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Water Resources Division

Field Guide to Spring Valley Monitoring Program Springs

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Acronyms

BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BWG	Biological Working Group
DOI	U.S. Department of the Interior
NAVD88	North American Vertical Datum of 1988
NPS	National Park Service
NSE	Nevada State Engineer
SNWA	Southern Nevada Water Authority
TM	Thematic Mapper
TRP	Technical Review Panel
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

Abbreviations

°C	degrees Celsius
amsl	above mean sea level
bgs	below ground surface
cm	centimeter
ft	foot
in.	inch
L	liter
m	meter
mEq	milliequivalent
mg	milligram
mi	mile
min	minute
ml	milliliter
µg	microgram
µS	microsiemen
‰	per mil
pmc	percent modern carbon
pCi	picocurie

ABBREVIATIONS (CONTINUED)

psi	pounds per square inch
yr	year

1.0 INTRODUCTION

This report was prepared by the Southern Nevada Water Authority (SNWA) to provide a summary of the physical characteristics and hydrologic data for spring monitoring sites located within Spring Valley, Nevada, (Hydrographic Area 184) as presented in Figure 1-1. The subject springs are part of the SNWA hydrologic monitoring network which includes stream- and spring-discharge, groundwater-level, and precipitation monitoring elements. A detailed description of the hydrologic monitoring program, including the spring network, is contained in *Hydrologic Monitoring and Mitigation Plan for Spring Valley* (SNWA, 2011a) (SVMM Plan). Hydrologic data and the status of each element of the monitoring program are presented in annual hydrologic data reports documenting monitoring activities since 2007 (SNWA 2008, 2009, 2010, 2011b, 2012).

1.1 Background

The Spring Valley spring monitoring network was developed and implemented per the requirements of the Office of Nevada State Engineer (NSE) set forth in NSE Ruling 6164 and the stipulation agreement between SNWA and United States Department of Interior (DOI) (Stipulation, 2006). The DOI Bureaus consist of National Park Service (NPS), Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS) and Bureau of Indian Affairs (BIA). Technical representatives from the DOI Bureaus and SNWA compose the Technical Review Panel (TRP) which, in consultation with the NSE, is responsible for selection and review of the spring monitoring network.

The springs that are included in the monitoring program were identified by the TRP in consultation with the NSE. The hydrologic monitoring set forth by the Stipulation Agreement between SNWA and DOI states that SNWA shall install, equip, and maintain at least one piezometer near 12 spring locations. In 2007, the TRP, in conjunction with the Biological Working Group (BWG) and NSE, reviewed and conducted a field visit to the spring monitoring locations. At that time, the TRP, BWG, and NSE agreed to the spring network and added one additional spring to the program for a total of 13 spring monitoring locations. As required by the SVMM Plan approved in the NSE Ruling 6164, Turnley Spring and two additional springs located on Cleveland Ranch were also added to the network. Currently, a total of 16 representative springs located in Spring Valley comprise the spring monitoring network.

In addition to the 16 spring sites in Spring Valley, Big Springs in Snake Valley is included in the network. Two gages are maintained and operated by the USGS which continuously measure the discharge at Big Springs. Historic discharge data from Big Springs are presented in the SNWA annual reports.

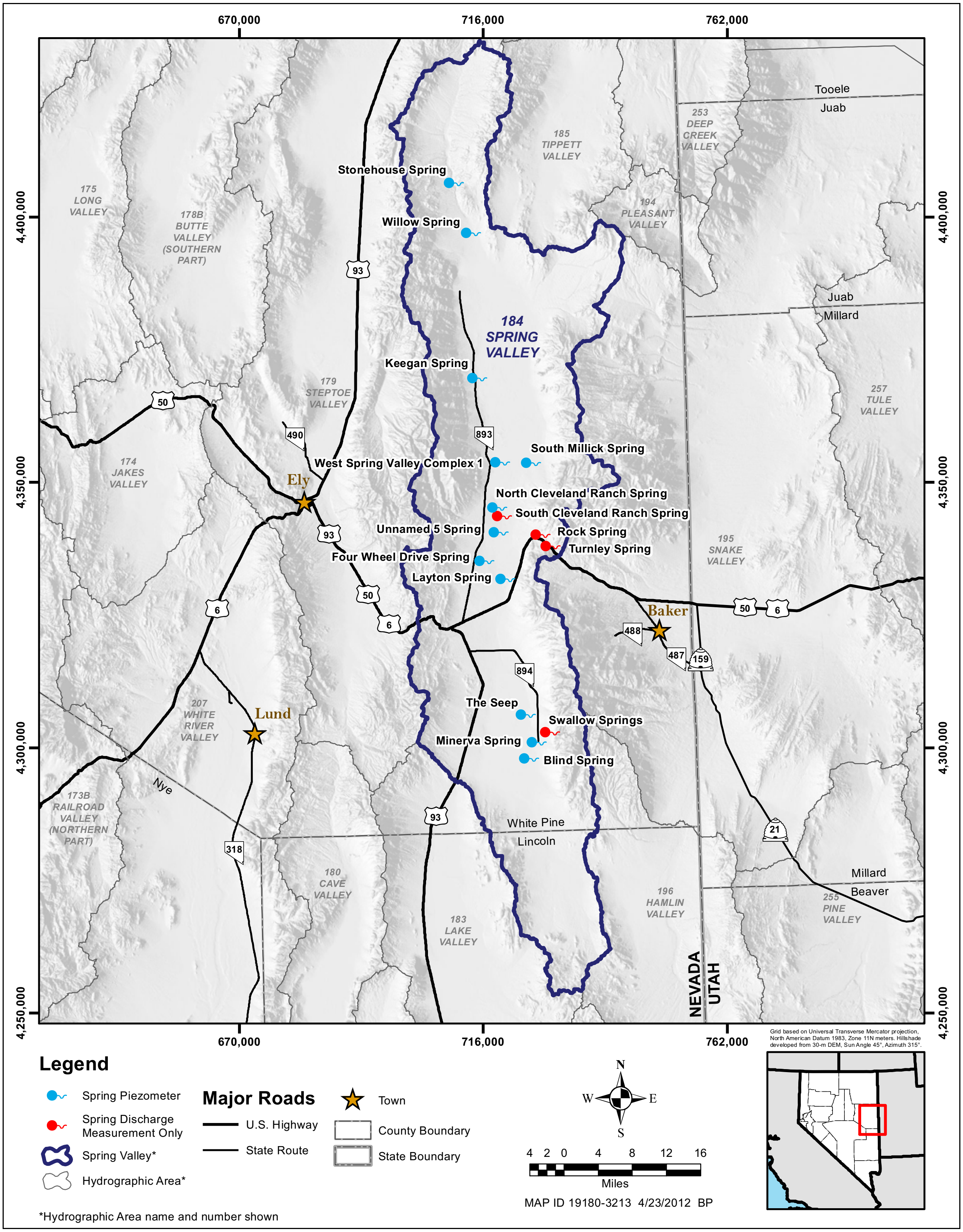


Figure 1-1
Spring Valley Spring-Monitoring Locations

1.2 Program Objectives

The purpose of this field guide is to describe the physical attributes of each network spring and to present hydrologic and water-chemistry data collected to date from each location. The objective of the monitoring program is to characterize the baseline conditions of the springs including assessing the hydrologic dynamics of each of the sixteen springs and response to varying hydrologic conditions. This baseline understanding of the hydrology of each spring is important to define the natural variation of the spring hydrology so potential future effects due to anthropogenic activities can be discerned.

1.3 Spring Monitoring Program

The spring monitoring network is spatially distributed across Spring Valley and includes locations on the mountain-block, valley-margin, and valley-floor areas. The springs are monitored by continuous discharge instrumentation and periodic site visits. Information obtained includes discharge, spring-pool surface elevations, and/or groundwater levels in the spring piezometer. Locations including coordinates, elevation, spring classification, geographic setting, monitoring method and frequency, and land owner is presented in Table 1-1.

Each section of this report describes the location and characteristics of the individual network springs. A topographic map and aerial photo of the area in the vicinity of each spring is presented. High-resolution aerial imagery for each spring depicting hydrologic and biologic monitoring locations are also presented for each spring. Satellite imagery for June 2002, 2005, and 2011 for the area in the vicinity of each spring is presented. The 2002 imagery corresponds to below-normal hydrologic conditions and 2005 corresponds to above-normal conditions based on mean annual precipitation of Nevada Division 2 of the U.S. Climate Divisions (NCDC, 2011). The 2011 imagery is the most current available and is presented in comparison to the wet period and dry period imagery. Hydrologic, geologic, and water-chemistry data associated with each spring including groundwater levels, spring discharge measurements, spring-pool elevation data, and lithologic logs for the shallow piezometers are presented. The monitoring method and frequency for each spring is discussed in each section.

Monitoring approach for each network spring was developed based upon spring characteristics. Discharge is measured at locations where measurement of discharge is technically feasible. Discharge is measured using a current meter or flume and at two sites full gaging stations are operated. All discharge measurements and discharge records are obtained and calculated in accordance with the procedures and methods described in Rantz and others (1982). Staff plates were installed at selected springs where spring pools are present to measure the pool-surface elevation. Shallow piezometers were installed to measure groundwater levels adjacent to the springs where hydrogeologic conditions are appropriate for collection of representative data.

Twelve shallow piezometers located in the vicinity of network springs were installed in 2010. Appropriate permits and right-of-ways were obtained prior to installation. One piezometer (SPR7007Z) located at Minerva Spring South was installed in 2008. A survey of location coordinates, ground-surface, and top-of-casing measuring-point elevation was performed for each piezometer by a licensed Nevada Land Surveyor. The piezometers were each equipped with integrated data logger and

Table 1-1
Spring Monitoring Locations

Site Number	Spring Name	Location[a] UTM Northing (m)	Location[a] UTM Easting (m)	Surface Elevation[b] (ft amsl)	Spring Classification/Geographic Setting	Monitoring Type	Ownership
1845501	Willow Spring	4,397,069	713,756	5,987	Local / Valley Floor	MDM, CGW	BLM
1845702	South Millick Spring	4,353,754	725,031	5,593	Local / Valley Floor	MDM, CGW	BLM
1845901	Layton Spring	4,331,794	720,204	5,698	Local / Valley Floor	CGW	BLM
1846201	Swallow Springs	4,302,920	728,597	6,080	Local / Valley Margin	CSM	SNWA
1846401	Blind Spring	4,298,025	724,717	5,773	Local / Valley Floor	CGW, WSE	BLM
1847001	Four Wheel Drive Spring	4,335,256	716,255	5,754	Local / Valley Floor	CGW, WSE	BLM
1847101	Keegan Spring	4,369,664	715,050	5,603	Local / Valley Floor	MDM, CGW	SNWA
1847201	Minerva Spring	4,301,025	726,101	5,825	Local / Valley Floor	CGW	SNWA
1847301	Rock Spring	4,340,204	726,798	6,364	Local / Mountain Block	CSM	BLM
1847401	Stonehouse Spring	4,406,507	710,511	6,256	Local / Valley Floor	CGW	SNWA
1847501	The Seep	4,306,263	724,060	5,764	Local / Valley Floor	CGW, WSE	BLM
1847601	West Spring Valley Complex 1	4,353,812	717,309	5,603	Local / Valley Floor	CGW	BLM
1847701	Unnamed 5 Spring	4,340,641	718,911	5,645	Local / Valley Floor	CGW	SNWA
1848001	Turnley Spring	4,338,050	728,695	6,774	Local / Mountain Block	MDM	Mr. and Mrs. Rountree
1848400	Cleveland Ranch Spring North	4,345,297	718,646	5,628	Local / Valley Floor	MDM, QGW	CPB
1848501	Cleveland Ranch Spring South	4,343,666	719,523	5,610	Local / Valley Floor	MDM	CPB

[a]Coordinates are approximate. All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).
CPB = Corporation of the Presiding Bishop of the Church of Latter-Day Saints.
MDM = Miscellaneous discharge measurements.
CGW = Piezometer continuous ground-water levels.
CSM = Continuous stage measurement with discharge measurement to verify flume ratings.
WSE = Orifice pool water surface elevation.
QGW = Piezometer quarterly ground-water levels.

a vented pressure transducer in 2011 to collect continuous water-level data. All continuous water-level are corrected for water temperature. Location and construction attributes of the piezometers are presented in Table 1-2. A lithologic log for the piezometer borehole is presented in the individual spring sections of this report.

Rock and Swallow springs are monitored for discharge only. The hydrogeologic conditions at these locations preclude the use of a piezometer. Gaging stations were installed at these two sites to measure and record continuous stage data. The stage data is applied to a standard flume equation and verified with a current meter measurement. Rock Springs has a 3-in. modified Parshall flume, and the south channel of Swallow Springs has a 6-in. Parshall flume installed.

Turnley Spring is a mountain-block spring on property owned by Katherine and William Rountree and is used as both domestic and irrigation water supply. In accordance with Ruling 6164, a monitoring program was developed in consultation with the NSE and the Rountrees and consists of periodic spring discharge measurements using a temporary flume.

Spring discharge is measured periodically at three springs using permanently installed flumes. These are Keegan, Cleveland Ranch North, and Cleveland Ranch South springs. Periodic discharge measurements are also performed using temporary flume installations at Layton, Minerva South, and Willow Springs. South Millick spring discharge is measured using a current meter. Discharge is measured downstream of the reservoir at Minerva Spring South using a current meter and temporary flume. However, the discharge measurements at Minerva are influenced by the operation of the storage reservoir.

A permanent staff plate is used to measure spring-pool elevation at locations where a significant pool exists. These sites are Blind Spring, The Seep, Four Wheel Drive Spring, and South Millick Spring.

1.4 Satellite Imagery

The satellite imagery used as the background for the map series displayed at 1:60,000 was acquired from the USGS LANDSAT 5 platform. LANDSAT 5 is the 5th image-collecting satellite platform in a series of earth observation platforms beginning in 1972, with the primary goal of providing a global archive of satellite photos. LANDSAT 5 is in a sun synchronous, polar orbit, regular acquisition schedule revisiting each spot on the earth every 16 or 18 days.

The LANDSAT 5 platform utilizes Thematic Mapper (TM) sensors which detect reflected or emitted energy from the Earth surface in the visible and infrared (IR) wavelengths and stores the data in 7 bands. TM bands 1-5 and 7 collect reflected energy; band 6 collects emitted energy.

Bands 7, 4 and 2 were used to display the imagery as a "natural-like" rendition to distinguish between water, vegetation, and dry areas. Healthy vegetation appears as bright green, grasslands as light green, pink areas represent barren soil, oranges and browns represent sparsely vegetated areas. Dry vegetation is represented as orange and open water ranges from dark-blue to black. Soils are highlighted in a multitude of colors, but are generally light colors.

Table 1-2
Spring Piezometer Location and Completion Information

Site Number	Associated Spring	Location[a]		Surface Elevation[b] (ft amsl)	Completion Date	Drill Depth (ft bgs)	Well Depth (ft bgs)	Well Diameter (in.)	Open Interval (ft bgs)	Screened Interval (ft bgs)	Aquifer
		UTM Northing (m)	UTM Easting (m)								
SPR7007Z	Minerva Spring	4,301,057.50	726,134.41	5,828.66	1/18/2008	35	31	4	12 to 31.3	16 to 31	Basin Fill
SPR7011Z	Blind Spring	4,297,998.80	724,727.36	5,769.71	5/6/2010	31.3	31.3	2	13 to 31.3	16.1 to 31.1	Basin Fill
SPR7012Z	4WD Spring	4,335,263.36	716,235.95	5,756.22	5/8/2010	25	25	2	4 to 25	9.8 to 24.8	Basin Fill
SPR7014Z	The Seep	4,306,272.49	724,093.39	5,778.54	5/7/2010	31	30.7	2	6 to 30.7	15.5 to 30.5	Basin Fill
SPR7015Z	West Spring Valley Complex	4,353,816.21	717,284.37	5,602.90	5/8/2010	40	38.2	2	8 to 38.2	23 to 38	Basin Fill
SPR7016Z	Unnamed Spring 5	4,340,637.10	718,885.72	5,645.67	5/4/2010	35	32	2	15 to 32.0	16.8 to 31.8	Basin Fill
SPR7018Z	S. Millick Spring	4,353,623.95	725,156.47	5,587.16	5/4/2010	31	25.2	2	8 to 25.2	10 to 25	Basin Fill
SPR7019Z	Layton Spring	4,331,753.27	720,064.21	5,686.63	5/7/2010	35.3	35.3	2	9 to 35.3	20.1 to 35.1	Basin Fill
SPR7020Z	Stonehouse Spring	4,406,416.78	710,617.88	6,264.62	5/5/2010	9.3	9.3	2	2 to 9.3	4.1 to 9.1	Basin Fill
SPR7021Z	Keegan Spring	4,369,693.31	714,898.91	5,613.12	5/8/2010	20.7	20.7	2	4 to 20.7	5.5 to 20.5	Basin Fill
SPR7022Z	Willow Spring	4,397,090.42	713,752.68	5,987.54	5/5/2010	35	33.5	2	7 to 33.5	18.3 to 33.3	Basin Fill
SPR7031Z	Cleveland Ranch North Spring	4,345,295.85	718,622.45	5,637.32	3/3/2011	11.5	10.3	2	4 to 10.3	5 to 10	Basin Fill

[a]All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).

1.5 Water-Chemistry Sampling and Analyses

Water-chemistry samples were collected, using protocols based upon USGS methodology, from the springs for selected chemical parameters agreed upon by the TRP in consultation with the NSE. In situations where the springs were not flowing, samples were collected from the associated piezometers using teflon bailers. Samples for major ions, trace metals, and carbon isotope analyses were filtered in the field. Water temperature, pH, specific conductance and dissolved oxygen (DO) were measured in the field.

Water samples were analyzed for major-ion and trace-element concentrations by the Southern Nevada Water System in Henderson, Nevada. Deuterium and $\delta^{18}O$ analyses were analyzed by the Nevada Stable Isotope Laboratory at the University of Nevada, Reno; carbon-isotope analyses were performed by the National Science Foundation's Accelerated Mass Spectrometer Laboratory at the University of Arizona, Tucson. Enriched tritium and some split samples for δD and $\delta^{18}O$ analyses were performed by the Environmental Isotope Laboratory of the University of Waterloo, Canada. Chemical and strontium isotope samples were analyzed by the Division of Earth and Ocean Sciences of Duke University.

Analytical results from these samples and other historical data for some of the springs are provided in Appendix A and were used for the baseline assessment and characterization of the springs. Historical water-chemistry data for the spring locations is also presented in SNWA, 2012.

1.6 Characterization of Springs

Based on the classification of flow systems defined in the Basin and Range Carbonate-Rock Aquifer Study (Welch, 2007) and the physical characteristics of the network springs, all springs in Spring Valley are derived from the local groundwater system with recharge occurring within the Spring Valley Hydrographic Area. These local springs occur within the mountain blocks, valley margins, and valley floor areas. The springs exhibit different degrees of hydraulic connection and flow path distance from the recharge areas, and therefore exhibit different discharge characteristics.

2.0 BLIND SPRING

Blind Spring is located in southeastern Spring Valley approximately 7 mi east of US Highway 93 and about 8.6 mi north of the Lincoln and White Pine county line. The spring is approximately 3.3 mi west of the Snake Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 2-1 and 2-2, respectively.

2.1 Physical Description and Satellite Imagery

Blind Spring is located on the valley floor in an area of fine sediments and dense to moderate vegetation coverage. The spring consists of a pool created by a man-made raised berm that surrounds the spring. Blind Spring does not have discharge out of the pool other than through evapotranspiration. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations, and biological monitoring transects is presented in Figure 2-3. LANDSAT 5 satellite imagery for the region around Blind Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 2-4. Field photos of the spring are presented in Figures 2-5 and 2-6.

2.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7011Z, which is located to the southeast of the spring. The spring-pool elevation is monitored periodically using a staff plate located in the southern portion of the pool. The staff plate and piezometer have been surveyed to determine elevation and planar coordinates. Fluctuations of the spring-pool elevation can be compared to the piezometer water level in order to evaluate the degree of hydrologic connection between the spring and the shallow water table.

2.3 Hydrogeology

The borehole for SPR7011Z was advanced through surficial sediments to 31.3 ft bgs. Lithologic soil samples were collected at 5-ft intervals during drilling. The penetrated soils consist of tan fat clays exhibiting high plasticity. Saturated soils were observed at approximately 4 ft bgs. A summary of the lithologic log is presented in Figure 2-7.

A hydrograph of water-level data collected at the piezometer is presented on Figure 2-8. The staff-plate elevation measurements are also presented on the hydrograph. The piezometer water level and spring-pool elevation are generally comparable and the spring-pool elevation appears to represent the shallow water table at the site.

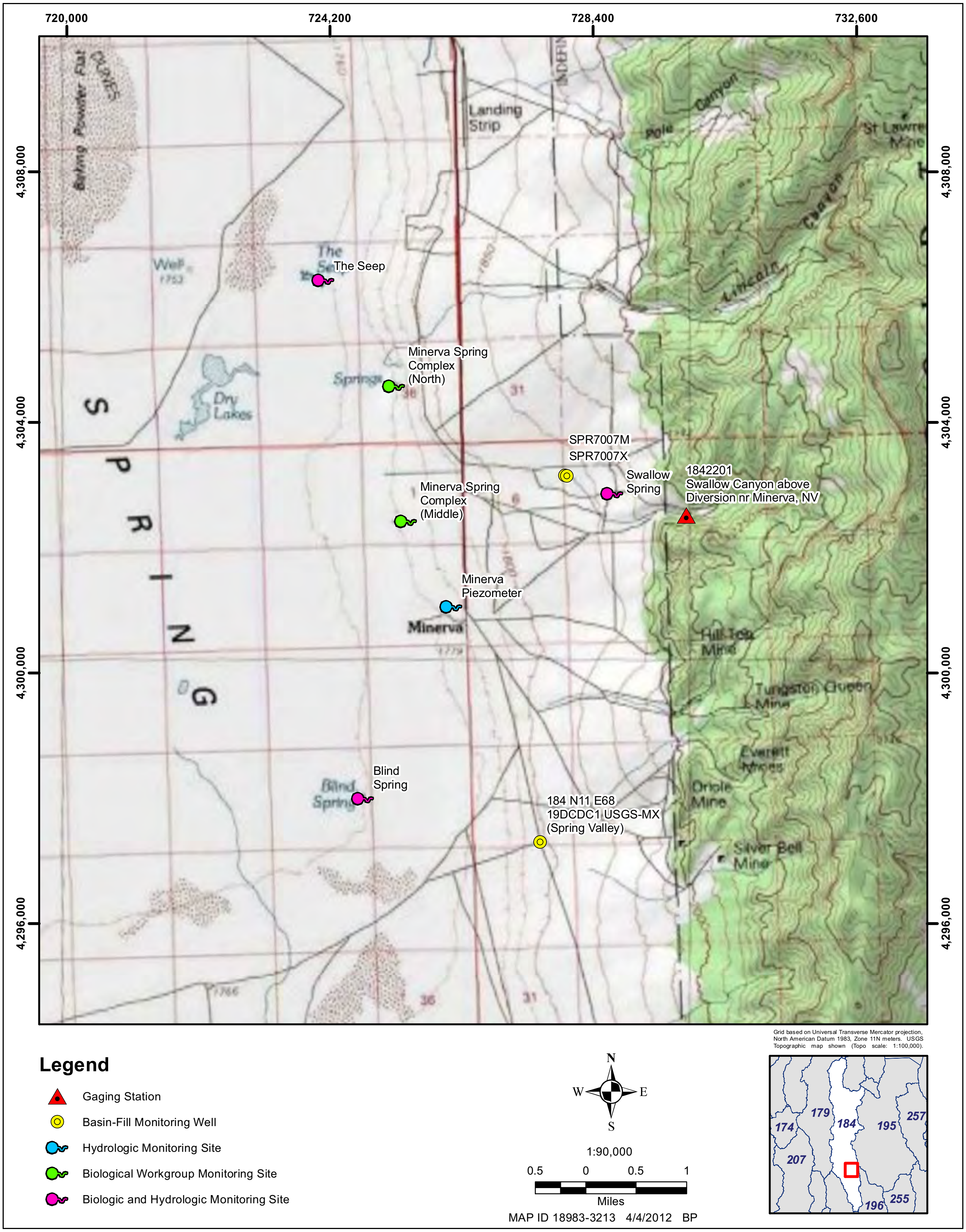


Figure 2-1
Surface and Groundwater Monitoring Locations in the Vicinity of Blind Spring

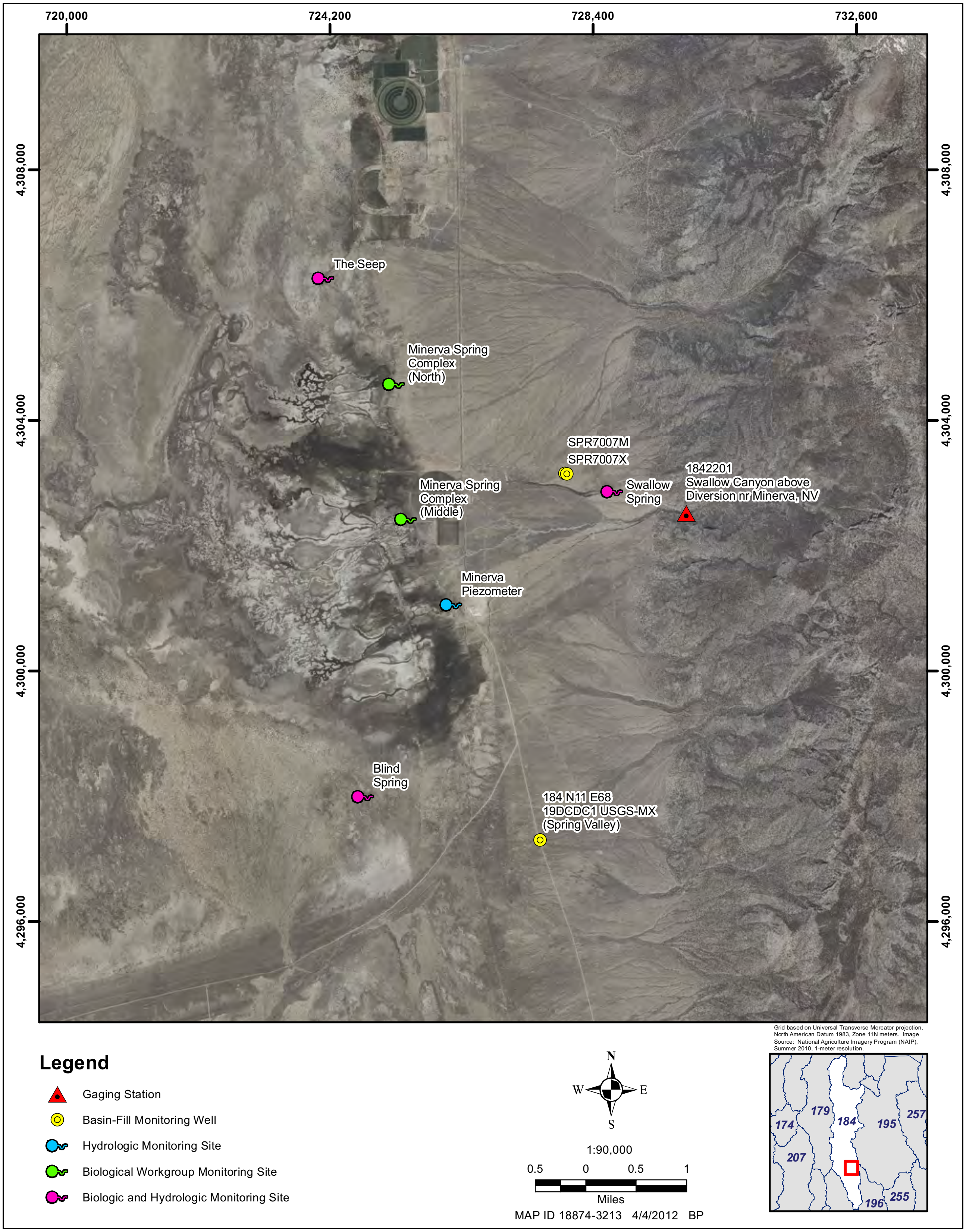


Figure 2-2
Aerial Photo of the Blind, Minerva, Swallow Springs, and The Seep

Figure 2-3
High-Resolution Aerial Photo of Blind Spring

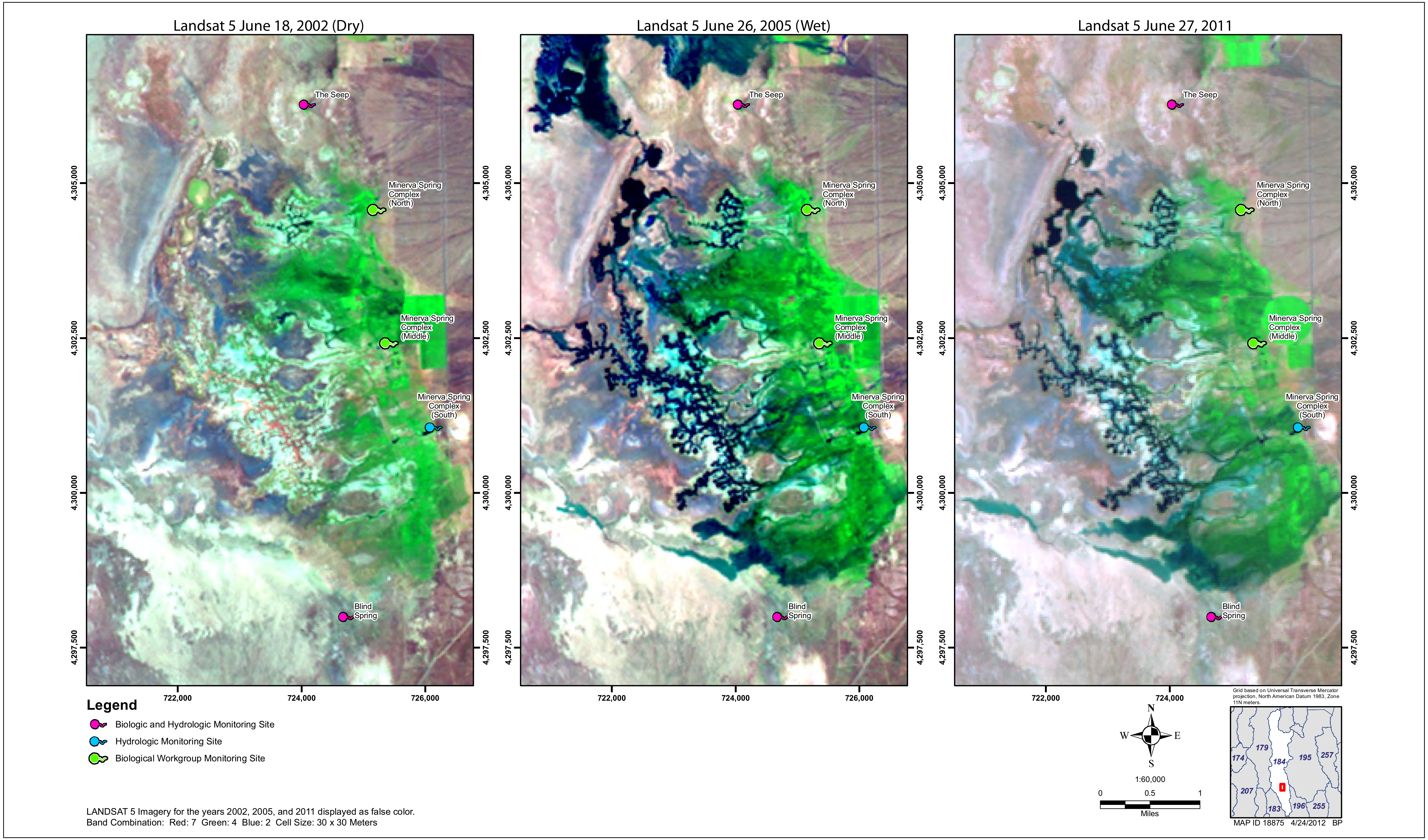


Figure 2-4
LANDSAT Imagery of Blind, Minerva, and The Seep

Figure 2-5
Blind Spring Looking Southeast

Figure 2-6
Blind Spring Looking Northeast

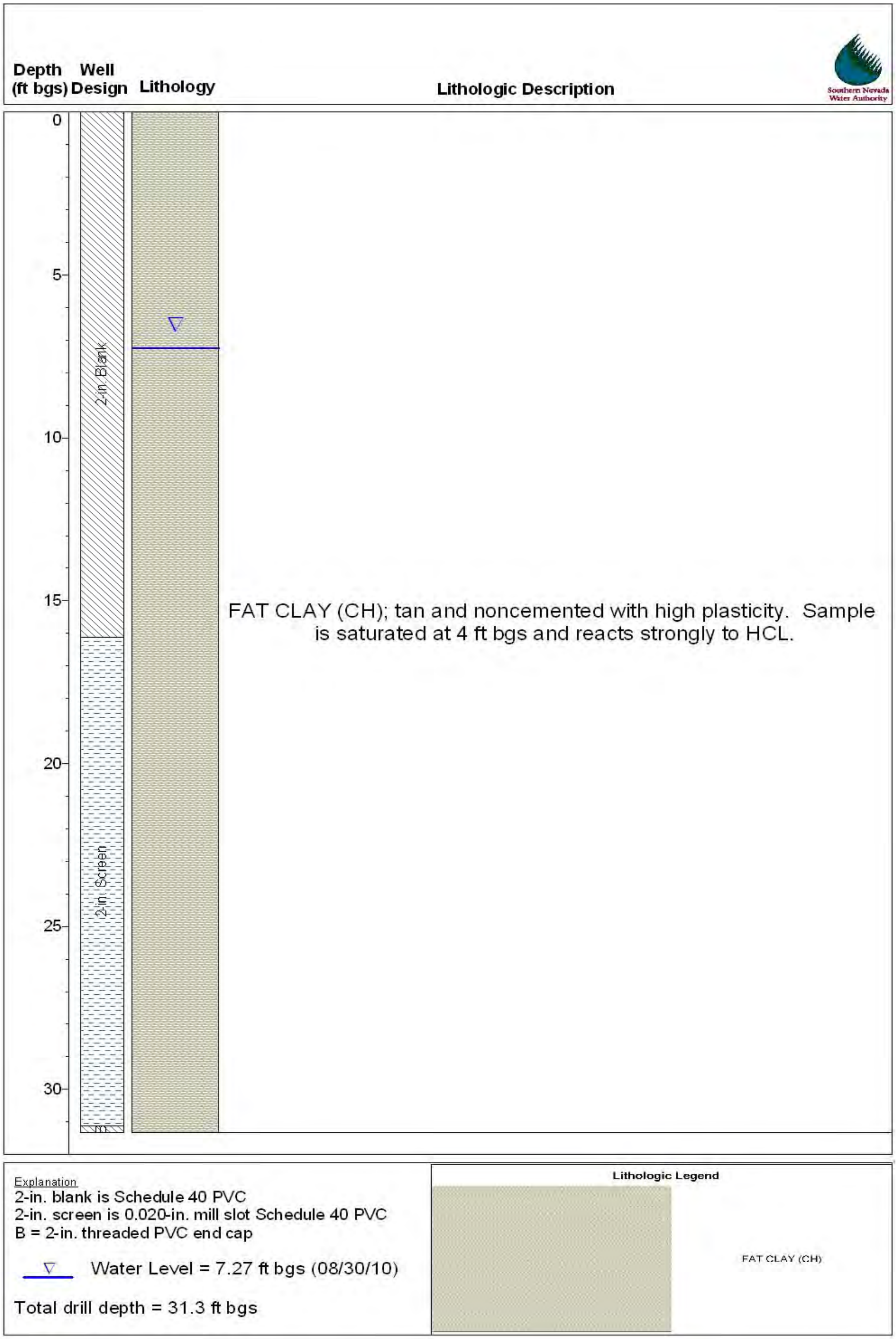


Figure 2-7
Blind Spring Piezometer Lithologic Log

2.4 Spring Water Chemistry

Water samples were collected from piezometer SPR7011Z using a teflon bailer on October 24, 2010. These samples were collected from the bailer as opposed to the spring pool to avoid the changes in water chemistry as a result of evaporation as the spring has no observable discharge other than evapotranspiration. The temperature of the piezometer SPR7011Z sample was 12.1°C, with a pH of 7.34, and EC of 673 µS/cm. The water is a Ca-Mg-HCO_3 type. Blind Spring was previously sampled from the spring pool on August 16, 2006. Previous sample results show the effect of evaporation on the water quality of the spring pool compared to the piezometer shallow groundwater sample. The analytical results for both the spring and the piezometer are provided in Appendix A.

The general fluctuation of the water level of Blind Spring, cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, lack of flow from the spring, and hydrogeologic conditions indicate that the spring is local and most likely a reflection of the shallow water table in the vicinity of the site.

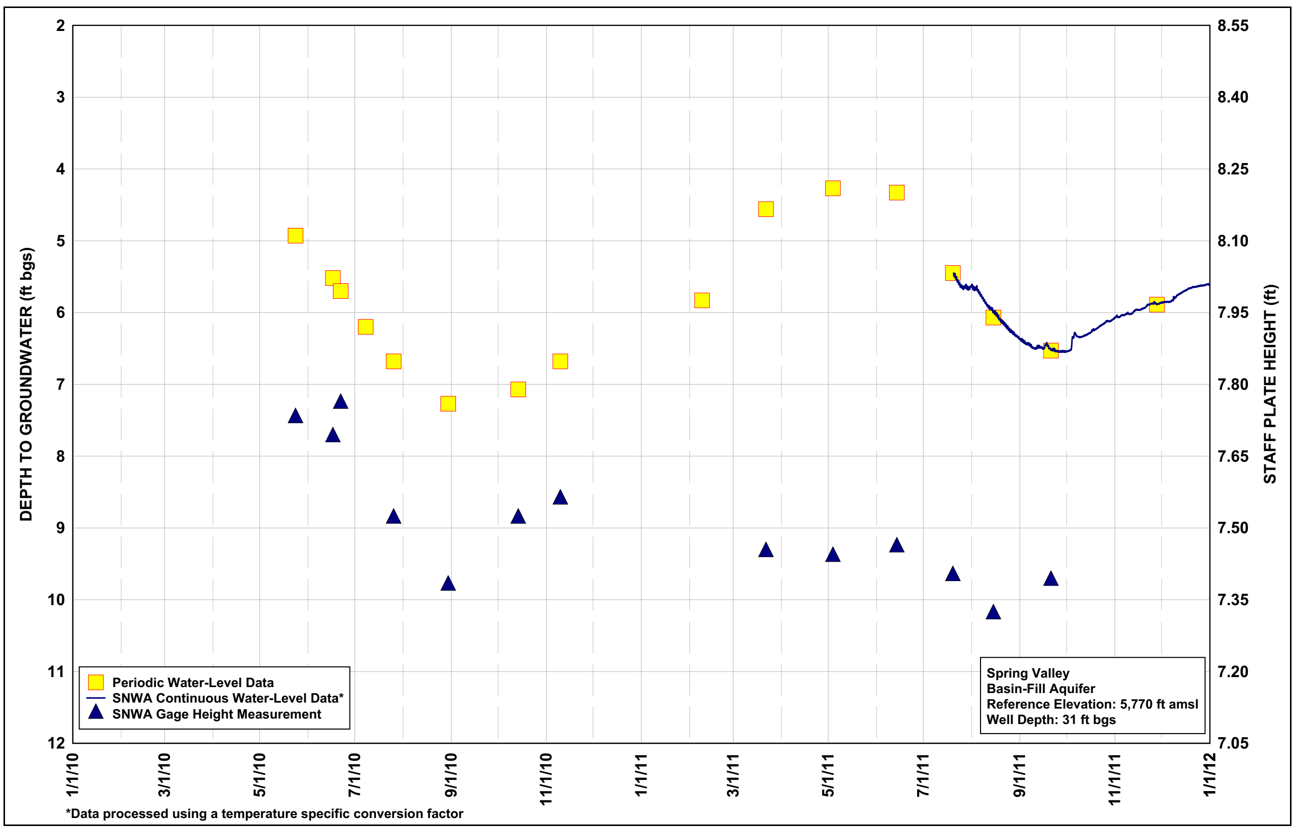


Figure 2-8
Hydrograph of Blind Spring

3.0 MINERVA SPRINGS

Minerva Springs is a large complex of springs that can be divided into three distinct groups, south, middle and north. Located in the southeastern part of Spring Valley near the southern end of the paved section of State Highway 894. Minerva Spring South is included in the hydrologic monitoring network. This spring is approximately 10.5 mi north of the Lincoln and White Pine county line and 3.3 mi west of the Snake Range. Two additional springs in the complex, Minerva Spring North and Minerva Spring Middle are included in the biological monitoring program. A topographic map and aerial photo of the area in the vicinity of the springs are presented in Figures 2-1 and 2-2, respectively.

3.1 Physical Description and Satellite Imagery

Minerva Spring South is situated on the valley floor. The spring is likely the result of contrasting hydraulic conductivities of the basin-fill deposits, where the coarse alluvial material interfingers with the finer lacustrine (lake sediment) deposit. The spring emanates at the toe of an alluvial fan on the western flank of the Snake Range. The spring discharge is stored in a small man-made storage reservoir which is regulated by two head gates. The spring consists of numerous orifices along the bank and bed of the reservoir, as well as multiple spring orifices west of the reservoir along the discharge channel. The spring is located on land owned by SNWA.

A high-resolution aerial photo which shows the spring dimensions, hydrologic monitoring locations and biological monitoring transects for Minerva Spring North, Minerva Spring Middle, and Minerva Spring South is presented in Figures 3-1 through Figure 3-3. LANDSAT 5 satellite imagery for the region around Minerva Springs for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 2-4. Field photos of the spring are presented in Figures 3-4 and 3-5.

3.2 Monitoring Program

The spring is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7007Z, which is located approximately 130 ft to the northeast upgradient of Minerva Spring South reservoir on SNWA land. Miscellaneous discharge measurements are performed periodically using a current meter and/or a temporary flume downstream of the storage reservoir. Discharge measurements from the reservoir are affected by the ranch operation releases from the reservoir and do not always represent spring discharge. The piezometer has been professionally surveyed to determine elevation and planar coordinates.

3.3 Hydrogeology

Lithologic soil samples were collected for SPR7007Z at 5-ft intervals during the drilling process. The borehole was drilled within surficial sediments from 0 to 35 ft bgs. The soil encountered consists of

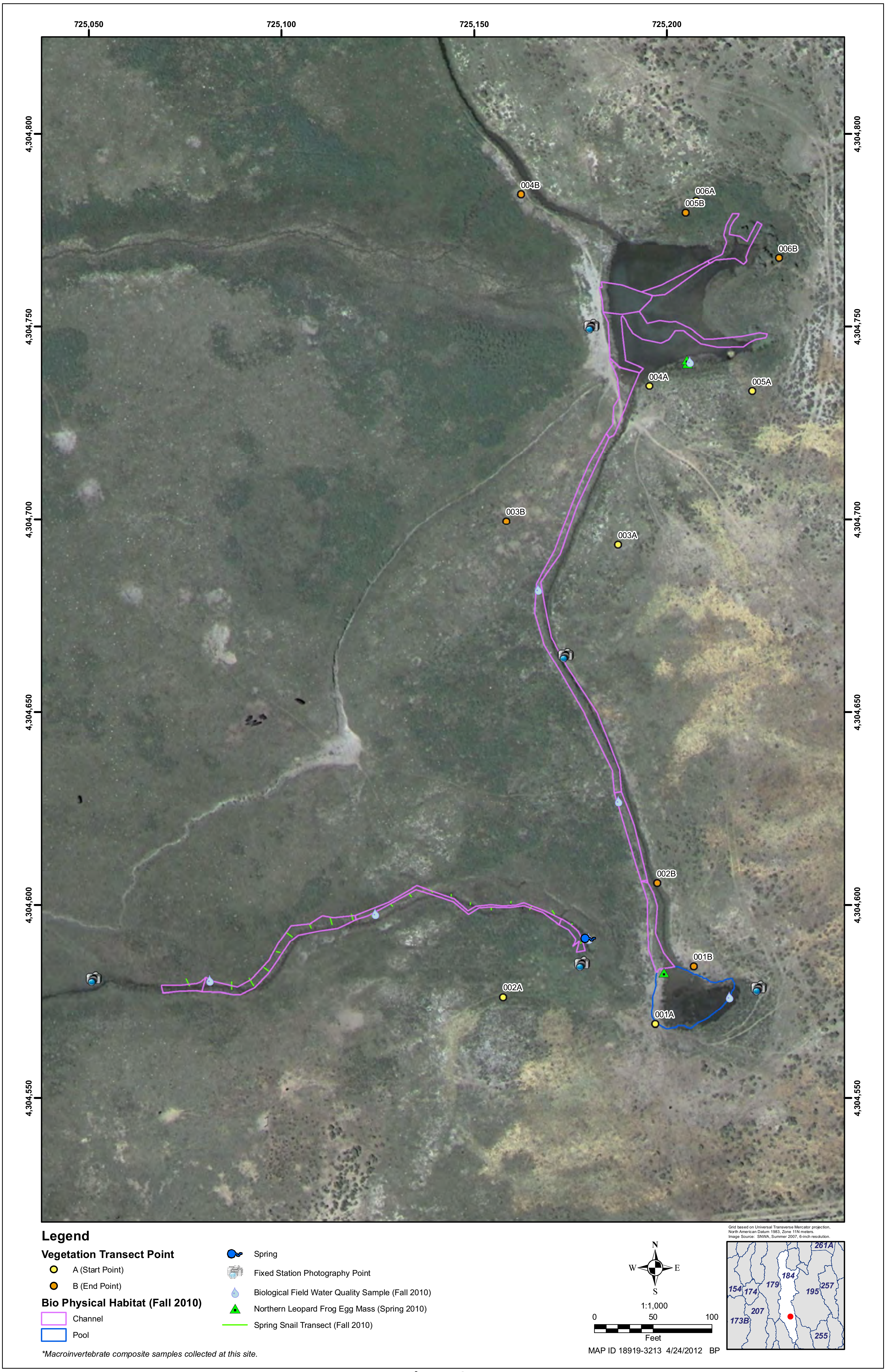


Figure 3-1
High-Resolution Aerial Photo and BWG Mapped Habitat of Minerva Spring North

Figure 3-2

High-Resolution Aerial Photo and BWG Mapped Habitat of Minerva Spring Middle

Figure 3-3
High-Resolution Aerial Photo and BWG Mapped Habitat of Minerva Spring South

Figure 3-4
Minerva Spring South Reservoir Looking East

Figure 3-5
Minerva Spring South Reservoir Dry Conditions Looking Northeast

sands and gravels with clay, underlain by clay with sand and gravel. Soil became saturated at approximately 15-ft bgs during the advancement of the borehole. A summary of the lithologic log is presented in Figure 3-6.

A hydrograph of the reservoir discharge is presented in Figure 3-7. A hydrograph of periodic and continuous water-level data collected at the piezometer is presented in Figure 3-8.

Changes in the groundwater levels observed in the piezometer are a result of the natural variation in groundwater recharge in upgradient areas on the alluvial fan and within the mountain block.

3.4 Spring Water Chemistry

Samples from Minerva Spring South were collected from the spring orifice on October 24, 2010. The temperature of the Minerva Spring South sample was 11.4^{o}C, pH was 7.23, and EC was 626 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring are provided in Appendix A.

Cool water temperature, variation in groundwater levels and spring discharge, similarity of the stable isotopic composition to that of modern day precipitation, ^{14}C activity, high tritium concentration, and hydrogeologic conditions indicate that the spring is of local origin.

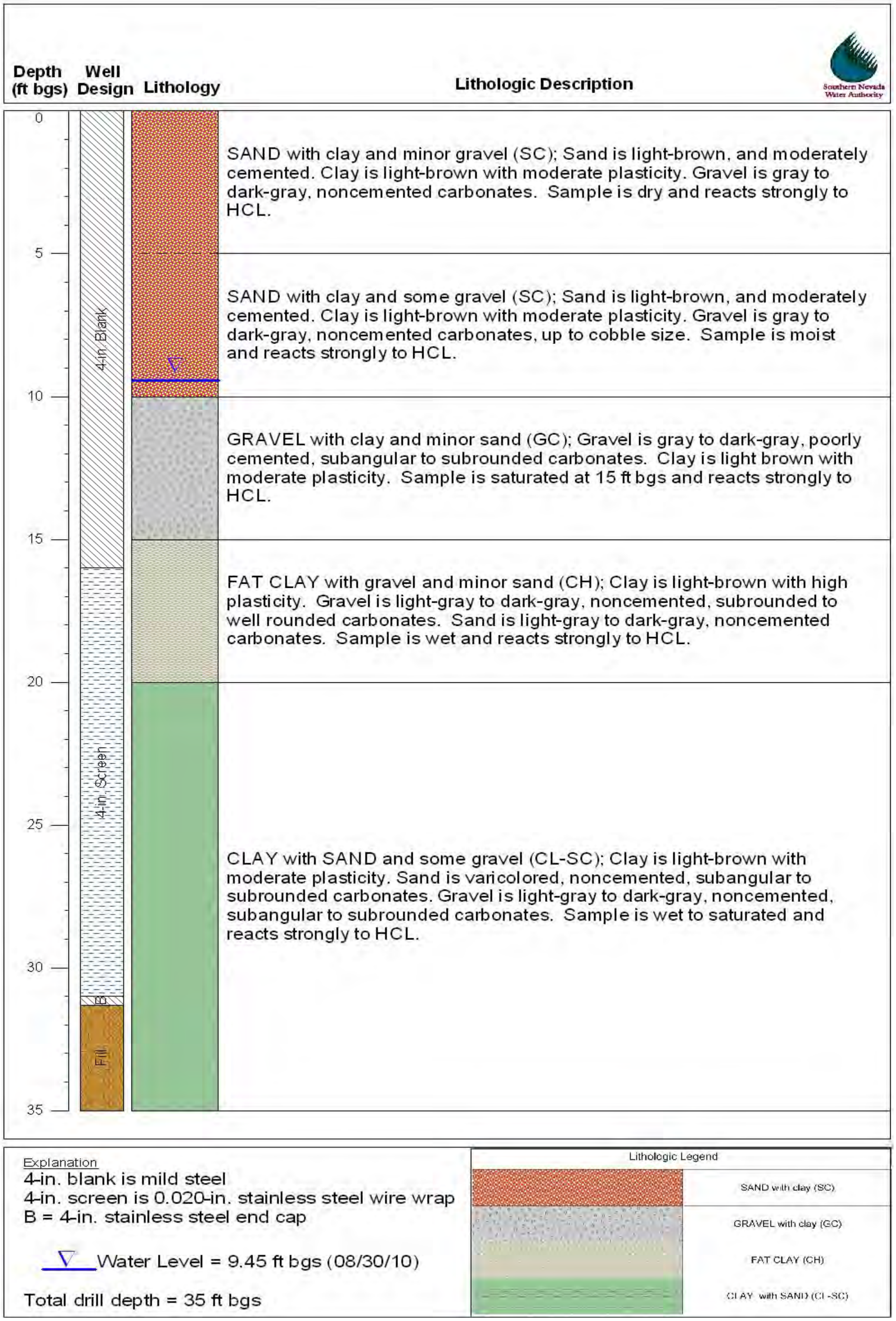


Figure 3-6
Minerva Spring South Piezometer Lithologic Log

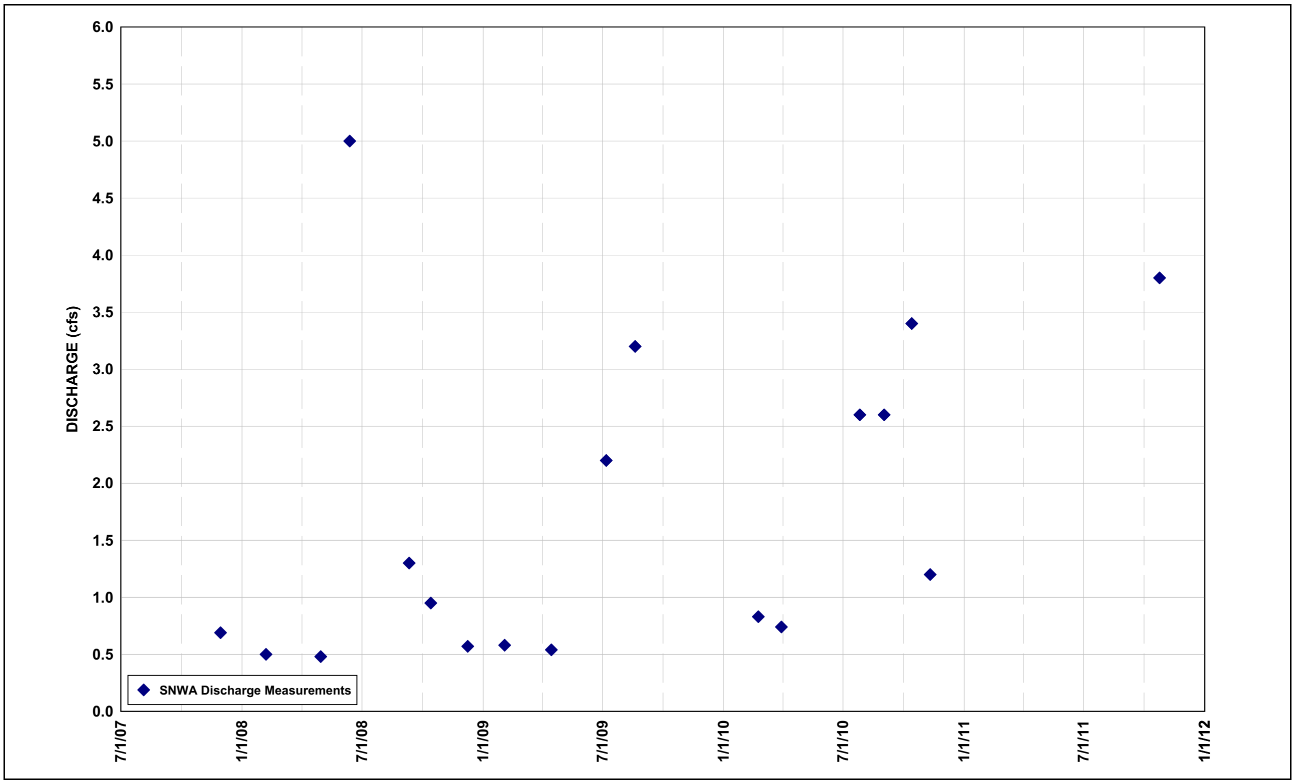


Figure 3-7
Hydrograph of Minerva Spring South Reservoir Discharge

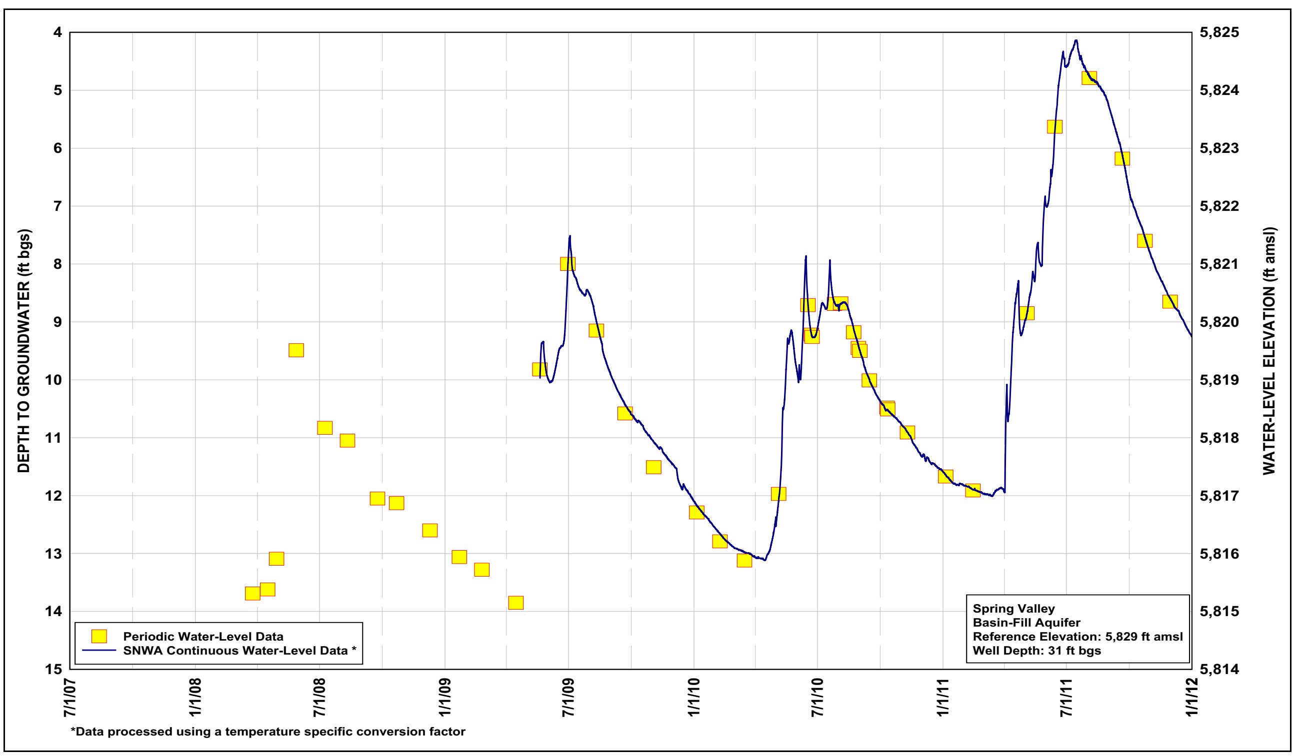


Figure 3-8
Hydrograph of Minerva Spring South Piezometer

4.0 THE SEEP

The Seep is located in south central Spring Valley on BLM managed land approximately 13.8 mi north of the Lincoln and White Pine county line and approximately 3.4 mi west of the Snake Range. The Seep is located adjacent to the SNWA Phillips Ranch property. A topographic map and aerial photo of the area in the vicinity of The Seep are presented in Figures 2-1 and 2-2, respectively.

4.1 Physical Description and Satellite Imagery

The Seep is an intermittent spring located on the unconsolidated valley floor sediments. The Seep has been observed to be dry over extended periods of time since 2007 when regular observations were initiated at the site. The spring consists of an area of seepage along the base of an elevated ridge located at the southeast edge of the spring. The spring pool area, when present, is limited in size and is heavily trampled by cattle who use it as a water source. The pool has no discharge other than evapotranspiration.

A high-resolution aerial photo of The Seep which shows the spring dimensions, hydrologic monitoring locations and biological monitoring transects is presented in Figure 4-1. LANDSAT 5 satellite imagery for the region around The Seep for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 4-2. Field photos of the spring are presented in Figures 4-3 and 4-4.

4.2 Monitoring Program

The site is monitored by collecting continuous water-level measurements at one-hour intervals in piezometer SPR7014Z, which is located approximately 30 ft to the east of The Seep. SPR7014Z was completed to a depth of 30.7 ft bgs in unconsolidated material. Soil became saturated at approximately 10 ft bgs during advancement of the borehole. The spring-pool elevation, when present, is monitored periodically using a staff plate located in the southeastern portion of the spring-pool. The staff plate and piezometer have been professionally surveyed to determine elevation and planar coordinates. Prior to and since the installation of the piezometer and staff plate in May 2010 The Seep has remained dry. The groundwater levels in the piezometer and site hydrologic conditions indicate that there is a direct hydraulic connection between The Seep and the shallow water table.

4.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7014Z at 5-ft intervals during the drilling process. The borehole was advanced within surficial sediments to 30.7 ft bgs. The soils encountered consist of gravel with clay and sand with clay, underlain by clay with sand. The gravels encountered

Figure 4-1
High-Resolution Aerial Photo of The Seep

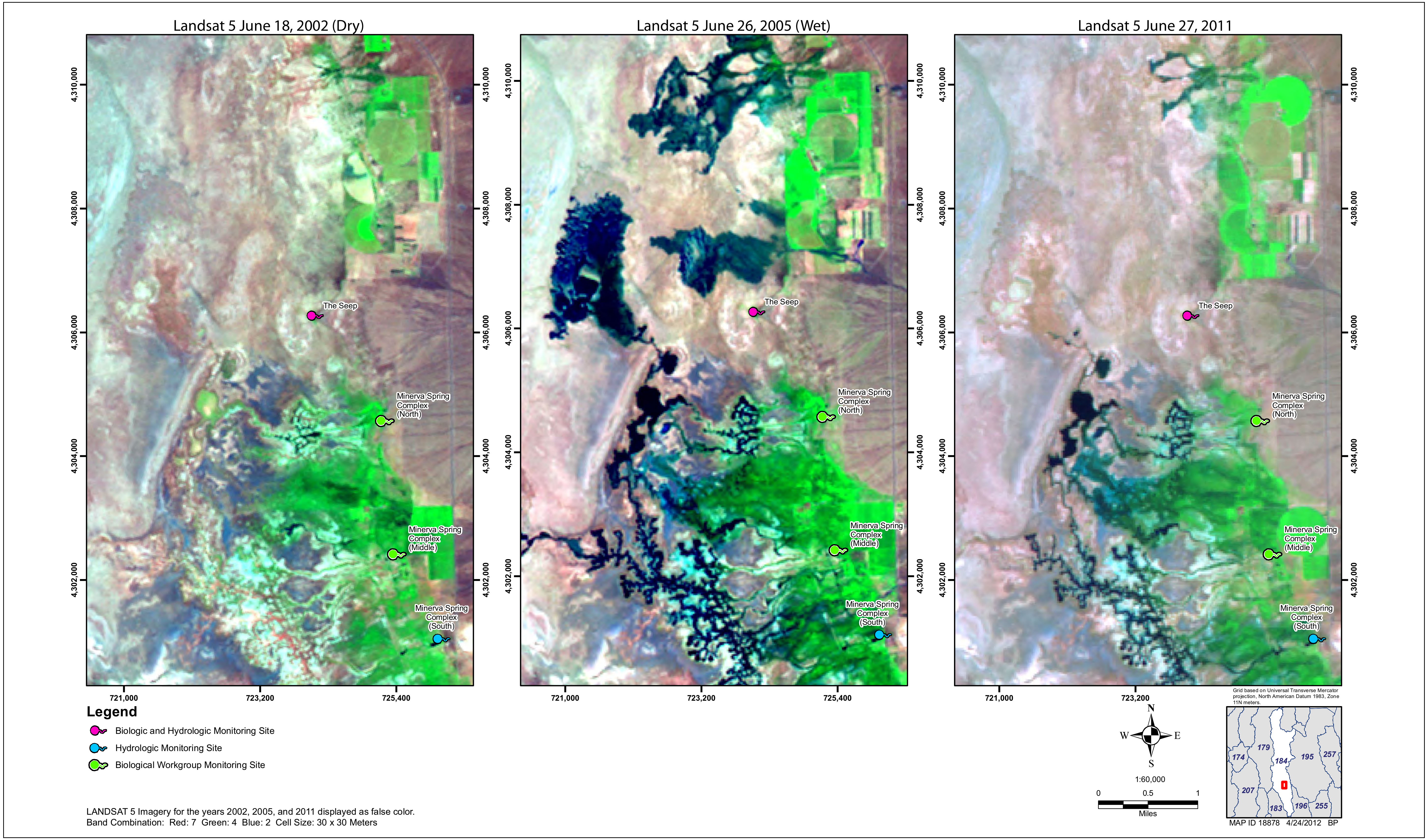


Figure 4-2
LANDSAT Imagery of The Seep

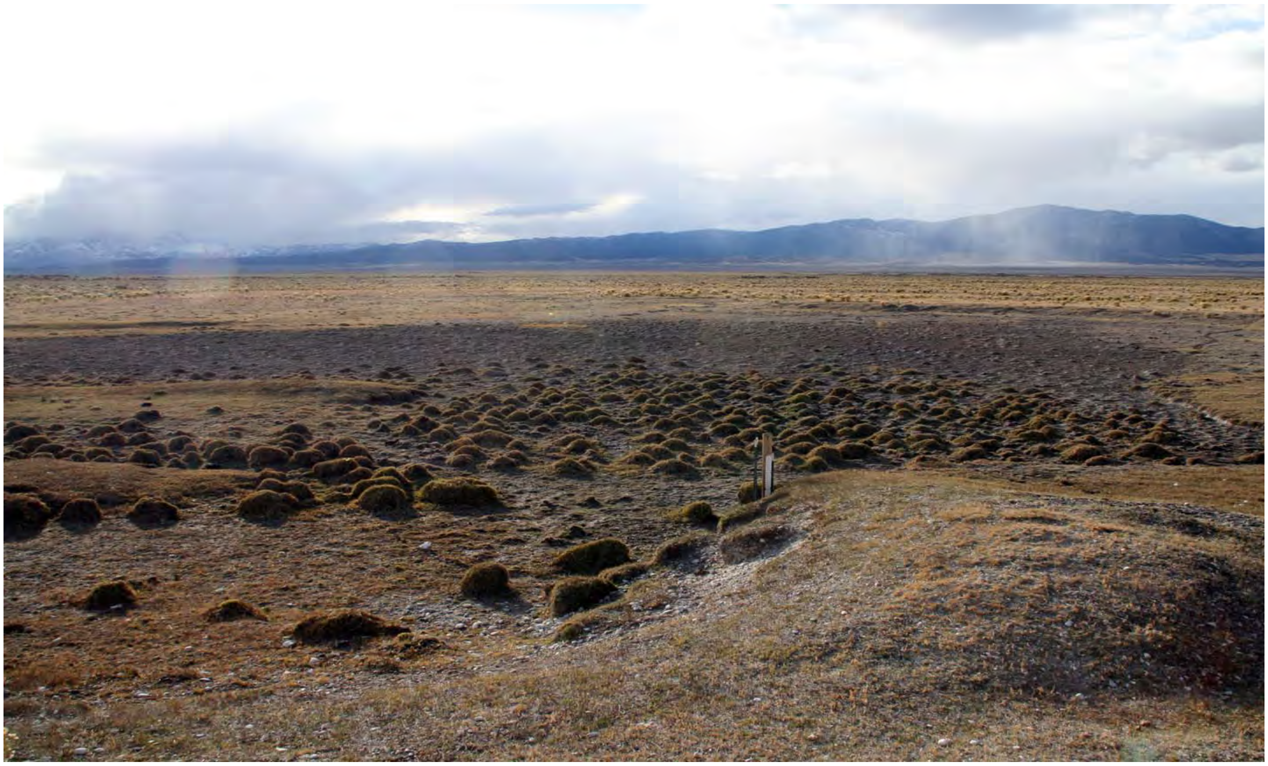


Figure 4-3
The Seep Under Dry Conditions Looking Southwest

Figure 4-4
The Seep Under Dry Conditions Looking East

were subangular to well-rounded, varicolored limestones, while the sand was tan to brown, and noncemented. The clays encountered were tan to brown with low to high plasticity. A summary of the lithologic log is presented in Figure 4-5.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 4-6. Spring-pool elevation is also measured and the data collected is presented on the hydrograph. The piezometer water levels and spring-pool elevation have exhibit seasonal fluctuations, a rise in water-level during spring and summer and a recession in water-level in the fall and spring. The hydrograph indicates a direct hydraulic connection between The Seep and the local water table.

4.4 Water Chemistry

Using a teflon bailer, water samples were collected on October 24, 2010 from piezometer SPR7014Z because the spring pool was dry at the time of sampling. The temperature of the SPR7014Z sample was 11.3°C, the pH was 7.23, and the EC was 313 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the piezometer are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, high tritium concentration, and hydrogeologic conditions indicate that the spring is local and in direct hydraulic connection with the shallow water table.

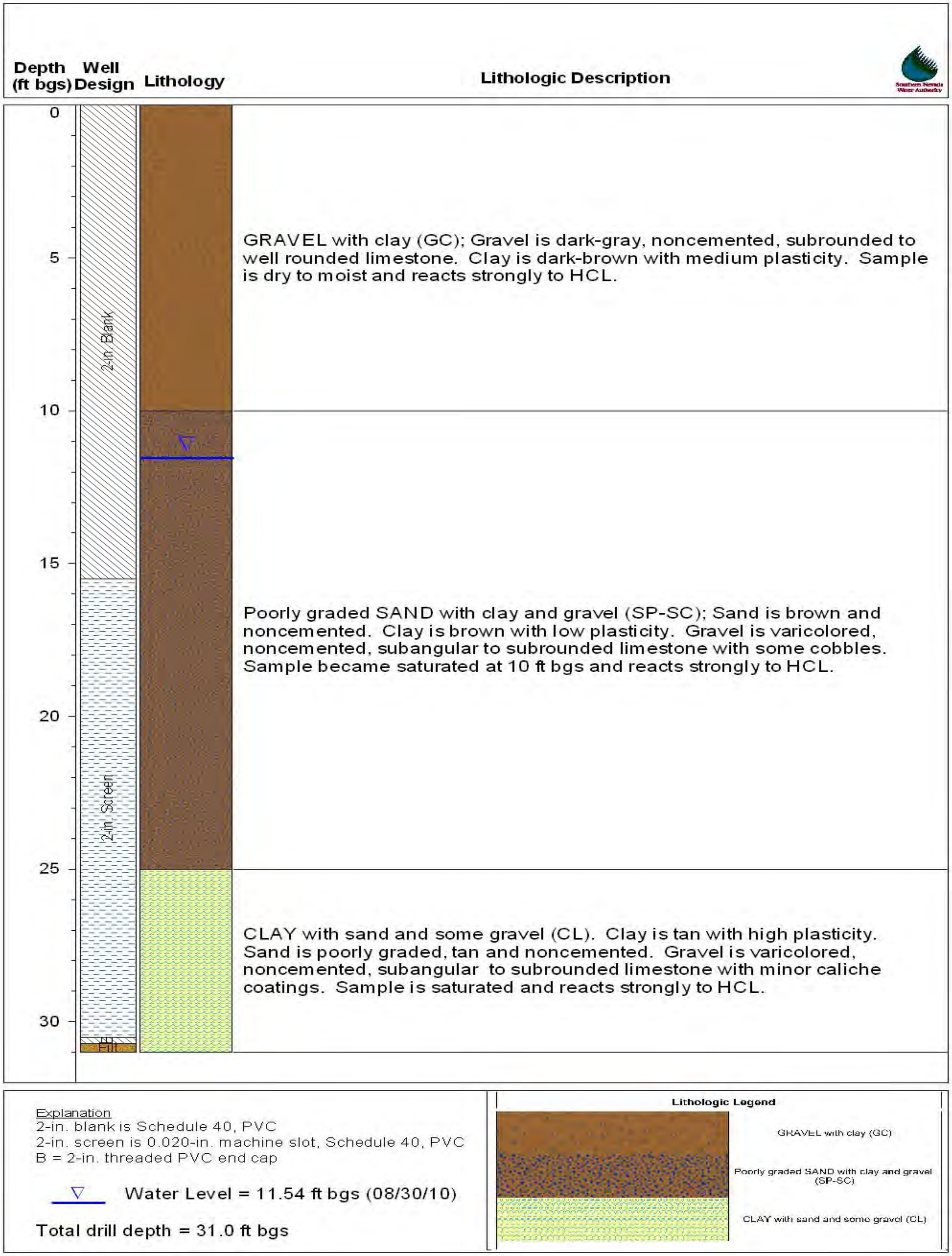


Figure 4-5
The Seep Spring Piezometer Lithologic Log

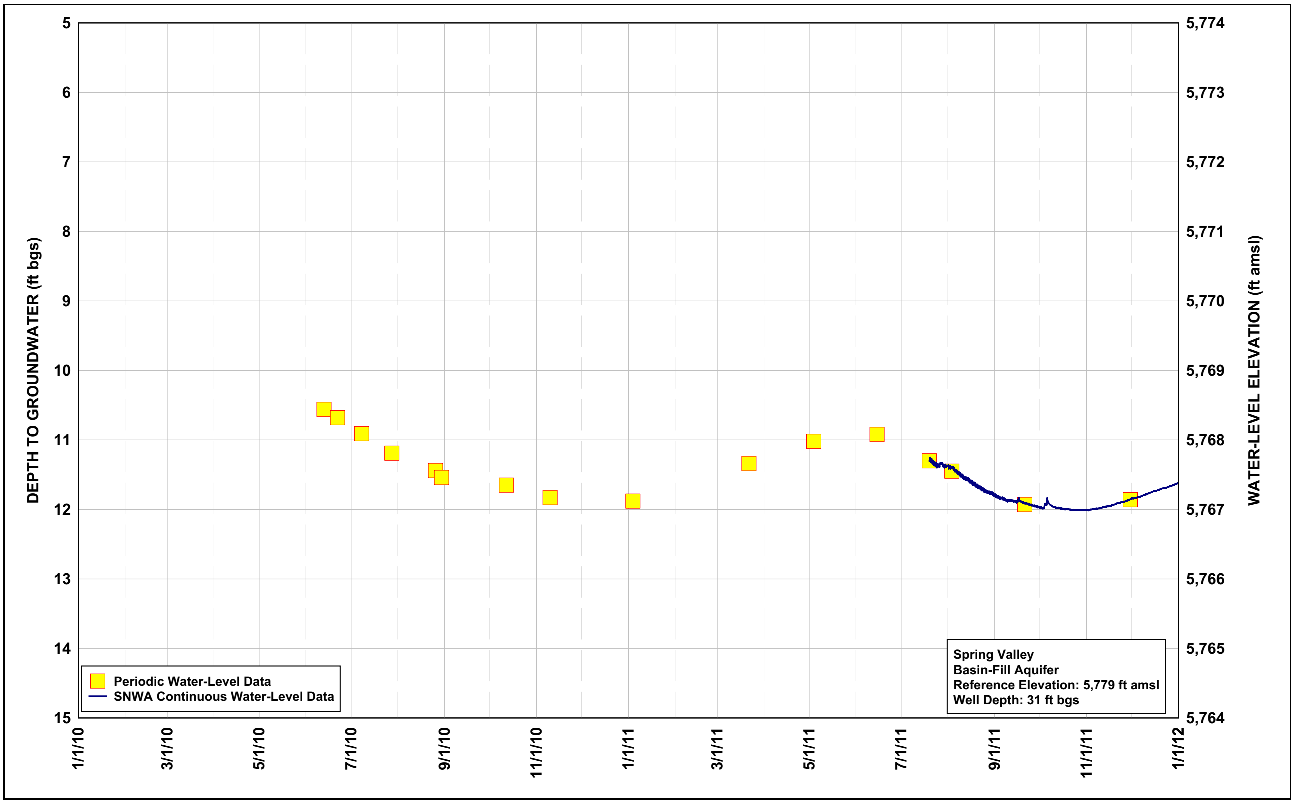


Figure 4-6
Hydrograph of The Seep Piezometer

5.0 SWALLOW SPRINGS

Swallow Springs are located in southeastern Spring Valley approximately 1.5 mi east of SR 894 and about 11.6 mi north of the Lincoln and White Pine county line. The spring is approximately 0.8 mi west of the Snake Range. The spring orifices, referred to as the north and south orifices, discharge into separate channels, which join to form a single channel downstream. The springs are surrounded by a grove of large cottonwood trees. A topographic map and aerial photo of the area in the vicinity of Swallow Springs are presented in Figure 5-1.

5.1 Physical Description and Satellite Imagery

Swallow Springs are located on the valley margin on the Swallow Canyon alluvial fan west of the Snake Range mountain front. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 5-2. LANDSAT 5 satellite imagery for the region around Swallow Springs for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 5-3. Field photos of the spring are presented in Figures 5-4 and 5-5.

5.2 Monitoring Program

The spring discharge is monitored with a gaging station at the 6-in. Parshall flume located in the southern channel downstream of the orifice. The northern channel is measured periodically at two flume locations. A piezometer was constructed to a depth of 65 ft near the south spring orifice. There does not appear to be a direct hydraulic connection between the shallow groundwater and the springs because the depth to groundwater in the piezometer is greater than 50 ft. Therefore, discharge monitoring is more effective in documenting spring conditions. The flumes have been surveyed to determine elevation and planar coordinates. In addition to the gaging station and piezometer there is a tipping bucket and bulk gage which is used to measure precipitation duration, intensity, and volume.

5.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7013Z at 5 ft intervals during the drilling process. The borehole was advanced within surficial sediments to 65 ft bgs. The soils encountered consist of well graded gravel with silty clay underlain by well graded sand with clay and gravel. The gravels were subangular to subrounded, light to dark gray limestones, while the sand was light tan, and noncemented. The clays were tan to brown with low to moderate plasticity. Saturated soils were observed at approximately 38 ft bgs. Water inflow into the boring did not occur during advancement of the borehole and was not measurable until the piezometer construction was completed. The lithologic log is presented in Figure 5-6.

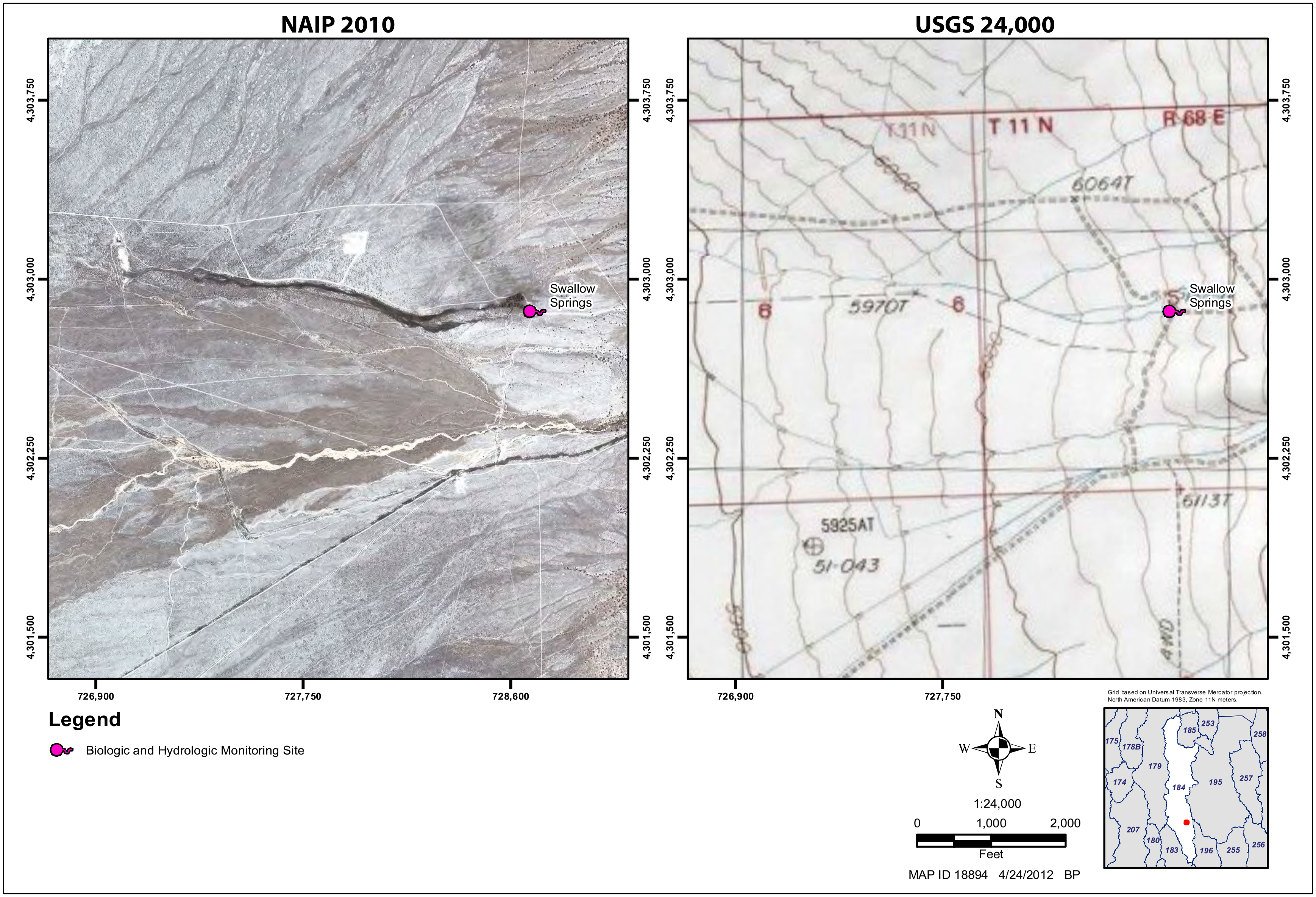


Figure 5-1
Aerial Photo and Topographic Map of Swallow Springs

Figure 5-2
High-Resolution Aerial Photo of Swallow Springs and Hydrologic and Biologic Monitoring Locations

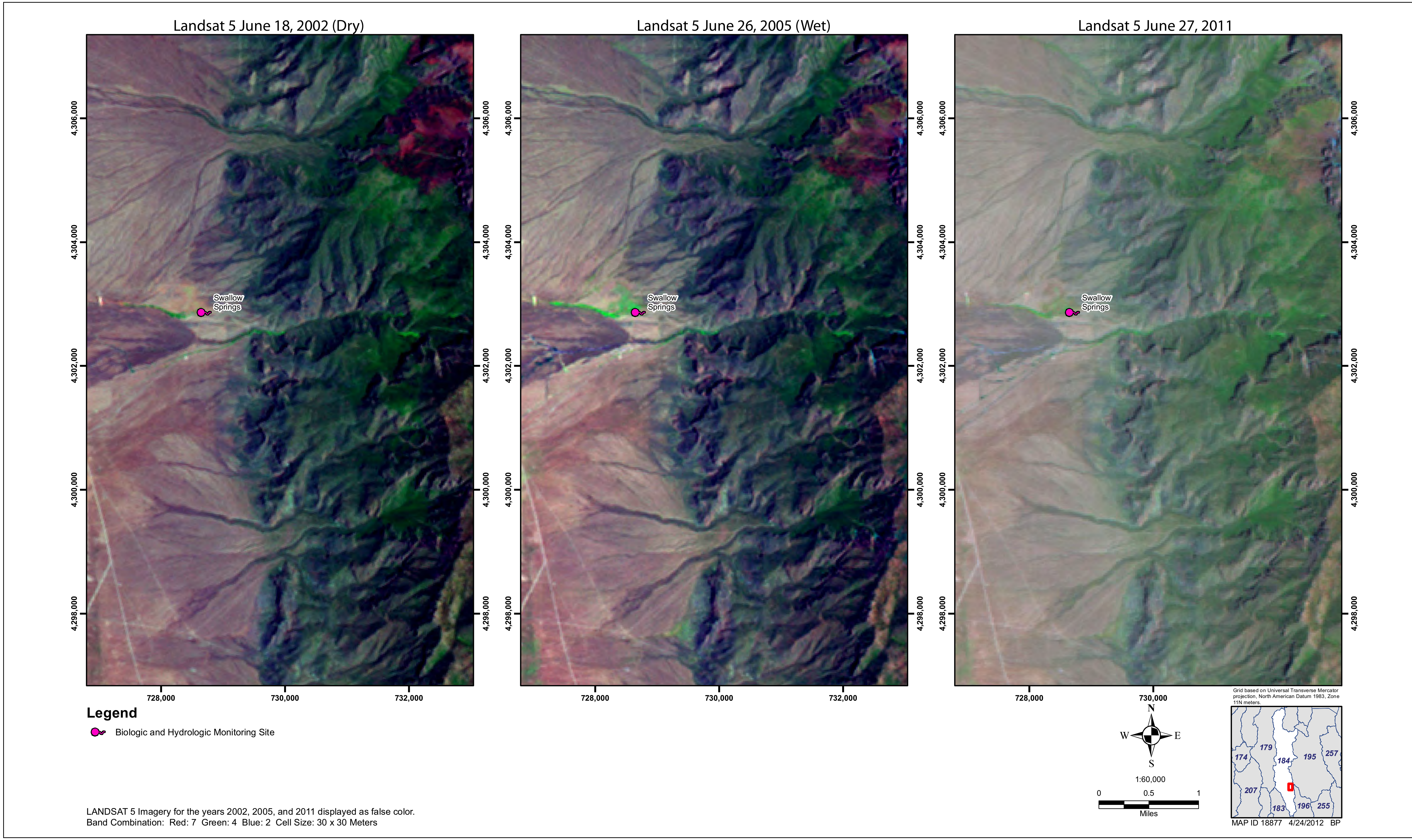


Figure 5-3
LANDSAT Imagery of Swallow Springs

Figure 5-4
Swallow Springs South Channel

Figure 5-5
Swallow Springs South Channel Gaging Station

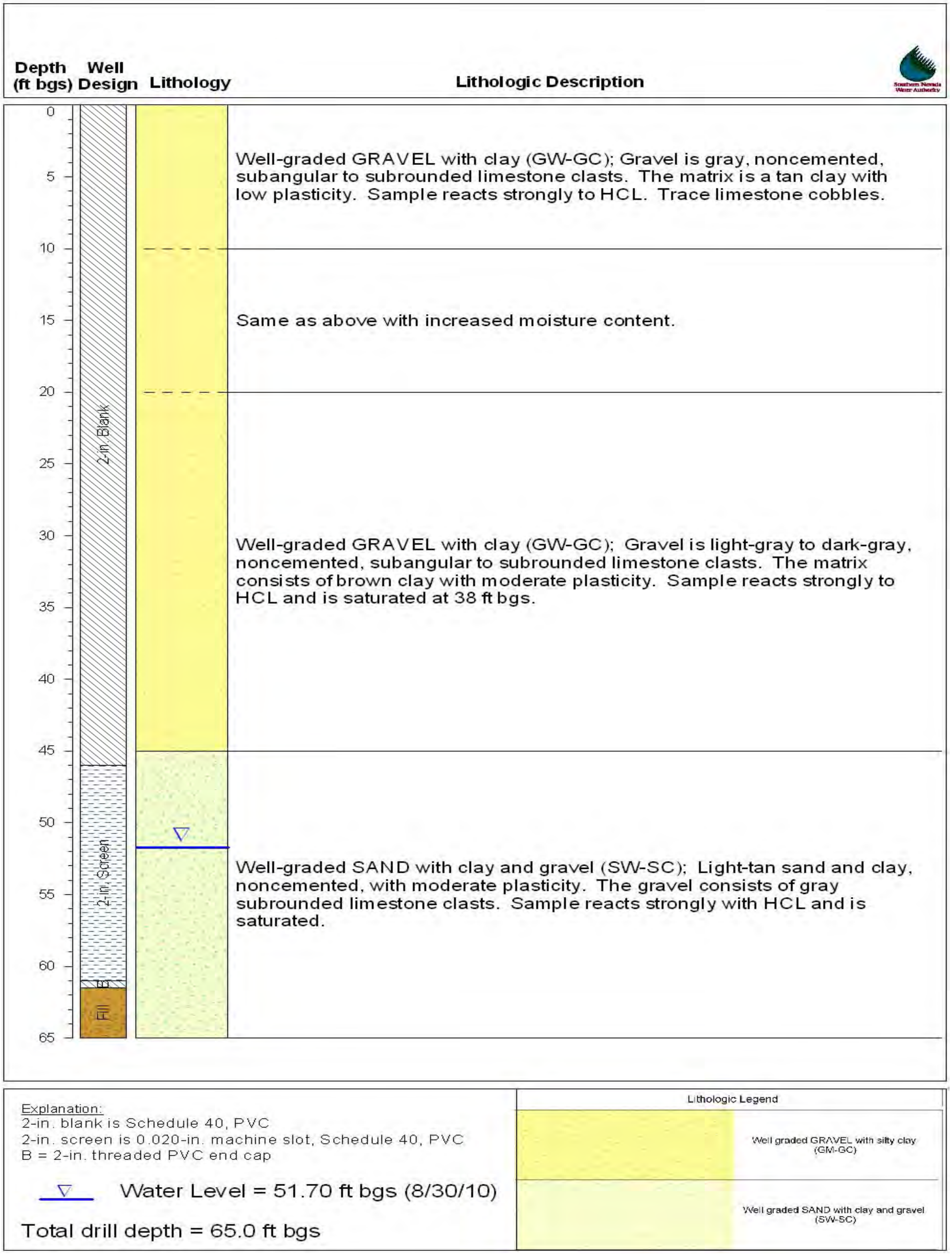


Figure 5-6
Swallow Springs Piezometer Lithologic Log

Discharge data from Swallow Spring north and south channels are presented in Figure 5-7.

5.4 Spring Water Chemistry

Water chemistry samples were collected from the Swallow Springs south orifice on October 24, 2010. The water temperature of the spring discharge sample was 9.8°C, the pH was 7.63, and the EC was 345 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, ^{14}C activity, high tritium concentration, and hydrogeologic conditions indicate that the spring is local.

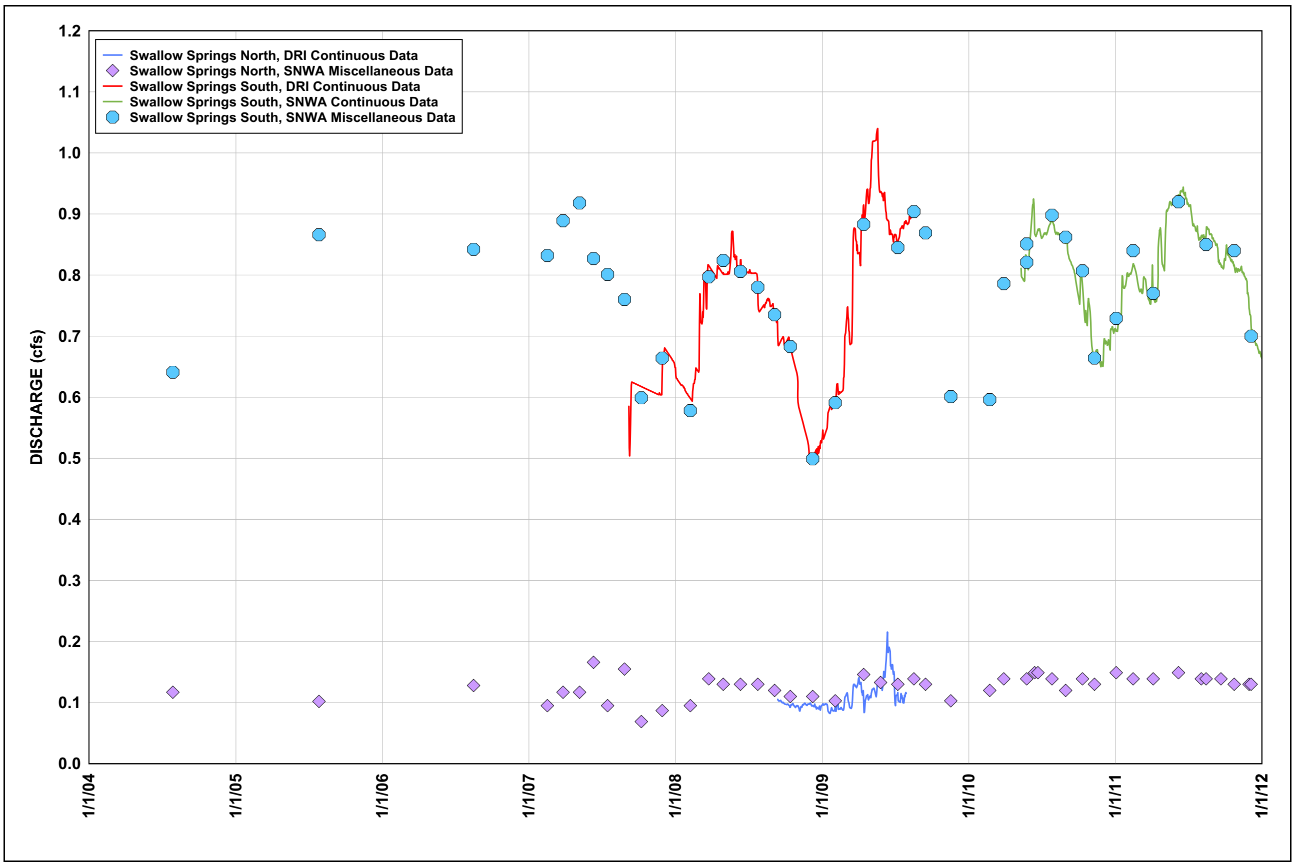


Figure 5-7
Hydrograph of Swallow Springs North and South Discharge

6.0 LAYTON SPRING

Layton Spring is located in central Spring Valley approximately 2.5 mi north of U.S. Highway 50 on BLM managed land. It is located 29.7 mi north of the Lincoln and White Pine county line and 2.3 mi west of the Snake Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figure 6-1 and Figure 6-2, respectively.

6.1 Physical Description and Satellite Imagery

Layton Spring is located on the valley floor in unconsolidated sediments in an area of surrounded by dense, mature vegetation coverage over 5 ft tall. The spring discharges from the base of a small fault or escarpment. The spring has been modified from its natural state with a collector system placed into the scarp and piped to a trough. the spring trough and pool is used for cattle watering. water is present in the pool when the discharge from the spring is sufficient to overflow the trough or when precipitation collects in the depression.

A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 6-3. LANDSAT 5 satellite imagery for the region around Layton Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 6-4. Water overflowing the trough collects and ponds in a low area near the trough. Field photos of the spring are presented in Figures 6-5 and 6-6.

6.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7019Z, which is located to the southeast of the spring. The piezometer has been professionally surveyed to determine accurate elevation and planar coordinates. Discharge from the spring collector pipe is measured volumetrically on a regular basis when discharge is occurring.

When water is present discharge measurements have been made at Layton Spring. The spring has been observed to be dry or have minimal discharge over extended periods of time since 2007 when regular observations were initiated at the site.

6.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7019Z at 5 ft intervals during the drilling process. The borehole was advanced within surficial sediments to 35.3 ft bgs. The soils encountered consists of fat clay with gravel, and clay with sand. The clays encountered were gray or greenish-gray with medium to high plasticity. The sand was tan to gray, poorly sorted, and noncemented. Soils became saturated at approximately 10 ft bgs, during advancement of the borehole. The lithologic log

Figure 6-1
Topographic Map of Layton Spring and Vicinity

Figure 6-2
Aerial Photo of Layton Spring and Vicinity

Figure 6-3
High-Resolution Aerial Photo of Layton Spring

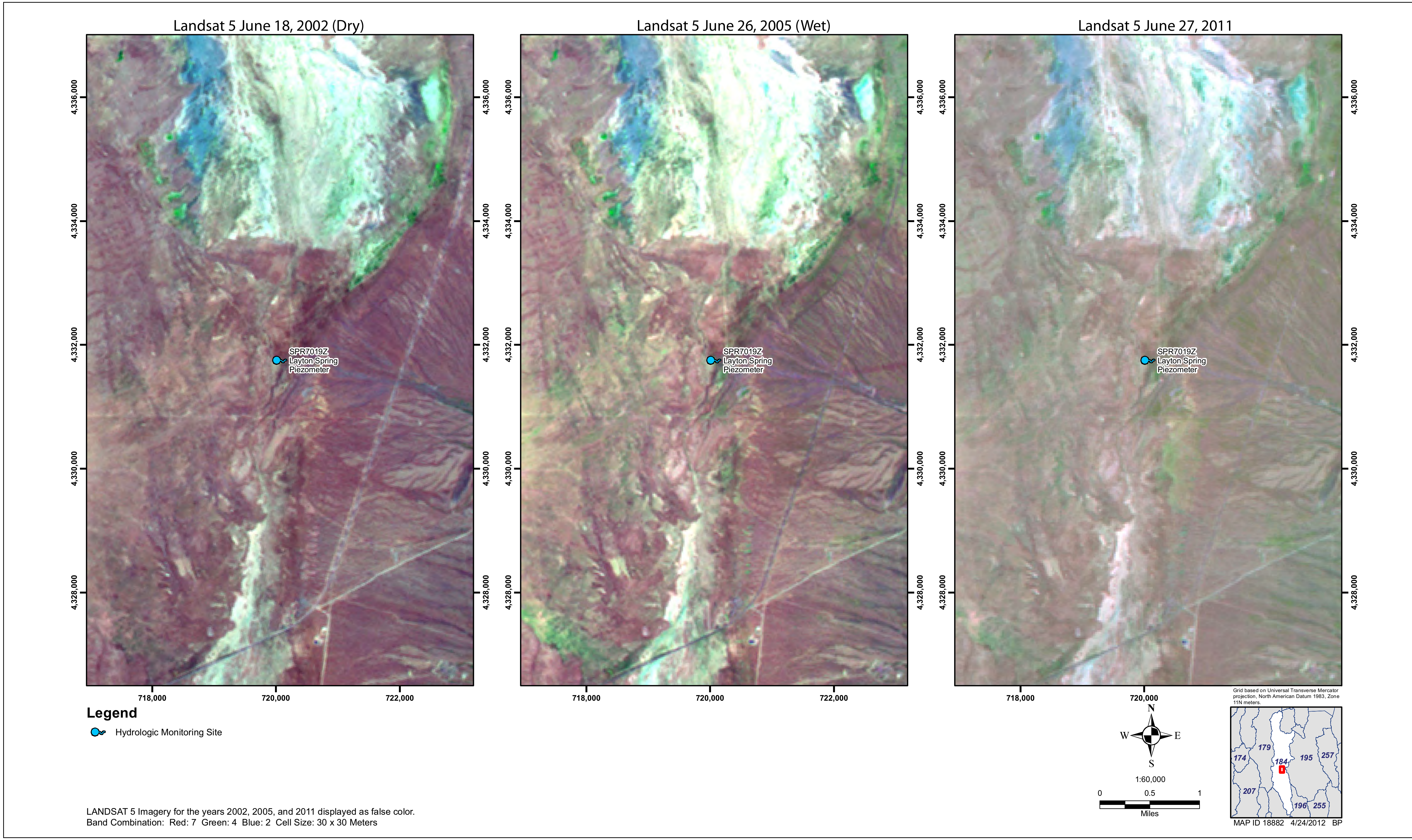


Figure 6-4
LANDSAT Imagery of Layton Spring

Figure 6-5
Layton Spring Looking North

Figure 6-6
Layton Spring Looking Northwest Under Dry Conditions

for the piezometer borehole is presented in Figure 6-7. During the September 2011 visit to the site, a gravel pit operation was observed directly to the south of Layton Spring along the same fault scarp.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 6-8. Spring discharge measurements are presented on Figure 6-9. The site hydrogeologic conditions and hydrographs indicate the spring is susceptible to seasonal changes such as increasing water-levels and discharge during spring and summer and decreases during fall and winter.

6.4 Water Chemistry

Layton Spring was dry at the time of sampling and therefore samples were collected from piezometer SPR7019Z on October 25, 2010 using a teflon bailer. The water temperature of the SPR7019Z sample was 10.8°C, the pH was 7.15, and the EC was 306 µS/cm. The water is a Ca-Mg-HCO_3 type. The spring has been previously sampled several times in 1991 and 2006. The analytical results for the piezometer and spring are provided in Appendix A.

The seasonal fluctuation of discharge and water-levels, cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, and hydrogeologic conditions indicate that the spring is of local origin.

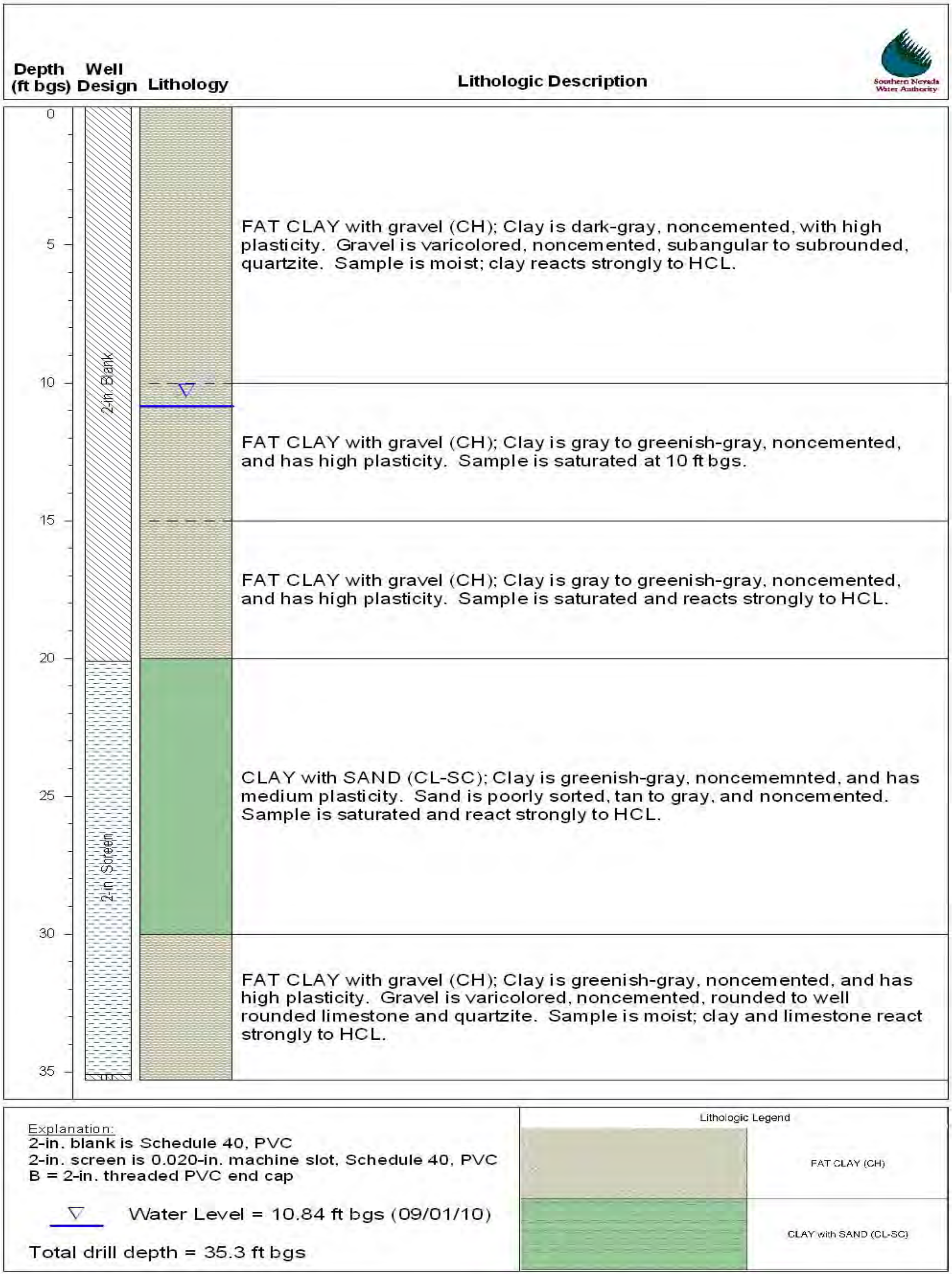


Figure 6-7
Layton Spring Piezometer Lithologic Log

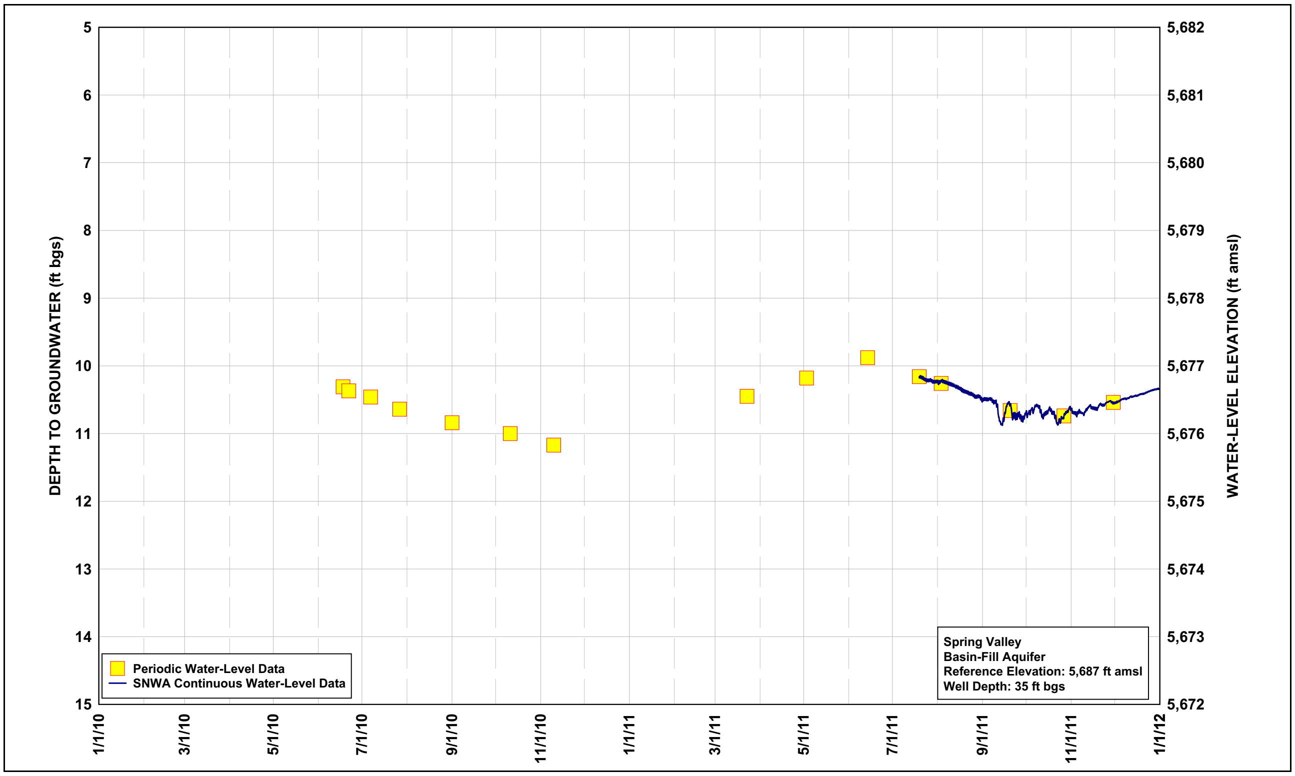


Figure 6-8
Hydrograph of Layton Spring Piezometer

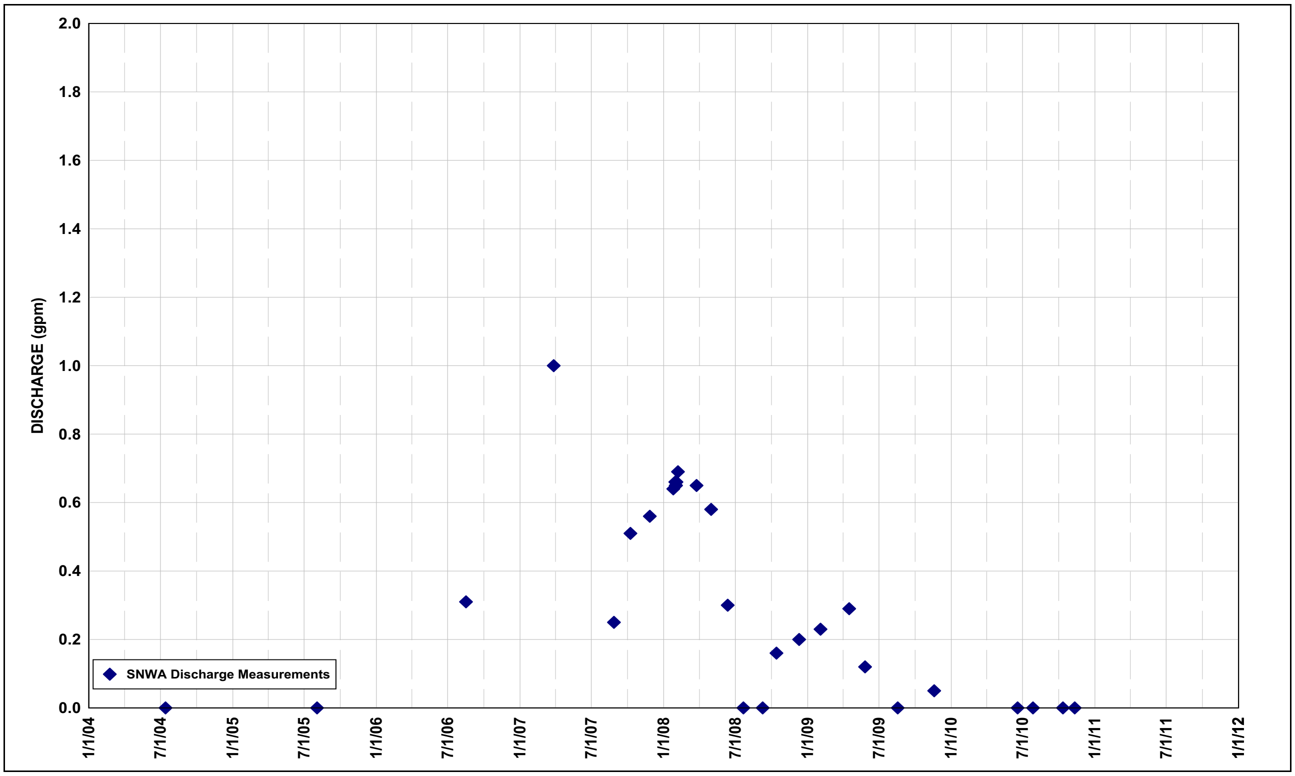


Figure 6-9
Hydrograph of Layton Spring Discharge

7.0 FOUR WHEEL DRIVE SPRING

Four Wheel Drive Spring is located in west central Spring Valley approximately 1.2 mi east of State Route 893 and about 31.5 mi north of the Lincoln and White Pine county line. The spring is approximately 3.6 mi east of the Schell Creek Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 7-1 and 7-2, respectively.

7.1 Physical Description and Satellite Imagery

Four Wheel Drive Spring is located on the valley floor in unconsolidated basin-fill sediments. The spring consists of a pool which has a man-made raised berm surrounding it. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 7-3. LANDSAT 5 satellite imagery for the region around Four Wheel Drive Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 7-4. A field photo of the spring is presented in Figure 7-5.

7.2 Monitoring Program

The site is monitored by collecting continuous water-level measurements at one-hour intervals at piezometer SPR7012Z, which is located approximately 25 ft to the northwest of the spring. The spring-pool elevation is monitored periodically using a staff plate located in the southern portion of the spring pool. The staff plate and piezometer have been surveyed to determine accurate elevation and planar coordinates. Several small-diameter shallow piezometers are located around the perimeter of the spring pool. These were installed in the past as part of an university research project. The piezometers are still in place; however, they are not utilized in the current monitoring program, due to the uncertainty of there construction.

7.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7012Z at 5 ft intervals during the drilling process. The borehole was advanced within surficial sediments to 25 ft bgs. The soils encountered consisted of fat clay with gravel, and gravel with silty clay. The clays encountered were brown with high plasticity, while the gravels consist of angular to subangular variable colored volcanic clasts. Soil became moist less than 1 ft bgs, with water encountered at approximately 20 ft bgs during advancement of the borehole. A summary of the lithologic log is presented in Figure 7-6.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 7-7. A hydrograph of the spring-pool elevation is presented in Figure 7-8. The spring-pool elevation and observed surface area is comparable to the piezometer water level The hydrograph also displays seasonal water-level fluctuations which would indicate a direct hydraulic connection

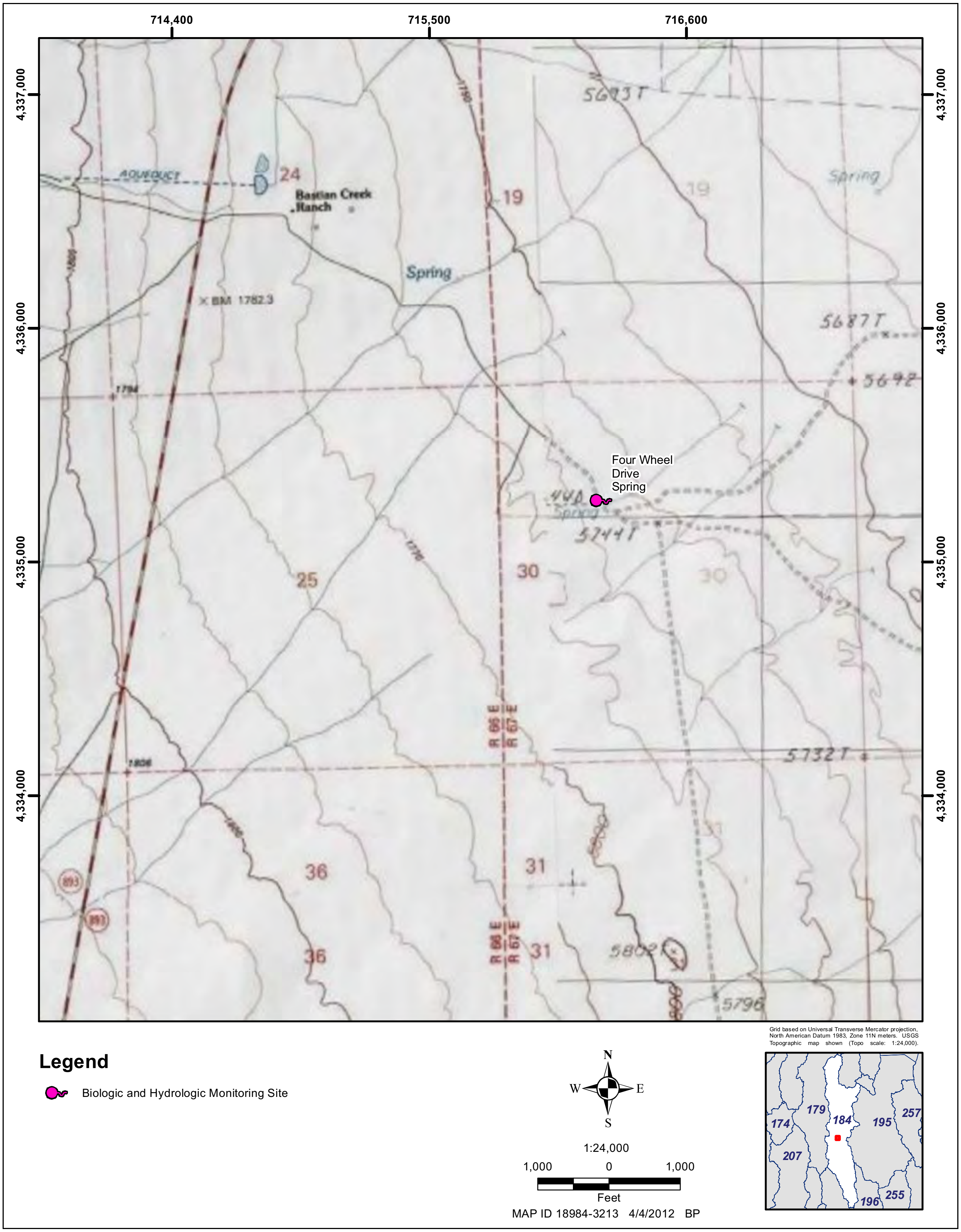


Figure 7-1
Topographic Map of Four Wheel Drive Spring

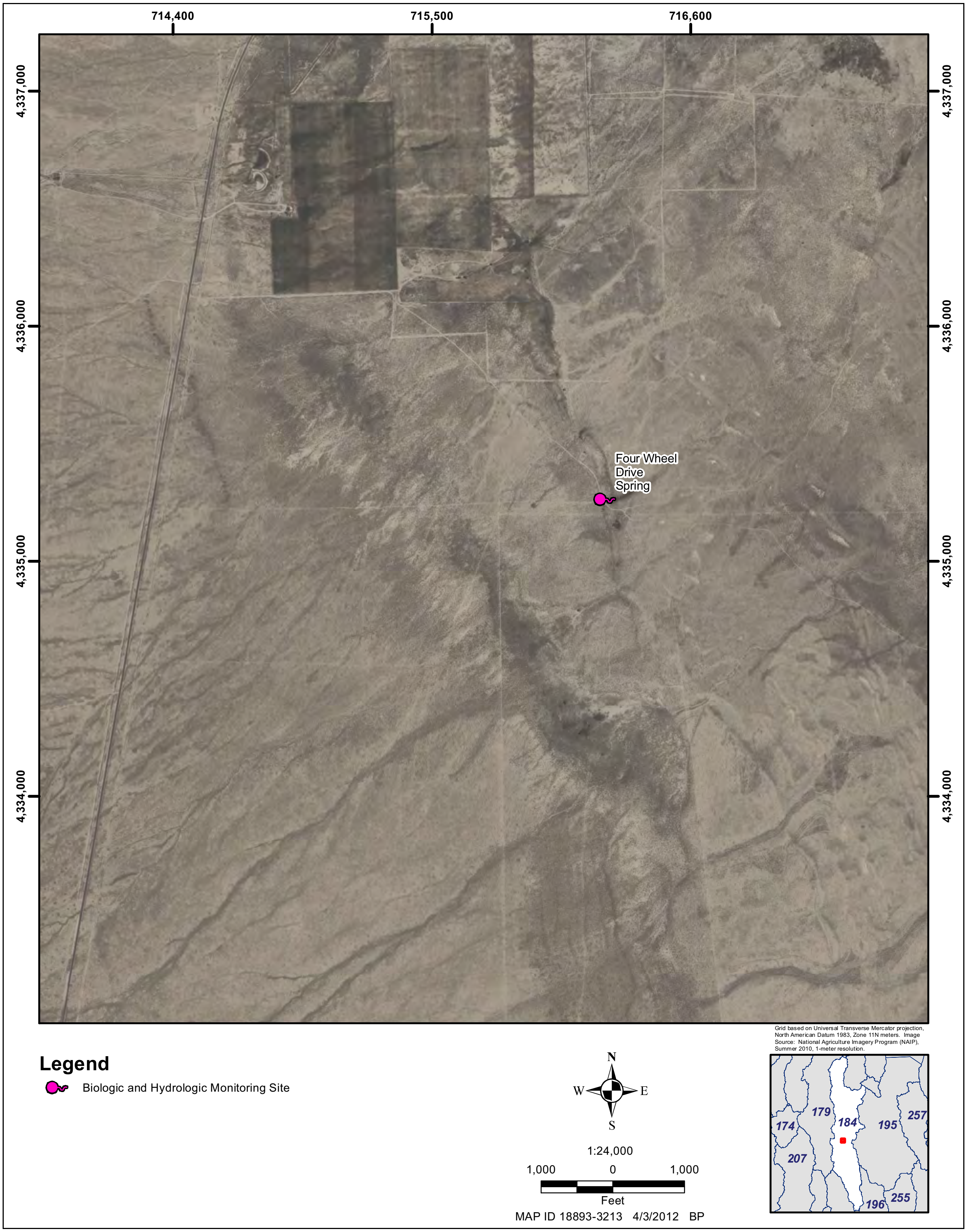


Figure 7-2
Aerial Photo of Four Wheel Drive Spring Area

Figure 7-3
High-Resolution Aerial Photo of Four Wheel Drive Spring

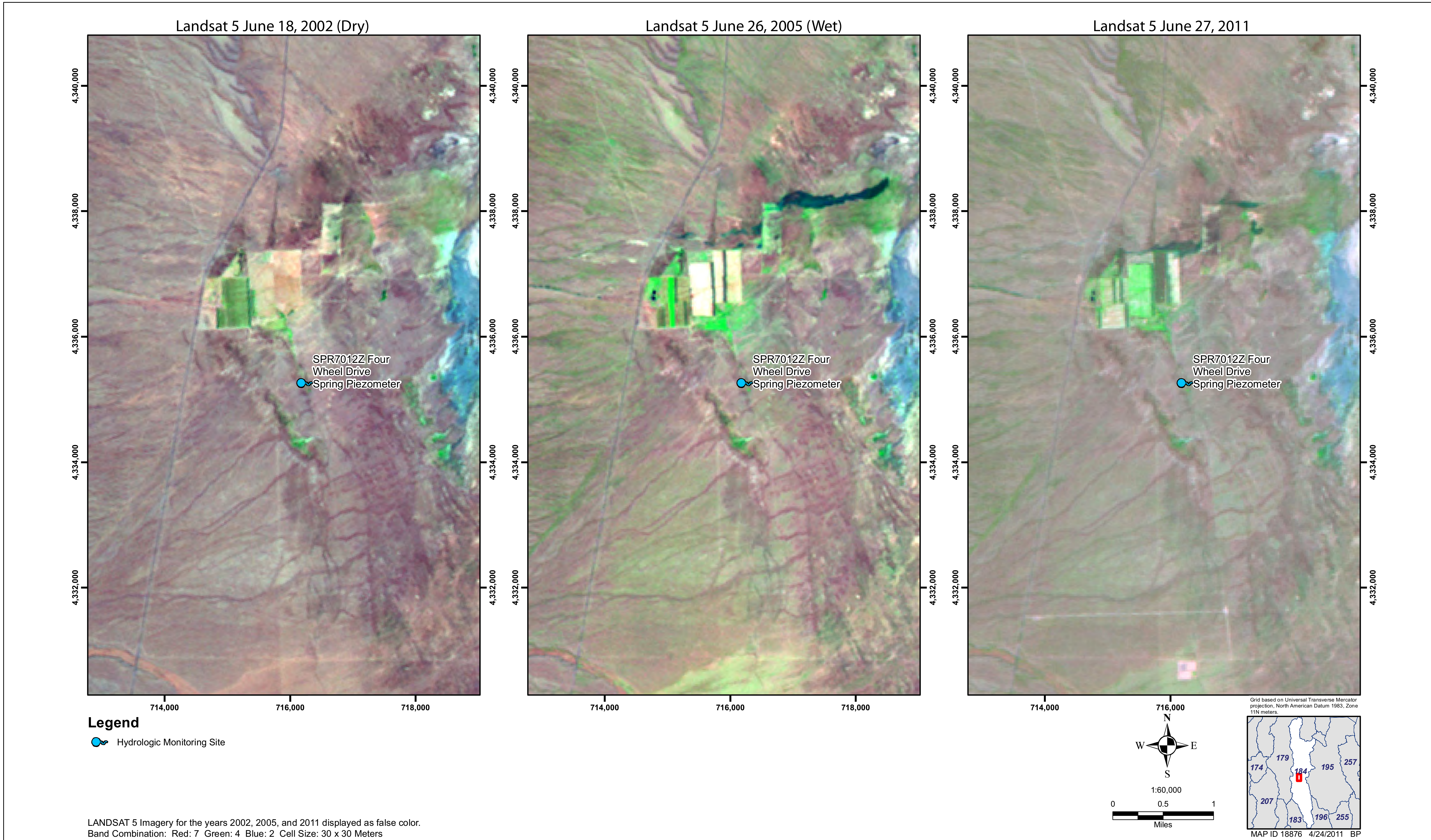


Figure 7-4
LANDSAT Imagery of Four Wheel Drive Spring

Figure 7-5
Four Wheel Drive Spring Looking East

between the spring pool and local shallow groundwater. Four Wheel Drive Spring discharges, eastward in a small channel, where the water is lost through infiltration, evaporation from open water in the pool and channel, and evapotranspiration by vegetation.

7.4 Water Chemistry

Samples from Four Wheel Drive Spring were collected from piezometer SPR7012Z on October 25, 2010 using a teflon bailer. The temperature of the SPR7012Z sample was 12.2^{o}C, the pH was 7.7, and the EC was 301 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for piezometer SPR7012Z are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, and hydrogeologic conditions indicate that the spring is of local origin.

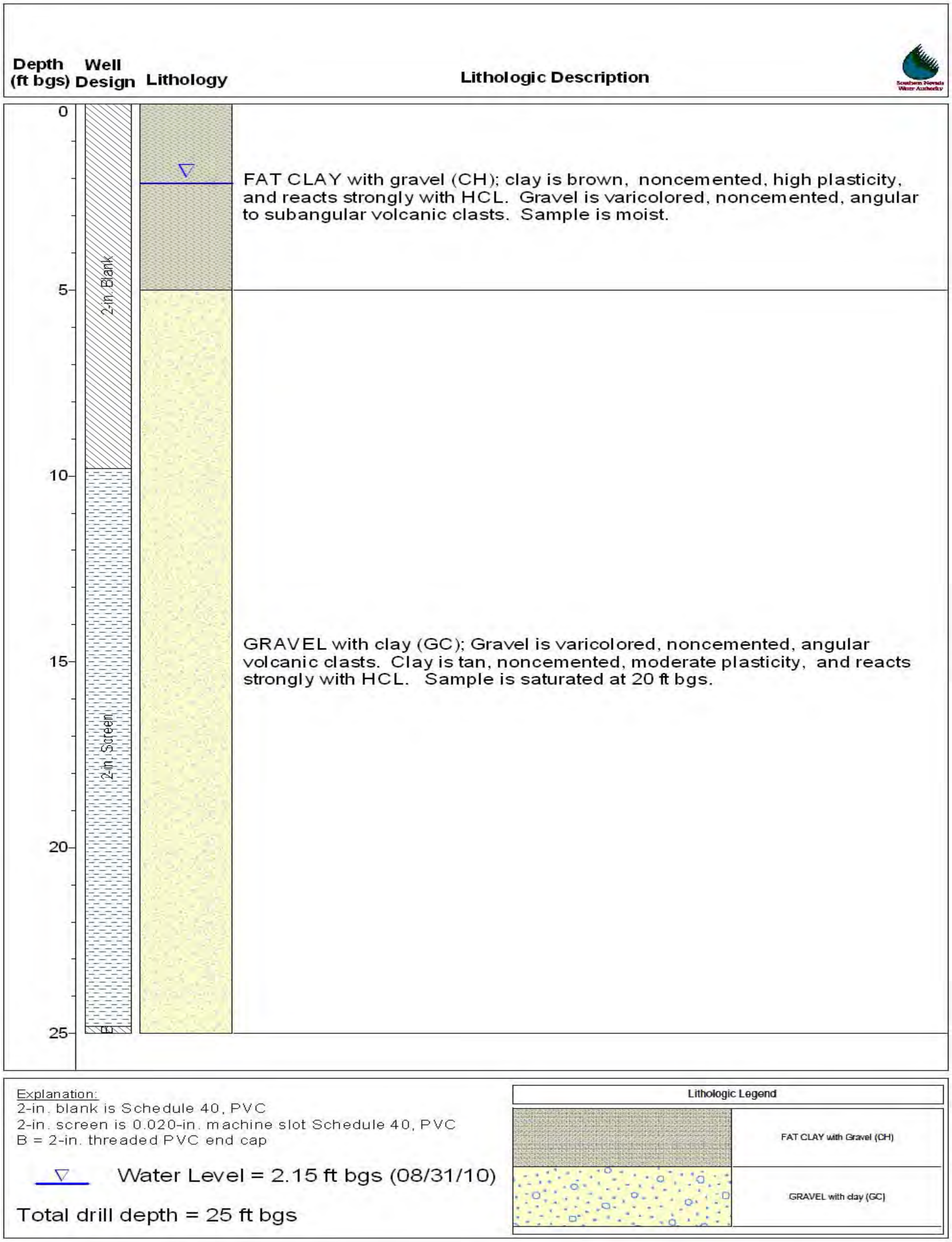


Figure 7-6
Four Wheel Drive Spring Piezometer Lithologic Log

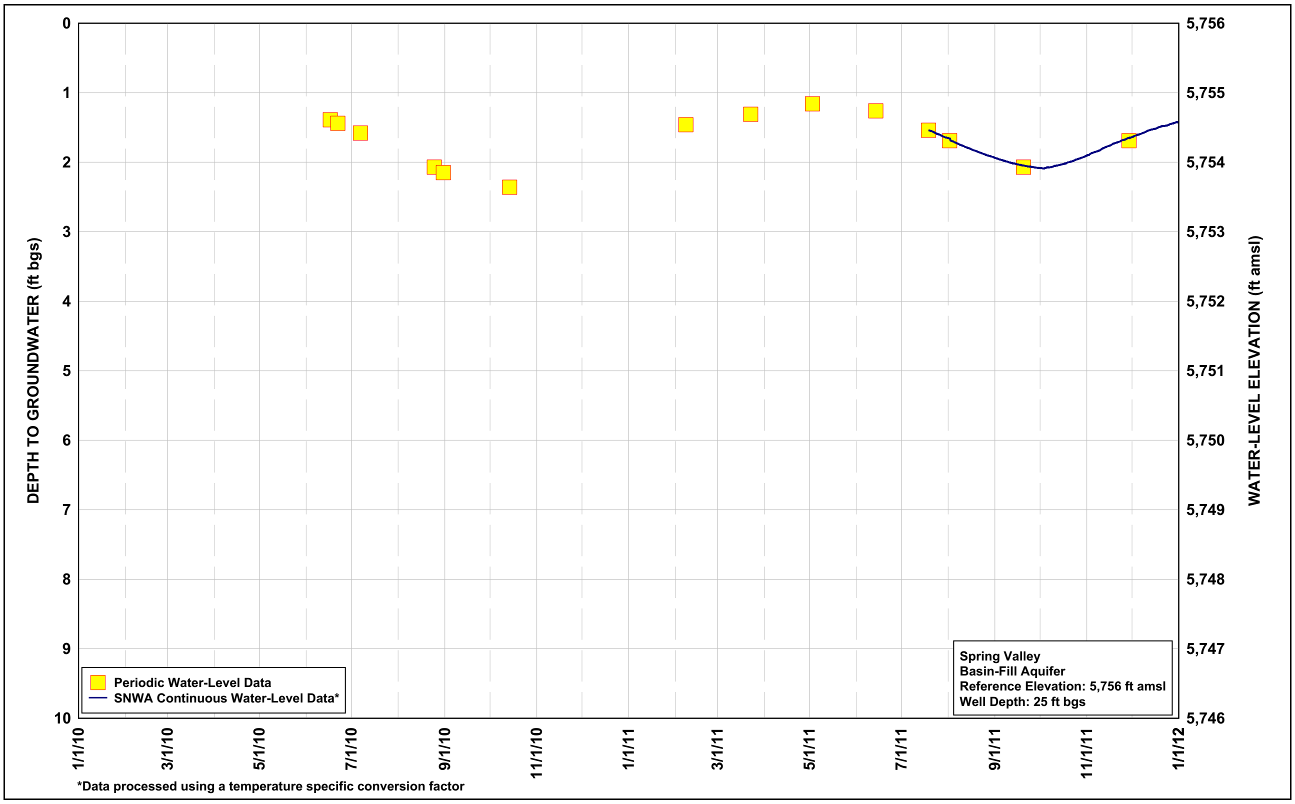


Figure 7-7
Hydrograph of Four Wheel Drive Spring Piezometer

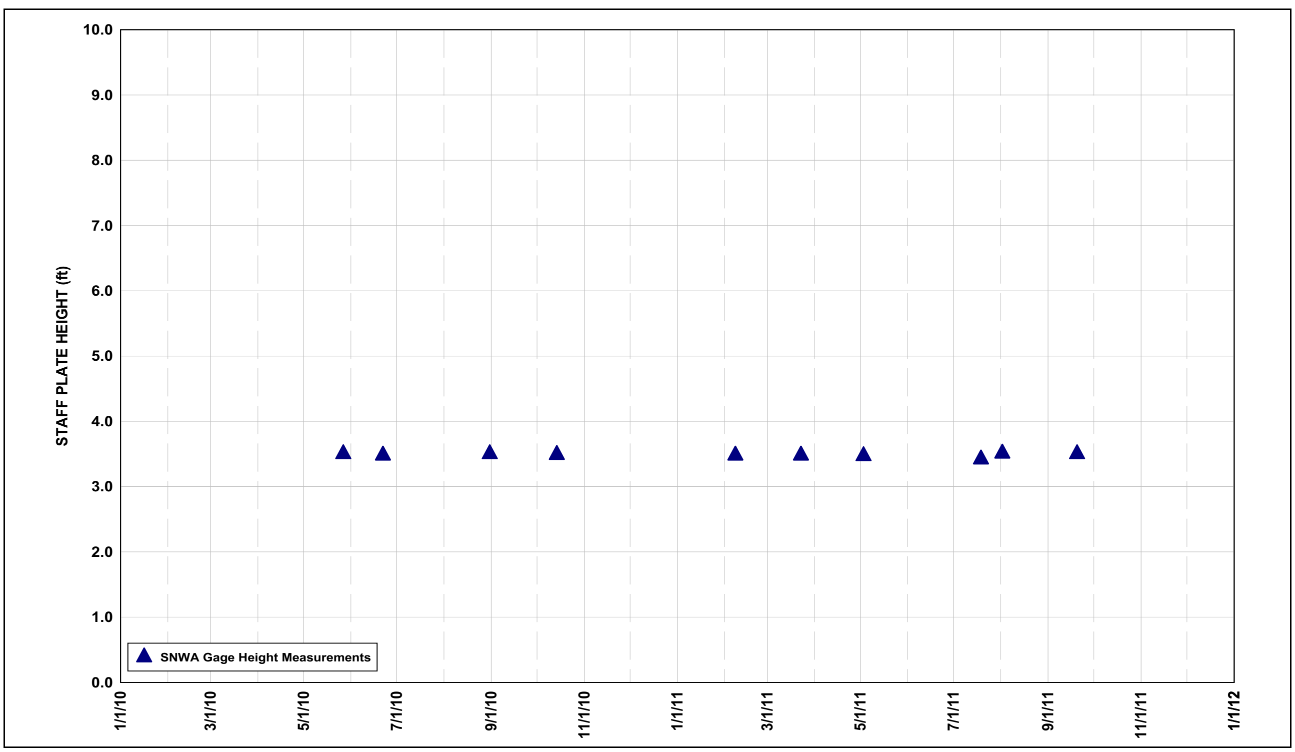


Figure 7-8
Spring-Pool Elevation Hydrograph for Four Wheel Drive Spring

8.0 UNNAMED SPRING NUMBER FIVE

Unnamed Spring Number Five is located in west central Spring Valley east of State Route 893 about 35.1 mi north of the Lincoln and White Pine county line. The spring is approximately 4.6 mi east of the Schell Creek Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 8-1 and 8-2, respectively.

8.1 Physical Description and Satellite Imagery

Unnamed Spring Number Five is situated on the valley floor in unconsolidated basin-fill sediments. Unnamed Spring Number Five is located in an area of moderate to dense grasses and sage brush. The spring has orifices along the pool edge and bottom along with significant algal growth along both the edges and bottom. Multiple spring orifices can also be found to the west below the spring-pool. At the south end of the pool a small diversion ditch has been constructed allowing the spring to flow eastward toward the center of the valley.

A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 8-3. LANDSAT 5 satellite imagery for the region around Unnamed Spring Number Five for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 8-4. Field photos of the spring are presented in Figures 8-5 and 8-6.

8.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7016Z, which is located approximately 25 ft to the west of the spring. The piezometer has been professionally surveyed to determine elevation and planar coordinates.

8.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7016Z at 5 ft intervals during the drilling process. The borehole was advanced within surficial sediments to 35 ft bgs. The soils encountered consist of fat clays and sand with clay. The clays encountered were tan to dark brown with high plasticity, while the sand was poorly graded, tan to brown, quartzite clasts, with no cementation. Saturated soils were observed at 4 ft bgs during the advancement of the borehole. A summary of the lithologic log is presented in Figure 8-7.

The springs are likely the result of a change in hydraulic conductivity of the basin-fill deposits, where the coarse-alluvial material interfingers with the finer lacustrine materials. The spring is representative of the shallow water table at the site, and is in direct hydraulic connection with the

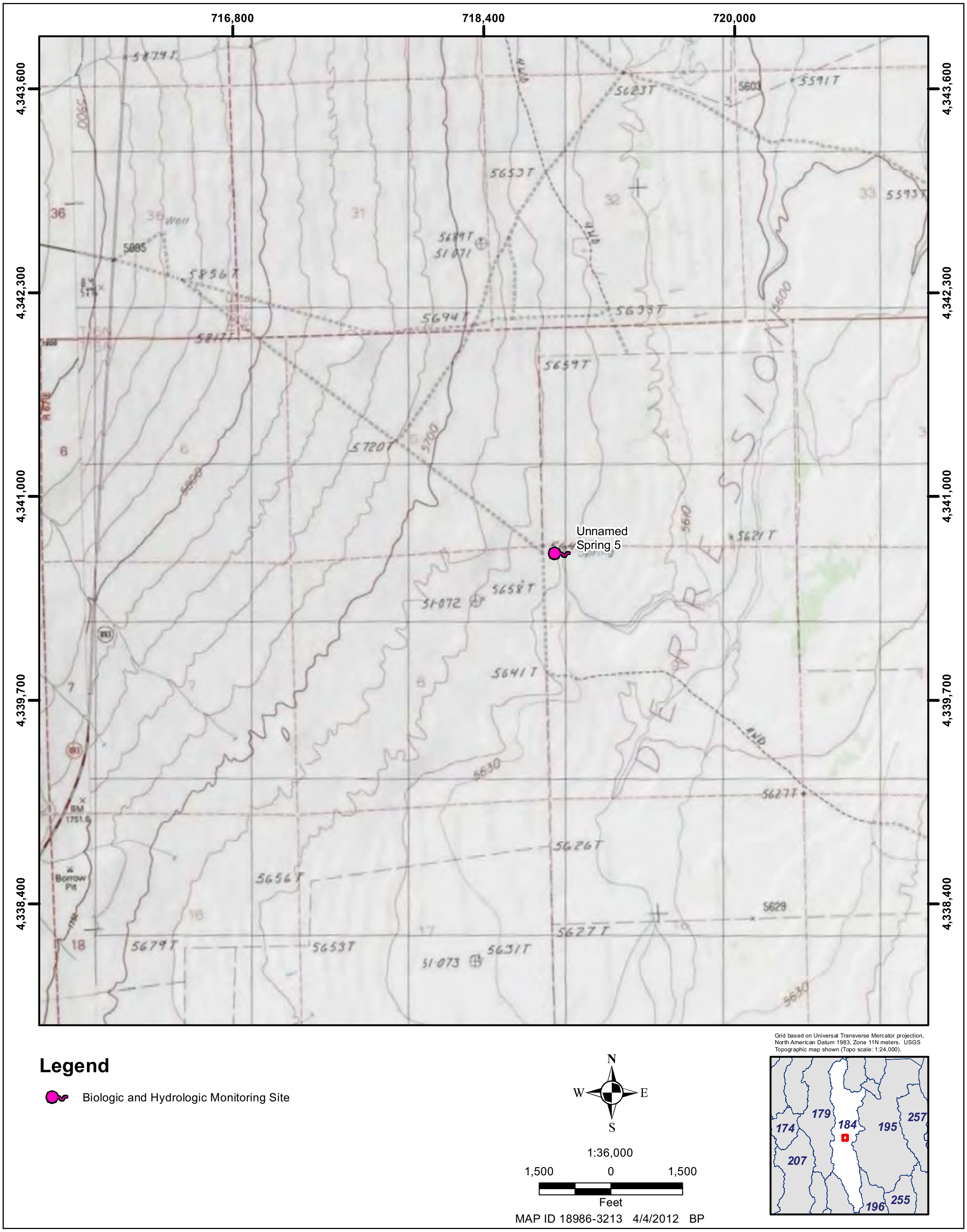


Figure 8-1
Topographic Map of Unnamed Spring Number Five

Figure 8-2
Aerial Photo of Unnamed Spring Number Five

Figure 8-3
High-Resolution Aerial Photo of Unnamed Spring Number Five

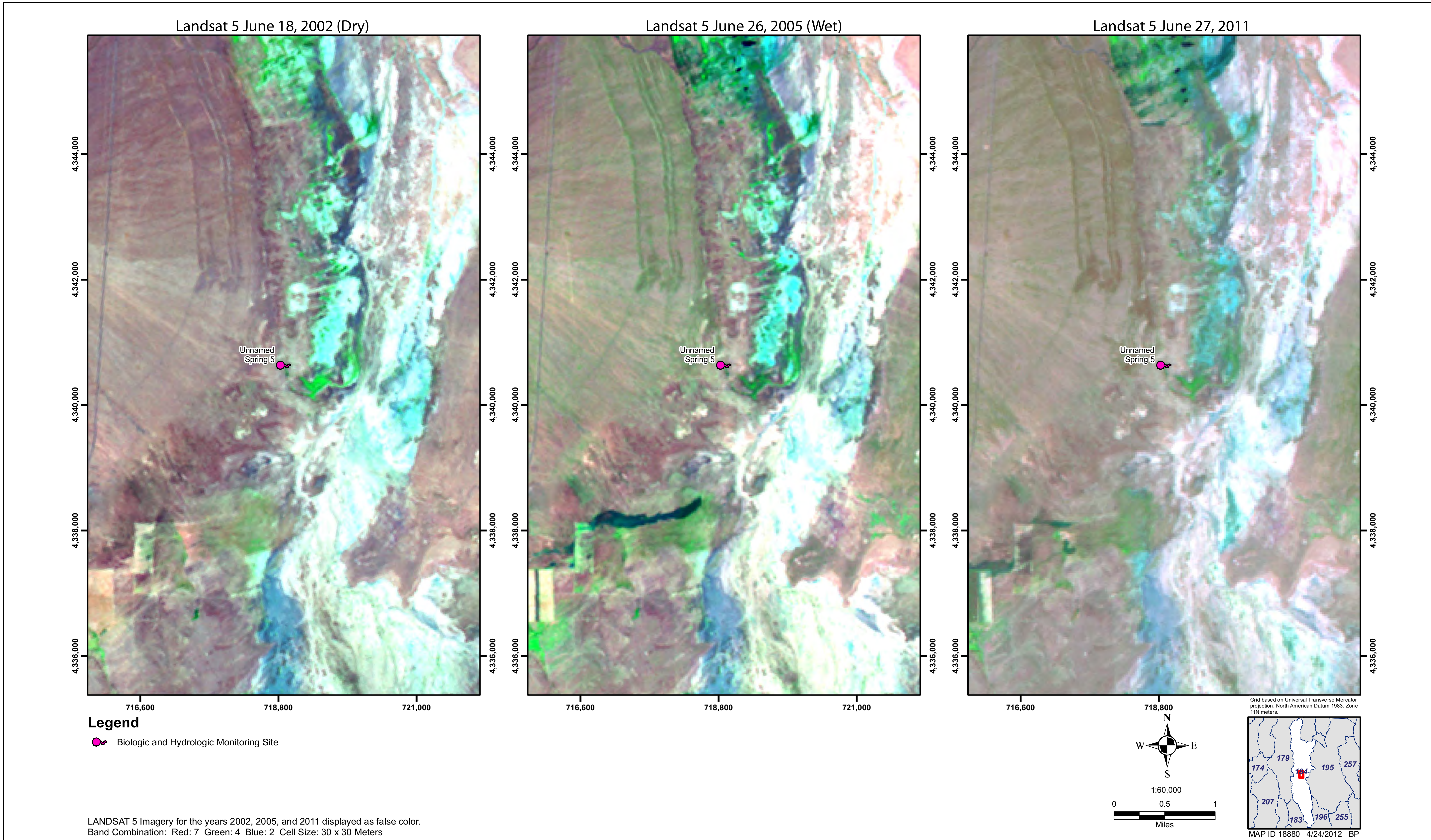


Figure 8-4
LANDSAT Imagery of Unnamed Spring Number Five

Figure 8-5
Unnamed Spring Number Five at South End of Spring Pool Looking East

Figure 8-6
Unnamed Spring Number Five at North End of Spring Pool Looking East

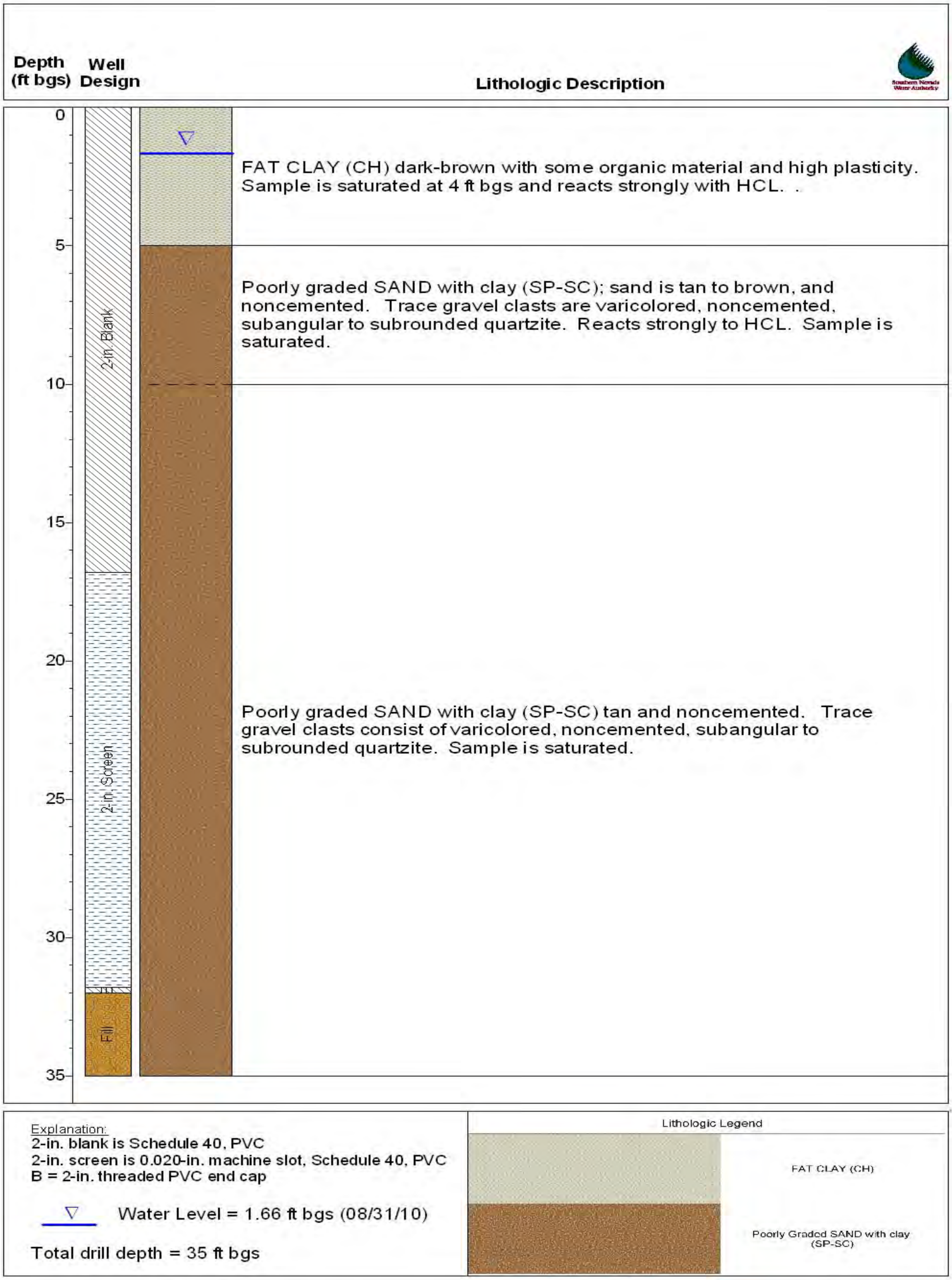


Figure 8-7
Unnamed Spring Number Five Spring Piezometer Lithologic Log

local shallow groundwater system. A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 8-8.

8.4 Water Chemistry

Samples from Unnamed Spring Number Five were collected directly from the spring orifice on October 25, 2010. The temperature of the sample was 12.4°C, the pH was 7.13, and the EC was 389 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the samples are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, presence of tritium, and site hydrogeologic conditions indicate that the spring is of local origin.

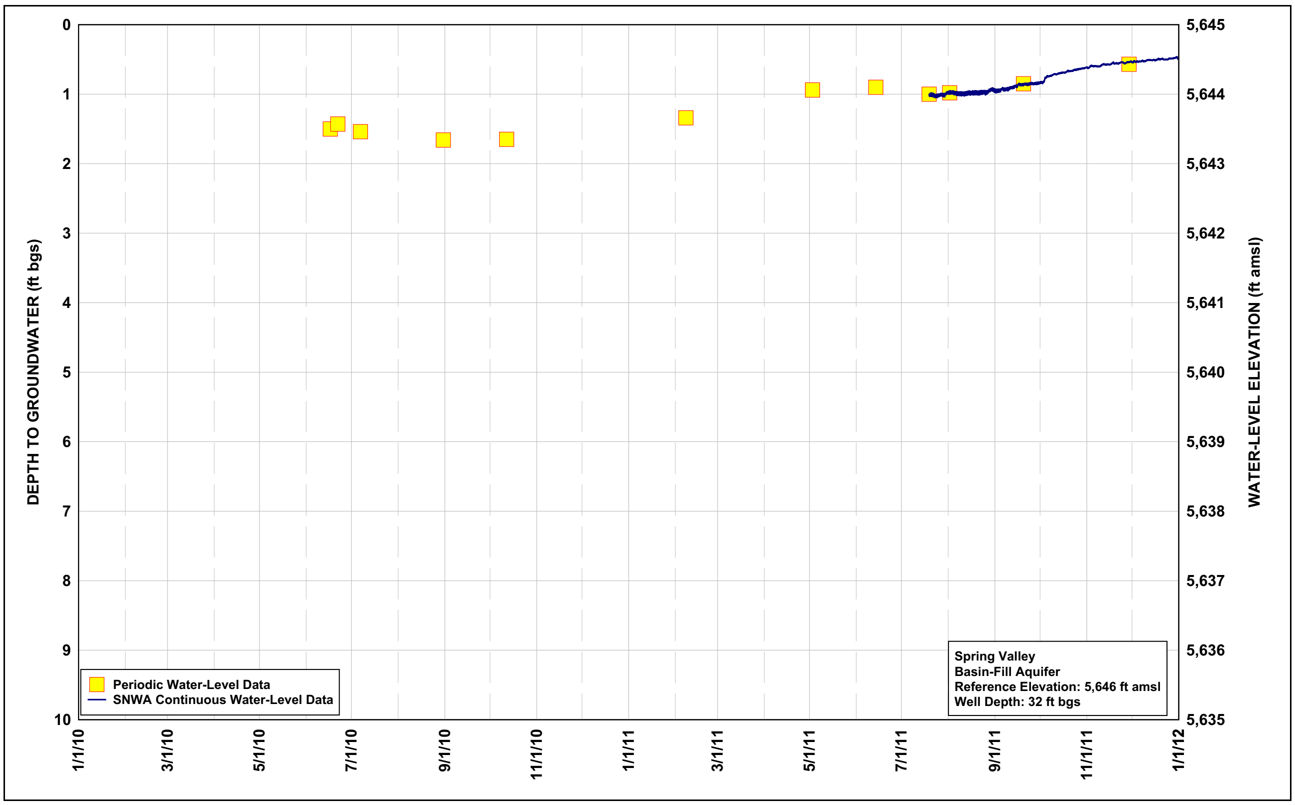


Figure 8-8
Hydrograph of Unnamed Spring Number Five Piezometer

9.0 South Millick Spring

South Millick Spring is located in northeastern Spring Valley approximately 43.2 mi north of the Lincoln and White Pine county line and 2.4 mi west of the Snake Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 9-1 and 9-2, respectively.

9.1 Physical Description and Satellite Imagery

South Millick Spring is located on the valley floor in unconsolidated basin-fill sediments. The spring consists of a large pool to which several small orifices contribute flow. The pool itself is rich in aquatic vegetation, with sparse sage and grasses surrounding the pool. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 9-3. LANDSAT 5 satellite imagery for the region around South Millick Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 9-4. Field photos of the spring are presented in Figures 9-5 and 9-6.

9.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7018Z, which is located approximately 47 ft to the east upgradient of the spring. The spring-pool elevation is monitored periodically using a staff plate located in the right bank (east side) of the spring pool. The staff plate and piezometer have been surveyed to determine accurate elevation and planar coordinates. Spring discharge is also measured periodically downstream of the orifice using a current meter. The spring-pool elevation and discharge is comparable to the piezometer water level and indicates a direct hydrologic connection between the spring and the shallow water table.

9.3 Hydrogeology

Lithologic soil samples were collected for piezometer SPR7018Z at 5 ft intervals during the drilling process. The borehole was advanced within surficial sediments to 31 ft bgs. The soils encountered consisted of fat clays with some gravel. The clays were tan to brown with high plasticity, while the gravel was subangular to subrounded, varicolored limestone with calcite veins. Saturated soils were observed at approximately 7 ft bgs during the advancement of the borehole. A summary of the lithologic log is presented in Figure 9-7.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 9-8. A hydrograph of the spring discharge measured at this site is presented in Figure 9-9.

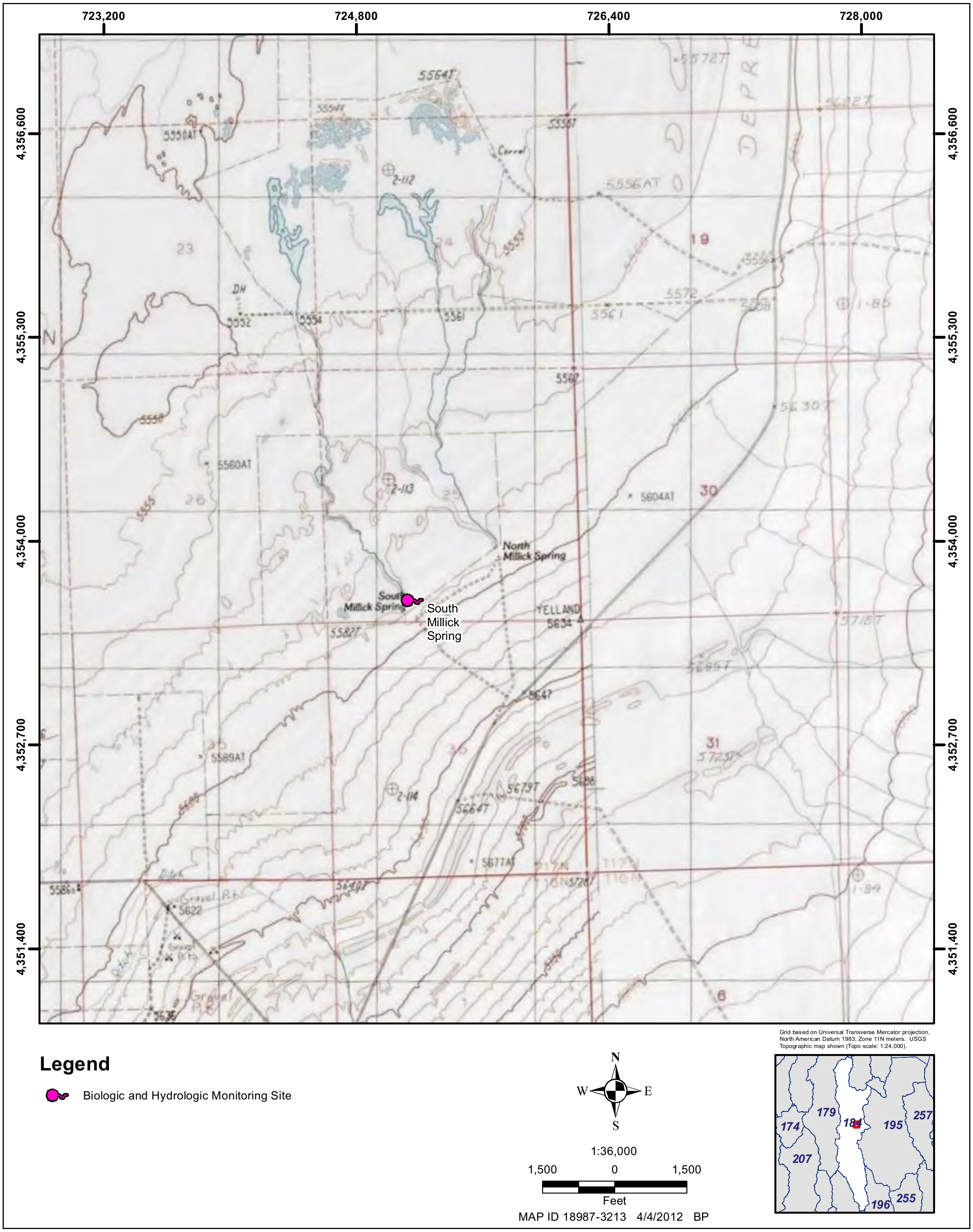


Figure 9-1
Topographic Map of South Millick Spring

Figure 9-2
Aerial Photo of South Millick Spring

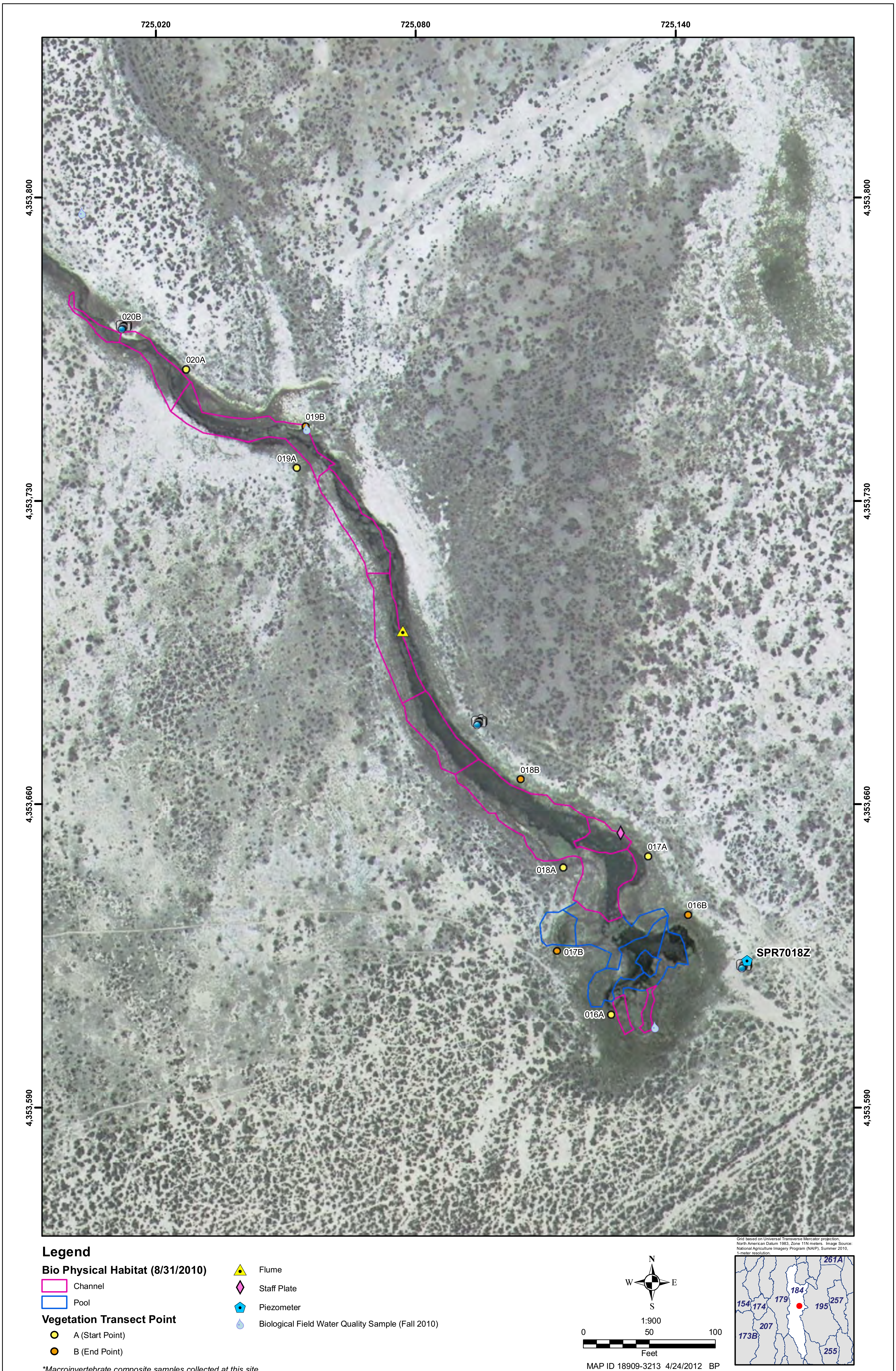


Figure 9-3
High-Resolution Photo of South Millick Spring

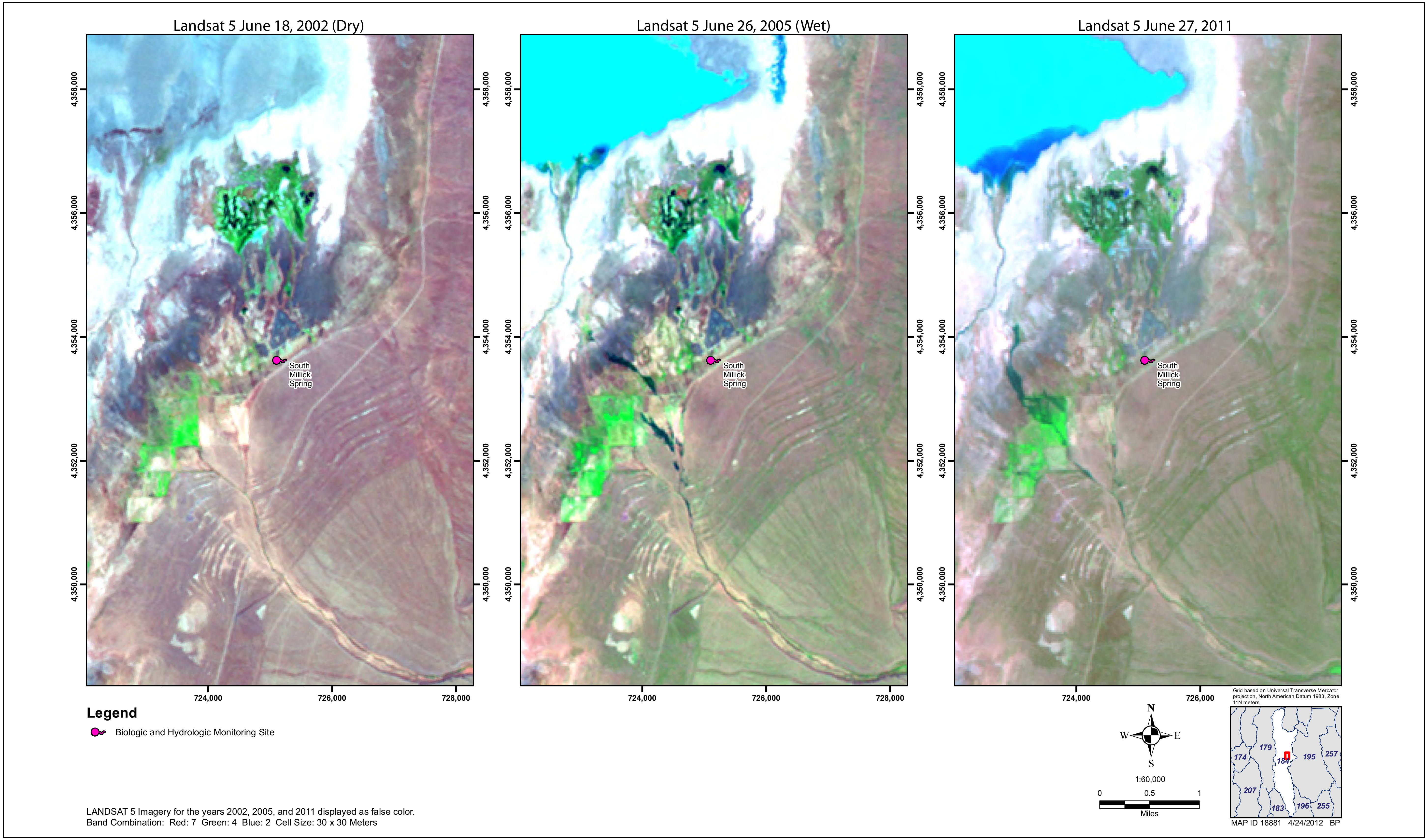


Figure 9-4
LANDSAT Imagery for South Millick Spring

Figure 9-5
South Millick Spring Looking Southeast

Figure 9-6
South Millick Spring Looking Northwest

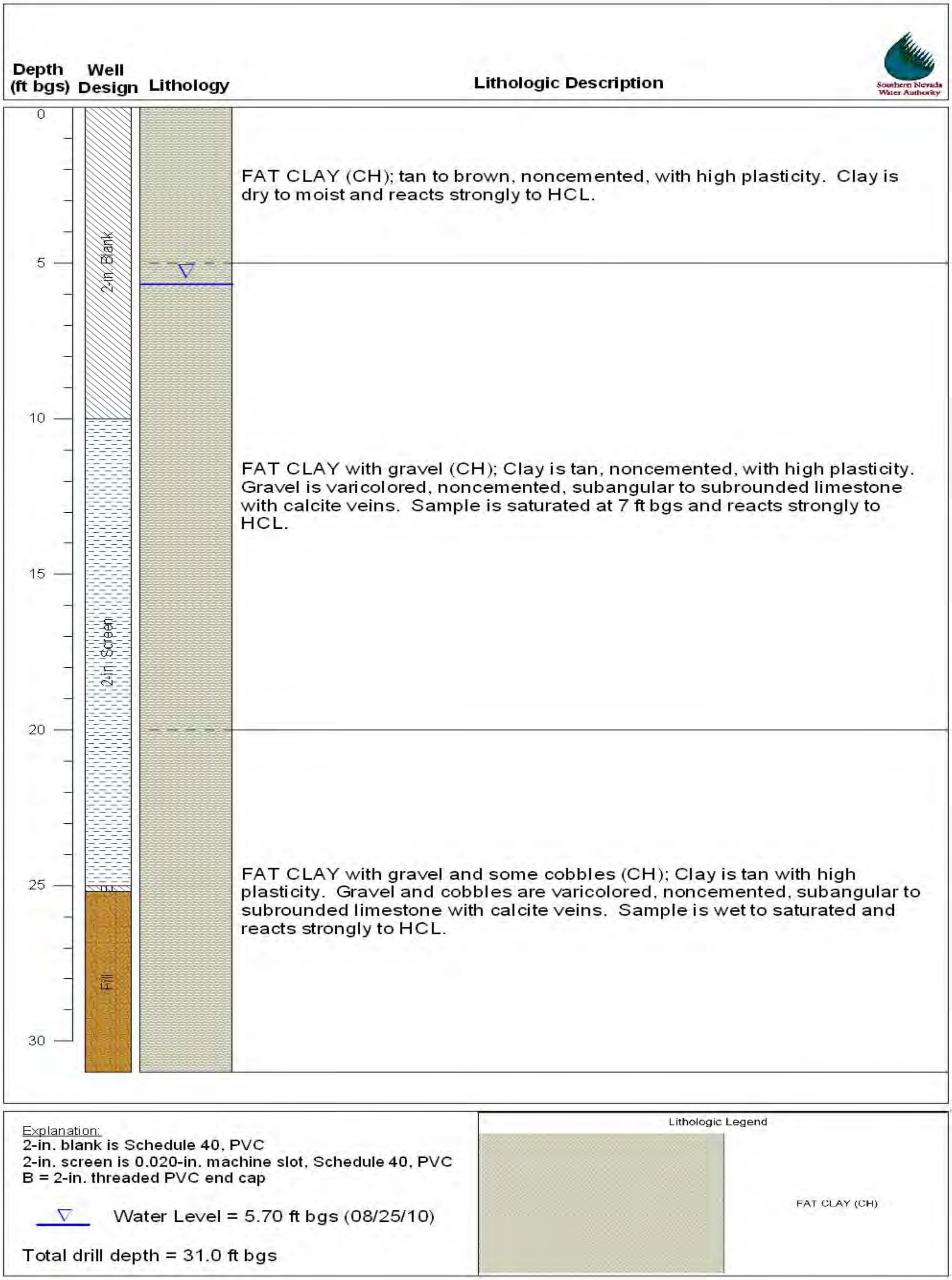


Figure 9-7
South Millick Spring Piezometer Lithologic Log

9.4 Spring Water Chemistry

Samples from South Millick Spring were collected directly from the spring orifice on October 25, 2010. The water temperature of the South Millick Spring sample was 9.8°C, the pH was 7.63, and the EC was 345 µS/cm. The water is a Ca-Mg-HCO_3 type. South Millick Spring has been previously sampled several times in 1991, 2004, and 2006. The analytical results for samples are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, presence of tritium, and site hydrogeologic conditions indicate that the spring is of local origin.

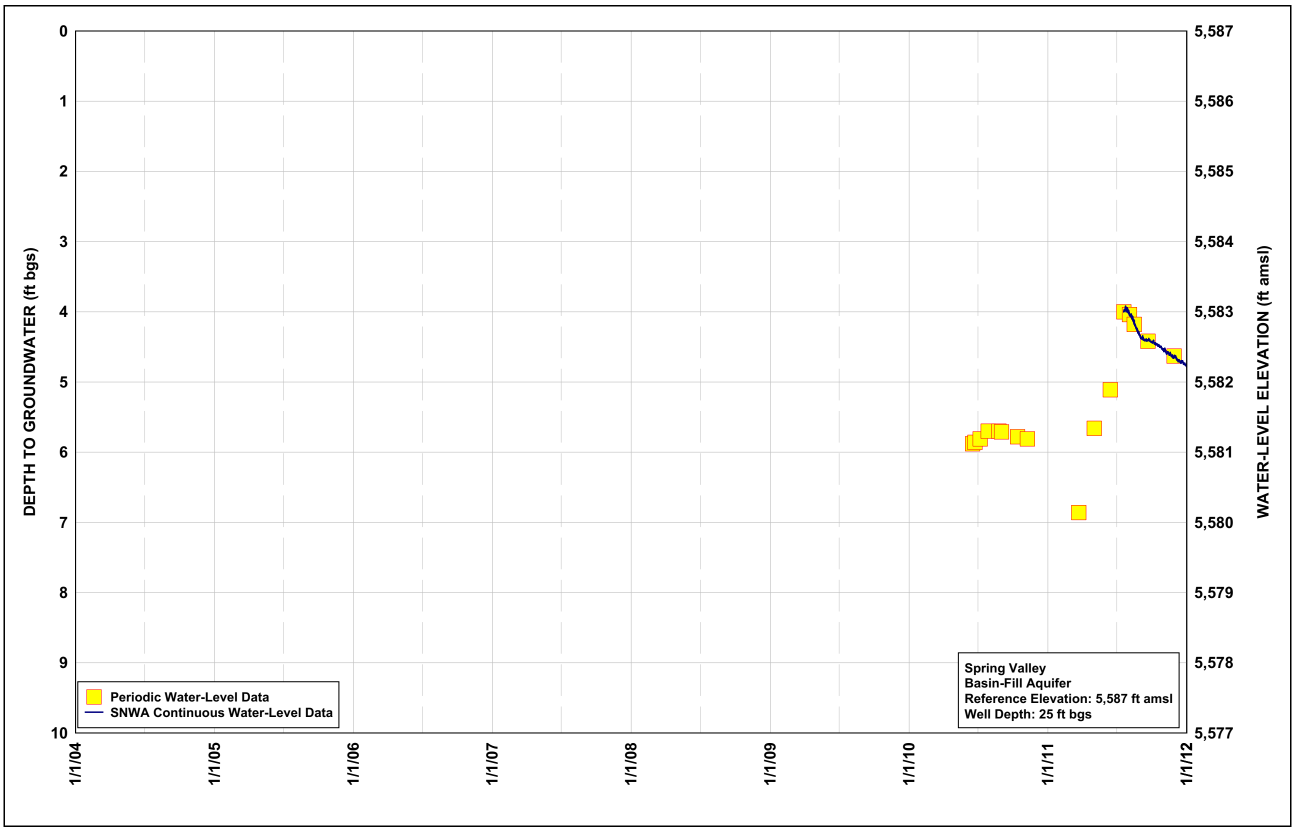


Figure 9-8
Hydrograph of South Millick Spring Piezometer

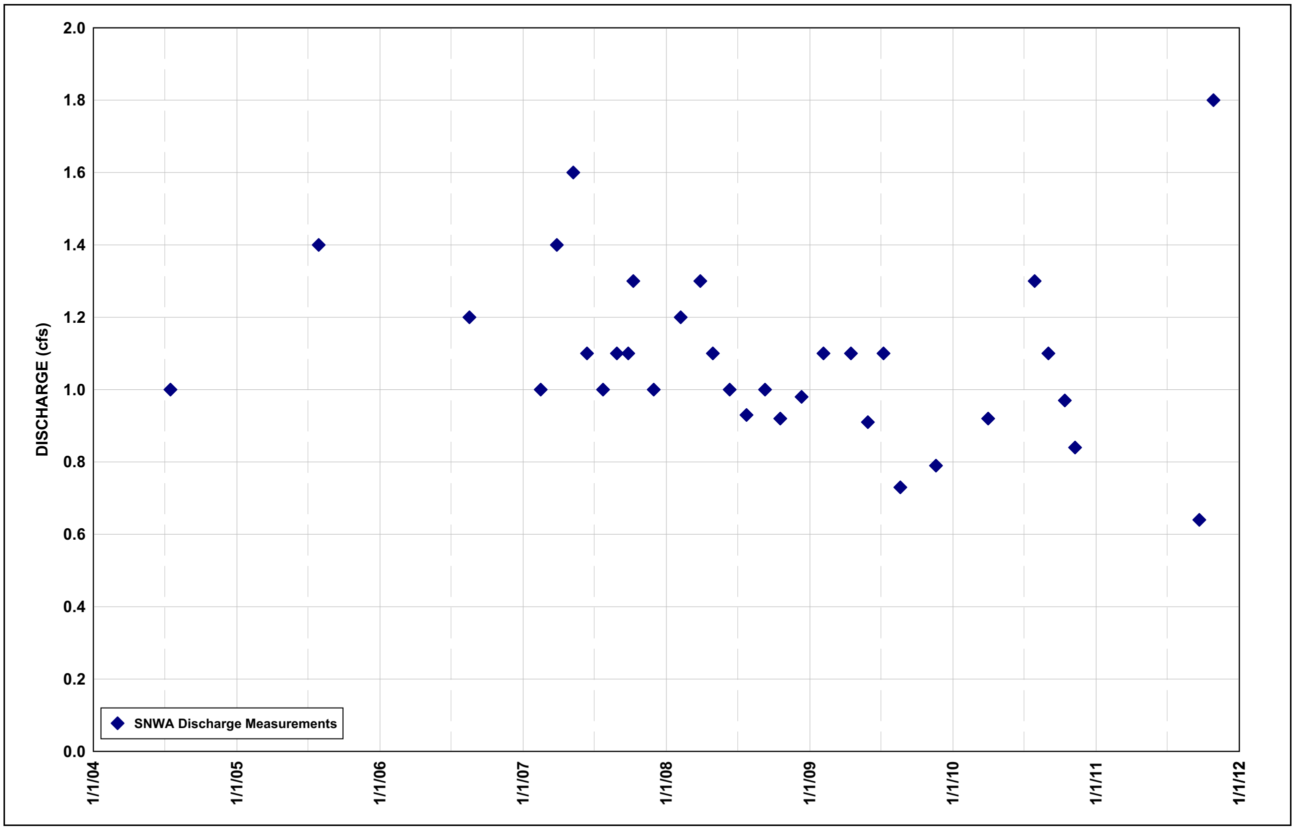


Figure 9-9
Hydrograph of South Millick Spring Discharge

10.0 WEST SPRING VALLEY COMPLEX 1

West Spring Valley Complex 1 is located in northwestern Spring Valley 0.1 mi. east of State Route 893, on the Cazier Ranch and approximately 43.5 mi north of the Lincoln and White Pine county line. The spring is approximately1.2 mi east of the Schell Creek Range. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 10-1 and 10-2, respectively.

10.1 Physical Description and Satellite Imagery

The West Spring Valley Complex extends approximately 2.5 miles from the SW 1/4 of Sec. 19 Twp. 17N, Rng. 67E to the NW 1/4 of Sec. 7 Twp. 16N, Rng. 67E, and contains numerous springs and seeps. In consultation with the TRP one spring was chosen to represent the entire complex. West Spring Valley Complex 1 is located on the valley floor in unconsolidated basin-fill sediments in an area of dense to moderate vegetation. The complex is located on private land along an alluvial fan margin.

A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 10-3. LANDSAT 5 satellite imagery for the region around West Spring Valley Complex 1 for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 10-4. Field photos of the spring are presented in Figures 10-5 and 10-6.

10.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7011Z, which is located to the west of the spring. The piezometer has been surveyed to determine accurate elevation and planar coordinates.

10.3 Hydrogeology

The borehole for piezometer SPR7015Z was advanced within surficial sediments to 40 ft bgs. Lithologic soil samples were collected at 5-ft intervals during the drilling process. The soils encountered consist of organic clay, fat clay, and some sand. The clays encountered were brown, gray or greenish-gray with medium to high plasticity, while the sand was gray and well-graded. Saturated solids were observed at approximately 17-ft bgs during advancement of the borehole. A summary of the lithologic log is presented in Figure 10-7.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 10-8.

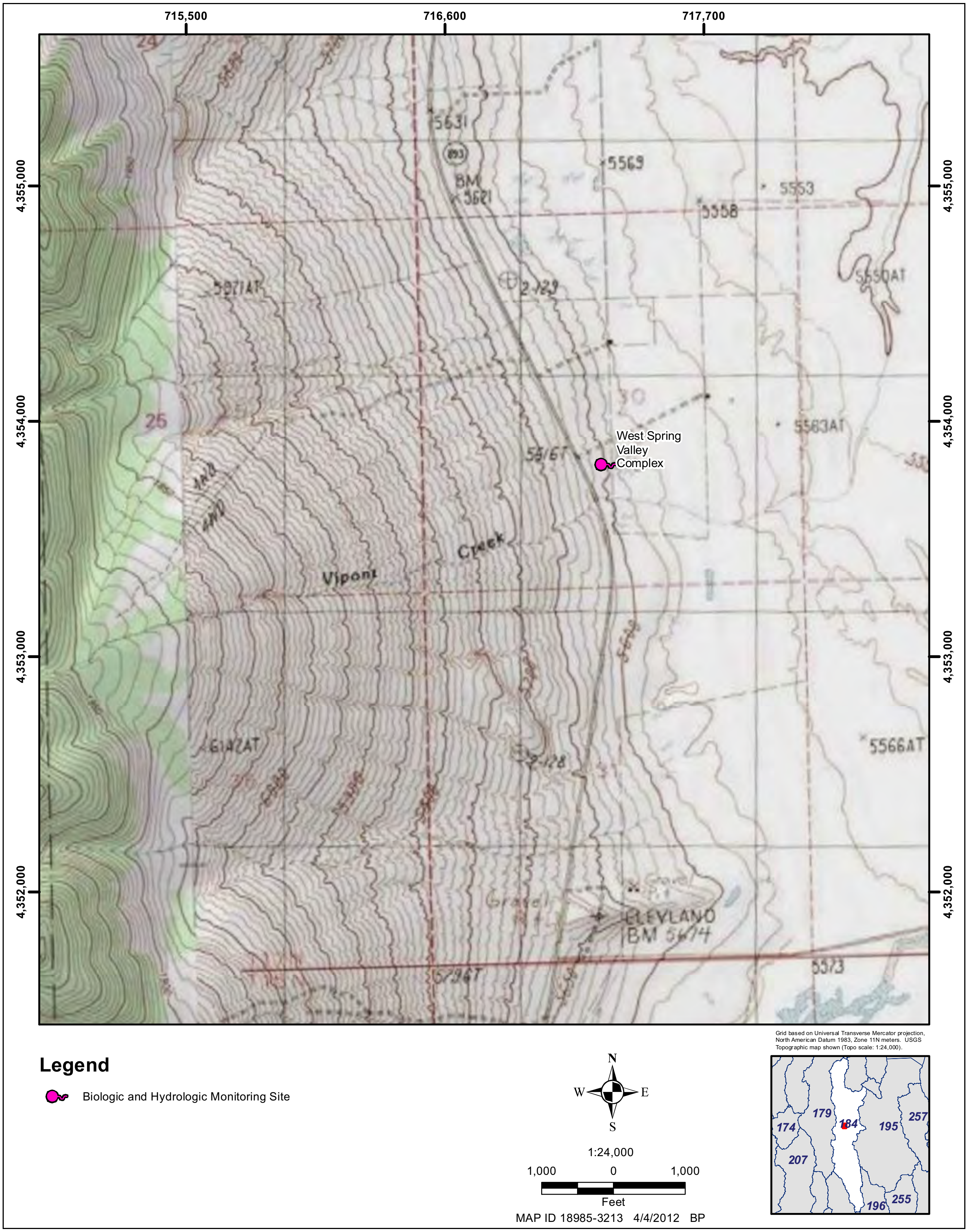


Figure 10-1
Topographic Map of West Spring Valley Complex 1

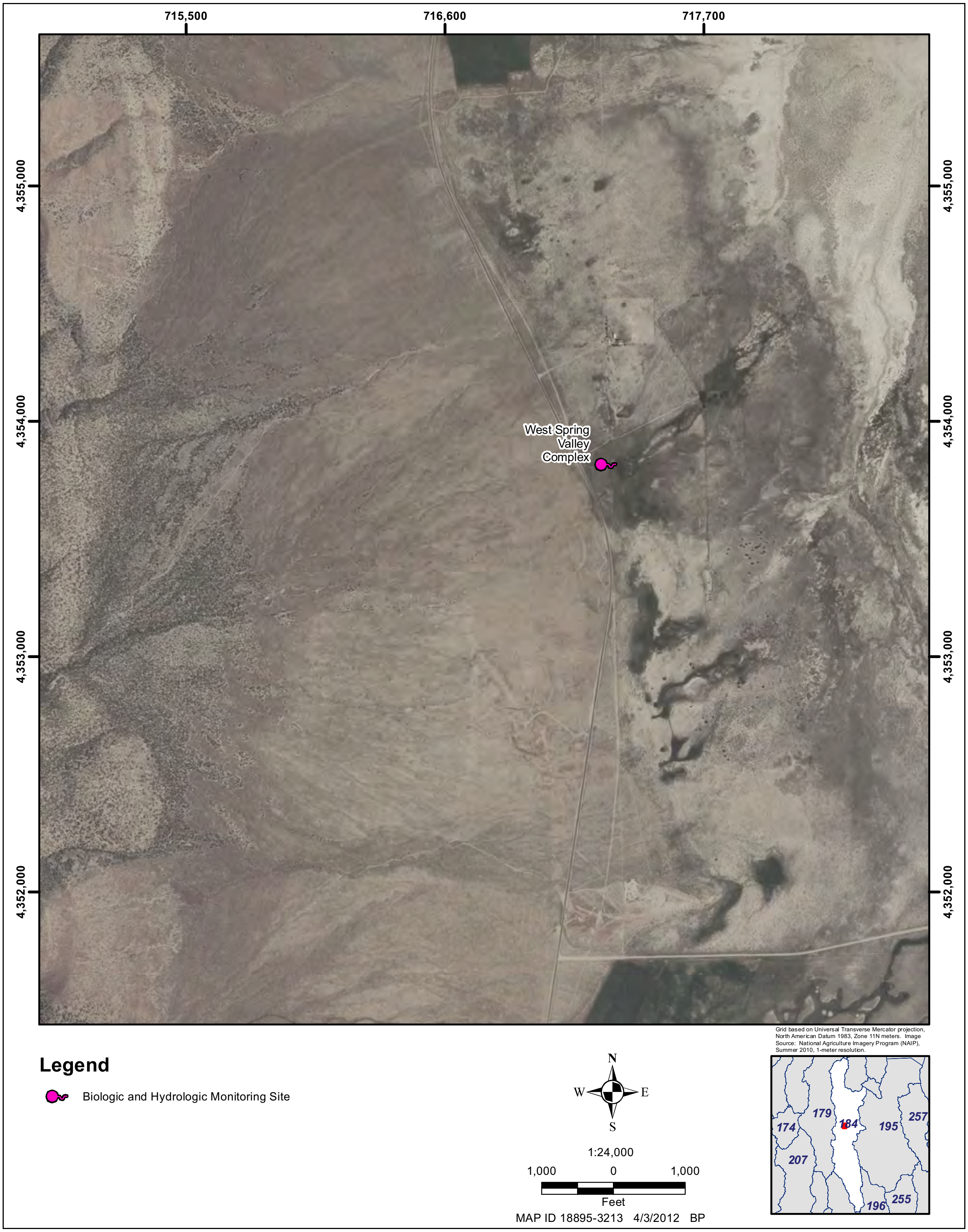


Figure 10-2
Aerial Photo of West Spring Valley Complex 1

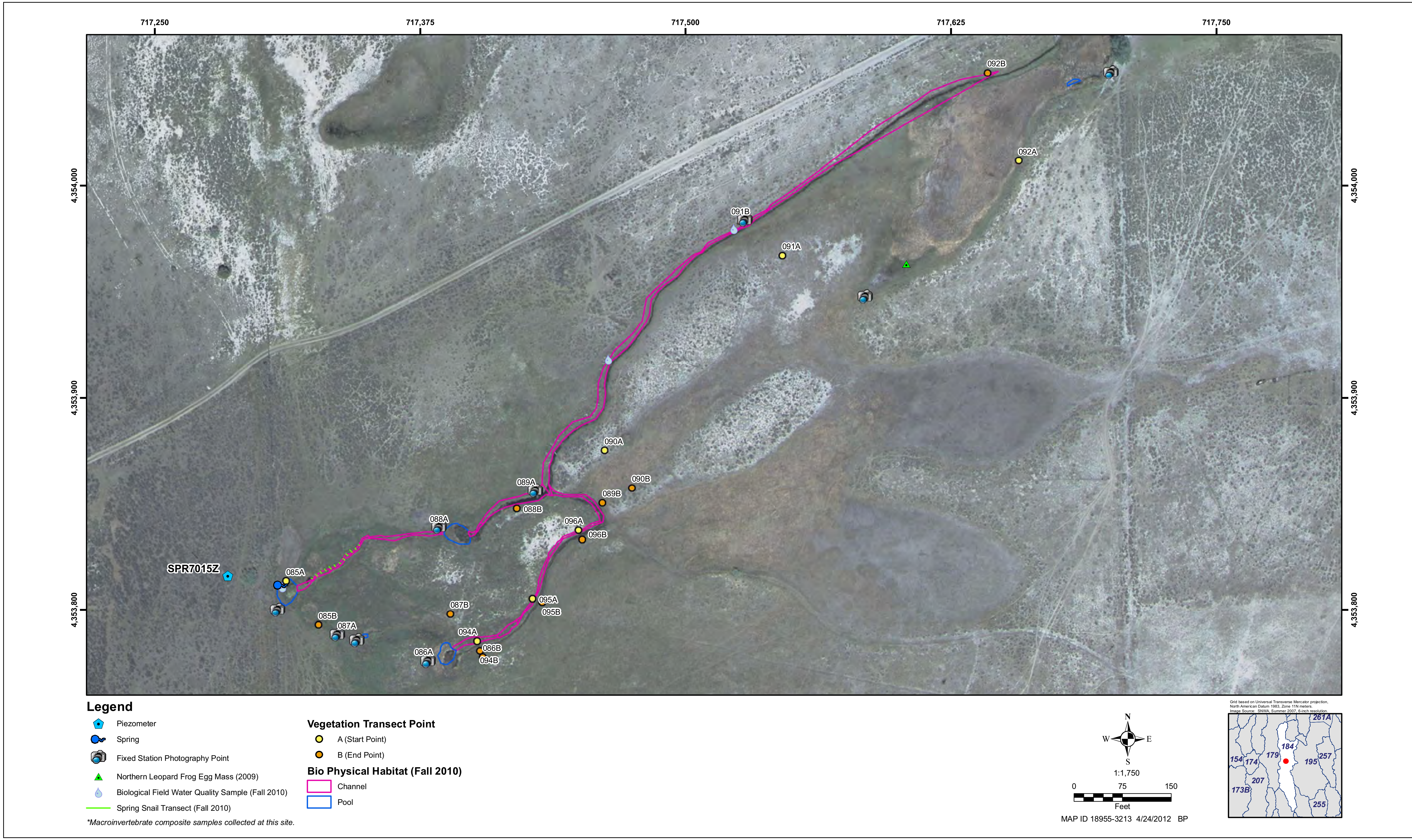


Figure 10-3
High-Resolution Aerial Photo of West Spring Valley Complex 1

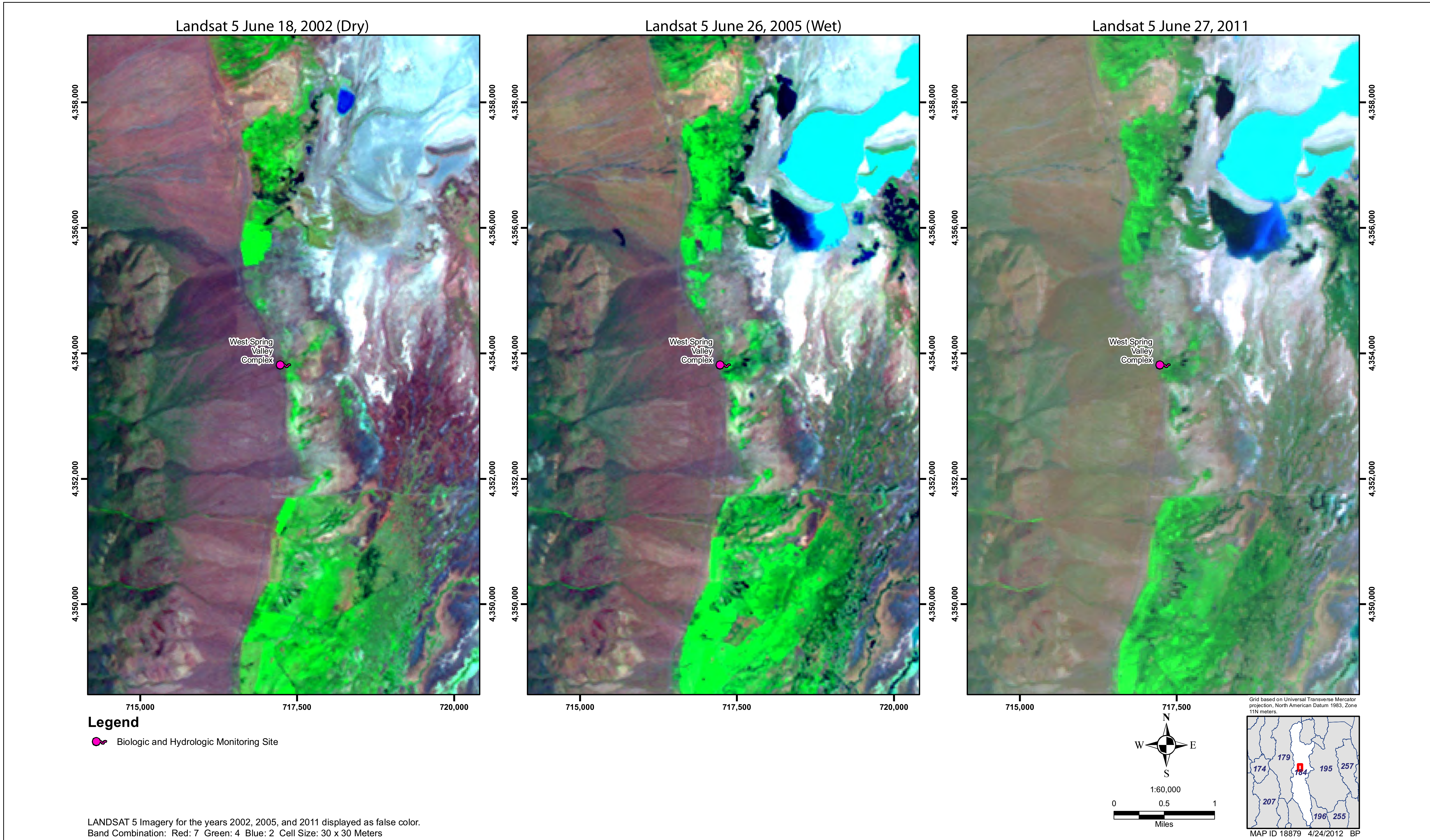


Figure 10-4
LANDSAT Imagery of West Spring Valley Complex

Figure 10-5
West Spring Valley Complex 1 During Wet Conditions

Figure 10-6
West Spring Valley Complex 1 During Dry Conditions

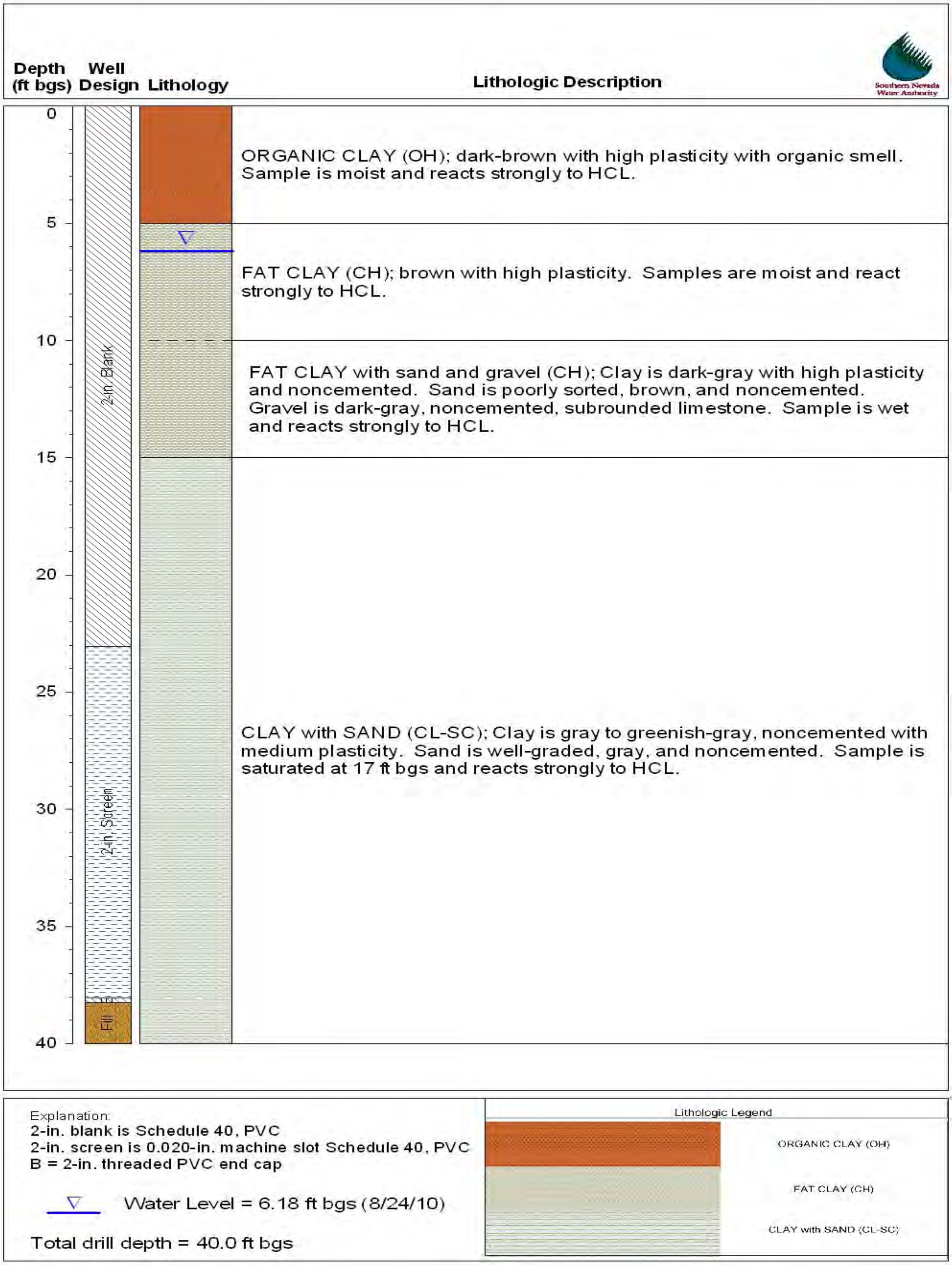


Figure 10-7
West Spring Valley Complex 1 Piezometer Lithologic Log

10.4 Spring Water Chemistry

Samples for the West Spring Valley Complex 1 were collected from piezometer SPR7015Z on October 25, 2010 using a teflon bailer. The water temperature of the SPR7015Z sample was 12.8°C, the pH was 7.4, and the EC was 406 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for samples collected from piezometer SPR7015Z are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, and site hydrogeologic conditions indicate that the spring is of local origin.

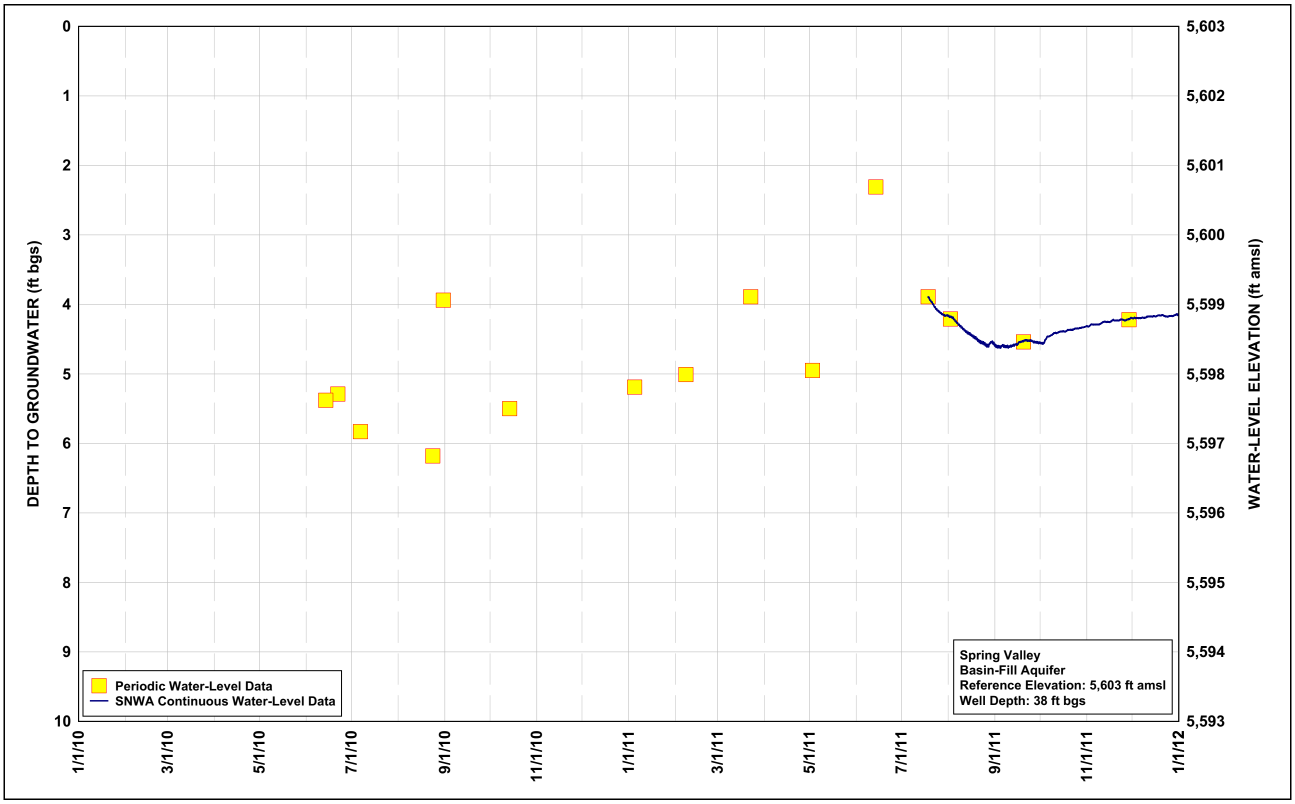


Figure 10-8
Hydrograph of West Spring Valley Complex 1 Piezometer

11.0 KEEGAN SPRINGS

Keegan Springs is a spring complex located in northwestern Spring Valley east of State Route 893 approximately 53.2 mi north of the Lincoln and White Pine county line. The northern most springs in the complex are identified as numbers 1 through 3 and are located approximately 1.0 mi east of the Schell Creek Range. The spring is located on the SNWA Robinson Ranch property, and consists of multiple orifices. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 11-1 and 11-2, respectively.

11.1 Physical Description and Satellite Imagery

Keegan Spring is located on the valley floor in unconsolidated basin-fill sediments in an area of dense to moderate vegetation. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 11-3. LANDSAT 5 satellite imagery for the region around Keegan Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 11-4. Field photos of the spring site are presented in Figures 11-5 and 11-6.

11.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7021Z, which is located approximately 20 ft to the south of the Keegan Spring No.1. The spring discharge is monitored periodically using a permanently installed flume located southeast of the Keegan Spring Nos. 1-3. The flume and piezometer have been surveyed to determine elevation and planar coordinates. Temporal variations of the spring discharge generally coincides with fluctuations of groundwater levels measured in the piezometer, which indicates a direct hydrologic connection between the spring and the shallow groundwater system.

11.3 Hydrogeology

The borehole for piezometer SPR7021Z was advanced within surficial sediments to 20.7 ft bgs. Lithologic samples were collected at 5-ft intervals during the drilling process. The soils encountered consisted of fat clay with gravel, clay with gravel, and gravel with clay. The clays encountered were gray, dark gray, and greenish-tan with medium to high plasticity. The gravel was varicolored, subrounded to rounded quartzite. Soils became saturated at approximately 2 ft bgs and then encountered artesian conditions upon reaching the total depth of the borehole. A summary of the lithologic log is presented in Figure 11-7.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 11-8. A hydrograph of the spring discharge measured at the permanent flume is presented in

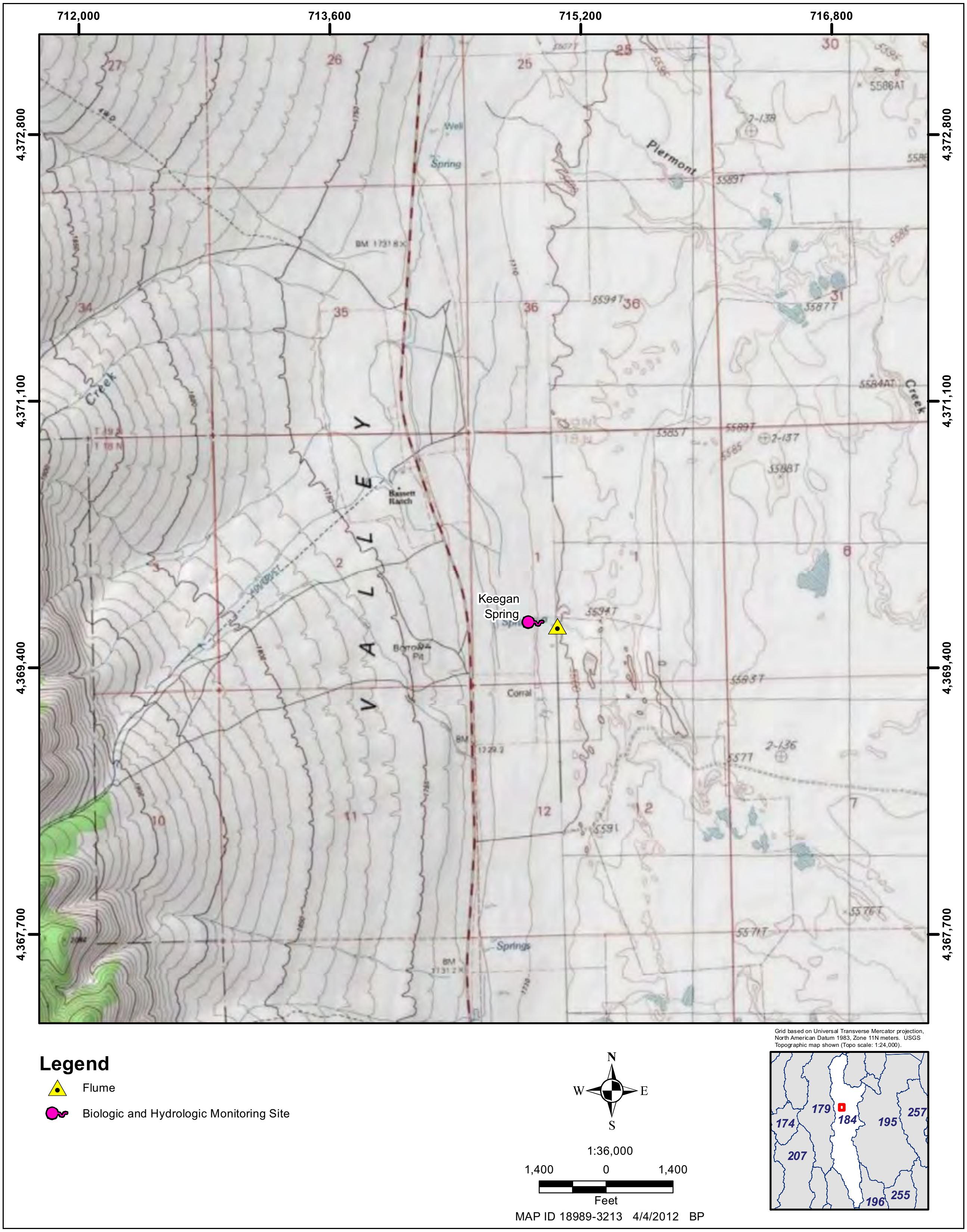


Figure 11-1
Topographic Map of Keegan Spring Complex

Figure 11-2
Aerial Photo of Keegan Spring Complex

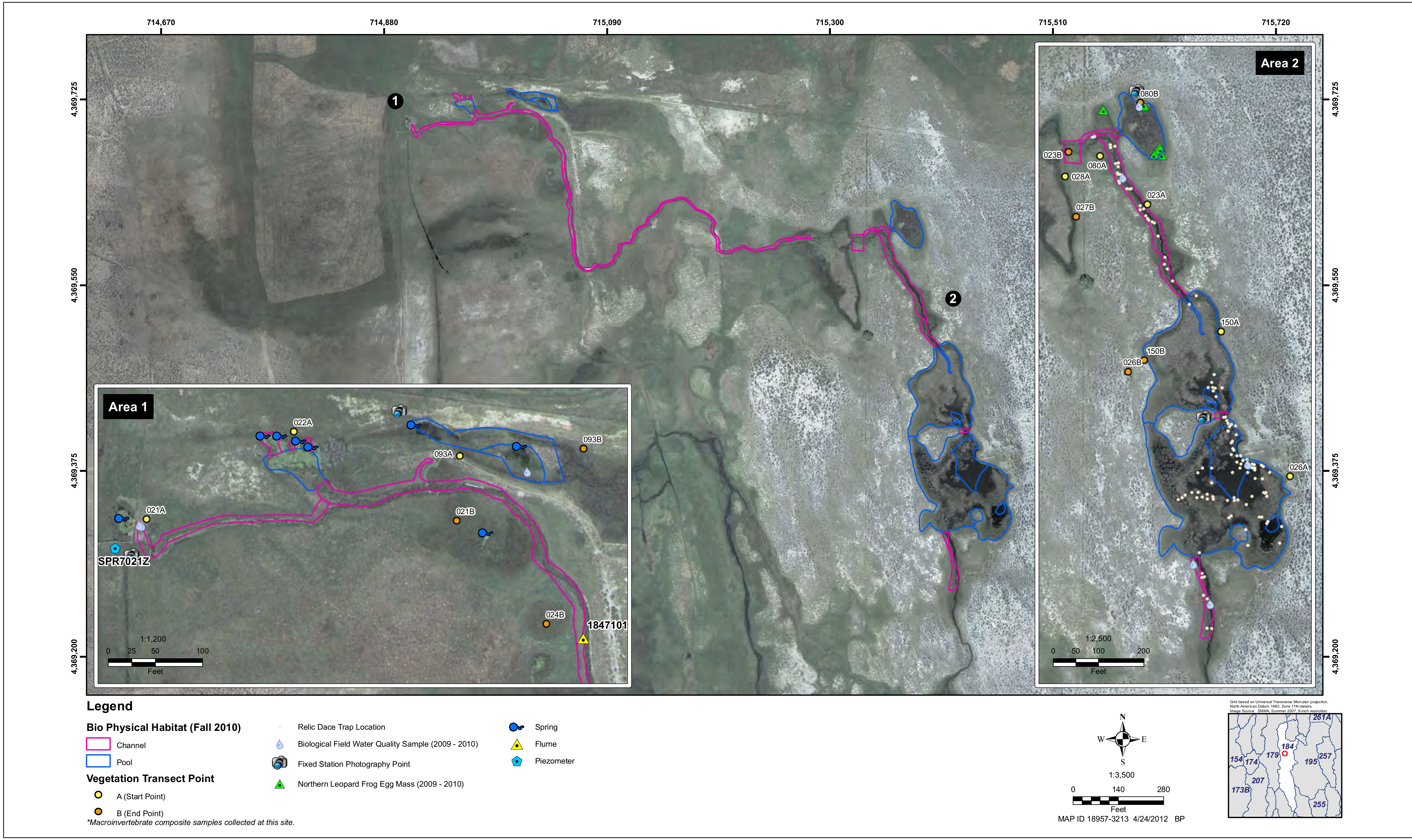


Figure 11-3
High-Resolution Aerial Photo of Keegan Spring

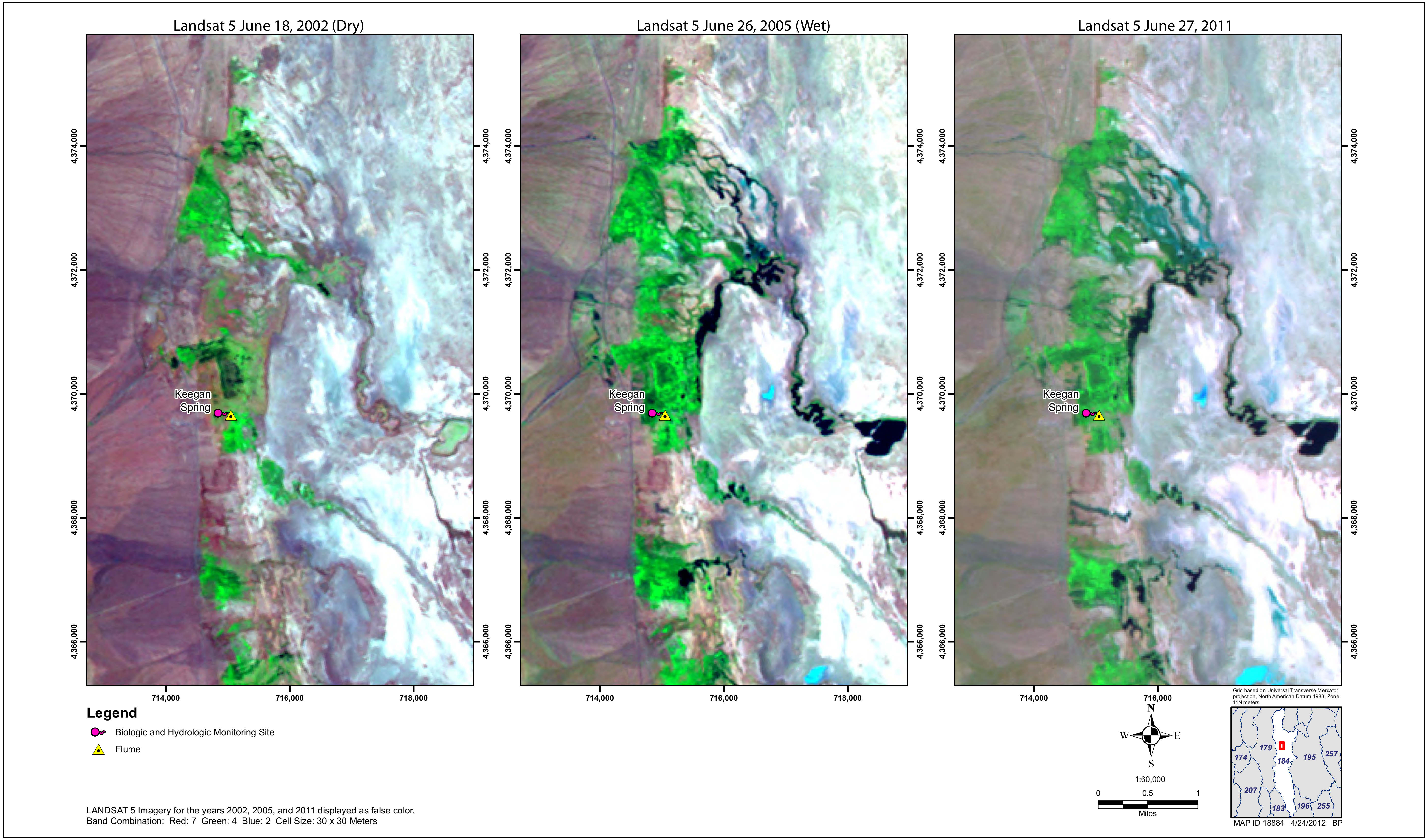


Figure 11-4
LANDSAT Imagery of Keegan Spring Complex

Figure 11-5
Keegan Springs Flume Located Southeast of Keegan Spring Nos. 1-3

Figure 11-6
Looking North at Keegan Spring No. 1 and Piezometer SPR7021Z

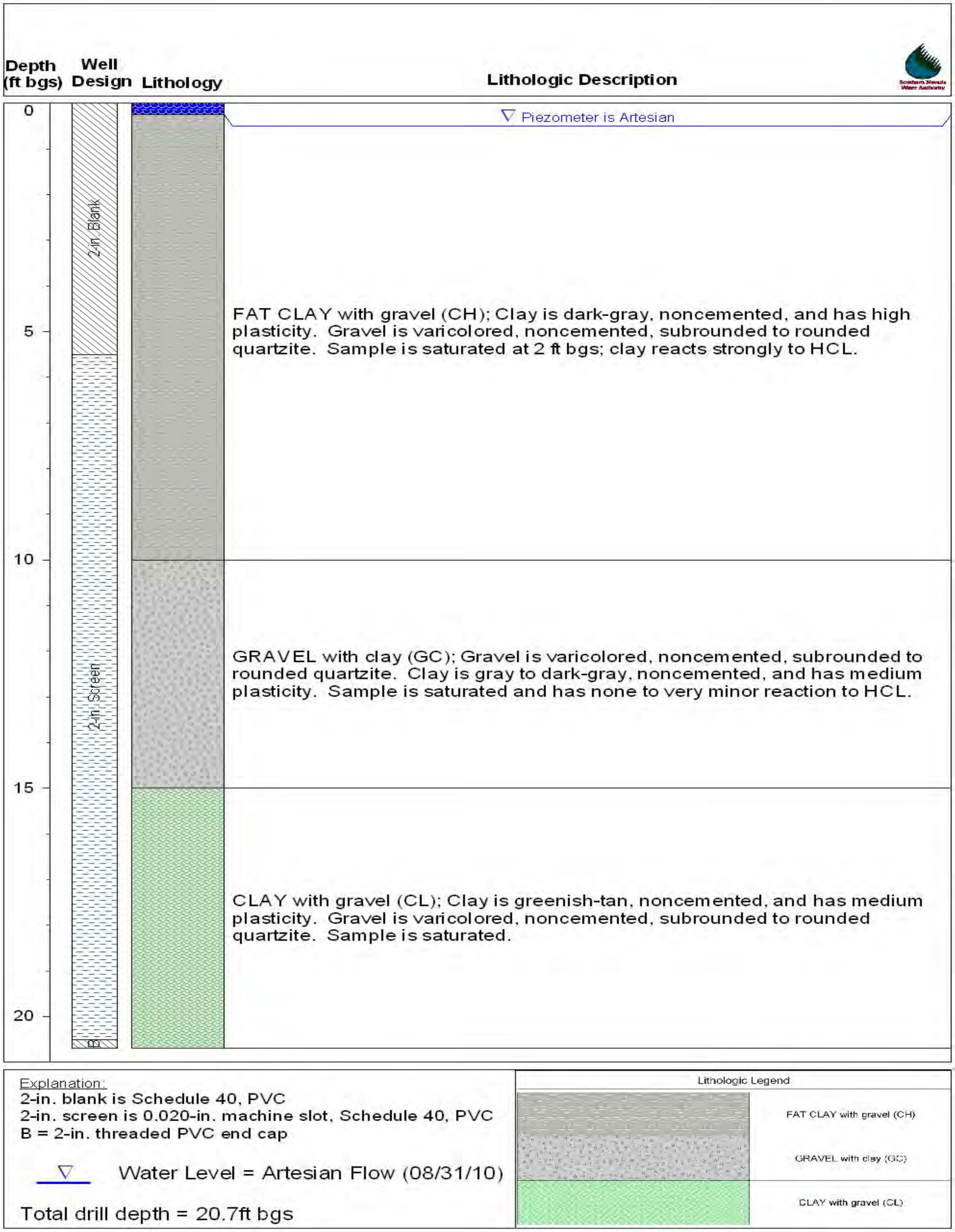


Figure 11-7
Keegan Spring Piezometer Lithologic Log

Figure 11-9. The piezometer water level and spring discharge observations have similar trends. The hydrograph and site hydrogeologic conditions indicate a direct hydraulic connection between the spring and shallow groundwater system.

11.4 Spring Water Chemistry

Samples from Keegan Spring were collected directly from the Keegan Spring No. 1 orifice on October 25, 2010. The water temperature of the water sample was 10.8°C, the pH was 6.73, and the EC was 61 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the sample are provided in Appendix A.

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, ^{14}C activity, presence of tritium, variability in water levels, and site hydrogeologic conditions indicate that the spring is of local origin.

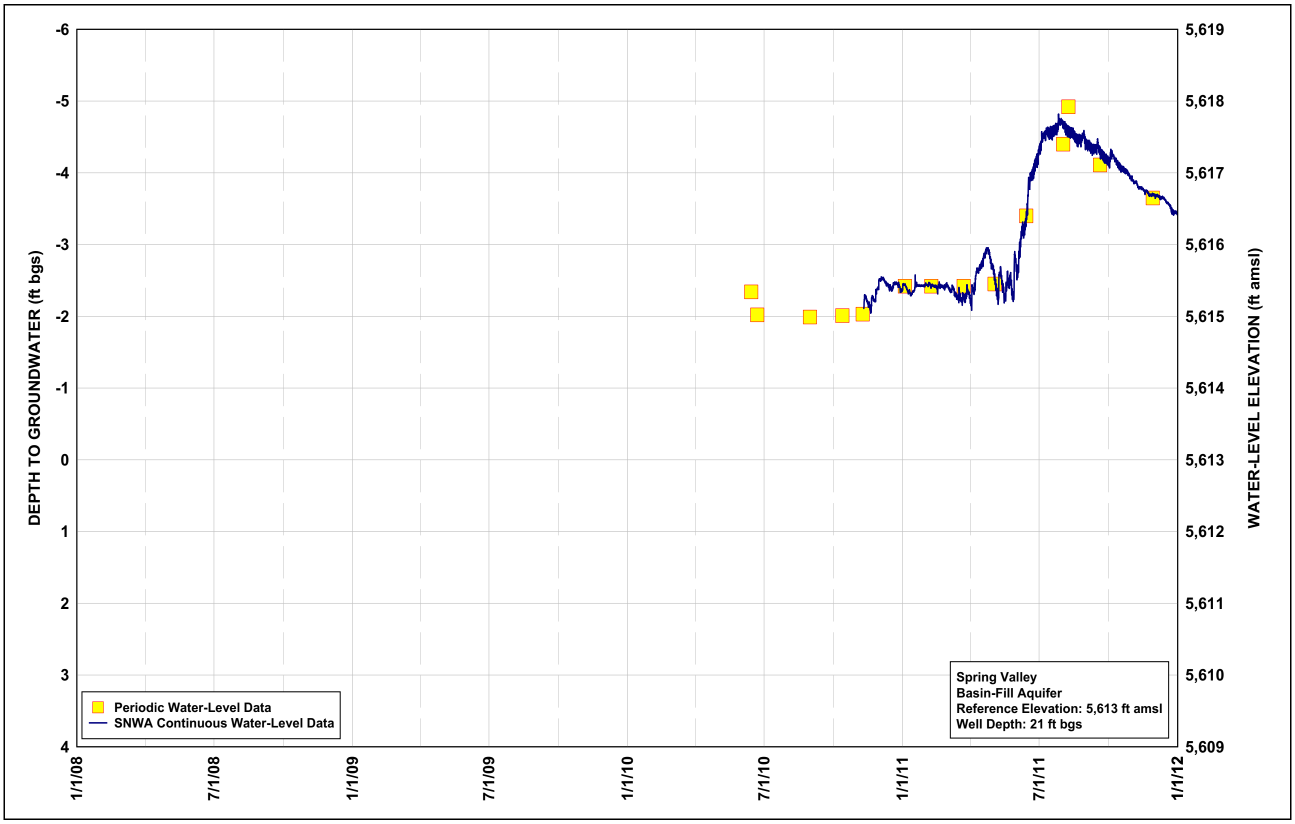


Figure 11-8
Hydrograph of Keegan Spring Piezometer

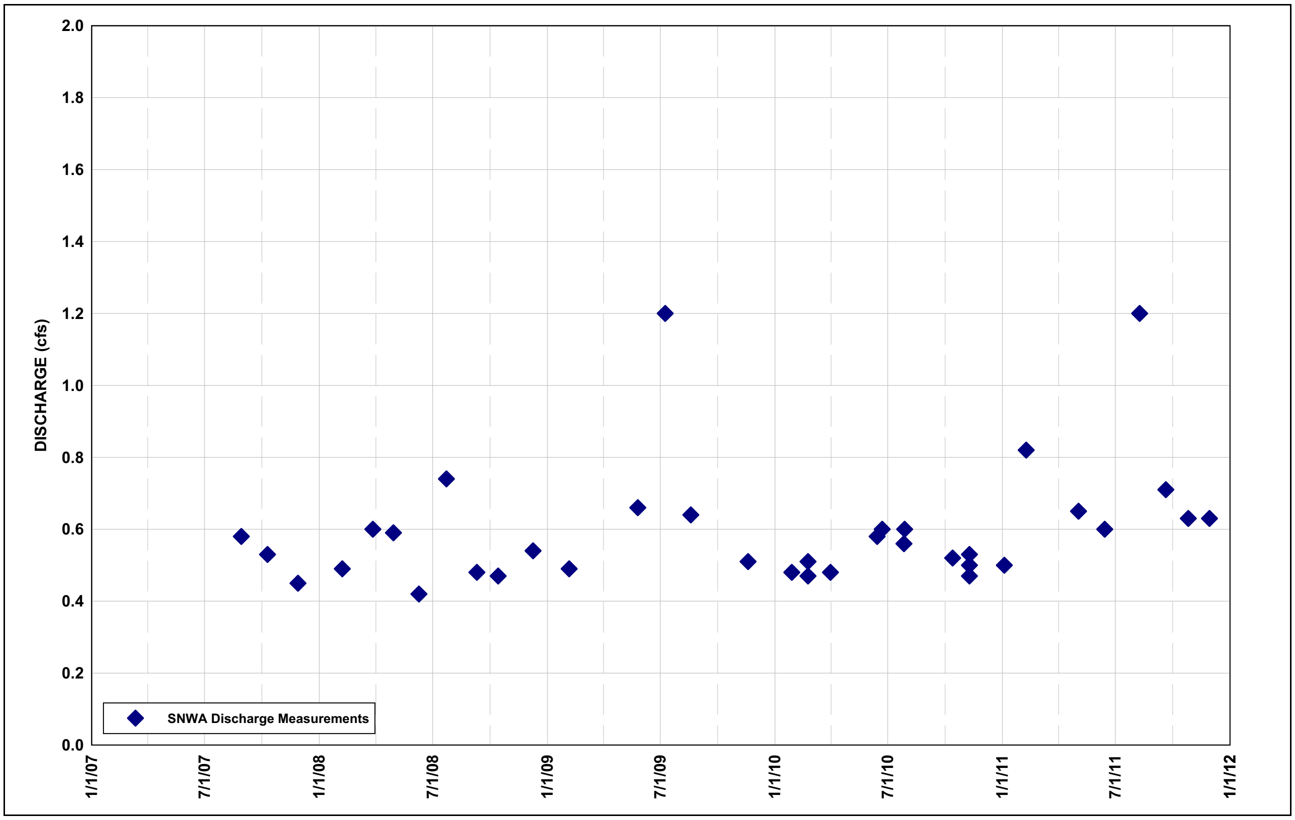


Figure 11-9
Hydrograph of Keegan Spring Discharge

12.0 WILLOW SPRING

Willow Spring is located in northwestern Spring Valley on BLM managed land approximately 1.3 mi east of State Route 893 approximately 70.2 mi north of the Lincoln and White Pine county line. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 12-1 and 12-2, respectively.

12.1 Physical Description and Satellite Imagery

Willow Spring is located on the valley floor in unconsolidated basin-fill sediments in an area of dense to moderately dense vegetation, and is used for stock watering. Willow Spring has two distinct orifices that discharge into a single channel that form a small pond that is covered with grass and surrounded by Rabbit Brush and Sagebrush. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 12-3. LANDSAT 5 satellite imagery for the region around Willow Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 12-4. Field photos of the spring are presented in Figures 12-5 and 12-6.

12.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7022Z, which is located approximately 45 ft to the north of the springs. The combined discharge of the two small orifices are monitored periodically using a temporary 3-in. Parshall flume. The piezometer has been surveyed to determine accurate elevation and planar coordinates. The spring discharge is comparable to the piezometer water level and indicates a hydrologic connection between the spring and the shallow groundwater system.

12.3 Hydrogeology

The borehole for piezometer SPR7022Z was advanced within surficial sediments from 0 to 35.0 ft bgs. Lithologic samples were collected at 5-ft intervals during the drilling process. The soils encountered consist of clay, clay with gravel, and poorly-graded gravels. The clays encountered were brown with some silt. The gravel was gray to varicolored, angular to subrounded, carbonates. Saturated soils were observed at approximately 7 ft bgs during advancement of the borehole. A summary of the lithologic log is presented in Figure 12-7.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 12-8. A hydrograph of the spring discharge measured at the combined channel using a temporary flume is presented in Figure 12-9. The piezometer water level and spring discharge observations have similar trends.

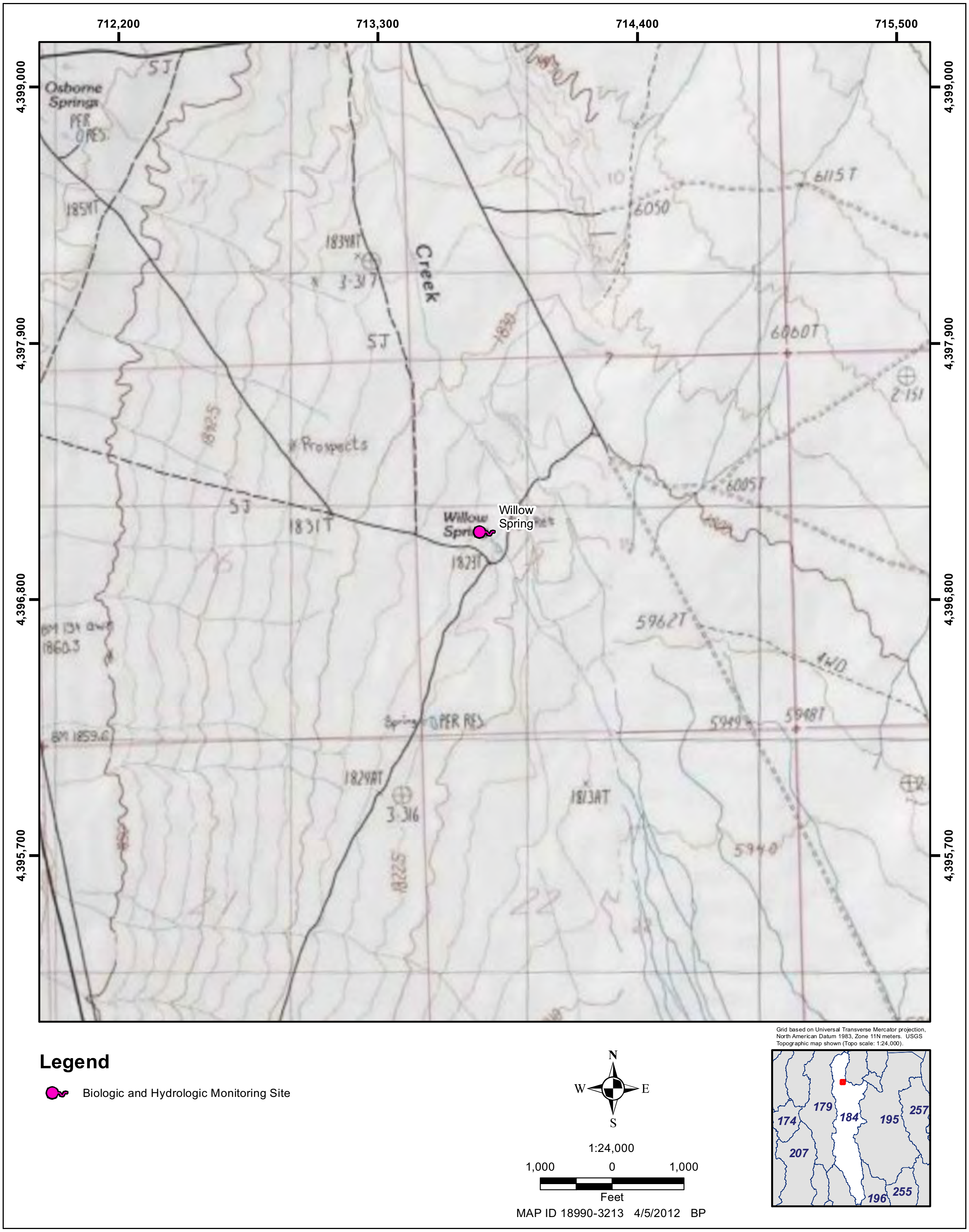


Figure 12-1
Topographic Map of Willow Spring

Figure 12-2
Aerial Photo of Willow Spring

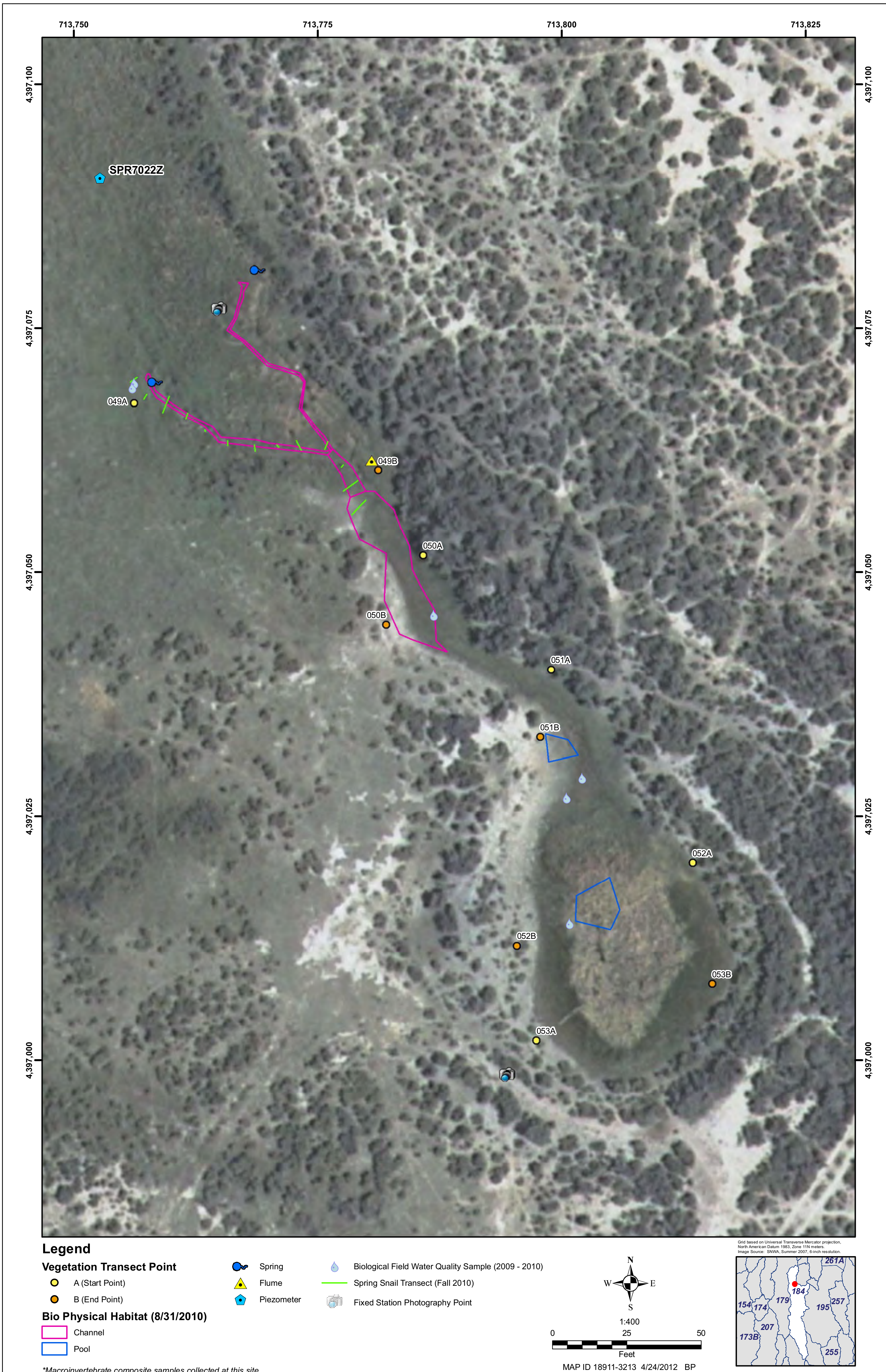


Figure 12-3
High-Resolution Aerial Photo of Willow Spring

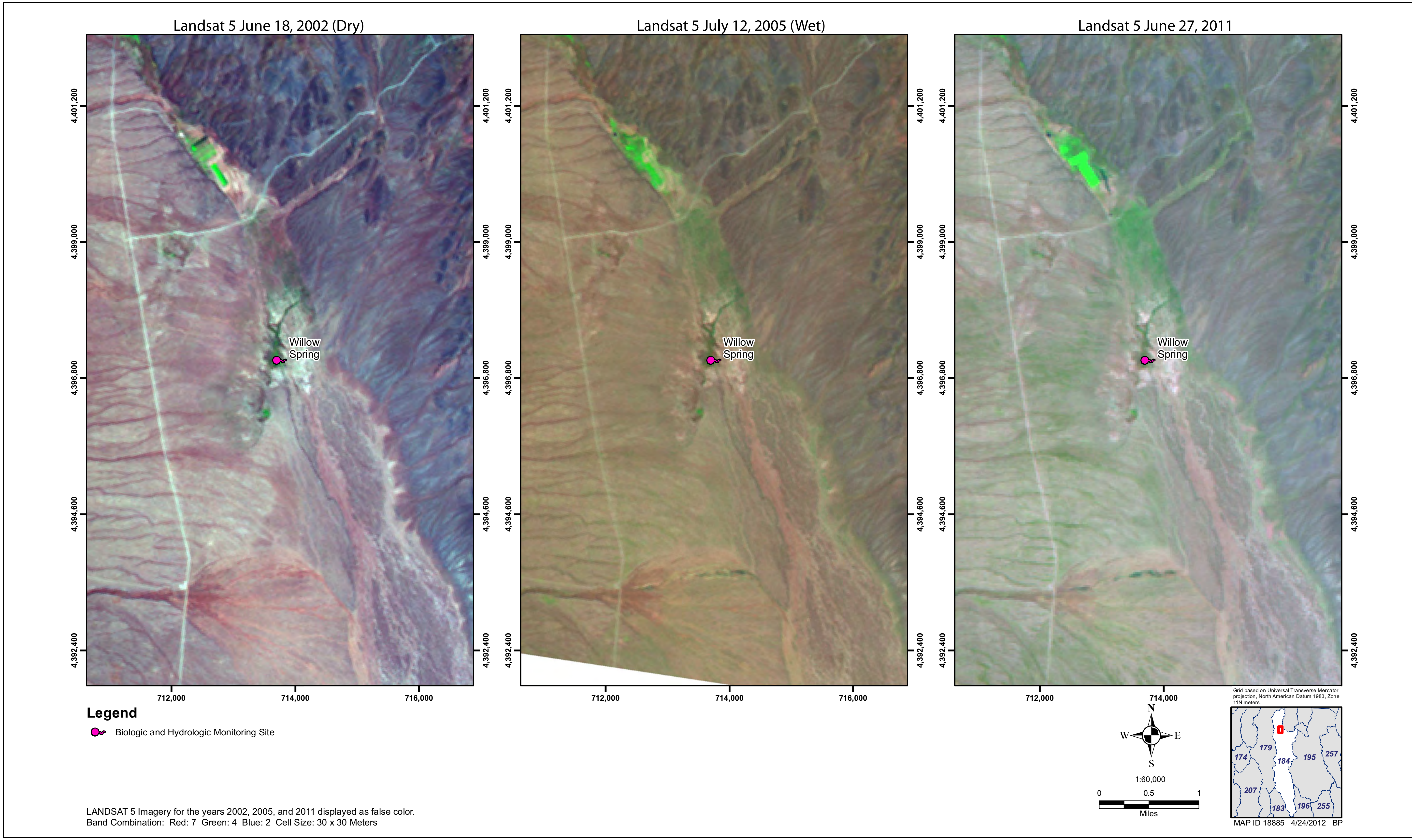


Figure 12-4
LANDSAT Imagery of Willow Spring

Figure 12-5
Willow Spring Orifice

Figure 12-6
Willow Spring Pool Looking Southeast

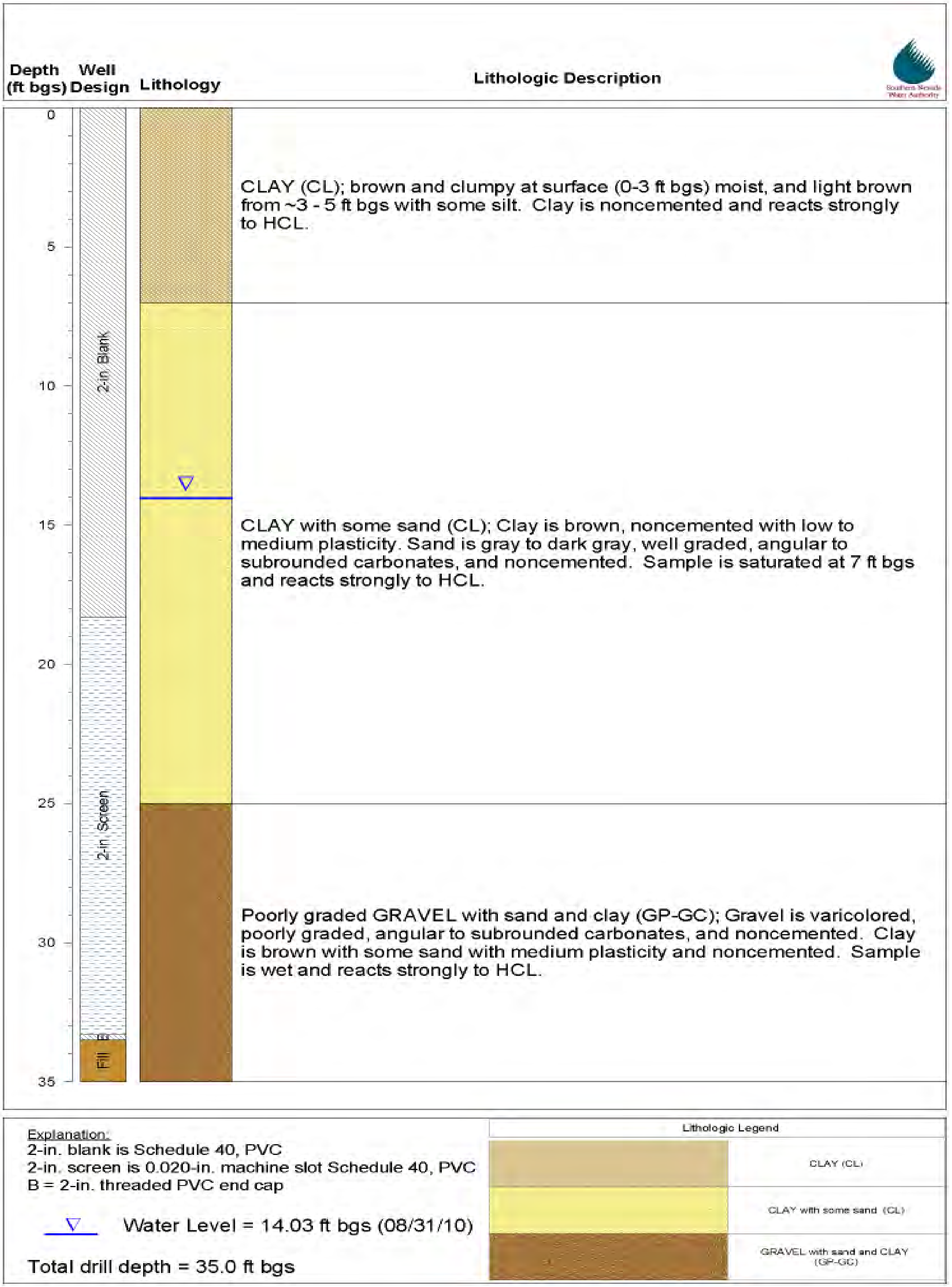


Figure 12-7
Willow Spring Piezometer Lithologic Log

12.4 Spring Water Chemistry

Water chemistry samples at Willow Spring were collected directly from the spring orifice on October 26, 2010. The water temperature of the sample was 10.6°C, the pH was 7.4, and the EC was 443 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring are provided in Appendix A.Willow spring has been previously sampled several times in summer and fall 2004 and 2005 with results presented in the most recent annual report (SNWA, 2012).

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, variation in discharge, and site hydrogeologic conditions indicate that the spring is of local origin.

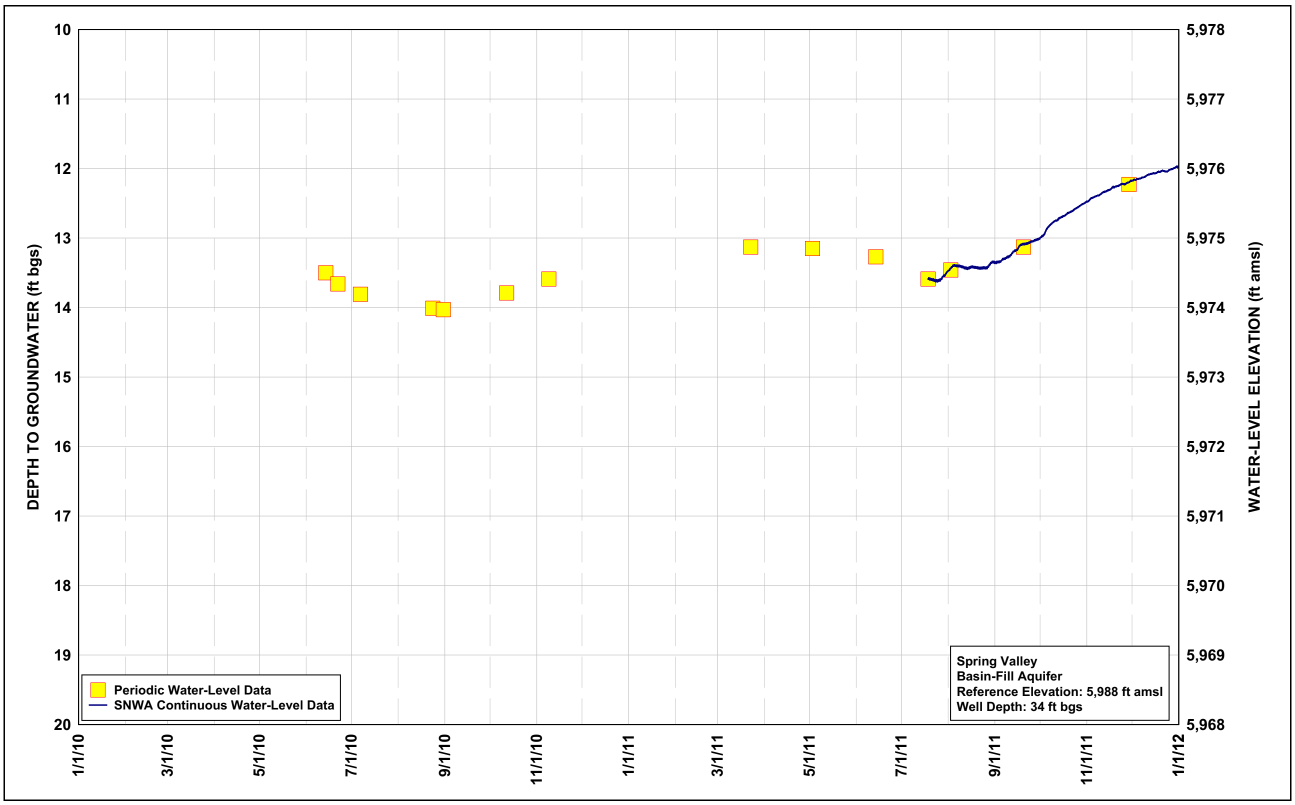


Figure 12-8
Hydrograph of Willow Spring Piezometer

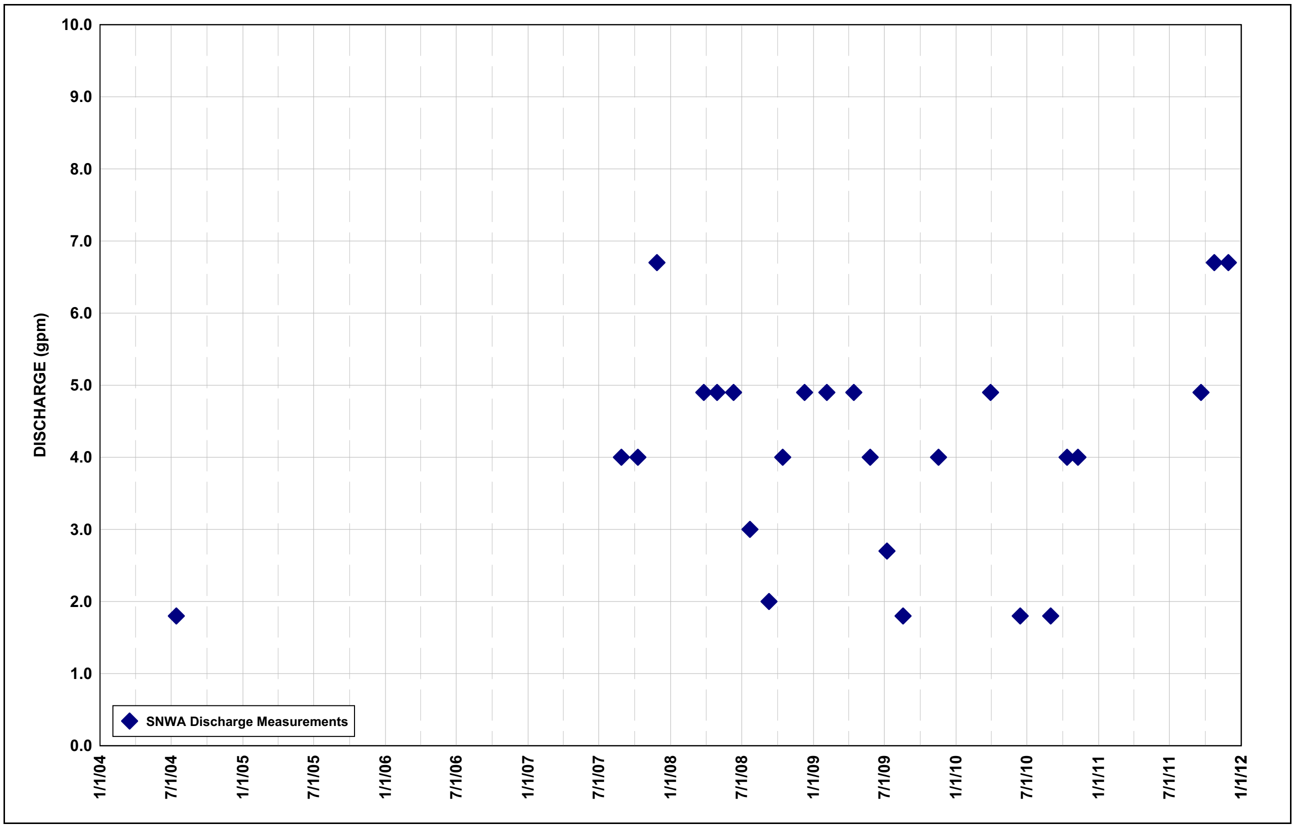


Figure 12-9
Hydrograph of Willow Spring Discharge

13.0 Stonehouse Spring

Stonehouse Spring is located in northwestern Spring Valley on the west side adjacent to State Route 893 approximately 76.2 mi north of the Lincoln and White Pine county line. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figure 13-1.

13.1 Physical Description and Satellite Imagery

Stonehouse Spring is located on the valley floor in unconsolidated basin-fill sediments located in an area of moderately dense vegetation and is used for stock watering. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring location, and biological monitoring transects are presented in Figure 13-2. LANDSAT 5 satellite imagery for the region around Stonehouse Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 13-3. Field photos of the spring are presented in Figures 13-4 and 13-5.

13.2 Monitoring Program

The site is monitored by collecting water-level measurements at one-hour intervals at piezometer SPR7020Z, which is located to the east of the spring pool adjacent to State Route 893. The piezometer has been surveyed to determine elevation and planar coordinates.

13.3 Hydrogeology

The borehole for piezometer SPR7020Z was advanced within surficial sediments to 9.3 ft bgs. Lithologic samples from drill cuttings were collected at 5-ft intervals during the drilling process. The soils encountered consisted of fat clay with gravel. The clay encountered were gray with high plasticity. The gravel was dark gray, subrounded limestone. Saturated soils were observed at approximately 2.0 ft bgs during advancement of the borehole. The borehole lithologic log is presented in Figure 13-6.

A hydrograph of periodic and continuous water-level data collected at the piezometer is presented on Figure 13-7. The spring pool dimensions generally coincides with fluctuations of groundwater levels measured in the piezometer water level and indicates a hydrologic connection between the spring and the shallow groundwater system.

13.4 Spring Water Chemistry

Samples from Stonehouse Spring were collected from piezometer SPR7020Z on November 1, 2010 using a teflon bailer. The water temperature of the SPR7020Z sample was 13.8^{o}C, the pH was 7.03,

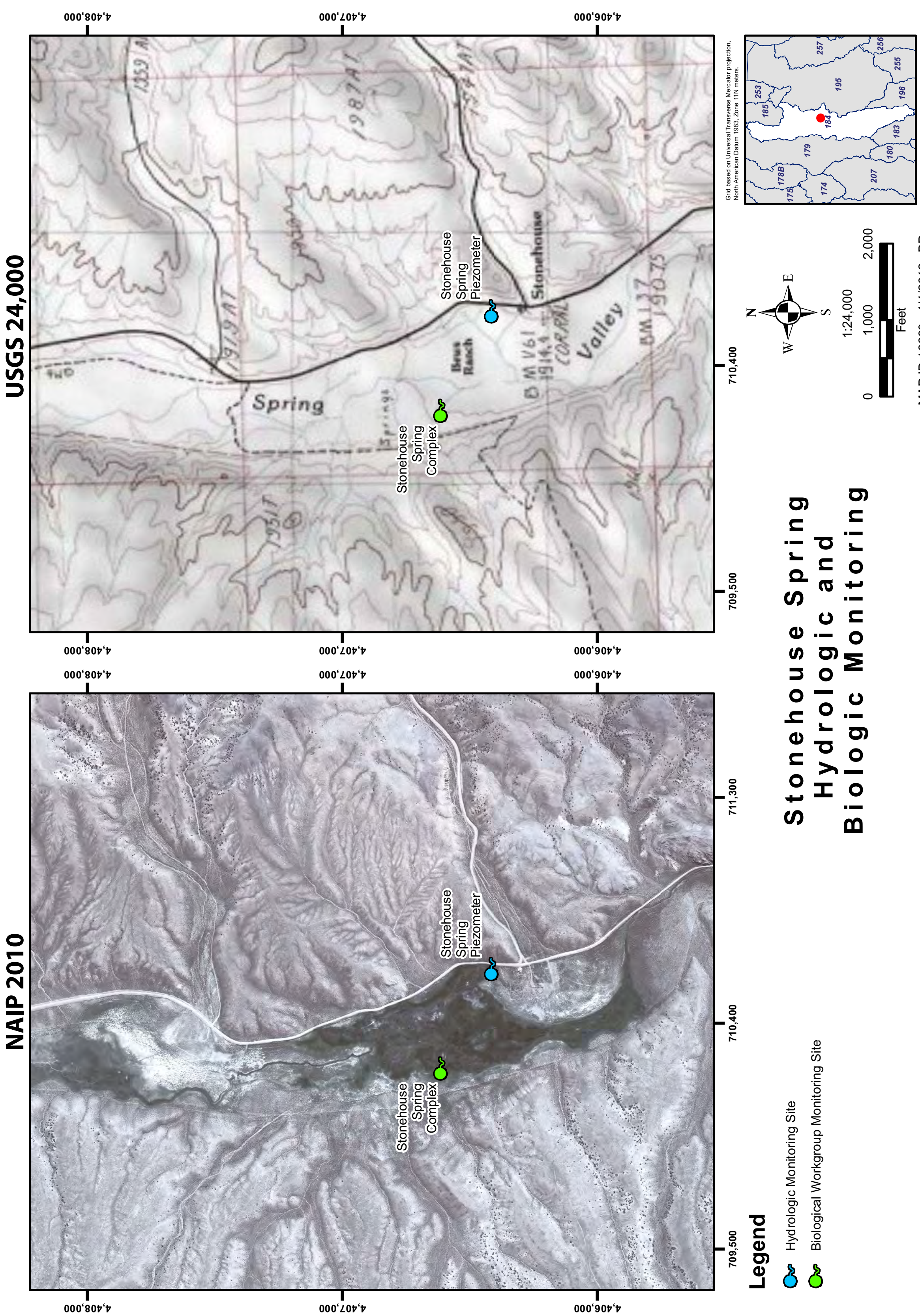


Figure 13-1
Aerial Photo and Topographic Map of Stonehouse Spring

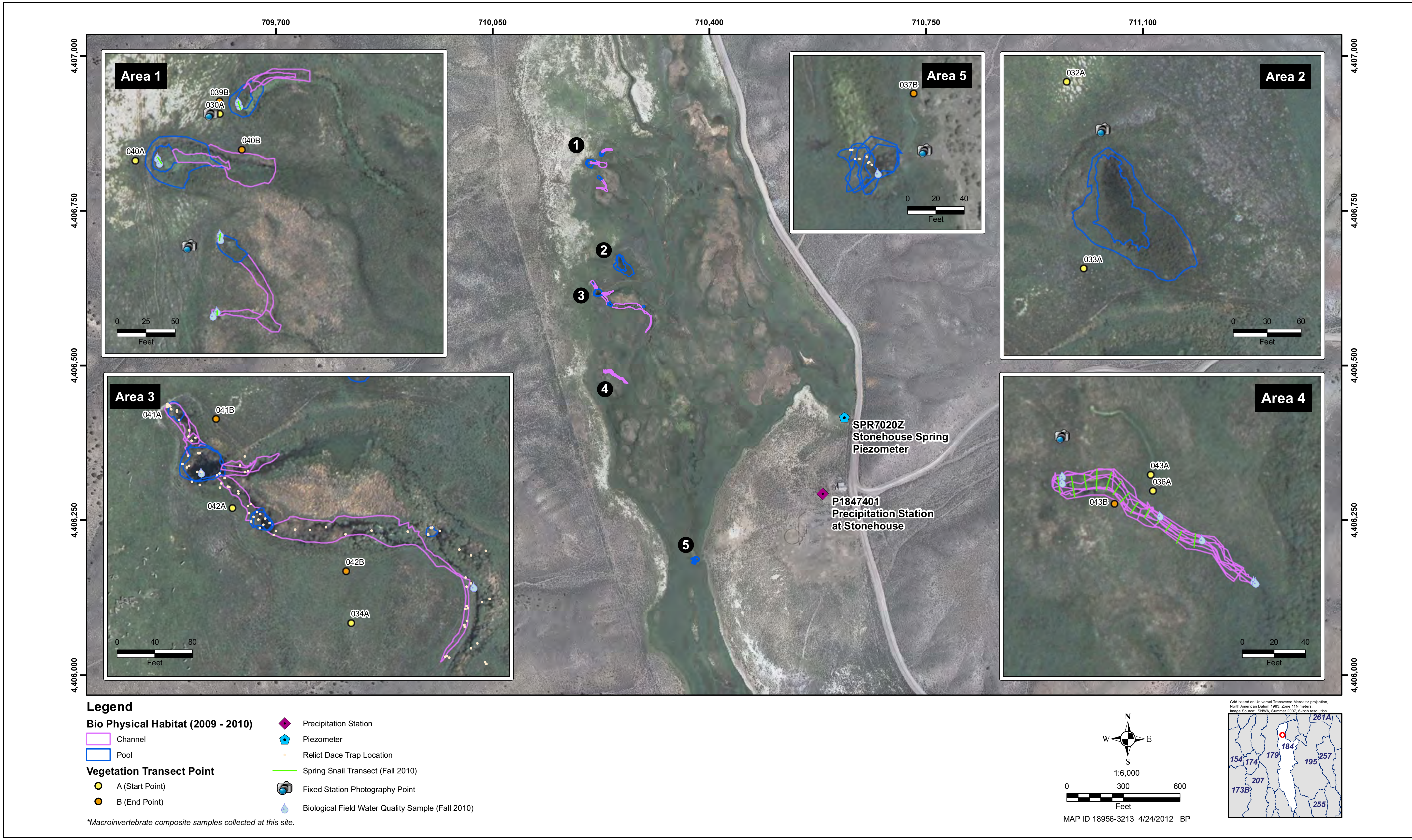


Figure 13-2
High-Resolution Aerial Photo of Stonehouse Spring

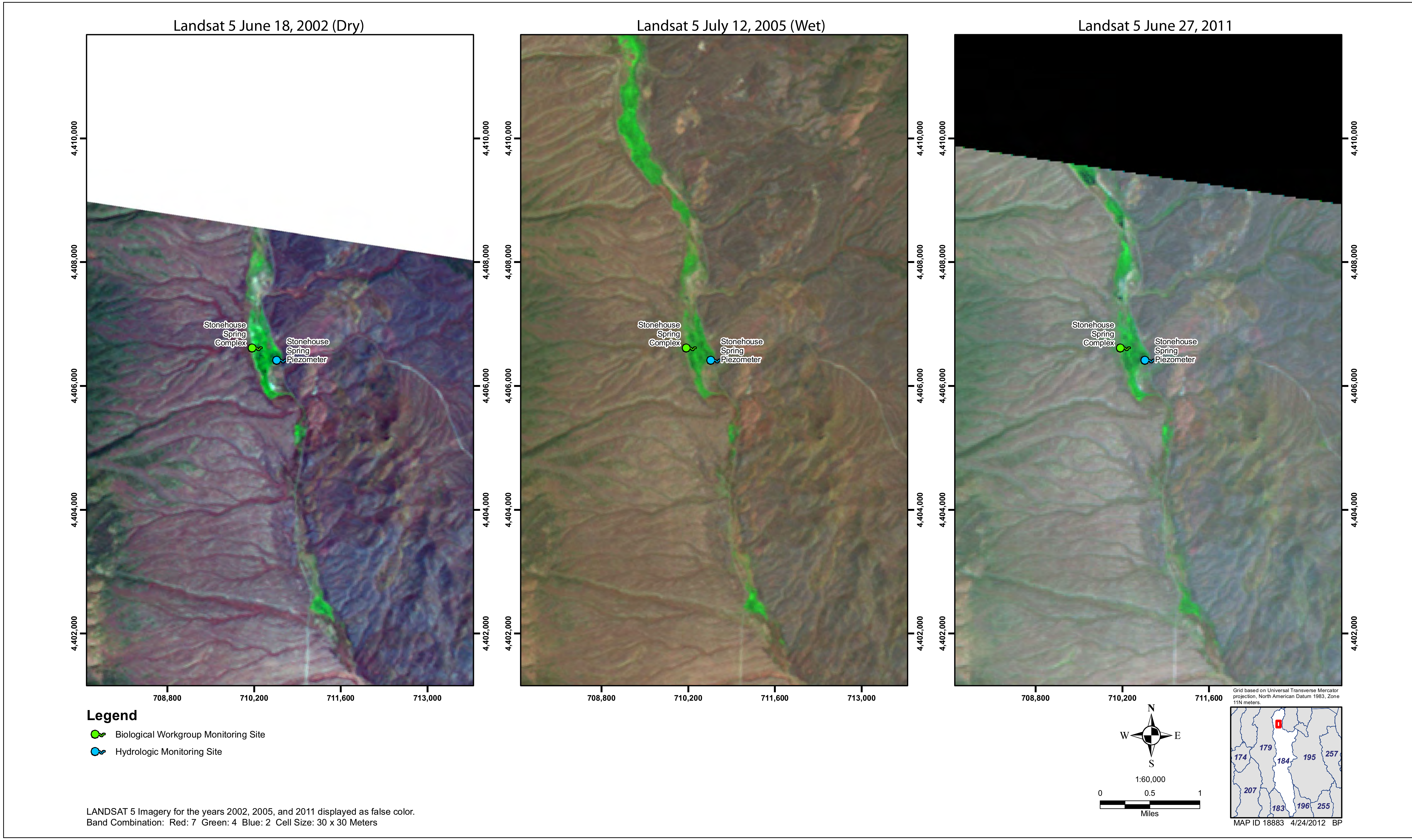


Figure 13-3
LANDSAT Imagery of Stonehouse Spring

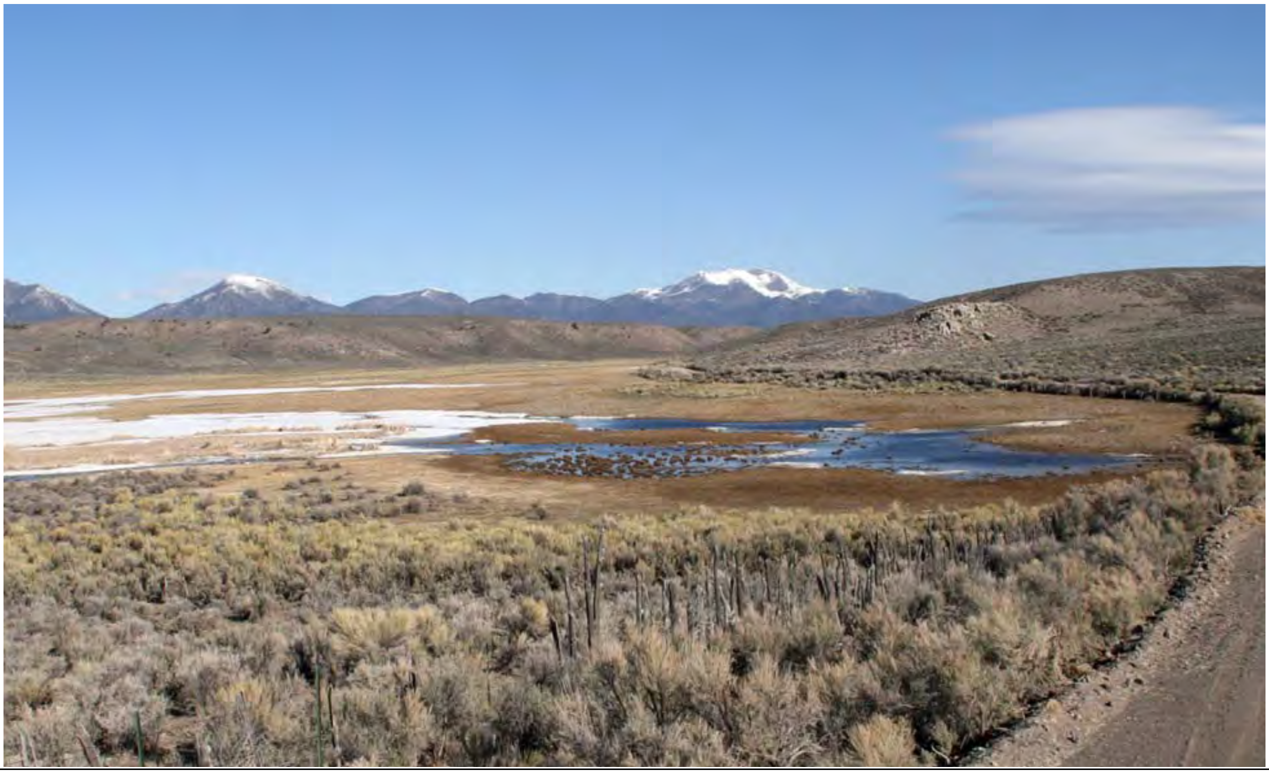


Figure 13-4
Stonehouse Spring Looking North

Figure 13-5
Stonehouse Spring Looking Northwest

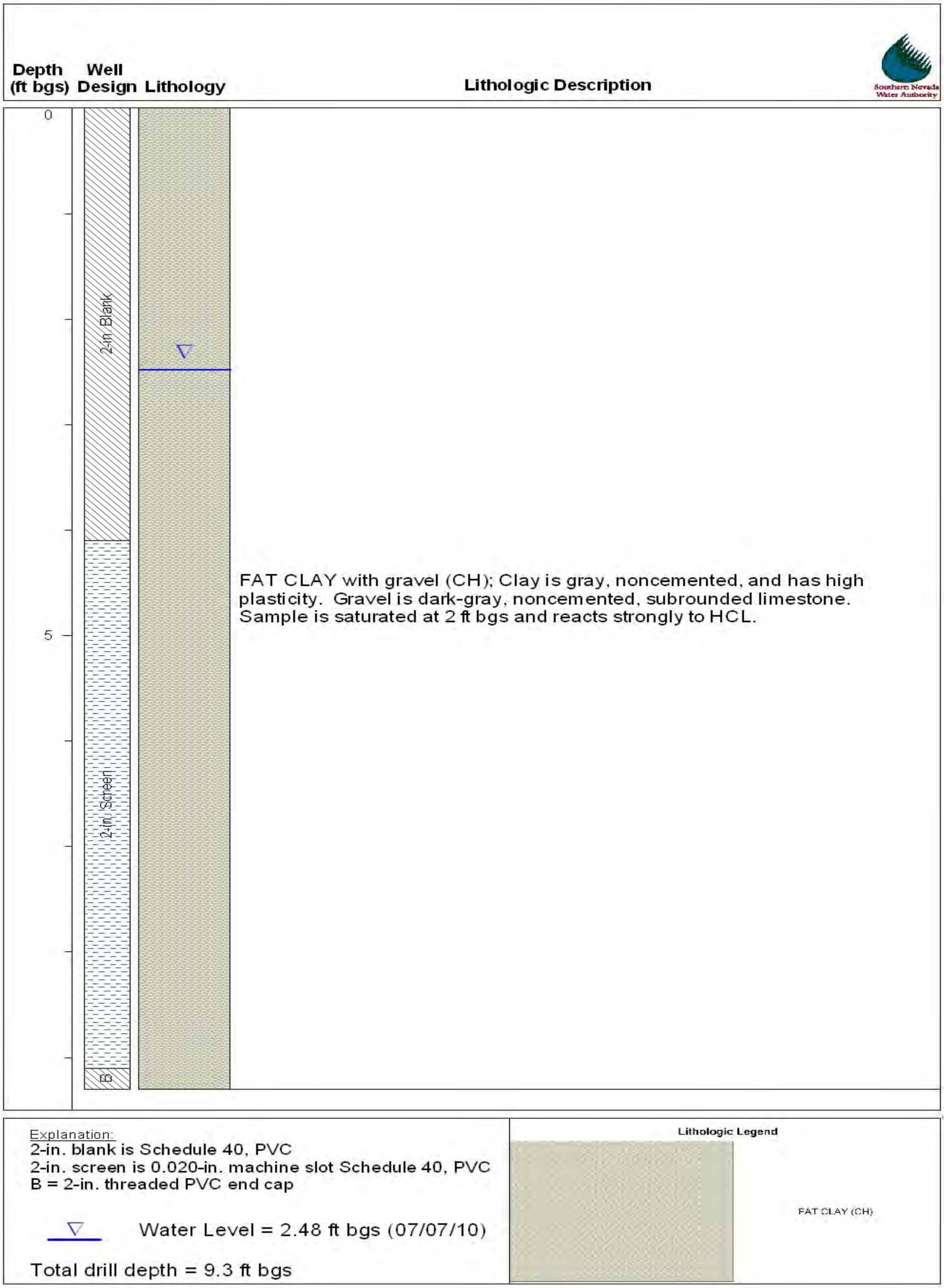


Figure 13-6
Stonehouse Spring Piezometer Lithologic Log

and the EC was 691 µS/cm. The water is a Ca-Na-Mg-HCO_3 type. The analytical results for the piezometer are provided in Appendix A. Stonehouse Spring has been previously sampled on October 23, 1991. The spring has been previously sampled with results presented in the most recent annual report (SNWA, 2012).

The cool water temperature, similarity of the stable isotopic composition to that of modern day precipitation, and site hydrogeologic conditions indicate that the spring is of local origin.

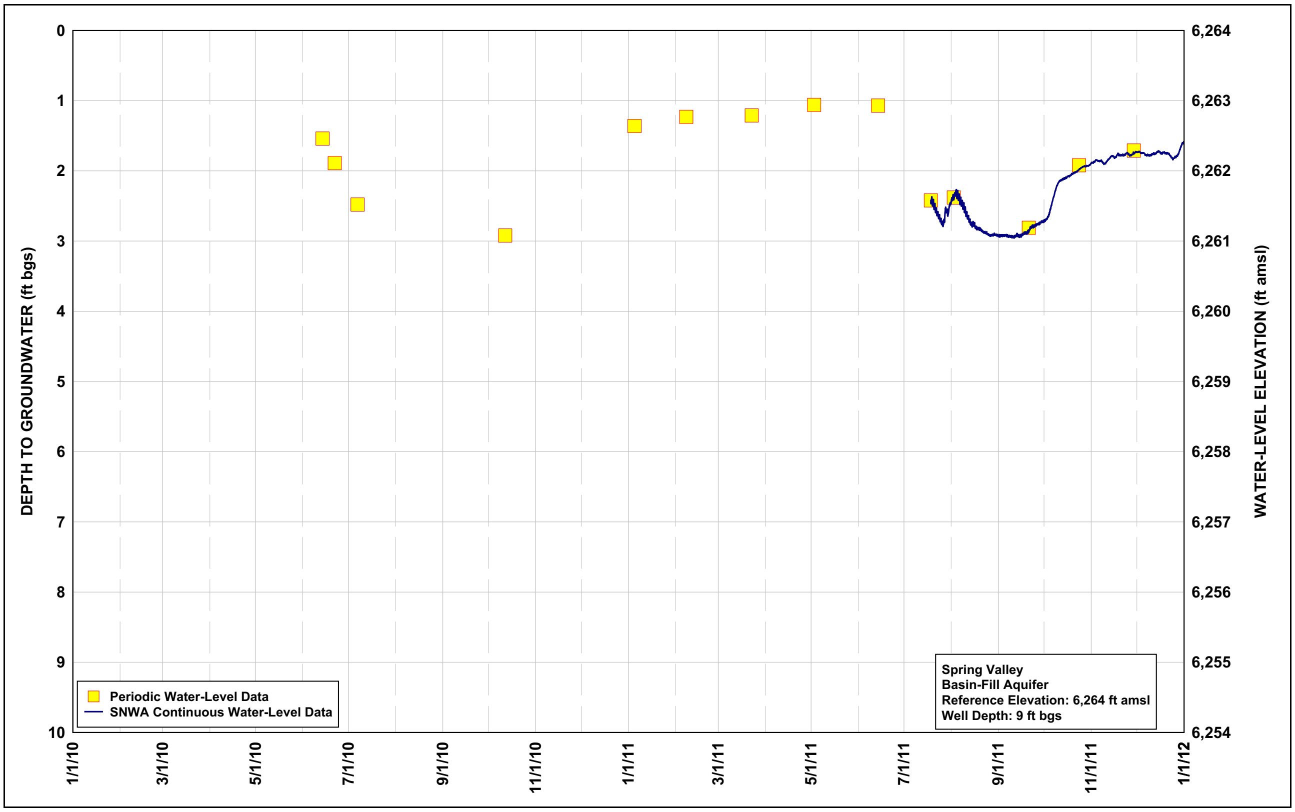


Figure 13-7
Hydrograph of Stonehouse Spring Piezometer

14.0 ROCK SPRING

Rock Spring is located in east central Spring Valley approximately 0.6 mi north of Highway 50 and 3.4 mi west-northwest of Sacramento Pass on BLM managed land. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 14-1 and 14-2, respectively.

14.1 Physical Description and Satellite Imagery

Rock Spring is located on the mountain block. A high-resolution aerial photo depicting the spring location, hydrologic monitoring locations and biological monitoring transects are presented in Figure 14-3. LANDSAT 5 satellite imagery for the region around Rock Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 14-4. Field photos of the spring are presented in Figures 14-5 and 14-6.

14.2 Monitoring Program

The spring discharge is monitored using a 3-in. modified Parshall flume and gaging station which is permanently installed approximately 130 ft downstream of the Rock Spring orifice. The gaging station is equipped with a data logger and gas bubbler system. The Parshall flume and concrete wingwalls create a gage pool and the stage is measured at 15 min intervals. This value is used to calculate a discharge at the flume. With this system, a continuous record of discharge through the flume is calculated. The flume has been surveyed to determine accurate elevation and planar coordinates.

A piezometer was not installed at this location due to hydrogeologic conditions at the site (bedrock outcrop) which prevented augering a borehole to accommodate the piezometer.

14.3 Hydrogeology

Discharge at Rock Spring is from a carbonate-rock outcrop. This discharge is derived locally from within the Snake Range through recharge from precipitation that infiltrates into the carbonate rocks and flows primarily though fractures until discharging at the base of the outcrop. A geologic map of the region in the vicinity of the spring is presented in Figure 14-7. Discharge from this spring forms a small creek that flows past the gaging station and 3-in. Parshall flume into a small reservoir. From the reservoir, the creek continues downgrade for approximately 0.6 mi before completely infiltrating into the alluvial system. Discharge from Rock Spring is displayed in the hydrograph presented in Figure 14-8.

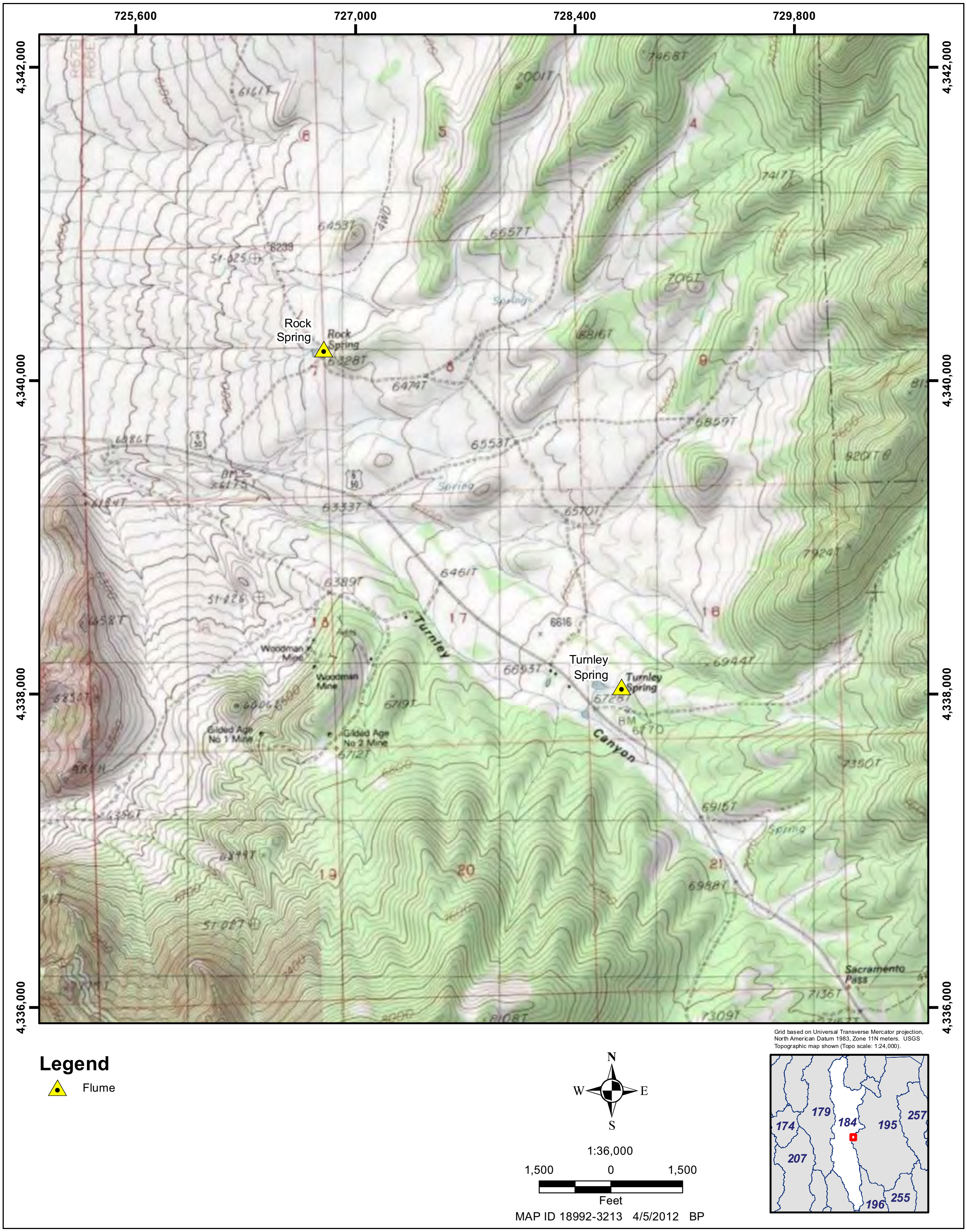


Figure 14-1
Topographic Map of Rock and Turnley Springs

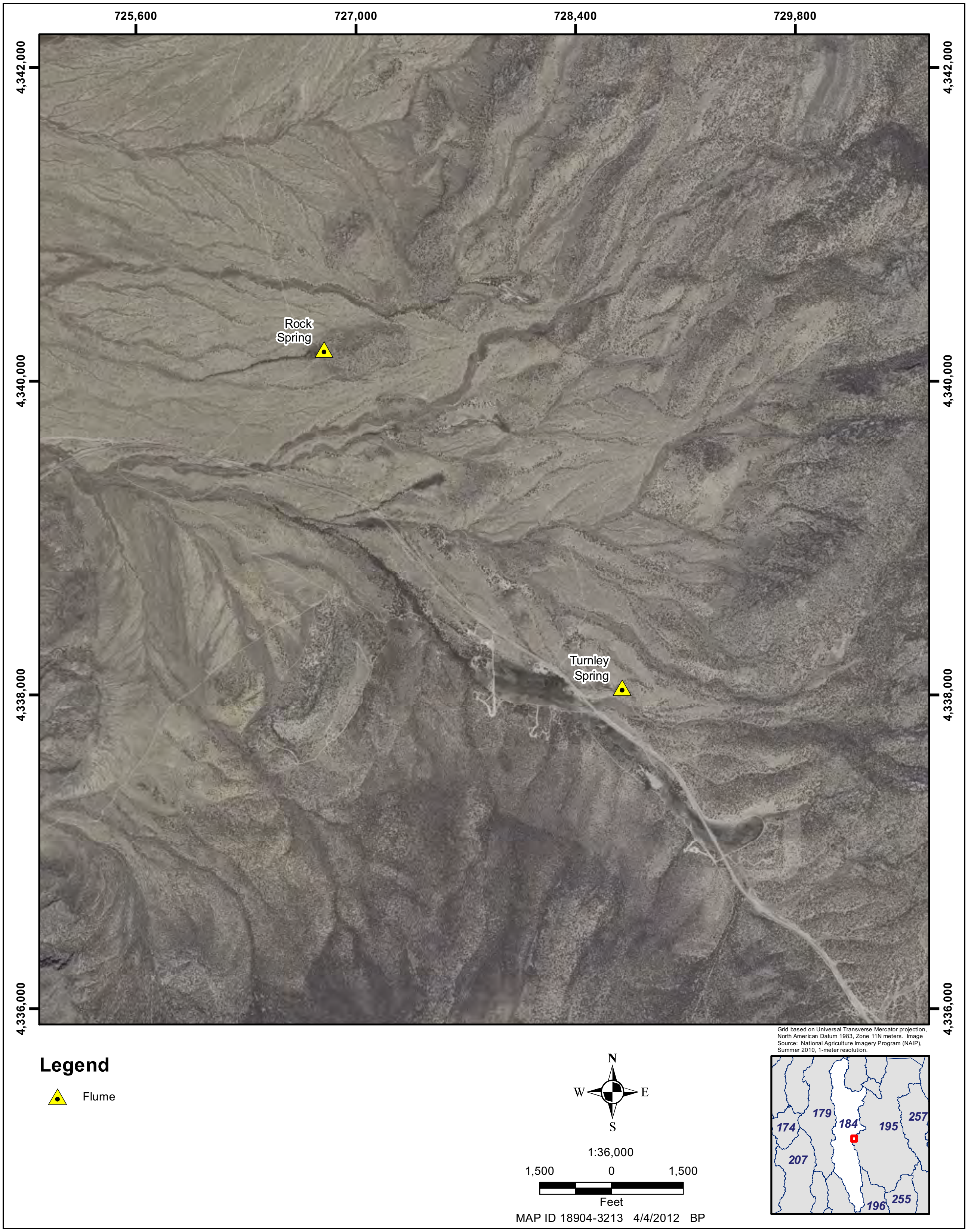


Figure 14-2
Aerial Photo of Rock and Turnley Springs

Figure 14-3
High-Resolution Aerial Photo of Rock Spring

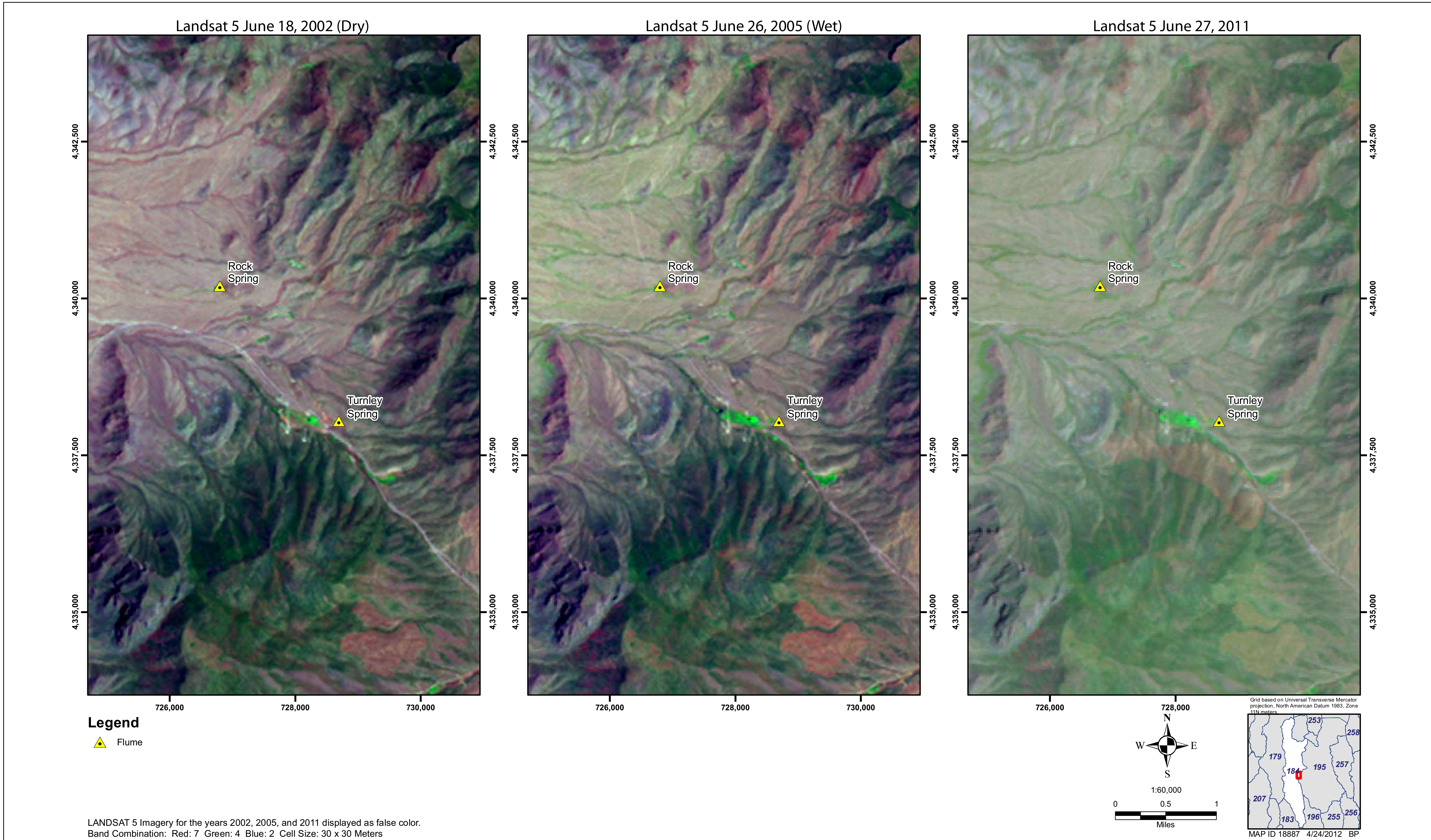


Figure 14-4
LANDSAT Imagery of Rock and Turnley Springs

Figure 14-5
Rock Spring Orifice at Base of Outcrop

Figure 14-6
Rock Spring Flume

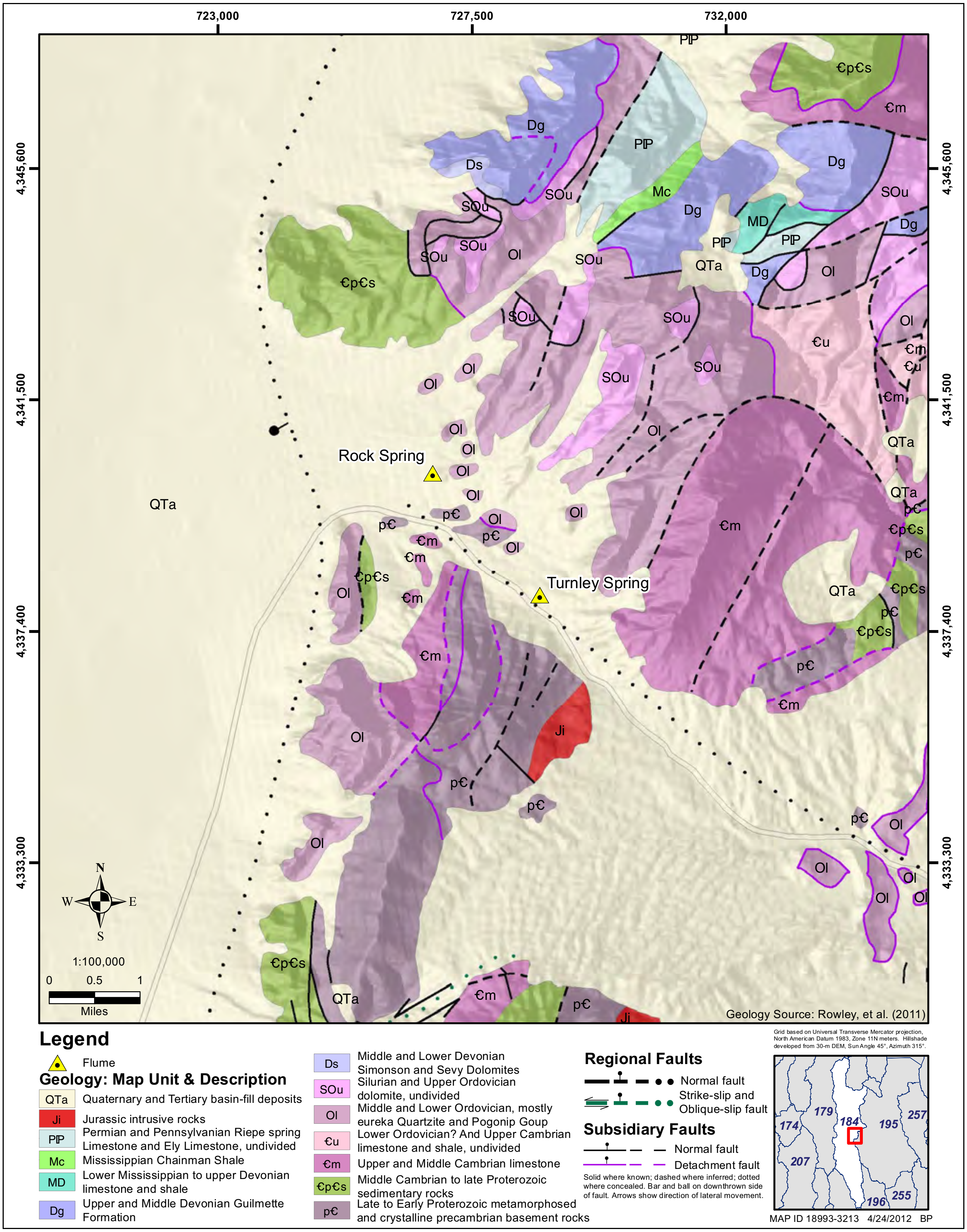


Figure 14-7
Geologic Map of Rock and Turnley Springs

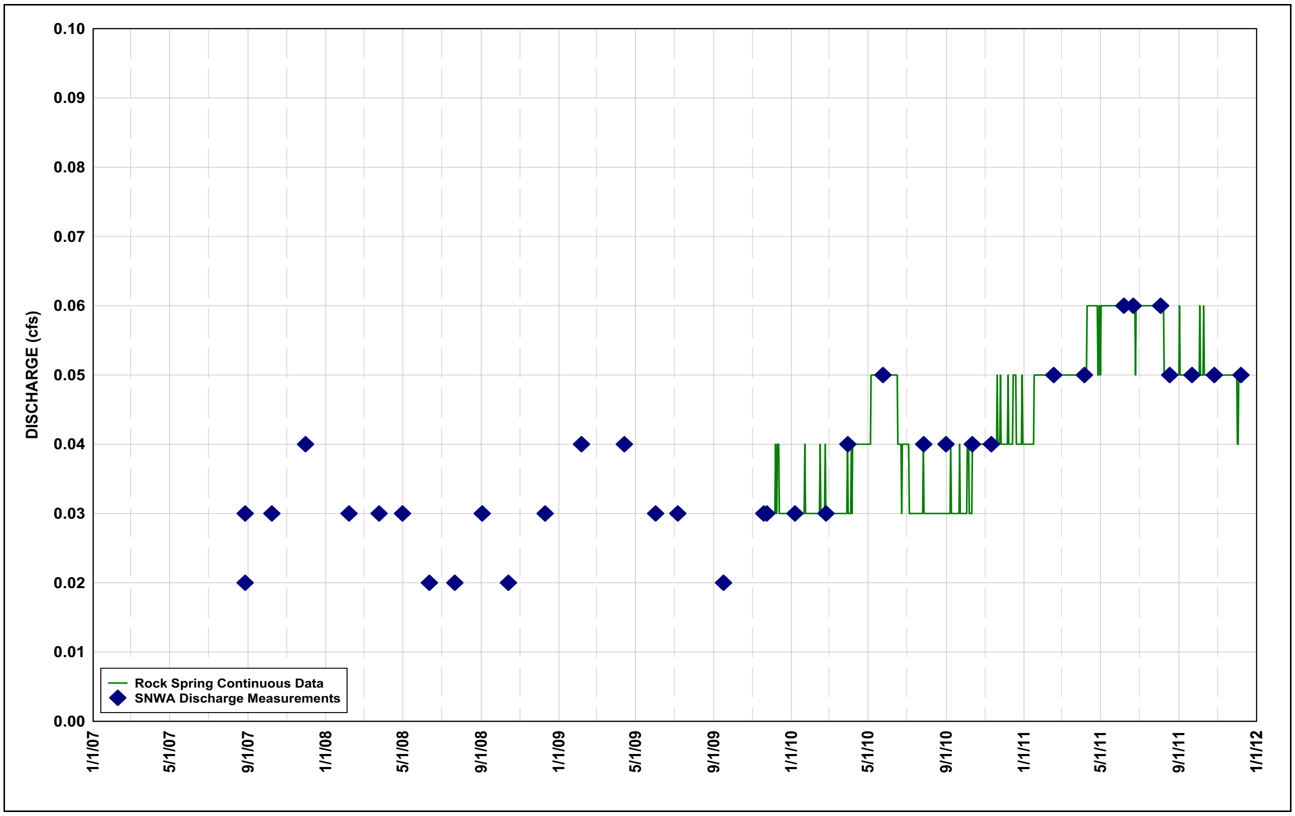


Figure 14-8
Hydrograph of Rock Spring Discharge

14.4 Spring Water Chemistry

Samples from Rock Spring were collected from the discharge channel near the spring orifice October 25, 2010. The water temperature of the Rock Spring sample was 12.2^{o}C, the pH was 7.23, and the EC was 645 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring samples are provided in Appendix A. The spring has been previously sampled on December 12, 2005 and July 31, 2006 with results presented in the most recent annual report (SNWA, 2012).

The cool water temperature, the similarity of the stable isotopic composition to that of modern day precipitation, presence of tritium, and site hydrogeologic conditions indicate that the spring is of local origin.

15.0 Turnley Spring

Turnley Spring is located in east-central Spring Valley along the western flank of the Snake Range at the end of a short dirt road approximately 800 ft north of US 50 and approximately 1.6 mi west of Sacramento Pass. The spring is owned by William and Katherine Rountree. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 14-1 and 14-2, respectively.

15.1 Physical Description and Satellite Imagery

Turnley Spring is located within the mountain block in an area of dense to moderately-dense vegetation. The spring has been developed and discharge is collected and piped for domestic and irrigation uses. Spring flow emits from carbonate rocks into a collection pipe and feeds directly into a spring box and distribution lines.

A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 15-1. LANDSAT 5 satellite imagery for the region around Turnley Spring for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 14-4. Field photos of the spring are presented in Figures 15-2 and 15-3.

15.2 Monitoring Program

The discharge of Turnley Spring is measured by SNWA on a regular basis on a schedule developed in consultation with William and Katherine Rountree and the NSE. To measure the discharge of the spring the irrigation and domestic supply lines are shut-off and a small reservoir begins to fill. The water from the reservoir flows through a homemade V-notch weir constructed by the Rountrees. The discharge forms a small creek after flowing through the weir and small discharge culvert. A modified 3-in. Parshall flume is then temporarily installed in the creek to obtain discharge measurements. Head measurements are taken at 5-min intervals until the reservoir and head in the flume have come into equilibrium. During periods of high discharge a larger Parshall flume is installed or the discharge is measured with a current meter.

15.3 Hydrogeology

Discharge at Rock Spring is from a carbonate-rock outcrop. This discharge is derived locally from within the Snake Range through recharge from precipitation that recharges the carbonate rocks in the mountain block, and flows primarily though fractures until discharging at the base of the outcrop. A geologic map of the region in the vicinity of the spring is presented in Figure 14-7. A hydrograph of Turnley Spring over the period of record is presented in Figure 15-4.

Figure 15-1
High-Resolution Aerial Photo of Turnley Spring

Figure 15-2
Turnley Spring Reservoir and Diversion Structure

Figure 15-3
Turnley Spring Monitoring Site

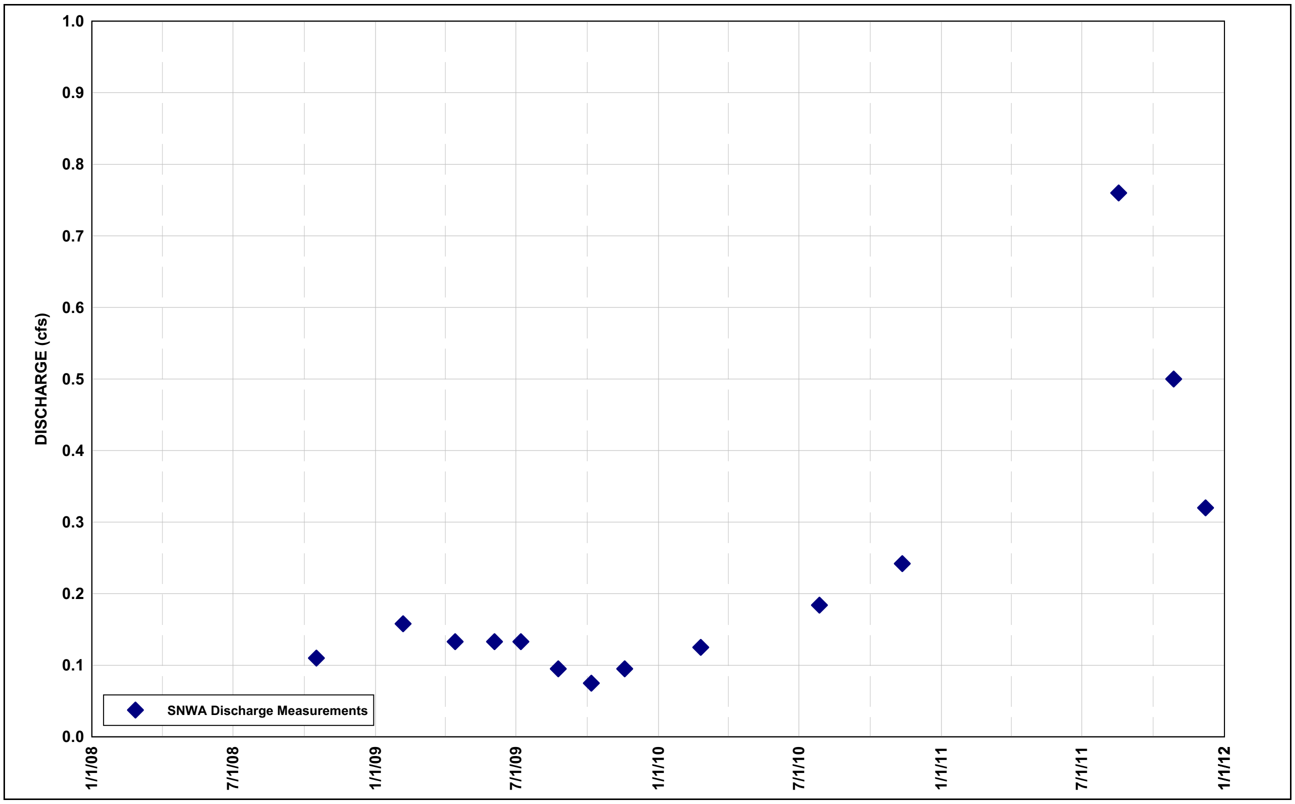


Figure 15-4
Hydrograph of Turnley Spring Discharge

15.4 Spring Water Chemistry

Samples were not collected during the 2010 sampling event for Turnley Spring. However, Turnley Spring has been previously sampled on October 3, 2008. The water temperature of the Turnley Spring sample was 11.9°C, the pH was 6.95, and the EC was 554 µS/cm. The water is a Ca-Mg-HCO_3 type.

The cool water temperature, the similarity of the stable isotopic composition to that of modern day precipitation, the ^{14}C activity, presence of tritium, and site hydrogeologic conditions indicate that the spring is of local origin.

16.0 CLEVELAND RANCH SPRING NORTH

Cleveland Ranch Spring North is located on Cleveland Ranch property in central Spring Valley approximately 1.5 mi east of SR 893 approximately 12.5 mi north of its intersection of US 50. A topographic map and aerial photo of the area in the vicinity of the spring are presented in Figures 16-1 and 16-2, respectively.

16.1 Physical Description and Satellite Imagery

Cleveland Ranch Spring North is located on the valley floor in unconsolidated basin-fill sediments. The spring is situated in an area of multiple diffuse springs and surrounded by moderately dense vegetation coverage consisting of grass, shrubs, and Swamp Cedar trees. A high-resolution aerial photo depicting the spring area, hydrologic monitoring locations and biological monitoring transects are presented in Figure 16-3. LANDSAT 5 satellite imagery for the region around Cleveland Ranch Spring North for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 16-4. Field photos of the spring are presented in Figures 16-5 and 16-6.

16.2 Monitoring Program

The site is monitored by collecting quarterly water-level measurements at piezometer SPR7031Z and periodic discharge measurements using a 3-in. modified Parshall flume. The flume was permanently installed approximately 25 ft from the confluence of the two spring orifices selected as a monitoring locations. The flume and piezometer have been surveyed to determine accurate elevation and planar coordinates.

16.3 Hydrogeology

The borehole for piezometer SPR7031Z was advanced using an auger through surficial sediments to 11.5 ft bgs. Lithologic samples were collected at 5-ft intervals during the drilling process. The soils encountered consist of clay with some gravel. The clays encountered were light gray with low plasticity. The gravel was light gray, subrounded quartzite. The lithologic log is presented in Figure 16-7.

A hydrograph presenting the depth to groundwater at SPR7031Z is presented in Figure 16-8. Spring discharge is measured quarterly at the 3-in. modified Parshall flume. The head in the flume is measured after clearing vegetation from the mouth, throat, upstream and downstream of the flume. The head is measured in the flume every 5 min after cleaning until the stage has equilibrated. A discharge hydrograph is presented in Figure 16-9.

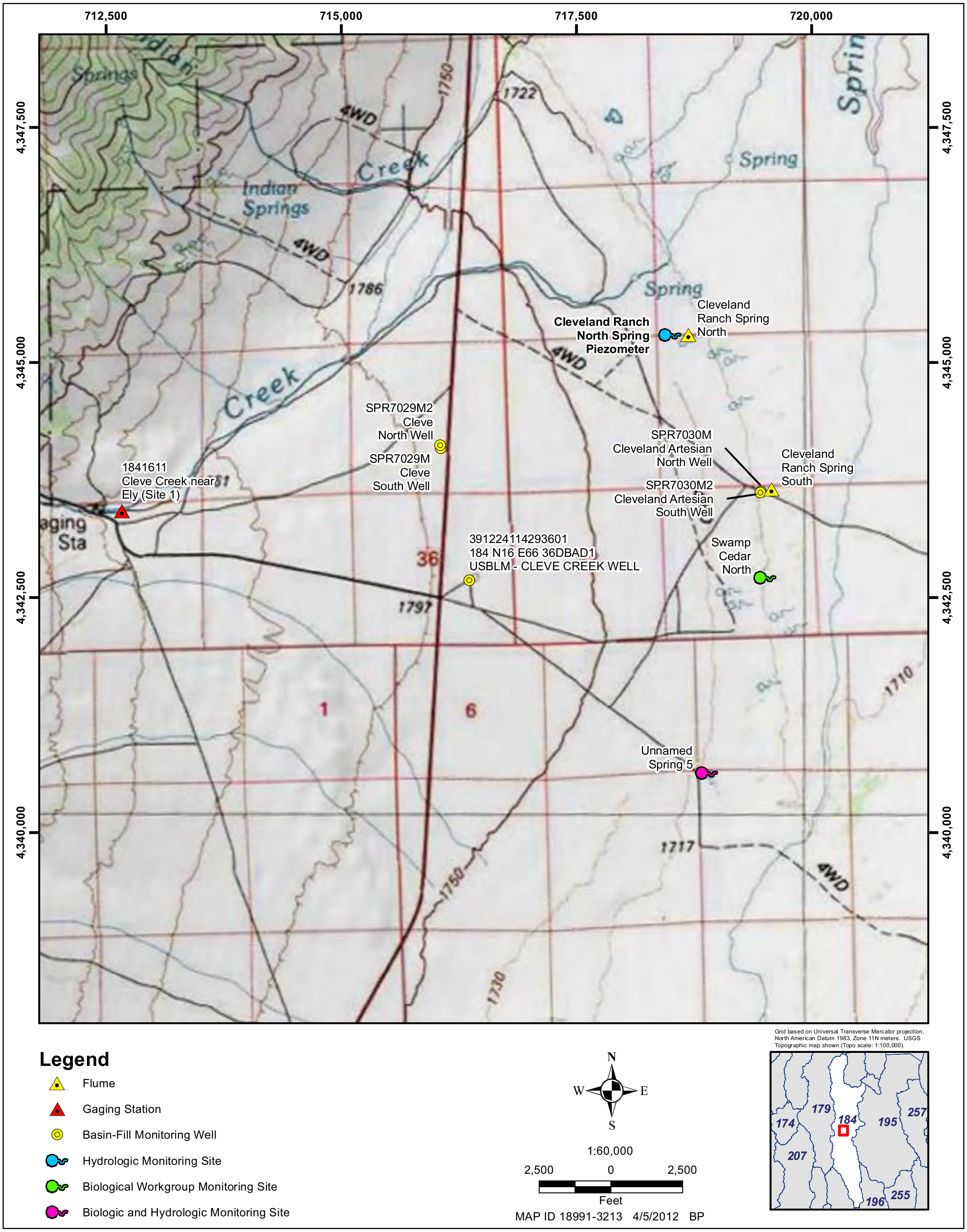


Figure 16-1
Topographic Map of the Cleveland Ranch Area

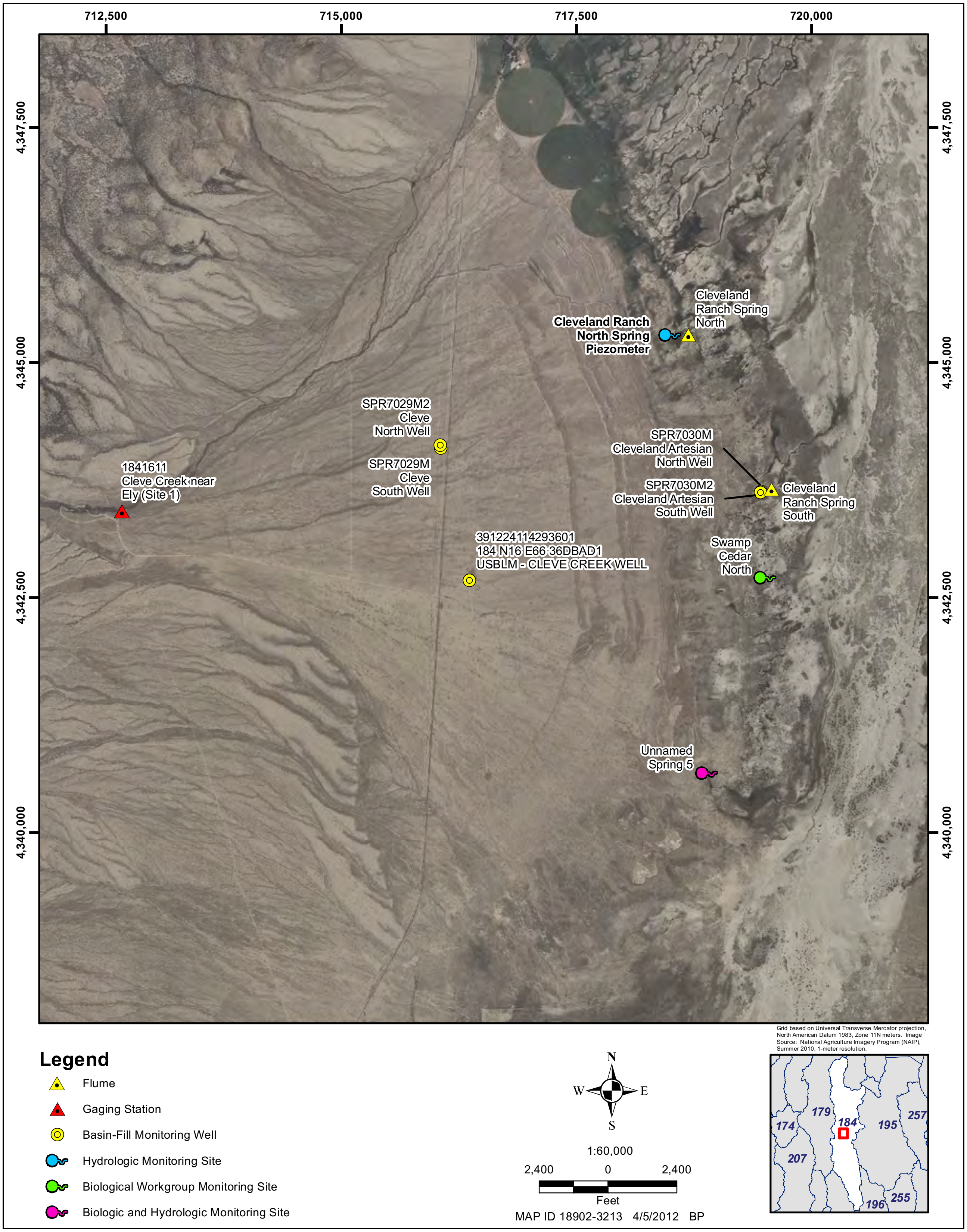


Figure 16-2
Aerial Photo of the Cleveland Ranch Area

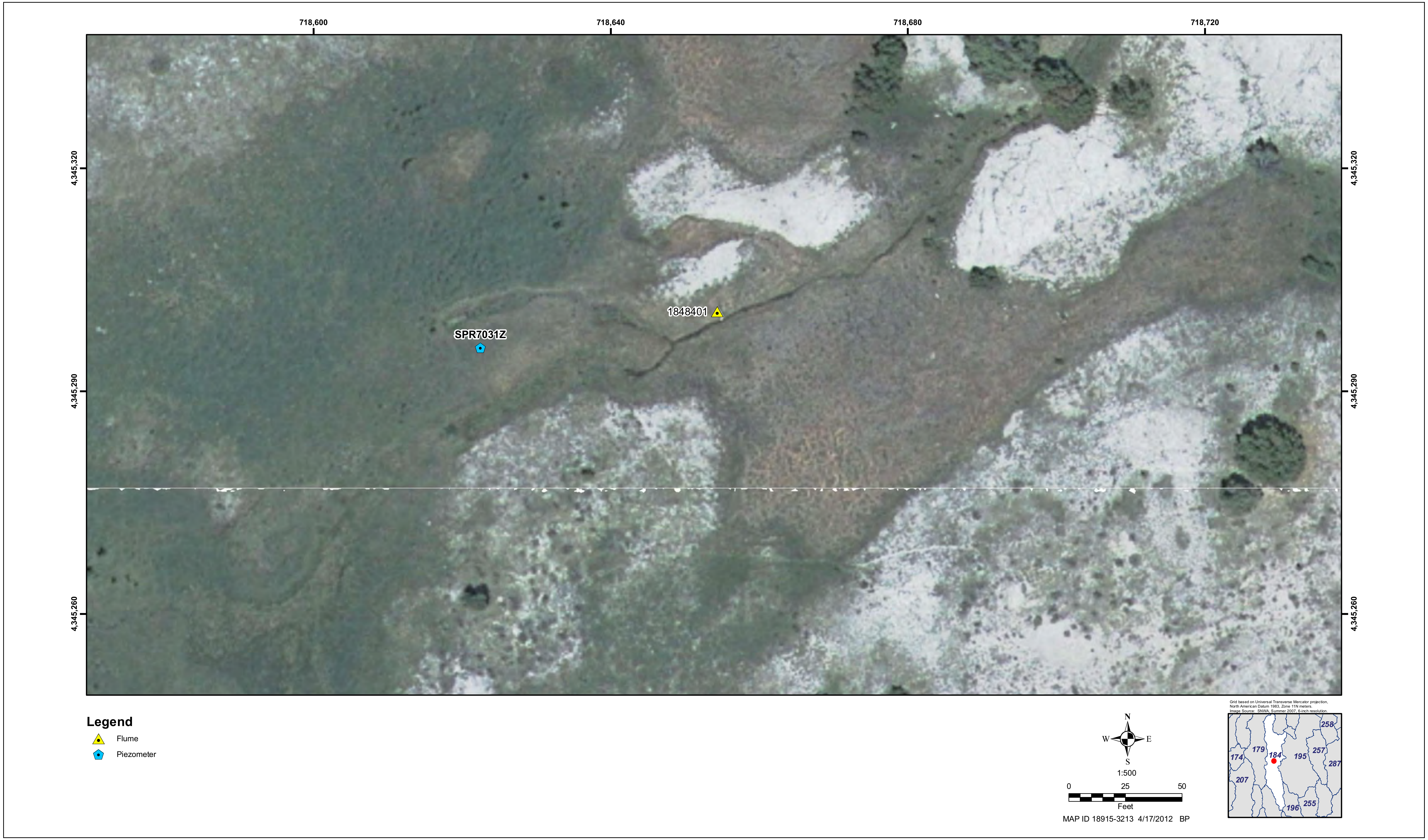


Figure 16-3
High-Resolution Aerial Photo of Cleveland Ranch Spring North

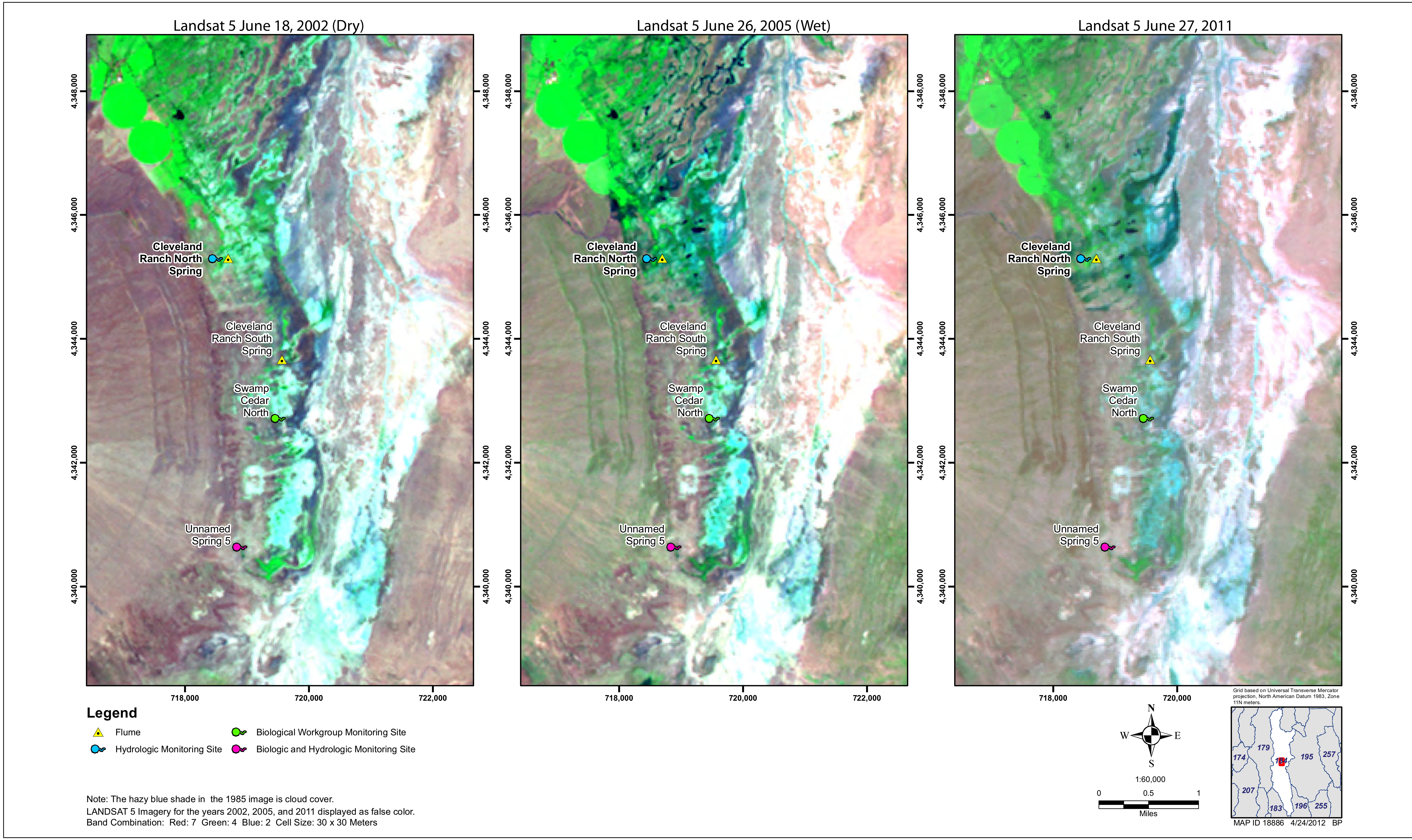
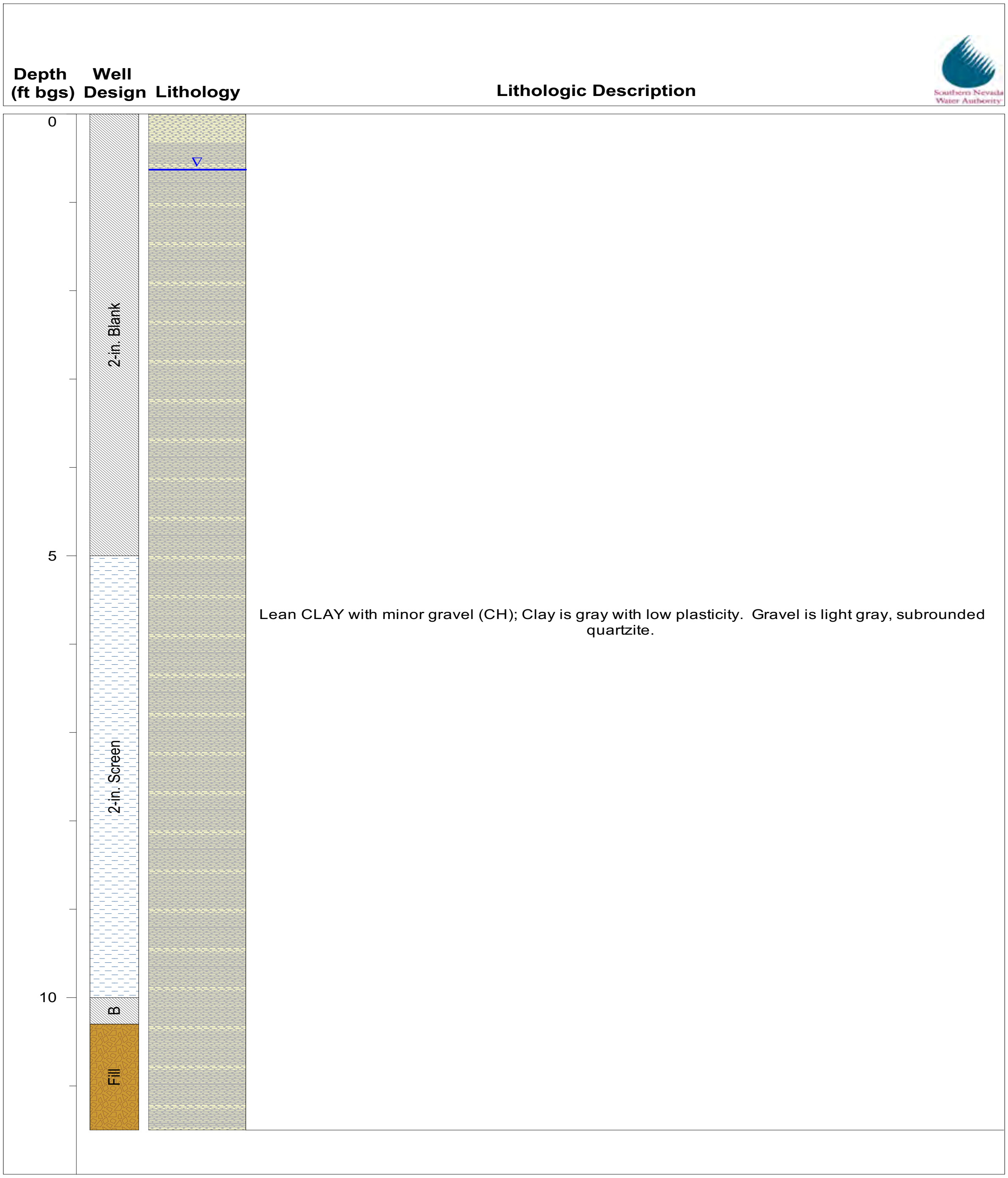


Figure 16-4
LANDSAT Imagery of Cleveland Ranch Area

Figure 16-5
Flume Installation at Cleveland Ranch Spring North

Figure 16-6
Spring Discharge Channel and Piezometer Cleveland Ranch Spring North



Explanation:
2-in. blank is Schedule 40, PVC
2-in. screen is 0.020-in. machine slot Schedule 40, PVC
B = 2-in. threaded PVC end cap

∇ Water Level = 0.63 ft bgs (03/03/11)

Total drill depth = 11.5 ft bgs

Lithologic Legend

LEAN CLAY (CH)

Figure 16-7
Cleveland Ranch Spring North Piezometer Lithologic Log

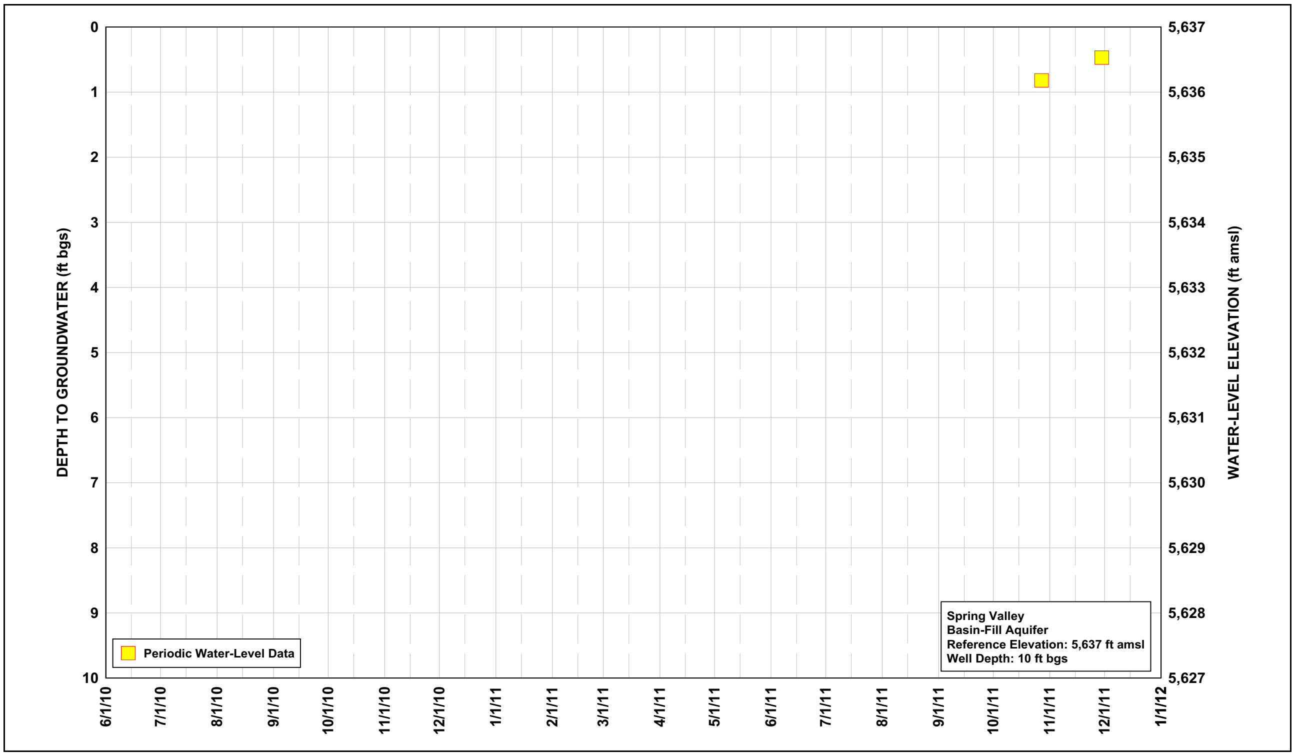


Figure 16-8
Hydrograph of Cleveland Ranch Spring North Piezometer

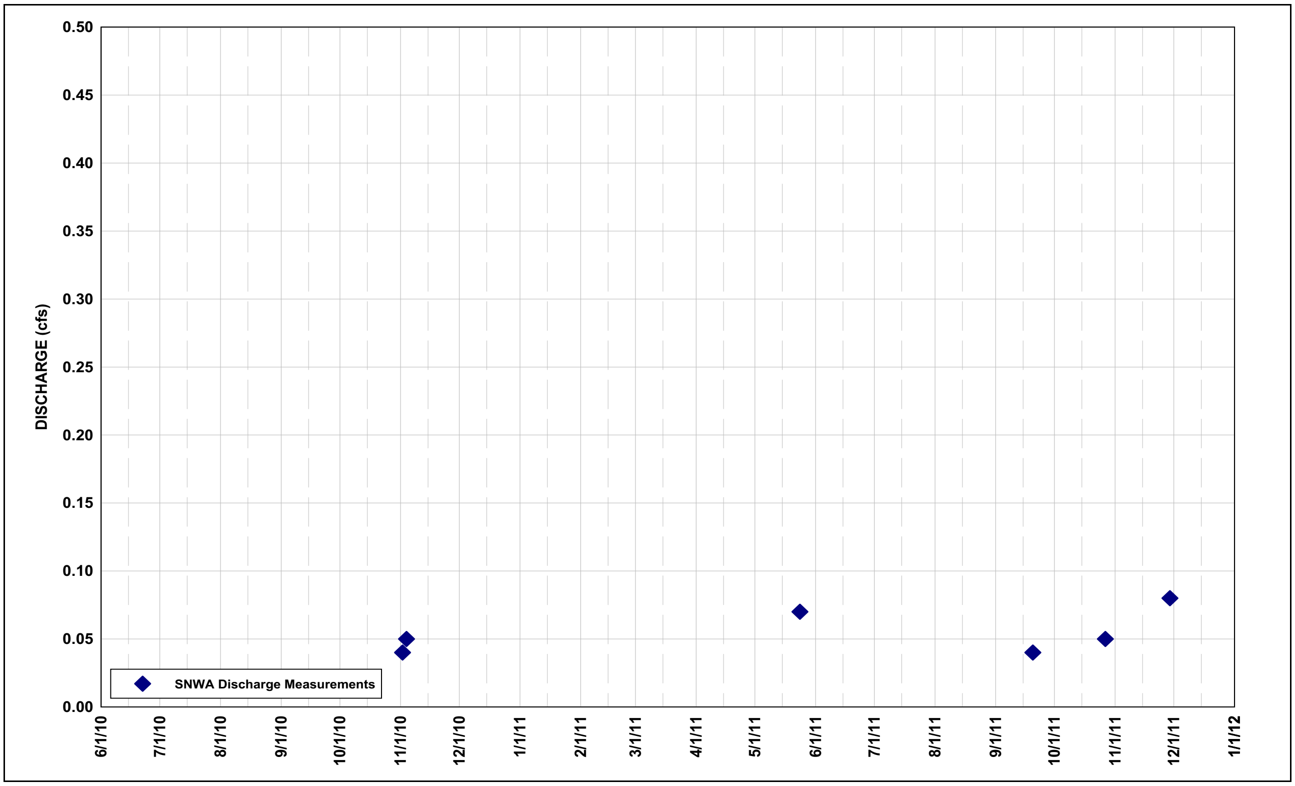


Figure 16-9
Hydrograph of Cleveland Ranch Spring North Discharge

16.4 Spring Water Chemistry

Samples from Cleveland Spring North were collected from the discharge channel near the north spring orifice on February 14, 2012. The water temperature of the sample was 8.6°C, the pH was 7.58, and the EC was 413 μS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring sample are provided in Appendix A.

The cool water temperature, the similarity of the stable isotopic composition to that of modern day precipitation, presence of tritium, and site hydrogeologic conditions indicate that the spring is of local origin.

17.0 CLEVELAND RANCH SPRING SOUTH

Cleveland Ranch Spring South is located on Cleveland Ranch property in central Spring Valley approximately 2 mi east of SR 893 approximately 12 mi north of its intersection of US 50. A topographic map and aerial photo of the area in the vicinity of the Cleveland Ranch are presented in Figures 16-1 and 16-2, respectively.

17.1 Physical Description and Satellite Imagery

Cleveland Ranch Spring South is located on the valley floor in unconsolidated basin-fill sediments. The spring emits from a spring pool approximately 15 ft in diameter and is located in an area of multiple diffuse springs and surrounded by moderately-dense vegetation coverage consisting of grass, shrubs, and swamp cedar trees. A high-resolution aerial photo depicting the spring dimensions, hydrologic monitoring locations and biological monitoring transects are presented in Figure 17-1. LANDSAT 5 satellite imagery for the region around Cleveland Ranch Spring South for a dry period (2002), wet period (2005), and last year (2011) is presented in Figure 16-4. Field photos of the spring are presented in Figures 17-2 and 17-3.

17.2 Monitoring Program

The spring discharge is measured quarterly using a permanent 3-in. modified Parshall flume which was permanently installed immediately downstream of the orifice. The groundwater levels at the site are also measured periodically at monitor wells SPR7030M and SPR7030M2, which are located approximately 230 ft to the southwest of the spring. The flume and piezometer have been surveyed to determine accurate elevation and planar coordinates. A discharge hydrograph is presented in Figure 17-4. Monitor well construction attributes and groundwater elevation data are presented in the 2011 Hydrologic Data Report (SNWA, 2012).

17.3 Spring Water Chemistry

Samples from Cleveland Ranch Spring South were collected from the orifice on October 25, 2011. The water temperature of the Cleveland Ranch Spring South sample was 13.3^{o}C, the pH was 7.85, and the EC was 237 µS/cm. The water is a Ca-Mg-HCO_3 type. The analytical results for the spring samples are provided in Appendix A.

The cool water temperature, the similarity of the stable isotopic composition to that of modern day precipitation, presence of tritium, and site hydrogeologic condition indicate that the spring is of local origin.

Figure 17-1
High-Resolution Aerial Photo of Cleveland Ranch Spring South

Figure 17-2
Cleveland Ranch Spring South November 11, 2010

Figure 17-3
Cleveland Ranch Spring South June 30, 2011

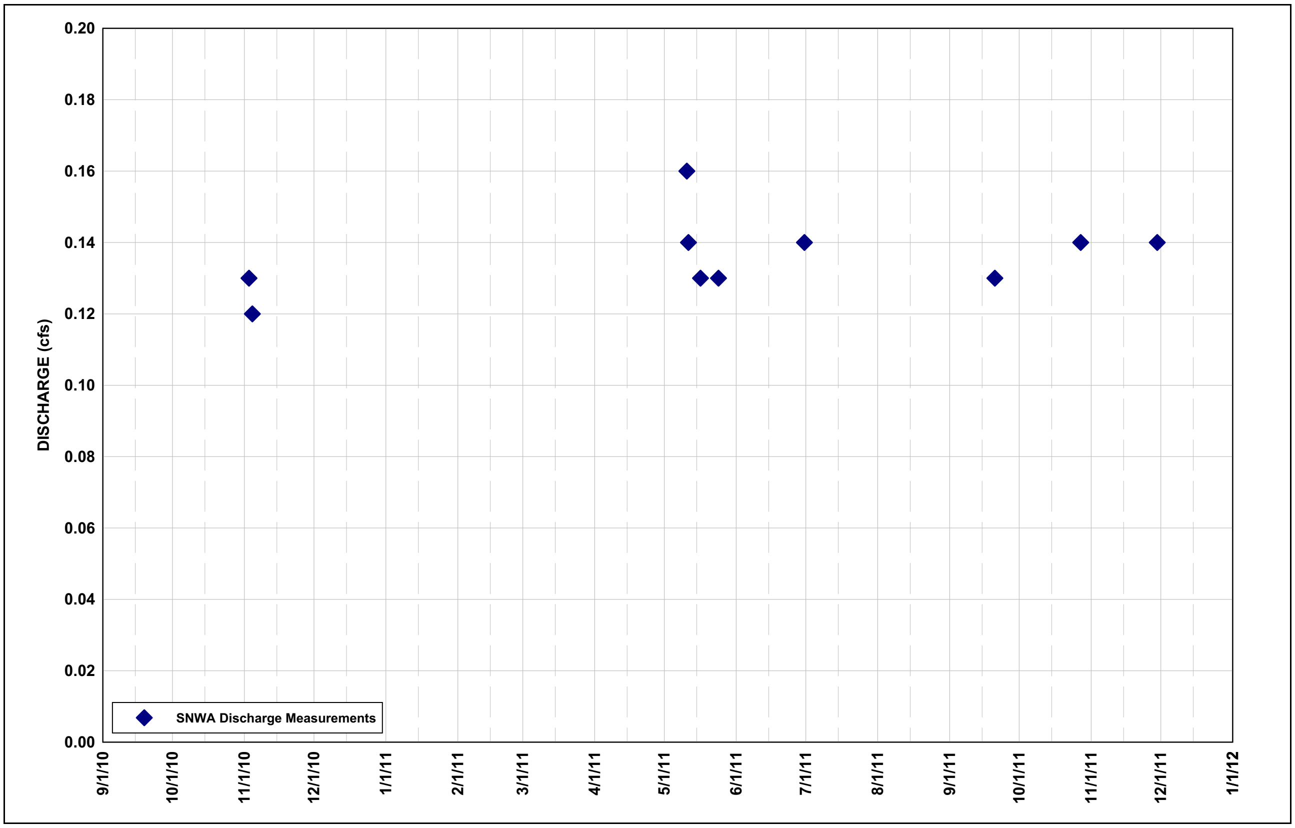


Figure 17-4
Hydrograph of Cleveland Ranch Spring South Discharge

18.0 References

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Appendix A

Water Chemistry

Table A-1
Isotopic Data for Creeks, Wells, Springs, and Piezometers in the Spring Valley Monitoring Network
(Page 1 of 2)

Site Number	Site Name	Sample date	$\delta^{13}C$*	^{14}C PMC (%)	$\delta^{18}O$ (‰)	δD (‰)	E^3H (T.U.)	± 1σ	$^{87}Sr/^{86}Sr$ (Ratio)	Sr (ppb)
1841611	Cleve Creek	10/25/2010	-13.8	84.2	-15.1	-111.5	8.5	0.8	0.716320	26
1845501	Willow Spring	10/26/2010	-10.5	70.6	-16.05	-123.1	<0.8	0.3	0.711000	236
		R10/26/2010	---	---	---	---	---	---	0.710999	---
1845702	South Millick Spring	10/25/2010	-8.7	53.9	-15.41	-116.8	2.3	0.4	0.711193	218
1846103[a]	Shoshone Well 1[a]	5/4/2011	-12.1	67.5	-14.89	-109.8	<0.8	0.3	0.712802	83.87
		R5/4/2011	---	---	---	---	---	---	---	104.32
1846201	Swallow Springs	10/24/2010	-8.9	81.8	-15.02	-111.3	6.8	0.6	0.711241	204
1847101	Keegan Spring	10/25/2010	-15	103.8	-16.23	-119.4	8	0.7	0.715881	50
1847201	Minerva Spring	10/24/2010	-9.2	76.9	-15.12	-109.8	8.8	0.8	0.711547	197
		R10/24/2010	---	---	---	---	---	---	---	198
1847301	Rock Spring	10/25/2010	-9.7	67.6	-14.73	-114.2	2.2	0.4	0.710961	211
1848400	Cleveland Ranch Spring North	2/14/2012	---	---	-16.1	-121	---	---	---	---
1848501	Cleveland Ranch Spring South	10/25/2010	-8.2	47.5	-16.23	-120.3	2.2	0.4	0.712990	192
		R10/25/2010	---	---	---	---	---	---	---	190
		6/20/2011	---	---	---	---	---	---	0.712983	175.78
		R6/20/2011	---	---	---	---	---	---	---	184.08
1951901	Big Spring South Channel	11/2/2010	-8.0	31.0	-14.98	-111.9	2	0.4	0.711200	129
		R11/2/2010	---	---	---	---	---	---	0.711196	132
Stateline Springs	Stateline Springs	11/2/2010	-11.0	24.1	-14.59	-110.7	<0.8	0.3	0.709595	361
1953001	Clay Spring	11/2/2010	-7.0	5.0	-14.98	-112.8	<0.8	0.3	0.708328	1909
383023114115302	USGS MX (Hamlin Valley S.)	11/2/2010	-6.0	6.8	-14.96	-114.2	<0.8	0.3	0.713023	391
383704114225001	USGS MX Well (South Spring Valley)	5/11/2011	-11.1	31.5	-13.87	-106.6	<0.8	0.3	0.710686	297.99
		R5/11/2011	---	---	---	---	---	---	---	320.20
385622114250001	Shoshone Well #4	5/3/2011	-12.7	64.1	-14.85	-109.8	<0.8	0.3	0.715283	157.66
		R5/3/2011	---	---	---	---	---	---	---	157.73
1847701	Unnamed Spring #5	10/25/2010	-8.2	50.6	-16.17	-120.7	2.3	0.4	0.712895	193
393055114310001	Robison Irrigation	9/29/2010	-9.0	46.7	-16.22	-121.5	<0.8	0.3	0.715320	154
184W101	184W101	2/24/2011	-6.2	4.2	-15.15	-113.6	<0.8	0.4	0.710561	185.02
184W103	184W103	2/15/2011	-7.8	11.0	-14.9	-110.7	<0.8	0.3	0.709693	179.60
		R2/15/2011	---	---	---	---	---	---	---	173.54
184W105	184W105	2/10/2011	-7.5	6.0	-15.01	-113.7	<0.8	0.3	0.709286	174.05

Table A-1
Isotopic Data for Creeks, Wells, Springs, and Piezometers in the Spring Valley Monitoring Network
(Page 2 of 2)

Site Number	Site Name	Sample date	$\delta^{13}C$*	^{14}C PMC (%)	$\delta^{18}O$ (‰)	δD (‰)	E^3H (T.U.)	± 1σ	$^{87}Sr/^{86}Sr$ (Ratio)	Sr (ppb)
184W508M	184W508M	2/16/2011	-10.8	60.4	-14.42	-109.2	<0.8	0.4	0.710905	129.86
		R2/16/2011	---	---	---	---	---	---	---	132.29
SPR7005X	SPR7005X	2/2/2011	-7.3	42.1	-16.31	-121.9	5.4	0.6	0.712851	159.09
SPR7006M	SPR7006M	3/1/2011	-8.2	42.8	-14.93	-109.9	<0.8	0.4	0.716859	154.95
SPR7007X	SPR7007X	2/8/2011	-9.7	67.0	-14.93	-109.4	8.2	0.8	0.712771	165.82
SPR7008X	SPR7008X	2/7/2011	-7.9	23.3	-15	-111.1	<0.8	0.3	0.713625	142.26
SPR7023I	SPR7023I	10/6/2010	-13.9	67.2	-14.82	-109	<0.8	0.3	0.716648	73
SPR7024M	Shoshone Pond South Well	5/4/2011	-11.2	56	-14.76	-109.2	<0.8	0.3	0.711353	79.76
SPR7024M2	Shoshone Pond North Well	5/3/2011	-7.6	23	-14.87	-108.6	<0.8	0.3	0.715132	119.22
SPR7029M	Cleve South Well	5/10/2011	-7.7	44	-16.0	-121	---	---	---	---
		R5/10/2011	---	---	-16.1	-121	---	---	---	---
SPR7029M2	Cleve North Well	5/25/2011	-11.7	37.6	-16.23	-122.6	2.3	0.4	0.71317	178.38
SPR7011Z	Blind Spring Piezometer	10/24/2010	-9.1	53.6	-14.52	-111.4	<0.8	0.3	0.710482	357
SPR7012Z	4WD Spring Piezometer	10/25/2010	-10.1	46.8	-16.15	-120.1	<0.8	0.3	0.711527	220
SPR7014Z	The Seep Piezometer	10/24/2010	-8.4	56.5	-15.25	-111.6	8.2	0.7	0.712706	214
SPR7015Z	West Spring Valley Complex 1 Piezometer	10/25/2010	-3.8	19.8	-16	-120.7	<0.8	0.4	0.721150	430
SPR7019Z	Layton Spring Piezometer	10/25/2010	-9.6	43.2	-15.02	-110.5	<0.8	0.3	0.712590	219
SPR7020Z	Stonehouse Spring Piezometrer	10/26/2010	---	---	---	---	---	---	0.711342	517
		R10/26/2010	---	---	---	---	---	---	0.711342	---
		11/1/2010	-11.3	72.9	-16.12	-125	<0.8	0.3	---	---

[a]Additional sampling collected at the southern Shoshone Pond referred to as the Well no. 1 or the Fish and Game Well. This well was not part of the monitoring program sampling site list.
R = Sample is split in the laboratory and analyzed as a duplicate.
Tritium is reported in Tritium Units
1 TU = 3.221 Picocurries/L per IAEA, 2000 Report
1 TU = 0.11919 Becquerels/L per IAEA, 2000 Report
SPR7029M - Laboratory report for Isotopic data for this site was not received by the time this report was published.

Table A-2
Major-and Minor-Solute Data for Wells, Springs, and Piezometers in the Spring Valley Monitoring Network

Site Number	Site Name	Date Collected	Water Temp (°C)	Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)	Alkalinity, Total (mg/L)	TDS (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica, Reactive (mg/L)	Sulfate (mg/L)	Nitrate as N (mg/L)	Nitrite as N (mg/L)	o-Phosphate as P (mg/L)	T-Phosphate as P (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)
1841611	Cleve Creek	10/25/2010	7	43	7.07	9.67	18.3	44.6	<0.02	1.2	<0.1	8.8	2.6	0.2	<0.02	0.028	0.05	7.4	1.3	0.76	1.2
1845501	Willow Spring	10/26/2010	10.6	443	7.4	5.4	181	264	0.114	18	0.15	31	22	<0.02	<0.02	0.004	0.054	56	14	3.2	19
1845702	South Millick Spring	10/25/2010	11.7	471	7.51	6.61	212	257	0.0518	8.5	<0.1	13	17	0.42	<0.02	0.0025	0.013	56	25	1.4	8.7
1846103	Shoshone Well 1	5/4/2011	18.9	126.2	7.97	7.26	62.6	96	0.0144	2.4	0.22	20	4.1	0.13	<0.02	0.0089	0.021	21	1.8	0.72	5.4
1846201	Swallow Springs	10/24/2010	9.8	345	7.63	8.57	172	190	<0.02	0.87	<0.15	6.3	6.4	0.26	<0.02	0.0048	0.0078	55	11	0.58	1.3
1847101	Keegan Spring	10/25/2010	10.8	61	6.73	5.78	25.5	52.4	<0.02	1.9	<0.1	13	6.1	0.27	<0.02	0.03	0.086	8.2	2.1	0.84	3.4
		D10/25/2010	10.8	61	6.73	5.78	31.7	55.6	<0.02	1.9	<0.1	13	6.1	0.27	<0.02	0.03	0.1	8.1	2.1	0.77	3.3
1847201	Minerva Spring	10/24/2010	11.4	626	7.23	6.16	175	195	<0.02	1.2	<0.14	7.8	5.6	0.1	<0.02	0.0015	0.027	58	10	0.58	3.2
1847301	Rock Spring	10/25/2010	12.2	645	7.23	6.98	281	365	0.158	23	<0.1	17	27	1.5	<0.02	0.0021	0.0097	69	35	1.7	19
1848400	Cleveland Ranch Spring North	2/14/2012	8.6	413	7.58	---	190	198	<0.02	<5	<0.1	15	7.1	0.13	<0.02	0.0042	0.022	46	21	2.4	4.4
1848501	Cleveland Ranch Spring South	10/25/2010	12	258	7.46	7.31	153	173	<0.02	1.7	<0.1	11	6.8	0.25	<0.02	0.0068	0.012	44	15	0.97	2.7
		6/20/2011	13.3	237	7.85	6.31	156	172	0.0239	1.8	<0.1	11	7	0.22	<0.02	0.0063	0.011	45	15	1.1	3.2
1951903	Big Spring South Channel	11/2/2010	17.4	373	7.13	5.31	188	212	0.0256	5	0.15	13	8.3	0.49	<0.02	0.0038	0.0096	51	21	1.5	4.8
		D11/2/2010	17.4	373	7.13	5.31	190	215	0.0265	4.9	0.15	13	8.3	0.49	<0.02	0.0036	0.0091	51	21	1.6	4.9
Stateline Springs	Stateline Springs	11/2/2010	13.8	366	7.3	5.23	122	226	0.0842	23	0.49	39	27	1.6	<0.02	0.0065	0.023	34	18	3.5	17
1953001	Clay Spring	11/2/2010	13.7	642	7.2	1.97	172	408	0.0527	13	1.8	15	150	0.19	<0.02	0.0017	0.0092	74	39	2.1	11
383023114115302	USGS-MX (Hamlin Valley S.)	11/2/2010	19.2	404	7.25	3.6	157	253	0.0779	17	0.77	28	31	0.62	<0.02	0.0086	0.033	37	19	5.2	24
383704114225001	USGS-MX (Spring Valley South)	5/11/2011	15.6	294	8.05	4.8	108	185	0.0197	11	0.34	49	8.1	0.33	<0.02	0.01	0.036	29	12	4	8.7
385622114250001	Shoshone Well # 4	5/3/2011	19.9	129	7.89	6.52	63.5	93.4	0.0122	1.9	0.16	20	3.8	0.11	<0.02	0.0068	0.019	20	1.4	0.74	5.9
1847701	Unnamed Spring # 5	10/25/2010	12.4	389	7.13	6.78	151	166	<0.02	2.3	<0.1	12	7.1	0.26	<0.02	0.007	0.013	43	15	0.95	3
393055114310001	Robison Irrigation	9/29/2010	18	270	8.03	0.92	113	138	0.0356	5.8	<0.1	20	12	0.26	<0.02	0.006	0.016	33	12	1.3	7.2
184W101	184W101	2/24/2011	25.8	369	7.52	3.41	163	215	0.0338	5.3	0.32	25	17	0.13	<0.02	0.0033	0.013	45	17	2.5	7
184W103	184W103	2/15/2011	11.7	256	7.82	6.52	155	198	0.0589	5.4	0.19	29	9.4	1.1	<0.02	0.0041	0.016	38	21	2.5	7
184W105	184W105	2/10/2011	13.3	427	7.9	4.42	164	204	0.0703	7.5	0.2	18	14	0.86	<0.02	0.0029	0.009	39	23	1.7	7.4
		D2/10/2011	13.3	427	7.9	4.42	---	200	---	---	0.2	---	---	---	---	---	---	---	---	---	---
184W508M	184W508M	2/16/2011	18	262	7.7	5.44	124	218	0.0674	9.4	0.29	63	8.6	0.4	<0.02	0.021	0.046	30	5.4	6.3	25
SPR7024M	Shoshone Ponds South	5/4/2011	17.1	148	7.88	6.31	75.9	112	0.0194	2.9	0.23	15	6	0.13	<0.02	0.0055	0.024	28	2	0.74	5.3
SPR7024M2	Shoshone Ponds North	5/3/2011	26.8	185	7.87	5.58	76	116	0.0116	1.9	0.26	15	6.7	0.21	<0.02	0.0034	0.022	25	2.2	1.2	6.8
SPR7005X	SPR7005X	2/2/2011	22	464	7.89	4.04	158	176	0.0172	2	<0.1	11	10	0.31	<0.02	0.0037	0.0072	46	18	1	3.5
SPR7006M	SPR7006M	3/1/2011	23.7	288	7.85	4.98	121	193	0.0577	7.9	0.39	21	12	0.37	<0.02	0.0081	0.022	39	7.7	3.2	11
SPR7007X	SPR7007X	2/8/2011	12.4	356	7.55	7.44	153	176	0.0388	2	<0.1	8.8	6.6	0.47	<0.02	0.0045	0.0075	51	12	0.65	2.3
		D2/8/2011	12.4	356	7.55	7.44	---	210	---	---	<0.1	---	---	---	---	---	---	---	---	---	---
SPR7008X	SPR7008X	2/7/2011	20.6	392	6.93	4.42	115	161	0.111	9.3	0.27	18	11	0.44	<0.02	0.0051	0.011	37	8.9	2	8.8
SPR7011Z	Blind Spring	10/24/2010	12.1	673	7.34	11.72	264	379	0.316	43	0.42	31	21	0.027	<0.02	0.019	0.07	75	37	6	13
SPR7012Z	Four Wheel Drive Spring Piezometer	10/25/2010	12.2	301	7.7	6.3	156	176	<0.02	2	<0.1	21	5.3	0.27	<0.02	0.012	0.13	44	12	1.2	4.7
SPR7014Z	The Seep Piezometer	10/24/2010	11.3	313	7.23	6.28	154	189	<0.02	1.9	0.13	20	5.8	0.054	<0.02	0.005	0.042	45	11	0.73	3.1
SPR7015Z	W Spring Valley Complex Piezometer	10/25/2010	12.8	406	7.38	6.33	166	264	0.0437	6.3	0.34	21	35	0.11	<0.02	0.028	0.051	60	8.3	4.6	16
SPR7019Z	Layton Spring Piezometer	10/25/2010	10.8	306	7.15	4.41	152	211	0.0475	6.9	0.32	30	10	0.07	<0.02	0.014	0.12	42	9	2.3	10
SPR7020Z	Stonehouse Spring Piezometer	11/1/2010	13.8	691	7.03	3.98	296	492	0.225	42	0.76	52	54	<0.02	<0.02	0.069	0.27	91	24	11	46
SPR7023I	Harbecke Irrigation Well	10/6/2010	16.8	132.1	6.67	4.43	53.5	98.4	<0.02	4.1	0.12	23	4.2	0.26	<0.02	0.025	0.027	16	4.5	1	6.5
SPR7029M	Cleve South Well	5/10/2011	16.6	268	7.65	6.52	149	192	0.0841	2.7	<0.1	11	15	1	<0.02	0.013	0.026	41	12	0.93	14
SPR7029M2	Cleve North Well	5/22/2011	17.6	353	7.72	7.26	151	170	0.0198	2	<0.1	10	7.6	0.27	<0.02	0.01	0.015	44	14	0.95	3
		5/25/2011[a]	17.2	302	7.7	7.39	151	167	0.0164	1.9	<0.1	11	7.6	0.27	<0.02	0.0097	0.017	41	13	0.86	2.9
SPR7030M	Cleveland Ranch South Spring North Well	6/20/2011	13	230	8.22	6.74	151	166	0.0177	1.6	<0.1	11	6.9	0.23	<0.02	0.008	0.014	43	15	1	2.9
		D6/20/2011	13	230	8.22	6.74	149	166	0.0209	1.6	<0.1	11	6.9	0.23	<0.02	0.0075	0.014	43	15	1.1	3

[a]SPR7029M2 sampled before aquifer test on 5/22/11 and after aquifer test on 5/25/11.

Table A-3
Trace-Elements Data for Creeks, Wells, Springs, and Piezometers in the Spring Valley Monitoring Network

Site Number	Site Name	Date Collected	Iron (µg/L)	Mercury (µg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Lead (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
1841611	Cleve Creek	10/25/2010	130	<0.2	110	<0.6	<1	210	<0.4	<0.5	<5	<5	<1	5	<5	<5	<1	<5	<0.2	<5	<5
1845501	Willow Spring	10/26/2010	<100	<0.2	<5	<0.6	3.2	33	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1845702	South Millick Spring	10/25/2010	<100	<0.2	<5	<0.6	<1	110	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1846103	Shoshone Well 1	5/4/2011	<100	<0.2	<5	<0.6	1.3	27	<0.4	<0.5	<5	<5	<!	<5	<5	<5	<1	<5	<0.2	<5	<5
1846201	Swallow Springs	10/24/2010	<100	<0.2	<5	<0.6	<1	21	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1847101	Keegan Spring	10/25/2010	<100	<0.2	6.9	<0.6	<1	70	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
		D10/25/2010	<100	<0.2	5.5	<0.6	<1	70	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1847201	Minerva Spring	10/24/2010	<100	<0.2	<5	<0.6	<1	31	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1847301	Rock Spring	10/25/2010	<100	<0.2	<5	<0.6	2.2	97	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1848400	Cleveland Ranch Spring North	2/14/2012	<100	<0.2	<5	<0.6	1.9	150	<0.4	<0.5	<5	<5	<1	5	<5	<5	<1	<5	<0.2	<5	<5
1848501	Cleveland Ranch Spring South	10/25/2010	<100	<0.2	<5	<0.6	<1	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
		6/20/2011	<100	<0.2	<5	<0.6	<1	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1951901	Big Spring South Channel	11/2/2010	<100	<0.2	<5	<0.6	2.6	110	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
		D11/2/2010	<100	<0.2	<5	<0.6	2.6	110	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
Stateline Springs	Stateline Springs	11/2/2010	<100	<0.2	<5	<0.6	4.8	10	<0.4	<0.5	<5	<5	<1	<5	<5	<5	1.2	<5	<0.2	6.4	<5
1953001	Clay Spring	11/2/2010	<100	<0.2	<5	<0.6	<1	20	<0.4	<0.5	<5	<5	<1	<5	5	<5	2.2	<5	<0.2	<5	<5
383023114115302	USGS MX (Hamlin Valley S.)	11/2/2010	<100	<0.2	<5	<0.6	8	92	<0.4	<0.5	<5	<5	<1	18	<5	<5	<1	<5	<0.2	6.1	25
383704114225001	USGS MX Well (South Spring Valley)	5/11/2011	<100	<0.2	<5	<0.6	4.6	36	<0.4	<0.5	<5	<5	<1	33	<5	<5	<1	<5	<0.2	11	21
385622114250001	Shoshone Well #4	5/3/2011	<100	<0.2	<5	<0.6	2.6	29	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
1847701	Unnamed Spring #5	10/25/2010	<100	<0.2	<5	<0.6	1.4	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
393211114320701	Robison Irrigation	9/29/2010	<100	<0.2	<5	<0.6	1.2	77	<0.4	<0.5	<5	<5	1.6	<5	<5	<5	<1	<5	<0.2	<5	8.6
184W101	184W101	2/24/2011	<100	<0.2	<5	<0.6	3.7	190	<0.4	<0.5	<5	<5	<1	13	5.2	<5	<1	<5	0.34	<5	78
184W103	184W103	2/15/2011	<100	<0.2	<5	<0.6	4.6	59	<0.4	<0.5	<5	<5	<1	33	<5	<5	<1	<5	<0.2	6	86
184W105	184W105	2/10/2011	<100	<0.2	<5	<0.6	1.9	47	<0.4	<0.5	<5	<5	<1	<5	<5	<5	1.8	<5	<0.2	<5	18
184W508M	184W508M	2/16/2011	<100	<0.2	<5	<0.6	2.9	46	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	11
SPR7024M	Shoshone Pond South Well	5/4/2011	<100	<0.2	9.3	<0.6	<1	37	<0.4	<0.5	<5	<5	<1	17	<5	<5	<1	<5	<0.2	<5	13
SPR7024M2	Shoshone Pond North Well	5/3/2011	<100	<0.2	<5	<0.6	1.3	57	<0.4	<0.5	<5	<5	<1	34	<5	<5	<1	<5	<0.2	<5	23
SPR7005X	SPR7005X	2/2/2011	<100	<0.2	<5	<0.6	1.2	120	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	150
SPR7006M	SPR7006M	3/1/2011	<100	<0.2	<5	<0.6	4.4	230	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	140
SPR7007X	SPR7007X	2/8/2011	<100	<0.2	<5	<0.6	<1	31	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	29
SPR7008X	SPR7008X	2/7/2011	<100	<0.2	<5	<0.6	5.7	270	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	41
SPR7011Z	Blind Spring Piezometer	10/24/2010	<100	<0.2	12	<0.6	4.7	150	<0.4	<0.5	<5	<5	<1	44	8.3	<5	<1	<5	<0.2	<5	13
SPR7012Z	4WD Spring Piezometer	10/25/2010	<100	<0.2	<5	<0.6	1.5	65	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
SPR7014Z	The Seep Piezometer	10/24/2010	<100	<0.2	5.7	<0.6	1.2	70	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
SPR7015Z	W Spring Valley Complex 1 Piezometer	10/25/2010	<100	<0.2	13	<0.6	<1	110	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
SPR7019Z	Layton Spring Piezometer	10/25/2010	<100	<0.2	5.1	<0.6	5.1	140	<0.4	<0.5	<5	<5	<1	98	<5	<5	<1	<5	<0.2	<5	<5
SPR7020Z	Stonehouse Spring Piezometer	11/1/2010	<100	<0.2	<5	<0.6	5.4	160	<0.4	<0.5	<5	<5	<1	98	<5	<5	<1	<5	<0.2	<5	10
SPR7023I	SPR7023I	10/6/2010	<100	<0.2	<5	<0.6	<1	62	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
SPR7029M	Cleve South Well	5/10/2011	<100	<0.2	12	<0.6	<1	140	<0.4	<0.5	<5	<5	<1	5.8	<5	<5	<1	<5	<0.2	<5	90
SPR7029M2	Cleve North Well	5/22/2011[a]	<100	<0.2	<5	<0.6	<1	170	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
		5/25/2011[a]	<100	<0.2	<5	<0.6	<1	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	<5
SPR7030M	Cleveland Ranch South Spring North Well	6/20/2011	<100	<0.2	<5	<0.6	<1	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	6.1
		D6/20/2011	<100	<0.2	<5	<0.6	<1	160	<0.4	<0.5	<5	<5	<1	<5	<5	<5	<1	<5	<0.2	<5	12

[a]SPR7029M2 sampled before aquifer test on 5/22/11 and after aquifer test on 5/25/11.

Appendix B

Historic Water-Chemistry Data

Table B-1
Historic Isotopic Data for Wells, Springs, and Piezometers in the Spring Valley Monitoring Network
(Page 1 of 2)

Site Number	Site Name	Sample Date	$\delta^{13}C$ DIC (per mil)	^{14}C DIC (pmc, %)	$\delta^{18}O$ (per mil)	δD (per mil)	Tritium (TU)	$^{87}Sr/^{88}Sr$ (ratio)
393055114310001	Robison Irrigation	8/15/2006	---	---	-16.22	-119.45	---	---
		R 8/15/2006	---	---	---	-119.04	---	---
1841611	Cleve Creek	7/24/2006	---	---	-15.22	-113.43	---	---
		R 7/24/2006	---	---	---	-113.08	---	---
1845501	Willow Spring	7/14/2004	-10.22	74.59	-16.02	-125.36	---	---
		R 7/14/2004	---	---	---	-125.58	---	---
		10/20/2005[a]	-9.6	69.9	-16.17	-122.7	---	---
1845702	South Millck Spring	9/17/2006[b]	---	---	-15.54	-115.7	---	---
		6/18/1992[c]	-7.7	56.8	-15.2	-116	---	---
		7/15/2004	-10.67	64.59	-15.42	-119.13	---	---
		R 7/15/2004	---	---	-15.34	-118.64	---	---
		7/27/2005	---	---	---	---	7.7	0.711301
1845901	Layton Spring	8/3/2006[d]	-11.16	98.94	-15.26	-109.9	0.2	---
		8/16/2006	-10.8	83.2	-14.66	-109.22	---	0.712898
		R 8/16/2006	---	---	---	-109.67	---	---
1846201	Swallow Springs	7/28/2004	-8.82	84.83	-15.16	-112.45	---	---
		R 7/28/2004	---	---	---	-112.27	---	---
1846401	Blind Spring	8/16/2006	---	---	-5.9	-71.55	---	---
		R 8/16/2006	---	---	-5.75	-72.18	---	---
1847301	Rock Spring	12/12/2005[a]	---	---	-14.7	-114	2.3	---
		7/31/2006[b]	---	---	-14.81	-113.7	---	---
184W101	184W101	4/12/2007	-5.8	4.93	-14.98	-113.05	<0.8	0.710542
		R 4/12/2007	---	---	---	---	---	0.710535
184W103	184W103	3/26/2007	-6.7	10.37	-14.77	-110.69	<0.8	0.70902
		R 3/26/2007	---	---	-14.76	-110.36	---	---
184W105	184W105	3/8/2007	-5.8	6.09	-14.84	-112.18	<0.8	0.709282
		R 3/8/2007	---	---	---	-112.82	---	---
SPR7005X	SPR7005X	7/10/2008	-7.5	43.45	-16.15	-121.33	4.5	---
		R 7/10/2008	---	---	---	-121.29	---	---
SPR7006M	SPR7006M	10/18/2007	---	---	-15.03	-111.44	---	---
		R 10/18/2007	---	---	---	-111.26	---	---

Table B-1
Historic Isotopic Data for Wells, Springs, and Piezometers in the Spring Valley Monitoring Network
(Page 2 of 2)

Site Number	Site Name	Sample Date	$\delta^{13}C$ DIC (per mil)	^{14}C DIC (pmc, %)	$\delta^{18}O$ (per mil)	δD (per mil)	Tritium (TU)	$^{87}Sr/^{86}Sr$ (ratio)
SPR7007X	SPR7007X	2/14/2008	-7.6	57.01	-15.25	-109.49	9.4	---
		R 2/14/2008	---	---	---	-109.86	9.3	---
SPR7008X	SPR7008X	1/31/2008	-7.2	21.6	-15.2	-110.77	<0.8	---
		R 1/31/2008	---	---	---	-110.62	---	---
SPR7023I	Harbecke Irrigation Well	2/4/2009	---	---	-15.25	-108.89	---	---
		R 2/4/2009	---	---	---	-108.92	---	---

[a]Hershey et al. (2007)
[b]DRI Data
[c]Hershey and Mizell (1995)
[d]Gillespie (2008)
R =Sample is split in the laboratory and analyzed as a duplicate.
<Less Than

Table B-2
Historic Data for Major- and Minor-Solutes for Wells, Springs, and Piezometers in the Spring Valley Monitoring Network

Site Number	Site Name	Sample Date	pH	Water Temp (°C)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Alkalinity (Total) (mg/L as $CaCO_3$)	Alkalinity (mg/L as HCO_3)	Alkalinity (mg/L as CO_3)	TDS (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (Total) (mg/L)	Silica, (Dissolved) (mg/L)	Sulfate (mg/L)	Nitrite (mg/L as N)	Nitrate (mg/L as N)	O-Phosphate (mg/L as P)	T-Phosphate (mg/L as P)	Calcium (Total) (mg/L)	Calcium (Dissolved) (mg/L)	Magnesium (Total) (mg/L)	Magnesium (Dissolved) (mg/L)	Potassium (Total) (mg/L)	Potassium (Dissolved) (mg/L)	Sodium (Total) (mg/L)	Sodium (Dissolved) (mg/L)
393055114310001	Robison Irrigation	8/15/2006	---	---	---	---	110	140	<2	170	37	6.4	<0.1	17	---	11	---	H0.86	---	---	30	---	11	---	1.2	---	6.4	---
1841611	Cleve Creek	7/24/2006	8.31	16.6	53.6	---	31	38	<2	40	<10	0.73	<0.1	8.3	---	2	---	H<0.5	---	---	9.7	---	1.5	---	0.6	---	1.3	---
1845501	Willow Spring	10/23/1991[a]	7.76	11.8	434	---	---	E194	---	---	---	---	---	---	---	---	---	---	---	---	54.3	---	13.3	---	---	---	---	---
		7/14/2004	8.2	22.9	383	---	193	230.391	2.292	270	0.12	18	0.17	---	29	20	H<0.05	H0.085	H0.014	---	---	51	---	14	---	<1	---	20
		8/17/2006	7.8	14.9	356	3.46	180	220	<2	260	110	19	0.14	30	---	22	---	H<0.5	---	---	58	---	14	---	3.1	---	23	---
		10/20/2005[b]	7.2	12.7	473	1.3	---	211	---	---	0.11	18	0.13	---	29.9	21.8	---	---	---	<0.01	---	62.9	---	16.5	---	3.43	---	25.8
		10/20/2005[b]	---	---	---	---	---	---	---	---	---	---	---	---	---	25	---	---	---	---	---	---	---	---	---	---	---	---
1845702	South Millck Spring	9/17/2006[c]	7.51	13.1	442	7.04	---	252	0.00	---	0.06	9.86	0.08	---	12.90	17.7	---	0.63	---	---	---	54.9	---	23.00	---	1.19	---	8.54
		10/24/1991[a]	7.65	13.5	431	---	---	E219	---	---	---	---	---	---	---	---	---	---	---	---	49.3	---	24.4	---	---	---	---	---
		6/18/1992[d]	7.65	12.7	432	---	---	266	ND	---	---	8.5	0.09	---	10.5	14.6	---	0.39	---	---	---	52.4	---	22.6	---	1.35	---	8.64
		7/15/2004	7.2	13.4	309	---	218	265.742	ND	244	0.08	8.9	0.1	---	12	15	H<0.05	H0.58	H<0.01	---	---	39	---	19	---	<1	---	7.2
		8/16/2006	7.4	13.3	338	3.19	210	260	<2	260	55	9.1	<0.1	13	---	16	---	H2.2	---	---	57	---	24	---	1.4	---	9.4	---
1845901	Layton Spring	10/24/1991[a]	9.92	10	228	---	---	E28	E60	---	---	---	---	---	---	---	---	---	---	---	20.8	---	8.35	---	---	---	---	---
		8/3/2006[e]	7.25	18.5	315	---	---	189.30	---	274.15	---	8.36	0.21	---	---	10.57	---	---	---	---	---	42.16	---	9.45	---	2.9	---	11.2
		8/16/2006	7.4	21.9	404	---	150	180	<2	210	55	7.8	0.22	26	---	11	---	H<0.5	---	---	40	---	9.1	---	2.3	---	14	---
1846201	Swallow Springs	6/1/1980[f]	8	9	---	---	---	---	---	137	---	1.1	0.1	---	5	4	---	0	---	---	---	48	---	8.8	---	0.4	---	1.4
		7/28/2004	L,H8.01	10	L335	---	184	224.296	ND	H289	0.071	<5	<0.05	---	5.5	5.4	H<0.05	H0.23	H<0.01	---	---	46	---	9	---	<1	---	<5
1846401	Blind Spring	8/16/2006	7.2	18.3	525	3.76	340	420	<2	400	36	3.8	0.52	42	---	11	---	H<0.5	---	---	65	---	48	---	3.1	---	11	---
1847301	Rock Spring	12/12/2005[b]	---	12.2	720.4	6.45	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
		7/31/2006[c]	7.73	12.3	660	6.53	---	338	0.00	---	0.2	30.3	0.07	---	16.30	33.6	---	1.67	---	---	---	71.3	---	34.90	---	1.52	---	23.7
1847401	Stonehouse Spring	10/23/1991[a]	8.2	6.8	1655	---	---	E584	---	---	---	---	---	---	---	---	---	---	---	---	102	---	61.1	---	---	---	---	---
184W101	184W101	4/12/2007	7.7	24.1	359	2.29	190	230	<2	180	42	4.6	0.27	25	---	18	<100	<0.1	<2	<10	43	---	16	---	2.7	---	9.1	---
184W103	184W103	3/26/2007	7.9	12	263	6.34	160	190	<2	190	51	5.2	0.18	27	---	17	<100	4.4	4.4	<10	35	---	19	---	2.4	---	9.6	---
184W105	184W105	3/8/2007	7.8	13	282	5.08	170	200	<2	200	66	7.5	0.16	17	---	16	<100	0.7	<2	<10	35	---	20	---	1.8	---	9.3	---
SPR7005X	SPR7005X	7/10/2008	7.4	24.3	327	3.53	160	200	<2	170	13	1.8	<0.1	10	---	11	<100	0.30	9.1	<10	40	40	16	16	1.1	1.2	4.9	5
SPR7006M	SPR7006M	10/18/2007	8.2	22.3	298	---	110	130	<2	150	55	7.1	0.36	20	---	12	---	H1.6	---	---	34	---	6.8	---	3.2	---	11	---
SPR7007X	SPR7007X	2/14/2008	7.58	9.1	305	7.43	150	180	<2	210	15	1.6	<0.1	9.1	---	6.6	<100	0.39	3.4	<10	42	42	11	11	<1	0.65	2.8	2.8
SPR7008X	SPR7008X	1/31/2008	7.93	18.1	250	---	120	150	<2	160	53	8.6	0.25	17	---	11	<100	2.1	7.4	<10	35	34	8.1	7.9	2.1	1.9	9.1	8.9
SPR7023I	Harbecke Irrigation Well	2/4/2009	7.52	16.1	127.3	8.6	58	70	<2	62	39	4.1	0.13	21	21	3.9	<100	0.95	H26	26	13	13	3.9	3.9	0.97	0.98	6.8	6.7

[a]Brothers et al. (1994)
[b]Hershey et al. (2007)
[c]DRI Data
[d]Hershey and Mizell (1995)
[e]Gillespie (2008)
[f]Bunch and Harrill (1984)
E = Parameter analyzed in the field.
L = Parameter analyzed in the laboratory.
R = Sample is split in the laboratory and analyzed as a duplicate.
H = Analysis holding time was exceeded.
< Less Than
ND=Non Detect