}O$	6	-14.88	-13.17	-14.47	-14.21	0.64
South Egan Range	δD	8	-111.4	-103.4	-106.6	-106.9	3.3
South Egan Range	$\delta^{18}O$	8	-15.04	-13.32	-14.21	-14.15	0.70
			Dry Lake Valley				
South Schell Creek Range	δD	1	-100.9	-100.9	-100.9	-100.9	NA
South Schell Creek Range	$\delta^{18}O$	1	-13.17	-13.17	-13.17	-13.17	NA
North Pahroc Range	δD	8	-97.3	-90.5	-94.1	-94.3	2.4
North Pahroc Range	$\delta^{18}O$	8	-13.06	-11.76	-12.43	-12.39	0.42
Fairview Range	δD	13	-103.5	-97.4	-98.9	-99.5	2.0
Fairview Range	$\delta^{18}O$	13	-13.60	-12.34	-12.73	-12.88	0.44
Bristol and Highland Ranges	δD	6	-101.2	-95.0	-99.1	-98.9	2.2
Bristol and Highland Ranges	$\delta^{18}O$	6	-13.87	-12.07	-13.36	-13.28	0.66
Chief Range	δD	9	-98.9	-88.2	-95.0	-94.6	3.9
Chief Range	$\delta^{18}O$	9	-12.98	-11.69	-12.32	-12.36	0.52
			Delamar Valley				
Delamar Range	δD	17	-98.9	-87.0	-91.8	-92.4	4.2
Delamar Range	$\delta^{18}O$	17	-12.98	-11.46	-12.47	-12.32	0.49
South Pahroc Range	δD	8	-97.4	-92.6	-94.2	-94.6	1.8
South Pahroc Range	$\delta^{18}O$	8	-13.24	-12.30	-12.84	-12.81	0.35

Table 3. Variability of δD and $\delta^{18}O$ of regional warm (> 20°C) springs in the WRFS. Values are reported in permil.

Site Name		Number of Samples	Minimum	Maximum	Median	Mean	Standard Deviation
			North White River Valley				
Preston Big Spring	δD	13	-126.0	-120.0	-121.8	-122.0	1.5
Preston Big Spring	$\delta^{18}O$	13	-15.99	-15.60	-15.88	-15.87	0.12
North White River Valley	δD	3	-124.0	-121.8	-123.5	-123.1	1.2
North White River Valley	$\delta^{18}O$	3	-16.10	-15.80	-15.88	-15.93	0.16
			South White River Valley				
Hot Creek Springs	δD	12	-120.5	-117.4	-119.1	-119.1	0.9
Hot Creek Springs	$\delta^{18}O$	12	-15.82	-15.50	-15.71	-15.69	0.10
South White River Valley	δD	4	-120.0	-118.0	-119.4	-119.2	0.9
South White River Valley	$\delta^{18}O$	4	-15.80	-15.30	-15.65	-15.60	0.21
			Pahranagat Valley				
Crystal Springs	δD	18	-111.0	-106.9	-109.0	-109.0	1.0
Crystal Springs	$\delta^{18}O$	15	-14.53	-14.23	-14.41	-14.40	0.08
Hiko Spring	δD	7	-110.5	-105.0	-109.5	-108.7	1.9
Hiko Spring	$\delta^{18}O$	4	-15.30	-13.80	-14.23	-14.39	0.67
Ash Springs	δD	6	-112.0	-107.0	-108.7	-109.1	1.8
Ash Springs	$\delta^{18}O$	3	-14.20	-14.03	-14.10	-14.11	0.09
Pahranagat Valley	δD	4	-109.1	-107.2	-108.9	-108.5	0.9
Pahranagat Valley	$\delta^{18}O$	4	-14.40	-14.11	-14.29	-14.27	0.14

Table 3. Variability of δD and $\delta^{18}O$ of regional warm (> 20°C) springs in the WRFS (continued).

Site Name		Number of Samples	Minimum	Maximum	Median	Mean	Standard Deviation
		Upper Moapa Valley (Muddy Springs area)					
Baldwin Spring	δD	9	-98.6	-96.3	-97.9	-97.6	0.8
Baldwin Spring	$\delta^{18}O$	9	-13.05	-12.91	-12.95	-12.97	0.05
Big Muddy Spring	δD	6	-99.0	-96.5	-98.0	-97.9	0.8
Big Muddy Spring	$\delta^{18}O$	5	-13.05	-12.75	-12.89	-12.89	0.11
Jones Spring Pumphouse	δD	6	-98.9	-97.3	-97.9	-97.9	0.5
Jones Spring Pumphouse	$\delta^{18}O$	6	-13.10	-12.99	-13.07	-13.05	0.05
Pederson's East	δD	9	-98.7	-97.0	-97.7	-97.8	0.6
Pederson's East	$\delta^{18}O$	9	-13.06	-12.89	-12.98	-12.98	0.06
Pederson's Warm Spring (M-13)	δD	15	-99.0	-96.5	-97.4	-97.5	0.6
Pederson's Warm Spring (M-13)	$\delta^{18}O$	13	-13.05	-12.75	-12.91	-12.93	0.09
Upper Moapa Valley	δD	9	-99.0	-96.5	-97.8	-97.7	0.7
Upper Moapa Valley	$\delta^{18}O$	8	-13.05	-12.45	-12.94	-12.87	0.19

province are presented in Table 3. δD values for Preston Big Spring range from -126.0 to -120.0‰, with a mean value of -122.0‰ and a standard deviation of 1.5‰. δD values range from -124.0 to -121.8‰, with a standard deviation of 1.2‰ for the average values of the three springs in the Preston warm spring province. In general, the standard deviations for the individual warm spring δD data and for the average values of all springs with isotopic data in a warm spring province are about 1‰ (Table 3). δ^{18}O data follow a similar pattern, with standard deviations ranging from 0.05 to 0.21‰ (except for one site with a standard deviation of 0.67‰). The variability of the warm spring isotopic data is similar to the analytical uncertainly of δD (1.0‰) and δ^{18}O (0.1‰). This low variability of the stable isotopic data shows that the stable isotopic composition of regional warm springs provides an appropriate means for evaluating groundwater sources and flow paths for the springs.

It is important to understand that the small degree of isotopic variation in some samples from warm springs is over a period lasting from 20 to 40 years. For example, isotopic data was first collected for Big Muddy Spring, in Upper Moapa Valley, in March 1970 and six samples from 1970 to 2004 have a range of only -99.0 to -96.5‰. Similarly, Hiko, Crystal, and Ash springs in Pahranagat Valley have isotopic data that were first collected in 1968. For all three springs during the time period of 1968 to 2006, δD only varied by 5.5‰. Preston Big Spring in northern White River Valley and Hot Creek Spring in southern White River Valley have samples that span 24 and 26 year periods with a range in δD values of 6.0 and 3.1‰, respectively (Table 3).Summary of Isotopic Variability

The small range in isotopic values and standard deviations of the recharge area and regional warm spring data shows that δD and δ^{18}O are appropriate tracers of groundwater in the WRFS that can be used to evaluate sources and flow paths. If temporal variability of δD and δ^{18}O of recharge area monitoring springs and regional warm springs had been high, then the uncertainty associated with using them to evaluate water sources and flow paths in regional flow systems would have also been high.

Isotopic Evaluation of Groundwater Sources and Flow Paths

The WRFS shown in Figure 1 and Plate 1 has a hydraulic gradient that extends from Long Valley in the north to Upper Moapa Valley (Muddy River Springs) in the south (Eakin, 1966; Mifflin, 1968; Kirk and Campana, 1990; Thomas et al., 1996; 2001; Thomas and Mihevc, 2007). Groundwater in this regional flow system flows primarily through carbonate-rock aquifers (Eakin, 1966; Mifflin, 1968; Thomas et al. 1986; 1996; Plume and Carlton, 1988; Kirk and Campana, 1990; Plume, 1996; Welch et al., 2007), although volcanic rocks are also present as is observed for parts of the DDC area of the White River Flow System (Plume and Carlton, 1988; Plume, 1996; Rowley and Dixon, 2011).

If δD and δ^{18}O data are going to be used to evaluate groundwater sources and flow paths, including interbasin flow, then these data have to be significantly different for the different recharge areas and for groundwater within each valley. Thomas and Mihevc (2007) showed that the δD and δ^{18}O values of groundwater in the northern part of the WRFS were 50 and 6.5‰ more negative, respectively, than groundwater in the southern part of the WRFS. Although the DDC area only extends through the middle and eastern part of the WRFS (Figure 1), δD and δ^{18}O data for the DDC area have a range of 24.4 and 3.35‰, respectively, from northern Cave Valley to southern Delamar Valley (Figure 9). Since, the analytical uncertainty of δD is +/- 1‰ and $\delta^{18}O$ is +/- 0.1‰, these differences in δD and $\delta^{18}O$ values observed for the DDC area are significant, so δD and $\delta^{18}O$ values can be used to evaluate sources and flow paths of groundwater in the DDC area and potential flow to adjacent valleys.

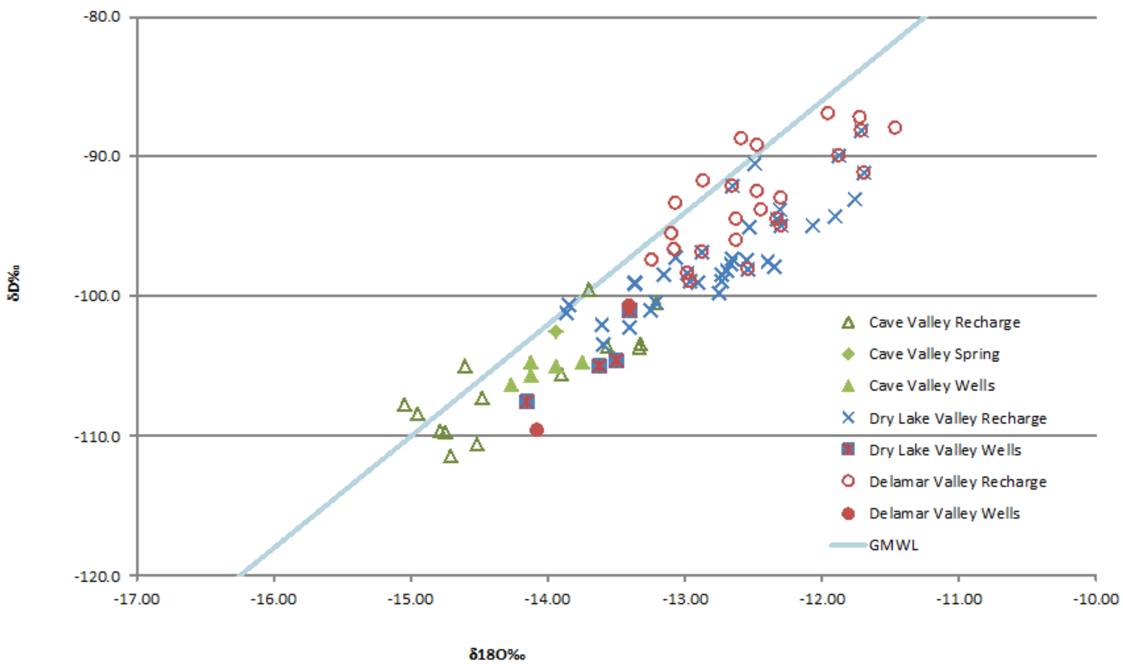

Figure 9. Plot of deuterium versus oxygen-18 for samples in the DDC area. GMWL is the Global Meteoric Water Line from Craig (1961).

Groundwater discharging from springs and in wells on the valley floors outside of recharge areas can be used to evaluate groundwater sources and flow paths. Two types of springs exist in the WRFS: (1) cool (< 20°C) springs that receive recharge from adjacent mountain block recharge areas surrounding a valley; and (2) warm (> 20°C) springs that have deep groundwater flow (thousands of feet below the land surface; Acheampong et al., 2005) and generally have interbasin flow as part, if not all, of their discharge. In the DDC area, cool springs and wells on the valley floors are present, but there are no warm springs in this area. However, regional warm springs are present in valleys adjacent to the DDC area, so isotopic data for warm springs in White River and Pahranagat valleys are used to evaluate potential groundwater flow from the DDC area to these regional warm springs.

<u>Delamar, Dry Lake, and Cave Valleys</u>

The DDC area has groundwater flow primarily in carbonate-rock aquifers underlying the three valleys and unconsolidated basin-fill aquifers within the valleys (Burns and Drici, 2011). There are also areas of volcanic rock in the DDC area that may contain local aquifers (Plume, 1996; Rowley and Dixon, 2011). A hydraulic gradient extends from Cave Valley (highest water level elevations) to Dry Lake Valley to Delamar Valley (lowest water level elevations; Figure 1 and Plate 1; Burns and Drici, 2011). Thus, potentially groundwater could flow from Cave to Dry Lake to Delamar valleys from north to south down the hydraulic gradient. However, due to geologic and structural controls in the central and southern parts of Cave Valley, groundwater in northwestern Cave Valley is thought to flow toward the southwest into southeastern White River Valley (along the Shingle Pass Fault system) and groundwater in northeastern and southern Cave Valley is thought to flow toward the southwest into northeastern Pahroc Valley (Eakin, 1966; Kirk and Campana, 1990; Thomas and Mihevc, 2007; Burns and Drici, 2011; Rowley and Dixon, 2011). Hydrogeologic data indicates that groundwater does flow from northern Dry Lake Valley to the south through Dry Lake Valley and into northern Delamar Valley. Groundwater in northern Delamar Valley flows to the south and eventually out of the southern end of the valley into Coyote Springs Valley. Groundwater in southern Delamar Valley also potentially flows to the southwest along the Pahranagat Valley Shear Zone and into the very southern end of Pahranagat Valley and northern Coyote Springs Valley (Eakin, 1966; Kirk and Campana, 1990; Thomas and Mihevc, 2007; Burns and Drici, 2011).

The δD and $\delta^{18}O$ data of mountain block recharge areas can be used with recharge estimates, evapotranspiration (ET) estimates, and groundwater flow directions to evaluate the sources, flow paths, and mixing of groundwater in the DDC area. Recharge to the southern Egan and southern Schell Creek ranges provide recharge to Cave Valley aquifers (Figure 10). The southern Egan Range recharge has average δD and $\delta^{18}O$ values of -106.9 and -14.15‰, respectively (Tables 2 and 4). The southern Schell Creek Range has average δD and $\delta^{18}O$ values of -105.0 and -14.21‰, respectively (Tables 2 and 4). The mixture of these two recharge sources to Cave Valley produces an average annual recharge to the valley of 13,700 acre-feet per year (afy) with an average isotopic composition of -105.9 and -14.18‰ (Table 4). There is an estimated 1,300 afy of groundwater lost by ET from shallow groundwater in Cave Valley (Burns and Drici, 2011). Thus, 12,400 afy of groundwater flows out of Cave Valley to southeastern White River Valley and northeastern Pahroc Valley. This groundwater has an isotopic signature of -105.9 and -14.18‰ for δD and $\delta^{18}O$, respectively.

The δD and $\delta^{18}O$ data for groundwater in springs and wells located on the valley floor of Cave Valley are used to evaluate the sources of groundwater supplying the aquifers of Cave Valley. If the mixture of water from the two main recharge areas is the only source supplying groundwater to Cave Valley aquifers, then groundwater in the valley should have similar δD and $\delta^{18}O$ values as the mixture of recharge waters. Groundwater discharging from Cave Spring (Appendix 1; plates 1 and 2; site 209) has average δD and $\delta^{18}O$ values of -102.5 and -13.94‰, respectively, for four samples. Groundwater in five wells (Appendix 1; plates 1 and 2; sites 600, 601, 620, 625, 627) have δD values ranging from -106.3 to -104.7‰ and $\delta^{18}O$ values ranging from -14.27 to -13.75‰, respectively (Plates 1 and 2; Appendix 1). Ideally, δD and $\delta^{18}O$ values would be within 2.0 and 0.2‰, respectively, of the proposed sources of water for the valley aquifers if these are the sources supplying all of the water to the valley aquifers (Thomas et al., 2001; Thomas and Mihevc, 2007). The average δD value of water flowing from Cave Spring is 3.4‰ more positive, and the average $\delta^{18}O$ value is 0.24‰ more positive, than that of the average recharge values. These Cave Spring values are 1.4 and 0.04‰ more positive than the ideal range of δD and $\delta^{18}O$ values, respectively, for supporting local recharge water as the sole source of water for the spring. However, these values are within the range of spring values in the Cave Valley recharge areas (Figure 9). In

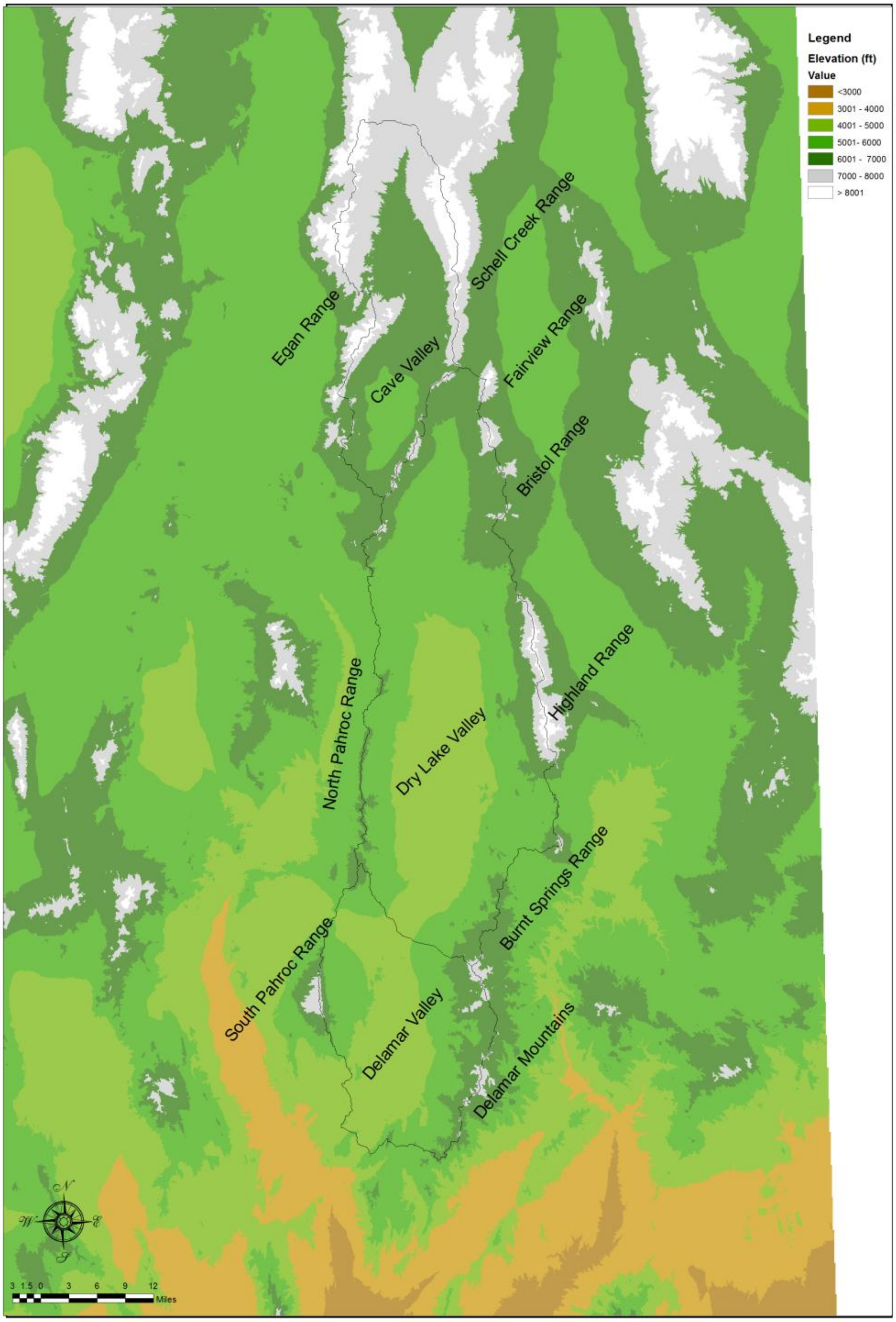

Figure 10. DDC area showing the mountain ranges that comprise the mountain block recharge areas for the three valleys.

Table 4. DDC area average isotopic values for mountain block recharge areas, valley groundwaters, and inflows and outflows to the valleys; and estimated recharge and evapotranspiration (ET) average annual rates, and outflow and inflow rates to valleys. δD and $\delta^{18}O$ values are in permil and recharge and ET values are in acre-feet per year. Recharge and ET values are from Burns and Drici (2011).

Site Name	**δD**	**$\delta^{18}O$**	**Recharge/ET**
	Cave Valley		
South Schell Creek Range	-105.0	-14.21	6,800
South Egan Range	-106.9	-14.15	6,900
Recharge to Cave Valley	-105.9	-14.18	13,700
ET from Cave Valley	-105.9	-14.18	1,300
Flow out of Cave Valley to southeastern White River Valley and northeastern Pahroc Valley	-105.9	-14.18	12,400
	Dry Lake Valley		
South Schell Creek Range	-100.9	-13.17	2,200
North Pahroc Range	-94.3	-12.39	1,000
Fairview Range	-99.5	-12.88	3,700
Bristol and Highland Ranges	-98.9	-13.28	7,600
Chief and Burnt Spgs Ranges	-94.6	-12.36	1,800
Recharge to Dry Lake Valley	-98.6	-13.02	16,300
Inflow to Dry Lake Valley from NE Pahroc Valley	-105.9	-14.18	2,000
ET from Dry Lake Valley			0
Flow out of Dry Lake Valley to Delamar Valley	-99.4	-13.15	18,300
	Delamar Valley		
Delamar Range	-92.4	-12.32	5,600
South Pahroc Range	-94.6	-12.81	1,000
Recharge to Delamar Valley	-92.8	-12.39	6,600
Inflow to Delamar Valley	-99.4	-13.15	18,300
ET from Delamar Valley			0
Flow out of Delamar Valley to Coyote Springs Valley	-97.6	-12.95	24,900

comparison, δD of groundwater for the five wells are within 2‰ of the average δD value of recharge to the valley and the values only vary by 1.6‰, although these values represent only one sample per well so the variability of groundwater isotopic values in these wells over time is not known. The $\delta^{18}O$ values of these wells varies by 0.52‰ and the most positive value is 0.43‰ more positive than the average recharge value, but all values fall within the range of recharge area spring values. Thus, although some of the groundwater δD and $\delta^{18}O$ values in Cave Valley fall outside the ideal range of recharge values, the isotopic data support local recharge from the mountain block recharge areas as the source of water in aquifers of the valley.

Although all available δD and $\delta^{18}O$ sample values are reported for wells drilled by SNWA in Appendix 1, if more than one sample is reported in Appendix 1 only the most recent sample is used in the evaluation of groundwater sources and flow paths. The most recent value is used instead of an average value, because a large amount of water from outside the valley was used to drill most of the wells and well development was likely not sufficient to remove this water in order to obtain representative isotopic values of groundwater in the aquifers (Jim Watrus, SNWA Hydrogeologist, oral communication, 2011). The most recent sample would have been collected after the most water had been pumped from the well and this sample would also have allowed time for any flushing of the well by water in the aquifer flowing through the well. These wells were drilled as observation wells to monitor groundwater levels rather than as potential production wells, so they were not extensively developed (Jim Watrus, SNWA Hydrogeologist, oral communication, 2011).

Lundmark et al. (2007), using a discrete-state compartment (DSC) model with δD as a calibration parameter, and based on the ability of Cave Valley's northern geologic boundary to allow groundwater flow between valleys (Welch et al., 2007), showed that Cave Valley could potentially receive groundwater flow from southern Steptoe Valley (the valley directly north of Cave Valley on Plates 1 and 2). However, the isotopic data presented in this report shows that little, if any interbasin flow enters Cave Valley from Steptoe Valley (Appendix 1 and Plate 2). If some groundwater does flow from southern Steptoe Valley to Cave Valley, then there would be water in addition to the local recharge in Cave Valley aquifers. Since the same mountain block recharge areas of Cave Valley extend north to form the western and eastern mountain block recharge areas of southernmost Steptoe Valley, recharge to these mountain blocks could have a similar isotopic composition as that of groundwater recharging Cave Valley. However, the average isotopic composition of groundwater recharging southern Steptoe Valley would be similar to groundwater recharging northern White River Valley because the two valleys receive recharge from the same part of the Egan Range. The average isotopic composition of this recharge is -112.3 and -15.15‰ for δD and $\delta^{18}O$, respectively (Thomas and Mihevc, 2007). These recharge isotopic values are 6.4 and 0.97‰ more negative than recharge to Cave Valley and Cave Valley groundwaters are slightly more positive than Cave Valley recharge. Thus, although recharge-area isotopic data do not preclude recharge to southernmost Steptoe Valley from flowing into Cave Valley, the amount of interbasin flow would be very limited based on the isotopic data.

Groundwater in Dry Lake Valley is derived from local recharge and potentially a small volume of flow (up to 2,000 afy) from northeast Pahroc Valley into northwest Dry Lake Valley (Burns and Drici, 2011). Recharge to Dry Lake Valley aquifers is received from the southern Schell Creek, north Pahroc, Fairview, Bristol, Highland, Chief, and Burnt Springs ranges (Plate 1 and Figure 10; Thomas and Mihevc, 2007; Burns and Drici, 2011). The total amount of recharge from the six mountain block recharge areas is 16,300 afy (Burns and Drici, 2011) with average δD and $\delta^{18}O$ values of -98.0 and -12.97‰, respectively. These recharge weighted average δD and $\delta^{18}O$ values are obtained by multiplying the average isotopic values for the recharge areas (Table 2) by the amount of recharge, adding up these values, and then dividing by the total amount of recharge to the valley (Table 4).

There are four wells in Dry Lake Valley that have been sampled for isotope analysis that can be used to evaluate the sources of groundwater for Dry Lake Valley aquifers. Along the northwest boundary of Dry Lake Valley that adjoins Pahroc Valley, the Fugro Dry Lake Valley Deep Well (Appendix 1 and Plate 1; site 179) was drilled and extensively developed by Fugro (a company that drilled the well for the proposed MX missile program). This well contains groundwater with average δD and $\delta^{18}O$ values of -107.5 and -14.16‰, respectively (Appendix 1). This groundwater contains significantly more negative isotopic values than the local recharge to northern Dry Lake Valley from the adjacent southern Schell Creek Range (Table 2; -100.9 and -13.17‰). The isotopic values of this groundwater are similar (within 2.0‰ δD and 0.2‰ $\delta^{18}O$) to that of groundwater flowing out of southwest Cave Valley to northeastern Pahroc Valley (-105.9 and -14.18‰). This similarity in δD and $\delta^{18}O$ values supports the hydrogeologic interpretation that groundwater flows from southwestern Cave Valley into northeastern Pahroc Valley. The hydrogeologic framework also supports groundwater flow from southern White River Valley to northern Pahroc Valley (Burns and Drici, 2011), so this could also be a source of groundwater flow from northeastern Pahroc Valley to northwestern Dry Lake Valley. However, any contribution of this flow reaching northern Dry Lake Valley would be limited because Thomas and Mihevc (2007) calculated groundwater flowing out of southern White River Valley would have an isotopic content of -113.6 and -15.04‰, which is significantly more negative than water in the Fugro well. The Fugro well in Dry Lake Valley (Appendix 1 and Plate 1; site 179) is located near the Dry Lake Valley-Pahroc Valley topographic divide (Plate 1), so groundwater in this area may continue to flow to the southwest into northeast Pahroc Valley or some (up to 2,000 afy) may flow southeast into central Dry Lake Valley.

Two wells located in central Dry Lake Valley, one on the east side of the valley (Vidler well PW-1; Appendix 1 and Plate 1; site 636) and one on the west side of the valley (SNWA well 181M-1; Appendix 1 and Plate 1; site 603) contain groundwater with δD and $\delta^{18}O$ values of -101 and -13.4‰ and -105.0 and -13.62‰, respectively. The hydrogeology indicates that these wells should receive most of their water from the southern Schell Creek, Fairview, Bristol, and Highland ranges (Burns and Drici, 2011). The recharge weighted average δD and $\delta^{18}O$ values for these four mountain block recharge areas is -99.4 and -13.15‰, respectively (Table 4). The isotopic values of water in the Vidler PW-1 well are very similar to the recharge values (1.6 and 0.25‰ different in δD and $\delta^{18}O$, respectively), so the isotopic data support the source of this water being local recharge. In contrast, the isotopic data for the SNWA well does not support local recharge as the main source of this water because the values are 5.4 and 0.47‰ more negative than the local recharge water. Local recharge to the adjacent northern Pahroc Range is even more positive than for the four northern recharge areas (Table 4), so this is not the source of the majority of water in this well either. This water may represent interbasin flow in the carbonate-rock aquifer. The δD value of this groundwater is only 0.9‰ more positive than groundwater inflow from northeast Pahroc Valley, but the $\delta^{18}O$ value is 0.56‰ more positive so only the δD value would support this groundwater being interbasin flow. Because this well is a new SNWA well that has not been extensively developed (Jim Watrus, SNWA Hydrogeologist, oral communication, 2011), the water in this well may contain mostly water used in drilling the well rather than primarily native groundwater in the aquifer.

SNWA well 181W909M and well SK-18 (Appendix 1 and Plate 1; sites 604 and 134) are located in the southern part of Dry Lake Valley, so their isotopic data can be used to evaluate the source(s) and flow paths of water in this part of the valley. The δD and $\delta^{18}O$ values for SNWA well 181W909M are -104.6 and -13.50‰, respectively. These values are significantly less than average recharge values for Dry Lake Valley (Table 4), so this sample may represent interbasin flow in the carbonate-rock aquifer (1.3 and 0.68‰ more positive in δD and $\delta^{18}O$, respectively, as compared to inflow from northeastern Pahroc Valley). The groundwater in this well has similar isotopic values of that of SNWA well 181M-1, so like groundwater in well 181M-1 the δD value would support interbasin flow, but the $\delta^{18}O$ value does not. This well also has not been extensively developed so the water in this well likely contains mostly water used in drilling the well rather than primarily native groundwater in the aquifer. Water in well SK-18 has a δD value of -95‰ (Kirk and Campana, 1990). Unfortunately, this sample does not have a $\delta^{18}O$ value, so it cannot be determined if groundwater in this well is significantly evaporated. If this groundwater has not undergone significant evaporation, then it is similar to the δD value of the average recharge to the valley and almost the same as recharge to the Chief, Burnt Springs and North Pahroc ranges in the southern part of the valley (Table 4). Thus, this sample indicates that local recharge to Dry Lake Valley is the primary source of groundwater in this part of the valley.

The hydrogeology of the DDC area indicates that groundwater in Delamar Valley is derived from interbasin flow from Dry Lake Valley and local recharge (Thomas and Mihevc, 2007; Burns and Drici, 2011). There are two wells with isotopic data that are available to evaluate groundwater sources and flow paths in Delamar Valley. These wells are SNWA well 182M1 (Appendix 1 and Plate 1; site 606) with δD and $\delta^{18}O$ values of -109.6 and -14.07‰, respectively, and SNWA well 182W906M (Appendix 1 and Plate 1; site 607) with δD and $\delta^{18}O$ values of -100.7 and -13.40‰, respectively. The water in well 182W906M is isotopically similar to the mixture of inflow from Dry Lake Valley with local recharge to Delamar Valley, but it is 3.1 and 0.45‰ more negative in δD and $\delta^{18}O$, respectively (Table 4), than the mixture of water in Delamar Valley. Thus, the isotopic data of groundwater in this well supports a mixture of local recharge and interbasin flow from Dry Lake Valley as the main source of water in this well. The slightly more negative isotope values may indicate more interbasin flow than local recharge reaches this well as presented in Table 4, or more likely that water used to drill the well has not been completely removed from the aquifer. The water in well 182M1 is likely almost all water used in drilling the well, since the isotopic data is similar to the isotopic values of the water used in drilling this well (Pahranagat Valley water) and the well has undergone little development because it is a low yielding well drilled for water level observation rather than water production (Jim Watrus, SNWA Hydrogeologist, oral communication, 2011).

In summary, δD and $\delta^{18}O$ data show that groundwater in the DDC area is supplied by local recharge from the mountain block recharge areas of the valleys. There is little, if any, interbasin flow from Steptoe Valley to the north into the most upgradient of these three valleys, Cave Valley. Groundwater in Cave Valley is derived from local recharge to the valley. Groundwater flows out of Cave Valley into southeastern White River Valley and northeastern Pahroc Valley. All of the groundwater in Dry Lake Valley is derived from local recharge to the valley, except for the potential of up to 2,000 afy of inflow to northwest Dry Lake Valley from northeast Pahroc Valley. All groundwater in Dry Lake Valley flows down gradient to the south to Delamar Valley. Delamar Valley aquifers also receive groundwater recharge from mountain block recharge areas in the valley that mixes with the groundwater flowing into the valley from Dry Lake Valley. All groundwater in the valley flows south out of southern Delamar Valley to northern Coyote Springs Valley. Although, some groundwater may flow southwest out of Delamar Valley along the Pahranagat Valley Shear Zone into the very southern part of Pahranagat Valley before flowing into northern Coyote Springs Valley (Burns and Drici, 2011). Potential groundwater flow from the DDC area to adjacent valleys is described in more detail in following sections of this report.

Potential Groundwater Flow from the DDC Area to White River Valley

The WRFS (Figure 1) was originally described by Eakin (1966). Eakin postulated that some of the water discharging from the Muddy River Springs area in Upper Moapa Valley originated more than 200 miles north of the spring area and that this regional interbasin flow system included 13 valleys. Eakin reached these conclusions on the basis of "preliminary appraisals of the distribution and quantities of the estimated groundwater recharge and discharge within the region, the uniformity of discharge of the principal springs, the compatibility of the potential hydraulic gradient with regional groundwater movement, the relative hydrologic properties of the major rock groups in the region, and to a limited extent, the chemical character of water issuing from the principal springs." The main conclusions of his study were: (1) Paleozoic carbonate rocks form the regional aquifer of the WRFS, (2) recharge and discharge estimates balance within the flow system, and (3) the principal discharging springs (warm springs in this report) have a uniform discharge rate, indicating a regional rather than local water source.

As noted earlier in this report, based on structural and geologic controls, groundwater in northwestern Cave Valley flows southwest into southeastern White River Valley (Burns and Drici, 2011; Rowley and Dixon, 2011). In southeastern White River Valley, three springs—Emigrant (site 207), Butterfield (site 202), and Flag #3 (site 201)—are located along the range-bounding fault on the east side of the valley (Plate 1). Flag Spring #3 has a water temperature of 22.8^{o}C; but because of its location, and similar isotopic and water chemistry content to that of Emigrant and Butterfield springs (Appendix 1); it is included with the other two cool springs along the range- bounding fault in our analysis. These three springs have isotopic values that range from -107.8 to -105.0‰ for δD and -14.50 to -14.20‰ for δ^{18}O. These values are similar to the average isotopic composition of recharge to the southern Egan Range in southern White River Valley and western Cave Valley, δD and δ^{18}O of -106.9 and -14.15‰, respectively (Table 4; Appendix 1; Thomas and Mihevc, 2007). Thus, the southern Egan Range is the most likely source of water supplying these springs (Plates 1 and 2; Figure 10). This includes recharge from the Egan Range to northwestern Cave Valley which could flow into southeastern White River Valley along the Shingle Pass fault system. Thus, outflow from northwestern Cave Valley could supply some of the flow observed at Emigrant, Butterfield and Flag #3 springs in southeastern White River Valley.

Two warm springs in southern White River Valley, Hot Creek Spring (site 197) and Moon River Spring (site 192) (Appendix 1; Plates 1 and 2), could potentially contain groundwater from Cave Valley since there is outflow from northwestern Cave Valley to southeastern White River Valley. The isotopic composition of these two warm springs ranges from -120.0 to -118.9‰ for δD and -15.80 to -15.69‰ for δ^{18}O. Since the average isotopic composition of northwestern Cave Valley groundwater outflow (recharge to the southern Egan Range) is -106.9‰ for δD and -14.15‰ for $\delta^{18}O$, little, if any, Cave Valley groundwater could be supplying flow to these two warm springs. Additionally, local recharge to southern White River Valley from the southern Egan and Grant Ranges has average δD values ranging from -106.9 to -106.5‰ and $\delta^{18}O$ values ranging from -14.23 to -14.15‰ (Thomas and Mihevc, 2007), so this also is not a source of water for the regional warm springs. Thus, the source of the southern White River Valley warm springs is groundwater from the north of this area that has more negative isotopic values (Thomas and Mihevc, 2007; Appendix 1 and Plate 2 this report).

Potential Groundwater Flow from the DDC Area to Pahranagat Valley

The regional warm springs in Pahranagat Valley discharge interbasin flow from several valleys. Pahroc Valley is the valley directly upgradient from Pahranagat Valley and it receives inflow from Cave, White River (which receives inflow from Jakes, Long, and southern Butte valleys), and Coal (which receives inflow from Garden Valley) valleys (Figure 1; Thomas and Mihevc, 2007). Thus, some of the groundwater discharging from Hiko (site 122), Crystal (site 116), Ash (site 110), and Little Ash (site 111) warm springs in Pahranagat Valley (Plate 1) likely originates in Cave Valley. Groundwater flow from northwestern Cave Valley to southeastern White River Valley is discharged by cool springs along the range-bounding fault of the Egan Range and is lost by evapotranspiration in the valley, so little, if any, of this groundwater would flow into Pahranagat Valley. Groundwater flow from southwestern Cave Valley that enters northeastern Pahroc Valley likely becomes part of the mixture of regional groundwater flow in the WRFS that contributes to groundwater inflow into Pahranagat Valley. Part of the groundwater inflow to Pahranagat Valley discharges from Pahranagat Valley warm springs, although the sources and flow paths of groundwater supplying the Pahranagat Valley warm springs are not well understood (Thomas and Mihevc, 2007). Groundwater flowing out of southwest Cave Valley has δD and $\delta^{18}O$ values of -105.9 and -14.18‰, respectively (Table 4). These values fall within the range of δD values -112.0 to -105.0‰ and $\delta^{18}O$ values -15.30 to -13.80‰ for the Pahranagat Valley warm springs and are similar to the average values of -108.5 and -14.27‰ for these springs (Table 3). Thus, the isotopic data indicate that some of the groundwater flowing out of southwestern Cave Valley likely contributes to Pahranagat Valley warm spring discharge. Some groundwater originating in Cave Valley likely flows south past the Pahranagat Valley warm springs as part of the mixture of regional groundwater flow in the WRFS.

RECHARGE TIMING AND GROUNDWATER TRAVEL TIMES

Understanding the timing of recharge to springs in the mountain block recharge areas and the time it takes groundwater to flow (travel time) from recharge areas to valleys and between valleys (interbasin flow) is important for determining if δD and $\delta^{18}O$ data in the WRFS represent current climatic conditions or past cooler and wetter climatic conditions. If groundwater discharging from regional warm springs contains a significant amount of groundwater recharged during a past cooler climate then the δD and $\delta^{18}O$ data used for determining sources and flow paths would need to be adjusted to account for more negative recharge isotopic values during this time.

Recharge Timing Based on Stable Isotope and Tritium Data

δD and $\delta^{18}O$ data for regional groundwater flow systems can be used to evaluate recharge timing irrespective of whether a regional flow system is responding to current climatic conditions or past climatic conditions. If recharge and discharge rates and flow directions are known for a regional groundwater flow system, then δD and $\delta^{18}O$ data can be used to evaluate if a flow system contains a significant amount of groundwater flowing through it that was recharged during a past (i.e., different) climatic condition. For the WRFS, the most recent past climatic condition that would have significantly different δD and $\delta^{18}O$ recharge values than present day conditions would be the cooler and wetter last glacial period, which ended about 12,000 to 16,000 years ago in southern Nevada. If the four main regional warm spring areas of the WRFS were discharging a significant amount of water from the last glacial period, then the isotopic composition of the springs would be at a minimum 10 and 1.2‰ more negative in δD and $\delta^{18}O$ composition, respectively, than present day recharge (Winograd et al., 1992; 2006), and could be as much as 16 and 2.0‰ more negative (Benson and Klieforth, 1989). Thus, if any significant portion of groundwater in the WRFS was recharged during the last glacial period, regional warm springs would be 10 to 20‰ more negative in δD and 1.0 to 2.0‰ more negative in $\delta^{18}O$ than present day values.

δD and $\delta^{18}O$ groundwater data for the WRFS combined with recharge and ET estimates (Thomas and Mihevc, 2007; Burns and Drici, 2011) show that the WRFS is responding to current climate conditions and not a past wetter and cooler climate. This is supported by the fact that if warm springs in the WRFS were discharging a significant amount of groundwater recharged under a cooler and wetter climate than the current climate, the isotopic values of the regional spring discharge would be significantly more negative than is currently measured. These regional warm springs are supported by interbasin flow that has groundwater with isotopically more negative values than the local recharge (Thomas and Mihevc, 2007). Thus, regional warm springs would have significantly more negative values than is measured today. Even during wetter climatic periods, there would not be sufficient local recharge to Pahranagat and Upper Moapa valleys to supply the warm spring discharge in these valleys, so interbasin flow would be needed to maintain even current flow conditions at these regional spring discharge areas, much less the increased flow expected for a cooler and wetter climate.

Tritium can be used to determine if recharge area springs are representative of present day climate conditions and also if present day recharge is entering valley aquifers. Groundwater that contains measureable tritium indicates that the water is less than about 60 years old and thus would represent present day climatic conditions. Tritium may also indicate mixing of young (< 60 year old) groundwater with older groundwater. Tritium data for groundwater in the WRFS shows that springs in mountain block recharge areas are discharging groundwater that was recharged within the last 60 years, because they contain measurable tritium (Thomas et al. 1996; Hershey et al., 2007). Lund, Butterfield, and Emigrant springs on the valley floor along the eastern side of White River Valley and Cave Spring in Cave Valley contain 1.2 to 17.4 tritium units (TU) of tritium (Table 5; Hershey et al., 2007), indicating that mountain block recharge that is < 60 years old is entering the valley aquifers. In contrast, none of the regional warm springs has tritium above 1.0 tritium units, indicating that all of the water discharging from regional warm springs was recharged before the early 1950s (Table 5).

Table 5. Tritium and carbon isotope data (when more than one sample is used to obtain a value, the number of samples is shown in parentheses and the reported value is an average value for all the samples and for the warm springs is weighted by the flow rates) and saturation indices for calcite, dolomite, and gypsum calculated in NETPATH. Mineral saturation indices (SI) values are negative for under saturation (mineral will dissolve) and positive for over saturation (mineral will precipitate from the water).

Site Name	**Tritium (TU)**	**Carbon-13 (permil)**	**Carbon-14 (pmc)**	**Calcite (SI)**	**Dolomite (SI)**	**Gypsum (SI)**
Recharge Groundwaters						
Lund Spring	1.9	-8.1	41.6	0.14	0.16	-2.62
Emigrant Spring	17.4	-9.2	55.7	-0.14	-0.45	-2.46
Butterfield Spring	1.2	-8.5	30.3	-0.18	-0.46	-2.81
Ave spring recharge	6.8 (3)	-8.60 (3)	42.5 (3)	-0.06	-0.24	-2.61
Northern White River Valley Warm Springs						
Preston Big Spring	<1	-5.7	11.2	-0.08	-0.19	-2.18
Nichols Spring	NA	-5.7	6.5	0.13	-0.23	-2.17
Preston Cold Spring	NA	-5.6	2.2	-0.11	-0.22	-2.20
Ave N. WRV warm Springs	<1 (1)	-5.69 (3)	9.2 (3)	0.00	-0.02	-2.18
Southern White River Valley Warm Springs						
Hot Creek Spring	<1	-4.26 (2)	5.0 (2)	0.02	0.03	-2.03
Moon River Spring	NA	-5.0	6.4	0.18	0.38	-2.06
Ave S. WRV warm springs	<1 (1)	-4.42 (2)	5.3 (2)	0.01	0.01	2.03
Pahranagat Valley Warm Springs						
Hiko Spring	<1	-6.45 (2)	6.1 (2)	0.23	0.52	-2.18
Crystal Spring	<1	-6.57 (4)	7.3 (3)	0.01	0.09	-2.24
Ash Spring	<1	-6.70 (2)	6.3 (3)	0.04	-0.10	-2.24
Ave Pahranagat V warm springs	<1 (3)	-6.61 (3)	6.6 (3)	-0.02	0.01	-2.23
Upper Moapa Valley Warm Springs						
Big Muddy Spring	<1 (2)	-5.90 (2)	8.2 (2)	0.00	0.03	-1.47

Carbon-14 Corrected Groundwater Ages and Travel Times

Cave, Dry Lake, and Delamar valleys are located within the larger WRFS and contribute to the overall groundwater resources of the WRFS. Understanding the time it takes groundwater to flow from recharge areas to valleys and between valleys (interbasin flow) within the WRFS is important for managing these groundwater resources. To estimate the time it takes groundwater to flow through aquifers in the WRFS, groundwater ages corrected for geochemical reactions and physical processes were determined by geochemical modeling using major ion chemistry and carbon-13 and carbon-14 isotopic data. The computer model NETPATH (Plummer et al., 1994; El-Kadi et al., 2010) was used to calculate carbon-14 corrected groundwater ages. Determining groundwater travel times in a regional flow system like the WRFS is complicated because every valley in the WRFS has local groundwater recharge that mixes with interbasin flow as groundwater flows from north to south down the

WRFS. Thus, groundwater travel times represent a central tendency of the actual recharge time for each recharge event. To evaluate groundwater travel times in the WRFS, carbon-14 corrected groundwater ages were determined for the four main warm spring discharge areas of the WRFS (see Thomas et al., 1996 and Hershey et al. 2007, for a detailed description of how carbon-14 corrected ages are calculated). Calculating carbon-14 corrected ages for regional warm springs is an effective way to evaluate groundwater travel times because these warm springs represent a mixture of up-gradient groundwaters that have traveled both a long distance -- generally tens of miles -- and to great depth -- generally thousands of feet -- before being discharged from the spring.

Groundwater carbon-14 data, reported as percent modern carbon (pmc), needs to be corrected for geochemical reactions and physical processes involving carbon in order to determine a realistic groundwater age. Some laboratories report carbon-14 ages for carbon-14 groundwater values, but these ages should never be used as groundwater ages because they do not account for reactions and processes that affect carbon-14 concentrations in the groundwater. For example, warm springs discharging from regional carbonate-rock aquifers in Ash Meadows in southern Nevada contain only 2 to 4 pmc carbon-14 (with one spring reaching 11 pmc), but these groundwaters are at most several thousand years old and could be as young as 1,000 years old (Winograd et al. 1992; 2006; Thomas et al., 1996). Thus, low carbon-14 values (< 15 pmc) in regional warm spring waters of the WRFS, which could indicate that these waters are more than 20,000 years old (Table 5; Thomas et al., 1996; Hershey et al., 2007), need to be corrected for geochemical reactions and physical processes in order to obtain realistic groundwater ages.

To obtain realistic groundwater ages using carbon isotope data (carbon-14 corrected ages), the dissolution of calcite and dolomite that comprise the carbonate-rock aquifers, dissolution or outgassing of CO_2, and adsorption and diffusion processes that remove carbon-14 from groundwater must be considered. Dissolution of calcite and dolomite add carbon to the water that contains no carbon-14. CO_2 may outgas or dissolve depending on the conditions near the spring area, but once water passing through the unsaturated zone (water will react with CO_2 gas in the unsaturated zone) reaches the saturated zone (i.e., the water table of an aquifer) there should be no additional dissolution or outgassing of CO_2 along a flow path, until the groundwater is discharged at the spring where some CO_2 may exsolve (degas from the water). Adsorption and diffusion processes can remove carbon-14 from groundwater (Hershey and Howcroft, 1998; Hershey et al., 2003; 2007). These reactions and processes involving phases that contain carbon (and carbon-13 and carbon-14 isotopes), need to be accounted for to obtain carbon-14 corrected groundwater ages. Regional warm springs in the WRFS are a mixture of flow that is contributed all along the regional flow system from many different recharge areas and valleys, so the age of water discharging from warm springs is an average age. Thus, a small percent of the water discharging from regional warm springs could have been recharged during the last glacial (or similar) period when the climate was cooler and wetter. However, the δD and $\delta^{18}O$ data; recharge and discharge estimates; and interbasin flow supported by the hydrogeologic framework for the WRFS do not support any significant amount of recharge from a cooler and wetter climate (this report; and Thomas et al., 1996, 2001; Thomas and Mihevc, 2007; Hershey et al., 2007).

Carbon-14 and carbon-13 isotopes of inorganic carbon dissolved in groundwater can be used to estimate groundwater ages by using geochemical models that account for all reactions and processes involving carbon from a recharge area to a sample location along a flow path. The change in isotopic composition between phases, such as differences in carbon-13 and carbon-14 values between carbon dissolved in water and calcite precipitated from water, is called isotopic fractionation. Groundwater ages calculated using geochemical models that account for changes in water chemistry and isotopic fractionations along a flow path, and from mixing of waters with different chemistries, are called carbon-14 corrected ages. These model calculated ages are called carbon-14 corrected ages because they account for the addition or removal of carbon (and carbon-14) to the groundwater and the changes (fractionations) of the isotope values as they change from one phase to another. Geochemical models that calculate carbon-14 corrected groundwater ages are only valid if the modeled carbon-13 value matches the carbon-13 value measured in the groundwater sample at the end of the flow path. Carbon-14 is radioactive and naturally decays over time, whereas carbon-13 is stable and does not decay (change) over time. The only way that a carbon-13 concentration can change is by mixing two, or more, waters with different carbon-13 values or by geochemical reactions that add or remove carbon to or from the water. Carbon-13 will fractionate as it reacts and moves from one phase to another; for example carbon dissolved in water can precipitate as calcite, and this can easily and accurately be accounted for if the pH, temperature and dissolved carbon content of the water sample is known (Deines et al., 1974; Wigley et al., 1978; Mook, 1980; Plummer et al., 1983; 1994).

Carbon-14 corrected groundwater ages and travel times have been previously calculated by Thomas et al. (1996) and Hershey et al. (2007) for groundwater discharging from regional warm springs in the WRFS. Thomas et al. (1996) and Hershey et al. (2007) used the same approach as was used in this report for calculating groundwater ages. Groundwater ages calculated for regional warm springs in Pahranagat and Upper Moapa valleys ranged from 4,800 to 8,500 years (Thomas et al., 1996; Table 18 model 3 and Figure 26). Groundwater travel time from the warm springs in northern White River Valley to the warm springs in southern White River Valley, based on groundwater ages calculated for a mixture of water containing 40 to 60 percent recharge water (with modern carbon-14 values of about 100 pmc) with northern White River Valley warm spring water, produced an average groundwater travel time for this mixture of water of 12,000 to 16,000 years (Hershey et al., 2007).

The NETPATH models used in this study are based on the same assumptions as those used by Thomas et al. (1996) and Hershey et al. (2007). The only difference in the NETPATH models used in this study, besides any new data that would be included in Table 3 and Appendix 1, is a simpler model using only calcite, dolomite, CO_2 gas, and gypsum. This simpler model was used because the goal of this study was to determine the carbon-14 corrected groundwater age and not to explain all major ion chemistry changes in the water along flow paths of the WRFS. Gypsum was included in this simple carbon model to account for calcium added to the water by gypsum dissolution, which can result in more calcite precipitation and dolomite dissolution. This process of gypsum dissolution producing more calcite precipitation and dolomite dissolution is called dedolomitization (Back et al., 1983). The water chemistry data used for NETPATH modeling is the average water chemistry for a site using the data presented in Appendix 1. The carbon isotope data used for the NETPATH modeling is presented in Table 5 and is from USGS, DRI, and SNWA sample collection and analysis at USGS, DRI, and the University of Arizona isotope laboratories.

Carbon-14 age dating model results are presented in Table 6. Columns two through five in the table present the mass transfer of calcite, dolomite, gypsum, and CO_2 gas needed to produce the water chemistry for the regional warm springs from an initial carbonate recharge water (see next paragraph for a description of this water). Minerals that are under saturated in the water [negative saturation indices (SI) values in Table 5] should dissolve, and those that are saturated (positive SI values) should precipitate from the water. The NETPATH model results in Table 6 are supported by the SI values in Table 5. Similar to the modeling approach used by Thomas et al. (1996) and Hershey et al. (2007), if carbon is added to the water along a flow path (a positive CO_2 mass transfer value > 0.30 millimoles per liter) this amount of carbon was added to the recharge water. The reason this CO_2 carbon is added to the recharge water is because once the water becomes isolated from the unsaturated zone, there should be little, or no, interaction with unsaturated zone CO_2 gas, and a previous study has shown that there is likely CO_2 outgassing in some of the recharge spring areas (Thomas et al., 1996). Column six in Table 6 shows the amount of calcite that is exchanged between the water and the aquifer (calcite dissolved and precipitated due to temperature and pressure changes as groundwater flows through the regional aquifers) to obtain modeled carbon-13 values that match measured values.

Table 6. NETPATH model results showing the mass transfer of calcite, dolomite, gypsum, and CO_2 gas in millimoles per liter (positive values indicate that the phase is entering the water and negative values indicate that the phase is being removed from the water). The carbon-14 corrected age is the age calculated after correcting for all carbon entering or leaving the water along the flow path and the fractionations associated with these reactions. All flow paths use the recharge waters listed in Table 3 as the initial water chemistry for a flow path. The final water along the flow path is listed in this table. A carbon-14 corrected age that is modern is less than about 1,000 years old.

Final Flow Path Site	**Calcite (mmoles/L)**	**Dolomite (mmoles/L)**	**Gypsum (mmoles/L)**	**CO_2 (mmoles/L)**	**Calcite cycled (mmoles/L)**	**Corrected Carbon-14 age (years)**
Northern White River Warm Springs	-0.51	-0.14	0.29	-1.15	1.3	10,000
Southern White River Warm Springs	-0.27	-0.05	0.36	0.24	>10	modern
Pahranagat Valley Warm Springs	-0.41	-0.12	0.24	0.20	4.2	8,700
Big Muddy Warm Spring	-1.82	0.16	1.85	0.00[a]	6.5	3,300

a—The original NETPATH model for Big Muddy Warm Spring had 1.25 mmoles/L of CO_2 being added to the water along the flow path. So in following the Thomas et al. (1996) and Hershey et al. (2007) modeling approach, this amount of CO_2 was added to the recharge waters so that the amount of CO_2 mass transfer along the flow path is 0.00 mmoles/L.

All of the NETPATH models assume that the water chemistry and isotope values of Lund, Emigrant, and Butterfield springs (Table 5), which are located along the eastern side of White River Valley, are representative of present day recharge to carbonate aquifers of the WRFS. These springs were chosen to represent groundwater recharging the carbonate rock aquifers of the WRFS because: 1) they occur along the eastern range-bounding fault of White River Valley so they represent recharge from the carbonate rock-dominated Egan Range that flows from the mountain block into the carbonate rock aquifers of the WRFS; 2) all three springs contain measureable tritium (Table 5), indicating that these groundwaters have been recharged since the 1950s; 3) they have carbon-14 and carbon-13 values in the ranges expected for recharging groundwaters that have been isolated from atmospheric CO_2 gas, and dissolved calcite and dolomite; 4) they have δD and δ18O values that represent local recharge to the adjacent Egan Range; and 5) groundwater flow from these springs, at least for Lund Spring, is highly variable indicating that they respond to local recharge from the adjacent mountains.

The carbon-14 corrected groundwater ages range from modern (< 1,000 years old) to 10,000 years old. These ages represent the average age of groundwater discharging from the regional warm springs. The discharge-weighted average carbon-14 values of the four regional warm springs in the WRFS range only from 5.3 to 9.2 pmc, but carbon-13 values range from -6.61 to -4.42 permil. This range in carbon-13 values for groundwaters that have similar chemistries results in this about 10,000 year range of groundwater ages. Of note, it is the more positive carbon-13 values of the southern White River Valley warm spring waters (Table 5), as compared to the other warm spring area groundwaters, which result in this warm spring area having a carbon-14 corrected age that is modern. It is important to consider that these carbon-14 corrected groundwater ages likely overestimate the age of the groundwater flowing from the regional warm springs because they do not account for diffusion processes which have been shown to be important in carbonate rock aquifers in southern Nevada (Hershey and Howcroft, 1998; Hershey et al., 2003; 2007). Correcting the model ages for diffusion processes is beyond the scope of this report.

If groundwater flowed from northern White River Valley warm springs to Big Muddy Springs in Upper Moapa Valley without any recharge being added along this flow path then the difference in groundwater ages of these springs could be used to determine groundwater travel times in the WRFS. However, local recharge water within each basin mixes with interbasin flow between warm spring discharge areas. This is observed by water balance studies and supported by the fact that δD and $\delta^{18}O$ values become more positive in WRFS warm springs as groundwater flows from north to south down the WRFS (Thomas and Mihevc, 2007). Thus, carbon-14 corrected groundwater ages represent the mixture of recharge and interbasin flow groundwater at a regional warm spring and provide a range for the time that it takes groundwater to flow from recharge areas to regional warm springs and for interbasin flow from one warm spring area to another within the WRFS.

SUMMARY AND CONCLUSIONS

Deuterium and oxygen-18 data were used to evaluate groundwater sources and flow paths in the DDC area. In order to use δD and $\delta^{18}O$ data for groundwater source and flow path evaluations they need to; (1) show a range throughout the study area so that different recharge areas have different isotopic signatures; (2) have little variability within a recharge area; and (3) the isotopic signature in recharge areas has to be similar to the signature of the past. Temporal and spatial isotopic variability were evaluated in this study.

Temporal isotopic variability of four recharge area monitoring springs within the WRFS was relatively small with standard deviations of δD and $\delta^{18}O$ data ranging from 0.7 to 1.1‰ and 0.07 to 0.11‰ (except for one site with a value of 0.33‰), respectively. The range in standard deviation for the four sites is for samples taken quarterly throughout all four seasons; and with one site having 7 years of data and two of the three sites having 6 years of data. The isotopic composition of these springs varied little from season to season even though spring flow ranged from about 100 to 5,000 gallons per minute. This lack of temporal isotopic variability of recharge area springs is important because recharge area springs are used to determine the sources of groundwater in the DDC area.

Temporal isotopic variability of 10 regional warm springs in the WRFS is relatively small with the standard deviation of δD and $\delta^{18}O$ data ranging from 0.5 to 1.9‰ and 0.05 to 0.21‰ (except for one site with a standard deviation of 0.67‰), respectively. This range in values is for samples taken throughout all four seasons, with some regional warm spring data extending over 40 years and a significant number of springs having data that spans 20 to 25 years. This lack of temporal isotopic variability of regional warm springs is important for evaluating potential groundwater flow from the DDC area to the Hot Creek Spring area in southern White River Valley and regional warm springs in Pahranagat Valley.

Spatial isotopic variability within the mountain block recharge areas of the DDC area shows that the spatial variability is greater than the temporal variability. The range in standard deviation of spring isotopic values for nine mountain block recharge areas is 1.8 to 4.2‰ for δD and 0.35 to 0.70‰ for $\delta^{18}O$.

The relationship of stable isotopes with altitude was evaluated for four major recharge areas in the study area with 14, or more, springs. These four recharge areas include the White Pine and Central Egan ranges in the northern part of the study area, the Fairview and Bristol ranges in the central part of the study area, and the Delamar Mountains in the southern part of the study area. There is only very weak relationships of δD with altitude in three of the four recharge areas (R^2 values of 0.066, 0.018, and 0.026), and the strongest correlation (0.066) was for an increase in isotopic values with increasing altitude (the opposite relationship is expected, that is more negative δD values with increasing altitude). The southernmost and lowest altitude recharge area, the Delamar Range, showed a correlation of more negative δD with increasing altitude with an R^2 value of 0.366. This lack of a relationship between isotopic values and altitude in recharge areas, for most of the recharge areas, is important because the average isotopic composition of all sites in a recharge area can be used to determine the isotopic signature for a recharge area.

The average δD and $\delta^{18}O$ values for recharge areas, weighted by the amount of recharge for each individual mountain block, were calculated to determine the average isotopic values of local recharge to a valley. These average values were compared with valley groundwater values to evaluate sources and flow paths of groundwater in the DDC area and to adjacent valleys. δD and $\delta^{18}O$ data show that groundwater in the DDC area is supplied by local recharge from the mountain block recharge areas of the valleys. There is little, if any, interbasin flow into the most upgradient of these three valleys, Cave Valley. Groundwater flows out of Cave Valley into southeastern White River Valley and northeastern Pahroc Valley. Potentially a small amount (up to 2,000 acre-feet per year) of groundwater may flow into northwest Dry Lake Valley from northeast Pahroc Valley. All of the groundwater in Dry Lake Valley is derived from local recharge to the valley, except for the potential of up to 2,000 afy of inflow to northwest Dry Lake Valley. There is no groundwater ET in Dry Lake Valley (Burns and Drici, 2011), so all groundwater in Dry Lake Valley flows down gradient to the south to Delamar Valley. Delamar Valley aquifers also receive groundwater recharge from mountain block recharge areas in the valley that mixes with the groundwater flowing into the valley from Dry Lake Valley. There is no groundwater ET in Delamar Valley (Burns and Drici, 2011), so all groundwater in the valley flows south out of southern Delamar Valley to northern Coyote Springs Valley. Although, some groundwater may flow southwest out of Delamar Valley along the Pahranagat Valley Shear Zone into the very southern part of Pahranagat Valley before flowing into northern Coyote Springs Valley.

Isotopic data show that groundwater originating in the DDC area supplies little, if any, water to the warm springs in southern White River Valley. These data also show that groundwater discharging from warm springs in Pahranagat Valley are a mixture of waters recharged in numerous valleys north of Pahranagat Valley, which likely includes Cave Valley.

Deuterium and oxygen-18 data, tritium data, and carbon-14 corrected groundwater ages, show that groundwater in the White River Flow System, which includes Delamar, Dry Lake, and Cave valleys, is recharged under current climatic conditions. Carbon-14 corrected groundwater ages also show that it can take thousands of years for groundwater from mountainous recharge areas to flow through numerous basins and discharge in warm spring areas throughout the WRFS. Carbon-14 corrected groundwater ages of the four regional warm spring areas in the White River Flow system range from modern (<1,000 years) to 10,000 years. None of the regional warm springs has tritium above 1.0 tritium units, indicating that all of the water discharging from regional warm springs was recharged before the early 1950s.

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APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA.

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Abandoned Spring	37.49914	-114.72889	10.2	7.7	7.80	-12.32	-94.5	81.00	20.00	50.00	2.26	35.20	357.00	41.80	27.80	--	59699	--	Spring	266	03/26/04
Acoma Well	37.54861	-114.17306	17.0	--	7.70	-12.60	-95.0	38.00	5.30	21.00	7.00	17.00	149.00	10.00	54.00	0.3	244	GS91	Well	118	06/03/85
Adaven Spring	38.13861	-115.60139	12.5	6.9	7.54	-13.95	-103.0	63.00	25.00	14.00	2.20	4.80	324.00	18.00	28.00	0.2	341	GS131	Spring	177	07/31/85
Adaven Spring	38.13861	-115.60139	9.9		7.10	-14.07	-107.6	--	--	--	--	--	358.00	--	--	--	340	IT115	Spring	177	02/03/97
Alamo City Well #7	37.36222	-115.16833	18.5	--	7.57	-13.46	-101.1	61.42	56.00	96.30	13.73	54.60	454.00	188.00	59.13	1.3	205	IT116	Well	104	08/08/95
Albert Spring	38.56833	-115.36167	14.5	--	--	-13.95	-107.0	--	--	--	--	--	--	--	--	--	403	GS182	Spring	204	07/24/85
APCAR	36.71099	-114.71682	--	--	--	-12.94	-98.2	62.90	27.20	95.00	11.20	62.10	257.00	176.00	31.60	--	61616	--	Spring	292	10/19/04
Arrow Canyon	36.73421	-114.74778	--	--	--	-12.91	-99.4	--	--	--	--	--	--	--	--	--	SNWA	--	Well	619	02/01/06
Ash Springs	37.46361	-115.19250	--	--	--	--	-107.0	--	--	--	--	--	--	--	--	--	222	IT27	Spring	110	08/01/68
Ash Springs	37.46361	-115.19250	--	--	--	--	-109.0	--	--	--	--	--	--	--	--	--	223	IT28	Spring	110	01/01/69
Ash Springs	37.46361	-115.19250	--	--	--	--	-112.0	--	--	--	--	--	--	--	--	--	224	IT29	Spring	110	03/01/70
Ash Springs	37.46361	-115.19250	36.0	2.3	7.04	-14.10	-108.0	43.00	14.00	27.00	7.40	8.50	259.00	34.00	30.00	0.8	225	GS81	Spring	110	07/20/81
Ash Springs	37.46356	-115.19252	--	--	--	-14.03	-110.0	--	--	--	--	--	--	--	--	--	SNWA	--	Spring	--	05/24/04
Ash Springs	37.46361	-115.19250	34.0	1.6	7.42	-14.20	-108.4	46.40	16.80	28.40	7.26	8.60	248.00	32.80	32.70	--	61099	--	Spring	110	07/30/04
Aspen Springs South	39.21629	-115.39800	6.9	9.4	7.00	-16.02	-120.9	--	--	--	--	--	--	--	--	--	62721	DRI-WP-16	Spring	324	06/07/05
Aspen Springs North	39.22100	-115.39905	6.9	7.7	6.50	-15.84	-119.3	--	--	--	--	--	--	--	--	--	62716	DRI-WP-11	Spring	349	06/07/05
Bailey Spring (Fairview)	38.17593	-114.72829	18.9	7.0	7.77	-12.68	-98.5	86.40	21.40	29.80	2.10	48.30	331.00	26.60	32.40	--	60849	--	Spring	277	06/29/04
Bailey Spring (Fairview)	38.17593	-114.72829	10.7	6.0	6.99	-12.70	-97.9	96.20	25.80	42.40	1.66	70.30	327.00	49.70	33.10	--	62407	DRI-FR-5	Spring	277	05/01/05
Bailey Spring (Wilson Ck)	38.35295	-114.36718	17.9	6.4	7.84	-12.93	-102.0	45.00	9.43	18.50	2.06	40.60	135.00	16.10	36.70	--	60310	--	Spring	310	05/18/04
Baldwin Spring	36.72035	-114.72415	31.9	2.6	7.30	-12.95	-96.3	63.80	28.10	96.30	11.60	63.80	260.00	180.00	32.00	--	58496	DRI-MV-3	Spring	291	01/12/04
Baldwin Spring	36.72035	-114.72415	32.0	3.0	7.48	-12.93	-96.8	63.70	27.60	94.70	11.10	64.10	263.00	180.00	29.20	--	60309	DRI-MV-3	Spring	291	05/18/04
Baldwin Spring	36.72035	-114.72415	--	--	--	-12.96	-98.6	62.80	27.40	95.00	11.20	61.40	258.00	174.00	32.10	--	61620	DRI-MV-3	Spring	291	10/19/04
Baldwin Spring	36.72035	-114.72415	31.8	2.7	7.30	-12.94	-98.1	63.10	27.40	95.70	11.20	61.70	252.00	178.00	29.60	--	62034	DRI-MV-3	Spring	291	02/10/05
Baldwin Spring	36.72035	-114.72415	32.0	2.8	6.80	-12.94	-97.2	--	--	--	--	--	--	--	--	--	62035	DRI-MV-3	Spring	291	06/08/05
Baldwin Spring	36.72035	-114.72415	31.8	2.6	7.32	-13.05	-98.0	63.50	27.20	96.80	10.90	61.10	253.00	176.00	29.60	2.2	64174	DRI-MV-3	Spring	291	02/16/06
Baldwin Spring	36.72035	-114.72415	30.2	5.3	7.35	-13.03	-98.2	71.10	22.10	93.40	11.20	63.40	254.00	180.00	30.40	2.2	64903	DRI-MV-3	Spring	291	06/21/06
Baldwin Spring	36.72035	-114.72415	32.3	4.8	7.29	-13.03	-97.1	64.50	28.00	83.90	9.35	61.70	259.00	178.00	29.10	2.2	65284	DRI-MV-3	Spring	291	08/23/06
Baldwin Spring	36.72035	-114.72415	31.7	4.3	7.33	-12.91	-97.9	61.80	27.40	93.50	11.20	60.00	251.00	175.00	29.50	2.2	65662	DRI-MV-3	Spring	291	10/30/06
Barrel Spring	38.13105	-114.05505	9.8	6.2	7.72	-13.36	-100.5	55.70	6.12	16.50	0.52	18.80	193.00	10.70	22.90	--	60316	--	Spring	317	05/21/04
Bennett Spring	37.78417	-114.52806	24.0	--	7.50	-13.70	-103.0	56.00	26.00	6.50	1.50	7.90	318.00	6.90	14.00	<.1	288	GS103	Spring	141	04/10/85
Big Muddy Spring	36.72196	-114.71682	--	--	--	--	-98.0	--	--	--	--	--	--	--	--	--	121.2	--	Spring	69	3/00/70
Big Muddy Spring	36.72196	-114.71682	32.5	3.0	7.24	-12.90	-96.5	66.00	26.00	96.00	10.00	61.00	270.00	190.00	29.00	2.1	122	GS42	Spring	69	07/22/81
Big Muddy Spring	36.72196	-114.71682	--	--	--	-12.75	-98.0	--	--	--	--	--	--	--	--	--	125	--	Spring	69	10/30/85
Big Muddy Spring	36.72196	-114.71682	--	--	--	-13.05	-99.0	--	--	--	--	--	--	--	--	--	124	GS44	Spring	69	01/07/88
Big Muddy Spring	36.72196	-114.71682	31.0	--	--	-12.84	-98.4	64.40	27.60	99.90	10.90	64.20	270.00	198.00	29.90	--	60308	--	Spring	69	05/18/04
Big Muddy Spring	36.72196	-114.71682	--	--	--	-12.89	-97.6	63.40	27.00	99.10	10.90	64.50	255.00	178.00	32.60	--	61615	--	Spring	69	10/19/04

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Big Spring (Clover)	37.52781	-114.35258	17.2	7.4	7.32	-12.89	-94.2	27.30	4.26	9.50	2.58	7.30	111.00	3.90	48.20	--	61094	--	Spring	253	07/31/04
Big Spring (Clover)	37.52781	-114.35258	17.0	7.1	7.44	-12.89	-92.9	30.20	4.46	11.10	2.55	9.00	114.00	4.80	45.80	--	62401	DRI-CR-6	Spring	253	04/30/05
Big Spring (Egan)	38.59947	-114.91624	14.0	5.4	6.79	-13.85	-106.0	34.00	5.80	13.00		4.20	156.00	7.20	50.00	0.1	408	GS187	Spring	206	08/03/85
Big Spring (Egan)	38.59947	-114.91624	13.0	5.8	6.50	-13.92	-104.2	--	--	--	--	--	--	--	--	--	--	--	Spring	206	10/14/03
Big Spring (Egan)	38.59947	-114.91624	12.9	5.2	6.11	-13.98	-106.1	34.70	5.78	12.40	2.36	3.80	152.00	7.10	51.70		62980	ER-4	Spring	206	07/31/05
Big Spring (Egan)	38.59947	-114.91624	12.8	5.4	6.76	-13.86	-105.8	34.10	5.83	12.60	2.38	3.90	146.00	7.00	52.10	0.1	65050	ER-24	Spring	441	07/13/06
Big Spring (Grant)	38.37056	-115.48111	12.5	--	8.10	-15.20	-112.0	78.00	7.00	4.90	--	2.10	268.00	13.00	9.50	<.1	366	GS151	Spring	194	07/24/85
Big Spring Snake Valley	38.69892	-114.13223	17.2	5.3	7.54	-15.14	-112.2	47.80	20.30	5.50	1.51	5.10	228.00	8.50	12.60	--	61964	--	Spring	325	01/22/05
Big Spring Snake Valley	38.69892	-114.13223	--	--	--	-15.22	-112.2	48.30	19.50	5.28	1.54	5.50	8.50	234.00	12.70	0.1	63226	SU-2	Spring	325	08/13/05
Big Spring Snake Valley	38.69892	-114.13223	17.2	4.9	7.50	-15.10	-110.3	42.90	20.20	5.34	1.51	5.80	229.00	8.50	12.70	0.1	63569	--	Spring	--	11/08/05
Big Spring Snake Valley	38.69892	-114.13223	16.8	5.2	7.61	-15.17	-111.6	47.50	19.60	5.32	1.50	5.50	229.00	8.60	12.50	0.1	64238	SU-2	Spring	325	02/25/06
Big Spring Snake Valley	38.69892	-114.13223	17.2	5.3	7.43	-15.10	-112.6	49.00	20.30	6.18	2.61	7.30	232.00	9.30	12.80	0.1	64741	SU-2	Spring	325	05/21/06
Big Spring Snake Valley	38.69892	-114.13223	17.3	5.4	7.49	-15.15	-111.8	47.70	20.40	5.20	1.42	5.33	232.00	8.84	12.70	0.1	65291	SU-2	Spring	325	08/24/06
Big Spring Snake Valley	38.69892	-114.13223	17.0	4.8	7.44	-15.20	-111.1	49.70	20.30	5.93	1.45	6.10	232.00	8.50	12.90	0.1	65659	SU-2	Spring	325	10/29/06
Big Spring North	38.65611	-114.63306	20.5	--	7.60	-15.10	-112.0	49.00	19.00	5.30	2.10	6.00	240.00	12.00	21.00	0.2	416	GS193	Spring	211	04/04/85
Big Spring South	38.65417	-114.63306	18.5	--	7.50	-14.80	-111.0	45.00	18.00	5.40	1.90	5.60	200.00	12.00	18.00	0.2	415	GS192	Spring	210	04/04/85
Bishop Spring	37.41854	-114.64169	--	--	--	-11.70	-85.5	--	--	--	--	--	--	--	--	--	208	GS80	Spring	107	02/02/84
Bishop Spring	37.41854	-114.64169	17.5	6.3	7.04	-11.67	-88.0	68.00	24.10	17.10	0.92	13.40	332.00	14.50	54.80	--	58493	--	Spring	107	01/14/04
Bishop Spring	37.41854	-114.64169	18.4	4.6	6.93	-11.78	-88.1	--	--	--	--	--	--	--	--	--	62618	DRI-DR-6	Spring	107	05/20/05
Bitter Spring	36.28500	-114.51417	17.2	4.8	7.58	-9.90	-77.0	--	--	--	--	--	--	--	--	--	22	PL15	Spring	14	02/06/96
Black Rock Spring	37.91204	-114.91906	--	--	--	-12.25	-94.0	--	--	--	--	--	--	--	--	--	313	GS117	Spring	158	03/22/88
Black Rock Spring	37.91204	-114.91906	12.1	8.3	7.60	-12.36	-93.6	36.70	7.98	16.10	4.62	13.90	146.00	15.90	63.60	--	59687	--	Spring	158	03/23/04
Blue Point Spring	36.39000	-114.43306	--	--	--	-12.40	-93.0	--	--	--	--	--	--	--	--	--	49	PL8	Spring	26	06/24/85
Blue Point Spring	36.39000	-114.43306	--	--	--	-12.35	-92.5	--	--	--	--	--	--	--	--	--	47.5	USGS	Spring	26	07/01/85
Blue Point Spring	36.39000	-114.43306	30.0	--	7.80	-12.50	-93.5	470.00	160.00	330.00	23.00	400.00	160.00	1900.00	16.00	1.5	48	GS15	Spring	26	07/01/85
Blue Point Spring	36.39000	-114.43306	29.6	2.7	7.05	-12.30	-91.0	--	--	--	--	--	--	--	--	--	47	PL8	Spring	26	02/08/96
Blue Point Springs	36.39000	-114.43306	--	--	--	-12.47	-93.0	--	--	--	--	--	--	--	--	--	USGS	--	spring	--	06/05/03
Blue Rock Spring	38.15344	-114.35401	--	--	--	-12.68	-93.4	--	--	--	--	--	--	--	--	--	--	--	Spring	311	04/28/04
Boulder Spring (KSV-4)	37.31436	-114.67261	--	--	--	-12.00	-87.5	--	--	--	--	--	--	--	--	--	196	Kirk1027	Spring	98	--
Boulder Spring (KSV-4)	37.31436	-114.67261	16.8	--	7.90	-12.60	-87.0	21.00	4.90	12.00	2.30	7.80	100.00	6.00	41.00	1.7	198	GS74	Spring	98	02/02/84
Boulder Spring (KSV-4)	37.31436	-114.67261	5.0	8.8	7.36	-12.60	-91.0	19.40	4.46	11.40	0.26	6.60	88.90	5.70	42.80	--	58491		Spring	98	01/13/04
Boulder Spring (KSV-4)	37.31436	-114.67261	13.6	7.7	7.59	-12.66	-91.3	21.20	3.78	55.20	4.08	25.00	138.00	34.80	65.30	--	62394	DRI-DR-3	Spring	98	04/27/05
Big Tom Plain Spring	39.08701	-115.37737	7.4	6.1	6.70	-15.92	-121.1	--	--	--	--	--	--	--	--	--	62713	DRI-WP-8	Spring	326	06/06/05
Bradshaw Well	37.34917	-114.54389	14.8	--	7.30	-11.40	-88.5	85.00	28.00	120.00	11.00	52.00	550.00	76.00	63.00	2.3	202	GS76	Well	102	02/01/84
Brady Spring	38.32746	-115.47509	10.3	--	--	-15.38	-108.5	82.80	8.45	2.90	1.01	0.80	292.00	2.90	13.80	--	57754	--	Spring	282	10/28/03
Brady Spring (duplicate sample)	38.32746	-115.47509	--	--	--	-15.38	-110.4	--	--	--	--	--	--	--	--	--	57754	--	Spring	282	10/28/03
Buckboard Spring	37.58886	-114.63111	14.7	7.1	7.70	-11.71	-88.2	45.10	8.31	17.30	2.05	13.90	182.00	10.60	45.50	--	59697	--	Spring	264	03/26/04
Burnt Canyon Spring (Unnamed Spring in Burnt Canyon)	38.28944	-114.20889	11.0	--	7.60	-12.30	-93.0	35.00	7.70	8.10	0.50	5.20	140.00	8.20	38.00	0.1	356	GS140	Spring	187	06/05/85

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Butcher Spring	38.03035	-114.01531	10.1	7.6	7.10	-14.22	-103.2	25.50	5.44	10.80	1.01	18.10	78.30	10.90	26.90	0.2	64910	MG-7	Spring	424	06/23/06
Butte Spring	39.75816	-115.24246	13.7	7.4	6.89	-15.79	-120.4	--	--	--	--	--	--	--	--	--	62619	DRI-BT-1	Spring	327	05/24/05
Byron Well	36.58368	-114.64163	--	--	--	-13.27	-97.1	--	--	--	--	--	--	--	--	--	108503	SNWA	Well	623	01/28/05
Butterfield Spring	38.43972	-115.01083	16.5	6.1	7.31	-14.20	-105.0	47.00	22.00	6.00	2.50	4.70	260.00	8.00	23.00	0.1	384	GS163	Spring	202	07/19/81
Caliente City Well	37.61583	-114.51333	14.3	--	--	-12.40	-89.0	--	--	--	--	--	--	--	--	--	263	GS95	Well	124	01/31/84
Cabin Spring	39.75790	-115.27245	11.0	8.7	7.00	-15.89	-124.4	--	--	--	--	--	--	--	--	--	62708	DRI-BT-7	Spring	328	06/05/05
Cain Springs	39.54258	-114.22588	14.9	4.5	6.92	-10.85	-98.4	191.00	53.60	117.00	0.85	352.00	322.00	162.00	34.70	0.3	63282	--	Spring	400	08/26/05
Caliente Hot Springs (Hotel)	37.62111	-114.51042	45.0	--	7.80	-14.50	-109.0	37.00	7.30	49.00	19.00	13.00	222.00	34.00	130.00	1.4	270	GS99	Spring	129	04/10/85
Caliente Hot Springs (Hotel)	37.62111	-114.51042	40.7	4.4	8.17	-14.52	-106.4	35.00	7.34	50.10	18.70	14.50	213.00	37.20	128.00	--	61621	--	Spring	129	10/20/04
Caliente Hot Springs (Hotel)	37.62111	-114.51042	40.4	4.1	8.06	-14.29	-109.3	35.60	7.17	51.80	19.00	14.50	208.00	44.80	119.00	--	61970	--	Spring	129	01/24/05
Caliente Hot Springs (Hotel)	37.62111	-114.51042	41.0	4.0	7.52	-14.43	-107.0	--	--	--	--	--	--	--	--	--	62620	DRI-MW-2	Spring	129	05/19/05
Caliente Hot Springs (Hotel)	37.62111	-114.51042	40.1	2.8	7.62	-14.47	-109.0	--	--	--	--	--	--	--	--	--	63230	DRI-MW-2	Spring	129	08/16/05
Caliente Hot Springs (Hotel)	37.62111	-114.51042	41.5	3.1	7.71	-14.47	-107.2	35.00	7.36	51.20	18.80	13.70	214.00	39.10	122.00	1.5	63572		Spring	129	11/09/05
Caliente Hot Springs (Hotel)	37.62111	-114.51042	39.7	4.5	7.91	-14.42	-107.7	38.40	7.61	52.20	18.90	17.30	215.00	43.60	119.00	1.4	64170	MW-2	Spring	129	02/17/06
Caliente Hot Springs (Hotel)	37.62111	-114.51042	39.9	3.3	7.98	-14.38	-107.3	39.00	7.93	53.60	21.10	18.50	224.00	46.50	118.00	1.4	64744	MW-2	Spring	129	05/22/06
Calpine Test Well 1a	36.54611	-114.80194	30.5	--	--	-13.50	-99.0	--	--	--	--	--	--	--	--	--	999	ECP-1a	Well	43	04/07/00
Camp Creek	38.24361	-114.25222	9.0	--	7.90	-14.00	-102.0	--	--	--	--	--	--	--	--	--	349	E3	Surface	184	04/09/85
Carpenter Spring	38.05000	-115.61167	16.0	--	--	-11.85	-95.0	--	--	--	--	--	--	--	--	--	332	GS126	Spring	171	07/31/85
Cave Spring (Cave Valley)	38.64111	-114.79583	12.0	8.4	7.41	-13.85	-100.0	16.00	2.20	3.10		1.00	62.00	4.50	14.00	<.1	414	GS191	Spring	209	08/02/85
Cave Spring (Cave Valley)	38.64111	-114.79583	--	--	--	-14.16	-104.9	--	--	--	--	--	--	--	--	--	68110	SNWA	Spring	209	08/06/03
Cave Spring (Cave Valley)	38.64111	-114.79583	--	--	--	-13.54	-102.7	--	--	--	--	--	--	--	--	--	88485	SNWA	Spring	209	06/21/04
Cave Spring (Cave Valley)	38.64111	-114.79583	11.7	7.6	7.20	-14.20	-102.2	15.40	2.04	2.57	0.68	1.00	55.40	2.60	16.00	0.1	65057	SC-8	Spring	209	07/14/06
Cave Spring (Clover)	37.52979	-114.24092	18.7	4.7	7.00	-12.21	-90.8	47.80	9.12	26.40	8.41	20.00	219.00	10.80	57.40	--	61101	--	Spring	247	07/31/04
Cave Spring (Clover)	37.52979	-114.24092	18.7	4.7	7.00	-12.53	-94.7	--	--	--	--	--	--	--	--	--	61101B	--	Spring	247	07/31/04
Cave Valley MX	38.46859	-114.86944	--	--	--	-13.94	-105.0	--	--	--	--	--	--	--	--	--	--	USGS	Deep Well	620	07/10/03
Cave Valley Seedling Well	38.58298	-114.79334	--	--	--	-13.75	-104.7	--	--	--	--	--	--	--	--	--	112271	SNWA	Well	625	07/25/05
Cedar Spring	39.77309	-114.21140	14.4	2.8	7.20	-15.52	-121.5	104.00	50.60	16.50	1.60	42.90	208.00	262.00	14.60	0.5	63275	--	Spring	393	08/23/05
Cedar Cabin Spring	38.79689	-114.22339	9.6	9.0	7.55	-14.10	-106.0	62.30	20.20	5.45	1.04	5.00	5.70	272.00	12.00	<.04	62913	SN-4	Spring	380	07/13/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
The Cedars	38.93537	-114.41800	18.7	8.0	8.03	-15.02	-110.3	20.00	1.70	5.88	0.85	2.00	74.90	3.20	20.70	--	61965	--	Spring	329	01/22/05
The Cedars	38.93537	-114.41800	18.9	8.4	7.97	-15.03	-108.1	--	--	--	--	--	--	--	--	--	62621	DRI-SV-1	Spring	329	05/20/05
The Cedars	38.93537	-114.41800	--	--	--	-15.00	-108.6	19.80	1.68	5.85	0.86	2.00	3.30	74.20	20.60	0.3	63225	SV-1	Spring	329	08/12/05
The Cedars	38.93537	-114.41800	18.3	7.3	7.95	-15.00	-108.2	20.10	1.69	5.71	0.82	2.00	73.10	3.30	20.70	0.2	63570		Spring	329	11/08/05
The Cedars	38.93537	-114.41800	18.2	7.7	8.10	-15.02	-108.4	20.10	1.59	5.60	0.84	2.10	74.80	3.40	20.50	0.2	64240	SV-1	Spring	329	02/26/06
The Cedars	38.93537	-114.41800	18.8	8.5	7.90	-15.03	-108.3	20.10	1.67	5.85	1.84	2.10	74.10	3.50	20.80	0.2	64742	SV-1	Spring	329	05/21/06
The Cedars	38.93537	-114.41800	19.9	7.6	8.00	-14.97	-109.4	20.10	1.78	5.43	0.75	2.07	72.10	3.55	20.80	0.2	65369	SV-1	Spring	329	08/30/06
The Cedars	38.93537	-114.41800	18.4	8.3	7.83	-15.05	-109.9	20.00	1.68	5.67	0.82	2.00	72.90	3.40	20.60	0.2	65660	SV-1	Spring	329	10/29/06
CE-DT-4	36.79556	-114.89222	34.0	3.5	7.35	-13.00	-102.5	46.00	19.00	84.00	11.00	35.00	294.00	110.00	33.00	1.9	138	GS52	Well	78	12/23/80
CE-DT-6 Well	36.76778	-114.78694	--	--	--	-13.10	-99.0	--	--	--	--	--	--	--	--	--	130.2	DRI	Well	72	09/28/86
CE-DT-6 Well	36.76778	-114.78694	33.5	3.7	7.16	-12.95	-97.0	58.00	25.00	88.00	11.00	53.00	272.00	160.00	30.00	2.1	130	GS47	Well	72	09/28/86
CE-VF-2 Well	36.87500	-114.94556	--	--	--	-12.95	-101.0	--	--	--	--	--	--	--	--	--	155	USGS	Well	81	02/05/86
CE-VF-2 Well	36.87500	-114.94556	34.0	2.9	7.40	-13.10	-101.0	47.00	21.00	81.00	11.00	34.00	303.00	90.00	34.00	1.7	156	USGS	Well	81	01/06/88
Chicken Spring	39.23885	-115.38886	8.3	5.7	6.60	-16.17	-122.0	--	--	--	--	--	--	--	--	--	62715	DRI-WP-10	Spring	330	06/07/05
Chimney Rock Spring	38.83528	-114.88417	13.0	1.4	6.78	-14.30	-109.0	56.00	6.80	12.00		5.40	207.00	21.00	56.00	0.2	425	GS205	Spring	219	08/01/85
Chimney Rock Spring	38.83528	-114.88417	12.8	0.9	6.73	-14.74	-112.0	39.30	5.51	14.00	8.38	3.30	171.00	10.70	61.10	0.2	65052	ER-26	Spring	219	07/13/06
Circle Wash Spring	39.12170	-115.36929	7.6	7.1	6.20	-15.30	-114.5	--	--	--	--	--	--	--	--	--	62710	DRI-WP-5	Spring	331	06/06/05
Clover Creek Valley Well 232	37.50500	-114.27600	21.5	--	7.80	-11.70	-84.0	60.00	6.00	8.00	3.00	26.00	180.00	13.00	--	0.4	232	E29	Well	114	07/18/75
Clover Creek Valley Well 246	37.58470	-114.25980	26.0	--	7.80	-12.40	-89.0	41.00	6.00	10.00	5.00	17.00	166.00	4.00	--	--	246	E28	Well	120	07/18/75
Cold Spring	37.71370	-115.41016	--	--	--	-12.98	-98.9	49.70	12.10	22.80	1.50	19.40	208.00	22.60	50.70	--	60841	--	Spring	288	06/25/04
Cold Spring, Preston	38.91800	-115.06680	22.0	3.0	7.20	-15.80	-121.0	39.00	19.00	12.00	3.10	13.00	190.00	39.00	20.00	0.3	446	GS221	Spring	230	07/16/81
Cold Spring, Preston	38.91800	-115.06680	21.5	3.0	7.80	-15.80	-126.0	43.00	20.00	13.00	2.90	14.00	190.00	37.00	20.00	0.4	447	GS222	Spring	230	06/16/83
Connor Spring	37.90165	-114.56023	8.4	7.7	7.68	-13.84	-100.6	72.30	25.80	1.48	0.59	2.00	348.00	3.80	8.70	--	60838	--	Spring	283	06/24/04
Corn Creek Spring South	36.43890	-115.35775	21.4	4.0	7.44	-12.88	-95.0	51.00	48.20	9.81	3.02	9.10	401.00	25.10	28.70	--	58503	--	Spring	307	01/17/04
Corn Creek Spring South	36.43890	-115.35775	21.1	3.3	7.26	-12.89	-95.0	47.40	33.70	6.44	2.11	6.90	288.00	18.50	19.50	--	60852	--	Spring	307	06/30/04
Corral Spring (Unnamed Spring)	36.37056	-114.46000	17.0	6.2	7.31	-12.10	-91.5	--	--	--	--	--	--	--	--	--	28	PL13	Spring	19	02/07/96
Cottonwood Spring (Fairview)	38.31204	-114.63476	13.1	4.6	--	-13.40	-102.2	33.80	4.87	17.80	0.80	6.10	161.00	4.70	38.00	--	60848	--	Spring	274	06/29/04
Cottonwood Spring (Black Mtns.)	36.20333	-114.64361	12.6	6.5	7.81	-10.80	-80.0	524.00	220.00	209.00	10.70	63.60	205.00	2410.00	17.40	--	13	PL17	Spring	8	02/06/96
Cottonwood Spring (Delamar)	37.53418	-114.74636	15.5	2.3	7.10	-12.87	-96.9	80.00	9.32	29.50	0.70	17.30	311.00	18.70	48.70	--	59698	--	Spring	265	03/26/04
Cow Camp Spring	36.58361	-115.30722	14.5	--	7.60	-12.60	-90.5	48.00	31.00	21.00	0.70	28.00	290.00	23.00	16.00	0.2	75	GS19	Spring	47	10/28/81
Cow Camp Spring	36.58361	-115.30722	10.0	5.9	7.60	-12.60	-93.0	50.00	35.00	25.00	0.60	29.00	--	29.00	15.00	0.2	77	GS21	Spring	47	05/10/83
Cow Camp Spring	36.58361	-115.30722	16.8	5.1	7.26	-12.46	-92.0	48.90	35.60	26.90	0.55	23.50	312.00	24.60	17.60	--	61105		Spring	47	07/27/04
Cow Camp Spring	36.58361	-115.30722	10.1	8.4	6.96	-12.47	-91.9	52.00	38.00	38.90	0.29	39.90	298.00	48.60	15.10	--	62399	DRI-SR-4	Spring	47	04/28/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Coyote Spring	38.03186	-114.86219	--	--	--	-12.04	-97.2	--	--	--	--	--	--	--	--	--	88474	SNWA	Spring	169	06/21/04
Coyote Spring	38.03186	-114.86219	13.3	4.7	6.76	-12.26	-95.2	75.10	11.40	55.50	10.70	31.70	246.00	105.00	82.70	--	62409	DRI-DL-1	Spring	169	05/01/05
Coyote Spring	38.03186	-114.86219	--	--	--	-12.80	-95.0	--	--	--	--	--	--	--	--	--	330	Kirk1017	Spring	169	--
Crystal Springs	37.53144	-115.23364	--	--	--	--	-109.0	--	--	--	--	--	--	--	--	--	--	Win	Spring	116	08/01/68
Crystal Springs	37.53144	-115.23364	--	--	--	--	-110.0	--	--	--	--	--	--	--	--	--	--	Win	Spring	116	01/01/69
Crystal Springs	37.53144	-115.23364	--	--	--	--	-109.0	--	--	--	--	--	--	--	--	--	--	Win	Spring	116	03/01/70
Crystal Springs	37.53144	-115.23364	27.5	1.8	7.34	-14.30	-109.0	43.00	21.00	22.00	5.00	8.90	260.00	34.00	25.00	0.3	235	GS87	Spring	116	07/20/81
Crystal Springs	37.53144	-115.23364	26.5	--	7.40	-14.38	-108.4	44.00	22.00	24.00	5.40	8.60	248.00	32.00	24.00	0.3	238	GS90	Spring	116	08/16/94
Crystal Springs	37.53144	-115.23364	28.0	--	7.74	-14.39	-106.9	44.16	22.56	23.84	4.83	9.60	255.00	34.70	24.74	0.4	239	IT120	Spring	116	08/07/95
Crystal Springs	37.53162	-115.23363	--	--	--	-14.32	-108.0	--	--	--	--	--	--	--	--	--	USGS	--	Spring	116	06/03/03
Crystal Springs	37.53144	-115.23364	--	--	--	-14.23	-111.0	--	--	--	--	--	--	--	--	--	84392	SNWA	Spring	116	05/24/04
Crystal Springs	37.53144	-115.23364	27.3	5.1	7.25	-14.36	-109.2	43.10	22.20	23.60	5.26	8.70	255.00	32.30	26.40	--	61106	--	Spring	116	07/30/04
Crystal Springs	37.53144	-115.23364	27.3	1.3	7.59	-14.41	-109.0	45.30	22.40	24.20	5.28	9.10	240.00	33.60	26.60	--	61618	--	Spring	116	10/20/04
Crystal Springs	37.53144	-115.23364	27.2	1.3	7.50	-14.35	-109.4	45.60	22.00	24.10	5.18	8.80	247.00	33.20	25.20	--	61971	--	Spring	116	01/24/05
Crystal Springs	37.53144	-115.23364	27.1	1.3	7.26	-14.44	-107.3	--	--	--	--	--	--	--	--	--	62622	DRI-PV-2	Spring	116	05/18/05
Crystal Springs	37.53144	-115.23364	27.0	1.3	6.92	-14.46	-109.3	--	--	--	--	--	--	--	--	--	63229	DRI-PV-2	Spring	116	08/14/05
Crystal Spring	37.53144	-115.23364	27.1	1.3	7.38	-14.42	-110.1	45.70	22.20	23.80	5.10	9.30	248.00	33.10	25.00	0.3	63574	--	Spring	116	11/09/05
Crystal Spring	37.53181	-115.23383	27.1	1.4	7.43	-14.47	-108.5	45.10	22.10	23.60	5.13	9.30	245.00	33.90	24.70	0.3	65655	PV-2	Spring	116	10/28/06
Crystal Springs	37.53181	-115.23383	27.1	1.3	7.44	-14.53	-108.8	46.30	22.50	24.20	5.35	9.50	247.00	33.80	24.70	0.4	64168	PV-2	Spring	116	02/17/06
Crystal Springs	37.53181	-115.23383	27.2	1.2	7.51	-14.47	-109.5	45.50	21.90	24.00	5.72	9.50	247.00	35.10	25.40	0.4	64746	PV-2	Spring	116	05/22/06
Crystal Springs	37.53181	-115.23383	27.1	1.3	7.42	-14.49	-108.8	45.90	22.60	21.20	4.36	9.07	239.00	34.80	25.00	0.3	65290	PV-2	Spring	116	08/23/06
CSV-2 Well	36.78056	-114.72222	27.0	4.0	7.40	-12.85	-98.0	60.00	27.00	100.00	10.00	61.00	276.00	160.00	30.00	2.3	135	GS51	Well	76	01/26/86
CSV-2 Well	36.78056	-114.72222	--	--	--	-12.99	-97.7	--	--	--	--	--	--	--	--	--	USGS	--	Well	76	07/08/03
CSV-3 Well	36.69083	-114.92500	41.0	--	7.35	-10.35	-75.0	51.00	25.00	38.00	10.00	26.00	239.00	54.00	24.00	1.2	104	GS38	Well	60	10/07/87
CSV-3 Well	36.69083	-114.92500	--	--	--	-10.30	-75.8	--	--	--	--	--	--	--	--	--	121722	SNWA	Well	60	01/26/06
Davies Spring	36.96556	-114.50194	14.3	--	--	-12.50	-89.0	--	--	--	--	--	--	--	--	--	177	GS64	Spring	90	02/06/84
Deadman Spring (Highland)	37.91861	-114.54139	9.5	--	7.10	-13.30	-99.0	98.00	41.00	5.00	0.90	4.20	506.00	8.30	19.00	0.1	319	GS119	Spring	162	04/07/85
Deadman Spring (Highland)	37.91861	-114.54139	27.9	4.9	9.68	-10.83	-90.9	12.20	40.10	4.11	0.43	2.50	143.00	5.40	2.10	--	60837	--	Spring	162	06/24/04
Decathon Spring	38.80738	-114.27884	7.6	7.1	6.89	-14.60	-107.0	111.00	7.58	2.88	0.54	3.40	11.40	325.00	11.30	0.1	62914	SN-5	Spring	381	07/14/05
Deer Spring (White Pine)	38.99498	-115.39136	--	--	--	-15.87	-118.9	--	--	--	--	--	--	--	--	--	JThomas-032304-4	WP-4	Spring	322	10/12/03
Deer Spring (White Pine)	38.99498	-115.39136	9.4	6.3	6.90	-15.87	-119.6	--	--	--	--	--	--	--	--	--	62822	WP-4	Spring	322	06/28/05
Deer Spring (Butte)	39.48683	-115.27559	12.3	6.4	6.30	-14.74	-114.1	--	--	--	--	--	--	--	--	--	62704	DRI-BT-6	Spring	332	06/04/05
Delmues Spring (Unnamed Spring)	37.86000	-114.32222	18.0	--	7.70	-13.40	-104.0	47.00	6.70	30.00	6.30	24.00	180.00	18.00	64.00	0.6	302	GS111	Spring	149	04/08/85
Desert Valley (Dry Lake) Well #1	36.95306	-115.19750	19.0	2.8	7.97	-13.10	-98.0	22.00	27.00	35.00	5.70	8.90	413.00	48.00	49.00	0.6	171	GS61	Well	87	03/18/87
Dipping Tank Spring	39.77522	-114.47512	12.0	7.8	6.83	-15.74	-119.8	47.50	8.37	16.20	2.01	18.00	167.00	14.60	30.70	0.1	63280	--	Spring	398	08/25/05
DLLLC Hidden Valley	36.49340	-114.92657	--	--	--	-12.90	-97.0	--	--	--	--	--	--	--	--	--	999	HV-1	Well	37	06/05/00
Dodge Well	38.24444	-114.54250	17.0	--	--	-14.20	-107.0	--	--	--	--	--	--	--	--	--	350	GS137	Well	185	06/07/85
Douglas Spring	38.85003	-115.14867	--	--	--	-13.01	-106.4	--	--	--	--	--	--	--	--	--	112274	SNWA	Spring	626	07/26/05
Dry Lake Valley Well	36.45500	-114.84389	29.0	2.0	7.27	-13.30	-97.5	110.00	48.00	120.00	13.00	170.00	210.00	360.00	21.00	2.1	64	GS17	Well	34	07/01/85

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
East Settling Spring	37.37315	-114.23282	--	--	--	-12.76	-92.2	--	--	--	--	--	--	--	--	--	61100B	--	Spring	248	07/31/04
Easter Spring	39.04120	-115.34883	11.1	6.7	7.30	-15.56	-119.4	--	--	--	--	--	--	--	--	--	62823	WP-23	Spring	365	06/29/05
EH-3 Weiser Wash	36.69222	-114.52556	24.1	--	7.80	-12.70	-91.0	511.00	201.00	170.00	22.00	194.00	123.00	2100.00	15.00	--	--	4	Well	61	averages
EH-4 Weiser Wash	36.70639	-114.71611	22.8	0.0	8.30	-13.00	-98.0	49.00	30.00	90.00	12.00	57.00	245.00	171.00	28.00	0.0	AVG	--	Well	63	averages
EH-6 Weiser Wash	36.68167	-114.57000	24.8	0.0	7.70	-13.90	-99.5	341.00	131.00	274.00	31.00	41.00	178.00	1800.00	13.00	0.0	AVG	--	Well	59	averages
EH-7	36.67056	-114.53139	21.0	--	7.33	-12.45	-91.0	470.00	190.00	170.00	20.00	65.00	--	2000.00	15.00	0.9	99	GS35	Well	56	03/19/87
EH-8 Weiser Wash	36.67389	-114.57583	0.0	0.0	7.60	-13.70	-96.5	375.00	104.00	416.00	22.00	233.00	162.00	1780.00	26.00	0.0	AVG	--	Well	57	averages
Eightmile Spring	37.46466	-115.06440	17.9	6.7	7.23	-13.12	-96.7	45.00	9.15	13.20	1.49	10.60	189.00	8.90	43.20	0.0	61103	--	Spring	295	07/30/04
Eightmile Spring	37.46466	-115.06440	14.4	6.7	7.35	-13.06	-94.4	52.20	9.90	17.80	1.07	16.20	195.00	14.80	37.60	0.0	61106C	DRI-PR-11	Spring	295	04/30/05
Eight Mile Spring (Snake Range)	39.38830	-114.28433	11.1	7.7	7.02	-15.53	-116.3	77.80	18.30	5.74	0.86	4.70	307.00	9.50	12.60	<.05	63284	SN-32	Spring	402	08/26/05
Eight Mile Spring (Snake Range)	39.38830	-114.28433	11.0	7.1	7.31	-15.38	-114.8	79.70	18.50	5.28	0.76	4.86	306.00	9.59	12.40	0.1	65421	SN-32	Spring	402	09/17/06
Eight Mile Spring (Snake Range)	39.38830	-114.28433	11.5	7.5	7.36	-15.40	-114.3	80.20	18.70	5.79	0.81	4.81	333.00	8.96	11.40	0.1	68482	SN-32	Spring	496	06/02/08
Eight Mile Spring (Snake Range)	39.38830	-114.28433	11.4	6.9	7.39	-15.46	-112.0	78.40	18.70	5.76	0.83	4.61	330.00	9.02	12.00	0.0	68915	SN-32	Spring	496	09/12/08
Eight Mile Spring (Snake Range)	39.38830	-114.28433	11.4	7.5	7.31	-15.39	-115.7	78.90	18.80	5.78	0.84	4.65	322.00	8.87	11.60	0.1	69146	SN-32	Spring	496	11/01/08
Eight Mile Spring (Snake Range)	39.38830	-114.28433	--	--	--	-15.30	-114.8	79.70	18.50	5.58	0.73	4.74	316.00	8.43	12.20	0.1	69867	SN-32	Spring	496	08/15/09
Eight Mile Spring (Snake Range)	39.38830	-114.28433	--	--	--	-15.45	-115.6	77.90	17.70	5.79	0.82	4.93	329.00	9.01	11.50	0.0	70617	SN-32	Spring	496	11/17/09
Ella Spring	37.49072	-114.44835	7.5	3.6	7.70	-12.56	-95.8	44.20	8.55	11.10	1.84	7.00	170.00	8.80	27.10	--	59702	--	Spring	251	03/27/04
Emigrant Spring	38.62500	-115.04778	19.5	5.2	7.14	-14.50	-108.0	67.00	24.00	5.30	1.60	2.90	300.00	14.00	13.00	0.2	410	GS188	Spring	207	07/18/81
Emigrant Spring	38.62500	-115.04778	20.1	--	--	--	-107.5	--	--	--	--	--	--	--	--	--	411	GS189	Spring	207	01/17/84
Fence Spring	38.17978	-114.71593	--	--	--	-12.55	-97.4	--	--	--	--	--	--	--	--	--	--	--	Spring	278	06/29/04
Flag Spring #3	38.42139	-115.02222	22.8	-	7.50	-14.30	-105.0	50.00	21.00	10.00	3.40	6.60	270.00	12.00	26.00	0.2	380	GS161	Spring	201	01/17/84
Flatnose Spring (Unnamed Spring)	37.89611	-114.22583	25.0	--	8.00	-13.40	-101.0	26.00	3.50	34.00	5.60	10.00	146.00	18.00	55.00	1.3	306	GS113	Spring	153	04/08/85
Forest Home Spring (Unnamed Spring)	38.37750	-115.37528	14.0	5.3	7.63	-14.50	-108.5	62.00	26.00	9.90	--	6.90	309.00	19.00	14.00	<.1	368	GS152	Spring	195	07/24/85
Four Mile Spring	39.30724	-114.29803	9.4	6.5	7.23	-14.75	-112.5	85.50	33.70	8.88	1.18	7.49	375.00	40.20	15.80	0.1	65413	SN-25	Spring	488	09/16/06
Fox Cabin	38.16267	-114.65034	--	--	--	-13.59	-103.5	--	--	--	--	--	--	--	--	--	--	--	Spring	273	06/29/04
Fugro CV Deep Well CE-DT-5	36.79556	-114.89222	35.5	2.3	7.15	-12.90	-99.5	46.00	20.00	78.00	11.00	34.00	300.00	100.00	33.00	1.9	139	GS53	Well	77	07/22/81
Fugro CV Deep Well CE-DT-6	36.79556	-114.89222	--	--	--	-13.16	-100.1	--	--	--	--	--	--	--	--	--	65461	SNWA	Well	77	04/08/03
Fugro CV Deep Well CE-DT-5	36.79556	-114.89222	--	--	--	-12.99	-99.6	--	--	--	--	--	--	--	--	--	USGS	--	Well	77	05/28/03
Fugro CV Deep Well CE-DT-5	36.79556	-114.89222	--	--	--	-12.99	-99.6	--	--	--	--	--	--	--	--	--	USGS	--	Deep Well	77	02/16/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Fugro Dry Lake V Deep Well	38.14583	-114.89333	27.5	3.2	7.08	-14.20	-108.0	73.00	29.00	20.00	6.90	6.20	--	27.00	25.00	0.5	343	GS133	Well	179	12/10/80
Fugro Dry Lake V Deep Well	38.14583	-114.89333	--	--	--	-14.11	-107.0	--	--	--	--	--	--	--	--	--	USGS	--	Well	179	06/19/03
Fugro Steptoe V Deep Well	38.92000	-114.84528	11.0	5.5	7.50	-14.90	-117.0	66.00	14.00	15.00	4.40	12.00	--	57.00	28.00	0.4	443	GS218	Well	228	01/19/81
Garden Spring	37.26425	-114.28869	8.8	6.5	7.06	-11.54	-87.0	--	--	--	--	--	--	--	--	--	58500	--	Spring	246	01/15/04
Geyser Spring	38.68000	-114.66556	12.5	--	7.80	-14.50	-105.0	--	--	--	--	--	--	--	--	--	419	E1	Spring	213	04/03/85
Gourd Spring	36.95861	-114.29167	E16.	--	--	-10.60	-77.5	--	--	--	--	--	--	--	--	--	175	GS63	Spring	89	02/06/84
GP Apex Well	36.34111	-114.92667	--	--	--	-13.35	-97.5	--	--	--	--	--	--	--	--	--	999	Jim	Well	17	09/29/86
GP Apex Well	36.34111	-114.92667	31.0	5.5	6.96	-13.45	-98.0	120.00	47.00	130.00	13.00	200.00		380.00	23.00	1.4	24	PLC23	Well	17	09/30/86
GP Apex Well	36.34111	-114.92667	--	--	--	-13.80	-96.0	--	--	--	--	--	226.00	--	--	--	25	GS8	Well	17	09/30/86
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	27.0	492.0	7.23	-15.83	-119.6	49.80	16.80	29.30	3.94	23.90	245.00	22.10	23.10	--	61482	--	Spring	333	09/24/04
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	26.9	6.3	7.71	-15.88	-120.0	50.70	17.10	29.10	3.92	23.60	236.00	22.60	22.80	--	61963	--	Spring	333	01/22/05
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	--	--	--	-15.83	-119.4	--	--	--	--	--	--	--	--	--	62623	--	Spring	333	05/23/05
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	--	--	--	-15.93	-119.8	49.90	16.40	28.40	3.86	23.60	22.20	240.00	22.30	0.2	63224	SU-1	Spring	333	08/12/05
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	26.6	4.9	7.52	-15.90	-122.8	47.30	17.00	28.50	3.91	22.80	235.00	22.50	22.70	0.6	63568	--	Spring	333	11/08/05
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	26.8	5.5	7.58	-15.96	-119.5	50.80	16.20	28.20	3.89	23.70	236.00	22.80	22.50	0.7	64237	SU-1	Spring	333	02/25/06
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	27.3	5.8	7.55	-16.00	-121.2	50.40	16.60	28.80	4.92	24.20	236.00	23.50	23.00	0.6	64740	SU-1	Spring	333	05/21/06
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	26.7	5.8	7.59	-15.88	-120.4	51.20	17.00	24.10	3.01	24.40	247.00	22.80	21.80	0.6	65292	SU-1	Spring	333	08/25/06
Gandy Warm Spring (Warm Spring Near Gandy)	39.46000	-114.03707	26.9	5.7	7.56	-15.91	-120.3	51.10	17.10	28.60	3.85	24.10	233.00	22.70	22.40	0.6	65658	SU-1	Spring	333	10/29/06
Granite Spring	38.56271	-114.91658	11.8	5.8	6.83	-13.32	-103.4	44.60	10.90	16.60	2.92	12.60	186.00	17.20	57.30	0.2	65049	ER-23	Spring	440	07/13/06
Grapevine Spring (KSV-2)	37.12988	-114.70972	--	--	--	-11.60	-88.0	--	--	--	--	--	--	--	--	--	183	Kirk1028	Spring	93	--
Grapevine Spring (KSV-2)	37.12988	-114.70972	18.5	--	7.30	-12.00	-87.5	75.00	22.00	17.00	2.30	27.00	280.00	40.00	22.00	0.9	185	GS69	Spring	93	02/03/84
Grapevine Spring (KSV-2)	37.12988	-114.70972	18.2	2.4	7.56	-11.90	-88.6	77.20	17.30	20.20	2.90	31.40	236.00	44.50	28.30	--	62396	DRI-MM-1	Spring	93	04/27/05
Grapevine Spring (KSV-2)	37.12988	-114.70972	--	--	--	-11.95	-85.2	77.50	17.90	18.70	2.38	32.70	245.00	46.70	27.30	0.3	63223	DRI-MM-1	Spring	93	08/16/05
Grapevine Spring (KSV-2)	37.12988	-114.70972	18.3	5.7	7.71	-11.89	-87.7	79.20	17.60	18.10	2.62	30.10	244.00	42.80	26.80	0.7	63573	--	Spring	93	11/09/05
Grapevine Spring WR7	37.12988	-114.70972	12.1	4.9	7.50	-12.00	-87.3	76.30	18.00	18.00	1.95	32.10	228.00	44.80	24.20	0.7	64171	MM-1	Spring	93	02/16/06
Grapevine Spring WR7	37.12988	-114.70972	18.8	1.3	7.30	-11.92	-87.3	76.70	17.70	16.80	2.55	28.00	248.00	40.00	26.70	0.7	64745	MM-1	Spring	93	05/22/06
Grapevine Spring WR7	37.12988	-114.70972	20.7	2.6	7.14	-12.00	-87.4	73.40	18.50	16.70	1.96	31.00	233.00	45.60	24.80	0.7	65288	MM-1	Spring	93	08/23/06
Grapevine Spring WR7	37.12988	-114.70972	17.3	2.9	7.28	-11.93	-87.2	74.00	18.50	18.10	2.05	29.60	228.00	44.70	24.10	0.7	65665	MM-1	Spring	93	10/30/06
Grapevine Spring WR7	37.12988	-114.70972	--	--	--	-12.03	-87.5	--	--	--	--	--	--	--	--	--	--	MM-1	Spring	93	05/09/07
Grass Valley Springs	39.71321	-114.23300	9.2	6.0	6.35	-16.72	-124.7	18.00	3.26	12.30	0.94	5.90	81.00	5.10	26.60	0.1	63274		Spring	392	08/23/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Gubler Canyon Creek Spring (Unnamed Spring in Gubler Canyon)	39.13389	-114.96139	12.5	--	--	-14.90	-111.0	--	--	--	--	2.40	--	--	--	--	457	GS243	Spring	235	06/16/83
Hackberry Spring	36.91778	-114.43778	10.0	--	--	-12.30	-87.0	--	--	--	--	--	--	--	--	--	162	GS58	Spring	84	02/05/84
Haggerty Spring	38.66930	-114.90482	11.9	6.0	6.85	-14.78	-109.6	69.70	13.00	3.94	0.76	2.80	259.00	7.00	10.60	--	62979	ER-9	Spring	387	07/31/05
Headwaters Spring WR5	38.36575	-114.31935	9.6	6.5	7.00	-14.65	-106.9	10.40	2.41	4.47	1.31	4.50	37.10	4.70	19.10	--	60311	--	Spring	309	05/19/04
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.67	-108.7	--	--	--	--	--	--	--	--	--	60311B	--	Spring	309	07/18/04
Headwaters Spring WR5	38.36575	-114.31935	8.2	7.1	6.85	-14.67	-108.8	11.20	2.51	4.79	1.21	4.20	37.20	4.40	20.40	--	61481	--	Spring	309	09/23/04
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-15.01	-110.4	--	--	--	--	--	--	--	--	--	62970	--	Spring	309	07/27/05
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.99	-109.6	11.80	2.54	4.88	1.21	4.70	3.40	44.30	21.10	0.2	63221	WC-1	Spring	309	08/13/05
Headwaters Spring WR5	38.36575	-114.31935	9.5	6.0	6.36	-14.71	-107.8	13.80	3.00	5.43	1.34	6.20	46.90	4.40	21.40	0.1	63565		Spring	309	11/07/05
Headwaters Spring WR5	38.36575	-114.31935	9.3	6.3	6.54	-14.52	-106.3	11.40	2.57	5.21	1.27	3.70	45.00	3.70	22.00	0.1	64737	WC-1	Spring	309	05/23/06
Headwaters Spring WR5	38.36575	-114.31935	12.1	6.1	6.37	-14.59	-107.7	10.70	2.46	5.04	1.29	4.48	43.20	4.08	21.20	0.1	65370	WC-1	Spring	309	08/31/06
Headwaters Spring WR5	38.36575	-114.31935	8.9	7.1	6.50	-14.47	-107.3	11.50	2.68	5.28	1.30	4.41	41.10	4.03	21.50	0.1	65744	WC-1	Spring	309	11/16/06
WR 5 Autosampler	38.36575	-114.31935	--	--	--	-14.61	-107.6	--	--	--	--	--	--	--	--	--	DRI-65370-9	WC-1	Spring	309	12/01/05
WR 5 Autosampler	38.36575	-114.31935	--	--	--	-14.70	-108.6	--	--	--	--	--	--	--	--	--	DRI-65370-12	WC-1	Spring	309	01/01/06
WR 5 Autosampler	38.36575	-114.31935	--	--	--	-14.52	-107.7	--	--	--	--	--	--	--	--	--	DRI-65370-14	WC-1	Spring	309	02/01/06
WR 5 Autosampler	38.36575	-114.31935	--	--	--	-14.34	-105.7	--	--	--	--	--	--	--	--	--	DRI-65370-16	WC-1	Spring	309	03/01/06
WR 5 Autosampler	38.36575	-114.31935	--	--	--	-14.36	-105.5	--	--	--	--	--	--	--	--	--	DRI-65370-20	WC-1	Spring	309	05/01/06
WR5 Autosample 1	38.36575	-114.31935	--	--	--	-14.53	-105.7	--	--	--	--	--	--	--	--	--	65744 Auto1	WC-1	Spring	309	09/01/06
WR5 Autosample 5	38.36575	-114.31935	--	--	--	-14.10	-105.4	--	--	--	--	--	--	--	--	--	65744 Auto5	WC-1	Spring	309	11/01/06
Headwaters Spring WR5	38.36575	-114.31935	8.5	NA	6.24	-14.24	-105.0	10.60	2.41	4.62	1.24	3.10	41.80	3.50	19.40	0.1	65744	WC-1	Spring	309	05/07/07
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.33	-105.2	--	--	--	--	--	--	--	--	--	67249A	WC-1	Spring	309	06/01/07
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.21	-104.5	--	--	--	--	--	--	--	--	--	67249B	WC-1	Spring	309	07/01/07
Headwaters Spring WR5	38.36575	-114.31935	12.8	4.3	6.30	-14.32	-106.4	10.30	2.35	5.37	1.39	3.64	43.80	3.71	19.60	<.1	67249	WC-1	Spring	309	08/20/07
Headwaters Spring WR5	38.36575	-114.31935	10.1	5.5	6.40	-14.32	-105.3	10.30	2.33	4.81	1.18	3.80	40.80	3.60	18.90	0.1	67507	WC-1	Spring	309	11/02/07
Headwaters Spring WR5	38.36575	-114.31935	9.2	5.5	6.29	-14.30	-105.4	9.72	2.28	4.46	1.16	3.40	38.20	3.58	19.40	0.1	68475	WC-1	Spring	309	05/30/08
Headwaters Spring WR5	38.36575	-114.31935	11.5	6.4	6.32	-14.44	-104.9	9.94	2.40	4.53	1.26	3.72	38.70	3.72	20.30	0.1	68912	WC-1	Spring	309	09/11/08
Headwaters Spring WR5	38.36575	-114.31935	10.1	6.8	6.24	-14.44	-106.4	10.10	2.38	4.48	1.32	3.75	47.00	3.61	19.20	0.1	69143	WC-1	Spring	309	10/30/08
Headwaters Spring WR5	38.36575	-114.31935	9.0	7.3	6.17	-13.98	-103.4	10.10	2.42	4.51	1.29	3.47	40.30	3.70	19.00	0.1	69859	WC-1	Spring	309	05/18/09
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.14	-103.8	10.20	2.36	4.54	1.29	3.85	39.60	3.72	20.30	0.1	69859	WC-1	Spring	309	08/17/09
Headwaters Spring WR5	38.36575	-114.31935	--	--	--	-14.27	-104.7	9.70	2.25	4.52	1.20	4.08	38.20	3.75	18.60	0.1	70611	WC-1	Spring	309	11/14/09
Hells Acres Gulch Spring (Unnamed Spring in Hells Acres Gulch)	37.46028	-115.12472	13.0	--	8.30	-12.30	-93.0	45.20	9.03	20.70	2.38	8.20	198.00	19.90	39.00	--	211	K9	Spring	109	01/14/85
Henry Spring	37.68990	-115.37391	--	--	--	-12.77	-97.4	--	--	--	--	--	--	--	--	--	--	--	Spring	287	06/25/04
High Springs	39.13012	-114.95041	7.4	6.5	7.50	-15.43	-113.4	66.20	10.10	3.65	0.91	0.80	232.00	17.90	10.40	0.1	65042	ER-16	Spring	433	07/12/06
Highland Spring	37.92110	-114.54923	10.0	--	7.20	-13.30	-98.5	86.00	36.00	4.70	1.00	4.40	474.00	8.10	15.00	0.1	320	GS120	Spring	163	04/07/85
Highland Spring	37.92110	-114.54923	11.6	5.8	7.35	-13.49	-99.6	77.10	35.90	3.71	0.71	3.70	413.00	6.20	15.30	--	60839	--	Spring	163	06/24/04
Highland Spring	37.92110	-114.54923	10.2	7.3	6.79	-13.30	-99.3	82.90	35.10	4.34	0.64	3.40	403.00	5.90	16.10	--	62408	DRI-HR-1	Spring	163	05/01/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Hiko Spring	37.59833	-115.21444	--	--	--	-13.80	-109.0	--	--	--	--	--	--	--	--	--	249	PLC12	Spring	122	--
Hiko Spring	37.59833	-115.21444	--	--	--	--	-110.5	--	--	--	--	--	--	--	--	--	254	IT127	Spring	122	08/01/68
Hiko Spring	37.59833	-115.21444	--	--	--	--	-109.5	--	--	--	--	--	--	--	--	--	255	IT128	Spring	122	01/01/69
Hiko Spring	37.59833	-115.21444	--	--	--	--	-109.5	--	--	--	--	--	--	--	--	--	256	IT129	Spring	122	03/01/70
Hiko Spring	37.59833	-115.21444	26.0	--	7.40	-15.30	-110.0	49.0	23.00	26.00	7.40	11.00	282.00	37.00	30.00	0.6	251	IT124	Spring	122	01/14/85
Hiko Spring	37.59833	-115.21444	--	--	--	-14.00	-105.0	--	--	--	--	--	--	--	--	--	257	IT130	Spring	122	01/14/85
Hiko Spring	37.59833	-115.21444	26.5	--	7.73	-14.45	-107.7	46.40	23.33	25.57	6.63	11.00	273.00	38.10	33.08	0.5	252	IT125	Spring	122	08/07/95
Hole in the Bank Spring	38.84915	-114.89566	6.9	7.9	6.64	-15.37	-114.9	43.70	11.00	12.40	2.95	5.10	195.00	10.50	50.60	0.1	62977	ER-8	Spring	386	07/31/05
Horse Spring (Morman)	36.94139	-114.44639	--	--	--	-12.70	-89.0	--	--	--	--	--	--	--	--	--	167	GS59	Spring	85	02/05/84
Horse Spring (Grant)	38.32951	-115.38580	14.7	7.2	7.10	-12.86	-99.5	--	--	--	--	--	--	--	--	--	62829	GR-3	Spring	370	06/30/05
Horsethief Spring	38.02649	-114.24511	11.7	1.6	6.92	-12.73	-96.3	56.60	7.96	16.50	1.22	18.60	206.00	13.00	50.10	--	60314	--	Spring	314	05/20/04
Horsethief Spring	38.02649	-114.24511	9.7	1.9	6.39	-12.62	-97.6	76.50	10.60	27.60	0.50	19.50	293.00	13.50	60.30	--	62406	DRI-WC-6	Spring	314	05/01/05
Hot Creek Campground Well	38.38833	-115.13278	19.0	--	--	-15.30	-118.0	--	--	--	--	--	--	--	--	--	374	GS155	Well	198	07/19/81
Hot Creek Springs	38.38251	-115.15451	32.5	1.0	7.22	-15.50	-118.0	59.00	21.00	24.00	5.50	10.00	--	46.00	28.00	0.9	372	GS153	Spring	197	07/19/81
Hot Creek Springs	38.38251	-115.15451	--	--	--	-15.82	-120.0	--	--	--	--	--	--	--	--	--	68113	SNWA	Spring	197	08/08/03
Hot Creek Springs	38.38251	-115.15451	--	--	--	-15.51	-120.1	--	--	--	--	--	--	--	--	--	88477	SNWA	Spring	197	06/23/04
Hot Creek Springs	38.38251	-115.15451	31.8	1.3	7.17	-15.71	-120.5	57.90	22.10	24.90	4.82	10.10	282.00	43.90	28.20	--	61484	--	Spring	197	09/25/04
Hot Creek Springs	38.38251	-115.15451	31.3	1.4	7.33	-15.66	-119.0	59.00	22.20	25.00	5.28	10.00	272.00	45.50	27.80	--	61972	--	Spring	197	01/24/05
Hot Creek Springs	38.38251	-115.15451	31.2	1.6	7.05	-15.66	-118.6	--	--	--	--	--	--	--	--	--	62624	DRI-WV-2	Spring	197	05/18/05
Hot Creek Springs	38.38251	-115.15451	31.3	1.6	6.77	-15.70	-117.4	--	--	--	--	--	--	--	--		63228	DRI-WV-2	Spring	197	08/14/05
Hot Creek Spring	38.38251	-115.15451	30.9	1.5	7.33	-15.73	-119.1	59.70	22.40	24.30	5.03	10.00	273.00	45.10	27.70	1.0	63564	--	Spring	197	11/06/05
Hot Creek Spring	38.38251	-115.15451	31.3	1.9	7.32	-15.77	-119.2	58.70	22.10	24.50	5.22	10.20	269.00	45.40	27.80	1.0	65656	WV-2	Spring	197	10/28/06
Hot Creek Springs	38.38251	-115.15451	31.3	1.1	7.29	-15.75	-118.4	59.50	21.50	24.30	5.14	10.10	271.00	45.20	28.80	1.0	64234	WV-2	Spring	197	02/17/06
Hot Creek Springs	38.38251	-115.15451	31.7	1.5	7.36	-15.67	-120.1	59.60	21.60	25.20	5.15	10.60	269.00	47.00	28.40	1.0	64736	WV-2	Spring	197	05/22/06
Hot Creek Springs	38.38251	-115.15451	31.4	1.3	7.30	-15.75	-119.0	59.30	22.30	22.30	4.53	10.10	268.00	46.00	27.70	1.0	65367	WV-2	Spring	197	08/29/06
Indian Spring (N Jakes V)	39.44040	-115.31884	--	--	--	-15.25	-118.4	--	--	--	--	--	--	--	--	--	92573	SNWA	Spring	334	07/27/04
Indian Spring (N Jakes V)	39.44040	-115.31884	11.3	7.9	7.10	-15.31	-119.1	--	--	--	--	--	--	--	--	--	62709	DRI-BT-8	Spring	334	06/05/05
Indian Springs (S Springs V)	38.64160	-114.44957	--	--	--	-14.16	-106.3	26.30	4.10	12.70	4.56	9.40	114.00	6.70	72.80	0.1	62974	FO-1	Spring	375	07/29/05
Iverson's Spring	36.71028	-114.71194	--	--	--	--	-97.0	--	--	--	--	--	--	--	--	--	111	PLC18	Spring	65	--
Jenson Well	37.18417	-114.46444	18.0	--	7.70	-11.60	-88.5	55.00	14.00	100.00	7.20	45.00	340.00	80.00	56.00	2.1	187	GS70	Well	95	04/10/85
John Wadsworth	37.76861	-114.40694	14.5	--	7.50	-12.90	-101.0	120.00	47.00	150.00	9.50	88.00	601.00	200.00	76.00	6.5	286	GS101	Well	140	06/04/85
Johnson Spring	39.92319	-114.98923	10.2	9.0	7.54	-15.94	-123.4	--	--	--	--	--	--	--	--	--	62625	DRI-CC-1	Spring	335	05/24/05
Jones Spring Pumphouse	36.71116	-114.71694	27.2	5.3	7.44	-12.99	-98.9	63.40	27.40	95.70	11.10	63.10	252.00	178.00	29.50	--	62033		Spring	293	02/10/05
Jones Spring Pumphouse	36.71116	-114.71694	32.0	3.9	7.00	-12.99	-97.8	63.70	27.30	96.00	11.20	61.90	256.00	174.00	31.40	2.2	62034	DRI-MV-6	Spring	293	06/08/05
Jones Spring Pumphouse	36.71116	-114.71694	31.7	3.7	7.36	-13.07	-97.7	63.80	27.40	96.30	10.90	61.80	254.00	178.00	29.40	2.2	64175	MV-5	Spring	292	02/16/06
Jones Spring Pumphouse	36.71116	-114.71694	32.2	4.4	7.27	-13.07	-97.9	62.60	27.10	93.10	11.20	62.60	254.00	181.00	29.70	2.2	64902	MV-5	Spring	292	06/21/06
Jones Spring Pumphouse	36.71116	-114.71694	32.2	4.1	7.30	-13.10	-97.3	63.70	27.80	84.50	9.32	62.20	269.00	179.00	29.30	2.1	65285	MV-5	Spring	292	08/23/06
Jones Spring Pumphouse	36.71116	-114.71694	31.2	4.1	7.29	-13.05	-97.9	63.63	27.37	93.43	10.80	62.05	256.17	177.67	29.75	2.2	--	--	Spring	292	--

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Juanita Spring	36.63694	-114.24750	26.0	--	7.30	-11.65	-87.0	130.00	43.00	25.00	5.30	15.00	--	370.00	29.00	1.0	90	GS30	Spring	50	01/25/86
Kalamazoo Spring WR6	39.56648	-114.59594	12.1	6.8	7.33	-16.22	-121.6	47.20	15.50	2.46	0.71	2.10	208.00	10.60	10.50	--	60962	SC-3	Spring	336	07/20/04
Kalamazoo Spring WR6	39.56648	-114.59594	12.3	6.7	7.32	-16.22	-118.5	46.80	16.00	3.20	0.87	1.90	196.00	11.00	11.70	--	61348A	SC-3	Spring	336	09/21/04
Kalamazoo Spring WR6	39.56648	-114.59594	11.9	6.9	7.42	-16.28	-121.6	48.60	16.50	3.49	0.79	1.80	209.00	12.10	11.40	--	61966	SC-3	Spring	336	01/23/05
Kalamazoo Spring WR6	39.56648	-114.59594	--	--	--	-16.13	-118.6	--	--	--	--	--	--	--	--	--	62636	SC-3	Spring	336	05/23/05
Kalamazoo Spring WR6	39.56648	-114.59594	--	--	--	-16.18	-119.2	49.60	15.20	3.03	0.71	1.80	214.00	11.40	11.50	0.1	63222A	SC-3	Spring	336	08/12/05
Kalamazoo Spring WR6	39.56648	-114.59594	11.9	7.3	7.47	-16.17	-121.0	49.10	17.50	3.46	0.74	1.90	219.00	12.80	12.40	<.05	63567	SC-3	Spring	336	11/08/05
Kalamazoo Spring WR6	39.56648	-114.59594	11.7	7.1	7.60	-16.22	-119.3	49.30	16.60	3.42	0.79	2.00	213.00	12.80	12.10	<.1	64236	SC-3	Spring	336	02/25/06
Kalamazoo Spring WR6	39.56648	-114.59594	9.8	8.1	7.51	-16.06	-118.0	50.00	11.00	2.65	0.55	1.40	191.00	7.40	9.60	<.05	64739	SC-3	Spring	336	05/21/06
Kalamazoo Spring WR6	39.56648	-114.59594	--	--	--	-16.16	-120.1	--	--	--	--	--	--	--	--	--	--	SC-3	Spring	336	08/02/06
Kalamazoo Spring WR6	39.56648	-114.59594	11.9	7.3	7.55	-16.24	-119.7	50.00	17.10	2.87	0.60	2.02	230.00	12.40	12.00	<.05	65368	SC-3	Spring	336	08/30/06
Kalamazoo Spring WR6	39.56648	-114.59594	12.0	6.5	7.52	-16.11	-120.5	50.20	17.30	3.51	0.82	1.50	216.00	12.50	12.40	<.05	65657	SC-3	Spring	336	10/29/06
Kalamazoo Spring WR6	39.56648	-114.59594	11.3		7.60	-16.19	-120.4	48.70	16.30	3.67	0.76	1.45	220.00	11.70	12.40	0.1	65657	SC-3	Spring	336	05/08/07
Kalamazoo Spring WR7	39.56648	-114.59594	12.4	5.7	7.51	-16.22	-120.4	47.90	16.40	3.21	0.72	1.26	225.00	12.00	10.90	<.1	67250	SC-3	Spring	336	08/21/07
Kalamazoo Spring WR8	39.56648	-114.59594	12.0	4.2	7.67	-16.28	-120.7	50.10	17.40	3.35	0.77	1.40	227.00	12.30	11.30	<.05	67513	SC-3	Spring	336	11/04/07
Kalamazoo Spring WR9	39.56648	-114.59594	11.8	6.9	7.50	-16.30	-121.3	45.70	16.20	3.15	0.68	1.79	225.00	12.60	11.40	0.1	67947	SC-3	Spring	336	03/02/08
Kalamazoo Spring WR10	39.56648	-114.59594	11.7	6.9	7.67	-16.20	-120.4	48.20	16.40	3.44	0.78	1.79	220.00	12.10	11.50	0.0	68478	SC-3	Spring	336	05/31/08
Kalamazoo Spring WR11	39.56648	-114.59594	12.4	7.3	7.52	-16.37	-120.0	48.20	17.20	3.17	0.74	1.84	222.00	12.00	11.10	0.0	68917	SC-3	Spring	336	09/13/08
Kalamazoo Spring WR12	39.56648	-114.59594	12.3	7.0	7.55	-16.32	-121.4	47.90	17.30	3.38	0.92	1.80	218.00	12.00	11.00	0.1	69148	SC-3	Spring	336	11/01/08
Kalamazoo Spring WR13	39.56648	-114.59594	11.9	6.9	7.58	-16.36	-121.6	48.50	16.90	3.25	0.76	1.70	213.00	11.60	11.50	0.0	69427	SC-3	Spring	336	01/16/09
Kalamazoo Spring WR14	39.56648	-114.59594	10.3	7.6	7.57	-16.23	-118.9	46.90	12.00	3.27	0.70	1.46	195.00	8.91	11.30	0.0	69866	SC-3	Spring	336	05/21/09
Kalamazoo Spring WR15	39.56648	-114.59594	--	--	--	-16.21	-120.3	47.90	15.80	3.11	0.69	1.90	209.00	10.70	11.40	0.0	69866	SC-3	Spring	336	08/15/09
Kalamazoo Spring WR16	39.56648	-114.59594	--	--	--	-16.32	-121.1	48.00	16.50	3.28	0.82	1.97	225.00	11.50	10.80	0.0	70615	SC-3	Spring	336	11/15/09
Kane Springs (KSV-3)	37.24611	-114.70584	--	--	--	-12.60	-87.0	--	--	--	--	--	--	--	--	--	193	Kirk1025	Spring	97	--
Kane Springs (KSV-3)	37.24611	-114.70584	16.4	--	7.20	-11.90	-86.5	44.00	13.00	20.00	5.90	17.00	210.00	14.00	60.00	2.8	195	GS72	Spring	97	02/02/84
Kane Springs (KSV-3)	37.24611	-114.70584	14.8	5.2	7.04	-11.88	-87.0	49.00	13.60	20.30	1.36	17.60	214.00	15.10	64.50	--	58490	--	Spring	97	01/13/04
Kershaw-Ryan Spring #1	37.59028	-114.52010	20.0	6.5	8.40	-13.11	-95.1	24.20	2.66	26.50	4.38	6.30	140.00	4.40	46.10	--	59701	--	Spring	250	03/27/04
Kiln Spring	37.80510	-114.16423	11.5	2.4	7.11	-12.34	-91.9	93.50	22.90	34.80	0.53	51.20	320.00	56.90	27.40	0.2	64904	MG-1	Spring	418	06/21/06
Lake Mead Base Well #3	36.23917	-115.00444	--	--	--	-13.80	-101.5	--	--	--	--	--	--	--	--	--	19	PLC35	Well	12	--
Lake Valley Well	38.35556	-114.58917	18.0	--	8.10	-14.70	-111.0	61.00	9.70	22.00	2.10	68.00	121.00	25.00	25.00	0.2	365	GS147	Well	193	06/07/85
Lamb Spring	36.94500	-115.10583	13.5	--	--	-13.15	-92.5	37.00	41.00	8.70	0.60	8.60	--	24.00	12.00	0.2	168	--	Spring	86	05/19/88
Lester Mathews Well	37.79361	-114.39972	20.0	--	8.10	-13.30	-103.0	73.00	21.00	140.00	10.00	44.00	--	170.00	64.00	3.1	289	GS104	Well	142	06/04/85
Lime Spring	37.91467	-114.54022	21.0	--	8.30	-12.90	-97.0	55.00	31.00	3.80	0.90	4.10	290.00	8.90	14.00	0.1	315	GS118	Spring	160	04/07/85
Lime Spring	37.91467	-114.54022	15.1	0.4	7.35	-13.41	-99.9	76.10	40.60	3.27	1.09	3.60	433.00	6.40	14.10	--	60840	--	Spring	160	06/24/04
Lion Spring	38.25863	-114.13032	9.8	8.2	7.77	-14.11	-103.4	37.00	7.04	17.20	3.84	36.10	124.00	15.30	56.60	--	60317	--	Spring	318	05/21/04
Lion Spring (Egan Range)	39.18037	-114.98444	12.5	5.1	7.28	-15.34	-114.8	64.50	13.20	13.70	4.61	15.40	237.00	28.70	42.30	0.1	65039	ER-13	Spring	430	07/12/06
Little Ash Spring (Ash Spring)	37.46389	-115.19167	37.0	--	7.36	-14.20	-107.2	45.27	15.40	29.80	7.30	9.50	250.00	35.00	31.54	0.8	229	IT33	Spring	111	08/08/95
Little Boulder Spring	37.71330	-114.95217	12.0	6.4	7.10	-13.06	-97.2	21.80	5.88	7.99	2.91	4.90	101.00	7.80	44.80	--	59690	--	Spring	301	03/24/04
Little Currant Creek	38.83444	-115.35806	10.5	--	--	-15.00	-113.0	--	--	--	--	--	--	--	--	--	--	--	Surface	217	08/23/83

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Little Spring (Grant Range)	38.33197	-115.36050	14.7	1.7	6.90	-12.48	-99.4	--	--	--	--	--	--	--	--	--	62828	--	Spring	369	06/30/05
Little Springs (Clover Mts)	37.53418	-114.35607	18.5	5.3	7.56	-12.78	-93.0	30.20	5.11	11.20	2.77	9.70	137.00	4.80	56.50	--	61096	--	Spring	254	07/31/04
Little Springs (Clover Mts)	37.53418	-114.35607	17.1	6.7	6.81	-12.84	-93.5	29.60	4.73	10.80	2.45	8.60	112.00	5.00	46.60	--	62403	DRI-CR-7	Spring	254	04/30/05
Little Cut Spring	37.69653	-115.37810	--	--	--	-12.93	-98.4	68.80	19.70	21.10	2.57	22.20	295.00	30.60	55.90	--	60844		Spring	286	06/25/04
Little Cut Spring	37.69653	-115.37810	10.4	4.8	6.77	-12.76	-98.2	75.00	21.00	22.80	2.30	21.10	302.00	33.10	52.20	--	62410	DRI-MI-1	Spring	286	05/02/05
Little Tom Plain Spring	39.08092	-115.37152	8.0	7.2	6.70	-15.87	-121.8	--	--	--	--	--	--	--	--	--	62712	DRI-WP-7	Spring	337	06/06/05
Little Tom Plain Spring (RS)	39.08103	-115.37172	8.9	5.7	7.13	-15.85	-120.1	66.80	5.61	19.30	2.63	14.70	231.00	19.80	47.30	0.3	65037	WP-12	Spring	337	07/11/06
Littlefield Spring	38.23125	-114.70223	14.9	5.0	7.02	-12.73	-98.5	67.10	13.30	16.30	2.75	22.50	254.00	20.90	47.50	--	60847	--	Spring	275	06/26/04
Littlefield Spring	38.23125	-114.70223	--	--	--	-12.40	-98.0	--	--	--	--	--	--	--	--	--	112272	SNWA	Spring	275	07/25/05
Lone Pine Spring	38.89556	-114.89944	--	--	--	-14.98	-109.2	--	--	--	--	--	--	--	--	--	--	--	Spring	223	10/13/03
Lone Pine Spring	38.89556	-114.89944	8.0	7.4	7.50	-14.95	-111.5	67.00	4.20	3.50		1.60	224.00	3.70	17.00	<.1	434	GS214	Spring	223	08/01/85
Lone Pine Spring	38.89556	-114.89944	7.0	7.1	7.44	-14.77	-110.0	72.50	3.80	4.35	1.27	2.30	220.00	6.00	27.60	0.1	65053	ER-27	Spring	223	07/13/06
Lower Chokecherry Spring	37.53721	-114.69709	6.4	7.3	7.70	-12.98	-98.4	73.20	15.20	26.70	1.55	19.40	296.00	25.00	53.40	--	59694	--	Spring	261	03/25/04
Lower Fairview	38.17573	-114.65551	--	--	--	-12.39	-97.5	--	--	--	--	--	--	--	--	--	--	--	Spring	281	06/29/04
Lower Indian Spring	37.45006	-114.65730	21.4	3.6	8.30	-12.62	-96.0	1.90	0.17	95.10	0.80	12.10	221.00	10.40	56.20	--	58498	--	Spring	267	01/14/04
Lower Little Cherry Cr Spring	38.16722	-115.65333	--	8.0	7.55	-13.90	-103.0	--	--	--	--	--	268.00	--	--	--	346	GS135	Spring	182	07/31/85
Lower Pony Spring	38.31972	-114.60722	20.0	--	--	-13.20	-101.0	--	--	--	--	--	--	--	--	--	359	GS142	Spring	190	07/23/81
Lower Pony Spring	38.31972	-114.60722	14.0	--	7.90	-13.30	-101.0	45.00	2.00	36.00	1.10	10.00	202.00	8.20	47.00	0.1	360	GS143	Spring	190	04/05/85
Unnamed Spring in Snow Creek	40.07837	-114.91138	--	--	--	-16.24	-120.9	--	--	--	--	--	--	--	--	--	62629B	DRI-CC-3	Spring	338	05/24/05
Lund Spring	38.85000	-115.00250	19.0	5.7	7.49	-15.40	-113.0	56.00	23.00	3.80	0.90	2.80	270.00	11.00	11.00	0.1	429	GS210	Spring	221	04/27/82
Lund Spring	38.85000	-115.00250	--	--	--	-15.37	-117.1	--	--	--	--	--	--	--	--	--	68109	SNWA	Spring	221	08/06/03
Lund Spring	38.85000	-115.00250	--	--	--	-14.97	-115.3	--	--	--	--	--	--	--	--	--	88478	SNWA	Spring	221	06/24/04
M-8 Spring (Unnamed Spring)	36.72083	-114.72750	--	--	--	-12.75	-99.0	--	--	--	--	--	--	--	--	--	119	PLC15	Spring	68	10/30/85
M-9 Spring (Unnamed Spring)	36.72583	-114.72722	--	--	--	-12.45	-96.5	--	--	--	--	--	--	--	--	--	126	PLC16	Spring	70	10/30/85
Maynard Lake Spring (Unnamed Spring)	37.19167	-115.03389	9.6	--	7.90	-12.30	-94.0	43.00	23.00	114.00	14.00	30.00	405.00	88.00	--	--	186	IT136	Spring	94	01/14/85
McDermitt Spring	38.25914	-114.63164	--	--	--	-11.21	-94.3	--	--	--	--	--	--	--	--	--	--	--	Spring	323	06/26/04
Meadow Valley Wash, Cal.	37.63581	-114.51357	5.0	--	7.80	-13.10	-97.0	58.00	25.00	94.60	15.40	59.10	387.00	66.20	59.00	2.0	271	E27	Surface	130	12/00/79
Meloy Spring	38.25181	-114.70497	14.4	6.9	7.15	-12.75	-99.8	68.10	12.20	16.40	4.40	24.90	248.00	18.10	54.20	--	60845	--	Spring	276	06/26/04
Merril's Camp #39	38.18825	-113.86636	8.4	6.3	7.21	-14.13	-102.1	41.80	5.69	8.36	0.38	6.50	156.00	5.40	15.50	0.1	63597	--	Spring	410	11/19/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Mesquite Wtr Bunkerville 1	36.77528	-114.11806	23.0	--	7.50	-13.51	-102.5	54.00	28.00	39.00	8.10	31.00	198.00	120.00	25.00	0.9	132	GS49	Well	74	08/17/94
Mesquite Wtr Bunkerville 2	36.77417	-114.12889	23.0	--	7.60	-13.51	-102.1	38.00	20.00	50.00	7.50	13.00	220.00	89.00	21.00	1.4	131	GS48	Well	73	08/18/94
Mesquite Wtr Virgin Vly 5	36.77806	-114.08417	26.5	--	7.40	-13.78	-103.3	110.00	54.00	100.00	7.60	100.00	145.00	440.00	22.00	0.3	133	GS50	Well	75	08/17/94
Mesquite Wtr Virgin Vly 25	36.80833	-114.07250	23.0	--	7.60	-12.85	-98.9	55.00	34.00	210.00	9.30	160.00	210.00	300.00	28.00	1.2	152	GS54	Well	79	08/18/94
Moapa Well	36.53139	-114.79667	--	--	--	-13.40	-99.0	--	--	--	--	--	--	--	--	--	999	TH-1	Well	41	04/07/00
Mike's Spring	39.64370	-114.20490	10.7	6.4	6.77	-15.89	-121.1	61.90	18.90	31.80	1.81	29.20	246.00	34.80	27.50	0.4	63272	--	Spring	390	08/23/05
Mirant	36.41861	-114.95750	--	--	--	-13.23	-96.8	--	--	--	--	--	--	--	--	--	USGS	618	Well	622	06/04/03
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.7	8.7	7.50	-15.58	-111.2	56.70	10.00	2.48	0.61	1.10	229.00	4.30	7.40	--	57694	WP-1	Spring	320	10/12/03
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.0	8.5	7.46	-15.32	-113.3	76.00	7.73	2.68	0.70	1.10	259.00	3.30	9.00	--	59578	WP-1	Spring	320	03/23/04
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.7	9.7	8.00	-15.62	-114.0	60.50	9.88	2.09	0.54	1.00	219.00	3.80	7.80	--	60784	WP-1	Spring	320	06/21/04
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	7.3	10.1	7.41	-15.51	-115.7	60.80	10.90	3.17	1.00	1.20	231.00	4.20	7.50	--	61478	WP-1	Spring	320	09/22/04
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.0	8.6	8.14	-15.58	-115.1	62.00	10.70	2.83	0.77	1.30	227.00	4.50	7.40	--	61962	WP-1	Spring	320	01/21/05
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.4	9.4	6.61	-15.55	-112.3	--	--	--	--	--	--	--	--	--	62632A	WP-1	Spring	320	05/21/05
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	9.4	6.80	-15.63	-113.2	59.10	9.81	2.38	0.63	1.10	224.00	4.30	7.60	0.5	63218	WP-1	Spring	320	08/14/05
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.7	9.8	7.20	-15.65	-113.8	57.20	10.10	2.34	0.58	1.20	211.00	4.50	7.40	0.1	63561	WP-1	Spring	320	11/05/05
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.7	8.1	7.51	-15.69	-113.8	55.70	9.83	2.45	0.64	1.20	208.00	4.70	7.30	<.1	64235	WP-1	Spring	320	02/24/06
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	9.2	7.38	-15.38	-111.8	59.10	6.32	1.89	0.49	1.00	199.00	2.40	7.80	0.1	64733	WP-1	Spring	320	05/20/06
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	--	--	--	-15.63	-114.1	--	--	--	--	--	--	--	--	--	--	WP-1	Spring	320	07/11/06
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.7	8.4	7.12	-15.64	-114.7	56.20	10.10	2.41	0.58	1.28	217.00	4.77	7.39	0.1	65365	WP-1	Spring	320	08/29/06
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.6	8.3	7.20	-15.67	-114.5	56.00	10.20	2.48	0.62	1.21	209.00	4.55	7.28	0.1	65743	WP-1	Spring	320	11/15/06
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	--	7.24	-15.61	-114.6	64.90	8.57	2.36	0.61	0.88	244.00	3.57	7.10	0.1	65743	WP-1	Spring	320	05/06/07
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.0	6.3	7.19	-15.64	-114.1	56.40	10.30	2.46	0.60	0.80	228.00	4.71	6.97	<.1	67246	WP-1	Spring	320	08/19/07
Monitoring Spring WR1 (White Pine Range)	38.94951	115.40898	5.7	6.11	7.27	-15.68	-113.8	59.4	10.6	2.31	0.56	1	231	4.6	6.76	0.06	67509	WP-1	Spring	320	11/03/07
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.8	8.1	6.67	-15.70	-114.2	54.10	9.74	2.43	0.61	1.10	224.00	4.85	6.86	0.1	67950	WP-1	Spring	320	03/03/08
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	7.3	7.40	-15.59	-113.0	65.10	9.03	2.42	0.63	1.09	244.00	3.74	7.20	0.1	68483	WP-1	Spring	320	05/29/08
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.6	9.7	7.48	-15.69	-113.2	59.80	10.80	2.42	0.58	1.16	235.00	4.66	7.19	0.1	68918	WP-1	Spring	320	09/14/08
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	6.0	8.6	7.22	-15.68	-114.7	60.20	10.90	2.54	0.68	1.04	235.00	4.64	7.00	0.0	69149	WP-1	Spring	320	10/31/08
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	8.6	7.39	-15.66	-114.2	61.00	10.70	2.55	0.66	1.00	228.00	4.50	7.00	0.1	69428	WP-1	Spring	320	01/15/09
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	5.9	9.2	7.23	-15.90	-116.2	62.60	3.09	1.78	0.54	0.85	217.00	2.09	6.15	0.0	69861	WP-1	Spring	320	05/19/09
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	--	--	--	-15.69	-113.9	59.70	10.40	2.04	0.52	1.06	222.00	4.10	7.41	0.0	69861	WP-1	Spring	320	08/16/09
Monitoring Spring WR1 (White Pine Range)	38.94903	-115.41008	--	--	--	-15.71	-114.6	58.90	10.40	2.39	0.64	1.14	236.00	4.33	6.85	0.1	70616	WP-1	Spring	320	11/16/09
Monitoring Spring WR1 (White Pine Range)	38.94951	115.40898	--	--	--	-15.69	-114.9	63.5	9.16	2.37	0.54	1.2	235	3.4	7.3	0.06	70616	WP-1	Spring	320	06/18/10

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Moon River Spring	38.35167	-115.18083	32.5	2.3	7.38	-15.80	-120.0	55.00	22.00	22.00	4.40	9.30	260.00	44.00	25.00	1.2	362	GS145	Spring	192	04/27/82
Moorman Spring	38.59472	-115.13833	37.0	1.7	7.03	-15.70	-119.0	58.00	19.00	24.00	5.90	9.90	--	47.00	27.00	1.3	405	GS185	Spring	205	07/18/81
Moorman Spring	38.59472	-115.13833	--	--		-15.54	-120.2	--	--	--	--	--	--	--	--	--	88479	SNWA	Spring	205	06/23/04
Mormon Well Spring	36.64389	-115.09778	11.5	--	7.26	-12.90	-92.5	81.00	40.00	11.00	0.40	24.00	--	--	16.00	0.1	94	GS32	Spring	53	10/27/81
Mormon Well Spring	36.64389	-115.09778	10.0	5.1	7.60	-12.50	-91.0	65.00	41.00	12.00	1.00	12.00	395.00	21.00	16.00	0.1	95	GS33	Spring	53	05/09/83
Mormon Well Spring	36.64389	-115.09778	12.0	--	7.36	-12.60	-92.0	84.00	44.00	13.00	0.50	12.00	--	23.00	17.00	0.2	96	GS34	Spring	53	10/07/87
Mud Spring (Buck Mts)	39.73587	-115.57036	11.6	9.4	6.90	-15.21	-117.6	--	--	--	--	--	--	--	--	--	62705	DRI-BK-1	Spring	339	06/05/05
Mud Sp Barcass 34 (Snake Range)	39.32571	-114.26714	6.9	7.5	7.13	-15.43	-117.1	73.40	14.50	3.02	0.64	2.50	287.00	5.40	10.00	<.05	63528	--	Spring	404	10/25/05
Mud Spring	39.08160	-114.97241	12.4	5.0	7.31	-14.53	-111.0	62.40	11.20	14.10	0.57	8.60	235.00	18.40	15.20	0.1	65055	ER-29	Spring	446	07/13/06
Murphy Spring	38.33973	-115.44937	10.6	8.7	6.70	-15.40	-114.5	--	--	--	--	--	--	--	--	--	62833	--	Spring	373	07/02/05
Mustang Spring	37.73553	-114.92166	10.0	3.4	7.00	-12.60	-91.0	111.00	7.98	17.30	6.49	11.40	346.00	58.00	58.00	--	277	K6	Spring	135	01/14/85
Mustang Spring	37.73553	-114.92166	13.4	6.2	6.80	-12.37	-90.0	105.00	7.77	18.40	6.77	9.90	319.00	61.60	62.10	--	59691	--	Spring	135	03/24/04
Mustang Spring (Snake)	38.86257	-114.27179	4.3	8.4	7.09	-15.30	-111.0	68.00	4.58	1.32	0.36	0.80	5.50	218.00	5.70	2.2	62915	SN-6	Spring	382	07/14/05
MVW above Eagle Canyon	38.02778	-114.18583	19.0	--	8.20	-12.00	-93.0	--	--	--	--	--	--	--	--	--	328	E6	Surface	168	04/09/85
Narrow Canyon Spring	37.36729	-114.67807	9.9	5.8	7.20	-12.47	-92.5	61.90	12.70	17.70	1.87	17.90	228.00	20.80	47.20	--	59683		Spring	257	03/22/04
Nellis AFB #4	36.24889	-115.00417	--	--	--	-13.20	-95.0	--	--	--	--	--	--	--	--	--	20	PLC36	Well	13	--
Nellis AFB Well #13	36.21222	-115.05000	--	--	--	-13.80	-98.0	--	--	--	--	--	--	--	--	--	18	PLC34	Well	11	--
Newels Spring	37.90248	-114.03202	21.5	7.2	7.74	-12.48	-96.0	88.00	16.90	22.60	2.39	39.00	289.00	36.50	36.10	0.5	64909	MG-6	Spring	423	06/22/06
Nicholas Spring	38.91062	-115.06142	22.0	3.4	7.75	-16.10	-124.0	42.00	19.00	13.00	3.30	24.00	180.00	40.00	20.00	0.6	440	GS219	Spring	227	04/27/82
North Creek Spring	38.71056	-114.73056	8.5	--	6.90	-14.60	-105.0	9.10	1.60	2.20	0.90	1.30	25.00	3.80	12.00	0.4	420	GS198	Spring	214	04/03/85
North Lee Well	37.82444	-114.38444	22.0	--3	8.00	-13.30	-101.0	59.00	12.00	44.00	9.90	48.00	220.00	33.00	54.00	1.0	299	GS109	Well	147	06/04/85
North Spring	39.15611	-114.96306	5.5	--	--	-15.00	-113.0	--	--	--	--	4.20	--	--	--	--	459	GS245	Spring	237	06/17/83
North Springs	39.15490	-114.96278	6.3	7.1	7.42	-15.21	-111.7	54.30	9.63	3.44	0.52	1.40	201.00	10.70	9.30	0.1	65041	ER-15	Spring	237	07/12/06
Oak Spring	37.60547	-114.71015	10.5	7.1	7.05	-11.87	-90.0	84.90	16.50	64.10	1.97	41.10	355.00	34.20	56.50	--	58502	--	Spring	269	01/16/04
Ox Valley Spring	37.97053	-114.05966	8.8	6.0	7.02	-13.95	-100.0	37.50	6.97	5.23	0.50	4.60	118.00	25.00	12.40	0.6	64908	MG-5	Spring	422	06/22/06
Oxborrow Well	37.88611	-114.30472	11.5	--	7.90	-11.80	-92.0	130.00	22.00	65.00	11.00	140.00	351.00	63.00	58.00	0.8	303	GS112	Well	150	06/05/85
Pahroc Spring	37.66466	-114.98065	16.0	0.8	7.60	-12.50	-89.0	30.90	8.28	12.30	5.63	11.70	135.00	11.40	59.00	--	272	K5	Spring	131	01/14/85
Pahroc Spring	37.66466	-114.98065	14.4	5.7	7.40	-12.65	-94.0	25.60	6.69	40.10	5.72	13.10	169.00	12.90	66.80	--	58494		Spring	131	01/16/04
Pahroc Spring	37.66466	-114.98065	--	--	--	-12.55	-93.9	--	--	--	--	--	--	--	--	--	111191/12 0746	SNWA	Spring	131	04/05/05
Pahroc Spring	37.66466	-114.98065	16.0	7.3	6.61	-12.79	-93.5	31.30	8.33	12.70	5.16	12.60	134.00	12.80	62.10	--	61106C	DRI-PR-1	Spring	131	04/30/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Panaca Spring	37.80754	-114.38086	29.0	5.6	7.80	-13.90	-106.0	32.00	9.80	36.00	6.80	15.00	--	29.00	45.00	1.6	294	GS107	Spring	144	04/26/84
Panaca Spring	37.80754	-114.38086	29.5	--	7.90	-14.00	-108.0	34.00	10.00	38.00	7.10	16.00	--	25.00	50.00	1.5	292	GS105	Spring	144	04/08/85
Panaca Spring	37.80754	-114.38086	28.5	6.2	7.79	-14.20	-106.5	33.00	10.00	37.00	6.70	17.00	--	27.00	48.00	1.4	293	GS106	Spring	144	11/11/86
Panaca Spring	37.80754	-114.38086	--	--	--	--	-107.0	--	--	--	--	--	--	--	--	--	293	DRI	Spring	144	11/11/86
Panaca Spring	37.80754	-114.38086	28.4	4.0	7.83	-14.11	-107.4	32.40	10.40	38.00	7.43	17.80	176.00	30.40	52.40	--	61619	--	Spring	144	10/20/04
Panaca Spring	37.80754	-114.38086	28.6	5.4	7.68	-14.25	-107.9	32.60	10.30	37.90	7.19	17.30	177.00	29.30	49.70	--	61969	--	Spring	144	01/24/05
Panaca Spring	37.80754	-114.38086	28.3	4.7	7.04	-14.15	-107.1	--	--	--	--	--	--	--	--	--	62626	DRI-MW-1	Spring	144	05/20/05
Panaca Spring	37.80754	-114.38086	28.9	4.4	7.04	-14.17	-106.4	--	--	--	--	--	--	--	--	--	63231	DRI-MW-1	Spring	144	08/16/05
Panaca Spring	37.80754	-114.38086	28.7	4.6	7.60	-14.18	-106.8	30.00	10.30	37.60	7.00	17.40	179.00	29.10	49.00	1.4	63571	--	Spring	144	11/09/05
Panaca Spring	37.80754	-114.38086	28.8	4.2	7.71	-14.20	-105.8	34.20	10.20	37.90	6.97	17.90	178.00	29.70	48.80	1.5	64169	MW-1	Spring	144	02/17/06
Panaca Spring	37.80754	-114.38086	28.8	5.9	7.80	-14.17	-107.1	32.60	9.97	37.00	9.66	18.20	180.00	30.70	50.20	1.5	64743	MW-1	Spring	144	05/22/06
Panaca Spring	37.80754	-114.38086	29.1	5.9	7.67	-14.24	-107.0	32.60	10.20	34.60	6.06	17.80	184.00	30.50	49.80	1.5	65289	MW-1	Spring	144	08/23/06
Panaca Spring	37.80754	-114.38086	28.9	4.4	7.62	-14.14	-106.9	32.70	10.00	37.00	1.74	17.30	175.00	29.80	49.90	1.5	65654	MW-1	Spring	144	10/28/06
Panaca Town Well	37.79722	-114.39917	29.5	--	7.90	-14.00	-106.0	45.00	1.00	47.00	8.30	19.00	203.00	68.00	58.00	1.8	291	E16	Well	143	06/04/85
Parsnip Spring	38.14944	-114.26250	19.0	--	7.70	-12.80	-93.5	16.00	3.00	12.00	2.20	7.50	70.00	9.10	41.00	0.1	344	GS134	Spring	180	06/05/85
Patterson Pass Spring WR3	38.60280	-114.71481	12.0	6.0	6.60	-14.91	-106.5	--	--	--	--	--	--	--	--	--	57755	SC-2	Spring	305	10/30/03
Patterson Pass Spring WR3 (duplicate sample)	38.60280	-114.71481	--	--	--	-14.94	-109.2	--	--	--	--	--	--	--	--	--	57755	SC-2	Spring	305	10/30/03
Patterson Pass Spring WR3	38.60280	-114.71481	11.8	3.6	6.07	-14.75	-106.2	19.50	3.83	1.99	1.42	0.90	68.60	9.60	10.80	--	59579	SC-2	Spring	305	03/24/04
Patterson Pass Spring WR3	38.60280	-114.71481	11.5	6.2	7.10	-14.84	-109.1	19.80	4.62	3.00	1.46	1.20	67.00	9.80	11.10	--	60786	SC-2	Spring	305	06/23/04
Patterson Pass Spring WR3	38.60280	-114.71481	12.0	5.9	7.45	-14.79	-107.9	18.50	3.86	1.94	1.39	0.90	66.50	9.40	10.20	--	61480	SC-2	Spring	305	09/23/04
Patterson Pass Spring WR3	38.60280	-114.71481	11.7	5.5	6.82	-14.77	-108.3	20.50	4.14	2.20	1.46	1.20	71.60	9.80	10.50	--	61967	SC-2	Spring	305	01/23/05
Patterson Pass Spring WR3	38.60280	-114.71481	11.4	6.0	6.66	-14.71	-106.8	--	--	--	--	--	--	--	--	--	61481	SC-2	Spring	305	05/20/05
Patterson Pass Spring WR3	38.60280	-114.71481	--	--	--	-14.83	-107.6	18.80	3.66	1.89	1.41	1.00	65.50	8.70	10.10	0.7	63220	SC-2	Spring	305	08/15/05
Patterson Pass Spring WR3	38.60280	-114.71481	12.1	6.1	6.97	-14.87	-107.5	19.30	3.74	1.90	1.35	1.10	63.80	8.70	10.00	0.4	63566	SC-2	Spring	305	11/07/05
Patterson Pass Spring WR3	38.60280	-114.71481	11.8	7.1	6.78	-14.91	-108.1	19.60	3.82	1.86	1.23	1.12	65.90	9.10	10.20	0.5	65371	SC-2	Spring	305	08/31/06
Patterson Pass Spring WR3	38.60280	-114.71481	12.2	6.8	6.87	-14.89	-108.4	19.20	3.81	2.07	1.43	1.00	66.30	8.80	10.10	0.5	65653	SC-2	Spring	305	10/28/06
Patterson Pass Spring WR3	38.60280	-114.71481	11.9	6.4	6.52	-14.90	-106.9	19.40	3.68	1.86	1.42	1.20	65.00	8.80	10.10	0.5	64239	SC-2	Spring	305	02/26/06
Patterson Pass Spring WR3	38.60280	-114.71481	11.7	7.5	6.95	-14.86	-108.5	19.20	3.80	2.20	1.20	1.20	67.20	9.10	10.20	0.5	64738	SC-2	Spring	305	05/23/06
Patterson Pass Spring WR3	38.60280	-114.71481	--	--	--	-14.86	-107.9	--	--	--	--	--	--	--	--	--	--	SC-2	Spring	305	07/14/06
Patterson Pass Spring WR3	38.60280	-114.71481	11.7	--	6.60	-14.96	-108.5	19.90	3.82	1.99	1.40	0.95	69.00	8.37	9.59	0.5	65653	SC-2	Spring	305	05/07/07
Patterson Pass Spring WR3	38.60280	-114.71481	12.0	5.1	6.80	-14.87	-108.2	19.30	3.81	1.97	1.38	0.97	71.00	9.16	9.72	0.1	67248	SC-2	Spring	305	08/20/07
Patterson Pass Spring WR3	38.60280	-114.71481	12.2	3.3	6.79	-14.90	-107.3	20.10	3.93	2.09	1.39	1.00	70.00	9.10	9.50	0.5	67508	SC-2	Spring	305	11/02/07
Patterson Pass Spring WR3	38.60280	-114.71481	11.8	5.2	6.39	-14.94	-107.7	18.20	3.67	2.03	1.40	1.00	71.50	9.16	9.34	0.5	67951	SC-2	Spring	305	03/04/08
Patterson Pass Spring WR3	38.60280	-114.71481	11.7	5.1	6.83	-14.93	-106.9	18.70	3.91	2.05	1.37	1.04	69.50	9.22	9.40	0.5	68476	SC-2	Spring	305	05/30/08
Patterson Pass Spring WR3	38.60280	-114.71481	12.0	6.2	6.90	-14.95	-106.6	18.80	3.91	1.90	1.30	1.03	71.70	9.44	9.92	0.5	68911	SC-2	Spring	305	09/11/08
Patterson Pass Spring WR3	38.60280	-114.71481	12.2	5.7	6.51	-14.95	-107.8	19.40	3.95	2.03	1.47	0.93	72.70	9.45	9.52	0.5	69142	SC-2	Spring	305	10/31/08
Patterson Pass Spring WR3	38.60280	-114.71481	12.1	6.1	6.82	-14.96	-107.2	19.80	3.94	2.06	1.45	0.90	77.50	9.00	9.80	0.5	69423	SC-2	Spring	305	01/14/09
Patterson Pass Spring WR3	38.60280	-114.71481	11.6	5.9	6.76	-14.87	-106.1	19.30	3.90	2.05	1.36	0.90	69.10	9.41	9.54	0.5	69860	SC-2	Spring	305	05/18/09
Patterson Pass Spring WR3	38.60280	-114.71481	--	--	--	-14.93	-107.7	17.90	3.83	1.85	1.36	0.86	68.60	9.19	10.00	0.5	69860	SC-2	Spring	305	08/17/09
Patterson Pass Spring WR3	38.60280	-114.71481	--	--	--	-14.95	-108.1	19.50	3.91	2.00	1.75	1.04	72.30	9.52	9.47	0.5	70613	SC-2	Spring	305	11/15/09

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Peach Spring	36.95444	-114.28972	15.1	--	--	-10.40	-76.5	--	--	--	--	--	--	--	--	--	173	GS62	Spring	88	02/06/84
Pederson's East	36.70933	-114.71556	32.0	2.4	7.31	-12.92	-97.0	64.30	28.50	96.40	11.60	66.10	255.00	178.00	30.30	--	58497	DRI-MV-2	Spring	290	01/12/04
Pederson's East	36.70933	-114.71556	31.9	2.7	7.38	-12.92	-97.0	64.60	27.60	94.20	11.10	61.40	264.00	181.00	29.10	--	60307	DRI-MV-2	Spring	290	05/18/04
Pederson's East	36.70933	-114.71556	--	--	--	-12.98	-98.4	68.20	28.30	94.00	11.30	61.50	257.00	178.00	31.20	--	61613	DRI-MV-2	Spring	290	10/19/04
Pederson's East	36.70933	-114.71556	31.2	3.2	7.37	-12.89	-98.3	64.40	27.70	95.60	11.20	62.00	253.00	181.00	29.50	--	62032	DRI-MV-2	Spring	290	02/10/05
Pederson's East	36.70933	-114.71556	32.0	3.0	6.80	-12.96	-98.3	--	--	--	--	--	--	--	--	--	62033	DRI-MV-2	Spring	290	06/08/05
Pederson East	36.70933	-114.71556	31.6	2.7	7.32	-13.00	-97.5	64.80	27.70	95.70	10.10	61.00	254.00	180.00	29.10	2.2	64173	MV-2	Spring	290	02/16/06
Pederson East	36.70933	-114.71556	31.7	2.7	7.28	-13.02	-97.7	63.40	27.30	92.70	11.10	61.70	253.00	182.00	29.40	2.2	64901	MV-2	Spring	290	06/21/06
Pederson East	36.70933	-114.71556	32.0	2.8	7.25	-13.06	-97.4	64.80	28.10	86.00	9.64	61.80	257.00	183.00	29.10	2.2	65287	MV-2	Spring	290	08/23/06
Pederson East	36.70933	-114.71556	31.9	2.6	7.30	-13.03	-98.7	63.90	27.80	93.30	11.00	59.30	253.00	179.00	29.00	2.2	65663	MV-2	Spring	290	10/30/06
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	--	-98.0	--	--	--	--	--	--	--	--	--	113.2	jim	Spring	67	1/00/69
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	--	-97.0	--	--	--	--	--	--	--	--	--	113.2	jim	Spring	67	3/00/70
Pederson's Warm Spring (M-13)	36.70958	-114.71594	32.5	--	7.20	-12.90	-96.5	66.00	26.00	96.00	10.00	61.00	270.00	190.00	62.06	2.1	113	IT249	Spring	67	07/22/81
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	-12.75	-97.0	--	--	--	--	--	--	--	--	--	118	PLC17	Spring	67	10/30/85
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	-13.05	-99.0	--	--	--	--	--	--	--	--	--	115	IT251	Spring	67	01/07/88
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	-12.85	-96.9	--	--	--	--	--	--	--	--	--	USGS	--	spring	67	07/30/03
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.6	2.2	7.29	-12.91	-97.2	65.30	28.40	99.20	11.40	67.70	261.00	189.00	28.40	--	58488	DRI-MV-1	Spring	67	01/12/04
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.1	3.8	7.42	-12.85	-97.5	65.40	27.80	97.20	10.90	65.90	265.00	184.00	29.20	--	60306	DRI-MV-1	Spring	67	05/18/04
Pederson's Warm Spring (M-13)	36.70958	-114.71594	--	--	--	-12.92	-97.4	64.50	27.80	97.20	11.00	63.00	257.00	183.00	30.60	--	61617	DRI-MV-1	Spring	67	10/19/04
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.2	3.0	7.31	-12.91	-98.0	64.80	27.40	98.80	10.90	63.20	256.00	186.00	29.80	--	62031	DRI-MV-1	Spring	67	02/10/05
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.9	3.6	7.00	-12.91	-97.6	--	--	--	--	--	--	--	--	--	62032	DRI-MV-1	Spring	67	06/08/05
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.3	2.7	7.34	-13.02	-97.2	66.60	27.70	99.20	10.60	62.40	255.00	185.00	29.40	2.2	64172	MV-1	Spring	67	02/16/06
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.6	4.3	7.39	-12.98	-98.1	64.10	27.20	95.20	10.90	62.90	255.00	186.00	29.10	2.2	64900	MV-1	Spring	67	06/21/06
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.8	2.9	7.24	-13.01	-97.7	65.30	28.20	90.00	9.30	63.70	251.00	187.00	29.20	2.2	65286	MV-1	Spring	67	08/23/06
Pederson's Warm Spring (M-13)	36.70958	-114.71594	31.5	2.3	7.35	-13.04	-97.3	64.80	27.80	97.00	10.90	61.30	254.00	184.00	28.80	2.2	65664	MV-1	Spring	67	10/30/06
Perry Sp Barcass 37	38.33285	-114.97586	12.1	4.8	7.06	-15.04	-107.7	78.90	20.90	24.10	2.64	19.10	333.00	25.10	27.90	0.2	63531	--	Spring	408	10/27/05
Pine Spring	37.90800	-114.55132	4.5	--	--	-13.40	-99.0	--	--	--	--	--	--	--	--	--	312	GS116	Spring	157	04/07/85
Pine Spring	37.90800	-114.55132	--	--	--	-13.33	-99.0	--	--	--	--	--	--	--	--	--	--	--	Spring	157	06/24/04
Pine Springs (Egan Range)	39.11755	-114.94425	8.7	7.9	7.90	-15.71	-116.0	71.10	9.58	3.69	0.46	0.70	246.00	13.90	10.90	0.1	65043	ER-17	Spring	434	07/12/06
Preston Big Spring	38.93331	-115.08222	21.0	3.1	7.70	-15.60	-126.0	44.00	20.00	13.00	2.90	14.00	185.00	36.00	20.00	0.4	450	GS224	Spring	231	06/16/83
Preston Big Spring	38.93331	-115.08222	22.0	3.1	7.65	-15.90	-123.0	45.00	20.00	13.00	3.00	15.00	--	38.00	19.00	0.4	452	GS226	Spring	231	06/26/84
Preston Big Spring	38.93331	-115.08222	--	--	--	-15.99	-121.8	--	--	--	--	--	--	--	--	--	68111	SNWA	Spring	231	08/06/03
Preston Big Spring	38.93331	-115.08222	--	--	--	-15.66	-123.1	--	--	--	--	--	--	--	--	--	88482	SNWA	Spring	231	06/24/04
Preston Big Spring	38.93331	-115.08222	21.2	2.6	7.32	-15.87	-122.6	40.70	19.40	13.60	3.11	15.90	182.00	37.70	19.90	--	61483	DRI-WV-1	Spring	231	09/25/04
Preston Big Spring	38.93331	-115.08222	20.8	3.1	7.64	-15.89	-122.4	41.90	19.80	13.00	3.23	16.00	176.00	38.10	19.90	--	61968	DRI-WV-1	Spring	231	01/24/05
Preston Big Spring	38.93331	-115.08222	21.1	3.1	7.52	-15.86	-120.0	--	--	--	--	--	--	--	--	--	62627	DRI-WV-1	Spring	231	05/21/05
Preston Big Spring	38.93331	-115.08222	21.1	3.0	7.04	-15.88	-121.2	--	--	--	--	--	--	--	--	--	63227	DRI-WV-1	Spring	231	08/14/05
Preston Big Spring	38.93331	-115.08222	20.9	2.6	7.77	-15.86	-120.4	41.90	19.60	12.60	3.08	15.80	174.00	38.10	20.00	0.3	63563	--	Spring	231	11/06/05
Preston Big Spring	38.93331	-115.08222	21.3	3.8	7.66	-15.95	-121.8	41.60	19.20	13.20	3.16	16.50	175.00	39.90	20.40	0.4	64735	WV-1	Spring	231	05/20/06
Preston Big Spring	38.93331	-115.08222	-	-	-	-15.98	-121.7	-	-	-	-	-	-	-	-	-	--	WV-1	Spring	231	07/12/06
Preston Big Spring	38.93331	-115.08222	21.0	2.7	7.54	-15.96	-121.6	42.00	19.70	12.50	2.94	16.10	183.00	39.60	19.90	0.4	65366	WV-1	Spring	231	08/29/06
Preston Big Spring	38.93331	-115.08222	21.0	3.0	7.66	-15.88	-120.9	41.80	19.60	12.70	3.16	15.60	174.00	39.00	19.80	0.4	65652	WV-1	Spring	231	10/27/06

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Quaking Aspen Spring	37.37563	-114.24255	9.6	3.2	6.18	-12.98	-93.6	13.80	3.68	11.40	1.48	4.10	83.30	2.10	49.60	--	61100	--	Spring	255	07/31/04
Rabbit Brush	39.18383	-114.27363	--	--	--	-15.50	-117.1	--	--	--	--	--	--	--	--	--	--	--	Spring	412	10/26/05
Railroad Well	37.35111	-114.53389	16.0	--	7.60	-11.60	-86.0	42.00	14.00	98.00	8.80	42.00	300.00	60.00	51.00	2.3	204	GS77	Well	103	01/31/84
Railroad Well (Farrier, NV)	36.81361	-114.65389	22.8	--	8.00	-12.50	-97.5	84.00	31.00	150.00	19.00	52.00	64.00	550.00	23.00	1.6	154	USGS	Well	80	02/04/84
Raised Sp Barcass 36	38.97259	-114.37041	10.8	7.6	6.07	-13.54	-103.7	7.01	1.77	2.38	0.66	1.00	31.20	2.40	11.40	0.1	63532	--	Spring	407	10/27/05
Ram. Res. Wtr Supply Well	39.74333	-115.45111	11.9	50.0	8.02	-16.75	-129.5	--	--	--	--	--	155.00	--	--	--	470	GS261	Well	244	07/19/85
Ramone Mathews Well	37.52667	-114.24417	18.5	--	7.80	-12.30	-92.0	42.00	6.30	20.00	5.90	15.00	171.00	12.00	61.00	0.3	233	GS86	Well	115	06/03/85
Randono Well	37.32389	-114.50222	17.2	--	7.60	-11.70	-87.5	46.00	14.00	100.00	8.40	44.00	350.00	63.00	54.00	2.3	200	GS75	Well	100	02/03/84
Rattlesnake Spring	37.82624	-114.93012	14.1	7.4	7.80	-12.65	-97.3	47.60	7.50	27.60	5.16	16.50	199.00	19.30	52.50	--	59692	--	Spring	302	03/24/04
Red Rock Spring	37.56698	-114.75320	10.0	--	7.32	-12.30	-95.0	85.40	13.30	28.40	2.40	15.70	332.00	16.30	41.10	--	58495	--	Spring	256	01/10/04
Reed Spring	37.55731	-115.41800	--	--	--	-14.24	-98.4	49.60	14.20	13.70	2.78	17.30	199.00	18.90	43.90	--	60843	--	Spring	289	06/25/04
Ripgut Sp #40	38.24802	-114.03920	18.7	5.7	6.95	-14.38	-106.4	25.20	4.58	18.20	8.17	17.00	116.00	6.40	63.50	0.2	63598	--	Spring	411	11/19/05
Robison Spring	38.21273	-114.70636	--	--	--	-12.34	-97.9	--	--	--	--	--	--	--	--	--	--	--	Spring	279	06/29/04
Robbers Roost #2 Spring (Butte)	39.49596	-115.28046	12.7	1.3	6.20	-14.39	-112.0	--	--	--	--	--	--	--	--	--	62703	DRI-BT-5	Spring	340	06/04/05
Robbers Roost Spring (Schell Ck)	38.77051	-114.78331	--	--	--	-14.75	-109.7	58.80	27.90	11.20	0.56	7.20	304.00	21.70	14.30	0.1	62978	SC-5	Spring	389	07/31/01
Robbers Roost Spring (Schell Ck)	38.77051	-114.78331	--	--	--	-14.15	-109.2	--	--	--	--	--	--	--	--	--	68116	SNWA	Spring	389	08/06/03
Rock Springs	39.85979	-114.47277	9.4	5.1	6.05	-15.17	-118.4	50.00	8.01	12.50	0.91	5.80	188.00	15.70	38.20	0.1	63281	--	Spring	399	08/25/05
Rogers Spring	36.37750	-114.44389	30.5	2.3	7.02	-12.20	-92.0	410.00	140.00	280.00	21.00	330.00	--	1600.00	18.00	1.3	35	GS10	Spring	21	07/21/81
Rogers Spring	36.37750	-114.44389	30.0	--	7.48	-12.40	-92.0	423.00	143.00	291.00	22.70	327.00	161.00	1620.00	16.80	1.4	33	PL11	Spring	21	03/19/92
Rogers Spring	36.37750	-114.44389	30.0	2.6	7.03	-12.40	-91.0	--	--	--	--	--	--	--	--	--	32	PL11	Spring	21	02/08/96
Ryans Spring D 38	38.33121	-113.92855	8.0	2.2	7.07	-13.68	-103.5	80.80	8.31	24.90	0.91	41.50	264.00	22.80	33.30	0.1	63596	--	Spring	409	11/19/05
Rye Patch Spring	36.57967	-115.30586	9.7	8.1	7.54	-12.31	-89.3	49.50	24.20	16.00	1.98	17.50	218.00	22.00	13.70	--	62397	DRI-SR-5	Spring	341	04/28/05
Saddle Spring (White Pine)	38.97541	-115.40023	--	--	--	-15.00	-116.0	--	--	--	--	3.10	--	--	--	--	438	GS217	Spring	357	06/15/83
Saddle Spring (White Pine)	38.97541	-115.40023	7.6	6.9	6.20	-15.66	-118.6	--	--	--	--	--	--	--	--	--	62820	WP-2	Spring	357	06/28/05
Saddle Spring (White Pine)	38.97541	-115.40023	--	--	--	-15.70	-115.7	--	--	--	--	--	--	--	--	--	--	WP-2	Spring	357	10/12/03
Sage Hen Spring	39.11533	-115.39212	7.7	7.0	6.20	-14.76	-112.4	--	--	--	--	--	--	--	--	--	62714	DRI-WP-9	Spring	342	06/06/05
Sand Spring	39.33056	-115.45500	13.0	--	--	-16.20	-123.0	--	--	--	--	--	--	--	--	--	465	GS250	Spring	239	07/14/81
Sammy Spring	39.43597	-115.32453	11.6	6.9	6.93	-15.30	-117.6	--	--	--	--	--	--	--	--	--	62628	DRI-BT-2	Spring	343	05/24/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Sandstone Spring	36.21111	-114.55667	11.0	2.0	7.03	-10.50	-79.0	209.00	79.20	21.90	4.96	16.90	249.00	725.00	13.80	--	17	PL16	Spring	10	02/07/96
Sawmill Spring (Sheep)	36.68056	-115.17611	--	--	--	-12.85	-92.0	12.00	29.00	1.80	0.60	2.10	--	5.90	6.10	0.2	101	GS36	Spring	58	05/19/88
Sawmill Spring (Delamar Range)	37.36762	-114.69708	10.3	10.3	6.90	-12.58	-88.7	56.20	10.40	18.90	2.18	16.60	220.00	19.00	41.70	--	59685	--	Spring	259	03/22/04
Sawmill Spring West	37.36734	-114.69749	9.7	6.6	6.50	-12.86	-91.8	33.90	4.55	12.10	2.00	7.40	146.00	7.00	36.80	--	59684	--	Spring	258	03/22/04
Scirpus Spring (No spring on Map)	36.37694	-114.44917	17.0	0.7	7.13	-12.00	-90.0	513.00	186.00	350.00	25.30	386.00	266.00	2040.00	20.40	--	30	PL12	Spring	20	02/07/96
Scotty Spring	38.16479	-114.68374	14.2	1.9	7.07	-12.73	-98.9	67.30	12.60	23.00	1.36	30.70	254.00	21.10	44.60	--	60846		Spring	272	06/26/04
Seaman Spring	37.86120	-115.19877	--	--	--	-13.13	-99.0	--	--	--	--	--	--	--	--	--	--	--	Spring	306	06/25/04
Second Sawmill Spring	38.87583	-114.89861	6.5	--	--	-14.70	-110.0	--	--	--	--	--	--	--	--	--	431	GS212	Spring	222	08/01/85
Secret Spring	38.83889	-115.28972	--	--	--	-14.00	-110.0	--	--	--	--	11.00	--	--	--	--	427	GS208	Spring	220	06/16/83
Sheep Spring (Clover)	37.40063	-114.27779	10.0	--	6.80	-12.00	-87.0	24.00	5.00	9.80	1.30	7.90	96.00	7.00	33.00	0.7	209.5	Jim	Spring	108	06/03/85
Sheep Spring (Clover)	37.40063	-114.27779	18.5	1.1	6.90	-12.06	-90.5	32.70	6.46	11.80	2.01	9.80	143.00	5.10	45.50	--	61097	DRI-CR-9	Spring	108	07/31/04
Sheep Spring (Schell Ck)	38.67611	-114.77667	14.0	6.7	6.63	-13.70	-99.5	8.00	2.10	2.80	--	1.50	46.00	4.10	14.00	<.1	418	GS194	Spring	212	08/02/85
Sheep Spring (Sheep Range)	36.89500	-115.11472	15.0	6.5	7.75	-13.35	-96.0	31.00	40.00	7.90	1.10	7.10	--	13.00	13.00	0.2	159	GS57	Spring	83	05/19/88
Shellback Spring	39.13197	-115.38436	7.7	8.8	6.50	-16.54	-123.6	--	--	--	--	--	--	--	--	--	62719	DRI-WP-14	Spring	344	06/07/05
Shingle Spring	38.53972	-114.93472	15.0	--	--	-13.25	-103.5	--	--	--	--	--	--	--	--	--	388	GS168	Spring	203	08/03/85
Shingle Spring	38.53958	-114.93553	15.2	4.3	7.15	-13.41	-103.8	61.70	18.80	15.60	2.51	16.20	260.00	23.30	44.80	0.2	65048	ER-22	Spring	203	07/13/06
Sidehill Spring	38.41596	-114.79613	13.0	--	--	-13.05	-100.0	--	--	--	--	--	--	--	--	--	377	GS160	Spring	200	08/02/85
Sidehill Spring	38.41596	-114.79613	--	--	--	-13.10	-101.8	--	--	--	--	--	--	--	--	--	88483	SNWA	Spring	200	06/21/04
Sidehill Spring	38.41596	-114.79613	12.6	6.3	6.76	-13.37	-100.8	50.90	16.60	12.50	1.14	6.90	242.00	11.90	51.40	0.1	62981	--	Spring	200	08/01/05
Silver Spring	38.81085	-114.88121	9.3	7.8	6.72	-14.74	-111.9	80.60	5.42	5.40	0.66	3.50	261.00	10.30	12.50	0.1	62975	ER-7	Spring	385	07/29/05
Silver Spring (RS)	38.81061	-114.88117	9.0	8.3	7.43	-14.68	-110.8	79.90	5.50	5.45	0.59	3.10	255.00	10.70	12.60	0.1	65051	ER-25	Spring	385	07/13/06
Sixmile Spring	37.49222	-115.08806	22.0	--	7.85	-13.06	-93.4	45.19	10.58	16.90	1.30	3.20	207.00	11.70	49.58	0.1	230	IT151	Spring	112	08/08/95
SK-10	38.75000	-115.17000	--	--	--	--	-119.0	--	--	--	--	16.30	--	--	--	--	423	Kirk110	Well	218	--
SK-18	37.71000	-114.80000	--	--	--	--	-95.0	--	--	--	--	11.30	--	--	--	--	276	Kirk130	Well	134	--
Snow Creek Spring (Unnamed Spring in Snow Creek)	40.07837	-114.91138	7.9	9.3	7.21	-16.22	-120.7	--	--	--	--	--	--	--	--	--	62629A	DRI-CC-2	Spring	345	05/24/05
Snowmelt Below Duckwater Peak	38.90056	-115.38250	10.0	--		-14.10	-105.0	--	--	--	--	0.60	--	--	--	--	437	GS216	Surface	224	06/15/83
South Monument Spring	38.25586	-114.11651	9.1	5.8	7.10	-14.23	-102.3	25.50	5.59	12.60	5.78	22.50	101.00	8.60	55.50	--	60318	--	Spring	319	05/21/04
South Spring (Egan)	39.14556	-114.97000	7.0	--	---	-15.00	-111.0	--	--	--	--	3.00	--	--	--	--	458	GS244	Spring	236	06/17/83

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
South Springs (Egan)	39.14526	-114.97287	6.8	8.8	7.80	-15.23	-111.9	46.60	10.90	5.15	0.53	2.30	190.00	11.20	9.50	0.1	65040	ER-14	Spring	236	07/12/06
South Spring (Snake)	38.80405	-114.17588	9.7	5.7	6.87	-14.70	-108.0	66.30	28.80	2.23	0.54	2.60	3.40	343.00	7.60	0.2	62917	SN-7	Spring	383	07/14/05
Spencer Well	37.39500	-115.18028	19.0	--	7.69	-13.68	-104.1	53.76	43.97	119.40	14.50	45.90	466.00	158.00	59.81	1.6	206	IT155	Well	106	08/06/95
Spring Creek Spring	38.90935	-114.11295	12.9	8.1	7.26	-15.40	-113.0	64.20	7.85	6.94	1.22	6.70	12.50	227.00	11.50	1.5	62916	SN-8	Spring	384	07/16/05
Unnamed Spring nr Redd's Cabin Summit	38.12512	-114.06920	8.0	--	7.90	-12.50	-95.0	92.00	19.00	26.00	2.40	23.00	--	25.00	23.00	0.3	334	GS128	Spring	173	04/09/85
Unnamed Spring nr Redd's Cabin Summit	38.12512	-114.06920	15.9	7.7	7.85	-12.37	-93.7	93.10	21.30	30.90	1.32	26.90	374.00	31.60	25.50	--	60315	WM-3	Spring	173	05/21/04
Unnamed Spring in Schell Creek Range	38.51851	-114.74229	--	--	--	-14.40	-108.1	17.60	3.77	1.87	1.16	0.90	67.90	9.50	10.80	--	57756	--	Spring	304	10/29/03
Unnamed Spring in Schell Creek Range	38.51851	-114.74229	--	--	--	-14.46	-105.8	--	--	--	--	--	--	--	--	--	57756	--	Spring	304	10/29/03
Unnamed Spring in Schell Creek Range	38.51851	-114.74229	10.7	6.5	7.22	-14.61	-106.9	56.00	8.70	23.20	0.34	11.80	210.00	26.20	16.20	0.2	62976	SC-4	Spring	304	07/30/05
Unnamed Spring in Schell Creek Range	38.51851	-114.74229	11.0	3.8	7.41	-14.45	-108.3	55.60	8.58	21.40	<.1	11.50	210.00	25.00	15.40	0.1	65058	SC-9	Spring	304	07/14/06
Indian Spring near Steward Ranch	38.31056	-114.65028	8.0	--	7.00	-13.60	-102.0	38.00	5.90	17.00	0.60	7.90	161.00	12.00	46.00	0.2	357	GS141	Spring	188	04/05/85
Stock Well (Delamar Wash)	37.34944	-114.75833	--	--	--	--	-88.0	--	--	--	--	--	--	--	--	--	1000	GS999	Well	101	--
Stove Spring	39.09486	-115.36359	9.1	7.1	6.40	-15.71	-114.5	--	--	--	--	--	--	--	--	--	62711	DRI-WP-6	Spring	347	06/06/05
Summit Spring	39.55109	-115.23000	7.7	6.4	6.50	-15.94	-120.8	--	--	--	--	--	--	--	--	--	62702	DRI-BT-4	Spring	348	06/04/05
Summit Spring (Mahogany Mts.)	37.74984	-114.15359	13.2	2.1	7.07	-12.04	-92.1	107.00	24.40	57.10	2.74	59.40	422.00	40.80	55.00	0.4	64905	MG-2	Spring	419	06/21/06
Teaspoon Spring	38.34509	-115.41189	11.9	4.8	7.00	-13.26	-100.0	--	--	--	--	--	--	--	--	--	62830	--	Spring	371	06/30/05
The Seeps (Spring)	37.73944	-115.57556	9.0	--	7.50	-13.30	-98.0	110.00	25.90	53.00	3.88	41.70	455.00	53.40	55.00	--	281	K10	Spring	136	01/15/85
Thirty Mile Spring	39.55556	-115.21806	8.5	--	8.00	-16.40	-126.0	29.00	4.60	13.00	2.80	5.50	140.00	7.90	43.00	0.2	468	GS256	Spring	242	08/23/83
Tippet Spring	39.87691	-114.37348	21.4	2.8	6.80	-16.24	-121.9	54.80	30.20	7.65	1.08	7.10	279.00	26.00	12.00	0.1	63276	--	Spring	394	08/24/05
Tobe Spring	38.00609	-114.08980	19.8	8.0	8.70	-13.04	-100.0	49.60	7.84	25.30	3.21	20.90	89.10	20.50	45.60	--	60312	--	Spring	315	05/20/04
Tobe Spring 2	38.00675	-114.08969	13.7	4.0	7.20	-12.09	-93.6	38.20	5.72	17.10	3.44	14.80	157.00	7.00	47.00	--	60313	--	Spring	316	05/20/04
Trough Spring	38.36971	-114.96316	--	--	--	-13.56	-103.6	--	--	--	--	--	--	--	--	--	--	--	Spring	413	28-Oct_05
Tunnel Spring	39.35142	-115.44964	10.4	5.5	7.00	-15.02	-118.3	--	--	--	--	--	--	--	--	--	62832	--	Spring	366	07/01/05
Twin Spring	37.46996	-115.02371	16.9	7.0	7.23	-13.24	-97.4	40.90	9.48	17.20	2.15	10.40	190.00	8.80	48.60	--	61104	--	Spring	294	07/30/04
Unnamed Chokecherry Spring	37.53905	-114.70312	11.8	6.2	7.20	-12.54	-98.1	23.90	5.86	9.31	1.43	3.50	109.00	7.90	48.60	--	59696	--	Spring	263	03/25/04

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Unnamed Hayden Canyon Spring	39.15147	-115.39264	6.9	6.0	7.00	-15.69	-120.9	--	--	--	--	--	--	--	--	--	62718	DRI-WP-13	Spring	350	06/07/05
Unnamed Near Little Willow Spring	39.72235	-115.60986	9.4	8.4	7.20	-17.04	-125.9	--	--	--	--	--	--	--	--	--	62707	DRI-BK-3	Spring	351	06/05/05
Unnamed Shellback Ridge Spring	39.14038	-115.38952	7.0	0.3	4.90	-16.18	-123.6	--	--	--	--	--	--	--	--	--	62720	DRI-WP-15	Spring	352	06/07/05
Unnamed Spring (Unnamed Combs Creek Spring)	39.50919	-114.99298	--	--	--	-15.63	-118.9	--	--	--	--	--	--	--	--	--	62630	DRI-ER-6	Spring	353	05/24/05
Unnamed Spring #3 (Snake)	38.73321	-114.33335	11.7	6.5	6.78	-14.10	-109.0	104.00	21.40	44.70	1.70	90.10	70.00	283.00	114.00	0.2	62920	SN-3	Spring	379	07/13/05
Unnamed Spring #4 (Snake)	38.83515	-114.19643	6.1	5.0	6.43	-14.65	-107.2	131.00	22.30	6.06	1.02	6.60	474.00	17.90	11.00	0.1	62972	SN-1	Spring	376	07/28/05
Unnamed Spring #5 (Snake)	38.85148	-114.17036	11.9	5.8	6.97	-14.04	-106.7	58.40	30.80	9.34	1.22	9.20	322.00	9.20	10.90	0.1	62973	SN-2	Spring	377	07/28/05
Unnamed Spring #1 (White Pine)	38.96778	-115.39900	8.3	8.9	6.50	-15.36	-114.8	--	--	--	--	--	--	--	--	--	62818	--	Spring	359	06/28/05
Unnamed Spring #2 (Mahogany Mts)	37.94321	-114.06842	13.4	6.3	7.35	-13.47	-100.7	64.10	8.94	12.10	0.89	10.20	210.00	23.60	21.60	0.7	64907	MG-4	Spring	421	06/22/06
Unnamed Spring #1(White Rock Mts)	38.30341	-114.16038	10.4	8.0	7.35	-15.05	-109.6	47.20	8.85	15.90	0.98	45.50	128.00	14.00	35.50	0.1	64897	WM-8	Spring	415	06/19/06
Unnamed Spring #2 (White Rock Mts)	38.19539	-114.10582	11.1	2.8	6.67	-13.00	-97.0	29.10	7.85	10.40	0.52	3.30	130.00	8.30	40.70	0.2	64899	WM-10	Spring	417	06/19/06
Unnamed Spring #1(Egan)	39.06895	-114.91885	7.0	6.9	7.11	-15.14	-112.2	82.60	9.14	4.46	0.94	1.60	277.00	20.90	11.20	0.1	65044	ER-18	Spring	435	07/12/06
Unnamed Spring #2 (White Pine)	38.97696	-115.40065	8.7	5.9	5.70	-15.66	-114.9	--	--	--	--	--	--	--	--	--	62819	--	Spring	360	06/28/05
Unnamed Spring #2 (Egan Range)	39.04577	-114.92458	4.1	7.6	7.50	-15.14	-110.0	50.70	5.87	3.95	0.68	1.00	182.00	5.80	9.20	0.1	65045	ER-19	Spring	436	07/12/06
Unnamed Spring #3 (White Pine)	38.98418	-115.39037	9.8	2.9	6.10	-14.96	-113.1	--	--	--	--	--	--	--	--	--	62821		Spring	361	06/28/05
Unnamed Spring #3 (Egan Range)	39.05677	-114.92678	4.8	8.8	7.50	-15.07	-110.2	66.90	4.69	3.98	0.69	0.90	221.00	5.50	10.20	0.1	65046	ER-20	Spring	437	07/12/06
Unnamed Spring #4 (White Pine)	39.03633	-115.39347	8.1	3.7	6.90	-15.01	-116.3	--	--	--	--	--	--	--	--	--	62824	--	Spring	362	06/29/05
Unnamed Spring #4 (Egan Range)	39.08531	-114.92188	6.7	8.7	7.43	-15.37	-114.0	65.10	10.10	3.38	0.78	1.30	229.00	11.90	11.50	0.1	65047	ER-21	Spring	438	07/12/06
Unnamed Spring #5 (White Pine)	39.00631	-115.39043	9.0	7.0	7.00	-16.01	-120.4	--	--	--	--	--	--	--	--	--	62825	WP-13	Spring	363	06/29/05
Unnamed Spring #5 (White Pine)	39.00631	-115.39043	--	--	--	-14.04	-106.7	--	--	--	--	--	--	--	--	--	62973	WP-13	Spring	363	07/28/01
Unnamed Spring #5 (RS, White Pine)	39.00630	-115.39043	8.9	6.8	7.12	-16.02	-120.8	62.50	5.30	14.80	1.16	6.90	224.00	10.60	30.50	0.2	65038	WP-13	Spring	363	07/11/06
Unnamed Spring #5 (Egan Range)	38.90310	-114.92343	7.3	7.1	7.04	-14.72	-109.6	93.10	18.30	4.39	0.92	3.30	331.00	32.40	14.00	0.1	65054	ER-28	Spring	445	07/13/06

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Unnamed Spring #6 (White Pine)	38.99300	-115.37519	9.1	0.5	6.80	-14.98	-115.1	--	--	--	--	--	--	--	--	--	62826	--	Spring	364	06/29/05
Unnamed Spring #7 (Quinn)	38.16152	-115.64159	7.4	6.1	6.70	-14.23	-105.9	--	--	--	--	--	--	--	--	--	62834	--	Spring	367	07/02/05
Unnamed Spring #8 (Quinn)	38.05659	-115.66484	11.5	0.3	6.50	-14.18	-104.4	--	--	--	--	--	--	--	--	--	62835	--	Spring	368	07/02/05
Unnamed Spring #7 (Kern MTS)	39.68072	-114.19089	10.2	0.1	6.32	-15.80	-116.3	51.50	11.00	25.70	0.82	14.90	232.00	14.10	36.00	0.4	63273	--	Spring	391	08/23/05
Unnamed Spring #8 (Antelope Range)	39.98778	-114.43341	9.2	2.9	6.13	-15.85	-121.4	35.90	6.98	12.80	1.89	11.10	130.00	22.10	44.90	0.1	63277	--	Spring	395	08/24/05
Unnamed Spring #9 (Antelope Range)	39.99364	-114.42071	8.3	5.6	6.16	-16.41	-123.0	32.80	6.25	8.86	3.03	14.80	109.00	14.90	44.40	0.1	63278	--	Spring	396	08/25/05
Unnamed Spring #10 (Antelope Range)	39.93797	-114.36074	12.9	1.3	6.59	-15.95	-122.0	92.00	49.20	34.10	1.19	35.50	329.00	175.00	19.30	0.2	63279	--	Spring	397	08/25/05
Unnamed Springs #11(Snake Range)	39.48477	-114.31032	8.9	7.9	6.71	-15.65	-117.1	60.10	11.40	11.40	1.56	8.30	231.00	11.10	19.10	0.1	63283	--	Spring	401	08/26/05
Unnamed Spring #12 (Snake Range)	39.30746	-114.21610	7.6	6.5	7.24	-15.89	-116.6	39.10	3.53	4.78	0.64	2.40	130.00	4.20	11.90	0.1	63527	--	Spring	403	10/25/05
Unnamed Sp Silver Cr Canyon	39.22899	-114.26075	9.2	3.1	7.39	-15.38	-115.7	71.30	30.40	8.93	0.75	6.60	322.00	35.40	12.60	0.1	63529	--	Spring	405	10/26/05
Unnamed Spring 13 (Snake Range)	39.17779	-114.28686	9.9	6.2	7.48	-14.76	-114.3	79.10	94.70	67.80	1.14	83.60	437.00	234.00	19.60	0.2	63530	--	Spring	406	10/26/05
Unnamed Stone Cabin Spring	39.15911	-115.39892	8.5	8.2	6.80	-15.31	-114.2	--	--	--	--	--	--	--	--	--	62717	DRI-WP-12	Spring	354	06/07/05
Unnamed Stone Cabin Spring	39.15911	-115.39892	9.2	7.2	7.31	-15.47	-118.2	66.70	11.70	14.30	0.92	7.90	248.00	13.00	16.80	0.2	65036	WP-11	Spring	354	07/11/06
Unnamed Spring (Clover)	37.27654	-114.30744	3.3	4.9	7.09	-12.20	-88.0	126.00	22.60	56.60	1.51	14.80	401.00	157.00	35.40	--	58501	--	Spring	249	01/15/04
Unnamed Spring	37.49917	-114.45250	10.0	--	--	-11.60	-86.5	--	--	--	--	--	--	--	--	--	231	GS85	Spring	113	06/03/85
Unnamed Spring in dry creek bed (White Pine Range)	38.89546	-115.38372	--	--	--	-15.31	-113.6	--	--	--	--	--	--	--	--	--	--		Spring	321	10/12/03
Unnamed Spring in Miller Canyon	38.32738	-114.24383	--	--	--	-14.27	-103.7	--	--	--	--	--	--	--	--	--	--		Spring	313	05/19/04
Unnamed Spring in Road (South Pahroc Range)	37.53638	-115.10651	28.4	4.5	6.37	-13.07	-96.7	42.60	10.00	16.10	1.53	8.80	193.00	8.70	49.70	--	61098	--	Spring	303	07/30/04
Unnamed Spring nr Clover Creek	37.61461	-114.45061	16.2	0.9	6.99	-11.96	-89.7	67.40	9.05	29.90	6.83	20.30	299.00	11.10	55.60	--	61102	--	Spring	252	07/31/04
Unnamed Spring nr Six Mile seep	37.49680	-115.09102	--	--	--	-12.62	-94.5	--	--	--	--	--	--	--	--	--	61106A	--	Spring	296	07/30/04
Unnamed Spring--nr Blackrock	37.91689	-114.91859	9.2	7.1	7.40	-11.90	-94.3	45.90	9.28	25.80	6.14	23.70	184.00	23.10	69.20	--	59688	--	Spring	299	03/23/04
Unnamed Well (Longdale)	36.59000	-114.48000	--	--	7.80	-13.20	-103.0	29.00	2.20	35.00	5.20	6.00	135.00	26.00	132.68	1.0	78	IT174	Well	48	03/04/74

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Unnamed Well (Near Dry Lake Range)	36.38278	-114.91667	26.5	0.5	7.33	-13.70	-96.0	123.00	46.00	140.00	16.00	190.00	230.00	360.00	21.00	1.6	41	GS12	Well	24	04/26/82
South Fox Well	38.77222	-114.52667	12.0	3.3	7.80	-15.00	-113.0	34.00	21.00	7.10	1.60	6.00	--	8.00	15.00	0.3	422	GS201	Well	216	07/06/83
Unnamed, Kaolin Wash	36.48722	-114.46667	14.1	6.0	8.46	-11.30	-88.0	48.90	25.90	77.60	21.30	46.50	213.00	168.00	19.10	--	67	PL3	Spring	35	02/09/96
Upper Burnt Canyon Spring	38.28729	-114.20049	14.8	3.0	6.80	-12.83	-97.6	65.90	15.30	11.50	0.57	17.30	251.00	6.70	50.40	0.2	64898	WM-9	Spring	416	06/19/06
Upper Burnt Canyon Spring #2	38.28729	-114.20049	--	--	--	-13.66	-103.6	--	--	--	--	--	--	--	--	--	--	WM-9b	Spring	416	06/19/06
Upper Chokecherry Spring	37.53746	-114.69833	9.3	7.3	8.00	-12.96	-98.9	53.00	10.60	23.20	1.23	13.60	219.00	16.70	50.00	--	59695	--	Spring	262	03/25/04
Upper Conner Spring	37.90278	-114.56056	8.0	8.2	7.43	-13.85	-100.0	73.00	26.00	2.20	0.50	2.10	351.00	5.40	8.50	<.1	310	GS115	Spring	156	11/11/86
Upper Conner Spring	37.90278	-114.56056	9.2	8.1	7.74	-13.88	-102.3	76.90	27.60	1.58	0.59	1.90	368.00	3.60	8.50	--	60836	--	Spring	156	06/24/04
Upper Fairview	38.18657	-114.66620	18.0	1.8	7.23	-12.66	-97.7	60.20	10.60	28.10	2.64	23.60	259.00	14.50	48.40	--	60850	--	Spring	280	06/29/04
Upper Illipah Crk	39.28167	-115.39000	--	--	--	-16.00	-124.0	--	--	--	--	--	--	--	--	--	--	GS999	Surface	238	06/13/83
Upper Illipah Crk	39.28167	-115.39000	--	--	--	-16.20	-123.0	--	--	--	--	--	--	--	--	--	--	GS999	Surface	238	08/23/83
Upper Illipah Crk	39.28167	-115.39000	--	--	--	-15.95	-120.9	--	--	--	--	--	--	--	--	--	68119	SNWA	Surface	238	08/05/03
Upper Indian Spring	37.45202	-114.65831	11.7	3.6	7.31	-11.46	-88.0	68.00	19.30	23.90	0.34	9.10	319.00	13.00	53.40	--	58499		Spring	268	01/14/04
Unnamed Spring near Pony Spring	38.32139	-114.64222	11.5	--	--	-12.90	-99.0	--	--	--	--	--	--	--	--	--	361	GS144	Spring	191	07/23/81
Upper Riggs Spring WR4	37.36833	-114.64778	10.8	--	--	-11.90	-88.0	--	--	--	--	--	--	--	--	--	207	GS78	Spring	105	02/02/84
Upper Riggs Spring WR4	37.36833	-114.64778	10.1	4.4	7.30	-11.90	-87.0	64.70	15.90	19.40	0.02	17.50	274.00	12.00	57.80	--	58492	--	Spring	105	01/13/04
Upper Riggs Spring WR4	37.36833	-114.64778	16.9	10.9	7.99	-11.95	-86.6	57.60	15.90	17.60	3.36	16.50	256.00	12.70	48.80	--	60082	--	Spring	105	04/29/04
Upper Riggs Spring WR4	37.36833	-114.64778	13.2	0.7	7.37	-11.55	-86.2	63.40	16.60	18.80	4.16	16.40	277.00	8.70	57.20	--	61614	--	Spring	105	10/19/04
Upper Riggs Spring WR4	37.36833	-114.64778	6.0	6.8	7.08	-12.46	-87.0	35.50	8.79	11.60	2.04	7.20	153.00	8.10	42.00	--	62035	--	Spring	105	02/10/05
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	--	--	39.70	10.90	4.09	0.72	2.10	173.00	7.30	11.90	--	57696	ER-1	Spring	270	10/13/03
Upper Terrace Spring WR2	39.08664	-114.92565	8.2	5.1	7.10	-15.43	-114.9	39.80	11.00	4.07	0.72	2.10	172.00	7.30	12.10	--	57697	ER-1	Spring	270	10/15/03
Upper Terrace Spring WR2	39.08664	-114.92565	7.6	--	7.90	-15.44	-111.8	40.50	10.80	4.25	0.80	2.10	172.00	7.10	9.20	--	60080	ER-1	Spring	270	04/26/04
Upper Terrace Spring WR2	39.08664	-114.92565	8.0	8.0	7.51	-15.40	-115.6	40.40	10.70	3.60	0.71	2.40	169.00	7.40	11.80	--	60785	ER-1	Spring	270	06/23/04
Upper Terrace Spring WR2	39.08664	-114.92565	8.2	7.1	6.85	-15.35	-114.4	41.60	11.30	4.29	0.75	2.40	177.00	7.30	11.80	--	61479	ER-1	Spring	270	09/22/04
Upper Terrace Spring WR2	39.08664	-114.92565	7.2	8.3	7.82	-15.41	-114.6	40.30	10.70	4.24	0.81	2.30	168.00	7.70	11.10	--	62030	ER-1	Spring	270	02/09/05
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	-15.24	-113.7	--	--	--	--	--	--	--	--	--	62633A	ER-1	Spring	270	05/21/05
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	-15.43	-113.4	41.80	10.50	4.14	0.76	2.30	173.00	7.90	11.20	<.05	63219	ER-1	Spring	270	08/14/05
Upper Terrace Spring WR2	39.08664	-114.92565	7.7	8.1	7.77	-15.41	-113.7	41.30	10.80	4.06	0.74	2.20	167.00	7.50	11.30	0.1	63562	ER-1	Spring	270	11/06/05
Upper Terrace Spring WR2	39.08664	-114.92565	7.5	8.3	7.87	-15.41	-114.5	40.50	10.70	4.23	1.10	2.30	164.00	7.70	11.50	0.1	64734	ER-1	Spring	270	05/24/06
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	-15.43	-114.1	--	--	--	--	--	--	--	--	--	--	ER-1	Spring	270	07/12/06
Upper Terrace Spring WR2	39.08664	-114.92565	7.9	7.6	7.68	-15.48	-114.1	41.40	10.90	3.65	0.61	2.13	166.00	7.61	11.20	0.1	65364	ER-1	Spring	270	08/29/06
Upper Terrace Spring WR2	39.08664	-114.92565	7.7	7.1	7.80	-15.50	-115.2	41.10	10.90	4.34	0.92	1.40	169.00	7.20	11.20	0.1	65651	ER-1	Spring	270	10/27/06
Upper Terrace Spring WR2	39.08664	-114.92565	7.5		7.87	-15.46	-114.2	40.30	10.70	4.07	0.76	1.89	173.00	6.47	10.60	0.1	65651	ER-1	Spring	270	05/08/07

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
Upper Terrace Spring WR2	39.08664	-114.92565	8.2	6.2	7.70	-15.46	-114.7	39.80	10.70	4.07	0.82	1.25	178.00	6.92	10.80	--	67247	ER-1	Spring	270	08/23/07
Upper Terrace Spring WR2	39.08664	-114.92565	8.0	5.9	7.83	-15.46	-113.6	41.70	11.20	4.00	0.75	1.90	176.00	6.70	10.50	0.1	67510	ER-1	Spring	270	11/03/07
Upper Terrace Spring WR2	39.08664	-114.92565	7.8	8.2	7.84	-15.48	-113.7	39.90	11.00	4.08	0.77	2.00	176.00	6.66	10.40	0.1	68479	ER-1	Spring	270	06/01/08
Upper Terrace Spring WR2	39.08664	-114.92565	8.4	8.2	7.78	-15.54	-113.3	38.80	10.70	3.95	0.67	2.07	178.00	6.82	11.00	0.1	68910	ER-1	Spring	270	09/10/08
Upper Terrace Spring WR2	39.08664	-114.92565	8.3	7.9	7.86	-15.50	-114.8	40.10	11.00	4.11	0.88	1.95	184.00	6.75	10.50	0.1	69141	ER-1	Spring	270	10/29/08
Upper Terrace Spring WR2	39.08664	-114.92565	7.9	8.1	7.85	-15.55	-114.3	39.60	10.80	4.00	0.75	1.97	168.00	6.61	10.40	0.1	69862	ER-1	Spring	270	05/19/09
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	-15.47	-114.9	40.80	10.90	4.08	0.69	2.04	172.00	6.42	11.20	0.1	69862	ER-1	Spring	270	08/15/09
Upper Terrace Spring WR2	39.08664	-114.92565	--	--	--	-15.64	-114.9	40.80	11.00	4.12	0.77	2.07	182.00	6.58	10.50	0.1	70610	ER-1	Spring	270	11/13/09
Upper Tower Spring	38.12049	-114.33344	--	--	--	-12.30	-93.3	20.20	3.33	16.30	6.15	7.60	104.00	7.20	45.80	--	60081	--	Spring	312	04/28/04
US Lime Well (Genstar)	36.39139	-114.90389	24.0	4.8	7.40	-12.75	-97.0	120.00	47.00	140.00	1.30	180.00	226.00	370.00	23.00	1.6	52	GS16	Well	27	03/31/86
USGS CSV-1	36.76694	-114.86194	29.5	--	--	-13.55	-103.0	260.00	93.00	160.00	30.00	39.00	--	1300.00	19.00	1.2	127	GS45	Well	71	05/18/88
USGS-MX C.V. Well (CV-DT-1)	38.13778	-115.33861	23.0	3.4	7.20	-14.60	-110.0	37.00	19.00	20.00	4.60	5.70	253.00	26.00	36.00	0.4	338	GS130	Well	176	10/15/81
USGS-MX C.V. Well (CV-DT-1)	38.13778	-115.33861	--	--		-14.52	-108.0	--	--	--	--	--	--	--	--	--	USGS	--	Well	--	06/25/03
USGS-MX CE, VF-1	36.87528	-114.94528	28.0	--	7.03	-12.65	-94.0	41.00	7.50	34.00	1.20	42.00	156.00	20.00	14.00	0.5	157	GS56	Well	82	01/06/88
Valley of Fire Well	36.42250	-114.54778	28.0	--	7.40	-10.60	-82.0	118.00	53.00	39.00	8.20	21.00	164.00	449.00	8.30	0.2	58	PLC33	Well	31	06/24/85
VF Spring 1	36.40139	-114.40194	23.0	5.0	7.10	-11.20	-88.0	--	--	--	--	--	--	--	--	--	53	PL7	Spring	28	02/09/96
VF Spring 2	36.40528	-114.43056	13.5	3.9	7.76	-11.80	-92.0	--	--	--	--	--	--	--	--	--	55	PL6	Spring	29	03/07/96
VF Spring 3	36.40583	-114.44389	15.0	5.3	7.61	-12.20	-93.0	537.00	208.00	295.00	51.10	278.00	169.00	2290.00	12.40	--	57	PL5	Spring	30	03/07/96
Wamp Spring	36.64167	-115.07000	7.0	--	8.15	-10.60	-81.0	71.00	13.00	10.00	2.10	4.90	585.00	8.40	24.00	0.2	91	GS31	Spring	52	03/20/87
Water Canyon	38.98816	-114.96032	11.0	--	--	-15.00	-115.0	--	--	--	--	--	--	--	--	--	1033	GS999	Surface	233	06/14/83
Water Canyon	38.98816	-114.96032	9.0	--	--	-15.50	-117.0	--	--	--	--	--	--	--	--	--	1033	GS999	Surface	233	08/23/83 --
Water Canyon at USGS gage	38.98700	-114.95500	--	--	--	-15.41	-109.5	--	--	--	--	--	--	--	--	--	--	--	Spring	271	10/24/03
Water Canyon at USGS gage (duplicate sample)	38.98700	-114.95500	--	--	--	-15.43	-112.7	--	--	--	--	--	--	--	--	--	--	--	Spring	271	10/24/03
Water Canyon Spring	39.00691	-114.91063	8.9	7.9	7.30	-15.60	-114.4	40.10	11.00	4.04	0.72	7.30	180.00	1.64	12.00	--	57695	--	Spring	358	10/14/03
Water Canyon Spring (Mahogany)	37.95662	-114.06494	11.1	2.2	7.11	-13.68	-100.4	81.90	11.80	9.44	1.12	5.10	210.00	84.10	17.20	1.6	64906	MG-3	Spring	420	06/22/06
Water Tank 0.4mi West of Sixmile	37.49119	-115.09605	--	--	--	-12.44	-93.8	--	--	--	--	--	--	--	--	--	61106C	--	Spring	297	07/30/04
Weaver Well	37.74472	-114.43070	17.0	--	7.70	-13.10	-101.0	100.00	42.00	110.00	14.00	110.00	430.00	180.00	73.00	2.9	283	GS100	Well	137	06/04/85
Well at Alligator Ridge	39.73735	-115.51432	34.0	4.1	7.20	-16.60	-127.0	60.00	23.00	19.00	6.50	6.70	--	52.00	26.00	1.0	469	GS260	Well	243	04/24/84
White Rock Spring (Sheep)	36.70791	-115.23942	19.9	1.7	7.02	-9.96	-84.8	41.80	35.10	18.20	11.90	10.80	326.00	12.70	57.70	--	61095	--	Spring	64	07/27/04
White Rock Spring (Sheep)	36.70791	-115.23942	10.2	3.8	6.51	-10.38	-86.1	39.80	35.20	16.80	10.50	10.30	303.00	12.50	46.50	--	62398	DRI-SR-3	Spring	64	04/28/05

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
White Rock Spring (Butte)	40.06079	-115.16385	9.4	6.0	6.38	-15.36	-119.2	--	--	--	--	--	--	--	--	--	62631	DRI-BT-3	Spring	355	05/24/05
White Rock Well	38.12557	-114.17027	14.5	--	7.90	-13.10	-101.0	68.00	10.00	11.00	4.00	51.00	168.00	20.00	61.00	0.6	336	E4	Well	175	07/24/75
White Rock Spring (Seaman Range)	37.89630	-115.01970	--	--	--	-12.10	-90.0	--	--	--	--	--	--	--	--	--	308	Kirk1019	Spring	154	01/13/85
								--	--	--	--	--	--	--	--	--					
Wildhorse Spring (Fairview)	38.19722	-114.60861	8.0	--	7.60	-11.70	-92.5	--	--	--	--	--	--	--	--	--	348	GS136	Spring	183	04/06/85
Wild Horse Spring (White Pine)	39.33361	-115.44333	17.5	--	--	-16.80	-129.0	--	--	--	--	--	--	--	--	--	466	GS251	Spring	240	07/14/81
Warm Spring (White Pine Range)	38.94778	-115.22806	53.0	1.0	9.25	-15.80	-118.0	1.60	<.12	61.00	0.60	9.40	--	16.00	56.00	13.0	453	GS204	Spring	232	04/29/82
Warm Spring (White Pine Range)	38.94778	-115.22806	--	--	--	-14.37	-114.8	--	--	--	--	--	--	--	--	--	112273	SNWA	Spring	232	07/26/05
Willow Spring (KSV-1)	37.09483	-114.83096	--	--	--	-11.90	-86.5	--	--	--	--	--	--	--	--	--	180	Kirk1026	Spring	92	--
Willow Spring (KSV-1)	37.09483	-114.83096	17.4	--	7.50	-11.60	-88.0	20.00	2.70	56.00	4.60	22.00	140.00	34.00	65.00	1.1	182	GS67	Spring	92	02/03/84
Willow Spring (KSV-1)	37.09483	-114.83096	9.3	8.3	7.52	-11.57	-88.0	18.20	3.17	55.90	2.24	21.30	131.00	33.50	67.30	--	58489		Spring	92	01/12/04
Willow Spring (KSV-1)	37.09483	-114.83096	16.7	1.6	7.44	-11.63	-89.1	19.90	4.25	9.85	1.74	6.50	84.90	6.30	37.20	--	62395	DRI-DR-2	Spring	92	04/27/05
Willow Spring 2 (So.of Oak Sps.summit)	37.55653	-114.69773	13.7	2.5	7.40	-11.69	-91.2	59.40	14.70	25.50	1.79	13.60	274.00	15.20	55.70	--	59693	--	Spring	260	03/25/04
Wilson Creek	38.31806	-114.40333	17.0	--	8.00	-13.20	-97.5	21.00	3.30	11.00	2.90	7.00	77.00	11.00	39.00	0.3	358	E2	Surface	189	04/05/85
Wiregrass Spring (Sheep)	36.63325	-115.20842	9.5	--	7.30	-12.80	-94.0	69.00	32.00	2.70	1.10	3.00	--	5.00	12.00	0.1	82	GS22	Spring	49	10/28/81
Wiregrass Spring (Sheep)	36.63325	-115.20842	6.5	6.1	7.30	-12.70	-96.0	68.00	32.00	3.20	1.10	3.20	--	9.00	12.00	0.1	83	GS23	Spring	49	05/11/83
Wiregrass Spring (Sheep)	36.63325	-115.20842	--	--	--	-12.85	-94.0	--	--	--	--	--	--	--	--	--	83.5	JIM	Spring	49	10/09/86
Wiregrass Spring (Sheep)	36.63325	-115.20842	4.0	--	7.32	-12.80	-91.5	71.00	34.00	2.80	1.10	3.40	374.00	6.90	12.00	0.1	84	GS24	Spring	49	03/20/87
Wiregrass Spring (Sheep)	36.63325	-115.20842	13.0	--	--	-12.55	-92.0	70.00	33.00	2.80	1.50	2.90	--	7.10	12.00	0.2	85	GS25	Spring	49	06/17/87
Wiregrass Spring (Sheep)	36.63325	-115.20842	14.0	5.4	7.34	-12.75	-94.0	68.00	33.00	3.10	1.00	2.90	372.00	7.30	12.00	0.2	86	GS26	Spring	49	08/04/87
Wiregrass Spring (Sheep)	36.63325	-115.20842	4.0	5.0	7.32	-12.85	-97.0	72.00	34.00	3.10	5.70	3.80	--	7.70	12.00	0.2	87	GS27	Spring	49	01/05/88
Wiregrass Spring (Sheep)	36.63325	-115.20842	8.0	5.0	7.41	-12.95	-95.5	72.00	34.00	2.80	1.00	2.60	--	7.30	12.00	0.2	88	GS28	Spring	49	04/06/88
Wiregrass Spring (Sheep)	36.63325	-115.20842	7.0	--	7.30	-12.85	-94.5	69.00	36.00	3.10	1.10	2.70	--	7.30	12.00	0.1	89	GS29	Spring	49	12/12/88
Wiregrass Spring (Sheep)	36.63325	-115.20842	8.2	2.3	7.34	-12.87	-94.0	--	--	--	--	--	--	--	--	--	58487	--	Spring	49	01/17/04
Wiregrass Spring (Sheep)	36.63325	-115.20842	9.9	2.5	6.89	-13.12	-96.8	67.80	33.20	2.48	0.98	3.70	367.00	6.00	14.40	--	60851	--	Spring	49	06/30/04
Wiregrass Spring (Sheep)	36.63325	-115.20842	8.3	4.0	6.55	-13.76	-101.2	74.40	40.60	3.92	1.27	3.90	404.00	5.40	14.80	--	62400	DRI-SR-2	Spring	49	04/29/05
Wiregrass Spring (Sheep)	36.63325	-115.20842	--	--	--	-13.19	-95.6	--	--	--	--	--	--	--	--	--	--	SH-2	Spring	49	04/29/06
Wiregrass Spring (Grant)	38.35211	-115.42693	14.3	4.3	7.50	-13.29	-101.4	--	--	--	--	--	--	--	--	--	62831	--	Spring	372	06/30/05
Woodchuck Spring	39.72453	-115.57297	7.5	6.9	6.80	-15.55	-119.6	--	--	--	--	--	--	--	--	--	62706	DRI-BK-2	Spring	356	06/05/05
180W501	38.59201	-114.84080	--	--	--	-14.12	-105.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	600	05/17/06
180W902M	38.36331	-114.82750	--	--	--	-13.99	-107.1	--	--	--	--	--	--	--	--	--	120738	SNWA	Well	601	10/19/05
180W902M	38.36331	-114.82750	--	--	--	-14.12	-104.7	--	--	--	--	--	--	--	--	--	--	SNWA	Well	601	05/18/06
181M1	37.91163	-114.85528	--	--	--	-13.57	-104.9	--	--	--	--	--	--	--	--	--	120739	SNWA	Well	603	08/30/05
181M1	37.91163	-114.85528	--	--	--	-13.67	-105.0	--	--	--	--	--	--	--	--	--	--	SNWA	Well	603	05/31/06
181W909M	37.69600	-114.74639	--	--	--	-13.70	-106.4	--	--	--	--	--	--	--	--	--	120737	SNWA	Well	604	04/27/05
181W909M	37.69600	-114.74639	--	--	--	-13.50	-104.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	604	06/05/06
182M-1	37.34683	-114.95796	--	--	--	-14.07	-109.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	606	05/23/06

APPENDIX 1. ISOTOPIC, FIELD PARAMETER, AND WATER CHEMISTRY DATA FOR ALL SITES USED IN THIS STUDY AND SOME ADDITIONAL SITES IN EASTERN AND SOUTHERN NEVADA (CONTINUED).

Name	Latitude Degrees	Longitude Degrees	Water Temp. (°C)	DO (mg/L)	pH	$\delta^{18}O$ (‰)	δD (‰)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Sample #	REF_ID	Site Type	Site #	Date
182W906M	37.32691	-114.85463	--	--	--	-12.89	-103.6	--	--	--	--	--	--	--	--	--	120743	SNWA	Well	607	03/19/05
182W906M	37.32691	-114.85463	--	--	--	-13.40	-100.7	--	--	--	--	--	--	--	--	--	120741	SNWA	Well	607	09/02/05
209M-1	37.64351	-114.98950	--	--	--	-13.00	-99.7	--	--	--	--	--	--	--	--	--	120742	SNWA	Well	608	08/04/05
209M-1	37.64351	-114.98950	--	--	--	-13.53	-104.7	--	--	--	--	--	--	--	--	--	--	SNWA	Well	608	06/14/06
CSI-1	36.79768	-114.91471	--	--	--	-13.08	-102.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	609	05/31/05
CSI-2	36.79768	-114.91471	--	--	--	-12.90	-100.2	--	--	--	--	--	--	--	--	--	--	SNWA	Well	610	09/30/05
CSI-3	36.82554	-114.91667	--	--	--	-13.03	-99.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	611	09/13/06
CSI-4	36.84998	-114.95452	--	--	--	-12.68	-98.6	--	--	--	--	--	--	--	--	--	174086	SNWA	Well	628	12/05/07
CSVM-1	36.79118	-114.88621	--	--	--	-13.13	-99.3	--	--	--	--	--	--	--	--	--	65462	SNWA	Well	632	02/27/03
CSVM-2	36.66182	-114.92305	--	--	--	-13.13	-96.3	--	--	--	--	--	--	--	--	--	65453	SNWA	Well	612	02/23/03
CSVM-2	36.66182	-114.92305	--	--	--	-13.14	-97.7	--	--	--	--	--	--	--	--	--	--	SNWA	Well	612	01/10/06
CSVM-3	37.05250	-114.98336	--	--	--	-12.86	-98.4	--	--	--	--	--	--	--	--	--	65456	SNWA	Well	613	05/19/03
CSVM-3	37.05250	-114.98336	--	--	--	-13.10	-98.0	--	--	--	--	--	--	--	--	--	--	SNWA	Well	613	01/06/06
CSVM-4	36.99106	-114.88648	--	--	--	-13.37	-102.7	--	--	--	--	--	--	--	--	--	65455	SNWA	Well	614	03/26/03
CSVM-4	36.99106	-114.88648	--	--	--	-13.41	-102.5	--	--	--	--	--	--	--	--	--	--	SNWA	Well	614	01/16/06
CSVM-5	36.74758	-114.98045	--	--	--	-12.82	-94.0	--	--	--	--	--	--	--	--	--	65452	SNWA	Well	615	02/06/03
CSVM-5	36.74758	-114.98045	--	--	--	-12.67	-95.0	--	--	--	--	--	--	--	--	--	--	SNWA	Well	615	01/08/06
CSVM-6	36.83250	-114.90916	--	--	--	-12.94	-100.2	--	--	--	--	--	--	--	--	--	65454	SNWA	Well	616	03/20/03
CSVM-6	36.83250	-114.90916	--	--	--	-12.97	-100.7	--	--	--	--	--	--	--	--	--	--	SNWA	Well	616	01/11/06
CSVM-7	37.04701	-114.99571	--	--	--	-12.47	-93.9	--	--	--	--	--	--	--	--	--	65457	SNWA	Well	617	05/04/03
CSVM-7	37.04701	-114.99571	--	--	--	-12.51	-93.6	--	--	--	--	--	--	--	--	--	--	SNWA	Well	617	01/23/06
KPW-1	--	--	--	--	--	-13.63	-105.0	--	--	--	--	--	--	--	--	--	120744	SNWA	Well	618	12/15/05
RW-1	36.45565	-114.84709	--	--	--	-13.19	-100.9	--	--	--	--	--	--	--	--	--	112270	SNWA	Well	624	07/20/05
CAV6002X	38.36281	-114.82736	--	--	--	-14.27	-106.3	--	--	--	--	--	--	--	--	--	174083	SNWA	Well	627	12/03/07
CSV3009X	36.98363	-114.96546	--	--	--	-13.48	-100.2	--	--	--	--	--	--	--	--	--	200044	SNWA	Well	629	12/08/08
CSV3011X	36.98195	-114.93191	--	--	--	-12.83	-90.4	--	--	--	--	--	--	--	--	--	200046	SNWA	Well	630	12/16/08
CSV3011X	36.98195	-114.93191	--	--	--	-12.87	-94.0	--	--	--	--	--	--	--	--	--	200045	SNWA	Well	630	12/20/08
UMVM-1 (MRS1009M)	36.75808	-114.82324	--	--	--	-13.15	-98.9	--	--	--	--	--	--	--	--	--	65460	SNWA	Well	631	06/14/03
GV-1	36.43506	-114.95859	--	--	--	-13.15	-98.8	--	--	--	--	--	--	--	--	--	79439	SNWA	Well	634	01/15/04
GV-2	36.35828	-114.92445	--	--	--	-13.46	-96.8	--	--	--	--	--	--	--	--	--	69559	SNWA	Well	635	09/25/03
PW-1	37.89546	114.71828	24.4	-	-	-13.4	-101	37	19	37	3.9	15	190	32	--	--	SNWA	DL-2	Well	636	1/21/10

APPENDIX 2. AMOUNT OF PRECIPITATION AND ISOTOPIC COMPOSITION FROM BULK STORAGE GAUGES AT WR1 IN THE WHITE PINE RANGE, WR2 IN THE EGAN RANGE, WR3 IN THE SCHELL CREEK RANGE, AND WR4 IN THE DELAMAR MOUNTAINS.

Site	Start Date	End Date	Precipitation (in)	$\delta^{18}O$	δD
WR1 - Altitude 8,012 ft	10/23/03	3/23/04	7.10	-17.13	-124.1
	3/23/04	4/26/04	9.60	-16.19	-116.4
	4/26/04	6/21/04	1.32	--	--
	6/21/04	9/22/04	2.76	-11.95	-87.8
	9/22/04	1/21/05	12.96	--	--
	1/21/05	5/21/05	15.36	-16.19	-112.9
	5/21/05	8/14/05	0.60	-11.79	-82.1
	8/14/05	11/5/05	0.96	-8.95	-58.5
	11/5/05	2/24/06	6.00	--	--
	2/24/06	5/20/06	9.36	-15.12	-107.8
	5/20/06	8/29/06	3.00	-7.11	-48.4
	8/29/06	11/15/06	2.40	-13.59	-96.8
	11/15/06	5/6/07	8.40	-17.42	-126.7
	5/6/07	8/19/07	2.76	-10.82	-79.8
	8/19/07	11/3/07	1.44	-11.70	-83.1
	11/3/08	3/3/08	8.04	-16.82	-122.2
	3/3/08	5/29/08	0.96	-16.58	-121.3
	5/29/08	9/14/08	2.88	-9.82	-70.0
	9/14/08	10/31/08	0.96	-10.09	-68.1
	10/31/08	1/15/09	4.32	-18.32	-132.1
	1/15/09	5/19/09	10.32	-16.36	-119.0
	5/19/09	8/16/09	4.20	-10.64	-75.3
	8/16/09	11/16/09	2.52	-16.97	-122.9
WR2 - Altitude 8,747 ft	10/15/03	4/26/04	13.32	-16.93	-119.8
	4/26/04	6/23/04	1.8	--	--
	6/23/04	9/22/04	1.68	-13.15	-93.5
	9/22/04	2/9/05	14.04	-16.53	-117.7
	2/9/05	5/21/05	21.24	-17.59	-127.6
	5/21/05	7/26/05	1.32	--	--
	7/26/05	8/11/05	0.36	--	--
	8/11/05	11/7/05	2.4	-11.70	-79.1
	11/7/05	5/24/06	16.92	-16.30	-116.4
	5/24/06	8/29/06	3.96	-9.28	-60.2

APPENDIX 2. AMOUNT OF PRECIPITATION AND ISOTOPIC COMPOSITION FROM BULK STORAGE GAUGES AT WR1 IN THE WHITE PINE RANGE, WR2 IN THE EGAN RANGE, WR3 IN THE SCHELL CREEK RANGE, AND WR4 IN THE DELAMAR MOUNTAINS (CONTINUED).

Site	Start Date	End Date	Precipitation (in)	$\delta^{18}O$	δD
	8/29/06	10/27/06	2.4	-13.82	-94.9
	10/27/06	5/8/07	9.84	-18.04	-131.5
	5/8/07	8/23/07	2.28	-13.46	-95.0
	8/23/07	11/3/07	1.68	-13.87	-94.2
	11/3/07	6/1/08	9.6	-18.22	-132.2
	6/1/08	9/10/08	1.8	-14.84	-105.8
	9/10/08	10/29/08	1.2	-13.20	-88.2
	10/29/08	5/19/09	9.72	-17.45	-124.7
	5/19/09	8/16/09	4.08	-11.91	-82.3
	8/16/09	11/13/09	2.88	-12.18	-82.2
WR3 – Altitude 7,484 ft	10/30/03	3/24/04	7.92	-16.25	-114.4
	3/24/04	4/27/04	3.72	-15.37	-104.3
	4/27/04	6/23/04	1.32	--	--
	6/23/04	9/23/04	2.64	-9.53	-69.3
	9/23/04	1/23/05	16.80	--	--
	1/23/05	5/20/05	13.20	-15.57	-110.5
	5/20/05	8/15/05	1.86	-7.12	-50.3
	8/15/05	11/7/05	2.76	-11.11	-74.9
	11/7/05	2/26/06	3.12	-13.77	-97.3
	2/26/06	5/23/06	6.60	-14.99	-105.6
	5/23/06	8/31/06	2.28	-8.88	-62
	8/31/06	10/28/06	2.16	-11.97	-84.5
	10/28/06	5/7/07	4.92	-17.49	-127.9
	5/7/07	8/20/07	2.04	-8.87	-63.4
	8/20/07	11/2/07	1.32	-11.32	-80.8
	11/2/07	3/4/08	7.56	-15.27	-109.2
	3/4/08	5/30/08	0.84	-16.96	-123
	5/30/08	9/11/08	0.84	-10.71	-81.3
	9/11/08	10/31/08	0.72	-10.87	-72.9
	10/31/08	1/14/09	3.41	-17.64	-126.1
	1/14/09	5/19/09	7.38	-15.33	-108
	5/19/09	8/17/09	4.08	-9.75	-67.3
	8/17/09	11/15/09	0.96	-9.34	-62.9
WR4 – Altitude 5,163 ft	04/29/04	10/19/04	2.88	-8.12	-61.8
	10/19/04	02/10/05	13.68	-11.86	-85.6
	02/10/05	05/19/05	8.04	-12.03	-87.3