# 3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

## 3.1 Introduction

The Project Area is located within the Basin and Range Physiographic Province, which is characterized by broad valleys separated by mountain ranges. Elevations range from approximately 6,400 feet amsl in Kobeh Valley to over 8,400 feet amsl at the top of Mount Hope. Vegetation in the Project Area ranges from piñon/juniper to upland communities containing grasses and big sagebrush.

The Project is located in the central Great Basin section of the Basin and Range Physiographic Province. Block faulting in the area has resulted in generally north south trending topography. Structural deformation has resulted in a series of valleys separated by mountain ranges. The three valleys of hydrologic interest are located primarily within Eureka County and include Diamond, Kobeh, and Pine Valleys. A majority of the Mount Hope watershed drains to the east and south into Diamond Valley. Except for a small area on the northwestern flank of the mountain, the remainder drains to the west and south into Kobeh Valley. A minor tributary to Henderson Creek, located within Pine Valley, drains the small area on the northwestern flank of Mount Hope.

The purpose of this EIS is to describe the existing environment in the Project Area and surrounding areas that might be affected by the Proposed Action and alternatives under consideration. Supplemental authorities that are subject to requirements specified by statute or executive order (EO) must be considered in all BLM environmental documents. The 18 elements associated with the supplemental authorities listed in the NEPA Handbook (BLM 2008a, Appendix 1) are listed in Table 3.1-1. The table lists the elements and their status in the Project Area as well as the rationale to determine whether an element present in the Project Area would be affected by the Proposed Action. Supplemental authorities that may be affected by the Proposed Action are analyzed in Chapter 3 following the discussion of the Affected Environment for each element, resource, or use. Those elements listed under the supplemental authorities that do not occur in the Project Area and would not be affected are not discussed further in this EIS. The elimination of nonrelevant issues follows CEQ policy, as stated at 40 CFR 1500.4.

**Table 3.1-1 Elements Associated with Supplemental Authorities and Rationale for Detailed Analysis for the Proposed Action**

| Supplemental Authority Element | Not Present | Present/ Not Affected | Present/ May be Affected | Rational/Reference Section |
|---|---|---|---|---|
| Air Quality | | | X | See Section 3.6. |
| Areas of Critical Environmental Concern | X | | | Element is not present. |
| Cultural Resources | | | X | See Section 3.21. |
| Environmental Justice | | X | | See Section 3.18. |
| Fish Habitat | | | X | See Section 3.23. |
| Floodplains | X | | | Element is not present. |

| Supplemental Authority Element | Not Present | Present/ Not Affected | Present/ May be Affected | Rational/Reference Section |
|---|---|---|---|---|
| Farmlands (prime and unique) | X | | | Element is not present. |
| Forests and Rangelands (Healthy Forest Restoration Act [HFRA] only) | X | | X | This Project does not meet the criterion for expedited NEPA compliance under the HFRA. |
| Human Health and Safety | | | X | See Sections 3.17, 3.19, and 3.24. |
| Migratory Birds | | | X | See Section 3.23. |
| Native American Traditional Values | | | X | See Section 3.22. |
| Noxious Weeds, Invasive & Nonnative Species | | | X | See Section 3.10. |
| Threatened or Endangered Species | | | X | See Section 3.23. |
| Wastes, Hazardous or Solid | | | X | See Sections 3.19. |
| Water Quality - Surface and Ground | | | X | See Section 3.3. |
| Wetlands and Riparian Zones | | | X | See Section 3.11. |
| Wild and Scenic Rivers | X | | | Element is not present. |
| Wilderness[1] | X | | | Element is not present. |

[1] Lands with Wilderness Characteristics: The Project Area is located within the Nevada Initial Inventory Units NV-060-505, 502, 512, 503, 511, 513, 520, 521, 522, 530, 531, and 533. According to the 1980 Initial Inventory, each of these units was considered to be lacking wilderness character due to an absence of either natural character or because of a lack of outstanding opportunities for solitude or primitive recreation. Current analysis, completed April of 2011, of Master Title Plats (MTPs), aerial photographs and route inventory data collected in 2006, and discussions with resource specialists indicate the Project Area is in an overall unnatural condition. This finding of unnatural condition is due to surface disturbance from historic and current mining operations as well as the abundance of developed roads and routes throughout the area. As outlined in Manual 6303, the analysis concluded the area clearly lacks wilderness character and is not recommended for further evaluation at this time.

In addition to the elements listed under supplemental authorities, the BLM considers other resources and uses that occur on public lands and the impacts that may result from the implementation of the Proposed Action. Other resources or uses of the human environment that have been considered for this EIS are listed in Table 3.1-2. Resources or uses that may be affected by the Proposed Action or other alternatives are further considered in the EIS.

**Table 3.1-2 Resources or Uses Other than Elements Associated with Supplemental Authorities**

| Other Resources or Uses | Not Present | Present/ Not Affected | Present/ May be Affected | Rational/Reference Section |
|---|---|---|---|---|
| Geology and Minerals | | | X | See Section 3.4. |
| Paleontology | X | | | See Section 3.5. |
| Visual Resources | | | X | See Section 3.7. |
| Soil Resources | | | X | See Section 3.8. |
| Vegetation Resources | | | X | See Section 3.9. |
| Forest Products | | | X | See Section 3.25. |

| Other Resources or Uses | Not Present | Present/ Not Affected | Present/ May be Affected | Rational/Reference Section |
|---|---|---|---|---|
| Wild Horses | | | X | See Section 3.13. |
| Land Use | | | X | See Section 3.14. |
| Recreation | | | X | See Section 3.15. |
| Auditory Resources | | | X | See Section 3.16. |
| Socioeconomic Values | | | X | See Section 3.17. |
| Historic Trails | | | X | See Section 3.20. |
| Transportation and Access | | | X | See Section 3.24. |
| Water Quantity | | | X | See Section 3.3. |
| Wilderness Study Areas | | X | | See Section 3.15. |
| Wildlife | | | X | See Section 3.23. |

The BLM has used environmental data collected in the Project Area to predict environmental effects that could result from the Proposed Action and alternatives. A level of uncertainty is associated with any set of data in terms of predicting outcomes, especially where natural systems are involved. The predictions described in this analysis are intended to allow comparison of alternatives to the Proposed Action, as well as provide a method to compare the anticipated impacts with the identified significance criteria.

## 3.2 Water Resources - Water Quantity

### 3.2.1 Regulatory Framework

Approval of the Proposed Action would require authorizing actions from other federal or state agencies with jurisdiction over the use of water resources for the Project. The regulation, appropriation, and preservation of water in Nevada falls under both state and federal jurisdiction. When a proposed project has the potential to directly or indirectly affect the waters under State of Nevada jurisdiction, then the State of Nevada is authorized to implement its own permit programs under the provisions of state law or the Federal Clean Water Act (CWA).

In 1926, a carte blanche Public Water Reserve (PWR) was created through an EO by President Coolidge entitled "Public Water Reserves No. 107" (PWR 107). PWR 107 ended the site-specific system of reserving springs and water holes. The purpose of PWR 107 was to reserve natural springs and water holes yielding amounts in excess of homesteading requirements. This order states that "legal subdivision(s) of public land surveys which is vacant, unappropriated, unreserved public land and contains a spring or water hole, and all land within one quarter of a mile of every spring or water be reserved for public use". There was no intent to reserve the entire yield of each public spring or water hole, rather reserved water was limited to domestic human consumption and stockwatering. All waters from these sources in excess of the minimum amount necessary for these limited public watering purposes is available for appropriation through state water law. To date, many of these PWRs have not been registered with the state and/or are not adjudicated.

The Nevada State Engineer Office of NDWR is responsible for the administration and adjudication of water rights. Water appropriation permits are obtained through the Nevada State Engineer.

### 3.2.2 Affected Environment

#### 3.2.2.1 Study Methods

Water resources information, descriptions and data are based on baseline studies of surface water conditions near Mount Hope conducted by SRK, and Interflow Hydrology (Interflow). Between 2005 and 2007, SRK collected data from three surface water locations along Henderson Creek, 24 springs and seeps, and one mine adit drainage (the Zinc Adit), providing chemistry and flow data for springs and streams generally within a five-mile radius of Mount Hope (SRK 2008a). SRK also performed a more extensive regional spring and seep survey in the fall of 2007, visited 229 sites, and collected water samples from 69 of those sites (SRK 2008c). Interflow made additional stream flow and spring and seep measurements during field investigations in 2007 and 2008 (Montgomery et al. 2010), including Roberts Creek, Rutabaga Creek, Snow Water Canyon, Ackerman Canyon, and Ferguson Creek in Kobeh Valley; Henderson and Vinini Creeks in Garden Valley (subbasin of Pine Valley); Tonkin Spring, Pete Hanson Creek, and Willow Creek in Pine Valley; and Allison Creek in Antelope Valley.

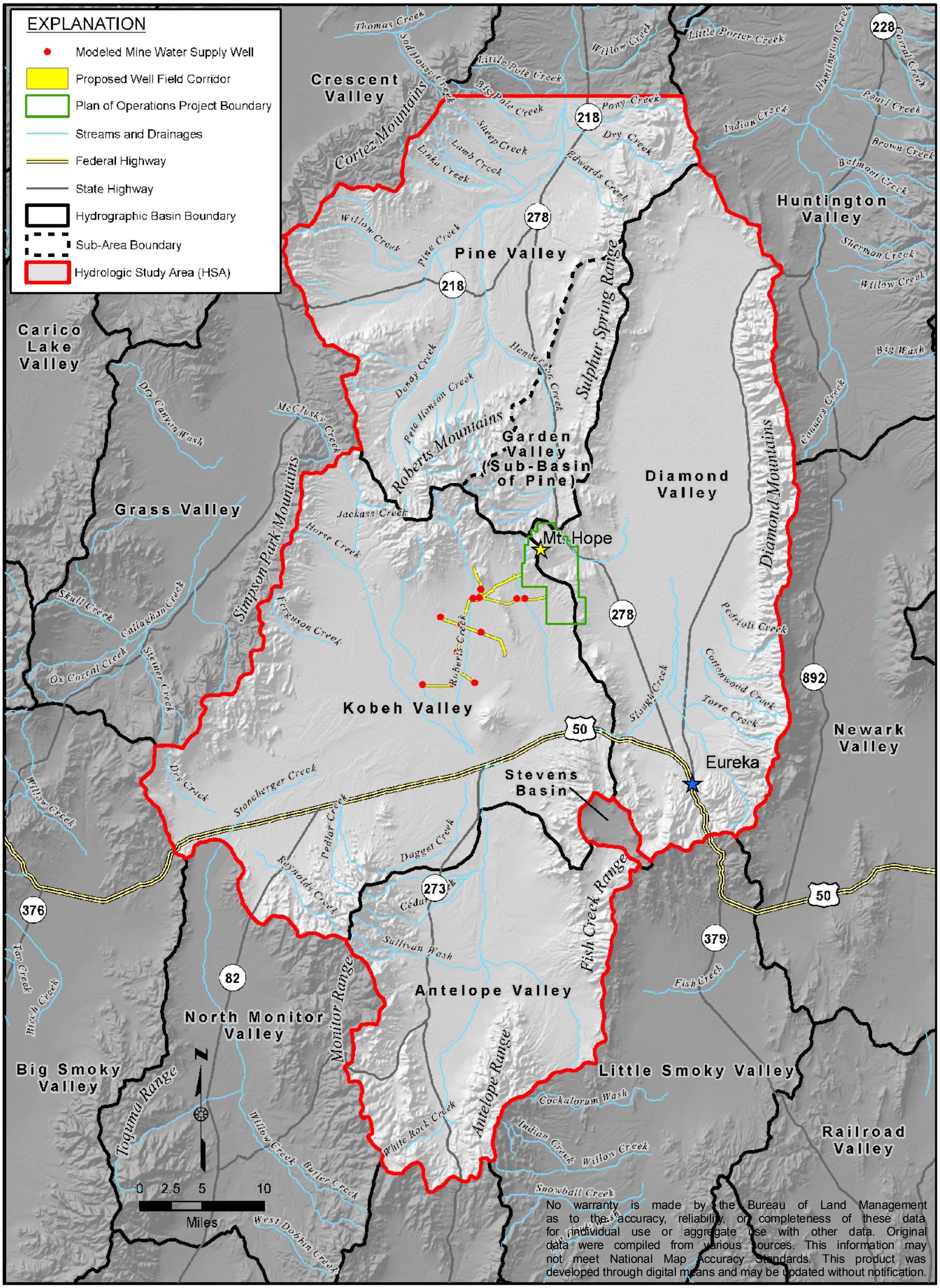
Baseline information describing the hydrogeologic conditions in the study area is presented in ten reports developed by various EML consultants (SRK 2008a; Interflow 2010; Interflow 2011; Montgomery & Associates 2010; Montgomery et al. 2010; Montgomery & Associates 2011; InTerraLogic, Inc. 2011; EML 2011; JBR 2009; 2010). The current understanding of the hydrogeologic conditions is based on the following: 1) previous studies of water resources in Pine, Diamond, Kobeh, Antelope, and Monitor Valleys (Eakin 1961 and 1962; Rush and Everett 1964); 2) lithologic logs for exploration drilling, monitoring wells, and test production wells; 3) aquifer pumping test results; 4) hydraulic properties of hydrolithologic units within the Hydrographic Study Area (HSA) compiled from site-specific and regional-scale hydrologic investigations; 5) water-level data for the HSA assembled from published and unpublished sources; and 6) the results of surface water field surveys. The results of previous studies have been combined with site-specific data to develop a conceptual understanding of the hydrogeologic ground water conditions in the study area.

#### 3.2.2.2 Existing Conditions

The following paragraphs describe the existing hydrologic conditions within the study area and the baseline conditions for the EIS water resources analysis. The baseline description consists of a detailed description, including current status and trends, of existing surface water and ground water quantity, and use within the study area. The description also includes a discussion of the hydrogeology and ground water flow patterns as they currently exist.

##### 3.2.2.2.1 Physiographic and Hydrologic Setting

The Project Area is located in the central Great Basin of the Basin and Range physiographic province. The HSA for the EIS water resources analysis encompasses the Project Area and includes four hydrographic basins: Kobeh; Diamond; Pine; and Antelope Valleys (Figure 3.2.1).




Date: 04/21/2010 Filename: \\Interflowshare\projectfiles\MtHopeModelUpdate\VicinityMap_StudyArea.mxd

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 |

FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Hydrologic Study Area (HSA) for the Water Resources Analysis**

**Figure 3.2.1**

Kobeh Valley is the largest of the basins entirely within the HSA, with a drainage area of approximately 860 square miles. The valley is approximately 35 miles across in both an east to west direction and a north to south direction (Figure 3.2.2). The Kobeh Valley alluvial basin is bounded on the north by the Roberts Mountains, on the west by the Simpson Park Mountains, on the east by Whistler Mountain, and on the south by the northern boundaries of the Monitor Range and Monitor and Antelope Valleys. The lowlands of Kobeh Valley range from approximately 6,400 feet amsl on the west side of the valley to approximately 6,000 feet amsl on the east side at Devils Gate, which is an erosional gap where eastward surficial drainage in the valley enters Diamond Valley.

Diamond Valley is the most hydrologically stressed of the four basins in the HSA because much of the ground water in this basin is extensively used for irrigation, domestic, and municipal purposes. The valley has a drainage area of approximately 750 square miles and is bounded on the west by the Sulphur Spring Range and Whistler Mountain, on the north by the Diamond Hills, on the east by the Diamond Mountains, and on the south by the Fish Creek Range (Figure 3.2.3). The lowlands of Diamond Valley range from approximately 6,200 feet amsl at the south end to approximately 5,770 feet amsl at the playa in the north end of the valley. Surficial drainage in Diamond Valley is from the margins of the valley to its long axis and then northward to the playa. There is no surface water outflow from the basin and an extensive playa occupies the northern half of the valley because it is a topographically closed basin. Irrigated agriculture dominates the southern half of Diamond Valley.

Pine Valley is located north of the Project Area. The drainage area of the entire basin is approximately 1,010 square miles, although the portion of Pine Valley that is within the HSA is limited to approximately 730 square miles of the southern portion of the basin because the inclusion of the northern portion of the basin would not provide any additional information for the analysis in this EIS. Pine Valley is bounded on the north and west by the northeast-trending Cortez Mountains, on the south by the Roberts Mountains, and on the southeast by the Sulphur Spring Range (Figure 3.2.4). Lowland elevations in Pine Valley range from approximately 5,800 feet amsl along Henderson Creek in the southern part of the valley to approximately 4,840 feet amsl at the Humboldt River at the north end. The Garden Valley subbasin of Pine Valley is directly north of Mount Hope. Surficial drainage from Garden Valley flows into central Pine Valley and ultimately drains into the Humboldt River approximately 56 miles north of Mount Hope.

Antelope Valley is a V-shaped valley, in plan view, open to Kobeh Valley on the northern end and bounded by the Monitor Range on the west and the Antelope and Fish Creek Ranges to the east (Figure 3.2.5). The drainage area of the valley is approximately 450 square miles. The lowlands of Antelope Valley range in elevation from more than 6,800 feet amsl at the south end of the valley to approximately 6,075 feet amsl in the north. Antelope Valley appears to be a connected tributary to Kobeh Valley.

The Kobeh, Diamond, and Antelope Valley portions of the HSA, together with North and South Monitor Valleys and Stevens Basin (Figure 3.2.1) constitute the Diamond Valley Regional Flow System, as defined by Harrill et al. (1988). The basins comprising this system are internally connected by ephemeral streams and subsurface ground water flow through basin-fill aquifers and possibly through deep carbonate aquifers (Tumbusch and Plume 2006). Diamond Valley is the terminus of the flow system and the water resources of the southern part of this basin have been developed for irrigation, mining, municipal, and domestic uses. The Pine Valley portion of the HSA is part of the Humboldt Regional Flow System, as defined by Harrill et al. (1988).

3.2.2.2.2 General Geologic Setting

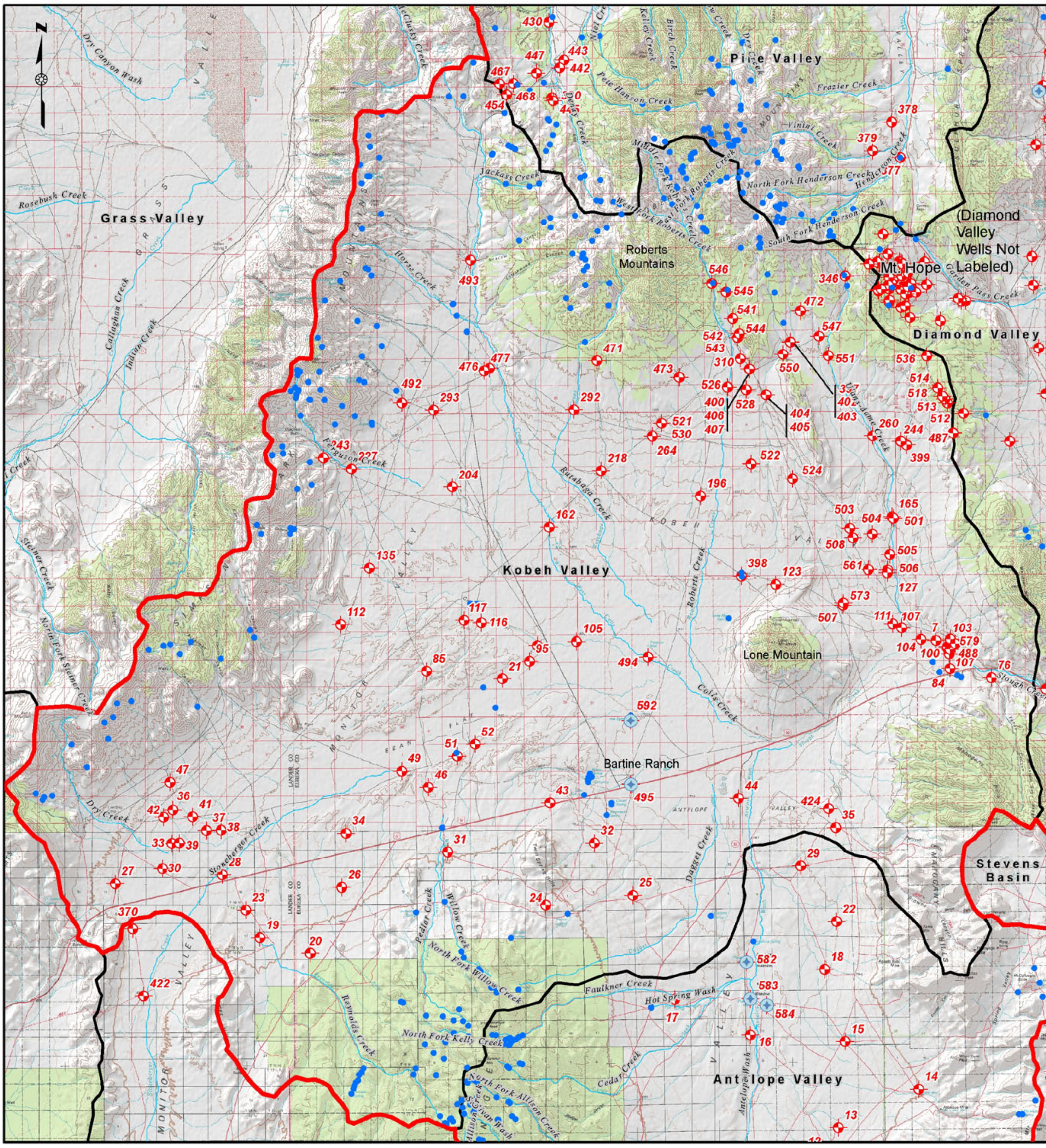
The structural basins within the HSA are typical of those that occur in the Great Basin. The rocks that form the mountain ranges and structural basins forming the valleys are composed primarily of complexly faulted and folded Paleozoic sedimentary rocks, with widespread occurrences of Jurassic, Cretaceous, and Tertiary intrusive rocks and Tertiary volcanic rocks. At various locations in the HSA, the volcanic rocks overlie all of the older hydrogeologic units. The structural depressions in the valleys have been partially filled by Tertiary and Quaternary lacustrine and subareal deposits, which are unconsolidated to semi-consolidated. The general stratigraphic and structural framework throughout the HSA and the Project Area is described in Section 3.4 Geology and Minerals. Figure 3.2.6 shows the distribution of generalized hydrolithologic units within the HSA.

Geomorphic and sedimentary evidence of Pleiocene and Pleistocene lakes have been recognized within portions of the Kobeh, Diamond, Pine, and Antelope Valleys and reflect a cooler, wetter climate. Lake Jonathan occupied the majority of Kobeh Valley and the northern part of Antelope Valley (Figure 3.2.7), while Lakes Pine and Diamond occupied their respective basins, with Lake Diamond extending slightly westward into eastern Kobeh Valley (Reheis 1999). The lithologic units of the valley-fill deposits, below the recent alluvium in the HSA, include claystone, fresh water limestone, and tuffaceous sediments indicative of lacustrine deposition associated with these ancestral lakes.

3.2.2.2.3 Climate

The climate of the HSA is characterized as mid-latitude steppe in the basin lowlands and as subhumid continental in the mountains. The mid-latitude steppe zone is semiarid, with warm to hot summers and cold winters. The subhumid continental zone has cool to mild summers and cold winters, with annual precipitation occurring mostly as snow (Houghton et al. 1975). Most precipitation in the HSA comes from winter storms. Although summer thunderstorms can produce large amounts of precipitation as rain in a short time, their effects are usually localized and do not contribute significantly to total annual precipitation.

Throughout the region, precipitation varies widely between seasons and years, as well as with elevation. The variation in average annual precipitation for weather stations within 60 miles of Mount Hope is summarized in Table 3.2-1. Three stations are within 25 miles of the Project Area: Beowawe – University of Nevada, Reno (UNR) Ranch; Eureka; and U.S. Department of Agriculture (USDA) Diamond Valley stations. Annual 30-year normal precipitation as computed by the National Weather Service (NWS) for the period from 1971 through 2000 is 11.04 inches at the Beowawe UNR Ranch station (elevation 5,740 feet amsl), 12.06 inches at the Eureka station (elevation 6,540 feet amsl), and 9.14 inches at the Diamond Valley USDA station (elevation 5,970 feet amsl). According to the Precipitation Elevation Regressions on Independent Slopes Model (PRISM) developed by the Spatial Climate Analysis Service at Oregon State University, 1971-2000 annual normal precipitation was estimated at approximately 13.6 inches at Mount Hope (SRK 2008a).



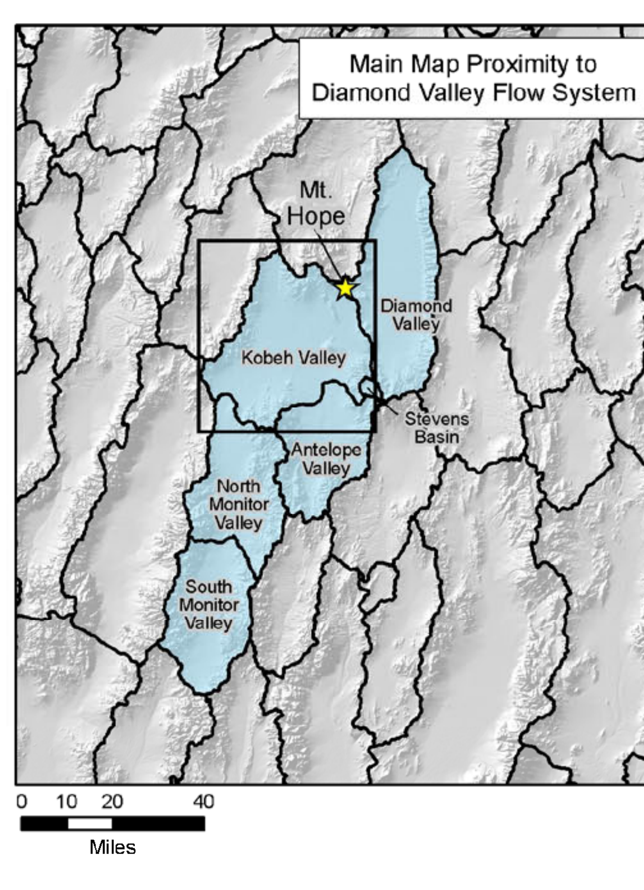

0 1.25 2.5 5

Miles

Source: Montgomery et al. (2010).

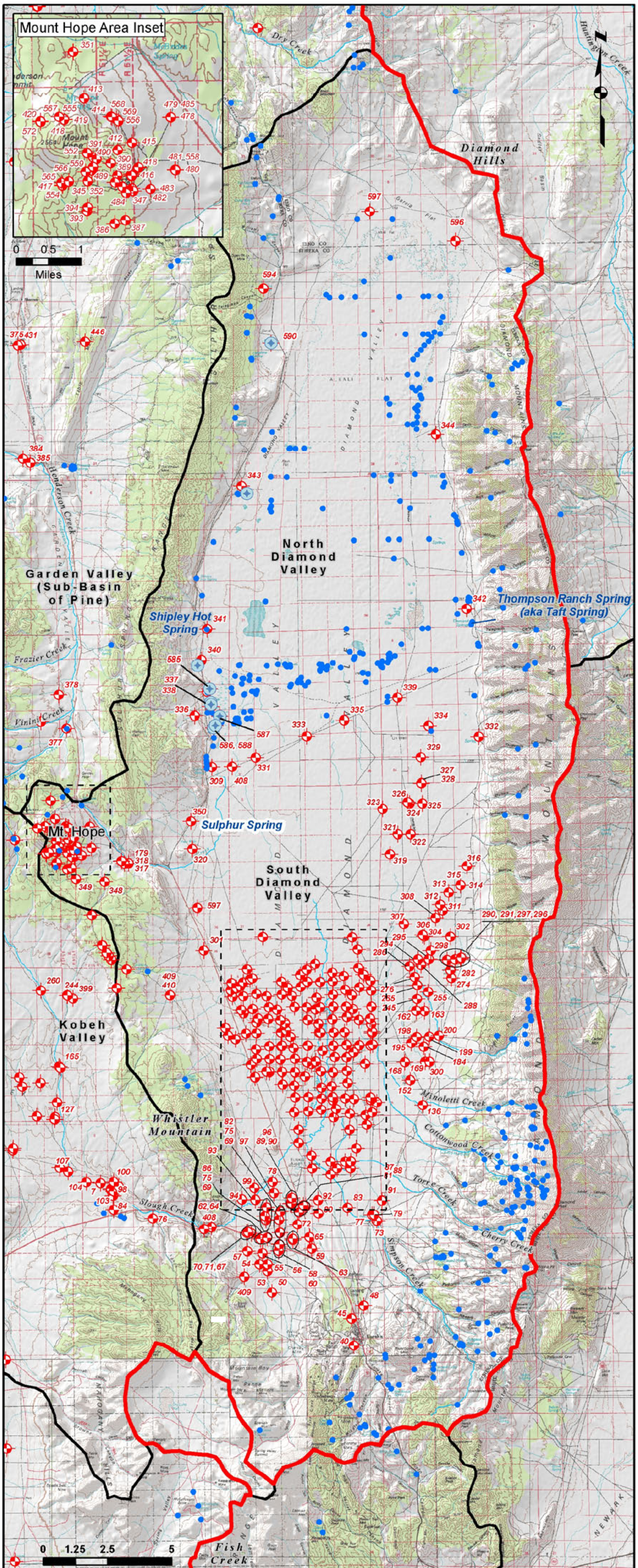
## EXPLANATION

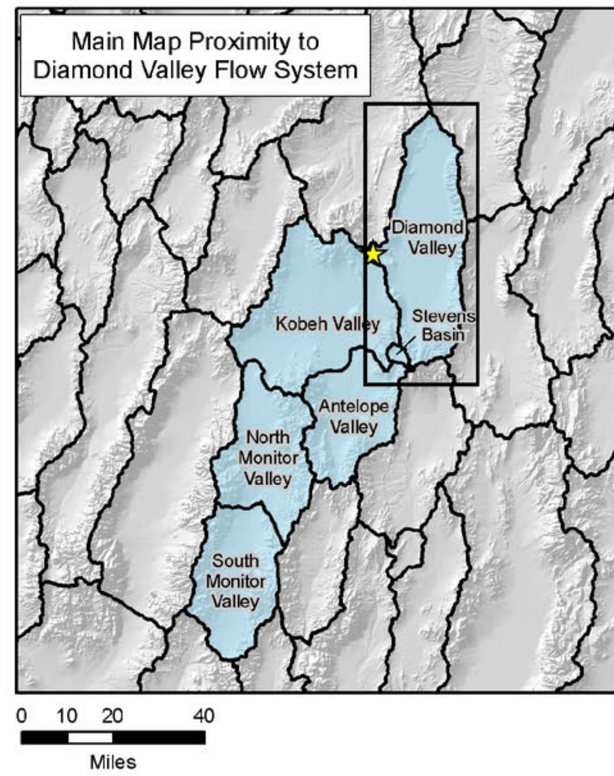
- Springs
- 41 Wells (Number is Database ID, as listed in Montgomery et al. (2010) Appendix G)
- Flowing Wells (Wells reported to have artesian flow at the time they were initially drilled.)
- Mt. Hope
- Streams and Drainages
- Hydrographic Basin Boundary
- Hydrologic Study Area Boundary

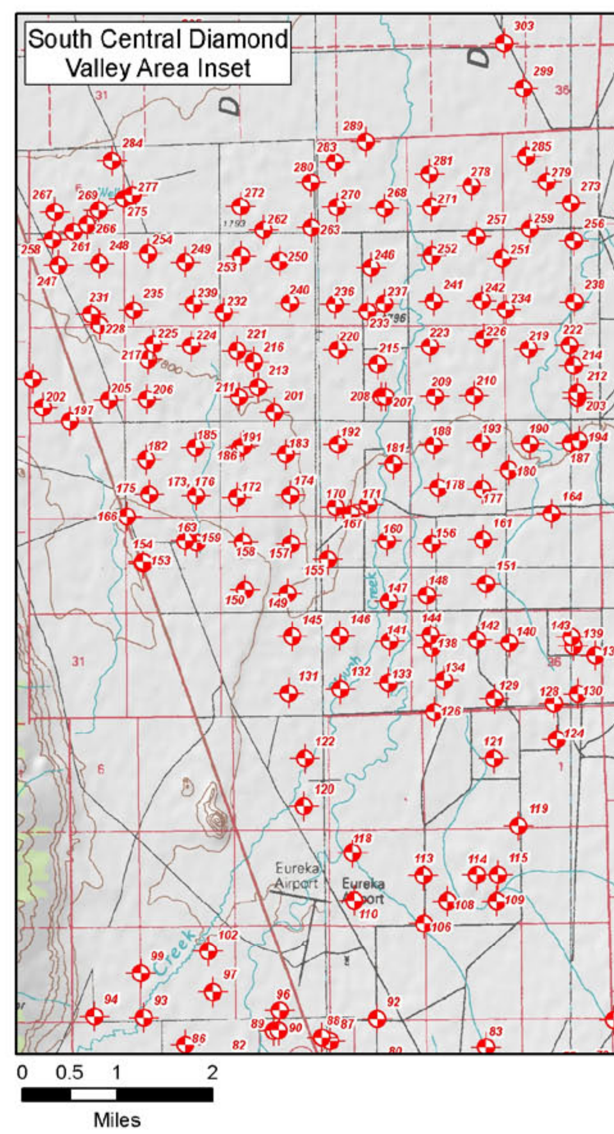



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | BUREAU OF LAND MANAGEMENT<br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>Basin Detail of Kobeh Valley<br>Figure 3.2.2 |
|---|---|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | | |
| CHECKED: - | APPROVED: - | DATE: 08/29/2011 | | |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | | | |




## EXPLANATION

- Springs
- Wells (Number is Database ID, as listed in Montgomery et al. (2010) Appendix G)
- Flowing Wells (Wells reported to have artesian flow at the time they were initially drilled.)
- Mt. Hope
- Streams and Drainages
- Hydrographic Basin Boundary
- Hydrologic Study Area Boundary

Source: Montgomery et al. (2010).

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 08/29/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

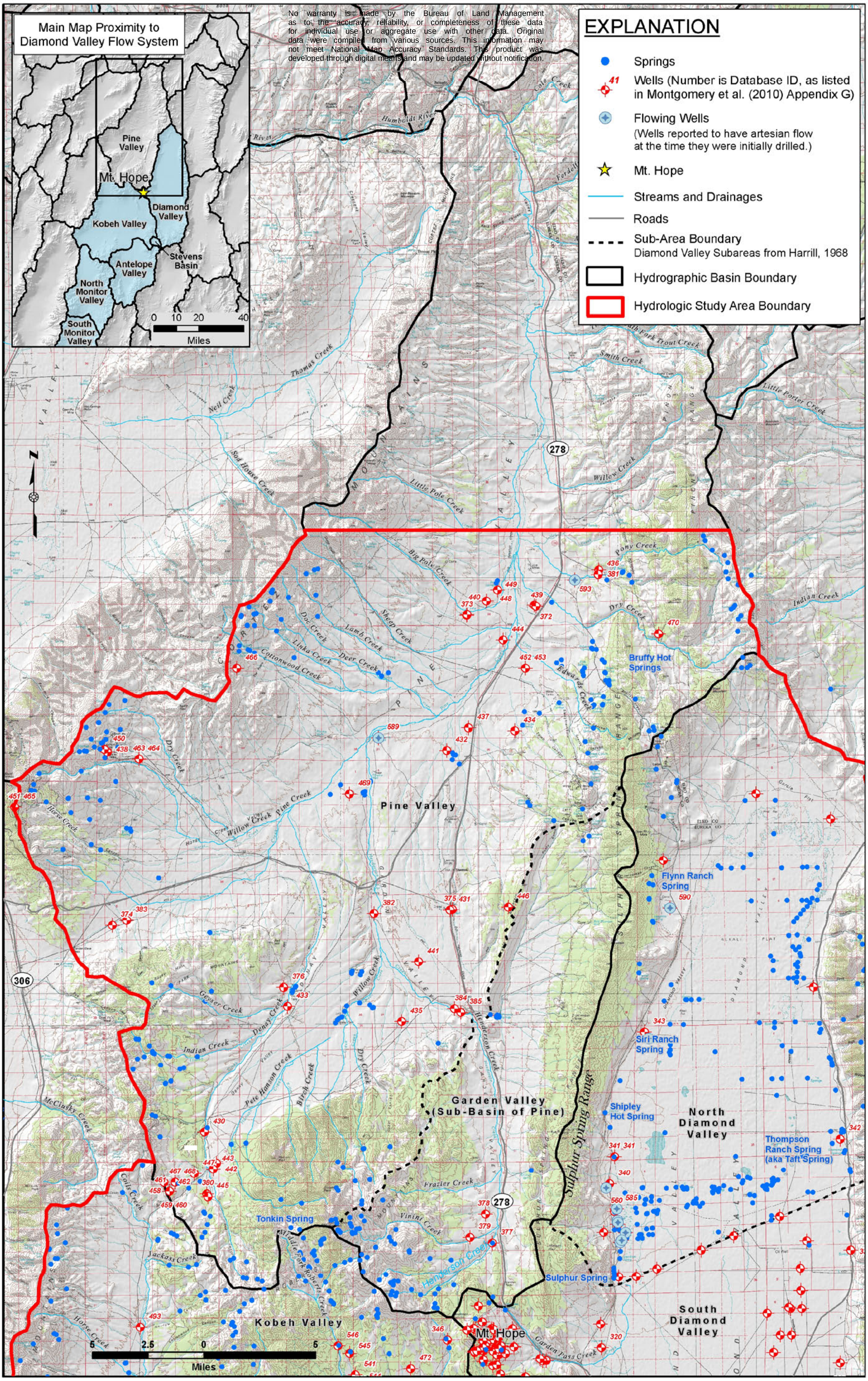
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

**Basin Detail of Diamond Valley**

**Figure 3.2.3**




Source: Montgomery et al. (2010)

NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 08/29/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

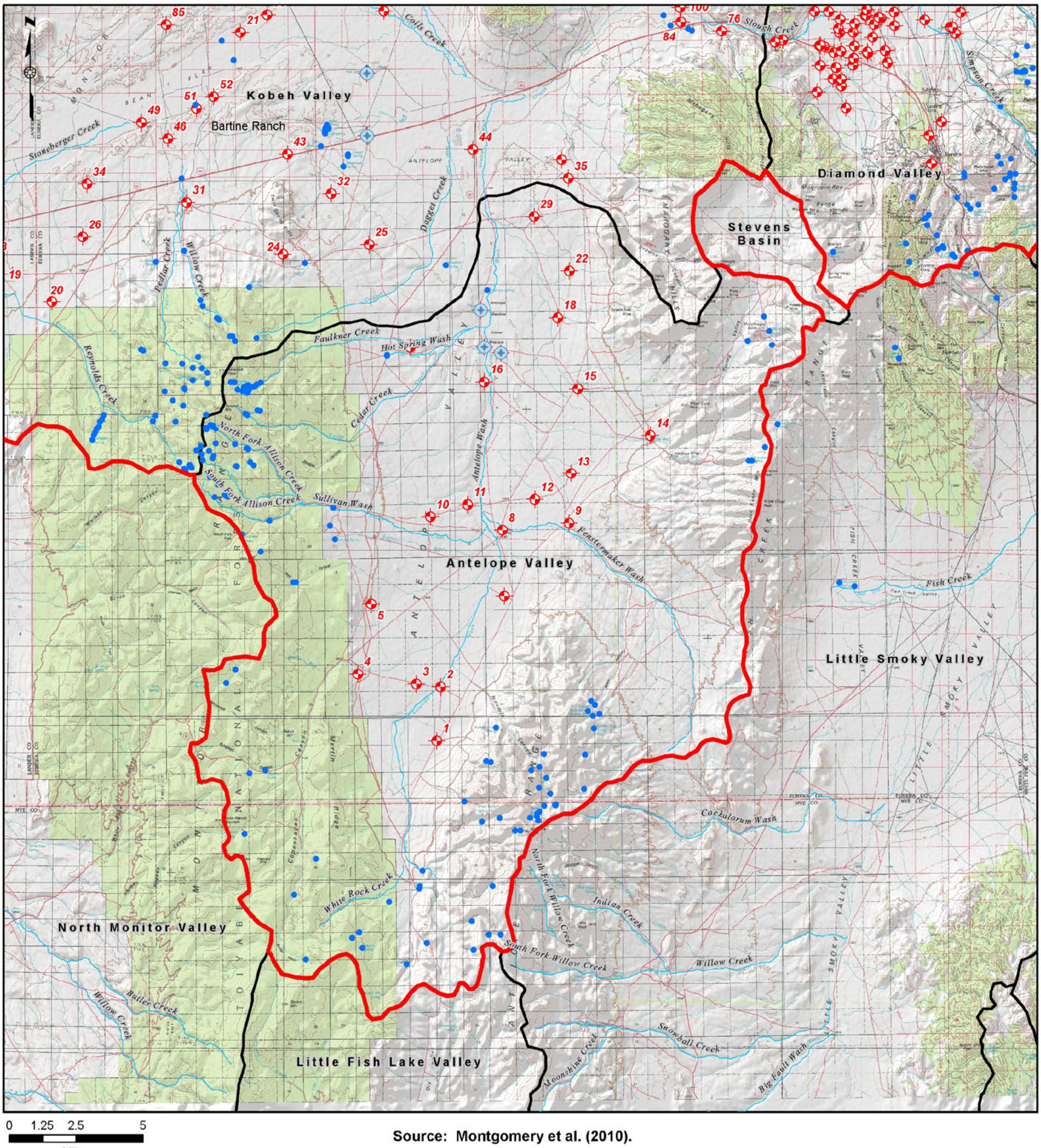
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Basin Detail of the Southern Part of Pine Valley**

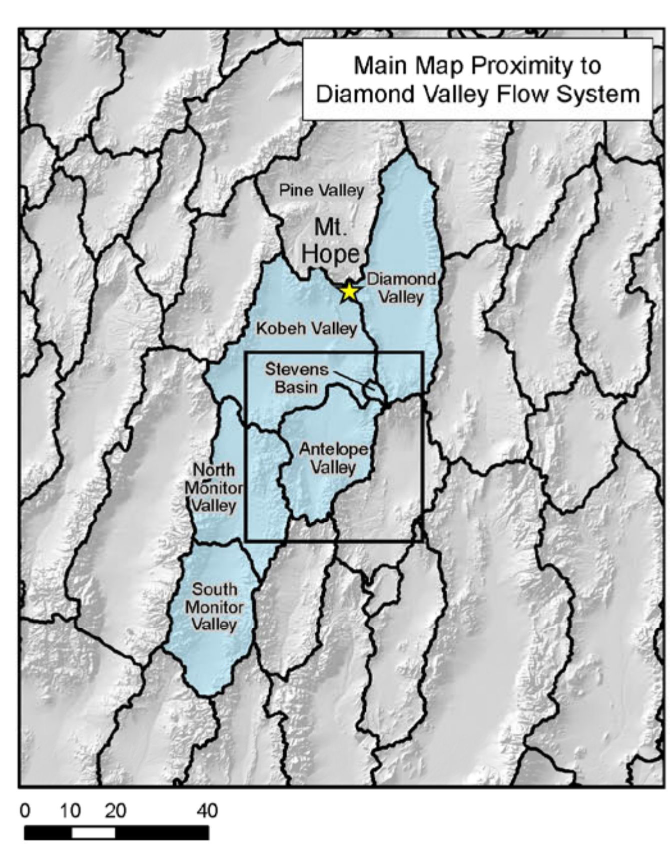
**Figure 3.2.4**




**Source: Montgomery et al. (2010).**

# EXPLANATION

- Springs
- Wells (Number is Database ID, as listed in Montgomery et al. (2010) Appendix G)
- Flowing Wells
  (Wells reported to have artesian flow at the time they were initially drilled.)
- Mt. Hope
- Streams and Drainages
- Hydrographic Basin Boundary
- Hydrologic Study Area Boundary




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 08/29/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

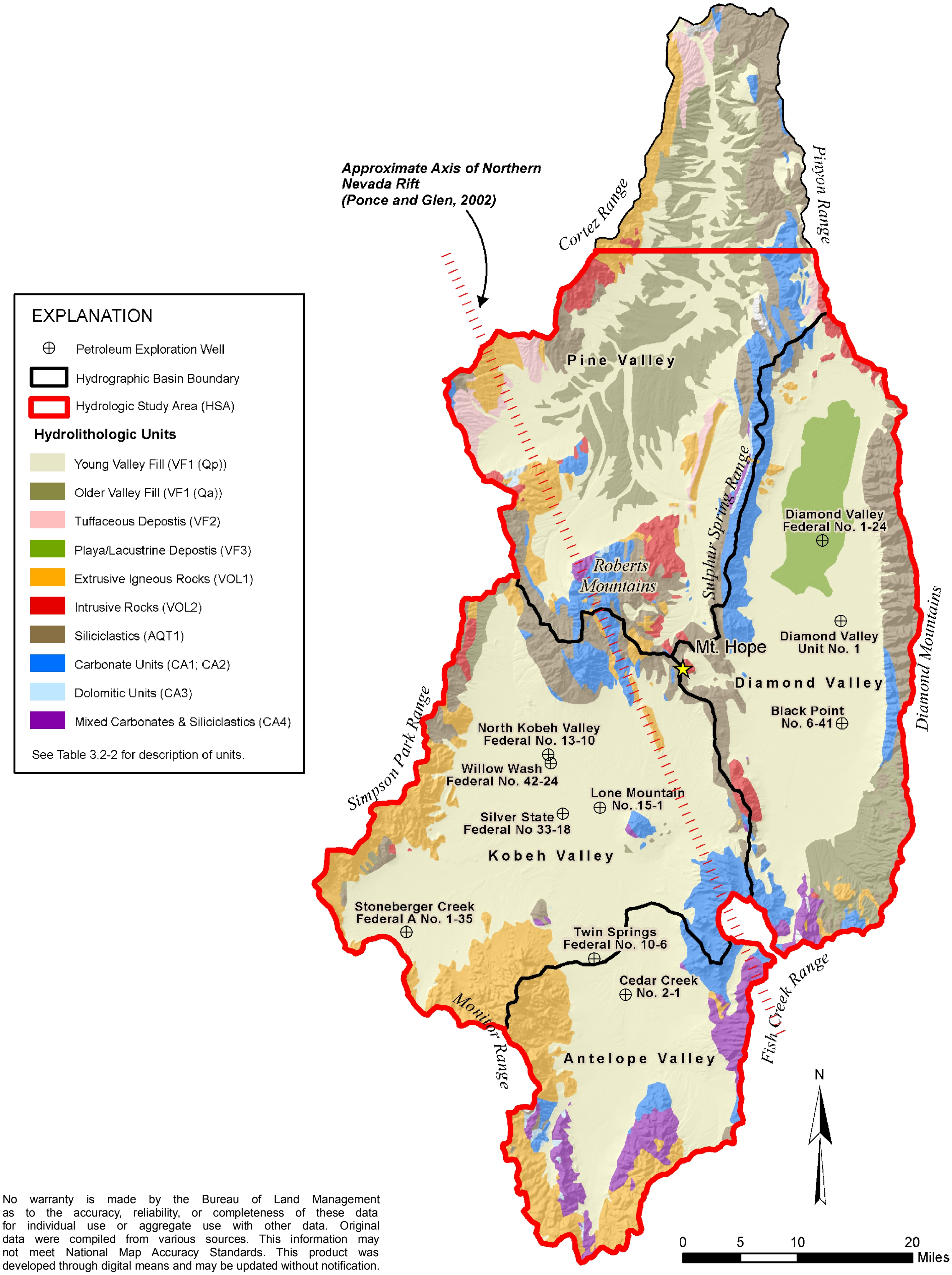
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Basin Detail of Antelope Valley**

**Figure 3.2.5**




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| | | |
|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | |

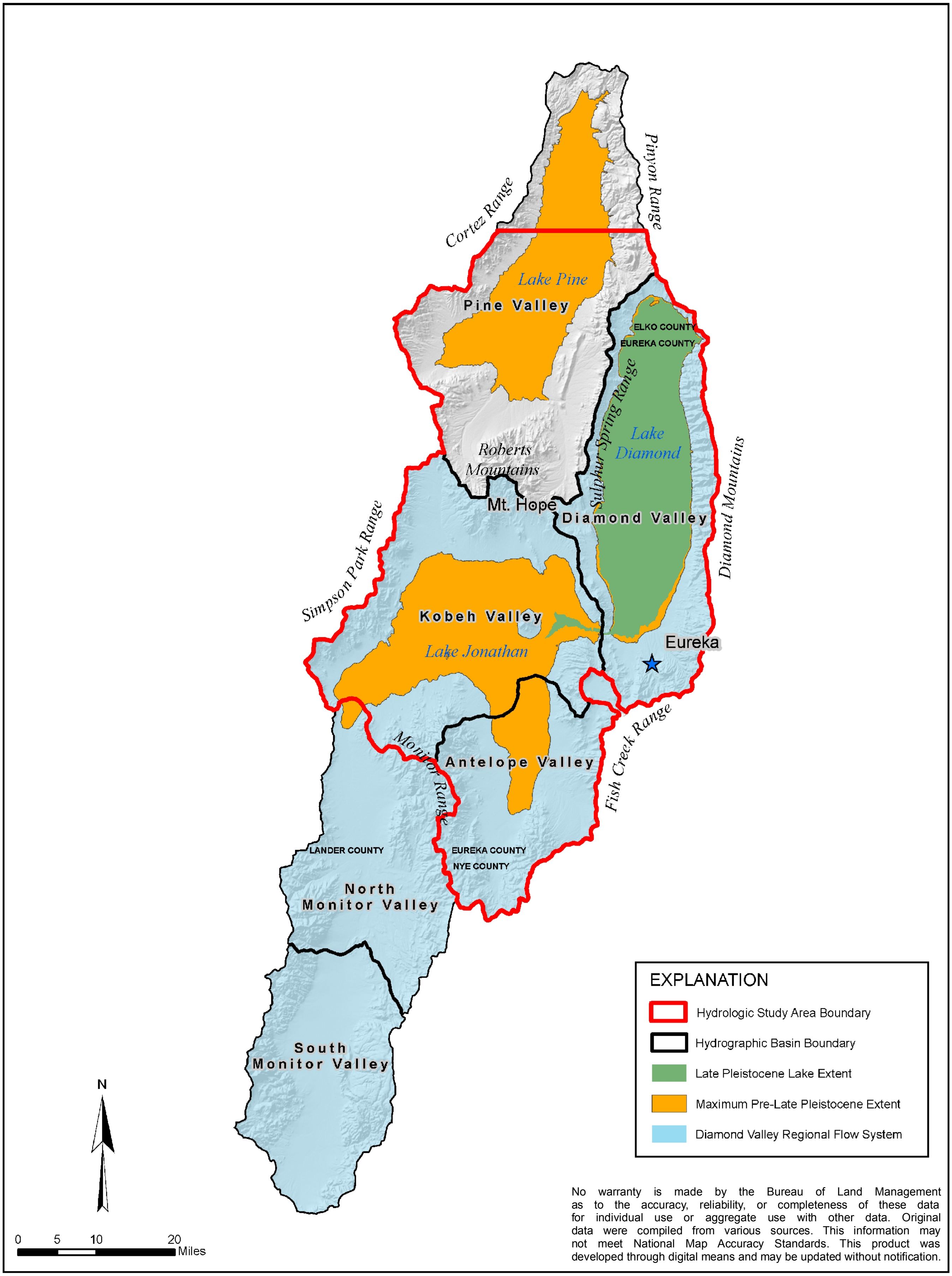
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Generalized Hydrogeologic Map of the HSA**

**Figure 3.2.6**




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| | | |
|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
| CHECKED: - | APPROVED: RFD | DATE: 06/23/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Extent of Pleistocene Lakes within the Hydrographic Basins that are Part of the HSA**

**Figure 3.2.7**

**Table 3.2-1: Mean Annual Precipitation at Weather Stations within 60 Miles of the Project Area**

| Station Name | Approximate Distance and Direction From Project Center | Approximate Elevation (feet amsl) | WRCC Period of Record Mean Annual Precipitation[1] (inches) | NWS 30-Year Normal Annual Precipitation[2] (inches) |
|---|---|---|---|---|
| Austin | 51 miles southwest | 6,600 | 13.02 | 14.33 |
| Beowawe | 58 miles northwest | 4,700 | 8.69 | 8.84 |
| Beowawe UNR Ranch | 23 miles west | 5,740 | 10.63 | 11.04 |
| Diamond Valley USDA | 10 miles southeast | 5,970 | 9.14 | 9.14 |
| Eureka | 21 miles southeast | 6,540 | 12.02 | 12.06 |
| Fish Creek Ranch | 37 miles southeast | 6,050 | 4.82 | - |
| Jiggs | 54 miles northeast | 5,420 | 11.09 | - |
| Jiggs Zaga | 50 miles northeast | 5,800 | 14.28 | 13.35 |
| Pine Valley Bailey | 45 miles north | 5,050 | 10.57 | 10.24 |
| Ruby Lake | 46 miles northeast | 6,010 | 12.93 | 13.66 |
| Snowball Ranch | 51 miles south | 7,160 | 9.02 | 8.81 |

[1] Western Regional Climate Center (WRCC). Source: Jeton et al. (2006)
[2] NWS 30-year normals for 1971 to 2000. Source: Jeton et al. (2006)

The BLM operated three flow-recording stations and 20 bulk precipitation-collection stations in the Coils Creek watershed, a 50-square mile area in the northwestern part of Kobeh Valley, during the time period 1963 to 1980 (Houng-Ming et al. 1983). Those data showed an average annual precipitation of 11.4 inches for the period of record, but they did not demonstrate a clear altitude- precipitation trend, which is uncommon in the Great Basin, where orographic lift effects usually produce a well-defined elevation-to-precipitation relationship. The precipitation data from the Coils Creek watershed may indicate unusual storm tracks, a lack of orographic lift effect, or potentially a data problem that cannot be resolved with existing information. (Montgomery et al. 2010).

Evaporation rates vary with a number of factors, of which temperature, wind speed, relative humidity, and solar radiation are primary. Two weather stations that measure pan evaporation are located near Mount Hope (SRK 2008a). During the period from 1948 through 2002, measured pan evaporation averaged approximately 51.5 inches per year at the Ruby Lake station, located at an altitude of 6,010 feet amsl approximately 46 miles to the northeast of the site. At the Beowawe UNR Ranch station, located at an altitude of 5,740 feet amsl approximately 23 miles west of the site, the measured pan evaporation averaged approximately 51.2 inches per year during the period from 1972 through 2002. Due to freezing conditions, pan evaporation is not measured in the winter months, November through March, at either station. With a typical pan coefficient of 0.7 applied to these measurements, the mean annual evaporation from an open-water surface would be approximately 36 inches. However, this calculation probably underestimates the actual annual open-water evaporation rate because some evaporation does occur during the winter months and is unaccounted for in the available data sets. Average annual ET, which includes the effects of vegetation, the ground surface, and other factors, may differ substantially from this estimate, as discussed in Section 3.2.2.6.5.

Most of the annual runoff within and through the HSA is derived from snowmelt. A large percentage of the annual precipitation falls as snow and is stored as snow pack in the higher elevations during the winter months. In the spring months, typically April through June, water from snowmelt produces runoff, which often results in the highest annual flows in many of the high mountain drainages. Occasionally, spring season rainfall coincides with the snowmelt runoff, resulting in extremely high runoff flows. The hot, dry weather in mid- to late-summer, with little or no rain and high evaporation rates generally produces the lowest annual flows.

### 3.2.2.3 Surface Water Resources

As is typical in the Great Basin, the HSA is dominated by mountain block watersheds that drain onto broad alluvial fans and valley bottoms. Perennial, intermittent, and ephemeral stream reaches occur in the bedrock-controlled mountain drainages, and flows typically dissipate into the fans along the valley margins or drain toward playas near the basin centers. Playas have formed in the topographically low areas of Kobeh and Diamond Valleys. The playa in Kobeh Valley is situated just west of Devil's Gate and has a relatively small surface area (note: at the scale of the maps in this section of the EIS, this small area is not shown). The Diamond Valley playa covers a large portion of the northern end of the basin. These playas are where ground water is naturally discharged.

The locations of streams and creeks and inventoried spring and seep sites are shown on the maps of the individual basins comprising the HSA (Figures 3.2.2 through 3.2.5). Available information on the streams and creeks within each basin of the HSA is summarized in the following paragraphs, followed by a discussion of the main springs and seeps within the HSA. Available measured flows for some of the major drainages in the HSA from the USGS database are outlined in Table 3.2-2 (Enviroscientists 2011a).

**Table 3.2-2: Measured Flows in Some Major Drainages Located in the Hydrologic Study Area**

| Stream Name | Valley | Period of Measure | Measurements | Average Flow (gpm) |
|---|---|---|---|---|
| Coils Creek | Kobeh Valley | 2/2/11 – 7/6/11 | 4 | 4,375 |
| Henderson Creek | Pine Valley | 7/27/10 – 6/27/11 | 7 | 2,904 |
| Tonkin Springs | Pine Valley | 7/26/10 – 6/29/11 | 16 | 673 |
| Pete Hanson Creek | Pine Valley | 10/18/85 – 6/29/11 | 17 | 1,131 |

#### 3.2.2.3.1 Streams and Creeks

Precipitation and geologic conditions in the HSA are such that perennial stream flow only occurs in a few isolated stream reaches. In general, perennial segments have their source in the mountains and, although they do respond to snow melt and rainfall events, much of their flow is provided by ground water discharge that occurs as spring and seep flow. Stream flows in the HSA primarily occur as intermittent flows from isolated springs, short-term seasonal runoff from snowmelt or winter storms, or as ephemeral flow from intense but infrequent thunderstorms. Ephemeral channels primarily carry runoff from rainfall. Rapid snowmelt may cause runoff in ephemeral channels; however, this occurs only infrequently.

Numerous drainages leave the mountain fronts and cross over alluvial fans where flows from those drainages typically dissipate on the fans. When water does reach the valley floor during larger runoff events, the water is soon taken up by ET and seepage into valley-floor sediments. Clearly defined stream channels tend to be confined to the margins of the basins where slopes are steepest and runoff is greatest during precipitation events. Channels become poorly defined as they near the flatter portion of the basins and runoff infiltrates into permeable alluvial fan material.

Kobeh Valley

In Kobeh Valley, surface drainage is directed generally from the mountains to the central valley floor and then eastward toward Devil's Gate, where flow occasionally passes into Diamond Valley via Slough Creek. Surface water occasionally flows into the southern part of Kobeh Valley via the main ephemeral drainages in Antelope Valley (Antelope Wash) and the northern part of Monitor Valley (Stoneberger Creek). The Stoneberger Creek drainage enters the southwestern side of Kobeh Valley from Monitor Valley and crosses southern Kobeh Valley in a west to east direction through Bean Flat (Figure 3.2.2). Antelope Wash enters Kobeh Valley from the south at a point where several ephemeral drainages join on the southeastern side of Kobeh Valley to form Slough Creek. Slough Creek, also ephemeral, drains east through Devil's Gate into southern Diamond Valley. Channel geomorphology and a lack of vegetation scour indicate that outflow through Devil's Gate is a rare occurrence related to low frequency, high runoff events. Reported flows in Slough Creek in May of 1964, during a peak period of seasonal flow, ranged from approximately 670 to 1,120 gpm (1.5 to 2.5 cubic feet per second [cfs]) (Robinson et al. 1967).

The two main internal drainages within Kobeh Valley are Coils Creek in the western part of the valley, which drains the east side of the Simpson Park Mountains and the western side of the Roberts Mountains, and Roberts Creek, which drains the central and southeastern part of the Roberts Mountains (Figure 3.2.2). Rutabaga Creek lies between these two drainages and drains the southern part of the Roberts Mountains.

Roberts Creek is identified as being perennial from the headwaters of its middle and east fork tributaries to near the mountain front (BLM 1997). A segment of the Cottonwood Canyon drainage, on the southwest side of the Roberts Mountains, is also identified as containing perennial flow upstream of its confluence with the Coils Creek drainage. The only other identified perennial stream reaches in Kobeh Valley are Snow Water Canyon and Ferguson Creek on the east side of the Simpson Park Mountains, as well as Ackerman Creek, Basin Creek, Coils Creek, Dry Canyon, Dry Creek, Kelly Creek, Jackass Creek, and Meadow Canyon. A small segment of U'ans-in-dame Creek to the east-northeast of Lone Mountain is also classified by the BLM (1997) as perennial. However, based on 2010 field observations and a review of Landsat images and the USDA's National Agricultural Imaging Program (NAIP) aerial photography, it is now believed that this stream segment is not perennial (Montgomery et al. 2010).

Stream discharge measurements were taken by Interflow along the course of Roberts Creek in 2007. Measurements made during August 2007 on the tributaries of Roberts Creek indicated that most of the flow originated from the east fork, at 108 gpm (0.24 cfs), which received its flow from springs along the west and south to southeast flanks of the Roberts Mountains. The west and middle forks of Roberts Creek contributed little flow at that time, with the west fork being dry, and the middle fork discharge estimated at 4.5 gpm (0.01 cfs) (Montgomery et al. 2010). Measured discharge below the confluence of the three forks of Roberts Creek consistently decreased with distance downstream, indicating that Roberts Creek is a losing stream over most of its length. These stream losses are assumed to result in recharge to the local alluvial and carbonate aquifer systems. Flow loss due to evaporation and transpiration from riparian vegetation adjacent to the stream bed may also be a contributing factor to the consistent downstream decrease in flow.

Coils Creek is interpreted by Rush and Everett (1964) to be the principal tributary to Slough Creek. They reported a flow of approximately 3,600 gpm (eight cfs) in May 1964 at a location in Section 27, T22N, R49E (near the locations of wells #476 and #477, shown on Figure 3.2.2). Intermittent reaches of upper Coils Creek are mainly fed by spring flow and are used for irrigation purposes. More recent estimates of intermittent flows in Coils Creek have not been found.

In August 2007, Interflow measured a flow of nine gpm (0.02 cfs) in Rutabaga Creek on the southern flanks of the Roberts Mountains (Montgomery et al. 2010). Along the east slope of the Simpson Park Mountains, on the west side of Kobeh Valley, Interflow observed the following: no surface flow in Snow Water Canyon during both June and December 2007 and also in April 2008; no flow in Ackerman Canyon in April and a flow of 27 gpm (0.06 cfs) in May of 2008; an estimated flow of less than 112 gpm (0.25 cfs) in Ferguson Creek in May and no flow in August 2007; and no flow in Dry Canyon in June 2007. At the stream gage on Roberts Creek, Interflow measured flows of 561 and 1,872 gpm (1.25 and 4.17 cfs) in April and May 2008, respectively.

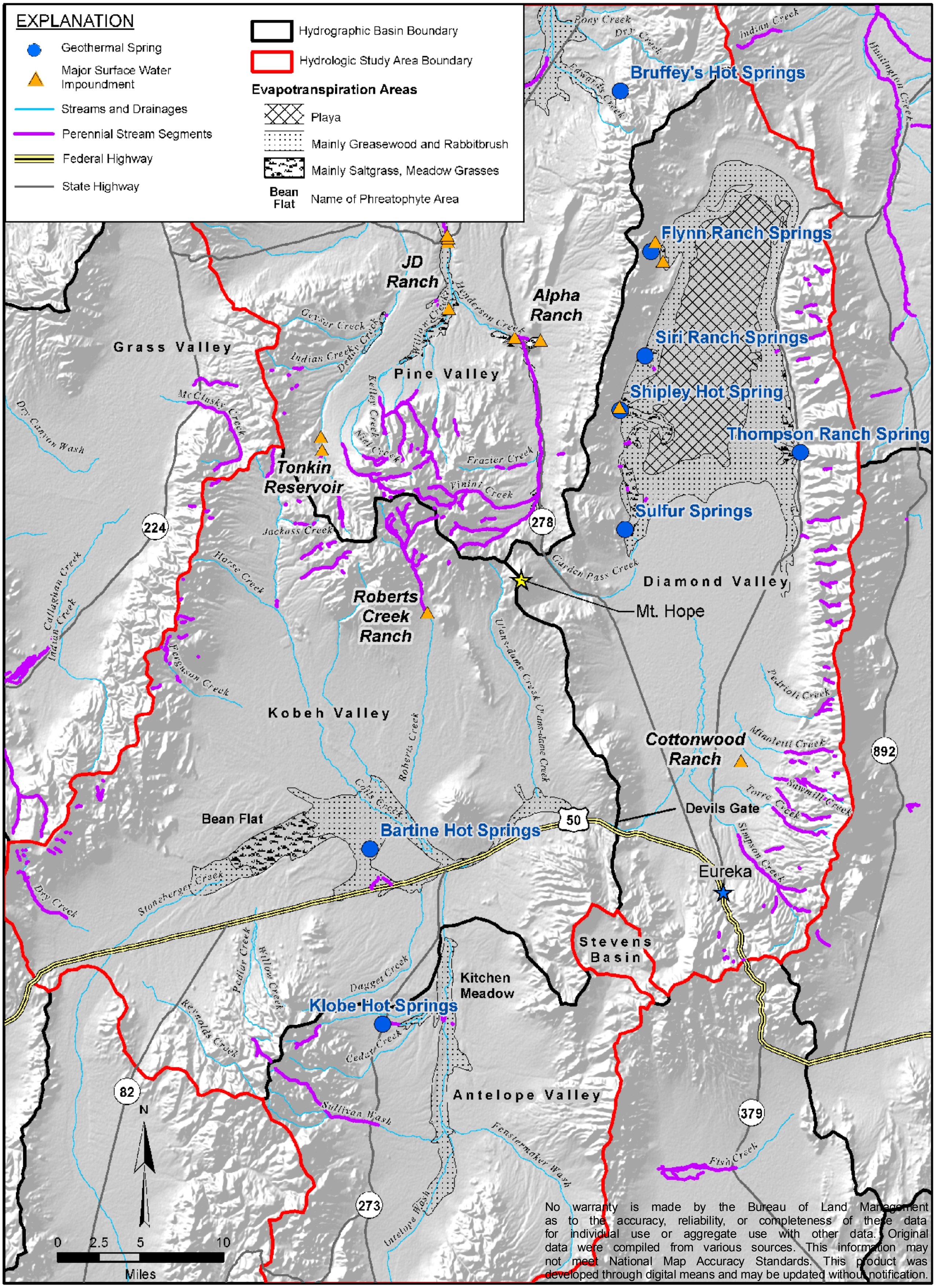
Reported flows in Willow Creek and Dagget Creek, which drain the north end of the Monitor Range in southern Kobeh Valley, were approximately 450 and 670 gpm (one and 1.5 cfs), respectively, in May 1964 (Robinson et al. 1967). No other drainages within the Kobeh Valley basin have recorded stream flows.

Antelope Valley

A limited number of perennial stream segments have been identified in Antelope Valley (Figure 3.2.8). In April and May 1964, flows of approximately 450 and 900 gpm (one and two cfs) were observed in Alison Creek and Copenhagen Canyon, respectively, along the east slope of the Monitor Range on the west side of Antelope Valley; also, a flow of approximately 670 gpm (1.5 cfs) was measured in Ninemile Creek on the eastern side of Antelope Valley in May of 1964 (Robinson et al. 1967). Interflow estimated a flow of less than 112 gpm (0.25 cfs) in Alison Creek in June of 2007 (Montgomery et al. 2010).

Pine Valley

The main streams in Pine Valley are in the Horse Creek, Denay Creek, Henderson Creek, and Pine Creek drainages. Pine Creek is the principal stream in the valley and is a tributary to the Humboldt River. Eakin (1961) reported that the flow in Pine Creek is maintained primarily by the discharge from hot springs in the northwest quarter of Section 12, T28N, R52E, which are located near the northern boundary of the HSA.




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 08/29/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Geothermal Resources, Perennial Stream Segments, and Major Surface-Water Impoundments within the HSA**

**Figure 3.2.8**

In the Pine Valley portion of the HSA, numerous headwater tributaries to Pine Creek form on the east and southeast-facing slopes of the Cortez Mountains (Horse Creek drainage) and the northern part of the Simpson Park Mountains (Denay Creek drainage), on the north to northwest flanks of the Roberts Mountains (Pete Hanson Creek, Neil Creek, Kelly Creek, Birch Creek, Willow Creek, and Dry Creek), and on the northeast side of the Roberts Mountains in the Garden Valley subbasin (Henderson Creek, Vinini Creek, and Frazier Creek). Perennial stream-flow segments have only been identified on portions of Denay Creek, Pete Hanson Creek, Willow Creek, Vinini Creek, and Henderson Creek (BLM 1997).

Isolated reaches in the Horse Creek drainage of Pine Valley were reported to have flows ranging from nine to 58 gpm (0.02 to 0.13 cfs) during August 2005 before surface flows were lost to infiltration or ET (BLM 2008b). The Denay Creek drainage arises from headwater springs in Red Canyon on the north slope of the Roberts Mountains, and is fed lower down in the drainage by perennial discharge from Tonkin Spring (discussed in Section 3.2.1.2.2). Denay Creek discharges into Tonkin Springs Reservoir, a small surface-water impoundment, approximately one mile downstream of Tonkin Spring. Between August 2007 and September 2009, Interflow measured the discharge from Tonkin Spring during all months of the year, and the range of observed flows was from 525 to 1,086 gpm (1.17 to 2.42 cfs) (Montgomery et al. 2010). This provides an estimate of the flows in Denay Creek just downstream of Tonkin Spring. Further east, along the north side of the Roberts Mountains, Interflow reported no flow in Pete Hanson Creek during August 2007 and a flow of 1,023 gpm (2.28 cfs) in June of 2009. Also, Willow Creek was observed to have flows of 31 and nine gpm (0.07 and 0.02 cfs) in August and October 2007, respectively.

As part of the baseline characterization investigations in 2006, SRK (2008a) established three surface water monitoring stations on Henderson Creek, allowing two distinct reaches of the creek to be studied. The upper monitoring station is approximately one-half mile southeast and downgradient of Spring 585 (discussed in Section 3.2.2.3.2) at an elevation of approximately 7,177 feet amsl. SRK reported that the creek flow is perennial at the upper monitoring station, with the flow sustained by discharge from local springs and seeps. The middle monitoring station is approximately two miles downgradient of the upper station and is located approximately 50 feet below the confluence of the north and south forks of Henderson Creek at an elevation of approximately 6,688 feet amsl. The creek flow at this location is also thought to be perennial and fed by springs and seeps in the upper part of the watershed. The stream channel morphology at the middle monitoring station is described as being substantially incised, with arroyo-like features. The lower monitoring station is approximately 2.5 miles downgradient of the middle station and is located roughly 60 feet west of SR 278 at an elevation of approximately 6,446 feet amsl. SRK characterized the lower reach as being perennial, but noted that the actual flowing locations of the creek near the lower monitoring station vary on a seasonal basis, such that the established sampling-point location was observed to be dry in the third and fourth quarters of 2006 and the first quarter of 2007.

During the field investigation site visits in 2006 and 2007, SRK (2008a) recorded maximum flow rates of approximately 400, 3,180, and 2,600 gpm (0.9, 7.1, and 5.8 cfs) at the upper, middle, and lower monitoring stations, respectively, on Henderson Creek in May 2006. Subsequent monitoring events recorded smaller flow rates, ranging from 45 to 112 gpm (0.1 to 0.25 cfs), at the upper and middle monitoring stations and no flow at the lower station. The measured stream-flow data indicate that the reach of Henderson Creek between the upper and middle stations generally gains flow, whereas the reach between the middle and lower stations generally loses flow.

Stream flow measurements were also made by Interflow on Henderson and Vinini Creeks, north of Mount Hope in the Garden Valley subbasin of Pine Valley (Montgomery et al. 2010). During August and October 2007, Vinini Creek was observed to be dry, whereas in May 2008 and June 2009 flows of 3,110 and 950 gpm (6.93 and 2.12 cfs), respectively, were recorded. Henderson Creek was measured in August 2007 at the confluence of its north and south fork tributaries. No stream flow was observed from the north fork at that time, whereas discharge from the south fork was reported to be 27 gpm (0.06 cfs). Other flow measurements in Henderson Creek are 36 gpm (0.08 cfs) in December 2007 and 135 gpm (0.3 cfs) in May of 2008. According to Interflow, Henderson Creek contained observable flow in a reach approximately 2.3 miles long before losing all of its surface flow to infiltration and ET (Montgomery et al. 2010). As shown on Figure 3.2.8, Henderson Creek is also perennial in its lower reaches near the Alpha Ranch.

Diamond Valley

Lamke, in Harrill (1968), described the existence of only a few perennial streams in Diamond Valley, all of which are located on the east side of the valley on the western slopes of the Diamond Mountains. Cottonwood and Simpson Creeks were mentioned as the two most prominent perennial streams, and the only ones that supported ranching operations in the 1960s. Figure 3.2.8 shows the location of the perennial stream segment in Diamond Valley. The only intermittent streams in Diamond Valley with a significant volume of seasonal runoff are also located in the Diamond Mountains. The rest of the streams in Diamond Valley are intermittent or ephemeral and were reported to have only minor flows.

Between May of 1965 and October of 1966, reported stream flows in 11 drainages along the western side of the Diamond Mountains ranged from zero flow to a maximum of 785 gpm (1.75 cfs) in Cottonwood Creek on one occasion; all other observed flows during that time period were less than 287 gpm (0.64 cfs) (Harrill 1968). No flow was observed during March and June of 1966 in Garden Pass Creek, an ephemeral creek on the western side of Diamond Valley that originates at the topographic divide between Pine and Diamond Valleys, and an unnamed drainage on the eastern slopes of the Sulphur Spring Range in the northern part of Diamond Valley was also reported to be dry in April and October of 1966 (Harrill 1968). Peak flow measurements made by the USGS in Garden Pass Creek between 1965 and 1981 ranged from 224 to more than 290,000 gpm (0.5 to 650 cfs) (Hydro-Search 1982).

Mount Hope Project Area

There are no perennial stream segments within the Project Area boundary, and the majority of the ephemeral streams near Mount Hope drain east and south into Diamond Valley. The closest perennial stream segment to Mount Hope is approximately three miles to the north, in the upper reaches of Henderson Creek, as described above in the discussion of Pine Valley.

Surficial drainage from Mount Hope occurs via ephemeral streams that radiate away from the mountain. Some of the ephemeral streams near Mount Hope drain to the west and south into Kobeh Valley. A minor, unnamed tributary to Henderson Creek drains a small area on the northwest flank of Mount Hope and is the only surface drainage from the Project Area into Pine

Valley. The northern and eastern sides of Mount Hope drain into Garden Pass Creek. Tyrone Creek drains the south side of the mountain and joins Garden Pass Creek southeast of the mountain, just upstream of where Garden Pass Creek cuts through the Sulphur Spring Range and enters Diamond Valley. A short distance east of this erosional gap, the creek disappears into the alluvium of Diamond Valley. Two ephemeral streams drain the western side of Mount Hope. These streams join to become a relatively well-defined channel (U'ans-in-dame Creek), which persists for approximately two miles before the stream channel becomes difficult to discern in the surficial alluvium of eastern Kobeh Valley.

The Zinc Adit, located approximately 0.25 mile east of the current core-shed building, is one of several adits associated with the historical workings of the Mount Hope Mine. Drainage from the Zinc Adit is the only known mine drainage from historical workings within the Project Area. Measurements of flow from the Zinc Adit were made quarterly from October of 2005 through the first quarter of 2007 and were fairly constant throughout the year, ranging from 7.6 to 9.4 gpm (0.017 to 0.021 cfs) (SRK 2008a).

3.2.2.3.2 Springs and Seeps

Springs and seeps are numerous within the HSA, and an inventory has been compiled from various sources, including the USGS National Hydrography Dataset, the Great Basin Center for Geothermal Research (GBCGR) database, field exploration by mine consultants (SRK and Interflow), and spring locations digitized from 1:24,000-scale USGS topographic maps. Interflow has compiled all of the available spring and seep data into a single inventory (spreadsheet file), which lists 1,102 individual sites within the HSA (Montgomery et al. 2010, Appendix E). The locations of inventoried springs and seeps are shown on the maps of the individual basins comprising the HSA (Figures 3.2.2 through 3.2.5) and a large-format composite map showing the location and inventory identifier for each spring and seep is presented in Montgomery et al. (2010, Appendix E).

Many of the springs in the HSA occur along the contacts between rocks of differing hydraulic properties. This condition can result from a variation in lithology or permeability, or be a result of faulting that juxtaposes differing rock units. Many of the springs in the HSA are seasonal in nature, with flow occurring during brief periods of time when ground water levels are temporarily elevated in response to recharge. To varying degrees, the flow of springs in the HSA is regulated by long-term climatic conditions and, in some cases, also by anthropogenic water use. Springs occur primarily in the mountains and along the mountain fronts, although some seeps occur on the valley floors where the depths to ground water are shallow.

Within the Diamond Valley basin, flows from some of the springs and seeps in the southern part of the valley and along the mountain fronts have declined since the mid-1960s, coincident with the observed changes in water levels in the basin-fill aquifer of that valley as discussed in Section 3.2.2.6.4. Outside of Diamond Valley, there have been no reports of generally declining spring and seep flows in any of the other basins in the HSA.

Most of the springs in the HSA that have substantial perennial flow or have some unique historical, cultural, ecological, or aesthetic significance, are described below in the discussion of geothermal springs. Of the numerous cold springs that exist in the HSA, Tonkin Spring (Spring 378) in the Denay Creek drainage of Pine Valley has the largest flows. Between August of 2007 and September of 2009, Interflow measured the discharge from Tonkin Spring during all months of the year (Montgomery et al. 2010). A minimum flow of 525 gpm (1.17 cfs) was observed during March of 2009, and a maximum flow of 1,086 gpm (2.42 cfs) was recorded during August of 2007. Measurements made for three consecutive years (2007, 2008, and 2009) during the month of August ranged between 718 and 1,086 gpm (1.60 and 2.42 cfs), with a mean value of 862 gpm (1.92 cfs). The recorded temperature of the spring is 55.6 ˚F.

Geothermal Springs

Springs with water temperatures elevated above the mean annual surface temperature are affected by heat from geologic materials at depth and are referred to as geothermal springs. The majority of the geothermal springs in the HSA are associated with major range-bounding faults and are thought to involve deep ground water circulation (Montgomery et al. 2010). The most prominent of these geothermal fault zones is the southern portion of the 22-mile long Piñon Range fault, which lies on the east side of Pine Valley along the Sulphur Spring Range. Another fault zone associated with elevated spring temperatures within the HSA is the Western Diamond Mountain fault zone, which runs along the base of the Diamond Mountains in a north-south orientation for approximately 40 miles. The Antelope Peak Fault System, located along the northern edge of the Monitor Range in Kobeh and Monitor Valleys is likely responsible for the elevated temperatures of waters located at Klobe Hot Springs, the Bartine Ranch area, and the Hot Spring Hill complex.

Brief descriptions of the geothermal springs within the HSA are presented below, with the spring inventory identifier numbers included for reference (Montgomery et al. 2010, Appendix E). The locations of known geothermal resources within the HSA are shown in Figure 3.2.8.

Klobe Hot Springs (also known as Bartholomae Springs, Springs 930 and 931): These springs are located at the northeastern end of the Monitor Range in Antelope Valley. Water temperatures in the flowing springs have been recorded as high as 156 ˚F (Fiero 1968), and were 158 ˚F in a water well installed over the spring complex (Rush and Everett 1964). Mariner et al. (1974) estimated reservoir temperatures of 163 ˚F using a sodium (Na)-potassium-Ca geothermometer technique. Two wells located four miles east of the springs have ground water temperatures of 72 ˚F and 74 ˚F, which were measured by Bartholomae Corporation; this difference in temperature indicates that the influence of the geothermal springs diminishes to the east. Montgomery et al. (2010) report a historical flow measurement of approximately 500 gpm (1.11 cfs) during April of 1964 at Klobe Hot Springs.

Bartine Hot Springs (Springs 816, 820, 824, and 826): These springs are located approximately 2.5 miles north of the Bartine Ranch along U.S. Highway 50 in Kobeh Valley. They are near the west side of Lone Mountain and are 11 miles north of, and along the same fault zone as, Klobe Hot Springs. Montgomery et al. (2010) report that two of the springs (824 and 826) emanate from a large travertine deposit (tufa mound), with an average water temperature of 106 ˚F and a discharge of approximately two to three gpm (0.004 to 0.007 cfs). The tufa-mound is locally referred to as “Hot Spring Hill”.

Bruffey’s Hot Springs (Springs 74 through 79): These springs are located on the west side of the Sulphur Spring Range in Pine Valley, along the Piñon Range fault. Large calcareous sinter terraces containing barite and fluorite have accumulated around multiple spring discharge points

(White 1955). Montgomery et al. (2010) report recorded temperatures as high as 152 ˚F and a flow rate of approximately 50 gpm (0.11 cfs) in June of 2007 for Bruffey's Hot Springs.

Flynn Ranch Springs (Springs 186 and 187): These springs are located along the east side of the Sulphur Spring Range in the northern part of Diamond Valley. They consist of several warm springs discharging into a deep pool. Water temperatures of approximately 70 ˚F and a combined discharge of ten gpm (0.022 cfs) have been reported (Reed et al.1983).

Shipley Hot Spring (Spring 330): This spring is located on the eastern flanks of the Sulphur Spring Range in the northern part of Diamond Valley. Estimated reservoir temperatures of 109 ˚F were determined using silica geothermometers (Mariner et al. 1983). As summarized by Montgomery et al. (2010), historical discharge measurements at Shipley Spring recorded between April of 1965 and January of 1991 ranged from 2,303 to 3,707 gpm (5.13 to 8.26 cfs). More recent discharge measurements made in 2008 and 2009 by SRK and Interflow recorded flows in the range of 935 to 1,600 gpm (2.08 to 3.56 cfs) (Montgomery et al. 2010).

Siri Ranch Springs (Springs 285 and 288): The Siri Ranch Springs are located on the eastern flanks of the Sulphur Spring Range in the northern part of Diamond Valley, approximately 4.5 miles north of Shipley Hot Spring. The reported temperature for the springs is 85 ˚F, and a nearby ranch well is reported to have a water temperature of approximately 95 ˚F (Reed et al. 1983). Mifflin (1968) reported a discharge of approximately 290 gpm (0.65 cfs) from the Siri Ranch Springs.

Sulfur Springs (Springs 560, 562, 564, 567, and 570): These springs are located along the eastern flanks of the Sulphur Spring Range in central Diamond Valley, approximately eight miles south of Shipley Hot Spring. These warm springs were reported to have a temperature of 74 ˚F and a discharge of 40 gpm (0.09 cfs) in November of 1965 (Harrill 1968). SRK observed no flow from Sulfur Springs during a field inspection in 2007 (SRK 2008c).

Thompson Ranch Spring (also known as Taft Spring, Spring 362): This spring is located on the east side of Diamond Valley along the western flanks of the Diamond Mountains and is reportedly associated with the Western Diamond Range fault zone (Harrill 1968). The recorded temperatures of the spring ranges from 69 to 75 ˚F (Mifflin 1968). Historical discharge measurements at Thompson Ranch Spring during the 1965 through 1990 time period ranged from 18 to 1,900 gpm (0.04 to 4.23 cfs). Montgomery et al. (2010) reported that the spring ceased flowing around 1990.

Mount Hope Area Springs and Seeps

SRK (2008a) inventoried the land area within approximately five miles of Mount Hope in September and October of 2005 and reported seven springs within the Project Area boundary and 13 springs outside of the Project Area boundary but within the five-mile radius. Brief descriptions of those inventoried springs are presented below along with the corresponding spring inventory identifier numbers (Montgomery et al. 2010, Appendix E). Subsequent field investigations by SRK (2008c) and spring database review by Interflow (Montgomery et al. 2010) identified 16 additional spring and seep locations with a five-mile radius of Mount Hope. Detailed descriptions of these additional springs and seeps are unavailable, but they were included in the overall inventory of springs and seeps within the HSA as Springs 519, 532, 544, 549, 576, 580, 583, 589, 591, 593, 594, 611, 616, 618, 638, and 639. In total, there are 31 inventoried springs and seeps within a five-mile radius of Mount Hope, as shown on Figure 3.2.9.

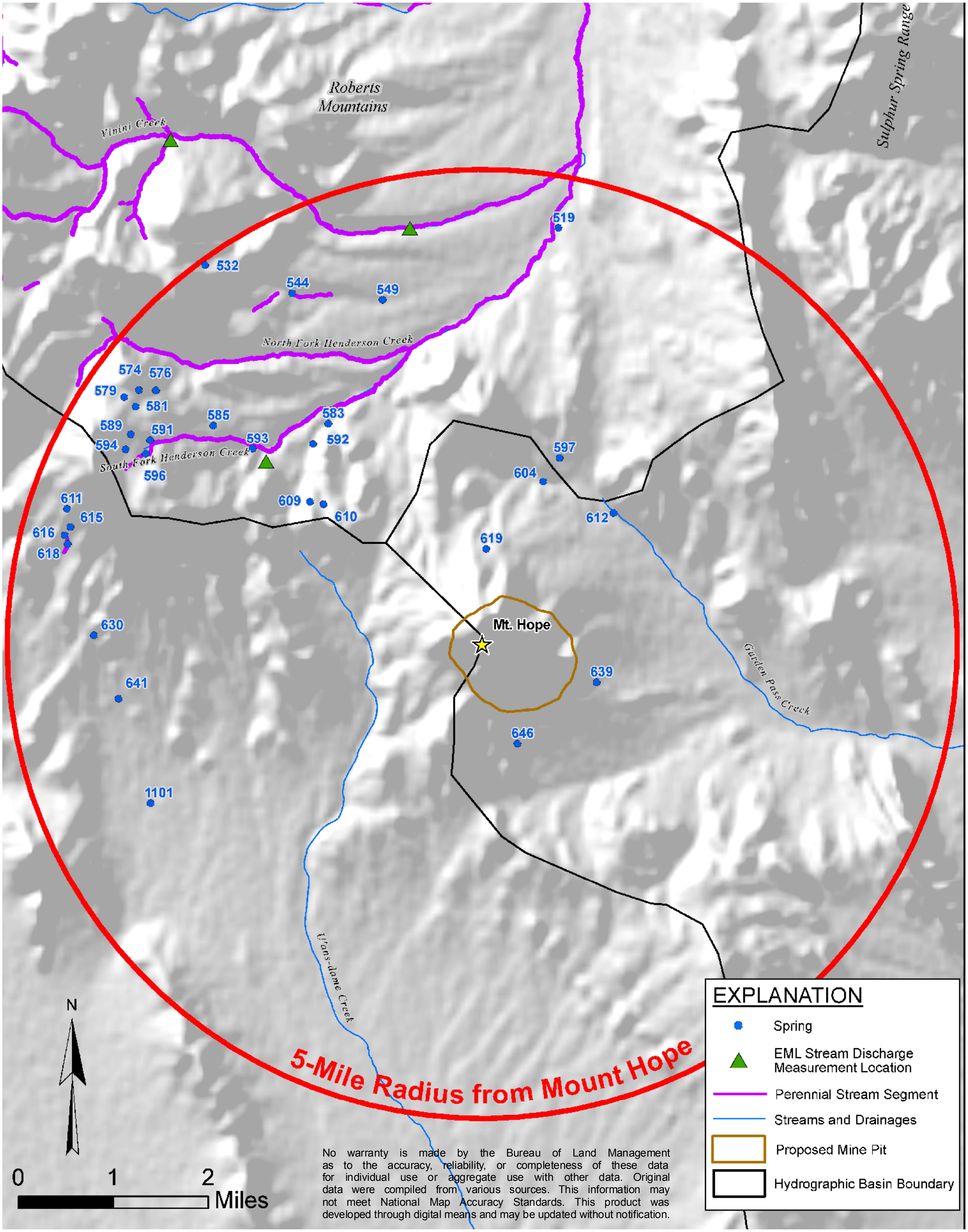
McBrides Spring (Spring 612): This spring is located approximately 150 feet east of SR 278, between Garden Pass and the Mount Hope road turnoff at an elevation of about 6,389 feet amsl. Within the riparian corridor of the spring there was no surface expression of water and the soil was dry to a depth of approximately 18 inches when visited by SRK. A pipe buried beneath the riparian area collects water and conveys it to a cattle trough approximately one mile south of the riparian area. A discharge of 1.8 gpm was recorded in October of 2006; during other quarterly visits the spring was dry. The site consists of a very small riparian area of approximately 200 feet square, containing Mexican rush (*Juncus mexicanus*), Kentucky bluegrass (*Poa pratensis*), and various forbs species surrounded by dense Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and rubber rabbitbrush (*Ericameria nauseosus*).

Garden Spring (Spring 597): This spring is located approximately 1.5 miles northwest of SR 278 at an elevation of approximately 6,468 feet amsl. The Garden Spring site consists of two separate points of discharge within the same general area; both were reported to be perennial water features with no visible outlet for surface water. Water that emanates from the spring collects in local depressions. Flow measurements for the spring have not been obtained because there is no discrete flow from either point of discharge. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye (*Elymus cinereus*), and Nebraska sedge (*Carex nebraskensis*).

Unnamed (Spring 604): This spring is located approximately 1,500 feet south of Garden Spring and 1.5 miles west of SR 278 between Garden Pass and the Mount Hope road turnoff at an elevation of approximately 6,400 feet amsl. The site consists of a permanent pond with no visible inlet or outlet for surface water flow. Since the site has been monitored, no flow measurements have been obtained from the spring, although the pond has been observed to contain varying amounts of water released from an upgradient artesian well, IGM-152, which is located approximately one mile from the spring site. The site is dominated by rubber rabbitbrush, with an understory of Great Basin wild rye.

Mount Hope Spring (Spring 619): This spring is located west of the preceding spring (Spring 604) and SR 278 between Garden Pass and the Mount Hope road turnoff at an elevation of approximately 7,175 feet amsl. The site consists of a buried steel pipe that daylights out of the hillside under a tree and runs above ground for about 30 feet to a cattle trough. The pipe is a permanent source of water for a partially buried cattle trough, which fully captures the inflow of water. The rate of inflow to the trough has been observed to vary by season, with a maximum recorded discharge of approximately 0.3 gpm in May 2006. The site vegetation community consists primarily of singleleaf piñon (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), and Wyoming big sagebrush.

Unnamed, next to monitoring well IGM-154 (Spring 631): This spring is located in close proximity to monitoring well IGM-154, and is approximately five miles southeast of SR 278 along the Garden Pass dirt road at an elevation of approximately 6,923 feet amsl. The site consists of a small gully with riparian vegetation that conveys water downgradient into two stock ponds, with no visible outflow of water from the stock ponds. This site was dry or frozen during




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 07/28/2011 |

FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Surface Water Resources within Five Miles of Mount Hope**

**Figure 3.2.9**

all of SRK's quarterly visits except for August of 2006, when a flow of two gpm was recorded. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, and various unidentified forbs species. The site has a riparian area of approximately 200 square feet surrounded by dense Wyoming big sagebrush, and rubber rabbitbrush.

Unnamed (Spring 637): This spring is located one-half mile south of monitoring well IGM-154 and the preceding spring (Spring 631), and is approximately five miles southeast of SR 278 along the Garden Pass two-track dirt road at an elevation of approximately 7,001 feet amsl. The site consists of a small riparian corridor surrounded by piñon and juniper. Discharge from the spring was observed to be intermittent during SRK's quarterly site visits; when present, measured flows ranged from approximately 0.8 to 8.6 gpm (in March of 2007 and May of 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, and various forbs species. The site is surrounded by an upland dominant vegetative community including singleleaf piñon, Utah juniper, and Wyoming big sagebrush.

Unnamed (Spring 646): This spring is located south of the Mount Hope Mine office building and core shed, approximately one mile due south of monitoring well IGM-169 at an elevation of approximately 6,819 feet amsl. The site consists of a small (roughly two feet by two feet) depression in the soil that contains one to two feet of standing water. The site appears to be a permanent water feature with a seasonally-fluctuating water level in the depression. SRK was unable to obtain a flow measurement from this spring during the 2005-2007 quarterly site visits. The immediate vicinity of the spring is dominated by Mexican rush. The site is surrounded by singleleaf piñon, and Utah juniper.

Unnamed, Henderson Creek watershed (Spring 585): This spring is located on the southeast side of Roberts Mountains near the south fork of Henderson Creek at an elevation of approximately 7,557 feet amsl. During wet periods, water issues from several points of discharge along a generally straight line, possibly indicating a fault. Flows from these multiple sources are conveyed into a common channel for approximately one-half mile before joining Henderson Creek. A discharge of approximately two gpm was recorded in May of 2006, but no spring flow was observed during SRK's other quarterly visits to the site. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, and various forbs species.

Unnamed, Henderson Creek watershed (Spring 592): This spring is located south of the south fork of Henderson Creek at an elevation of approximately 6,953 feet amsl. The spring was reported to be perennial, with seasonal variation in flow. Recorded discharge during SRK's quarterly site visits ranged from less than 0.1 to nine gpm (in August 2006 and May 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, coyote willow (*Salix exigua*), and various forbs species.

Unnamed (Spring 610): This spring is located on the northwest slope of Henderson Summit near historical mine prospects identified on USGS topographic maps at an elevation of approximately 7,313 feet amsl. SRK reported that the spring is perennial, with seasonal variation in flow. Spring discharge accumulates in a sump that is covered by several logs. From this sump, the water flows approximately 60 feet downgradient into a small stock pond. Recorded discharge during SRK's quarterly site visits ranged from approximately 0.15 to two gpm (in March 2007 and May 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, coyote willow, and various forbs species. Upland dominant vegetation surrounding the spring site includes Wyoming big sagebrush, singleleaf piñon, and Utah juniper.

Unnamed (Spring 606): This spring is located near the preceding spring (Spring 610) on the northwest slope of Henderson Summit at an elevation of approximately 7,203 feet amsl. The spring consists of several points of discharge that converge and then dissipate approximately 75 feet downgradient from the source. A discharge of approximately 0.15 gpm was recorded in May 2006, but no spring flow was observed during SRK's other quarterly visits to the site. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, coyote willow, and various forbs species. Upland dominant vegetation surrounding the spring site includes Wyoming big sagebrush, singleleaf piñon, and Utah juniper.

Unnamed (Spring 609): This spring is located near the two preceding springs (Springs 610 and 606) on the northwest slope of Henderson Summit at an elevation of approximately 7,334 feet amsl. The spring's flow is intermittent. During wet periods, water issues from several points of discharge and is conveyed approximately 120 feet downgradient in several small, discrete channels before terminating in a small stock pond. Flow measurements have not been collected from the site due to the distributed nature of the discharge points. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, coyote willow, aspen trees (*Populus tremuloides*), and various forbs species. Upland dominant vegetation surrounding the spring site includes Wyoming big sagebrush, singleleaf piñon, and Utah juniper.

Unnamed, east of Roberts Creek in Kobeh Valley (Spring 1101): This spring is located in the northeast part of Kobeh Valley in an unnamed drainage approximately two miles west of the Project Area at an elevation of approximately 6,650 feet amsl. The spring site is developed and consists of a seep area with a series of cattle troughs that are fed by a black pipe, which is buried in a small hill behind the troughs. Two small stock ponds are located immediately downgradient of the seep area and troughs, and they collect water from the seep area. No water was observed flowing from the pipe and the cattle troughs were dry during SRK's quarterly site visits, although the area immediately surrounding the cattle troughs showed different degrees of saturation depending on the season. Due to consistently dry conditions, there have been no spring flow measurements at this site. The spring site consists of an unvegetated area disturbed by cattle, surrounded by upland vegetation.

Unnamed, east of Roberts Creek in Kobeh Valley (Spring 641): This spring is located approximately one mile north of the preceding spring (Spring 1101) in an unnamed drainage in the northeast part of Kobeh Valley, approximately 2.5 miles west of the Project Area at an elevation of approximately 6,901 feet amsl. Spring discharge accumulates in a sump and then flows approximately 150 feet downgradient in a single channel that terminates in a series of small stock ponds, with no apparent outlet for flow from the stock pond area. Based on persistent discharge during the quarterly site visits, SRK (2008a) inferred that the spring is perennial, with seasonal variation in flow. Recorded discharge during SRK's quarterly site visits ranged from less than 0.1 to 3.4 gpm (in August and October of 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, stinging nettles (*Urtica dioica*), and Nebraska sedge.

Unnamed, east of Roberts Creek in Kobeh Valley (Spring 630): This spring is located approximately one-half mile north of the preceding spring (Spring 641) in an unnamed drainage in the northeast part of Kobeh Valley, approximately three miles west of the Project Area at an elevation of approximately 7,142 feet amsl. Spring discharge issues from partially weathered limestone bedrock and is conveyed through a small channel approximately 300 feet downgradient before it disperses into a series of small stock ponds. Based on persistent discharge during the quarterly site visits, SRK (2008a) inferred that the spring is perennial, with seasonal variation in flow. Recorded discharge during SRK's quarterly site visits ranged from approximately 0.5 to 13.6 gpm (in March 2007 and May 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, and Nebraska sedge. The site is surrounded by an upland dominant vegetative community including singleleaf piñon, Utah juniper, and Wyoming big sagebrush.

Unnamed, east of Roberts Creek in Kobeh Valley (Spring 615): This spring is located approximately one mile north of the preceding spring (Spring 630) in an unnamed drainage in the northeast part of Kobeh Valley, approximately 3.5 miles west of the Project Area at an elevation of approximately 7,572 feet amsl. The site consists of a series of seeps with many points of discharge. During quarterly site visits, SRK noted that the spring area was significantly impacted by wildlife and cattle. Water from the source area flows approximately 1,500 feet downgradient through approximately 30 acres of meadow area before dissipating in Kobeh Valley. Based on persistent discharge during the quarterly site visits, SRK (2008a) inferred that the spring is perennial, with seasonal variation in flow. However, flow measurements have not been collected from the site due to the distributed nature of the discharge points. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, and Nebraska sedge.

Unnamed, upper Henderson Creek watershed (Spring 579): This spring is located in the uppermost headwaters of the Henderson Creek watershed at an elevation of approximately 8,126 feet amsl. The spring's flow is intermittent. During wet periods, water issues from a small depression along a hill slope. A channel conveys flow to a series of low-lying natural depressions and overflow from this area spills into the upper reach of Henderson Creek. A small amount of discharge (less than 0.1 gpm) was recorded in May of 2006, but no spring flow was observed during SRK's other quarterly visits to the site. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Nebraska sedge, and wild iris (*Iris missouriensis*).

Unnamed, upper Henderson Creek watershed (Spring 574): This spring is located downgradient of the preceding spring (Spring 579) in the uppermost headwaters of the Henderson Creek watershed at an elevation of approximately 8,025 feet amsl. The spring water issues from a two-inch diameter steel pipe that is buried in the hillside and discharges to the upper reaches of Henderson Creek. Based on persistent discharge during the quarterly site visits, SRK (2008a) inferred that the spring flow is perennial. Recorded discharge during SRK's quarterly site visits ranged from approximately 1.7 to 5.5 gpm (in March of 2007 and August of 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Kentucky bluegrass, Great Basin wild rye, Nebraska sedge, wild iris, foothills lupine (*Lupinus ammophilus*), and Western Skunk cabbage (*Lysichiton americanus*).

Unnamed, upper Henderson Creek watershed (Spring 596): This spring is located in the second drainage south of, and approximately one-half mile from, Spring 579 in the uppermost headwaters of the Henderson Creek watershed at an elevation of approximately 8,039 feet amsl. Flow at this site issues from several sources within a large meadow, estimated at 100 acres in size. Water that accumulates in the meadow flows into a common channel, which reports to Henderson Creek. SRK (2008a) inferred that the spring is perennial, with seasonal variation in flow. Recorded discharge during SRK's quarterly site visits ranged from approximately 7.5 to 9.5 gpm (in October and August of 2006, respectively). The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, wild iris, foothills lupine, and Nebraska sedge.

Unnamed, upper Henderson Creek watershed (Spring 581): This spring is located approximately one-half mile south Spring 579 in the uppermost headwaters of the Henderson Creek watershed at an elevation of approximately 8,099 feet amsl. The spring's flow is intermittent. During wet periods, water issues from several points of discharge in a meadow approximately ten acres in size and collects in a single channel that reports to Henderson Creek. A discharge of approximately 23 gpm was recorded in May of 2006, but no spring flow was observed during SRK's other quarterly visits to the site. The primary vegetative community within the spring's riparian corridor consists of Mexican rush, Kentucky bluegrass, Great Basin wild rye, wild iris, foothills lupine, and Nebraska sedge. The site is surrounded by an upland dominant vegetative community that consists primarily of Wyoming big sagebrush.

#### 3.2.2.3.3 Other Surface Water Features

There are no naturally occurring lakes or ponds within the HSA at present. However, several man-made surface-water impoundments exist within the study area and are primarily used for stockwater and irrigation purposes. The locations of surface water impoundments within the HSA are shown in Figure 3.2.8, based on field inspections and a review of USGS 7.5-minute topographic maps and NAIP aerial photography (Montgomery et al. 2010). The identified surface water impoundments that intermittently or perennially contain water include the following: 1) Tonkin Reservoir on upper Denay Creek, JD Ranch reservoirs on lower Henderson Creek and Pete Hanson Creek, and the Alpha Ranch impoundments of Henderson Creek and Chimney Springs in Pine Valley; 2) the Roberts Creek Ranch impoundment on Roberts Creek in Kobeh Valley; 3) the Shipley Hot Spring pond and the Flynn Ranch springs water impoundments in Diamond Valley; and 4) several small reservoirs on the upper Antelope Wash and its tributaries near the Segura Ranch in Antelope Valley. There may be other, smaller man-made impoundments in various drainages and downgradient of certain springs within the HSA that were not located in the field or identified on maps or aerial photographs.

Saline flats or playas exist where streams empty or ground water discharges into areas with no outflow. Temporary ponding occurs in such areas after snowmelt or prolonged rainfall, but the accumulated water typically soon evaporates.

### 3.2.2.4 Flood Hydrology

Flooding can occur in all seasons. Winter floods are caused primarily by large rainstorms falling on low-lying snow or frozen ground. Spring floods occur as warming temperatures melt the snow packs. Summer flash floods occur as the result of localized high-intensity rainfall from thunderstorms. These floods can deposit large volumes of debris and sediment on the valley uplands or valley floor and sometimes result in standing water in the playas.

Site-specific flood peak flows and total runoff volumes have not been estimated for all of the drainages described above. In the vicinity of Mount Hope, Hydro-Search (1982) evaluated peak discharge rate and time to peak discharge for 15 watersheds ranging in size from approximately 430 acres (Upper Tyrone Creek) to 12,315 acres (Garden Pass Creek). The 24-hour, 100-year peak flows for watersheds less than 2,000 acres in size were estimated to be approximately 400 to 600 cfs, and on the order of 1,000 to 3,600 cfs for larger watersheds such as Garden Pass Creek. Based on the estimates of storm runoff and general stream characteristics of the mountainous areas of Nevada, Hydro-Search (1982) indicated that the potential for flooding in the Mount Hope area as a result of 100-year flood events appears to be small. At upper elevations, the stream channels are well defined and gradients are relatively steep, which generally prevents overbank flow in the upper parts of the watersheds. Localized flooding is possible at lower elevations on the alluvial fans, particularly in the lower reaches of streams in Kobeh and Diamond Valleys, and in the Garden Valley subbasin.

### 3.2.2.5 Waters of the United States

SRK (2007e) conducted a survey in September of 2005 to determine the presence or absence of waters of the U.S. and jurisdictional wetlands within the Project Area. Potential wetlands within the Project Area could be supported by spring and seep flow or ephemeral surface flows. The survey and wetlands delineations were performed in accordance with Section 404 of the CWA as administered by the U.S. Army Corps of Engineers (USACE). The survey identified approximately 1,400 square feet (0.03 acre) of wetlands, and indicated that waters of the U.S. were not present within the Mount Hope Project Area. Based on the information in the SRK report, the USACE concurred that there are no jurisdictional waters of the U.S., including wetlands, within the surveyed area that would be regulated under Section 404 of the CWA (USACE 2007). The USACE noted that all tributaries originating from Mount Hope flow southerly into Kobeh Valley, which could ultimately flow into Diamond Valley via Slough Creek, or else flow easterly into Diamond Valley via Garden Pass Creek. The USACE determined that these are isolated, intrastate closed basins with no nexus to interstate commerce.

Within Pine Valley, Henderson and Vinini Creeks are the perennial drainages closest to the Project Area. In certain reaches, these creeks have defined channels, along with evidence that the drainages experience surface water flows on an average annual basis. These creeks ultimately discharge into Pine Creek, which is a tributary to the Humboldt River, a navigable waterway that is considered to be waters of the U.S.

### 3.2.2.6 Ground Water Resources

#### 3.2.2.6.1 Hydrogeologic Setting

The Project Area and proposed water-supply well field (Figure 3.2.10) are located within the Diamond Valley Regional Flow System (Harrill et al. 1988), which consists of Antelope, Diamond, Kobeh, North and South Monitor Valleys, and Stevens Basin. These hydrographic basins are connected by surface and ground water flow and form an internally-drained hydrologic system that terminates in Diamond Valley. Ground water flowing into Diamond Valley is eventually discharged to springs, lost to ET from phreatophytic vegetation, consumed by pumping for agricultural, municipal, private, or industrial uses, or evaporated at the terminus of the flow system in the Diamond Valley playa. Pine Valley, to the north of the Project Area, is not part of this flow system, but is part of the Humboldt River drainage instead. Ground water resources of the HSA are mainly contained within the extensive valley-fill deposits of the hydrographic basins and, to a lesser extent, in the consolidated rocks that form the mountain blocks and underlie the valley-fill ground water systems of the valley floors.

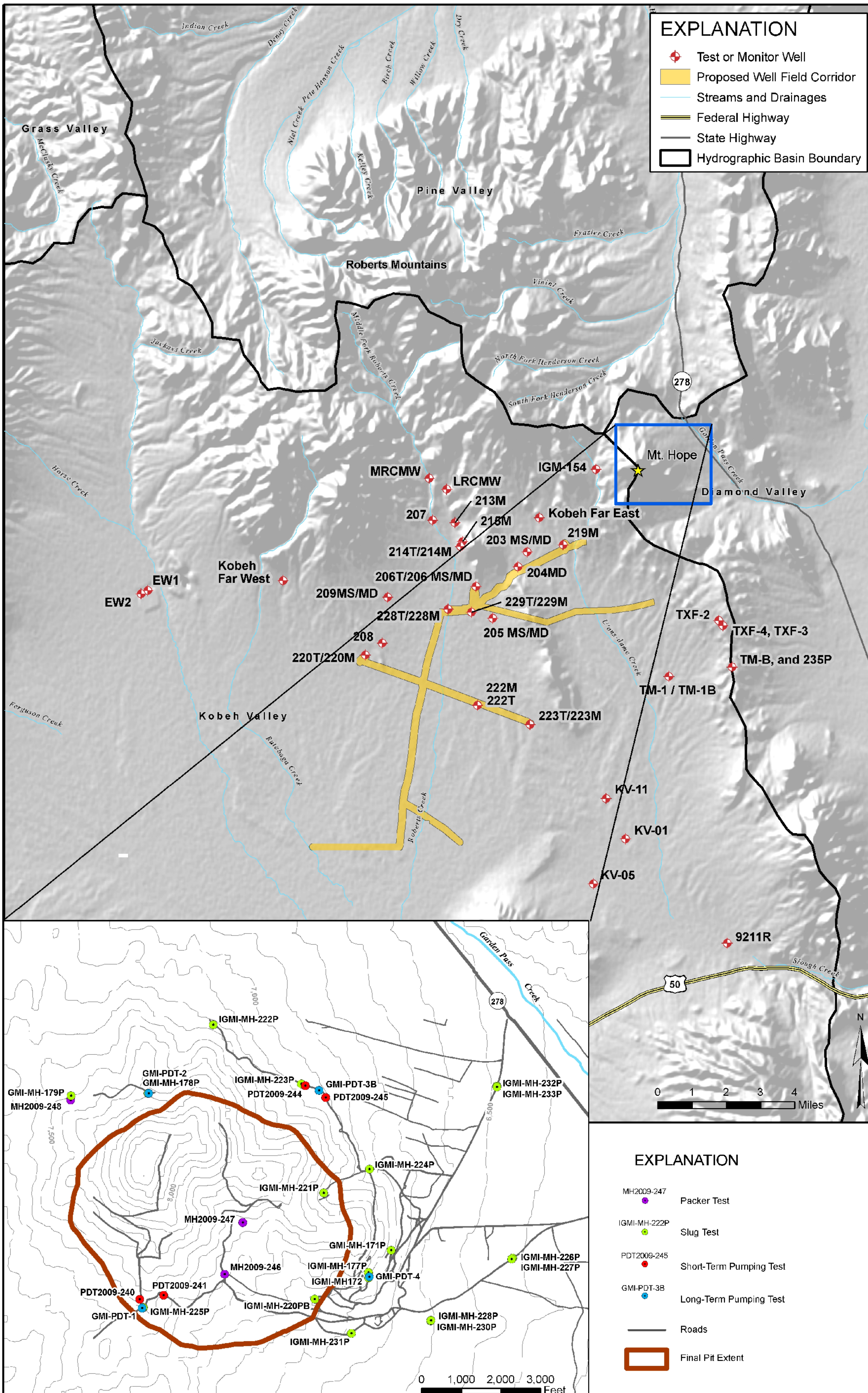
#### 3.2.2.6.2 Hydrolithologic Units and Properties

Recharge, storage, and movement of ground water are dependent, in part, on the geologic conditions and topography of a site. The general stratigraphic and structural framework of the HSA is described in Section 3.4, Geology and Minerals. For the purposes of characterizing the ground water conditions in the area, the various geologic formations have been grouped into seven hydrolithologic units (Montgomery et al. 2010). The general distribution of these units is presented in Figure 3.2.6, and their physical characteristics are summarized in Table 3.2-3. These seven hydrolithologic units include two distinct types of materials: consolidated rock (carbonate and dolomite, siliciclastic rocks and conglomerate, intrusive, and volcanic bedrock), and unconsolidated to poorly consolidated sediments (volcaniclastic and lacustrine sediments, alluvium, and valley-fill deposits). In the bedrock units, recharge, storage, flow, and discharge of ground water are primarily controlled by the secondary features (fractures, faults, and solution cavities) that have enhanced the overall porosity and permeability of the rock. In the unconsolidated to poorly consolidated sediments, the ground water is stored and transmitted through interconnected pores within the sediments.

Bedrock Units

The carbonate hydrolithologic units correlate to the eastern assemblage Paleozoic rocks discussed in Section 3.4, Geology and Minerals. Montgomery et al. (2010) define four carbonate hydrolithologic units within the HSA: 1) the lower eastern assemblage formations (Eureka Quartzite, Pogonip Group, and Hamburg Dolomite), which are deeply buried throughout Kobeh Valley and are exposed within the HSA only at Lone Mountain; 2) the Roberts Mountains and Lone Creek Dolomite Formations, which both crop out on the flanks of Lone Mountain in Kobeh Valley and also in isolated blocks on the north side of the Roberts Mountains in Pine Valley; 3) the Nevada, McColley Canyon Formation, and Denay Limestone Formation, which crop out in the Roberts Mountains, Sulphur Spring Range, and Lone Mountain area of Kobeh Valley; and 4) the Devils Gate Limestone, which crops out in the Roberts Mountains, Devils Gate area, and Mahogany Hills. Where sufficiently fractured or dissolved, these units may provide large quantities of water to wells or springs.

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.




| | | | |
|---|---|---|---|
| | BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | BUREAU OF LAND MANAGEMENT<br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>**Aquifer Testing and Monitoring Locations in Kobeh Valley and Near Mount Hope**<br>**Figure 3.2.10** |
| | DESIGN: EMLLC · DRAWN: GSL · REVIEWED: RFD | | |
| | CHECKED: - · APPROVED: - · DATE: 05/09/2011 | | |
| | FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

## Table 3.2-3: Hydrolithologic Units within the Study Area

| Hydrolithologic Unit | Hydrogeologic Map Units[1] (Geologic Age) | Estimated Thickness (feet) | Lithology | General Hydrologic Characteristics |
|---|---|---|---|---|
| Valley-Fill Deposits | VF1 (Quaternary) | 0 to >6,700 in Kobeh Valley | Alluvial fan, landslide, and floodplain deposits, playa silt and clay, terrace gravel, colluvium. | Hydraulic conductivity ranges from <1 to >100 feet per day; specific yield is approximately 0.1. Permeability generally decreases with depth due to compaction. |
| Volcaniclastic Sediments | VF2 (Tertiary) | 10 to 370 | Primarily ash-flow and air-fall tuffs. | Hydraulic properties unknown; Unit generally acts as an aquitard within the HSA. |
| Lacustrine Sediments and Conglomerates | VF3 (Quaternary and Tertiary) | 10 to >260 | Claystone, sandstone, fresh-water limestone, and conglomerate. | Hydraulic properties unknown; Unit generally acts as an aquitard except where intensely fractured. |
| Volcanic Rocks | VOL1 (Tertiary) | 0 to 1,000 | Rhyolite tuffs, basalt and andesite/dacite lava flows. | Hydraulic conductivity typically ranges from 0.01 to 10 feet per day. Local slug tests in the Mount Hope area produced conductivity values of <0.00001 feet per day. Mafic dikes of the Northern Nevada Trend are considered to be low permeability. |
| Intrusive Rocks | VOL2 (Cretaceous to Jurassic) | - | Granodiorite, alaskite, quartz porphyry. | Hydraulic conductivity ranges from 0.0001 to approximately 3 feet per day. The larger conductivity values correspond to locally fractured rock. |
| Siliciclastic Rocks | AQT1 (Permian to Cambrian) | >5,000 | Quartzite, sandstone, conglomerate, chert, shale, and minor limestone. | Hydraulic conductivity ranges from <0.00001 to 100 feet per day; storage coefficient ranges from 0.00001 to 0.03. The upper values of the ranges correspond to locally fractured rock. |
| Carbonate Rocks | CA1, CA2, CA3, CA4 (Devonian to Cambrian) | >9,000 | Limestone, dolomite, siltstone, mudstone, chert, quartzite, and shale. | Hydraulic conductivity ranges from 0.005 to 900 feet per day; storage coefficient ranges from 0.00002 to 0.014. Permeability is mostly secondary due to fracturing and solution widening. |

[1] See Figure 3.2.6 for distribution of hydrolithologic units.
Sources: Belcher et al. (2001); Harrill and Prudic (1998); Interflow (2010); Maurer et al. (1996); Montgomery et al. (2010); Plume (1996); Winograd and Thordarson (1975).

The hydrologic properties of carbonate rocks in the northern part of Kobeh Valley were evaluated by Interflow (2010) as part of the baseline characterization of hydrogeologic conditions in the proposed well field area. Figure 3.2.10 shows the locations of wells used in aquifer tests in the northern part of Kobeh Valley and near the proposed open pit at Mount Hope. Aquifer pumping tests were conducted for periods ranging from seven to 32 days on three test production wells (206T, 214T, and 220T) completed in the carbonate bedrock. Aquifer test data from the proposed well field area indicate that the local hydraulic conductivity of the carbonate bedrock generally ranges between eight and 18 feet per day and the storage coefficient is estimated to range from 0.0001 to 0.002. During testing of one of the wells (206T), a hydraulic conductivity value of 254 feet per day was estimated based on the early-time test data; however, the rate of drawdown increased with time as the test continued and the corresponding estimated hydraulic conductivity values decreased to approximately nine feet per day during the later part of the test (Interflow 2010), consistent with the range of values listed above for carbonate rocks in the northern part of Kobeh Valley. Interflow interpreted this behavior to indicate that the well was pumping from a highly permeable zone of fractured or dissolved carbonate rock that is also limited in its areal extent by barriers to ground water flow (i.e., compartmentalized).

The carbonate aquifer is a regionally extensive hydrolithologic unit in large portions of eastern and central Nevada. Aquifer test results throughout the region indicate that the carbonate aquifer has a wide range of hydraulic conductivity. For example, in the Carlin Trend area, just north of Pine Valley, the hydraulic conductivity and storage coefficient of the carbonate aquifer units are estimated to range from 0.1 to 150 feet per day and 0.00002 to 0.014, respectively (Maurer et al. 1996). At the Nevada Test Site, the carbonate aquifer has an estimated hydraulic conductivity that ranges from 0.7 to 700 feet per day (Winograd and Thordarson 1975). Harrill and Prudic (1998) and Plume (1996) reported values of hydraulic conductivity for carbonate aquifer regions of eastern Nevada that range from 0.005 to 900 feet per day.

The siliciclastic hydrolithologic unit correlates to the western assemblage Paleozoic rocks of the Webb and Vinini Formations and the Garden Valley Formation of the Overlap assemblage as described in Section 3.4, Geology and Minerals. This hydrolithologic unit is composed of chert, shale, calcareous sandstone, silica-cemented conglomerate, and quartzite, with minor amounts of fine-grained limestone. Within the HSA, siliciclastic rocks are exposed on the west side of the Sulphur Spring Range and north side of the Roberts Mountains in Pine Valley, on the southwestern flanks of the Roberts Mountains and northern part of the Simpson Park Mountains in Kobeh Valley, at Mount Hope and Whistler Mountain, and in the Diamond Mountains on the east side of Diamond Valley. Except in windows where these rocks have been removed by uplift and erosion, the siliciclastic hydrolithologic units generally overlie the carbonate hydrolithologic units. Where sufficiently fractured, the siliciclastic rocks may be water bearing. However, in general, this hydrolithologic unit is thought to have limited water production potential and is interpreted to typically act as an aquitard (Montgomery et al. 2010).

Site-specific hydrologic property values for siliciclastic rocks (primarily Vinini Formation) were determined from slug, packer, and pumping tests performed in core holes, piezometers, and completed wells in the vicinity of Mount Hope and the proposed open pit (Montgomery & Associates 2010). The results indicate a range of hydraulic conductivities for the various geologic media in that area, which included some volcanic and metamorphic rocks. Slug tests in three piezometers (228P, 231P, and 232P) in the Vinini Formation outside of the proposed open pit area produced hydraulic conductivity values ranging from approximately 0.0002 to 0.15 feet per day. Packer tests in a deep core hole (248) in the Vinini Formation outside of the proposed open pit showed hydraulic conductivity ranging from a value of one foot per day at a depth of approximately 434 feet bgs to a value of less than 0.00001 feet per day at a depth of approximately 3,000 feet bgs. Short-term pumping tests in two monitor wells (240 and 241) completed in the Vinini Formation (and some metamorphic rock) near the boundary of the proposed open pit produced estimated hydraulic conductivity values of 0.00067 and 0.26 feet per day. Longer term pumping tests in two test-production wells (PDT-1 and PDT-2) completed in the Vinini Formation (and rhyolite tuff) near the proposed open pit boundary were analyzed using the dual-porosity method of Moench (1984). Based on that analysis, the hydraulic conductivity of fractures was estimated to range from approximately 0.005 to 0.2 feet per day, and matrix hydraulic conductivity was estimated to range from approximately 0.0001 to 0.0003 feet per day. The fracture-specific storage ranged from $3.7^{-10}$ to $3.5^{-06}$, whereas the matrix-specific storage ranged from $8.3^{-07}$ to $2.3^{-03}$.

No aquifer tests have been conducted in rocks of the siliciclastic hydrolithologic unit elsewhere within the HSA except for the Mount Hope area because these rocks typically are not targets for water production. In the Carlin Trend, reported ranges of hydraulic conductivity and storage coefficient are approximately 0.001 to 100 feet per day and 0.00001 to 0.03, respectively, for similar rocks (Maurer et al. 1996). In general, except along faults and fracture zones, the hydraulic conductivities of siliciclastic rocks are low and they tend to act as barriers to regional ground water flow (Plume 1996).

Rocks comprising the volcanic hydrolithologic unit include Tertiary rhyolitic tuffs, basalt, andesite, and dacite lava flows. Within the HSA, volcanic rocks primarily occur as follows: in the Monitor and Antelope Ranges of Antelope Valley; at the northern end of the Monitor Range and in the southern part of the Simpson Park Mountains in Kobeh Valley; in the northern part of the Simpson Park Mountains and on the east side of the Cortez Mountains in Pine Valley; and in the central and eastern parts of the Roberts Mountains, generally along the north-northwest trend of the Northern Nevada Rift. Scattered outcrops of volcanic rocks also exist in Diamond Valley. Volcanic rocks also underlie basin-fill deposits in each of the basins of the study area at different depths (Tumbusch and Plume 2006).

Site-specific hydrologic property values for volcanic rocks (primarily rhyolite tuff) were determined from slug tests and pumping tests performed in piezometers and completed wells in the vicinity of Mount Hope and the proposed open pit (Montgomery & Associates 2010). The results indicate a wide range of hydraulic conductivities for the volcanic rocks in that general area. Slug tests in three piezometers (227P, 230P, and 233P) in unaltered rhyolite tuff outside of the proposed open pit produced hydraulic conductivity values ranging from 0.0000027 to 0.000094 feet per day. Short-term pumping tests in two monitoring wells (244 and 245) completed in rhyolite tuff near the boundary of the proposed open pit produced estimated hydraulic conductivity values of 0.25 and 0.44 feet per day. A long-term (26-day) pumping test conducted in a test-production well (PDT-3B) completed in rhyolite tuff near the proposed open pit boundary resulted in an estimated fracture hydraulic conductivity of 0.1 feet per day and an estimated matrix hydraulic conductivity of 0.000005 feet per day, based on the dual-porosity method of analysis (Moench 1984).

The hydraulic conductivity of volcanic rocks in the Carlin Trend area range from 0.01 to ten feet per day (Maurer et al. 1996). At the Nevada Test Site, measured values of the hydraulic conductivity of volcanic rocks, consisting of lava flows and ash-fall tuffs, range from approximately 1.5 to 17 feet per day (Winograd and Thordarson 1975). Plume (1996) reported that 54 drill-stem tests in volcanic rocks in the Railroad and White River Valleys in eastern Nevada produced hydraulic conductivity values that range from 0.000001 to 0.3 feet per day, with a mean value of 0.02 feet per day.

Tumbusch and Plume (2006) indicate that volcanic rocks probably have low permeability over much of the study area, citing the number of perennial stream segments underlain by volcanic rocks that exist within watersheds in the southern part of the Diamond Valley Flow System.

The intrusive hydrolithologic unit primarily consists of Jurassic to Tertiary granitic rocks. Within the HSA, intrusive igneous rocks are exposed in the central Simpson Park Mountains, at Whistler Mountain on the southwest side of Diamond Valley, and in the Cortez Mountains on the west side of Pine Valley. Igneous intrusive rocks (quartz porphyry) also occur locally at Mount Hope.

The extent of the outcrop area of these rocks generally does not indicate the full extent of the intrusive body in the subsurface.

Site-specific hydrologic property values for intrusive rocks (quartz porphyry mixed with altered tuffs and hornfels) were determined from packer tests of two core holes (246 and 247) in the vicinity of Mount Hope and the proposed open pit (Montgomery & Associates 2010). The tested depths ranged from approximately 560 to 2,760 feet bgs. Based on the packer-test results, hydraulic conductivity values were estimated to range from 0.0001 to 0.1 feet per day, with the smaller values generally corresponding to the upper (potassic) zones and the higher values correlated with the lower (silicic) zones of the core holes.

No aquifer tests have been conducted in rocks of the intrusive hydrolithologic unit within the HSA because these rocks typically are not targets for water production. Reported hydraulic conductivity values of granodiorite intrusions in the Carlin Trend area are approximately three to five feet per day where the rocks are highly fractured (Maurer et al. 1996). However, where fracturing is less extensive, intrusive rocks generally have very low permeability and impede the movement of ground water (Plume 1996). Belcher et al. (2001) report horizontal hydraulic conductivity values from 0.002 to 3.3 feet per day for Jurassic to Oligocene granodiorite, quartz monzonite, granite, and tonalite in southern Nevada and parts of California.

Basin Fill Deposits

The basin-fill (or valley-fill) hydrolithologic units consist of heterogeneous mixtures of fine-, medium-, and coarse-grained material eroded from mountain ranges and deposited in adjacent basins. Montgomery et al. (2010) define three basin-fill hydrolithologic units within the HSA, all of which are of late Tertiary to Quaternary: 1) younger and older alluvium, 2) volcaniclastic sediments, and 3) lacustrine deposits. The younger and older alluvium hydrolithologic unit comprises unconsolidated to semi-consolidated deposits of alluvial fans, landslides, stream flood plains, playas, and terrace deposits, which are locally interbedded with volcaniclastic sediments. The volcaniclastic sediment hydrolithologic unit consists primarily of reworked ash-flow or air-fall tuffs. The lacustrine deposit hydrolithologic unit includes claystone, sandstone, fresh-water limestone, and conglomerate. Within the HSA, these units partially fill the structural basins between mountain ranges.

The hydrologic properties of the younger and older alluvial sub-units of the basin-fill units in the northern part of Kobeh Valley were evaluated by Interflow (2010) as part of the baseline characterization of hydrogeologic conditions in the proposed well field area. Volcanoclastic and lacustrine units were not evaluated in the HSA and are generally not considered to be major water producing units. Aquifer pumping tests were conducted for periods ranging from five to seven days on three test production wells (222T, 228T, and 229T) completed in the alluvium of the proposed well field area. The completed intervals of the test wells ranged from 240 to 990 feet bgs. Aquifer test data from those wells indicate that the hydraulic conductivity of the alluvium in the well field area range from five to 19 feet per day and the storage coefficient is estimated to range from 0.0001 to 0.005. Montgomery & Associates (2008) evaluated short-term (approximately two hours to one day) aquifer tests conducted in three alluvial wells (9211R, EW-1, and KV-11) in eastern Kobeh Valley that were drilled as part of previous exploration efforts. The completed intervals of the test wells range from approximately 40 to 800 feet bgs. Reported hydraulic conductivity values of alluvium estimated from those aquifer tests range from six to 57 feet per day. In other basins of central and eastern Nevada, the estimated hydraulic conductivity of basin-fill deposits ranges from less than one foot per day to more than 100 feet per day (Plume 1996).

3.2.2.6.3 Hydrostructural Features

Ground water flow pathways are influenced by major faults and by complexities of the geologic environment that offset and displace rock units and older alluvial deposits. Depending on the physical properties of the rocks involved, faulting may create either barriers or conduits for ground water flow. For example, faulting of softer, less competent rocks typically forms zones of crushed and pulverized rock material (gouge) that behave as barriers to ground water movement. Faulting of hard, competent rocks often creates conduits along the fault trace, resulting in zones of higher ground water flow and storage capacity along the fault trace compared to the unfaulted surrounding rock.

Interflow (2010) describes three types of faults in the HSA that can be hydrologically important: thrust faults, normal faults, and young faults. The thrust faults are generally oriented north-south and reflect the eastward thrusting of western assemblage siliciclastic rocks over eastern assemblage carbonate rocks. In some cases, thrust fault contacts have fine-grained gouge and may also be associated with mineralization, both of which can reduce the permeability of the fault zone relative to the surrounding rocks. The tectonic activity that produced Basin and Range block faulting resulted in numerous northwest to southeast and conjugate east-northeast to west-southwest-trending high-angle normal faults. In the Roberts Mountains, some of these structures are thought to have provided conduits for the upward movement of mineralized fluids. Such mineralization associated with faults and the juxtaposition of rocks with contrasting hydraulic properties can create barriers to ground water movement, which lead to horizontal compartmentalization of the preexisting Paleozoic sedimentary rocks. Young faults are Quaternary structures that often act as conduits for ground water flow due to their relatively recent formation. Young faults in the HSA, as mapped by Dohrenwend et al. (1996), are located on the west side of the Roberts Mountains; on the north, south, and southwest sides of Lone Mountain; in the south-central part of the Roberts Mountains; and on the eastern side of Kobeh Valley.

As described in Section 3.4, Geology and Minerals, three Quaternary faults have been mapped within ten miles of the Project Area. Another group of normal faults in the Garden Valley area appear to down-drop to the Quaternary deposits of Garden Valley and place them in contact with Paleozoic and Tertiary bedrock of the Roberts Mountains and Sulphur Spring Range. A northwest-striking fault that follows the southwestern flank of the Roberts Mountains approximately ten miles southwest of Mount Hope is a major range front fault that appears to continue to the southeast beneath the piedmont-slope deposits of northern Kobeh Valley. None of these faults has been studied in detail and very little is known concerning their nature, movement history, and hydrogeologic behavior.

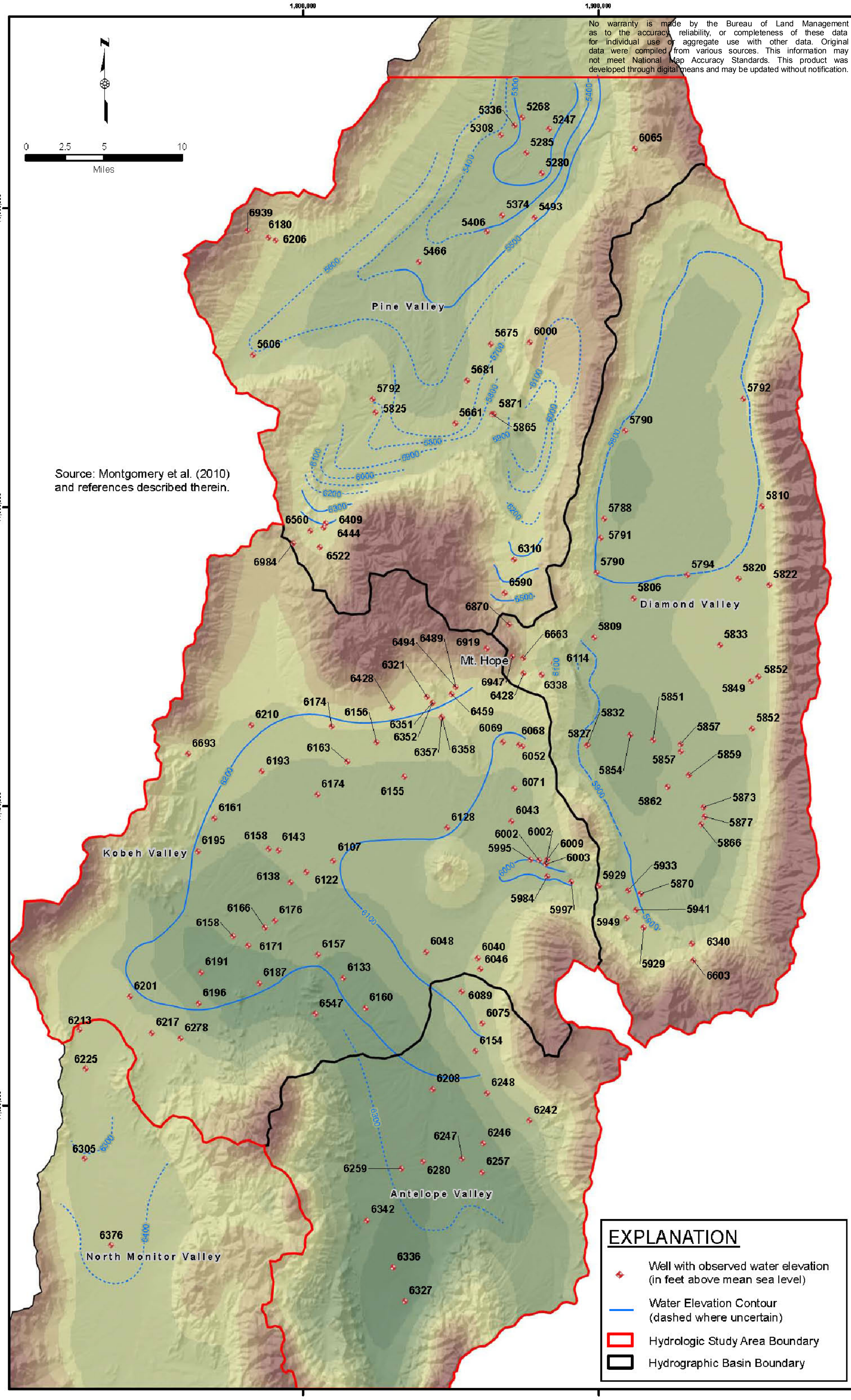
Dikes of basaltic composition have intruded fractures in carbonate rocks of the Roberts Mountains in a north-northwest-trending zone approximately six miles long and three to four miles wide, which are part of the Northern Nevada Rift. The average width of individual dikes is less than ten feet, although some are as wide as 50 feet, with lengths ranging from a few hundred feet to one or two miles (Tumbusch and Plume 2006). The hydrologic effect of the dikes is that they have reduced the fracture porosity and permeability of the carbonate rocks. The inferred extent of the zone of dikes across Kobeh Valley to the southeast, at least as far as the northern end of the Fish Creek Range, means that the dikes may create major barrier to ground water flow in these areas of carbonate rocks.

3.2.2.6.4 Ground Water Elevations and Flow Directions

Montgomery et al. (2010) compiled water level data for the HSA basins from published and unpublished sources. The majority of water level records were obtained from the USGS National Water Information System (NWIS) database (NWIS 2007). Some records were obtained from piezometers and monitoring wells in the Mount Hope area (Montgomery & Associates 2010) and from data published in USGS and Nevada Department of Natural Resources Reconnaissance Series Reports (Eakin 1961 and 1962; Rush and Everett 1964). Harrill (1968) was used as a source of historic water level data for Diamond Valley. Additional historic and more recent (2005) data for Antelope, Diamond, Kobeh, Pine, and North and South Monitor Valleys were obtained from Tumbusch and Plume (2006). In total, more than 4,400 water level measurements were assembled into an electronic database for this study, which includes data from 551 locations and spans the time period from 1900 to 2009 (Montgomery et al. 2010, Appendix F).

The locations of wells used to define ground water elevations in the basin-fill aquifers of the HSA under pre-development conditions (circa 1955) are shown in Figure 3.2.11. Contours of ground water elevations under pre-development conditions show that northward trending ground water flows from North Monitor and Antelope Valleys and easterly trending ground water flows from the Simpson Park Mountains and southerly trending ground water flows from the Roberts Mountains converge to an area of ground water discharge by ET in central and eastern Kobeh Valley. Ground water not discharged by ET in Kobeh Valley would have been directed eastward toward Devil's Gate and then eventually into the southern part of Diamond Valley at that time. Prior to irrigation development in the 1960s, ground water flow in Diamond Valley was from valley margins toward the valley axis and then northward to the large playa discharge area at the north end of the valley. In the Pine Valley basin, the primary flow pattern was laterally inward from the mountains toward the axis of the valley and then to the northeast, generally following the course of Pine Creek toward the Humboldt River.

The ground water elevations in the basin-fill aquifers of the HSA in 2005, interpreted from the available data, are shown in Figure 3.2.12. The 2005 water levels in North Monitor, Antelope, Kobeh, and Pine Valleys are interpreted to be generally the same as those shown for pre-development conditions (Figure 3.2.11). However, after approximately 40 years of agricultural pumping, a large area of ground water decline has developed in the basin-fill aquifer of southern Diamond Valley around the irrigated area, and the decline has created a divide between northward flow to the playa discharge area and southward flow to the pumped area. Tumbusch and Plume (2006) report that in 2005 water levels in the southern part of Diamond Valley exhibited a decline of as much as 90 feet relative to pre-irrigation development conditions. According to Montgomery et al. (2010), the water level data compiled for this study indicate that historic and continuing rates of water level declines range from approximately 1.3 to 3.3 feet per year for the wells in southern Diamond Valley.




Date: 04/21/10, Filename: Z:\MountHope_GIS_Project\Geology_PRISM\ArcMap\Predevelopment.mxd UTM NAD83, Zone 11, feet

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 05/09/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

**BUREAU OF LAND MANAGEMENT**

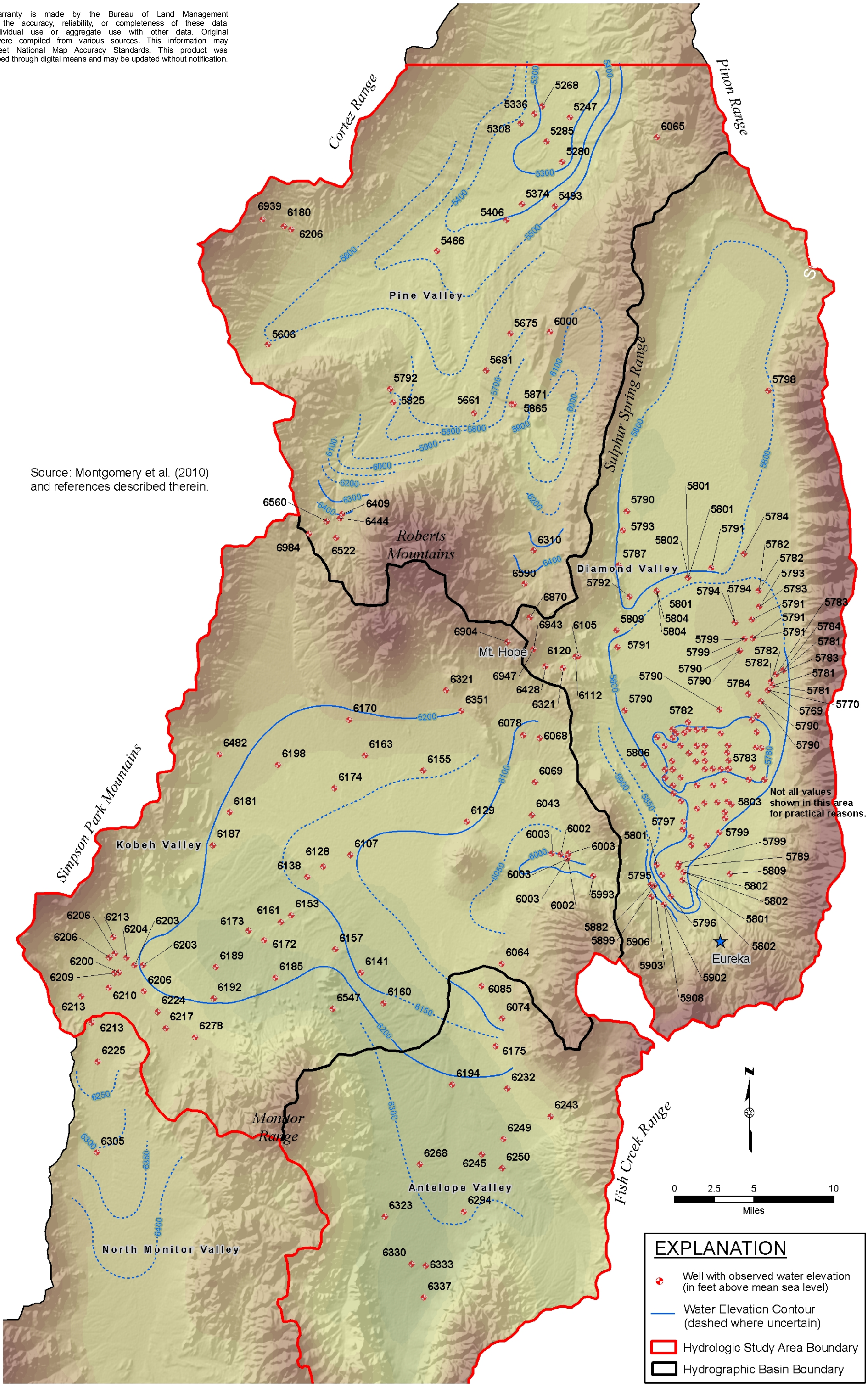
**MOUNT HOPE PROJECT**

DRAWING TITLE:

**HSA Basin-Fill Aquifer Groundwater Elevations Prior to Development (circa 1955)**

**Figure 3.2.11**

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.




Source: Montgomery et al. (2010) and references described therein.

Date: 08/04/10, Filename: Z:\MountHope_GIS_Project\RevisedJuneFigures\2005_conditions.mxd UTM NAD83, Zone 11, feet

| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | BUREAU OF LAND MANAGEMENT<br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>Hydrologic Study Area Basin-Fill Aquifer Ground Water Elevations in 2005<br>Figure 3.2.12 |
|---|---|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | | |
| CHECKED: - | APPROVED: - | DATE: 09/22/2011 | | |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | | | |

In the proposed Mount Hope open pit area, ground water levels were measured in approximately 40 piezometers and wells between 2007 and 2009 (Montgomery & Associates 2010). The measured ground water elevations range from greater than 7,200 feet amsl near the summit of Mount Hope to less than 5,800 feet amsl approximately six miles east of the summit in Diamond Valley. The ground water elevations and directions of movement in the proposed open pit area appear to be correlated with topography, and a local ground water divide may exist approximately one mile northwest of the proposed open pit (Montgomery & Associates 2010). Locally confined ground water conditions have been encountered at a few locations in the vicinity of the proposed open pit, with some recorded water pressures corresponding to hydraulic heads nearly 200 feet above the local ground surface.

Flowing (artesian) wells also have been encountered in each of the basins in the HSA and their reported locations are shown on the individual basin detail maps (Figures 3.2.2 through 3.2.5). In the 1960s, the estimated individual discharges from 14 flowing wells within the HSA ranged from approximately five to 233 gallons per minute (Montgomery et al. 2010).

3.2.2.6.5 Ground Water Recharge and Discharge

Inflow and outflow from the ground water system were estimated by Montgomery et al. (2010) to establish a baseline water balance for the HSA. The estimated average annual ground water budgets for pre-development (circa 1955) and existing (2009) conditions are presented in Tables 3.2-4 and 3.2-5, respectively. Existing ground water inflow components include precipitation recharge and subsurface inflow from North Monitor Valley across the southern HSA boundary into Kobeh Valley. Ground water outflow components include the following: evapotranspiration from phreatophyte areas in each of the HSA basins; evaporation from the playa area at the north end of Diamond Valley; ground water withdrawal for irrigation, municipal, domestic, and mining uses; discharge at springs and seeps; and subsurface outflow across the northern HSA boundary in Pine Valley.

The largest contribution to ground water recharge comes from precipitation in the mountain ranges of the HSA, with stream runoff from snowmelt considered to be part of that contribution. As is typical in Nevada, the higher elevations generally receive more rain and snow than lower elevations. This increase in precipitation at higher elevations recharges the bedrock aquifers and local perched systems through fractures in the bedrock outcrops or where bedrock is a porous sedimentary or volcanic unit. Where streams emerge from the mountains, some of the stream flow is lost as water infiltrates and recharges the alluvium.

Recharge to the ground water system from direct precipitation was estimated using an empirically-derived relationship between precipitation, recharge, and altitude developed by Maxey and Eakin (1949) and Eakin et al. (1951). The Maxey-Eakin relationship is based on a distribution of average annual precipitation into zones, with the amount of ground water recharge in each zone determined by empirically-derived recharge coefficients. For this study, the precipitation-altitude relationships and recharge coefficients reported in the USGS and Nevada Department of Natural Resources Reconnaissance Series Reports (Eakin 1961 and 1962; Rush and Everett1964) and in Harrill (1968) were utilized in combination with more recent (updated) calculations of precipitation-zone areas to estimate recharge for each basin in the HSA. The methodology used to estimate recharge is described in Montgomery et al. (2010). On the basis of the updated Maxey-Eakin calculations, and accounting for the spatial distribution of recharge to different landforms, the total recharge to the HSA is estimated to be approximately 75,900 afy (Tables 3.2-4 and 3.2-5).

**Table 3.2-4: Pre-Development (circa 1955) Estimated Annual Ground Water Budget for Individual Basins and the Entire HSA[1]**

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge[4] | 4,100 | 21,400 | 13,200 | 34,900 | 73,600 |
| Subsurface Inflow[5] | 0 | 7,300 (5,700 from Pine Valley and 1,600 from Kobeh Valley) | 4,600 (1,400 from Monitor Valley, 2,700 from Antelope Valley, and 500 from Pine Valley) | 0 | 1,400 (from Monitor Valley to Kobeh Valley) |
| **Total Inflow** | **4,100** | **28,700** | **17,800** | **34,900** | **75,000** |
| **Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,6] | 1,400 | 27,600 | 16,200 | 17,100 | 62,300 |
| Net Ground Water Pumping[7] | negligible | 800 | negligible | negligible | 800 |
| Subsurface Outflow[5] | 2,700 (to Kobeh Valley) | 0 | 1,600 (to Diamond Valley) | 17,500 (5,700 to Diamond Valley, 500 to Kobeh Valley, and 11,300 to northern Pine Valley) | 11,300 (from southern to northern Pine Valley) |
| **Total Outflow** | **4,100** | **28,400** | **17,800** | **34,600** | **74,400** |
| **Inflow - Outflow** | **0** | **300** | **0** | **300** | **600** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Values rounded to nearest 100 afy.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Source: Montgomery et al. (2010), Table 4.1-5.
[5] Source: Montgomery et al. (2010), Table 4.1-13.
[6] Source: Montgomery et al. (2010), Table 4.1-12.
[7] Source: Montgomery et al. (2010), Table 3.5-4.

Another source of inflow to the ground water system of the HSA is subsurface flow that enters Kobeh Valley from the adjacent North Monitor Valley to the south. The amount of subsurface flow from North Monitor Valley to Kobeh Valley is estimated to be approximately 1,900 afy under existing (2009) conditions (Montgomery et al. 2010), as shown in Table 3.2-5.

As shown in Table 3.2-4, ET is the primary mechanism of ground water loss from the HSA. Evaporation takes place from soil, wet plant surfaces, and open water bodies, whereas transpiration occurs by the action of plants. ET of ground water happens in areas where the water table is shallow, including areas near springs and seeps and along the valley floors of the HSA basins. Plants that send their roots to the water table and depend upon a constant supply of ground water are termed phreatophytes. Some phreatophytes, such as greasewood (*Sarcobatus* spp.), commonly send their roots as deep as 50 feet to the water table, although depths of up to 80 feet were reported by Eakin et al. (1951). The existing phreatophyte areas in the HSA are mainly found along the axial drainages of Antelope, Kobeh, and Pine valleys and surrounding the playa area in the northern part of Diamond Valley. The depth to water, vegetation type and density, soil characteristics, and climatic factors all influence the amount of ground water that phreatophytes transpire. Including evaporation from playa areas and spring and seep discharges, the total ET for the HSA under pre-development (circa 1955) conditions is estimated to be approximately 62,300 afy (Table3.2-4), and is approximately 49,100 afy under existing (2009) conditions (Table 3.2-5), as described in Montgomery et al. (2010).

**Table 3.2-5: 2009 Estimated Annual Ground Water Budget for Individual Basins and the Entire HSA[1]**

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge[4] | 4,100 | 21,400 | 13,200 | 34,900 | 73,600 |
| Subsurface Inflow[5] | 0 | 7,800 (5,800 from Pine Valley and 2,000 from Kobeh Valley) | 4,800 (1,600 from Monitor Valley, 2,700 from Antelope Valley, and 500 from Pine Valley) | 0 | 1,600 (from Monitor Valley to Kobeh Valley) |
| **Total Inflow** | **4,100** | **29,200** | **18,000** | **34,900** | **75,200** |
| **Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,5] | 1,400 | 14,700 | 15,900 | 17,100 | 49,100 |
| Net Ground Water Pumping[6] | negligible | 55,800 | 2,900 | negligible | 58,700 |
| Subsurface Outflow[5] | 2,700 (to Kobeh Valley) | 0 | 2,000 (to Diamond Valley) | 17,600 (5,800 to Diamond Valley, 500 to Kobeh Valley, and 11,300 to northern Pine Valley) | 11,300 (from southern to northern Pine Valley) |
| **Total Outflow** | **4,100** | **70,500** | **20,800** | **34,700** | **119,200** |
| **Inflow - Outflow** | **0** | **-41,300** | **-2,800** | **200** | **-44,000** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Values rounded to nearest 100 afy.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Source: Montgomery et al. (2010), Table 4.1-5.
[5] Source: Montgomery et al. (2010), Table 4.4-4.
[6] Source: Montgomery et al. (2010), Figure 4.4-2.

Other sources of natural ground water outflow include subsurface flow from the southern part of Pine Valley across the northern boundary of the HSA. The amount of subsurface flow from the southern part of Pine Valley across the northern boundary of the HSA is estimated to be approximately 3,100 afy under existing (2009) conditions (Montgomery et al. 2010), as shown in Table 3.2-5.

3.2.2.6.6 Ground Water Uses

Pumping withdrawals for irrigation, municipal, domestic, and mining uses account for the greatest amount of the ground water discharges from the HSA. Available data indicate that the distribution and amount of ground water pumping within the HSA has increased over time.

Development of ground water resources in Diamond Valley began in 1949, when two wells were installed along the eastern boundary of the valley (Eakin 1962). Additional wells installed prior to 1960 were located primarily along the periphery of the valley to augment flows from springs. An estimated 238 wells had been drilled in Diamond Valley by the end of 1965, with over 150 of those wells drilled between 1960 and 1965. Although numerous, the wells were not heavily pumped until 1972, when electrical power became available in Diamond Valley to supplement wind and diesel power (Arteaga et al. 1995). This change in technology, coupled with the increased price for alfalfa and the development of center-pivot irrigation, eventually caused a shift away from row crops and resulted in a significant increase in ground water withdrawals. Currently, the majority of irrigation is centered in south-central Diamond Valley and along the eastern portion of the valley

On a much smaller scale, irrigation development in Kobeh Valley followed a similar progression, and by 2005, approximately 1,000 acres of alfalfa were being irrigated along the basin’s western border. Existing ground water resources in the basin are still considered to be largely undeveloped (Tumbusch and Plume 2006) because of the limited scale of ground water withdrawals in Kobeh Valley.

Montgomery et al. (2010) summarized ground water pumping withdrawals from the HSA basins on the basis of published estimates of ground water withdrawals from Diamond Valley (Arteaga et al. 1995; Eakin 1962; Harrill 1968); detailed crop surveys and basin-estimate aggregates from the NDWR (1961-2005) for Diamond and Kobeh Valleys; estimates of public water-system requirements based on population for Nevada public water systems (Lopes and Evetts 2004); and pumping records from the Ruby Hill Mine. In the year 1955, under pre-development conditions, Montgomery et al. (2010) report that a total of approximately 800 afy of ground water was being pumped from the Diamond Valley basin, with negligible amounts being pumped from the other HSA basins at that time (Table 3.2-4). Under existing (2009) conditions, total consumptive use of ground water for agricultural purposes (minor mining and municipal uses) is estimated to be approximately 55,850 afy from the Diamond Valley basin and approximately 4,500 afy from the Kobeh Valley basin, with negligible amounts being pumped from Antelope Valley and the southern portion of Pine Valley within the HSA (Table 3.2-5).

3.2.2.6.7 Land Subsidence Due to Ground Water Withdrawals

Prolonged ground water withdrawals in the southern part of Diamond Valley have resulted in depressurization and some consolidation of the basin-fill aquifer, which in turn, has produced land surface subsidence in that area. Estimates of the cumulative subsidence in Diamond and Kobeh Valleys for the years 1992 to 2000 were made based on satellite-derived Interferometric

Synthetic Aperture Radar (InSAR) data. The methodology consists of utilizing two satellite radar scenes acquired over the same area at different times to determine radar phase changes produced by small displacements of the ground surface (Bell 2008). In the case of land subsidence due to ground water withdrawals, aquifer consolidation results in centimeter-scale changes of the ground surface that are detectable with InSAR data. A detailed description of the methods used to estimate land subsidence in Diamond Valley is presented in Bell and Arai (2009).

Based on the InSAR data analysis, at least 1.2 feet of land subsidence was estimated to have occurred in the south-central part of Diamond Valley between 1992 and 2000 (Figure 3.2.13). No measurable land subsidence was observed in Kobeh Valley during that time period (Montgomery et al. 2010).

The hydrogeological characteristics of Diamond and Kobeh Valleys are very similar (Harrill 1968; Tumbusch and Plume 2006). Both valleys contain thick (greater than [>] 3,000 feet) accumulations of basin-fill materials, much of which were derived from repeated cycles of lacustrine deposition during the late Cenozoic. It is reasonable, therefore, to expect that the aquifer system's response to pumping in Kobeh Valley would be similar to that observed in Diamond Valley in terms of land subsidence for a given amount of ground water drawdown.

#### 3.2.2.7 Water Rights

Water rights and applications for water rights were reviewed by Interflow and are summarized in Montgomery et al. (2010, Appendix C). These data were collected from the NDWR records in January 2010. The summary identified all water rights and applications for water rights for points of diversion within the HSA and within a 30-mile radius of Mount Hope, including those owned by EML or any of its subsidiaries. Of the 1,000 water rights and applications for water rights within the inventoried area, 472 were associated with surface water sources (e.g., streams and springs) and 528 were associated with underground sources (e.g., ground water wells). The primary uses for water in the area are stock watering, irrigation, mining and milling, and municipal. Since water rights are not necessary for most domestic wells in Nevada, this summary may not include all wells that exist within the inventoried area that are used for domestic water. An example of this is the domestic water well at the Roberts Creek Ranch. Additional vested water rights and subsisting rights for stockwater and future PWRs that are reserved for stockwatering (and domestic) purposes could exist within the Project Area and within the ten-foot ground water drawdown contour.

For the purpose of the EIS analysis, all underground water rights and pending applications for underground water rights owned by EML or its subsidiaries were excluded from the assessment of potential impacts; however, the actual streams and springs associated with any of EML's surface water features were not excluded. The boundary of the inventory area and locations of the points of diversion for the remaining (i.e., non-EML controlled) water rights and applications for water rights that were included in the assessment of potential impacts are shown in Figure 3.2.14; the owner, beneficial use, and annual duty for each water right are listed in Montgomery et al. (2010, Appendix C). Table 3.2-6 lists the non-EML controlled water rights and application for water rights that may be affected by Project activities, as discussed in Section 3.3.3.2.

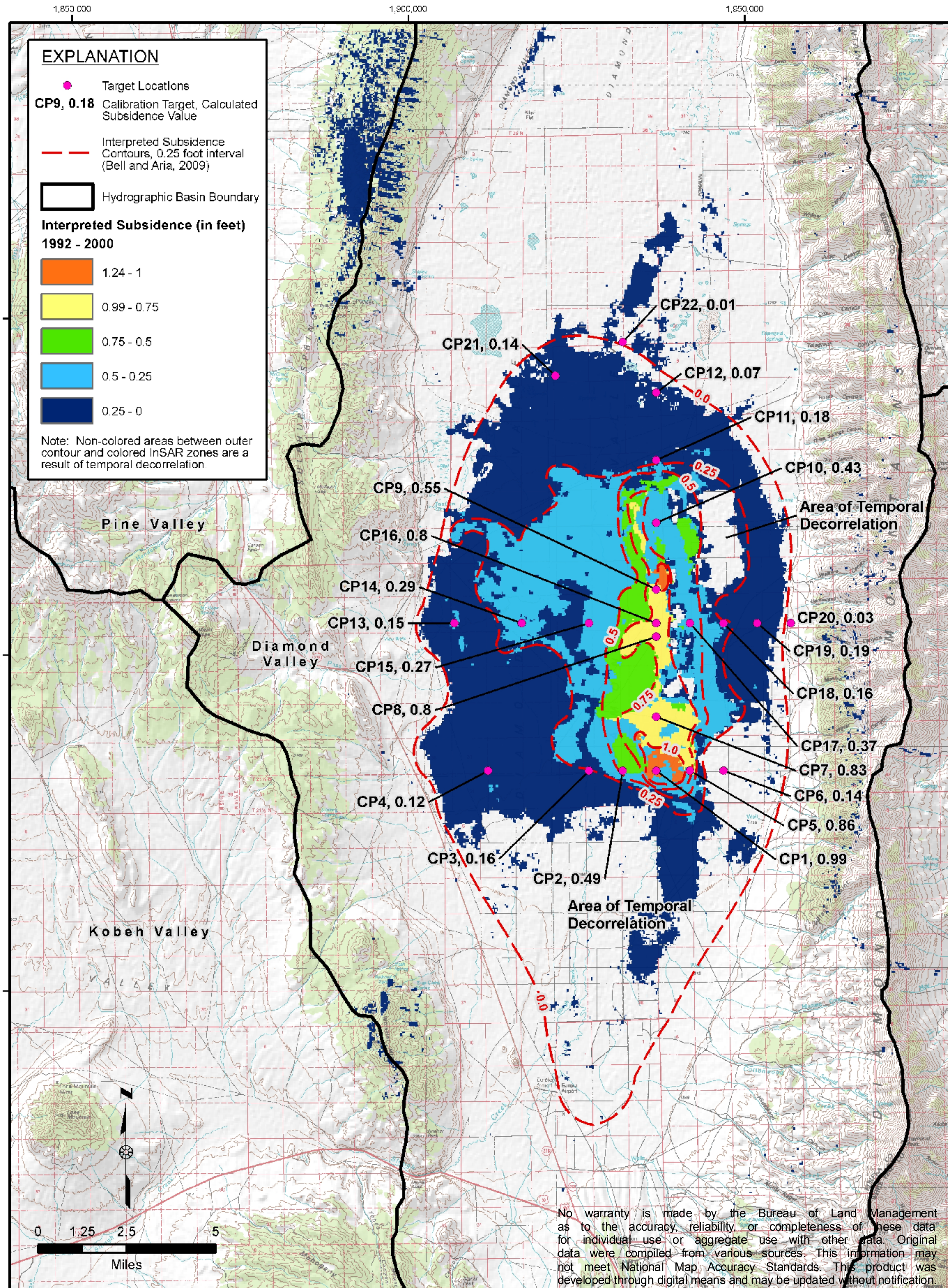
**Table 3.2-6: Non-EML Water Rights That May be Affected by Project Activities**

| Permit/ID Number/ Well Number | Basin | Source | Manner of Use | Duty (Af/Year) | Spring Number | Owner |
|---|---|---|---|---|---|---|
| 2732 | Kobeh Valley | STR | IRR | 120.00 | -- | Etcheverry Family LTD Partnership |
| 11188 | Kobeh Valley | UG | STK | 1.69 | -- | A C Florio |
| 12748 | Kobeh Valley | SPR | STK | 10.86 | 721 | Etcheverry Family LTD Partnership |
| 16802 | Kobeh Valley | STR[1] | IRR | 117.00 | -- | Etcheverry Family LTD Partnership |
| 43025 | Kobeh Valley | UG | STK | 5.16 | -- | BLM |
| 43321 | Pine Valley | SPR[2] | STK | 7.24 | -- | Etcheverry Family LTD Partnership |
| 44774 | Kobeh Valley | UG | STK | 6.51 | -- | BLM |
| 44775 | Kobeh Valley | UG | STK | 5.77 | -- | BLM |
| 48684 | Kobeh Valley | UG | STK | 8.68 | -- | Etcheverry Family LTD Partnership |
| 71594 | Kobeh Valley | UG | STK | 0.00 | -- | Roy Risi |
| R06940 | Diamond Valley | SPR | OTH | 10.65 | 619 | BLM |
| R06942 | Pine Valley | SPR | OTH | 10.65 | 597 | BLM |
| R06944 | Diamond Valley | SPR | OTH | 10.65 | 612 | BLM |
| R06951 | Kobeh Valley | SPR | OTH | 3.93 | 742 | BLM |
| R06952 | Kobeh Valley | UG[3] | OTH | 3.93 | -- | BLM |
| V01953 | Kobeh Valley | STR | IRR | 350 | -- | Bernard Damele |
| V02781 | Pine Valley | STR | IRR | 112.33 | -- | Eureka Livestock Company |
| 204* | Kobeh Valley | UG | STK | Unk | -- | Unk |
| 310* | Kobeh Valley | UG | STK | Unk | -- | Unk |

SPR=Spring, STR=Stream, STK=Stockwater, UG=Underground (well), IRR = Irrigation, OTH = Other (wildlife), Unk=Unknown
[1] - The water right is associated with Roberts Creek; however, NDWR identified the right as a spring in their database.
[2] - The water right is associated with a gravel pit that has water within the pit.
[3] - The water right is associated with a well; however, NDWR identified the right as a spring in their database.
* - Wells 204 and 310 appear to be used for stock watering and there are no water rights associated with these wells.

### 3.2.3 Environmental Consequences and Mitigation Measures

The Proposed Action and alternatives have the potential to impact surface water and ground water in the HSA. Potential water quantity impacts that may be associated with mining operations include the following: 1) reduction in surface and ground water quantity for current users and water-dependent resources from pit dewatering and production well withdrawals; 2) impacts from flooding, erosion, and sedimentation associated with mine construction, operation, and closure activities; and 3) changes in aquifer productivity or surficial drainage patterns or the creation of open fissures at the land surface related to dewatering-induced subsidence. The analysis of the magnitude and significance of these potential water resource




Date: 06-28-2010 File path: \\interflowshare\projectfiles\MountHope_GIS_Project\RevisedFigures_June2010\Diamond Valley Subsidence_Rev.mxd

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 |

FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd

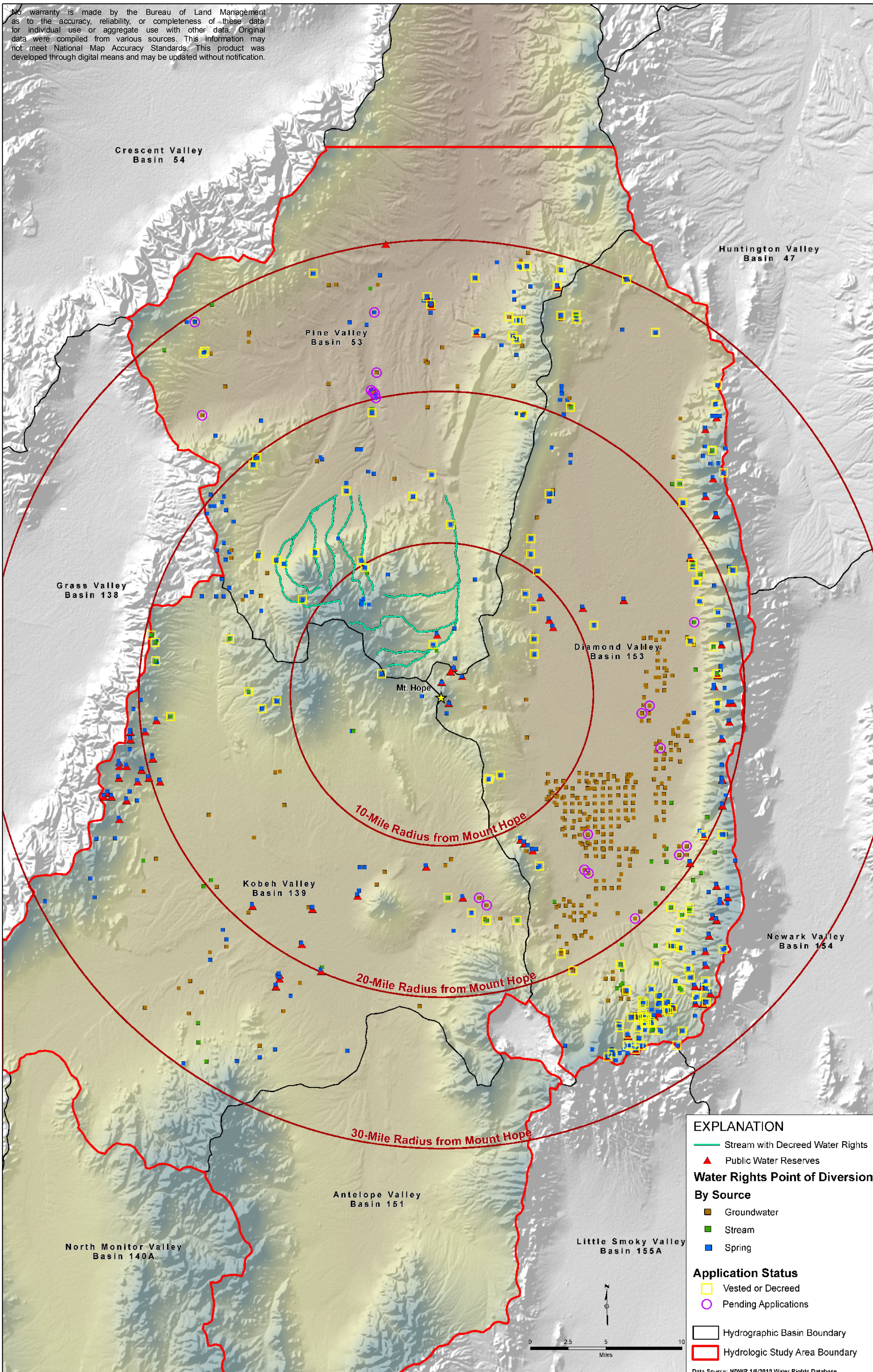
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Land Subsidence in Diamond Valley Interpreted From 1992-2000 InSAR Data**

**Figure 3.2.13**




| | | |
|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | BUREAU OF LAND MANAGEMENT<br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>**Non-EML-Controlled Water Rights and PWRs within HSA and 30-mile Radius of Mount Hope**<br>**Figure 3.2.14** |
| DESIGN: EMLLC · DRAWN: GSL · REVIEWED: RFD | | |
| CHECKED: - · APPROVED: - · DATE: 07/07/2011 | | |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

impacts in relation to the Proposed Action and alternatives are addressed in this section. Potential water quality impacts are discussed in Section 3.3.3.

#### 3.2.3.1 Significance Criteria

Criteria for assessing the significance of potential impacts to the quantity of water resources in the HSA are described below. Impacts to water resources are considered to be significant if any of these criteria are predicted to occur as a result of the Proposed Action or the alternatives.

##### 3.2.3.1.1 Surface Water Quantity

- Modification or sedimentation of natural drainages resulting in increased area or incidence of flooding.
- Reduction in the flow of springs, seeps, or streams. Impacts are considered to be significant where the predicted ten-foot water table drawdown contour encompasses a spring, seep, or stream and where the surface water feature is determined to be hydraulically connected to the aquifer affected by drawdown.
- Diversion or consumptive use of ground water that adversely affects other (non-EML) water rights holders. This criterion includes flows to springs, seeps, or streams where existing beneficial water uses, as defined by state law, may be affected.

##### 3.2.3.1.2 Ground Water Quantity

- Reduction of ground water levels that adversely affect water-supply, municipal, domestic, agricultural, or industrial wells caused by Project dewatering or post-mining pit lake development. Impacts are considered to be significant where the predicted ten-foot water table drawdown contour encompasses an existing well with an active water right and the well is hydraulically connected to the aquifer affected by drawdown.
- A long-term consumptive use of a water resource that does not provide for a beneficial use.
- Lowering of ground water levels that result in substantial land subsidence. For the purposes of this EIS, significant impacts are indicated where hydraulic parameters of the aquifer are substantially changed (such that aquifer productivity may be affected), where differential subsidence results in open fissures at the land surface, or if subsidence is great enough to change drainage directions or cause ponding.

For this impact analysis, the area that is predicted to experience a decline in ground water elevation of ten feet or more as a result of mine dewatering and water production activities was selected as the area of potential concern regarding impacts to water resources. This is a commonly used approach for EISs in Nevada, in part because changes in ground water levels of less than ten feet generally are difficult to distinguish from natural seasonal and annual fluctuations in ground water levels.

#### 3.2.3.2 Assessment Methodology

This section provides a summary of the methods used to evaluate the following: 1) the expected mine pit dewatering rates, 2) changes in ground water elevations and hydrographic basin water balances due to mining-related production well withdrawals and pit dewatering, and 3) the development and ultimate hydrologic conditions of the post-mining pit lake.

#### 3.2.3.2.1 Numeric Ground Water Flow Modeling

A pair of nested three-dimensional numerical ground water flow models have been developed, calibrated, and utilized to estimate potential effects to ground water and surface water resources from the Proposed Action and No Action Alternative, and from the cumulative effects of historical dewatering and projected future dewatering and water production activities for this EIS. The nested models consist of a larger, regional-scale model (the Regional Model) that encompasses the entire HSA and a smaller, imbedded local-scale model (the Local Model) that is focused on the vicinity of the proposed open pit. The two models are "coupled" by representation of the same time-varying ground water stresses (boundary conditions) in both model domains. Interflow, Inc., prepared the Regional Model, and Montgomery & Associates, prepared the Local Model. A detailed explanation of the conceptual hydrogeologic model, numerical modeling approach and setup, steady-state and transient calibrations, sensitivity analyses, optimization, model coupling, and predictive usage of both the Regional and Local Models is presented in the technical report by Montgomery et al. (2010, Chapter 4). Additional supporting data, analysis, and documentation for the numerical models are presented in Bell (2008), Bell and Arai (2009), Interflow (2010), Montgomery & Associates (2010), and SRK (2008a).

Interflow and Montgomery & Associates conducted the ground water flow modeling using an enhanced version of the USGS numerical code MODFLOW (McDonald and Harbaugh 1984). The enhanced version, known as MODFLOW-SURFACT (HydroGeoLogic 1996), contains many improvements over MODFLOW, including more robust and accurate simulation capabilities for handling complex field conditions (such as large ground water elevation fluctuations, which result in drying and wetting of model grid cells). MODFLOW originally was designed to simulate flow through porous media. However, it is common practice for MODFLOW models to be used to simulate ground water flow in bedrock aquifers where flow through the rock mass is primarily controlled by interconnected fracture or solution networks that behave similarly to porous media flow at the scale of the model grid cells (D'Agnese et al. 1997; Prudic et al. 1995). MODFLOW packages that were utilized in this analysis include the Interbed-Storage Package (Leake and Prudic 1991) to evaluate subsidence effects of dewatering and the LAK2 Package (Council 1999) to evaluate filling of the pit lake after mining.

The Regional Model encompasses the entire HSA as shown in Figure 3.2.1. The Regional Model contains eight variable-thickness layers to simulate the vertical range extending from over 10,000 feet amsl at the peaks of some of the HSA's mountain ranges to zero feet amsl (mean sea level) at the base of the model. To provide better resolution where ground water stresses would be greatest, the model grid cell dimensions vary horizontally from 5,000 feet by 5,000 feet at the outer margins of the model to 1,000 feet by 1,000 feet in the vicinity of the proposed well field and open pit areas. The Regional Model was calibrated to include the following: 1) historic (circa 1955, presumed steady-state) water levels in each of the HSA basins, 2) the estimated agricultural pumping and observed changes in ground water levels in Diamond Valley between 1956 and 2006, and 3) the results of six aquifer pumping tests conducted in carbonate bedrock and basin-fill deposits in Kobeh Valley as part of the baseline studies for this EIS (Interflow 2010).

The Local Model domain is nested within the Regional Model and covers a rectangular area of approximately 28 square miles, which includes Mount Hope and extends roughly two miles to the north, west, and south and five miles to the east of the proposed open pit, as shown in Figure 3.2.1. The Local Model consists of 19 horizontal layers of different thickness spanning the vertical range from the top of Mount Hope (8,411 feet amsl) to zero feet amsl (mean sea level) at the base of the model. Horizontal grid cell dimensions range from 100 feet by 100 feet in the proposed open pit area to 800 feet by 800 feet along the edges of the Local Model. These refined grid cells in the Local Model, relative to the Regional Model, allow the Local Model to more accurately represent hydrologic features, such as fault zones and steep hydraulic gradients, well locations, open pit geometry, and ground water levels, in the proposed mining area. The Local Model was calibrated to observed 2009 water levels in the proposed open pit area, which were assumed to represent steady-state conditions, and to the measured transient responses to three aquifer pumping tests conducted in the open pit area dewatering test wells as part of the baseline studies for this EIS (Montgomery & Associates 2010).

Transient, predictive Regional and Local Model simulations were developed to assess the potential water quantity impacts of the Proposed Action, No Action Alternative, and cumulative effects of historic dewatering and projected future dewatering and water management activities. Potential water quantity impacts due to the Partial Backfill Alternative were evaluated in a modeling assessment using the same methodologies as used for the Proposed Action, except modifying those parameters that would reflect the backfilling of the open pit (Montgomery & Associates 2011). The Off-Site Transfer of Ore Concentrate for Processing Alternative would require the same mining-related production well pumping, pit dewatering, and water production activities, and would result in the same development of the pit lake, as the Proposed Action; therefore, the potential water quantity impacts of the Off-Site Transfer of Ore Concentrate for Processing Alternative and the Proposed Action are considered to be the same. Potential water quantity impacts due to the Slower, Longer Project Alternative were evaluated in a modeling assessment using the same methodologies as used for the Proposed Action, except modifying those parameters that would reflect a doubling of the mining and pumping time frames and a one-half decrease in the production field pumping rate (Interflow 2011).

#### 3.2.3.2.2 Modeling Scenarios

The calibrated Regional Model was used to simulate a "No Action Alternative Scenario" and a "Cumulative Action Scenario," both of which are identical for the historical time period from 1955 through 2009, but differ for the predictive time period beginning in 2010. The modeling assumptions regarding anthropogenic ground water withdrawals during the predictive time period for the two scenarios are summarized as follows:

*No Action Alternative Scenario*

The No Action Alternative Scenario includes all of the relevant existing ground water withdrawals within the HSA, as outlined below.

- Consumptive use of ground water for agricultural irrigation in Diamond Valley continues at 2009 rates (34,630 gpm or 55,850 afy) through 2106, and then is reduced by 60 percent (to 13,850 gpm or 22,340 afy) for the remainder of the simulated time period to constrain the drawdown to approximately 300 feet bgs (Figure 3.2.15). The modeling of the future agricultural consumptive use in Diamond Valley as a step function is a more conservative assumption than using a monotonically declining curve, in terms of water consumption. It is entirely possible that future ground water use could continue at rates similar to the present until the currently available water supply (in the upper part of the aquifer tapped by the agricultural wells) is depleted.

- Consumptive use of ground water for agricultural irrigation in Kobeh Valley continues at 2006 rates (1,800 gpm or 2,900 afy, at the Bobcat Ranch) through 2011 and then increases to 2,330 gpm (3,750 afy) at the Bobcat and 3F Ranches for the remainder of the simulated time period.
- Town of Eureka municipal water-supply pumping continues at 2006 rates (190 gpm or 300 afy) throughout the simulated time period.
- Consumptive use of ground water at the Ruby Hill Mine continues at 2006 rates (280 gpm or 450 afy) through 2012 and then ceases.

*Cumulative Actions Scenario*

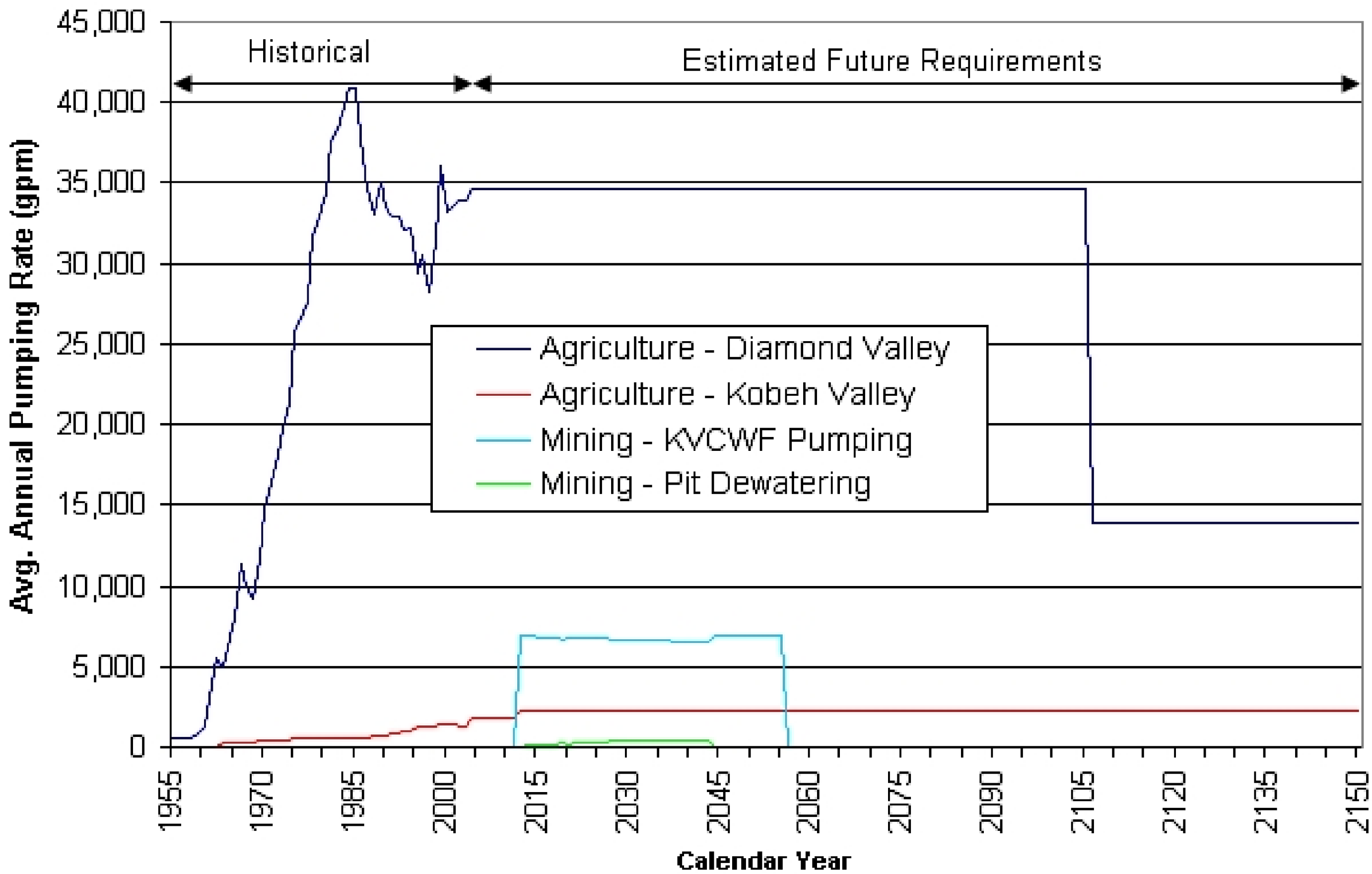
The cumulative actions scenario includes all of the assumed consumptive uses listed above for the No Action Alternative Scenario plus the following ground water withdrawals related to the Proposed Action.

- Mine construction water supply is pumped from two wells in the proposed mining area at a combined rate of 300 gpm (480 afy) for one year (2011).
- Production well pumping for the proposed mining and milling operations begins in the Kobeh Valley Central Well Field (KVCWF) in 2012 and continues for 44 years (through 2055); the amount of water extracted at the KVCWF varies yearly depending on the volume of water derived from open pit dewatering during mining, with the sum of the two water-supply sources equaling the total process-water demand of 7,000 gpm (11,300 afy) on an annualized average basis.
- Pit dewatering begins in 2012 and continues through 2043 (32 years); pit lake formation begins in 2044.

Historic pumping rates and projected future ground water withdrawals are summarized in Table 3.2-7 and shown on Figure 3.2.15.

The Local Model was coupled to the Regional Model simulation of the Cumulative Action Scenario for the predictive time period beginning in 2010. Lateral boundary conditions for the Local Model (specified hydraulic heads) were derived from the Regional Model via an iterative process that is explained in Montgomery et al. (2010). The Local Model was used to estimate the following:

- Passive ground water inflow rates to the mine open pit during the 32-year mining period;
- Pit lake formation (filling time, final lake stage) after dewatering ceases;




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Historical Pumping and Estimated Future Pumping and Dewatering Requirements**

**Figure 3.2.15**

- The ground water inflow and outflow component(s) of the pit lake water balance;
- Whether the pit lake would act as a hydrologic sink for ground water or as a through-flow system; and
- Ground water stresses from open pit dewatering and pit lake development, which feed back into the Regional Model to complete the model coupling process.

**Table 3.2-7: Summary of Historic Pumping and Estimated Future Pumping and Dewatering Requirements**

| Project Year | Calendar Year[1] | No Action Alternative | | | | Proposed Action | | Partial Backfill Alternative | |
|---|---|---|---|---|---|---|---|---|---|
| | | Net Agricultural Pumping (gpm)[2] | | | Other[3] (gpm) | KVCWF Pumping (gpm) | Pit Inflow[4,5] (gpm) | KVCWF Pumping (gpm) | Pit Inflow[4] (gpm) |
| | | Diamond Valley | Kobeh Valley | Total | | | | | |
| | 1955 | 510 | 0 | 510 | 0 | 0 | 0 | 0 | 0 |
| | 1956 - 2009 | 510 - 40,830 | 0 - 1,800 | 510 - 41,450 | 70 - 470 | 0 | 0 | 0 | 0 |
| | 2010 | 34,630 | 1,780 | 36,410 | 470 | 0 | 0 | 0 | 0 |
| 0 | 2011 | 34,630 | 1,780 | 36,410 | 470 | 0 | 300 | 0 | 300 |
| 1 | 2012 | 34,630 | 2,330 | 36,960 | 470 | 6,940 | 60 | 6,940 | 60 |
| 2 | 2013 | 34,630 | 2,330 | 36,960 | 190 | 6,910 | 90 | 6,910 | 90 |
| 3 | 2014 | 34,630 | 2,330 | 36,960 | 190 | 6,930 | 70 | 6,930 | 70 |
| 4 | 2015 | 34,630 | 2,330 | 36,960 | 190 | 6,820 | 180 | 6,820 | 180 |
| 5 | 2016 | 34,630 | 2,330 | 36,960 | 190 | 6,860 | 140 | 6,860 | 140 |
| 6 | 2017 | 34,630 | 2,330 | 36,960 | 190 | 6,850 | 150 | 6,850 | 150 |
| 7 | 2018 | 34,630 | 2,330 | 36,960 | 190 | 6,840 | 160 | 6,840 | 160 |
| 8 | 2019 | 34,630 | 2,330 | 36,960 | 190 | 6,690 | 310 | 6,690 | 310 |
| 9 | 2020 | 34,630 | 2,330 | 36,960 | 190 | 6,800 | 200 | 6,800 | 200 |
| 10 | 2021 | 34,630 | 2,330 | 36,960 | 190 | 6,780 | 220 | 6,780 | 220 |
| 11 | 2022 | 34,630 | 2,330 | 36,960 | 190 | 6,750 | 250 | 6,750 | 250 |
| 12 | 2023 | 34,630 | 2,330 | 36,960 | 190 | 6,750 | 250 | 6,750 | 250 |
| 13 | 2024 | 34,630 | 2,330 | 36,960 | 190 | 6,750 | 250 | 6,750 | 250 |
| 14 | 2025 | 34,630 | 2,330 | 36,960 | 190 | 6,750 | 250 | 6,750 | 250 |
| 15 | 2026 | 34,630 | 2,330 | 36,960 | 190 | 6,750 | 250 | 6,750 | 250 |
| 16 | 2027 | 34,630 | 2,330 | 36,960 | 190 | 6,640 | 360 | 6,640 | 360 |
| 17 | 2028 | 34,630 | 2,330 | 36,960 | 190 | 6,640 | 360 | 6,640 | 360 |
| 18 | 2029 | 34,630 | 2,330 | 36,960 | 190 | 6,640 | 360 | 6,640 | 360 |
| 19 | 2030 | 34,630 | 2,330 | 36,960 | 190 | 6,640 | 360 | 6,640 | 360 |
| 20 | 2031 | 34,630 | 2,330 | 36,960 | 190 | 6,640 | 360 | 6,640 | 360 |
| 21 | 2032 | 34,630 | 2,330 | 36,960 | 190 | 6,610 | 390 | 6,610 | 390 |
| 22 | 2033 | 34,630 | 2,330 | 36,960 | 190 | 6,610 | 390 | 6,610 | 390 |
| 23 | 2034 | 34,630 | 2,330 | 36,960 | 190 | 6,610 | 390 | 6,610 | 390 |
| 24 | 2035 | 34,630 | 2,330 | 36,960 | 190 | 6,610 | 390 | 6,610 | 390 |
| 25 | 2036 | 34,630 | 2,330 | 36,960 | 190 | 6,610 | 390 | 6,610 | 390 |

| Project Year | Calendar Year[1] | No Action Alternative | | | | Proposed Action | | Partial Backfill Alternative | |
|---|---|---|---|---|---|---|---|---|---|
| | | Net Agricultural Pumping (gpm)[2] | | | Other[3] (gpm) | KVCWF Pumping (gpm) | Pit Inflow[4,5] (gpm) | KVCWF Pumping (gpm) | Pit Inflow[4] (gpm) |
| | | Diamond Valley | Kobeh Valley | Total | | | | | |
| 26 | 2037 | 34,630 | 2,330 | 36,960 | 190 | 6,540 | 460 | 6,540 | 460 |
| 27 | 2038 | 34,630 | 2,330 | 36,960 | 190 | 6,540 | 460 | 6,540 | 460 |
| 28 | 2039 | 34,630 | 2,330 | 36,960 | 190 | 6,540 | 460 | 6,540 | 460 |
| 29 | 2040 | 34,630 | 2,330 | 36,960 | 190 | 6,540 | 460 | 6,540 | 460 |
| 30 | 2041 | 34,630 | 2,330 | 36,960 | 190 | 6,540 | 460 | 6,540 | 460 |
| 31 | 2042 | 34,630 | 2,330 | 36,960 | 190 | 6,580 | 420 | 6,580 | 420 |
| 32 | 2043 | 34,630 | 2,330 | 36,960 | 190 | 6,580 | 420 | 6,580 | 420 |
| 33 | 2044 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 180 | 7,000 | 0 |
| 34 | 2045 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 180 | 7,000 | 0 |
| 35 | 2046 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 180 | 7,000 | 0 |
| 36 | 2047 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 170 | 7,000 | 0 |
| 37 | 2048 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 170 | 7,000 | 0 |
| 38 | 2049 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 170 | 7,000 | 0 |
| 39 | 2050 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 160 | 7,000 | 0 |
| 40 | 2051 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 160 | 7,000 | 0 |
| 41 | 2052 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 160 | 7,000 | 0 |
| 42 | 2053 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 160 | 7,000 | 0 |
| 43 | 2054 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 150 | 7,000 | 0 |
| 44 | 2055 | 34,630 | 2,330 | 36,960 | 190 | 7,000 | 150 | 7,000 | 0 |
| | 2056 - 2105 | 34,630 | 2,330 | 36,960 | 190 | 0 | 150 - 120 | 0 | 0 |
| | 2106 - end | 13,850 | 2,330 | 16,180 | 190 | 0 | 120 - 60 | 0 | 0 |

[1]Calendar years used for numerical ground water flow model simulations; actual startup dates for the Proposed Action or Partial Backfill Alternative would depend on BLM and NDEP authorizations.
[2]Net agricultural pumping means net consumptive loss when referring to irrigation withdrawals. Average annual flow rate in gpm, rounded to nearest ten gpm.
[3] Includes Town of Eureka municipal water-supply pumping and Ruby Hill Mine pumping.
[4] Pit inflow value for Project Year Zero is local mine-area pumping for construction water.
[5] Pit inflow values after Project Year 32 are passive ground water inflows permanently lost to pit lake storage and/or evaporation from the lake's surface.

### 3.2.3.2.3 Pit Dewatering and Water Supply Pumping

The open pit excavation is planned to commence in late 2011, with one year of pre-production followed by 32 years of production. Upon completion, the open pit would extend downward approximately 2,550 feet bgs and would cover an area of approximately 730 acres. Existing ground water levels near the center of the proposed open pit are approximately 300 feet bgs; therefore, a ground water drawdown of approximately 2,250 feet would be required during mining operations to lower the ground water level to below the ultimate open pit bottom. Inflowing ground water would be pumped from sumps in the pit and removed for consumptive use in the mining and milling process. The results of the numerical ground water modeling indicate that the open pit dewatering requirements under the Proposed Action (and the Partial Backfill Alternative and the Off-Site Transfer of Ore Concentrate for Processing Alternative) would range from approximately 60 to 460 gpm (100 to 750 afy) on an average annual basis, as listed in Table 3.2-7 and shown on Figure 3.2.15.

In addition to open pit dewatering, the Proposed Action (and the Partial Backfill Alternative and the Off-Site Transfer of Ore Concentrate for Processing Alternative) would also involve pumping from the KVCWF for mining and milling water supply starting in 2012 and continuing for 44 years. The water-supply pumping was simulated from ten wells located along the well field corridor in central Kobeh Valley, as shown in Figure 3.2.1. Approximately ten percent of the total well field production was withdrawn from simulated wells in carbonate bedrock, whereas the remaining 90 percent was withdrawn from simulated wells in the basin-fill aquifer (Montgomery et al. 2010). The simulated KVCWF total production during the planned 44 years of operation ranged from 6,540 to 7,000 gpm (10,550 to 11,300 afy) on an average annual basis, as listed in Table 3.2-7 and shown on Figure 3.2.15.

The assessment of cumulative impacts associated with the proposed mine dewatering and KVCWF pumping include an evaluation of the total drawdown from all past, present, and reasonably foreseeable future mine dewatering, production well pumping, and other withdrawals of ground water for consumptive use. This includes the following: 1) historic pumping for agricultural irrigation in Diamond and Kobeh Valleys and continuing through the present; 2) projected future ground water withdrawals for agricultural irrigation, municipal water supply and mining and milling uses by other mines within the HSA; and 3) projected future dewatering and KVCWF pumping requirements for the Proposed Action.

3.2.3.2.4 Evaluation of Impacts to Ground Water Levels

The method used for calculating ground water drawdown for the Proposed Action, No Action Alternative, and cumulative effects assessment are described in detail in Montgomery et al. (2010). Briefly, the predicted water-table drawdown for the No Action Alternative was calculated by subtracting the No Action Alternative Scenario predicted water-level elevations at a certain time in the future (approximately 2055) from the simulated water-level elevations at the end of 2009 (Figure 3.2.16), thus illustrating only the predicted future drawdown relative to existing conditions. The predicted water-table drawdown for the cumulative effects assessment was calculated by subtracting the Cumulative Action Scenario predicted water-level elevations at a certain time in the future from the simulated water-level elevations in 1955, thus relating the simulated historic drawdown and the predicted future drawdown to pre-development conditions (Figure 3.2.11). The predicted water-table drawdown for the Proposed Action was calculated by subtracting the simulated No Action Alternative Scenario water-level elevations from the Cumulative Action Scenario water level elevations at the same point(s) in time in the future. By using this methodology, the predicted results for the Proposed Action do not include the simulated changes to ground water elevations that have occurred in the HSA due to the historic pumping and ground water consumption that occurred between 1955 and the end of 2009, which are shown in Figure 3.2.17. Hence, the baseline condition used as the reference for comparison of the Proposed Action and the alternatives is the simulated existing ground water elevations at the end of 2009, whereas for the cumulative analysis the baseline condition is the estimated pre-development steady-state ground water elevations that existed in 1955.

In addition, the magnitude, timing, and areal extent of drawdown was evaluated by analyzing the model simulation results at eight selected time intervals that represent the projected conditions at the end of the proposed mining/milling operations (in 2055) and at ten, 30, 50, 100, 200, 300, and 400 years after KVCWF pumping ceases under the Proposed Action.

### 3.2.3.3 Proposed Action

#### 3.2.3.3.1 Surface Water Resources

*Erosion, Sedimentation, and Flooding within Drainages*

The Project would require the alteration or diversion of existing natural drainages and washes that contain surface flow during the infrequent periods of high rainfall and snowmelt from the Roberts Mountains and at Mount Hope. All of the planned storm water diversion structures are designed to carry estimated peak flows of a 100-year, 24-hour storm event, with additional capacity to safely pass the inflow design flood peak flow during operations and at closure.

Surface disturbance generally causes an increase in erosion. Therefore, sediment from increased erosion may be transported to and accumulate in the local surface drainages. During mine operation, standard erosion prevention and maintenance procedures (see Section 2.1.7.4) would reduce impacts to less than significant levels.

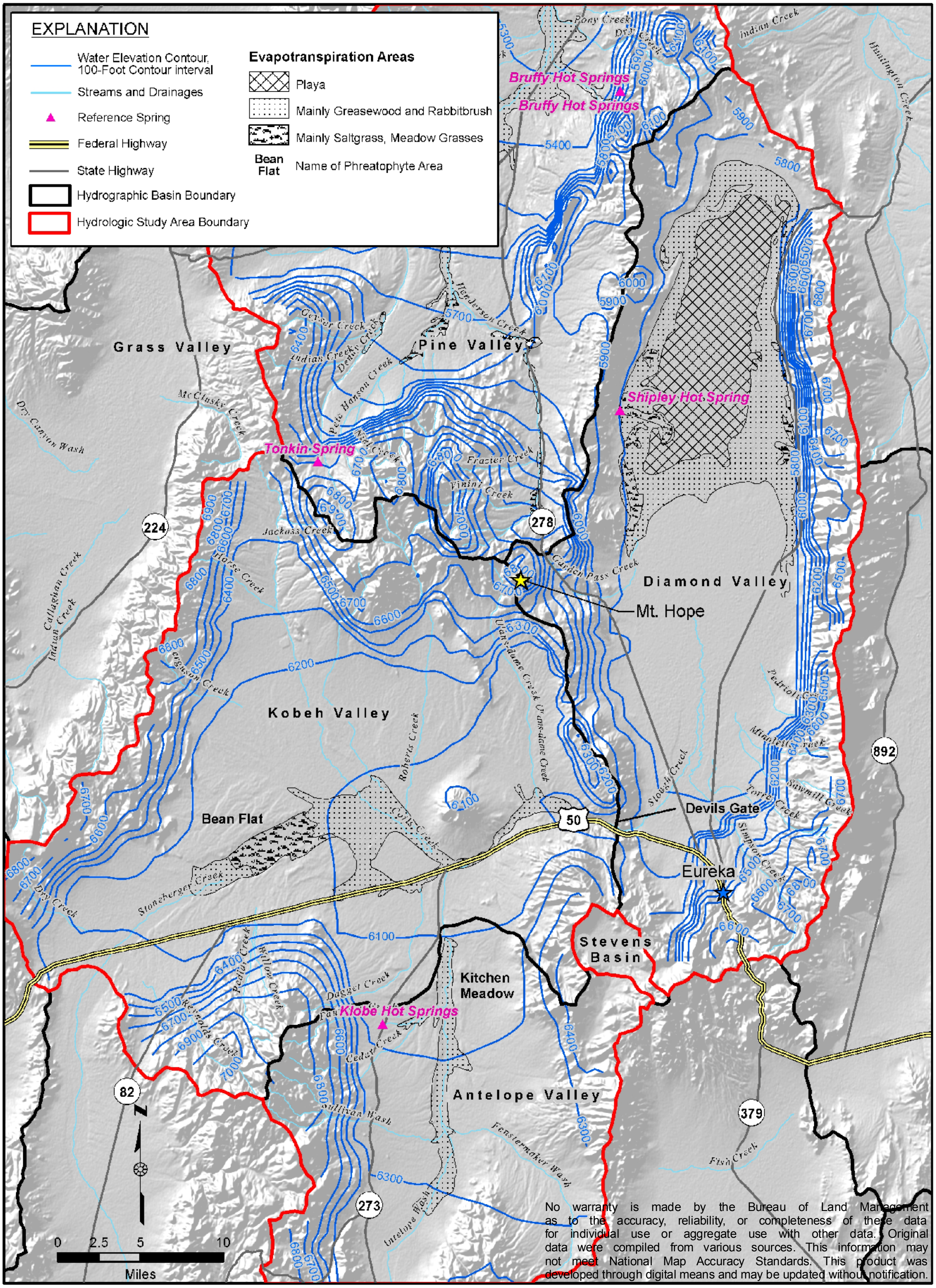
Small drainages affected by roads and small facility structures would be returned to their natural condition during reclamation. Permanent drainage alterations around the open pit, TSFs, and WRDFs would consist of open channels and berms. Such features would be left in place and reclaimed using revegetation or rock lining for stability and elimination of long-term maintenance under post-closure conditions.

- **Impact 3.2.3.3-1:** Grading, earth moving, diversion of drainages, and placement of fill could accelerate erosion and sedimentation, and alter surface water flood runoff patterns during mining and post-closure.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

*Effects of Ground Water Drawdown on Streams, Springs, and Surface Water Resources Covered by a Water Right*

Dewatering would be required in the open pit during the mining phase of the Project. The open pit dewatering would be achieved with in-pit sumps and, if necessary, horizontal drains and perimeter wells would also be used. The average pit inflow rate is estimated to range between 60 to 460 gpm (100 to 750 afy), commencing in Year 1 of the Project (2012) and continuing through Year 32 (2043), as shown in Table 3.2-7. In addition, ground water pumping in the KVCWF area for process-water supply would be achieved with high capacity production wells completed in the basin-fill and carbonate bedrock aquifers. The average total combined pumping rate of the well field is estimated to range between 6,540 to 7,000 gpm (10,550 to 11,300 afy), commencing in Year 1 of the Project (2012) and continuing through Year 44 (2055), as shown in Table 3.2-7. The open pit dewatering activities and KVCWF pumping would lower (draw down) the water table in the vicinity of those facilities. The predicted maximum drawdown in the




Date: 07/07/10. Filename: z:\Interflowshare\MountHope_GIS_Project\RevisedFigures_June2010\2009WaterLevels_MA_Rev.mxd.

Source: Montgomery et al. (2010).

| | | | |
|---|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | |
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | |
| CHECKED: - | APPROVED: RFD | DATE: 09/22/2011 | |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | | |

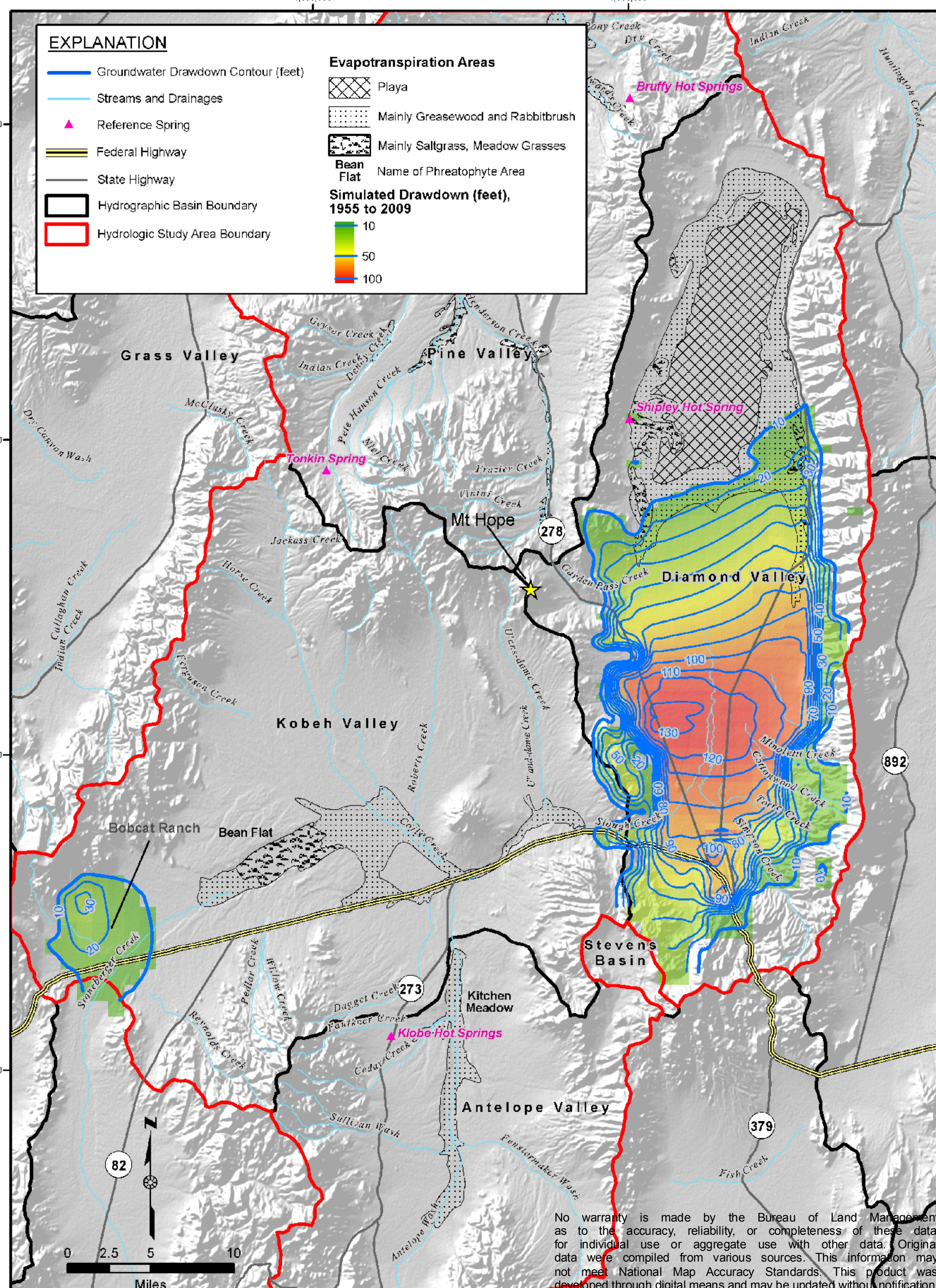
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Simulated Ground Water Elevations in 2009**

**Figure 3.2.16**




Date: 04/26/10 Filename: Z:\interflowshare\projectfiles\MountHope_GIS_Project\Transient_Model\Cumulative\WorkingDraft_MA\CurrentConditionsDDLayer1_2009_MA.mxd UTM83 NAD83, Zone11

| | | | |
|---|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | |
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | |
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 | |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Simulated Water Table Drawdown in 2009, Relative to Pre-Development Conditions (circa 1955)**

**Figure 3.2.17**

bedrock of the open pit area is approximately 2,250 feet, whereas in central Kobeh Valley, the predicted maximum drawdown is approximately 120 feet near the center of the well field after 44 years of pumping. This section investigates the potential for drawdown of the water table to affect surface water flow in certain streams and springs.

Figure 3.2.18 shows, graphically, the results of the numerical ground water flow model expressed as water table drawdown contours at the end of the mining and milling operations under the Proposed Action. This figure illustrates areas where the water levels are predicted to decrease over time, in comparison to the existing baseline ground water elevations at the end of 2009, due solely to the Proposed Action. By the end of the mining and milling operations (in 2055), two distinct drawdown areas are predicted to develop: one area centered on the open pit and the other area surrounding the KVCWF wells. These ground water modeling results indicate that the ground water would be drawn down by more than ten feet at 18 spring locations and at one perennial stream segment (Roberts Creek) at the end of the mining and milling operations. The ground water level is not expected to be drawn down by more than ten feet at any other spring or perennial stream segment at the end of mining/milling operations. Ten of the potentially affected springs (Table 3.2-8) and the perennial stream segments appear to be associated with water rights, as listed in Table 3.2-6. There are no PWRs within the ten-foot drawdown. In addition, springs that have not been identified as having PWRs, but may have sufficient flows (1,800 gpd) to support a PWR claim could be affected. It should be noted that the plotted spring locations in Figure 3.2.18 and other figures showing drawdown were obtained from various sources, as described in Section 3.2.2.3.2, whereas the water rights locations were derived from NDWR files. Both data sets appear on the figures; however, it should be understood that a single spring may be represented by more than one point; its actual location and in addition one or more associated water rights locations.

**Table 3.2-8: Springs that May be Affected by Project Activities**

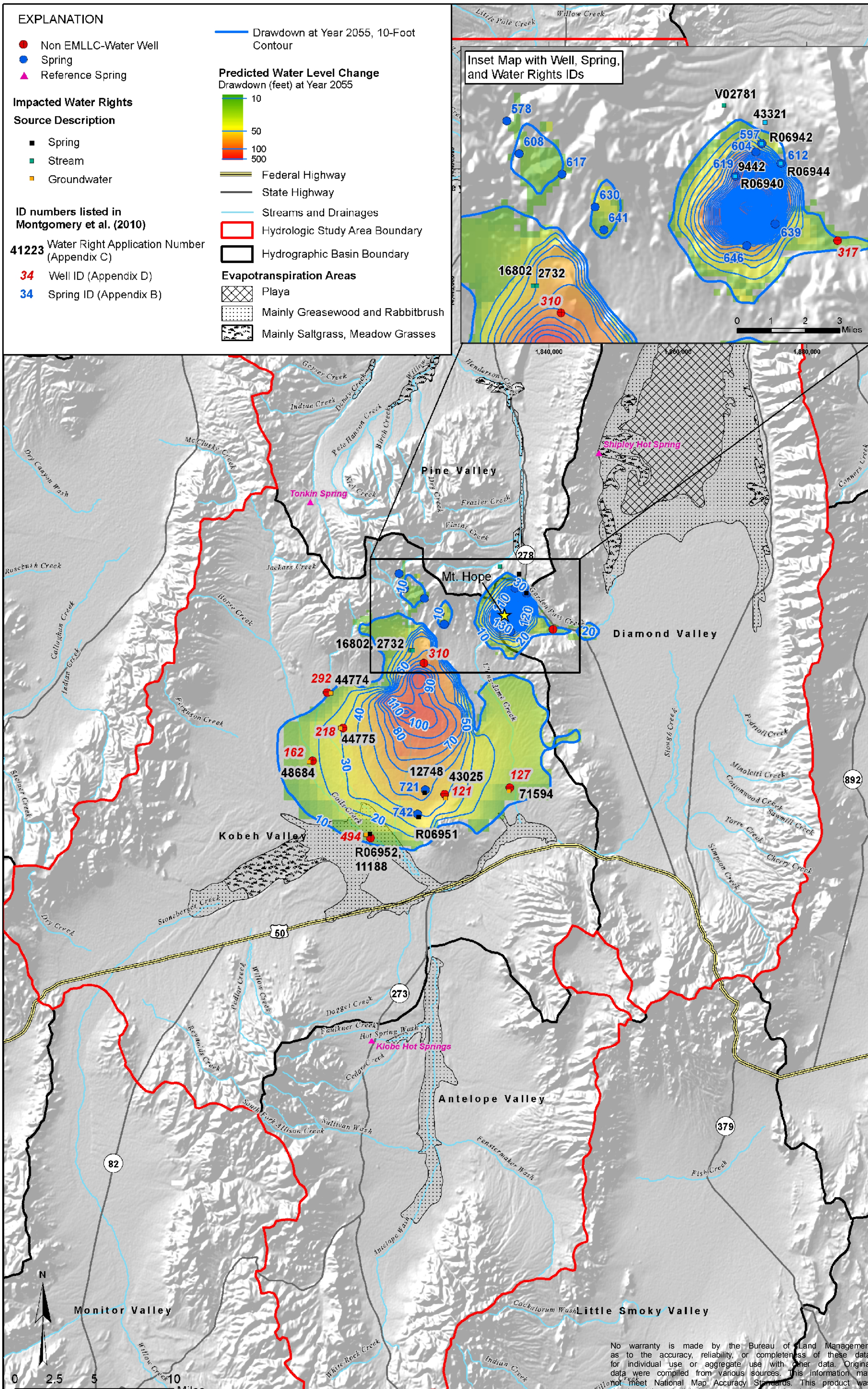
| Spring Number | Spring Name | Basin | Flow (gpm) | Use |
|---|---|---|---|---|
| 578 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 583 | Unnamed Spring | Pine Valley | -- | Livestock, Wildlife, and Wild Horses |
| 587 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 592 | Unnamed Spring (OT-2) | Pine Valley | 9.03 | Livestock, Wildlife, and Wild Horses |
| 597 | Garden Spring | Pine Valley | <0.1 | Livestock, Wildlife, and Wild Horses |
| 600 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 601 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 604 | Unnamed Spring | Diamond Valley | <0.1 | Livestock, Wildlife, and Wild Horses |
| 605 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 608 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 609 | Unnamed Spring (OT-5) | Pine Valley | -- | Livestock, Wildlife, and Wild Horses |
| 610 | Unnamed Spring (OT-3) | Pine Valley | 1.53 | Livestock, Wildlife, and Wild Horses |
| 612 | McBrides Spring | Diamond Valley | 1.8 | Livestock, Wildlife, and Wild Horses |
| 617 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 619 | Mount Hope Spring | Diamond Valley | 0.03 | Livestock, Wildlife, and Wild Horses |
| 630 | Unnamed Spring (OT-8) | Kobeh Valley | 6.97 | Livestock, Wildlife, and Wild Horses |

| Spring Number | Spring Name | Basin | Flow (gpm) | Use |
|---|---|---|---|---|
| 634 | Farrington Spring | Kobeh Valley | <1 | Livestock, Wildlife, and Wild Horses |
| 639 | Zinc Adit | Diamond Valley | 8 | Livestock, Wildlife, and Wild Horses |
| 641 | Unnamed Spring (OT-7) | Kobeh Valley | 2.36 | Livestock, Wildlife, and Wild Horses |
| 646 | Unnamed Spring (SP-7) | Diamond Valley | -- | Livestock, Wildlife, and Wild Horses |
| 721 | Mud Spring | Kobeh Valley | <1 | Livestock, Wildlife, and Wild Horses |
| 742 | Lone Mountain Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |

After dewatering ceases, the ground water would begin to recover in the open pit area. Similarly, ground water in the basin-fill and bedrock aquifers of Kobeh Valley would begin to recover when pumping in the KVCWF ceases. The limits of ground water drawdown surrounding the open pit and KVCWF would continue to expand in the perimeter areas after open pit dewatering and production well pumping cease, as the open pit and dewatered portions of the aquifers fill with ground water that is derived from storage as well as natural recharge. Due to aquifer geometry and heterogeneity, the rate and ultimate extent of continued lateral expansion of drawdown would not be the same in all directions. Figure 3.2.19 shows the simulated ten-foot water table drawdown contours at ten, 50, 100, 150, 200, 250, 300, 350, and 400 years of post-Project recovery, and illustrates the composite maximum-extent-of-drawdown used in this analysis. The boundary of the maximum-extent-of-drawdown encompasses all of the areas that are predicted to experience more than ten feet of drawdown at any time in the future due to the Proposed Action. In the vicinity of Mount Hope, the maximum extent of the ten-foot drawdown contour is approximately one mile beyond its location at the end of the mining and milling operations, whereas for the area surrounding the KVCWF, the difference generally is much less (on the order of 0.1 mile) beyond the ten-foot drawdown contour at the end of active pumping.

The maximum extent of the ten-foot drawdown contour encompasses 22 springs, two perennial stream segments (Roberts Creek and Henderson Creek), and portions of four intermittent and ephemeral stream drainages (Coils Creek, Rutabaga Creek, U'ans-in-dame Creek, and Garden Pass Creek), as shown in Figure 3.2.20. As discussed in Section 3.2.2.3.1, the stream reaches and springs located in this area can be characterized as either intermittent, ephemeral, or perennial. Intermittent and ephemeral stream reaches and spring sites flow only during or after wet periods in response to rainfall or snowmelt runoff events. By definition, these surface waters are not controlled by discharge from the regional ground water system. During the low flow period of the year (late summer through fall), intermittent and ephemeral stream reaches and springs typically would be dry.

In contrast, perennial stream segments and springs generally flow throughout the year. Flows observed during the wet periods, which typically extend from spring through early summer, include a combination of surface runoff and ground water discharge, whereas flows observed during the low-flow period are sustained entirely by discharge from the ground water system. If the flow in these stream segments and springs relies on the aquifer that is being dewatered, a reduction of ground water levels from mine-induced drawdown could reduce the ground water discharge to perennial stream segments or springs. The Pete Hanson Decree adjudicates all stream waters tributary to both Pete Hanson and Henderson Creek. The decree grants water rights subject to restrictions on points of diversion, season of use, and total duty. Potential




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 09/22/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

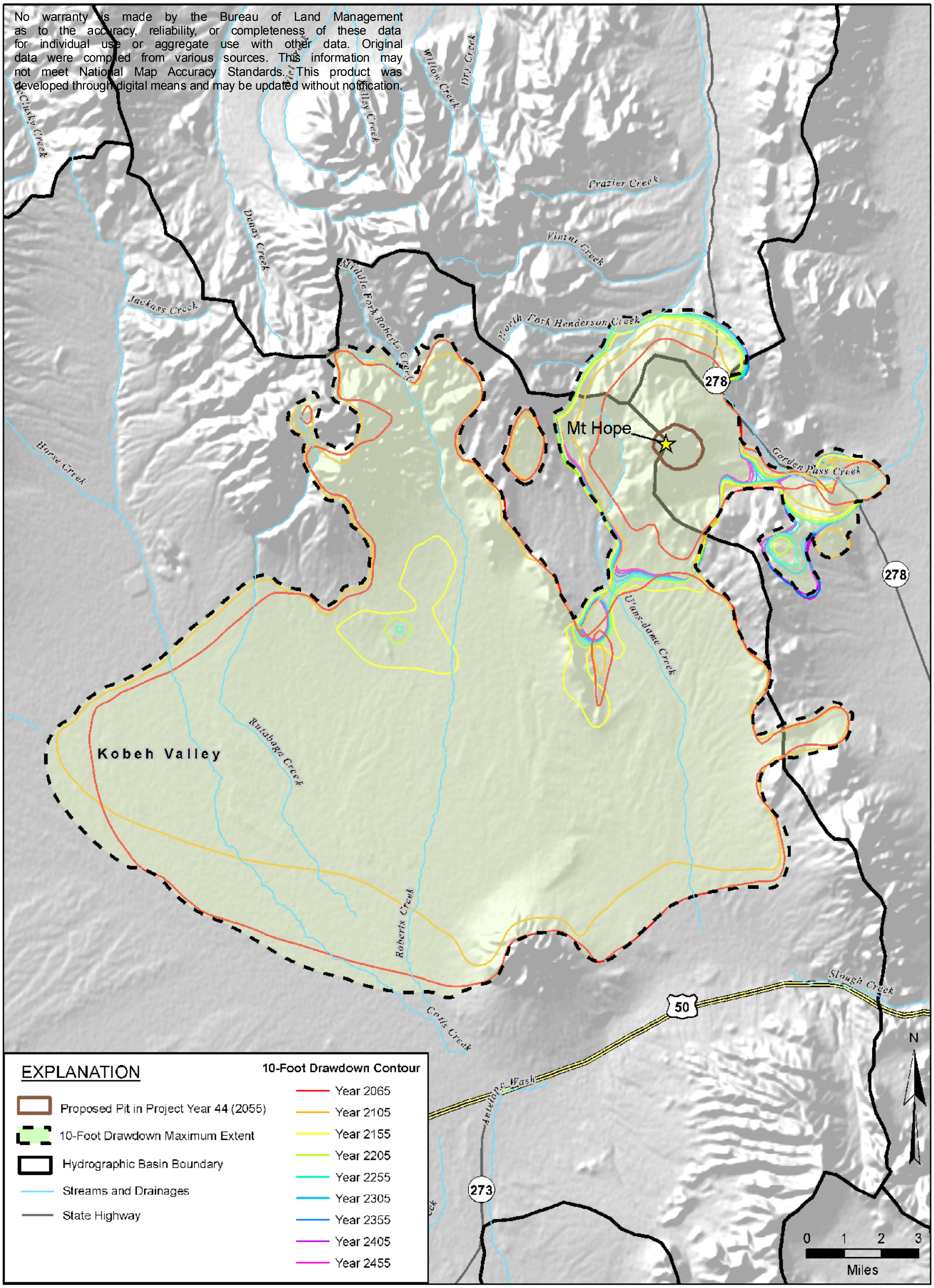
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

**Proposed Action Simulated Ground Water-Level Change in Year 2055, Relative to 2009 Conditions**

**Figure 3.2.18**




Date 07/13/10 Filename: Z:\Interflowshare\projectfiles\MountHope_GIS_Project\RevisedFigures_June2010\ExtentofDrawdown_PostYears_10_50_100_150_200_250_300_350_400_Rev.mxd.

| | | | |
|---|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | |
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | |
| CHECKED: - | APPROVED: RFD | DATE: 07/13/2011 | |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | | |

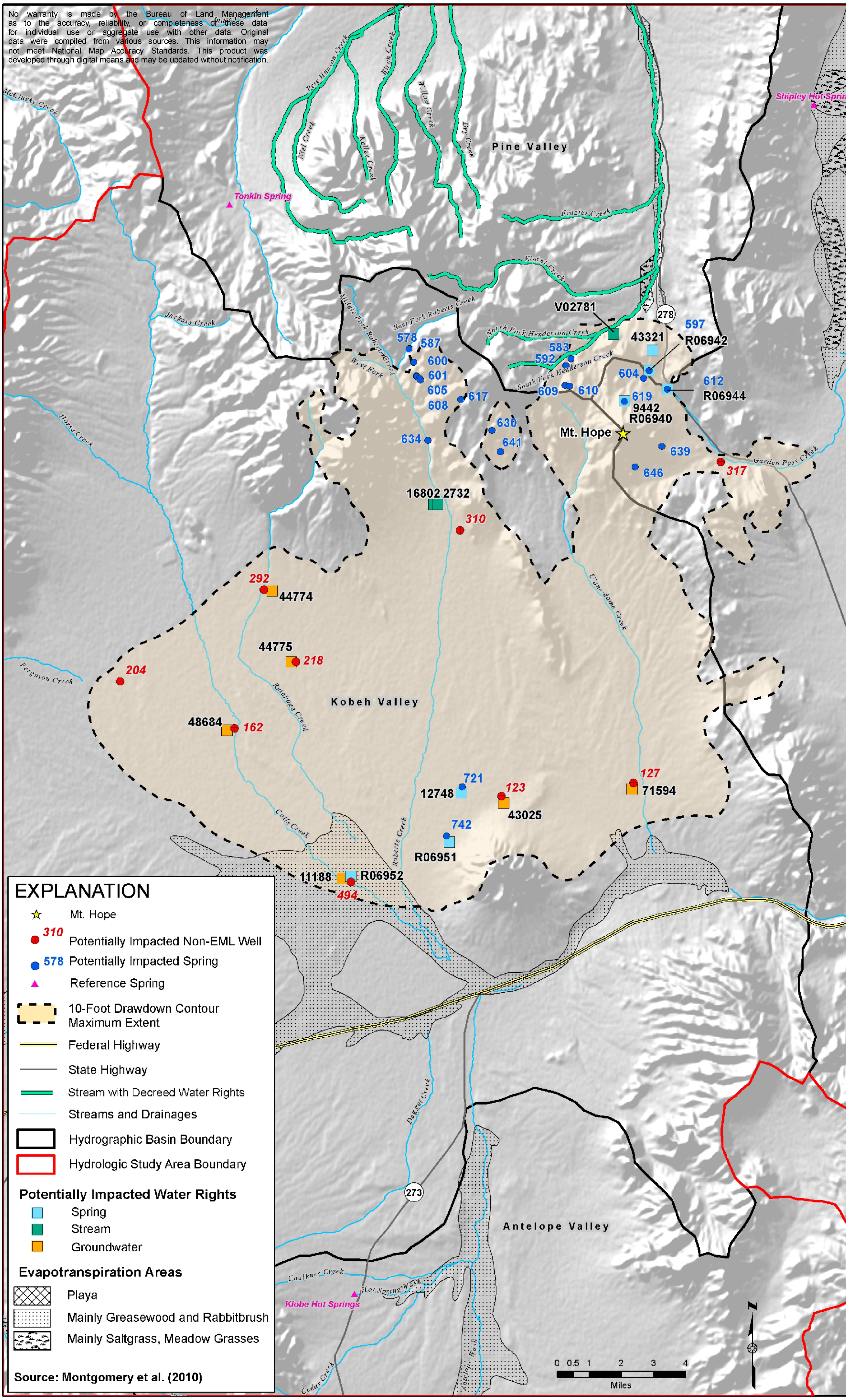
**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Proposed Action Simulated Ten-Foot Water Table Drawdown Contours During 400 Years of Post-Mining Recovery**

**Figure 3.2.19**




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 07/28/2011 |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Water Rights within the Proposed Action Simulated Maximum Extent of Ten-Foot Water Table Drawdown**

**Figure 3.2.20**

adverse effects to water rights from the Project would be mitigated subject to NDWR jurisdiction.

Of the 22 potentially impacted springs, six appear to be associated with water rights (Table 3.2-6) and at least eight are considered perennial (Table 3.2-8). The identified potentially-impacted perennial springs are all located at high elevations in the Roberts Mountains and on the flanks of Mount Hope, and within approximately four miles of the proposed open pit. The source of these springs is believed to be the fractured bedrock aquifer, which receives recharge from the higher elevations as infiltration of snowmelt and rainfall. It is possible that geologic block faulting has compartmentalized the ground water flow at some of these spring sites so that they would be isolated from mine-induced drawdown, but there is no available evidence to define such conditions if they exist. For the purposes of this analysis, it was conservatively assumed that all of the springs located in this area are interconnected with the regional ground water system and potentially could be impacted due to water-table lowering attributable to the Proposed Action.

Surface water flow in Roberts Creek, located approximately 6.5 miles west of the proposed open pit, is fed by springs that flow into Roberts Creek or its tributaries. The upper spring-fed segments of Roberts Creek generally flow throughout the year, but the springs within the drawdown area that feed those segments are believed to originate in areas of localized, perched ground water that are not hydraulically interconnected with the regional ground water system.

Surface flow in Roberts Creek diminishes below the confluence of its upper three forks, where the creek enters a small limestone canyon for approximately one mile and then opens into a broad alluvial channel after the stream exits the mountain valley. It is assumed that stream flow in that reach potentially could be impacted due to water-table lowering attributable to the Proposed Action because the simulated ground water drawdown is greater than ten feet beneath a perennial segment of Roberts Creek.

Surface water flow in the South Fork of Henderson Creek, located approximately three miles northwest of the proposed open pit, is perennial and is believed to be sustained by both perennial and non-perennial springs in headwater drainages that feed into the creek. Year-round flow occurs along at least a two-mile segment of the South Fork of Henderson Creek and ceases near its confluence with the North Fork of Henderson Creek, where all of the surface water flow infiltrates into the stream bed. Then approximately ten miles downgradient, the flow resurfaces, where it is used for irrigation. It is assumed that stream flow in that reach potentially could be impacted due to water table lowering attributable to the Proposed Action because the simulated ground water drawdown is greater than ten feet beneath a perennial segment of the South Fork of Henderson Creek. The other streams in the HSA are either located outside of the maximum-extent-of-drawdown induced by the Proposed Action, or are intermittent or ephemeral streams that would not be expected to be significantly impacted by mine-related dewatering and KVCWF pumping.

The actual impacts to individual stream reaches or springs would depend on the source of ground water that sustains the flow (perched or hydraulically isolated aquifer versus regional ground water system) and the actual extent of mine-induced drawdown that occurs in the area. The interconnection (or lack thereof) between surface water features and deeper ground water sources is controlled in large part by the specific hydrogeologic conditions that occur at each site.

Considering the complexity of the hydrogeologic conditions in the region and the inherent uncertainty in numerical modeling predictions relative to the exact areal extent of a predicted drawdown area, it is not possible to conclusively identify specific stream segments or springs that would or would not be impacted by future mine-induced ground water drawdown.

If the Project is approved, EML would be required to monitor surface and ground water to assess the extent of drawdown from open pit dewatering and ground water production over time and the potential effects to surface and ground water resources in the vicinity of the Project. EML's proposed monitoring program is outlined in Section 2.1.15 and Appendix B of this EIS.

- **Impact 3.2.3.3-2**: The ground water drawdown under the Proposed Action is predicted to be more than ten feet for two perennial stream segments (Roberts Creek and South Fork of Henderson Creek) and at 22 perennial or potentially perennial spring sites (Table 3.2-8) for varying periods of time up to at least 400 years after the end of the mining and milling operations.

  **Significance of the Impact:** The impacts are potentially significant at the two stream segments and 22 springs discussed above. Although significant impacts are not predicted to occur in the other individual streams or springs in the HSA due to the Proposed Action, the uncertainty of predicting impacts to streams and springs indicates a need for operational monitoring and mitigation measures to be implemented if significant impacts occur. If there are reduced flows in perennial stream segments or springs, based on monitoring (that the BLM determines can be attributed to the mining operation), then mitigation measures would be implemented, as described below.

- **Mitigation Measure 3.2.3.3-2a:** Specific mitigation for the two perennial stream segments and 22 perennial or potentially perennial spring sites are outlined in Table 3.2-9. Implementation of the mitigation outlined in this table would result in up to 46.3 acres of additional surface disturbance associated with the pipeline construction and maintenance. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B to track the drawdown associated with the open pit dewatering and ground water production activities. In addition, EML would periodically update the ground water flow model as determined by the BLM. EML would be responsible for monitoring and annual reporting of changes in ground water levels and surface water flows prior to and during operation, and for a period of up to 30 years in the post mining and milling phase.

- **Mitigation Measure 3.2.3.3-2b:** If monitoring (Mitigation Measure 3.2.3.3-2a) indicates that flow reductions of perennial surface waters are occurring and that these reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation would be required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted perennial water resource(s). Potential adverse effects to water rights from the

## Table 3.2-9: Surface Water Resources Specific Mitigation

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 578 | Unnamed Spring | 74.20 | This site is an emergent spring with water flowing from the hillside rocks 100 feet upstream to Roberts Creek. This site supports a diverse riparian vegetation community This site is used by wildlife and livestock for water and foraging. | 0.120 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-1: Pipe water along an existing road, approximately 7.9 miles long, from the Project water supply at a sustained rate of approximately 70 gpm. | The mitigation plan for SSMM-1 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horses uses, as well as flows for existing downstream irrigation uses. | Up to approximately 9.7 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 583 | Unnamed Spring | 5.62 | This site is a seep within a channel producing flow down gradient from the source. This site supports a riparian vegetation community. This site shows low utilization by livestock and wildlife. | 0.030 | Water supply for wildlife and wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-2: Pipe water along an existing road, approximately 6.9 miles long, from the Project water supply at a sustained rate of approximately five gpm. | The mitigation plan for SSMM-2 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horses uses, as well as flows for existing downstream irrigation uses. | Up to approximately 8.4 acres of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 587 | Unnamed Spring | 0.00 | This site is a seep that contains ponded standing water within hoof depressions only. Moderate hummocking was observed. The riparian vegetation community is present. An old fenceline runs through the middle of the site with fence posts remaining. This site shows moderate livestock use for water and forage. | 0.110 | Water supply for wildlife, livestock, and wild horses. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring | SSMM-3: Pipe water along a new road, approximately 0.3 mile long, from the pipeline to spring 578 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-3 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.7 acre of new surface disturbance for the installation and maintenance of the water pipeline. |
| 592 | Unnamed Spring (OT-2) | 11.90 | This site is a seep with saturated soil, but not contributing flow into the drainage. This site supports a riparian vegetation community. This site shows moderate livestock use for water. | 0.250 | Water supply for wildlife and wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-4: Pipe water along an existing road, approximately 0.3 mile long, from the pipeline to spring 583 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-4 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.7 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 597 | Garden Spring | 0.00 | This site consists of two adjacent ponded sources of water. There is piping and an old trough downgradient of the sites that is no longer functioning. Riparian vegetation is supported by these sites. These sites show use by wildlife, livestock, and wild horses. | 0.020 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-5: Pipe water along an existing and new road, approximately 2.8 miles long, from the pipeline to spring 583 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-5 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 4.1 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 600 | Unnamed Spring | 0.00 | This site is a seep located in an aspen stand. Flow from this site combines with flow from site 601 (to the east) and flows into a spring/meadow complex. Riparian vegetation is supported by this site. This site shows moderate use by livestock and wild horses for water and forage. | 2.360 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-6: Pipe water along an existing road, approximately 0.29 mile long, from the pipeline to spring 578 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-6 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.7 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 601 | Unnamed Spring | 6.80 | This site is a seep located in an aspen stand. Flow from this site combines with flow from site 600 (to the west) and flows into a spring/meadow complex. Riparian vegetation is supported by this site. This site shows moderate use by livestock and wild horses for water and forage. | 0.00* | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-7: Pipe water along an existing road, approximately 0.03 mile long, from the pipeline to spring 600 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-7 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.07 acre of new surface disturbance for the installation and maintenance of the water pipeline. |
| 604 | Unnamed Spring | 0.00 | This site consists of a man-made pond. The site has little riparian vegetation around the edge of the pond. This site show heavy use by wildlife and wild horses for water. | 0.060 | Water supply and riparian habitat for wildlife, livestock, and wild horses. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-8: Pipe water along an existing road, approximately 0.51 mile long, from the pipeline to spring 597 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-8 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.6 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 605 | Unnamed Spring | 4.40 | This site is part of a four spring complex with two channels flowing and is surrounded by Site 600, Site 601, and Site 608. These four sites are connected by riparian vegetation. Flow leaves the site in two separate channels. Riparian vegetation is present at this site. This site shows moderate to heavy use by livestock and wild horses for a water source and forage. | 0.00* | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-9: Pipe water along an existing road, approximately 0.1 mile long, from the pipeline to spring 601 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-9 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.2 acre of new surface disturbance for the installation and maintenance of the water pipeline. |
| 608 | Unnamed Spring | 4.20 | This site is part of a four spring complex and consists of a saturated area with flow forming in the channel below. Riparian vegetation is supported at this site This site shows heavy use by livestock and wild horses for water and forage. | 0.00* | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-10: Pipe water along an existing road, approximately 0.06 mile long, from the pipeline to spring 605 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-10 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.1 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 609 | Unnamed Spring (OT-5) | 0.06 | This site consists of a seeping area with a man-made berm to create a pond. There is flow from the seeping area into the pond, but no flow is leaving the pond. Riparian vegetation is supported at this site. This site shows use by livestock and wild horses for water. | 0.170 | Water supply for wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-11: Pipe water along an existing road, approximately 1.0 mile long, from the pipeline to spring 583 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-11 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 1.2 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 610 | Unnamed Spring (OT-3) | 1.40 | This site consists of a spring flowing into a pond created by a man-made berm. Water also flows from the man-made pond. Riparian vegetation is supported at this site. This site is used as a water source by livestock and wildlife. | 0.120 | Limited use as a water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-12: Install a guzzler designed for large game. | Mitigation plan for SSMM-12 would be highly effective at maintaining a water supply for wildlife. | Approximately 0.7 acre of new surface disturbance for guzzler installation. |
| 612 | McBrides Spring[4] | 0.35 | The site is a spring that has been developed with a valve box and water trough. Flow to the trough is controlled by a valve. There is no riparian vegetation at this site. This site is used by livestock, wildlife, and wild horses as a water source. | 0.000 | Perennial water supply for livestock, wildlife, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-13: Install a guzzler designed for large game. | Mitigation plan SSMM-13 would be highly effective at maintaining a water supply for wildlife. | Approximately 0.7 acre of new surface disturbance for guzzler installation. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 617 | Unnamed Spring | 0.00 | This site consists of an area saturated by a seep. There is no flow at this site. Riparian vegetation is supported at this site. This site shows heavy use by livestock for water and forage. | 0.110 | Water supply and riparian habitat for wildlife and wild horses, and limited livestock use. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-14: Pipe water along an existing road, approximately 4.5 miles long, from the pipeline to spring 578 at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-14 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 5.5 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 619 | Mount Hope Spring[4] | 0.03 | This site is a low-flow spring that has been developed with a trough. There is no riparian vegetation at this site. This site is used by livestock, wildlife, and wild horses as a water source. | 0.000 | Wildlife and wild horses. | Prior to the construction of the Project fence. | SSMM-15: Install a guzzler north of the Project fence designed for large game. | Mitigation plan for SSMM-15 would be highly effective at maintaining a water supply for wildlife. | Approximately 0.7 acre of new surface disturbance for guzzler installation. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 630 | Unnamed Spring (OT-8) | 7.31 | This site consists of a spring that has been partially developed with piping. Water is piped from the source to a bermed ponded area holding water then into a second bermed ponded area. The site is partially fenced. Riparian vegetation is supported at this site. This site shows heavy use by livestock and wild horses outside of the fenced area. | 0.080 | Water supply for wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-16: Pipe water along an existing road, approximately 3.2 miles long, from the Project water supply at a sustained rate of approximately seven gpm. | The mitigation plan for SSMM-16 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 3.9 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 634 | Farrington Spring | 1.10 | This site consists of a bank seep adding flow to the drainage. Riparian vegetation is supported by this site. This site shows moderate use by livestock for water and forage. | 0.001 | Water supply for wild horses with limited livestock use. | Any mitigation for this site would be addressed and covered under the mitigation for Roberts Creek. See SSMM-22. | | | |
| 639 | Zinc Adit | 2.00 | This site consists of water flowing from underground workings. The site supports an area of saturated soils and sparse riparian vegetation. This site is used by wildlife and wild horses as a water source. | 0.120 | Water supply for wild horses with limited livestock use. | Prior to the construction of the Project fence. | SSMM-17: Install a guzzler east of the Project fence and west of SR 278 designed for large game. | Mitigation plan for SSMM-17 would be highly effective at maintaining a water supply for wildlife. | Approximately 0.7 acre of new surface disturbance for guzzler installation. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 641 | Unnamed Spring (OT-7) | 2.70 | This site is a spring contained with the aid of earthen berms to form ponds. There is non-functioning piping present at the site. Riparian vegetation is supported at the site. This site is used by wildlife and wild horses as a water source. | 0.290 | Water supply for wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-18: Pipe water along a new road, approximately 0.02 mile long, from the pipeline to spring 630 at a sustained rate of approximately two gpm. | The mitigation plan for SSMM-18 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.1 acre of new surface disturbance for the installation and maintenance of the water pipeline. |
| 646 | Unnamed Spring (SP-7) | 0.00 | This site is a ponded spring with no flow. Riparian vegetation is present at this site. This site is used by livestock and wild horses as a water source. | 0.000 | Perennial water supply for livestock, wildlife, and wildhorses | Prior to the construction of the Project fence. | SSMM-19: Install a guzzler east of the Project fence and west of SR 278 designed for large game. | Mitigation plan for SSMM-19 would be highly effective at maintaining a water supply for wildlife. | Approximately 0.7 acre of new surface disturbance for guzzler installation. |
| 721 | Mud Spring | 0.00 | This site consists of a spring emerging from the alluvium creating a pond in the valley. Riparian vegetation is supported at this site. This site is used as a water source for livestock, wildlife, and wild horses. | 0.310 | Water supply for wild horses with limited livestock use. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-20: Pipe water along an existing road, approximately 0.24 mile long, from the Project water supply at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-20 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.3 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 742 | Lone Mountain Spring (KV035) | 0.00 | This site consists of a spring emerging from the alluvium creating a pond in the valley. Riparian vegetation is supported at this site. This site is used as a water source by wildlife and wild horses. | 0.200 | Water supply for wild horses with limited livestock use. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring | SSMM-21: Pipe water along a new road, approximately 1.61 miles long, from the Project water supply at a sustained rate of approximately 0.5 gpm. | The mitigation plan for SSMM-21 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 3.9 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| -- | Roberts Creek[4] | 6,825 | | *[5] | Perennial water supply for irrigation, livestock, wildlife, and wildhorses | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-22: Pipe water from the Project water supply at a minimum sustained rate of approximately 600 gpm. In the spring, as determined by the BLM, have three months of flow at 6,500 gpm. The supplimental flows would be discharged to the stream at multiple locations, as determined by the BLM. The pipeline under SSMM-1 would be utilized for this mitigation measure. | The mitigation plan for SSMM-22 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses, as well as flows for existing downstream irrigation uses. | Up to approximately one acre of new surface disturbance for the installation and maintenance of the water pipeline. The pipeline under SSMM-1 would be utilized for this mitigation measure. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics (as of the 2011 Site Visit) | Associated Riparian/ Wetland Vegetation (acres)[2] | General Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| -- | Henderson Creek[4] | 2,904 | | *[5] | Perennial water supply for irrigation, livestock, wildlife, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-23: Pipe water from the Project water supply at a minimum sustained rate of approximately 300 gpm. In the spring, as determined by the BLM, have three months of flow at 2,500 gpm. The supplimental flows would be discharged to the stream at multiple locations, as determined by the BLM.The pipeline under SSMM-2 would be utilized for this mitigation measure. | The mitigation plan for SSMM-23 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses, as well as flows for existing downstream irrigation uses. | Up to approximately one acre of new surface disturbance for the installation and maintenance of the water pipeline. |

[1]All flow data in this table from JBR 2011, unless otherwise noted

[2]All acreage data in this table from JBR 2011, unless otherwise noted

[3]Disturbance areas would be managed and reclaimed in accordance with BLM and State of Nevada requirements.

[4]Flows from Montgomery et al. 2010

[5]The riparian areas along the creeks have not been mapped in detail.

This Page Intentionally Left Blank

Project would be mitigated subject to NDWR jurisdiction. The mitigation plan would be submitted to the BLM identifying the excess amount of drawdown or drawdown impacts to surface water resources. Mitigation would depend on the actual impacts, site-specific conditions, and historical use and could include a variety of measures (e.g., flow augmentation, on-site or off-site improvements). Methods to enhance or replace the impacted perennial water resources include, but are not limited to, the following:

- Modification of pumping distribution in the water supply well field;
- Injection to confine the drawdown cone;
- Installation of a water-supply pump in an existing well (e.g., monitoring well);
- Installation of a new water production well;
- Piping from a new or existing source;
- Installation of a guzzler;
- Enhanced development of an existing seep or spring to promote additional flow; or
- Fencing or other protective measures for an existing seep to maintain flow.

3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

- **Mitigation Measure 3.2.3.3-2c**: The numerical ground water flow modeling indicates that some impacts to springs may occur after the end of mining and milling operations, when some of the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policies using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. If the BLM determines that the Project impacts perennial stream segments or springs in this post-operational phase, mitigation consisting of one or both of the following measures would be required:

1. Installation of a well and pump at affected stream or spring locations to restore the historic yield of the affected surface water resource.

2. Posting of an additional financial guarantee to provide for potentially affected water supplies in the future.

- **Effectiveness of Mitigation and Residual Effects:** Mitigation would be designed to address the specific spring or surface water that is affected, which enhances the effectiveness of the mitigation. In addition, a variety of approaches to mitigation can be used within these measures to achieve the objective. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by restoring or enhancing surface flows, and because the measures would be reviewed and addressed by the BLM. The effectiveness of Mitigation Measure 3.2.3.3-2c, if implemented, is less certain since it would be many decades in the future. If initial implementation was not successful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. However, if measures used in Mitigation Measure 3.2.3.3-2b are implemented, then the measure should be effective at mitigating the impacts from reduced surface water flows. Over a long period of time (tens to 100s of years) the effects to most surface water flows would diminish; however, for the springs nearest to the open pit, flows would be reduced or eliminated in perpetuity.

#### 3.2.3.3.2 Ground Water Resources

*Lowering of the Water Table*

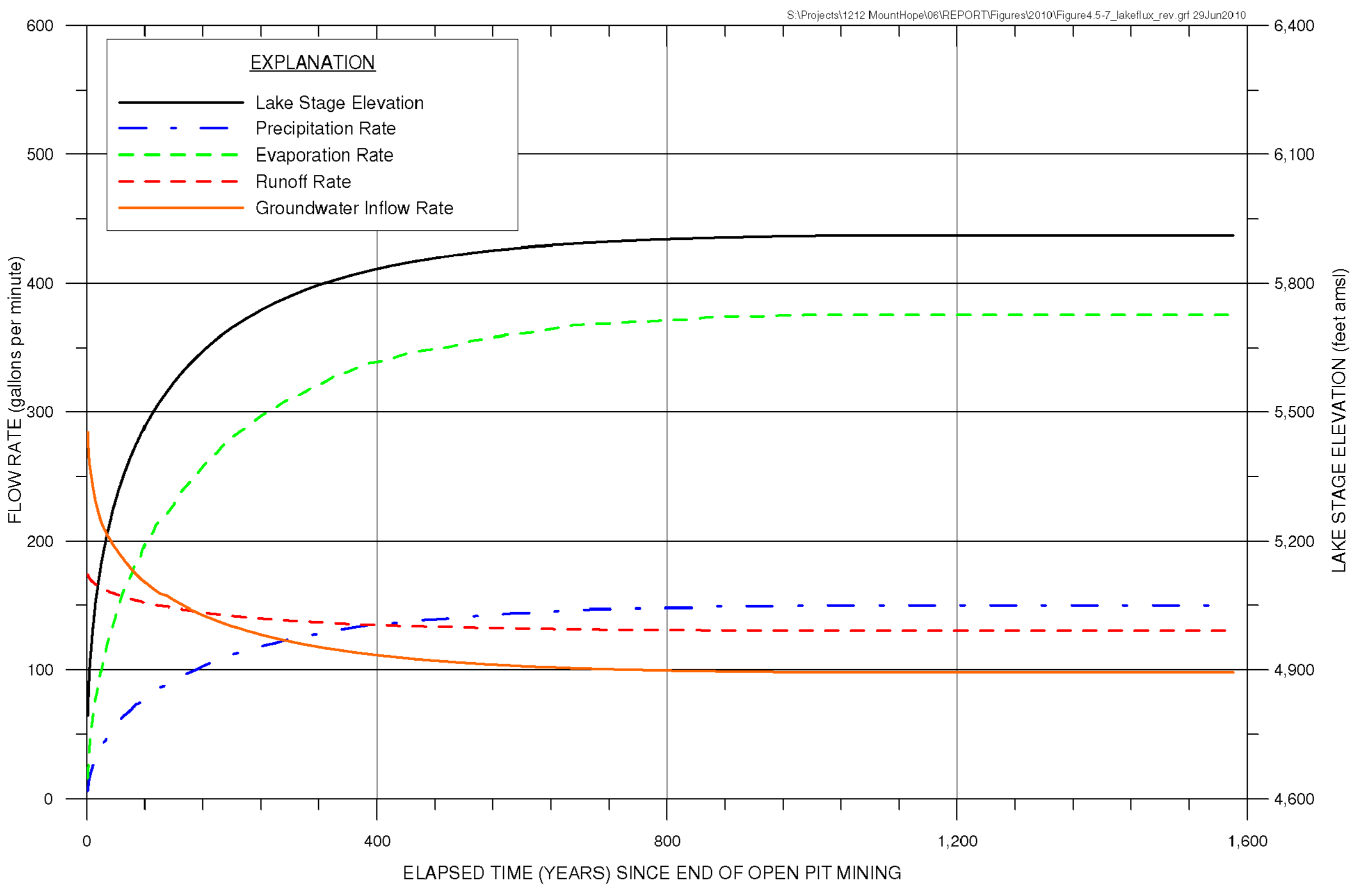
The dewatering associated with the proposed open pit mining would lower the bedrock ground water elevations by approximately 2,250 feet in the vicinity of the open pit during mining operations. At the same time, and continuing for 12 years after the end of pit dewatering, pumping in the KVCWF for process water supply would lower the water table in the basin-fill and bedrock aquifers of central Kobeh Valley and the southern part of the Roberts Mountains. Based on numerical ground water flow modeling, the expected amount of drawdown near the center of the KVCWF is approximately 120 feet after 44 years of pumping under the Proposed Action (Montgomery et al. 2010). The ground water levels in the areas of the open pit and the KVCWF would begin to recover immediately after Project-related dewatering and pumping cease. The Regional Model was used to evaluate water level recovery for a post-Project period of 400 years, whereas the post-Project recovery time frame simulated with the Local Model was 1,580 years. The longer period simulated with the Local Model exceeded the time required for ground water recovery in the pit area and for pit lake formation, but was completed to ensure that equilibrium conditions had been achieved for the pit lake (Figure 3.2.21).

<u>Impacts to Ground Water Resources</u>

Potential impacts to ground water resources and thus the associated ground water users within the area affected by drawdown were evaluated based on the ground water flow modeling results. Such impacts may involve lowering of ground water levels at wells. The Regional Model was used to evaluate potential impacts to wells, in addition to the surface water resources discussed above in Section 3.2.3.3.1. The evaluation of drawdown considered modeling results at eight different points in time: at the end of mining and milling operations (in 2055), and at ten, 30, 50, 100, 200, 300, and 400 years post-Project.

For the purpose of this analysis, all water rights owned or controlled by EML as of July 1, 2011, were excluded from consideration. As shown in Table 3.2-6 and Figure 3.2.20, there are seven wells located within the simulated mine-induced drawdown area (i.e., area where the ground water levels are predicted to be lowered by ten feet or more as a result of the mine stedewatering and well field pumping activities under the Proposed Action) that are not associated with EML water rights..

In addition to the seven wells with associated ground water rights located within the simulated mine-induced drawdown area, there also are two wells (Wells 204 and 310) used for stock watering that do not have associated water rights. As shown in Table 3.2-7, the magnitude,




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

| | | | |
|---|---|---|---|
| NATIONAL SYSTEM OF PUBLIC LANDS<br>U.S. DEPARTMENT OF THE INTERIOR<br>BUREAU OF LAND MANAGEMENT | BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820<br>DESIGN: EMLLC DRAWN: GSL REVIEWED: RFD<br>CHECKED: - APPROVED: RFD DATE: 05/09/2011<br>FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | **BUREAU OF LAND MANAGEMENT**<br>**MOUNT HOPE PROJECT** | DRAWING TITLE:<br>**Rate of Pit Lake Development Under the Proposed Action**<br>**Figure 3.2.21** |

timing, and duration of the predicted drawdown varies for these different locations. Based on the modeling results, all of the nine wells are predicted to experience recovery of ground water levels resulting in less than ten feet of drawdown within 100 years post-Project. In addition, there is a domestic water well at the Roberts Creek Ranch that is within the ten-foot drawdown contour. Further, Nevada water law allows for one domestic water well per private parcel; therefore, there is a potential for additional undocumented (not filed with the NDWR) domestic water wells affected by the drawdown because they are within the ten-foot drawdown cone of depression. Impacts to, and mitigation for, water rights are subject to the jurisdiction of the NDWR.

Changes to water levels at the location of the seven wells with associated ground water rights listed in Table 3.2-10 are considered to be significant under the Proposed Action because the associated wells are used or could be used to produce water, and because they are thought to be hydraulically connected to the basin-fill and bedrock aquifers affected by drawdown. Changes to water levels at the locations of the two additional stockwatering wells listed in Table 3.2-10 are not deemed significant because neither one is associated with a valid and active water right.

**Table 3.2-10: Estimated Water Level Change at Ground Water Rights and Wells that May be Affected by Project Activities**

| Water Right Permit Number | Well Inventory Number | Years After End of Dewatering and KVCWF Pumping (drawdown in feet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 30 | 50 | 100 | 200 | 300 | 400 |
| 43025 | 123 | 42 | 34 | 22 | 15 | 6 | 3 | 1 | 1 |
| 44774 | 292 | 10 | 13 | 14 | 13 | 7 | 5 | 1 | 1 |
| 44775 | 218 | 30 | 30 | 23 | 17 | 7 | 4 | 1 | 1 |
| 47907 | 317 | 12 | 11 | 10 | 10 | 9 | 9 | 9 | 8 |
| 48684 | 162 | 18 | 19 | 15 | 12 | 5 | 3 | 1 | 1 |
| 71594 | 127 | 13 | 15 | 14 | 10 | 4 | 2 | 1 | 1 |
| 11188, R06952 | 494 | 12 | 10 | 7 | 5 | 2 | 1 | <1 | <1 |
| - | 204 | 8 | 10 | 11 | 11 | 6 | 4 | 1 | 1 |
| - | 310 | 69 | 46 | 28 | 19 | 8 | 5 | 1 | 1 |

Note: Does not include ground water rights or wells owned or controlled by EML as of July 1, 2011.
Source: Montgomery et al. (2010)

- **Impact 3.2.3.3-3:** The ground water drawdown is predicted to exceed ten feet at the locations of seven wells with associated ground water rights.

  **Significance of the Impact:** Impacts to the seven wells with associated ground water rights listed in Table 3.2-10 are potentially significant until such time as the ground water level recovers to less than ten feet of drawdown, which is predicted to be less than 100 years post-Project in all cases. The impacts would become less than significant after implementation of the mitigation measures described below. Potential adverse effects to ground water rights would be mitigated subject to NDWR jurisdiction.

- **Mitigation Measure 3.2.3.3-3a:** For the seven wells with associated ground water rights EML would assess the distance of the screened interval and the pumping below the ground water table. If that difference is greater than maximum predicted drawdown, then EML would pay the water right holder for the increase in pumping costs based on historical usage. If the difference is greater than ten feet, then EML would pay for either the lowering of the pump to a depth greater than the maximum drawdown in the well, or the completion of a new well with the a screened depth greater than the maximum predicted drawdown and pay the water right holder for the increase in pumping costs based on historic usage. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and in Appendix B. If, through implementation of the water monitoring, it is determined that there are impacts to wells with associated ground water rights attributable to the Project, whether predicted or not, then the following mitigation measures would be implemented.

- **Mitigation Measure 3.2.3.3-3b:** If monitoring (Mitigation Measure 3.2.3.3-3a) indicates that mine-induced drawdown impacts a well with an associated water right, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation is required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted ground water that is appropriated by a valid water right(s). The mitigation plan would be submitted to the BLM identifying drawdown impacts to ground water resources. Mitigation would depend on the actual impacts and site-specific conditions and could include the following:

     - Lowering the pump in an existing well;
     - Deepening an existing well;
     - Drilling a new well for replacement of water supply;
     - Providing a replacement water supply of equivalent yield and general water quality;
     - Pay for any incremental increase in pumping costs.
     - Modifying the KVCWF pumping regime (well locations or rates) during operations to reduce drawdown in the area of the impacted ground water resources;
     - Infiltrating or injecting water during operations at strategic locations to limit drawdown propagation in certain areas.

  3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

- **Mitigation Measure 3.2.3.3-3c**: For any significant impacts to wells with associated ground water rights that do not occur until after the end of mining and milling operations, the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policies using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. Wells associated with active ground water rights not owned or controlled by

EML that are indicated to be significantly impacted would then be mitigated by one or more of the following measures, as directed by the BLM:

1. Purchase by EML of the affected water right(s).

2. Installation of a deeper well and pump at affected locations to restore the historical yield of the well (including incremental increase in pumping costs).

3. Posting of an additional financial guarantee or long-term funding mechanism to provide for potential future impacts to potentially affected water supplies.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of Mitigation Measure 3.2.3.3-3b and the use of any of the options outlined above would be very effective at mitigating the impacts to ground water rights. Mitigation would be designed to address the specific ground water source that is affected, which enhances the effectiveness of the mitigation. Because the mitigation measures are specifically intended to directly address the impact by providing financial compensation or ensuring that the water allocated by the water right is made available, and because the measures will be reviewed and assessed by the BLM, these mitigation measures are expected to be effective to very effective. If initial implementation were unsuccessful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. Any residual effects to ground water rights would be fully mitigated and over a long period of time (tens to 100s of years) the drawdown effects would fully diminish, except in the vicinity of the open pit where the effects would be in perpetuity.

Impacts to Basin Water Budgets

The water balance for the ground water system within the HSA was estimated using the calibrated ground water flow model (Montgomery et al. 2010) and the mine dewatering and consumptive use assumptions for the Cumulative Action Scenario and the No Action Alternative, as described in Section 3.2.3.2. The water budget changes attributable to the Proposed Action were derived from these results by using the same subtraction procedure that was used in the drawdown analysis, as described in Section 3.2.3.2.4. For comparison, the estimated annual ground water inflow and outflow rates under the baseline condition (2009) are summarized in Table 3.2-5. Projected future changes to the various components of the water budget under the Proposed Action are summarized for the final year of mining and milling operations and for 50 years after all mine-related pumping has ceased in Tables 3.2-11 and 3.2-12, respectively; the projected future changes due to the Proposed Action were estimated relative to the No Action Alternative water budgets at the same points in time (see Section 3.2.3.4.2). The estimated water budgets and net changes in total inflow and outflow reflect changes in storage and fluctuations of the major inflow and outflow components over time resulting from mine pit dewatering and KVCWF pumping.

The estimated changes in annual ground water budgets under the Proposed Action indicate that the mine-induced drawdown associated with pit dewatering and KVCWF pumping is predicted to result in a decrease in evapotranspiration in all basins of the HSA. Most of the predicted decrease (95 percent at 50 years after the end of mine-related pumping) in evapotranspiration within the HSA occurs in Kobeh Valley. The predicted water table drawdown in Kobeh Valley extends to the mapped phreatophyte areas northwest of Bean Flat and east of Lone Mountain (Figure 3.2.20). The predominant phreatophyte vegetation in these areas is greasewood. The simulated extinction depth for greasewood is 40 feet below the ground surface, and the ground water model results indicate that the magnitude of drawdown along the perimeter of these phreatophyte vegetation areas would exceed the extinction depth for some period of time (Montgomery et al. 2010). This could potentially lead to a decrease in the number and density of phreatophyte plants and an associated decrease in evapotranspiration of ground water, as reflected in the estimated water budget changes listed in Tables 3.2-11 and 3.2-12.

### Table 3.2-11: Estimated Change in Annual Ground Water Budgets in Final Year of Project (2055) Under the Proposed Action, Relative to the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |
| Subsurface Inflow[4] | 0 | 70 (55 from Pine Valley and 15 from Kobeh Valley) | 201 (1 from Monitor Valley, 33 from Antelope Valley, and 167 from Pine Valley) | 0 | 1 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | **70** | **201** | **0** | **1** |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,4] | -16 | -52 | -4,015 | -11 | -4,094 |
| Net Ground Water Pumping[5] | 0 | 0 | 11,300 | 0 | 11,300 |
| Subsurface Outflow[4] | 33 (to Kobeh Valley) | 0 | 15 (to Diamond Valley) | 222 (55 to Diamond Valley and 167 to Kobeh Valley) | 0 |
| **Net Change in Total Outflow** | **17** | **-52** | **7,285** | **211** | **7,206** |

1 Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
2 Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
3 Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
4 Source: Montgomery et al. (2010), Table 4.4-7.
5 Source: Montgomery et al. (2010), Figure 4.4-2.

### Table 3.2-12: Estimated Change in Annual Ground Water Budgets 50 Years Post-Project (2105) Under the Proposed Action, Relative to the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| Subsurface Inflow[4] | 0 | 42 (40 from Pine Valley and 2 from Kobeh Valley) | 189 (13 from Monitor Valley, 38 from Antelope Valley, and 138 from Pine Valley) | 0 | 13 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | **42** | **189** | **0** | **13** |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,4] | -30 | -65 | -2,314 | -35 | -2,444 |
| Net Ground Water Pumping | 0 | 0 | 0 | 0 | 0 |
| Subsurface Outflow[4] | 38 (to Kobeh Valley) | 0 | 2 (to Diamond Valley) | 178 (40 to Diamond Valley and 138 to Kobeh Valley) | 0 |
| **Net Change in Total Outflow** | **8** | **-65** | **-2,312** | **143** | **-2,444** |

1 Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
2 Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
3 Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
4 Source: Montgomery et al. (2010), Table 4.4-7.

In the final year of operations under the Proposed Action (2055), the estimated available ground water in Diamond Valley is predicted to be reduced by 52 afy as a result of open pit dewatering and KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-11). An increase in subsurface inflow to Diamond Valley of 70 afy (55 afy from Pine Valley and 15 afy from Kobeh Valley) also is predicted to occur as a result of open pit dewatering (since the pit is mostly located within the Diamond Valley basin), but because that water would be pumped and consumptively used by the mine under the Proposed Action, it would not contribute to the available ground water in Diamond Valley. Fifty years after the end of operations under the Proposed Action (2105), the estimated available ground water in Diamond Valley is predicted to be reduced by 65 afy as a result of pit lake capture and previous KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-12). In 2105, a predicted increase in subsurface inflow to Diamond Valley of 42 afy (40 afy from Pine Valley and two afy from Kobeh Valley) results from pit lake capture. The captured water either would be stored in the pit lake or lost to evaporation, so the water would not contribute to the available ground water in Diamond Valley. The predicted mine-related reduction in available ground water in Diamond Valley within 50 years post-Project under the Proposed Action (up to 65 afy) is minor (0.1 percent) in comparison to the estimated consumptive use of ground water for agricultural purposes in Diamond Valley (55,800 afy) in 2009.

The quantity of ground water leaving the HSA by subsurface flow and discharging into northern Pine Valley (the only location of subsurface outflow from the HSA) is not predicted to change significantly as a result of mine dewatering and KVCWF pumping.

- **Impact 3.2.3.3-4:** Ground water flow modeling indicates that there could be up to approximately a 25 percent decrease in evapotranspiration of ground water in Kobeh Valley due to phreatophyte plant reduction resulting from temporary mine-induced drawdown.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

- **Impact 3.2.3.3-5:** Ground water flow modeling indicates that there could be a time-varying net change (decrease or increase) in the available ground water in Diamond Valley that is due solely to effects of the Proposed Action by the end of mining and milling operations and for at least 50 years post-Project; however, the magnitude of the predicted changes are less than 0.1 percent, compared to the overall ground water budget for Diamond Valley.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

<u>Consumptive Losses</u>

Open pit dewatering and KVCWF pumping under the Proposed Action would constitute a combined maximum consumptive water use of 11,300 afy during the 44-year period of mining and milling operations. This consumptive use would cease at the end of that time period. After mining operations cease and the pit lake begins to fill, some pit lake water would be consumptively lost due to evaporation. The evaporative loss would increase over time with the increasing pit lake stage and water surface area after mine closure, but it would be divided between the various sources of water filling the pit (i.e., direct precipitation, pit-area runoff, and ground water inflow). For the Proposed Action after 100 years of pit filling, the consumptive loss of ground water due to pit lake evaporation is predicted to be approximately 165 gpm (Figure 3.2.21); after 800 years of pit filling a steady, long-term ground water loss of approximately 100 gpm (161 afy) is predicted. At all times during the simulated recovery period (through 1,580 years after mining and milling operations cease), including at final equilibrium, the hydraulic gradients are inward toward the pit in all directions, indicating that the pit consistently acts as a hydraulic sink during and after mine closure (Montgomery et al. 2010). The 161 afy is less than 0.1 percent of the water budget for Kobeh and Diamond Valleys combined.

The Pine Valley, Diamond Valley, and Kobeh Valley hydrographic areas are classified as designated basins by the NDWR and the withdrawal and use of ground water is regulated. Evaporative losses of approximately 161 afy may be treated as a consumptive use and accounted for as a water right at the discretion of the Nevada State Engineer. The resulting annual volume of water is comparable to the annual water use allowed for a land parcel of equivalent area placed under irrigation.

- **Impact 3.2.3.3-6:** Consumptive use of water during mining and milling operations would support a beneficial use and would not be expected to adversely impact water resources. Long-term consumptive use of ground water by evaporation from the pit lake surface is predicted to be approximately 100 gpm (161 afy) and would continue in perpetuity. This consumptive loss would only occur under the Proposed Action (and the Off-Site Transfer of Ore Concentrate for Processing Alternative and the Slower, Longer Project Alternative), and so represents a negative impact compared to the No Action Alternative.

**Significance of the Impact:** Impacts during mining and milling operations are less than significant. After those operations cease, direct impacts of pit lake evaporation do not result in significant impacts.

*Potential Impacts Due to Subsidence*

The land surface above an aquifer has the potential to subside when ground water is removed from an aquifer composed of unconsolidated fine-grained sediment, which undergoes consolidation due to the reduction in fluid pressure associated with fluid loss. The most extensive subsidence typically occurs in unconsolidated material containing fine-grained sediments that are interbedded with sand and gravel aquifers. No subsidence would occur due to dewatering of the bedrock aquifers because the rock is generally competent (load bearing). The amount of consolidation is greater in the fine-grained sediments (clays) than in the coarser sand and gravel because of the more collapsible structure of clay beds and because clays contain more fluid per unit volume. When the pressure is reduced by the withdrawal of ground water by dewatering, unconsolidated materials undergo compaction, which is often irreversible. Typically, only a small part of the compression is reversible during ground water level recovery.

An analysis of potential impacts due to subsidence was performed using the Interbed-Storage Package for MODFLOW (Leake and Prudic 1991) along with ground water flow modeling of the No Action Alternative and Cumulative Action Scenarios (described above in Section 3.2.3.3.3). The Proposed Action predicted subsidence was determined using the same procedure that was used to determine water-table drawdown under the Proposed Action (i.e., the No Action Alternative subsidence results were subtracted from the Cumulative Action Scenario results), and the predicted Proposed Action subsidence is presented relative to existing (2009) conditions. The modeled interbed-storage parameters were calibrated to the distribution of subsidence interpreted from InSAR data for the main agricultural area in Diamond Valley from 1992 to 2000, as described in Section 3.2.2.6.6. The hydrogeological characteristics of Diamond and Kobeh Valleys are very similar (Harrill 1968; Tumbusch and Plume 2006). Both valleys contain thick (greater than 3,000 feet) sections of basin fill, much of it related to repeated cycles of lacustrine deposition during the late Cenozoic. It is therefore reasonable to infer that the Kobeh Valley basin-fill aquifer system's response to pumping in the KVCWF area would be similar to that presently occurring in Diamond Valley. Diamond Valley thus provides a useful analogue for estimating future potential impacts due to increased pumping in Kobeh Valley under the Proposed Action (Bell 2008).

The numerical model shows that under the Proposed Action, subsidence of up to approximately 2.5 feet would occur in the northern part of the KVCWF area (Figure 3.2.22). The projected lateral extent of subsidence greater than one-half-foot is approximately four miles in radius and is centered on the northern part of the well field area. There is no other predicted land subsidence due to the effects of mine pit dewatering or KVCWF pumping under the Proposed Action within the HSA.

Potential for Changes to Aquifer Productivity

The greatest potential for permanent deformation would occur in the finer grained sediments (clays and silty clays) that are not the primary water-bearing materials in the basin-fill aquifer of Kobeh Valley. The result would be a slight loss in aquifer interbed storage, but no noticeable loss in aquifer productivity of water supply wells. Thus, the potential impacts to the aquifer due to subsidence under the Proposed Action, if any, would be localized and are not considered significant.

- **Impact 3.2.3.3-7**: A small change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately four miles quasi-radially from the center of subsidence effects in the northern part of the KVCWF area, and a maximum subsidence of approximately 2.5 feet is projected in a small part of that central area. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer.

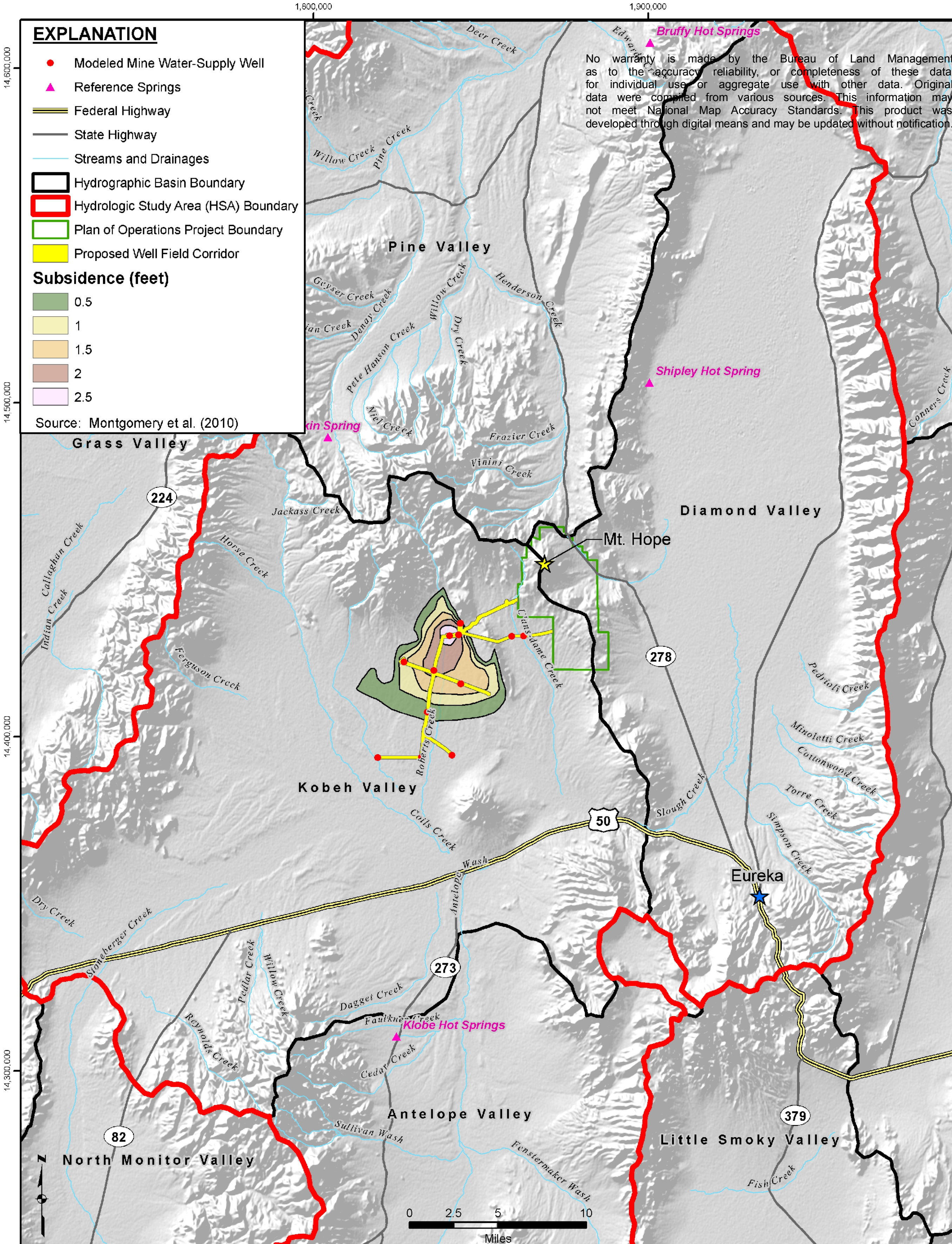
  **Significance of the Impact:** The potential for the Kobeh Valley basin-fill aquifer to transmit or store water is not expected to be significantly impacted and no mitigation measures are proposed.

Potential for Significant Land Surface Alteration

Consolidation of sediments that results in subsidence could also produce changes at the land surface. As noted above, ground subsidence of approximately 2.5 feet would occur in a small part of the northern KVCWF area, and subsidence of up to one-half-foot is projected to extend approximately four miles from the center of subsidence effects in the northern well field area. If the future subsidence is smoothly distributed (as simulated by the MODFLOW-based model and the Interbed-Storage Package), it would not be noticeable because the average slopes of the land surface would mask any effects.

However, subsidence is not always smoothly distributed and irregularities in subsidence may occur, which leads to the potential for ground water withdrawals to induce fissures in the basin-fill deposits. Such fissures, thought to be induced by subsidence, have been observed and studied in Crescent Valley (adjacent to Pine Valley on the west side of the Cortez Mountains in the northwest part of the HSA), as documented in BLM (2004). Newly induced fissuring in the basin-fill deposits has the potential to alter surface drainage by causing ponding adjacent to surface breaks, or by deflecting surface runoff to a new course that follows the newly induced fissures. More important is the possibility of deflecting surface runoff directly into openings along the fissures. Fissures induced by subsidence are usually initially too narrow to be readily apparent, but may be substantially enlarged by erosion if exposed to significant overland flow. The erosion could result in deep, wide fissure gullies, which could be a hazard to people and animals. Fissure gullies could also damage roads or mining facilities.

In addition, such fissures may initially be open directly from the land surface to the aquifer, thus creating a shortcut for recharge to the aquifer. If any contaminants entered such a fissure, they




Date: 7/07/10 Filename: Z:\MountHope_GIS_Project\RevisedFigures_June2010\Subsidence_KobehValley_MA_Rev.mxd UTM NAD83, Zone 11

| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | BUREAU OF LAND MANAGEMENT<br><br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>**Proposed Action Simulated Land Subsidence in Year 2055, Relative to 2009 Conditions**<br>**Figure 3.2.22** |
|---|---|---|
| DESIGN: EMLLC · DRAWN: GSL · REVIEWED: RFD | | |
| CHECKED: - · APPROVED: RFD · DATE: 05/09/2011 | | |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | |

would also be afforded a more direct route to the aquifer. Once subsidence stops, such fissures eventually naturally fill with sediment, but the natural process could take decades.

If differential subsidence induces fissuring in the basin-fill deposits, such fissures would be expected to occur in the areas of greatest subsidence (in the KVCWF area) and while ground water levels are falling (during pumping or soon thereafter). Hence, any potential impacts would likely be noticed prior to cessation of mine reclamation.

- **Impact 3.2.3.3-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for uncontained process fluids or chemical or hydrocarbon releases. Capture of surface runoff by fissures may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.

  **Significance of the Impact**: The impact would be significant if fissure gullies formed.

- **Mitigation Measure 3.2.3.3-8:** EML would be responsible for specifically monitoring for fissure gully development. If fissure gullies form, they would be filled in with clean, coarse-grained alluvium, with the intent of providing a rapid means of dissipation for any surface water entering the fissure and thereby reducing the propagation of the fissure through continued erosion. The fill material then would be seeded with a BLM-approved seed mix.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of Mitigation Measure 3.2.3.3-8 would be very effective at mitigating the fissures that develop because they would be filled immediately. Any residual effects of fissure development would be fully mitigated during the life of the Project.

### 3.2.3.4 No Action Alternative

Under the No Action Alternative, the proposed Project would not be developed, and the associated impacts would not occur. Under this alternative, consumptive uses of ground water in the HSA basins would continue according to existing authorizations. The modeling assumptions regarding assumed future ground water withdrawals under the No Action Alternative are described in Section 3.2.3.2.2 and summarized in Table 3.2-7.

#### 3.2.3.4.1 Surface Water Resources

*Erosion, Sedimentation, and Flooding within Drainages*

Under the No Action Alternative, there would be no mine-related alteration or diversion of existing natural drainages or washes that contain surface flow during high rainfall or snowmelt events. Existing exploration-related surface disturbance may cause an increase in erosion and sedimentation of the local surface drainages. Such impacts potentially could also occur as a result of other activities within the HSA that are not associated with the proposed Project.

- **Impact 3.2.3.4-1:** Grading, earth moving, diversion of drainages, and placement of fill could accelerate erosion and sedimentation, and alter surface-water flood runoff patterns in the future.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

*Effects of Ground Water Drawdown on Streams, Springs, and Surface Water Resources Covered by a Water Right*

Potential changes in water levels in the ground water system were evaluated using the methodology previously described in Section 3.2.3.2. The predicted change in ground water levels attributable to the No Action Alternative in Year 2055 is shown in Figure 3.2.23. This figure shows areas where the water levels are predicted to decrease over time in comparison to the existing baseline ground water elevation at the end of 2009, due solely to the simulated conditions under the No Action Alternative. By Year 2055, two distinct drawdown areas are predicted to develop: one near the Bobcat Ranch in the southwest part of Kobeh Valley, and one in the southern part of Diamond Valley. The ground water model results indicate that the ground water would be drawn down by up to 40 feet in the Bobcat Ranch area and by approximately up to 110 feet in the southern part of Diamond Valley, relative to existing (2009) conditions. The projected extent of future drawdown greater than ten feet encompasses one spring site and portions of five intermittent and ephemeral drainages in the Bobcat Ranch area, and numerous spring sites and stream drainages in the southern part of Diamond Valley.

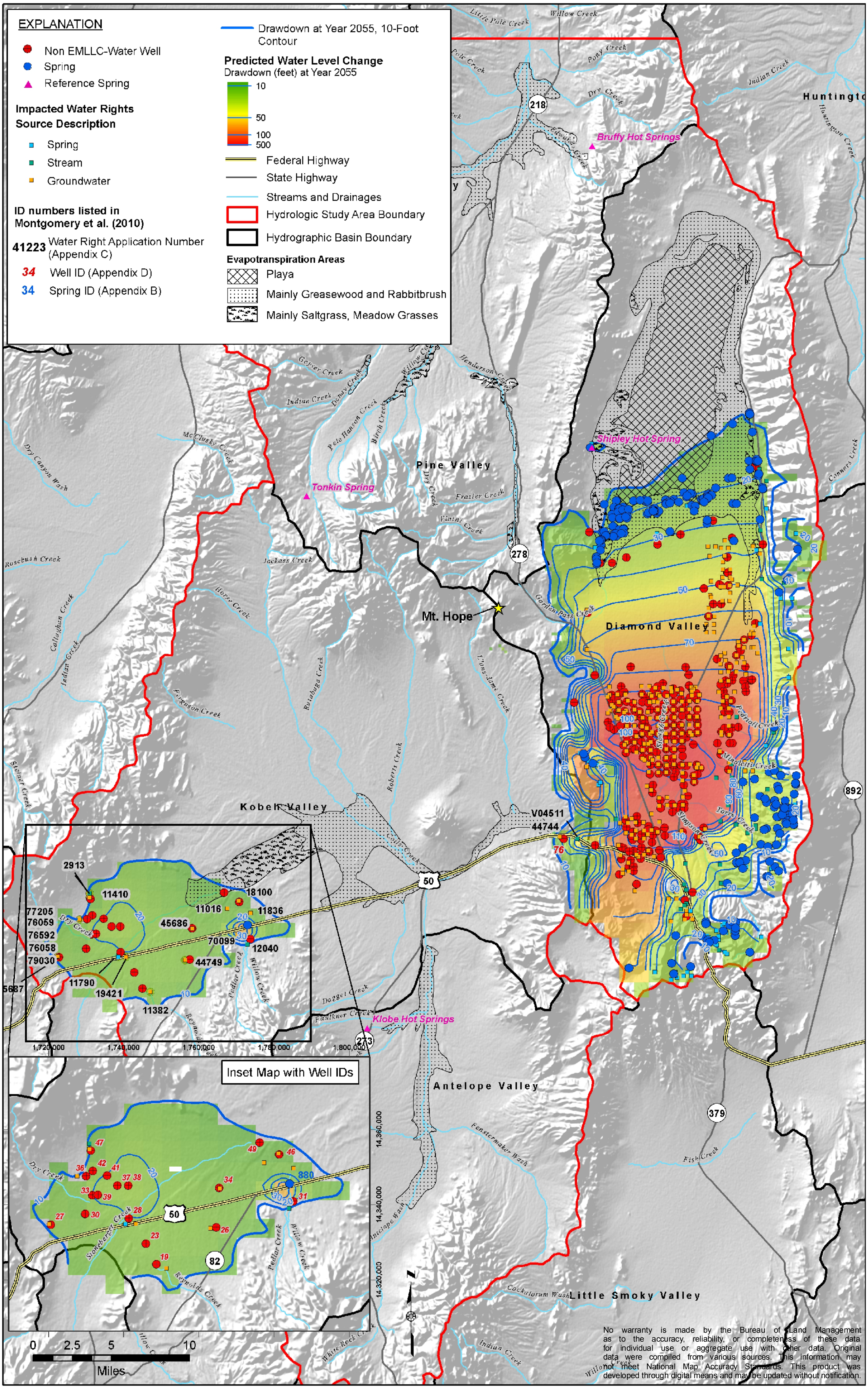
- **Impact 3.2.3.4-2:** The future ground water drawdown (relative to existing conditions in 2009) is predicted to be more than ten feet at one spring site and portions of five intermittent and ephemeral drainages in the Bobcat Ranch area, and at numerous spring sites and stream drainages in the southern part of Diamond Valley by the end of Year 2055.

  **Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

3.2.3.4.2 Ground Water Resources

*Lowering of the Water Table*

Based on the ground water modeling, the assumed continued agricultural pumping in Kobeh and Diamond Valleys under the No Action Alternative would lower the water table in the basin-fill aquifers of those valleys by up to 40 feet and 110 feet in Year 2055, respectively, relative to existing (2009) conditions, as shown in Figure 3.2.23. Continued pumping after that time may further increase the ground water drawdown in both areas, depending upon the magnitudes of the pumping rates.




Source: Montgomery et al. (2010).

| | | | |
|---|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | |
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | |
| CHECKED: - | APPROVED: - | DATE: 09/22/2011 | |
| FILE NAME: p1635_Fig3-2-X_Hydro_11i17i.mxd | | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**No Action Alternative Simulated Ground Water-Level Change in Year 2055, Relative to 2009 Conditions**

**Figure 3.2.23**

Impacts to Ground Water Resources

There are numerous ground water users within the projected future drawdown area under the No Action Alternative (see Figure 3.2.3). Water rights associated with water-supply wells and surface water resources within the projected future drawdown area were included in the previously described inventory of water rights compiled for the EIS analysis (Section 3.2.2.7), but they are not individually addressed in this section for practical reasons; however, they are illustrated in Figure 3.2.23. Notably, none of the non-EML-controlled water rights or wells predicted to be potentially impacted under the No Action Alternative are predicted to be impacted by the Proposed Action (or the Partial Backfill Alternative or the Off-Site Transfer of Ore Concentrate for Processing Alternative) leading to the conclusion that the impacts from the two alternatives are distinguishable.

- **Impact 3.2.3.4-3:** The ground water drawdown is predicted to exceed ten feet at the locations of numerous active ground water rights controlled by third parties in the Bobcat Ranch area of Kobeh Valley and in the southern part of Diamond Valley by the end of Year 2055. None of these locations are predicted to be impacted by the Proposed Action, the Partial Backfill Alternative, or the Off-Site Transfer of Ore Concentrate for Processing Alternative.

  **Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

Impacts to Basin Water Budgets

The water balance for the ground water system within the HSA was estimated using the calibrated ground water flow model (Montgomery et al. 2010) and the consumptive use assumptions for the No Action Alternative, as described in Section 3.2.3.2. The estimated annual ground water inflow and outflow rates in Years 2055 and 2105 are summarized in Tables 3.2-13 and 3.2-14, respectively. The projected pattern of changes in the water balance for the No Action Alternative through the end of Year 2105 indicate that there would be a continued decrease in evapotranspiration and further reduction in the available ground water stored in Diamond Valley.

- **Impact 3.2.3.4-4:** Ground water flow modeling indicates that there would be a continued decrease in evapotranspiration of ground water in Diamond Valley resulting from expanded drawdown associated with continued agricultural pumping.

  **Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

- **Impact 3.2.3.4-5:** Ground water flow modeling indicates that there would be a further decrease in the available ground water stored in Diamond Valley due to continued agricultural pumping under the No Action Alternative, and that the declining trend in available ground water would persist until Year 2105 or longer depending upon future pumping rates.

**Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

### Table 3.2-13: Simulated Ground Water Budgets for Individual Basins and the Entire HSA in 2055 Under the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 4,100 | 21,400 | 13,200 | 34,900 | 73,600 |
| Subsurface Inflow[5] | 0 | 8,300 (5,900 from Pine Valley and 2,400 from Kobeh Valley) | 5,100 (1,900 from Monitor Valley, 2,700 from Antelope Valley, and 500 from Pine Valley) | 0 | 1,900 (from Monitor Valley to Kobeh Valley) |
| **Net Total Inflow** | **4,100** | **29,700** | **18,300** | **34,900** | **75,500** |
| **Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,5] | 1,400 | 9,100 | 15,000 | 17,100 | 42,600 |
| Ground Water Pumping[5] | negligible | 55,800 | 3,800 | negligible | 59,600 |
| Subsurface Outflow[5] | 2,700 (to Kobeh Valley) | 0 | 2,400 (to Diamond Valley) | 17,700 (5,900 to Diamond Valley, 500 to Kobeh Valley, and 11,300 to northern Pine Valley) | 11,300 (from southern to northern Pine Valley) |
| **Net Total Outflow** | **4,100** | **64,900** | **21,200** | **34,800** | **113,600** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Values rounded to the nearest 100 afy.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Source: Montgomery et al. (2010), Table 4.1-5.
[5] Source: Montgomery et al. (2010), Table 4.4-5.
[6] Source: Montgomery et al. (2010), Figure 4.4-2.

### Table 3.2-14: Simulated Ground Water Budgets for Individual Basins and the Entire HSA in 2105 Under the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge[4] | 4,100 | 21,400 | 13,200 | 34,900 | 73,600 |
| Subsurface Inflow[5] | 0 | 8,700 (6,100 from Pine Valley and 2,600 from Kobeh Valley) | 5,400 (2,100 from Monitor Valley, 2,700 from Antelope Valley, and 600 from Pine Valley) | 0 | 2,100 (from Monitor Valley to Kobeh Valley) |

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Net Total Inflow** | **4,100** | **30,100** | **18,600** | **34,900** | **75,700** |
| **Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,5] | 1,400 | 6,300 | 14,300 | 17,000 | 39,000 |
| Net Ground Water Pumping[6] | negligible | 55,800 | 3,800 | negligible | 59,600 |
| Subsurface Outflow[5] | 2,700 (to Kobeh Valley) | 0 | 2,600 (to Diamond Valley) | 18,000 (6,100 to Diamond Valley, 600 to Kobeh Valley, and 11,300 to northern Pine Valley) | 11,300 (from southern to northern Pine Valley) |
| **Total Outflow** | **4,100** | **62,100** | **20,700** | **35,000** | **110,000** |
| **Net Total Outflow** | **0** | **-32,000** | **-2,100** | **-100** | **-34,300** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Values rounded to the nearest 100 afy.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Source: Montgomery et al. (2010), Table 4.1-5.
[5] Source: Montgomery et al. (2010), Table 4.4-5.
[6] Source: Montgomery et al. (2010), Figure 4.4-2.

Consumptive Losses

For ground water modeling purposes, it was assumed that future consumptive use of ground water in Kobeh and Diamond Valleys would be constant at rates that are similar in magnitude to those experienced in recent years and persisting for the foreseeable future. The estimated future average annual rates of usage were 2,355 gallons per minute (3,800 afy) in Kobeh Valley and 34,630 gallons per minute (55,850 afy) in Diamond Valley, as listed in Tables 3.2-12 and 3.2-13. In reality, future pumping rates would not be constant over time and they may vary significantly from the modeling assumptions.

- **Impact 3.2.3.4-6:** Consumptive use of water for authorized agricultural irrigation, stock watering, mining and milling, or municipal uses constitute beneficial uses of water resources. However, the historical and existing (2009) rates of consumptive usage in Diamond Valley already appear to have impacted some water resources and may be unsustainable in the long term. Some of the pumping-related consumption of ground water in Diamond Valley is offset by the reduction in ground water loss due to less evapotranspiration as the water table declines.

  **Significance of the Impact:** Impacts associated with the No Action Alternative are not considered significant.

*Potential Impacts Due to Subsidence*

The basis for this potential impact and the assessment methodology are the same as described for the Proposed Action in Section 3.2.3.3.2; therefore, they will not be repeated here. The numerical model shows that under the No Action Alternative, future subsidence (i.e., relative to existing conditions in 2009) of up to approximately 13.5 feet would occur in the southern part of

Diamond Valley by the end of Year 2055 (Figure 3.2.24). The projected lateral extent of subsidence greater than one-half-foot extends approximately 13 miles to the north and south and five miles to the east and west from the center of maximum subsidence in southern Diamond Valley. There is also a small area of predicted subsidence of approximately one-half-foot magnitude along Slough Creek immediately west of Devils Gate in Kobeh Valley in Year 2055 under the No Action Alternative. There is no predicted land subsidence due to the effects of ground water withdrawals under the No Action Alternative anywhere else within the HSA.

Potential for Changes to Aquifer Productivity

The greatest potential for permanent deformation would occur in the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer of Diamond Valley. The result would be a loss in aquifer interbed storage and, presumably, some loss in aquifer productivity of water supply wells (given the magnitude of the projected maximum future subsidence).

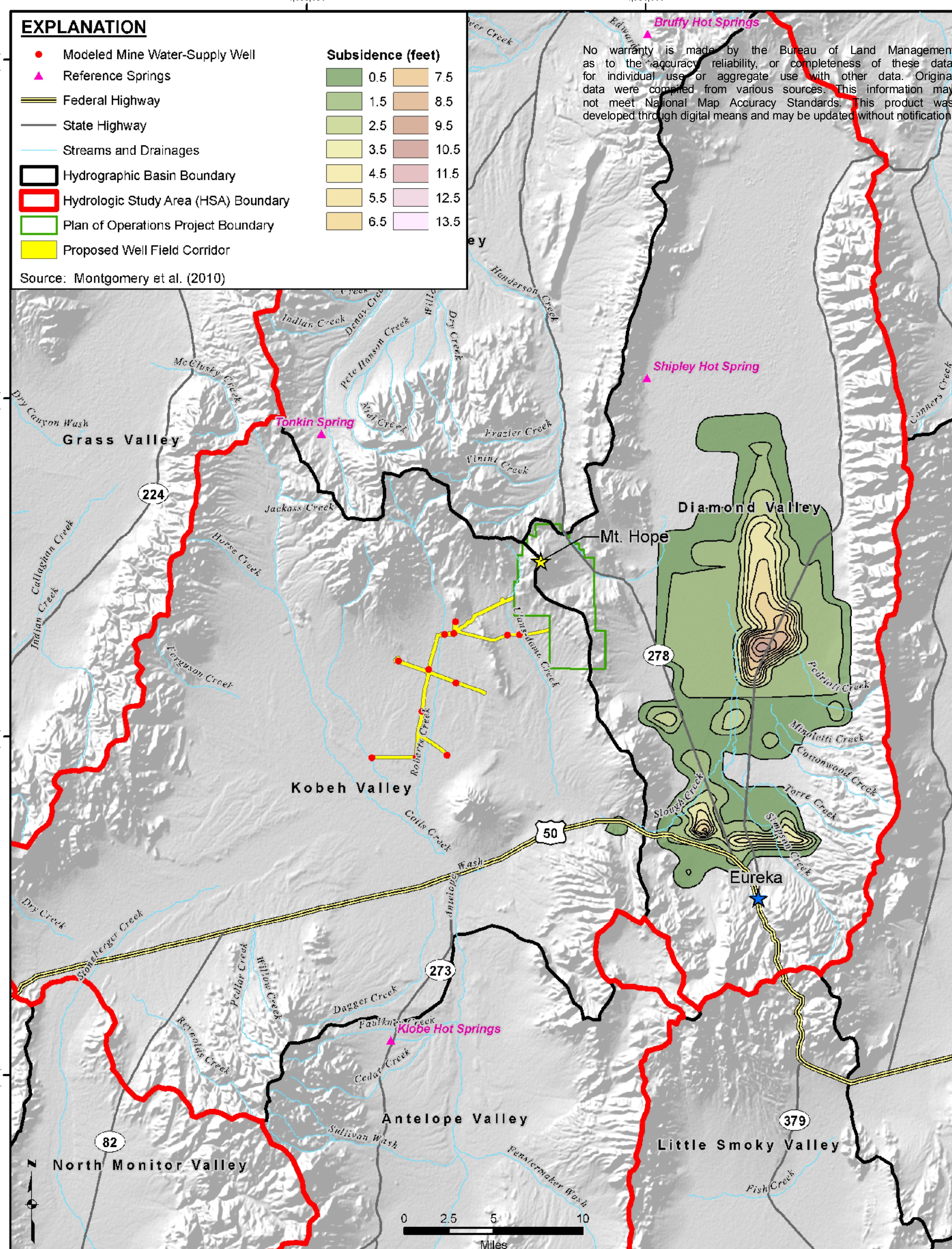
■ **Impact 3.2.3.4-7:** A change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately 13 miles to the north and south and five miles to the east and west from the center of maximum subsidence (approximately 13.5 feet) in southern Diamond Valley. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), but some reduction in the porosity of the primary water-bearing materials in the basin-fill aquifer may also occur.

  **Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

Potential for Significant Land Surface Alteration

Consolidation of sediments that results in subsidence could also produce changes at the land surface. As noted above, ground subsidence of up to approximately 13.5 feet would occur in the southern part of Diamond Valley, and subsidence of up to one-half-foot is projected to extend approximately 13 miles to the north and south and five miles to the east and west from the center of maximum subsidence. If the future subsidence is not evenly distributed, the subsidence may induce fissuring or promote the formation of fissure gullies, which could alter surface drainage patterns, create a safety risk for animals and humans, or allow potential contaminants to rapidly enter the ground water system. The issues and risks associated with this potential impact are the same as described for the Proposed Action in Section 3.2.3.3.2; therefore, they will not be repeated here.

■ **Impact 3.2.3.4-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for contaminants released at the ground surface to reach the ground water system. Capture of surface runoff by fissures may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.




Date: 7/07/10 Filename: Z:\MountHope_GIS_Project\RevisedFigures_June2010\Subsidence_KobehValley_MA_Rev.mxd UTM NAD83, Zone 11

| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | BUREAU OF LAND MANAGEMENT<br>MOUNT HOPE PROJECT | DRAWING TITLE:<br>No Action Alternative Simulated Land Subsidence in Year 2055, Relative to 2009 Conditions<br>Figure 3.2.24 |
|---|---|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | | |
| CHECKED: - | APPROVED: RFD | DATE: 05/09/2011 | | |
| FILE NAME: p1635_Fig3-2-X_Hydro_8i11i.mxd | | | | |

**Significance of the Impact:** Impacts associated with the No Action Alternative are considered significant; however, these impacts are not under BLM jurisdiction and no mitigation is proposed.

3.2.3.5 Partial Backfill Alternative

The Partial Backfill Alternative (described in Section 2.2.2) would have the same potential water quantity impacts as the Proposed Action (Section 3.2.3.3) during the 33-year period of open pit mining, but the impacts would differ after mining and pit dewatering cease in 2044. After dewatering ceases, a pit lake would form as surrounding ground water levels recover under the Proposed Action; under the Partial Backfill Alternative, the pit would be partially backfilled to eliminate the potential for a pit lake to form, and the backfill material would saturate as ground water levels recover. The pre-mining ground water elevation in the vicinity of the proposed open pit varies from northwest to southeast across the site from approximately 7,200 to 6,750 feet amsl. Under the Partial Backfill Alternative, the open pit would be backfilled to elevations that would be at least 100 feet above the sloping, pre-mining ground water surface, thus preventing any substantial evaporative ground water losses from that area, as well as allowing precipitation within the open pit to flow freely out of the open pit at the southeastern edge.

As ground water flows into the backfilled pit and the backfill becomes saturated there would be a corresponding ground water outflow from the backfilled pit soon after the end of mining. The onset of a well-defined flow-through condition would occur approximately 210 years after the end of dewatering and backfilling commences. Contours of the simulated ground water levels after 210 years of recovery are provided in Figure 3.2.25.

3.2.3.5.1 Surface Water Resources

*Erosion, Sedimentation, and Flooding within Drainages*

Even with the implementation of the Project BMPs, the potential impacts to surface drainages involving erosion, sedimentation, or alteration of flood runoff patterns under the Partial Backfill Alternative would occur, but would be proportionally less than for the Proposed Action, due to the smaller WRDFs as described in Section 3.2.3.3.1. This is primarily due to the placement of a large portion of the waste rock in the open pit and thus only the reclaimed surface of the backfill would be subject to erosion.

- **Impact 3.2.3.5-1:** Grading, earth moving, diversion of drainages, and placement of fill could accelerate erosion and sedimentation and alter surface-water flood runoff patterns during mining and post-closure.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

*Effects of Ground Water Drawdown on Streams, Springs, and Surface Water Resources Covered by a Water Right*

Potential impacts to the flow of streams and springs in the HSA resulting from mine-related ground water drawdown under the Partial Backfill Alternative would be proportionally less than for the Proposed Action, as described in Section 3.2.3.3.1. Figure 3.2.26 shows the maximum extent of drawdown under the Partial Backfill Alternative. There is very little difference from the potential impacts under the Proposed Action. However, near the open pit the maximum extent of drawdown is less and two springs are not located within the predicted extent of the ten-foot drawdown under the Partial Backfill Alternative (Spring sites 580 and 592) (Table 3.2-8). In addition, the location of Spring SP-7 would be uncovered by the placement of the Non-PAG waste rock in the open pit.

- **Impact 3.2.3.5-2:** The ground water drawdown is predicted to be more than ten feet for two perennial stream segments (Roberts Creek and South Fork of Henderson Creek) and at 22 perennial or potentially perennial spring sites (Table 3.2-8) for varying periods of time up to at least 400 years after the end of mining and milling operations.

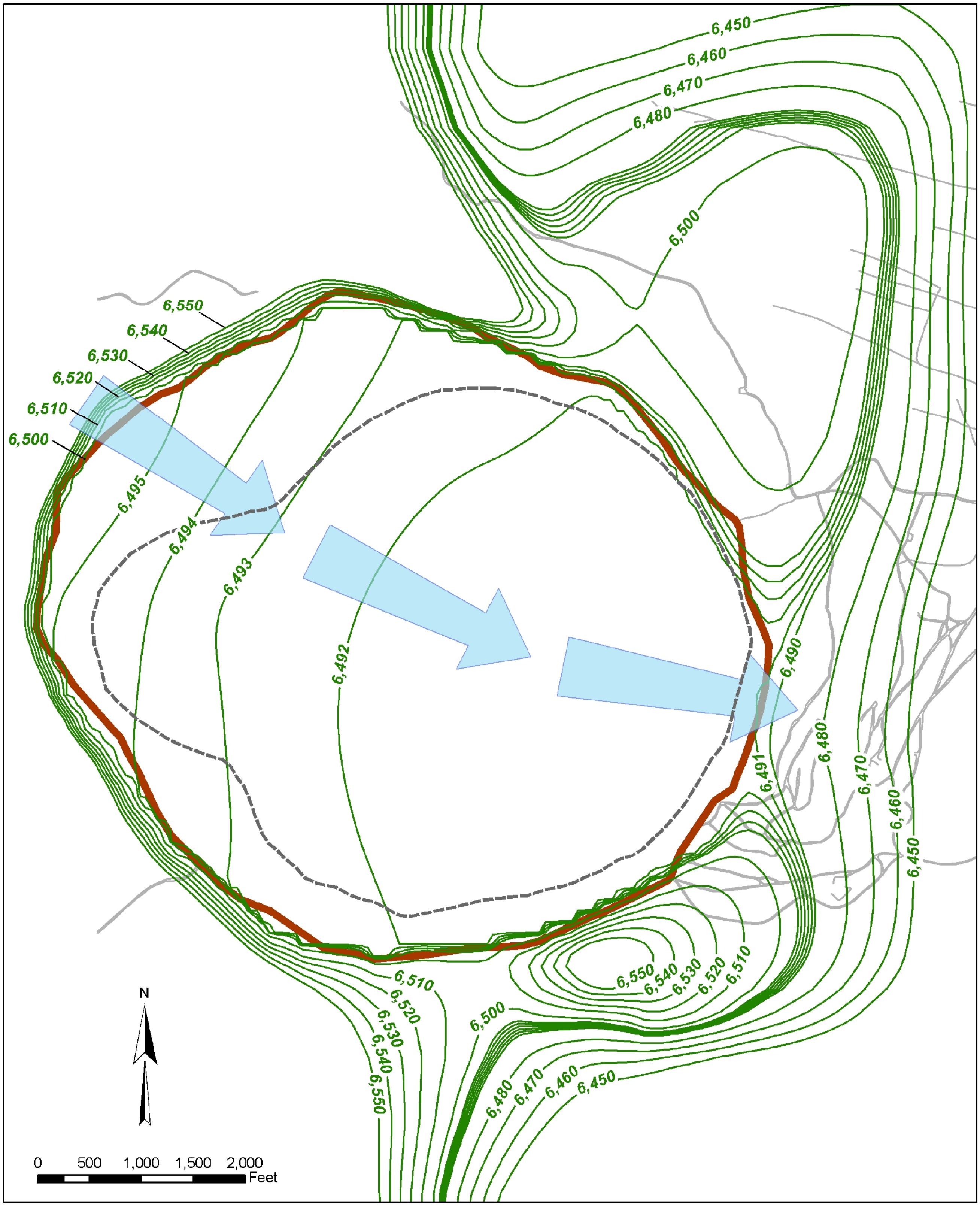
  **Significance of the Impact:** The impacts are potentially significant at the two stream segments and 22 springs mentioned above. Although significant impacts are not predicted to occur in the other individual streams or springs in the HSA, the uncertainty of predicting impacts to streams and springs indicates a need for operational monitoring and mitigation measures to be implemented if significant impacts occur. If there are reduced flows in perennial stream segments or springs, based on monitoring (that the BLM determines can be attributed to the mining operation), then mitigation measures would be implemented, as described below. Potential adverse effects to surface water rights would be mitigated subject to NDWR Jurisdiction.

- **Mitigation Measure 3.2.3.5-2a:** Specific mitigation for the two perennial stream segments and 22 perennial or potentially perennial spring sites are outlined in Table 3.2-9. Implementation of the mitigation outlined in this table would result in up to 46.3 acres of additional surface disturbance associated with the pipeline construction and maintenance. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B to track the drawdown associated with the open pit dewatering and ground water production activities. In addition, EML would periodically update the ground water flow as determined by the BLM. EML would be responsible for monitoring and annual reporting of changes in ground water levels and surface water flows prior to and during operation, and for a period of up to 30 years in the post-mining and milling phase.

- **Mitigation Measure 3.2.3.5-2b**: If monitoring (Mitigation Measure 3.2.3.5-2a) indicates that flow reductions of perennial surface waters are occurring and that these reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation would be required by the BLM for BLM-administered resources, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted perennial water resource(s). Potential adverse effects to surface water rights would be mitigated subject to NDWR jurisdiction.




EXPLANATION

Final Pit Extent

Direction of Groundwater Movement

Roads

Final Backfill Extent

6,500 — Simulated Water Level Contours in feet above mean sea level

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.


NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 05/06/2011 |

FILE NAME: p1635_Fig3-2-25_SimWL_Backfill_210yrs.mxd

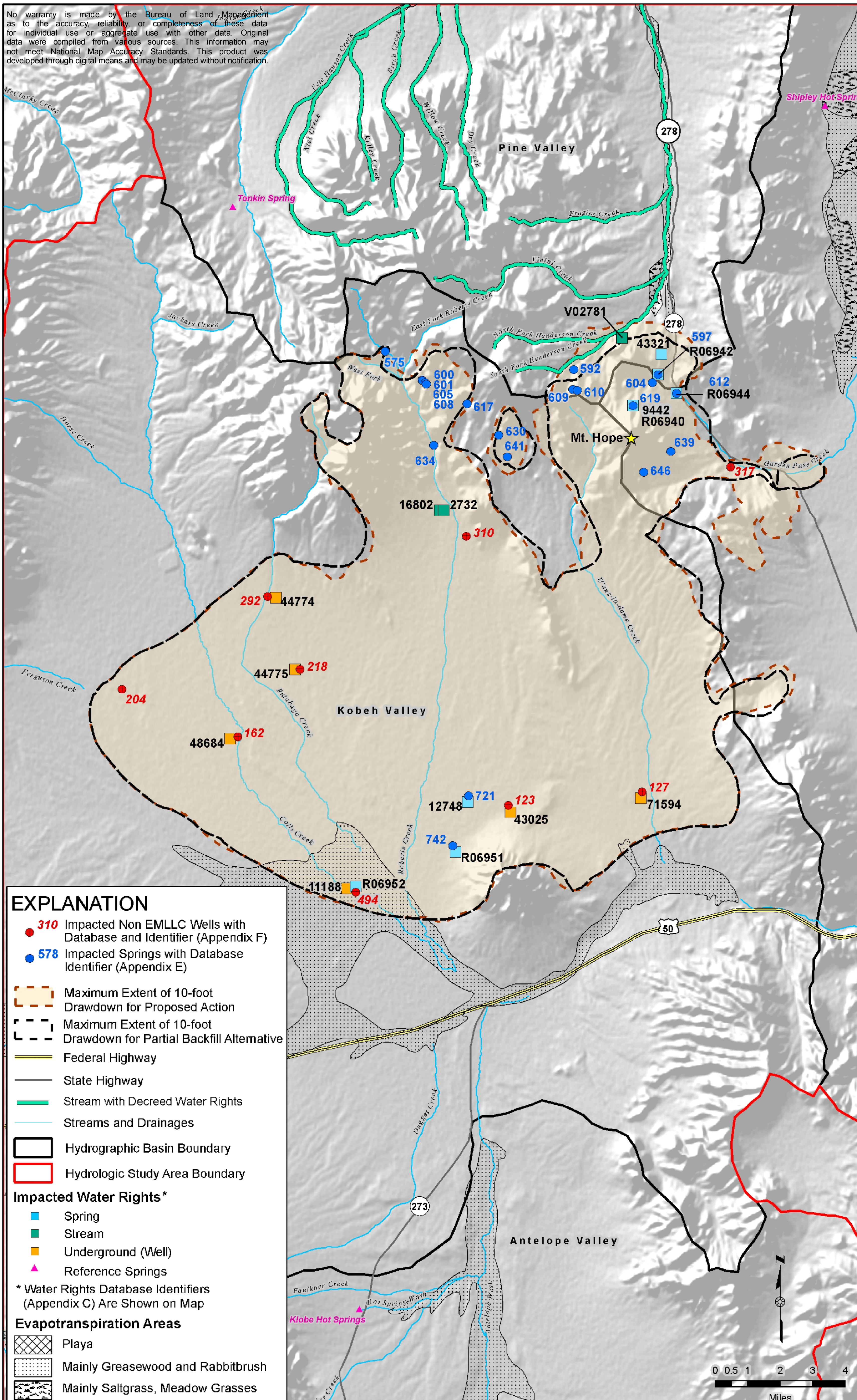
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:


**Simulated Water Level Contours in the Backfill Area 210 Years After End of Open Pit Mining**

**Figure 3.2.25**




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: - | DATE: 09/22/2011 |

FILE NAME: p1635_Fig3-2-26_ComparPropActPitBackfillSpringsNonEMLLCWells.mxd

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Comparison of Proposed Action and Partial Backfill Alternative with Respect to Springs, Non-EML Wells and Water Rights within the Composite Maximum Extent of the Ten-Foot Drawdown Contour**

**Figure 3.2.26**

The mitigation plan would be submitted to the BLM identifying the excess amount of drawdown or drawdown impacts to surface water resources. Mitigation would depend on the actual impacts, site-specific conditions, and historical use and could include a variety of measures (e.g., flow augmentation, on-site, or off-site improvements). Methods to enhance or replace the impacted perennial water resources include, but are not limited to, the following:

- Modification of pumping distribution in the water supply well field;
- Injection to confine the drawdown cone;
- Installation of a water-supply pump in an existing well (e.g., monitoring well);
- Installation of a new water production well;
- Piping from a new or existing source;
- Installation of a guzzler;
- Enhanced development of an existing seep or spring to promote additional flow; or
- Fencing or other protective measures for an existing seep to maintain flow.

3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

■ **Mitigation Measure 3.2.3.5-2c**: The numerical ground water flow modeling indicates that some impacts to springs may occur after the end of mining and milling operations, when some of the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policy using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. If the BLM determines that the Project would impact perennial stream segments or spring sites in this post-operational phase, mitigation consisting of one or both of the following measures would be required:

1. Installation of a well and pump at affected stream or spring locations to restore the historic yield of the affected surface water resource.

2. Posting of an additional financial guarantee to provide for potentially affected water supplies in the future.

■ **Effectiveness of Mitigation and Residual Effects:** Mitigation would be designed to address the specific spring or surface water that is affected, which enhances the effectiveness of the mitigation. In addition, a variety of approaches to mitigation can be used within these measures to achieve the objective. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by restoring or enhancing surface flows, and because the measures would be reviewed and addressed by the BLM. The effectiveness of Mitigation Measure 3.2.3.5-2c, if implemented, is less certain since the mitigation would be many decades in the future. If initial implementation was not successful, the

BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. However, if measures used in Mitigation Measure 3.2.3.5-2b are implemented, then the measure should be effective at mitigating the impacts from reduced surface water flows. Over a long period of time (tens to 100s of years) the effects to most surface water flows would diminish; however, for the springs nearest to the open pit, flows would be reduced or eliminated in perpetuity.

#### 3.2.3.5.2 Ground Water Resources

*Lowering of the Water Table*

The dewatering associated with the proposed open pit mining under the Partial Backfill Alternative would lower the bedrock ground water elevations by approximately 2,250 feet in the vicinity of the open pit during mining operations. At the same time, and continuing for 12 years after the end of pit dewatering, pumping in the KVCWF for process water supply would lower the water table in the basin-fill and bedrock aquifers of central Kobeh Valley and the southern part of the Roberts Mountains. Based on numerical ground water flow modeling, the expected amount of drawdown near the center of the KVCWF is approximately 120 feet after 44 years of pumping under the Proposed Action (Montgomery et al. 2010). The ground water levels near the open pit and the KVCWF would begin to recover immediately after Project-related dewatering and pumping cease. The Local Model was used to evaluate the ground water recovery in the backfilled pit under the Partial Backfill Alternative (Figure 3.2.27).

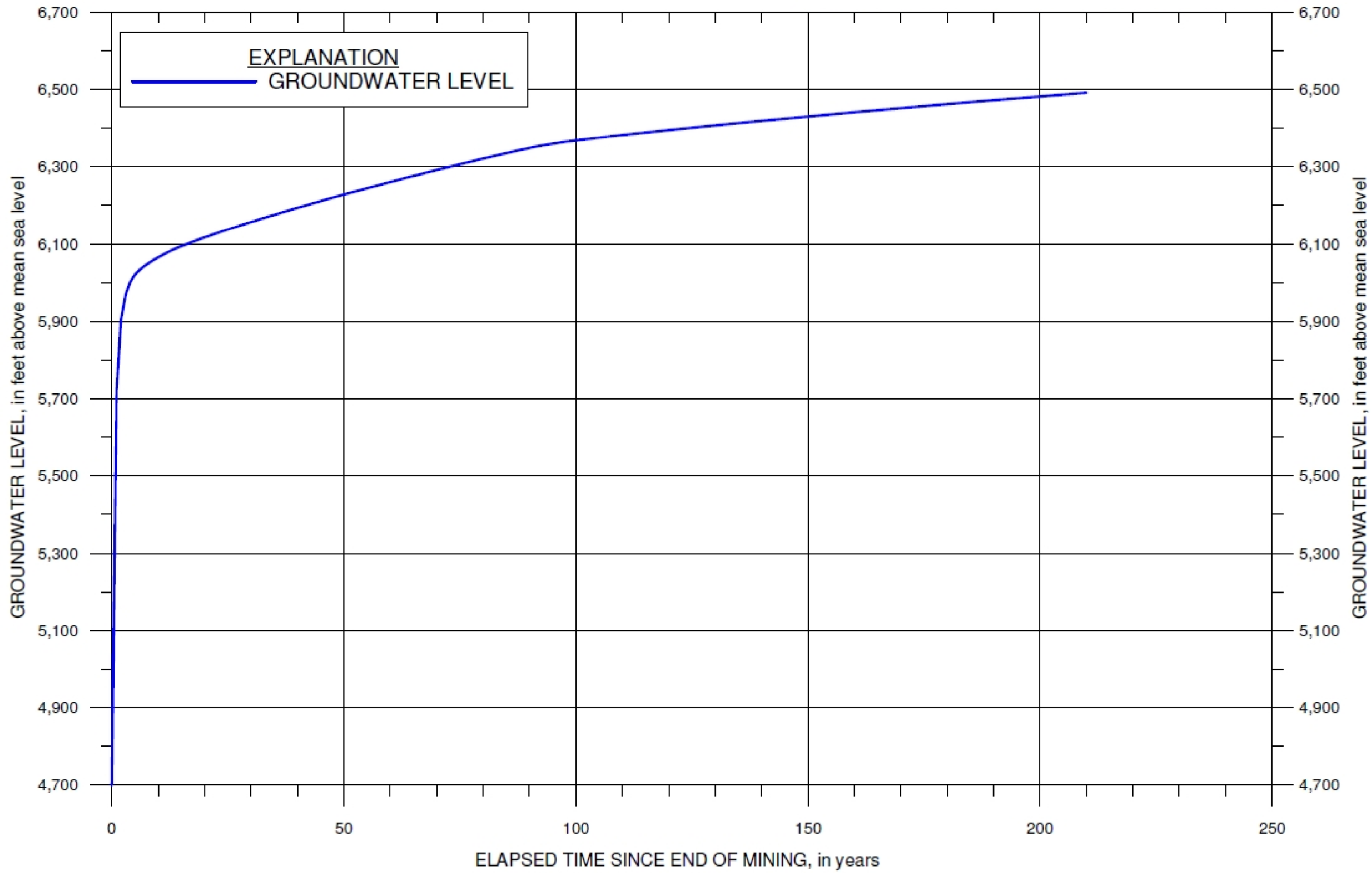
<u>Impacts to Ground Water Resources</u>

Potential impacts to the ground water and thus the associated ground water users in the HSA resulting from mine-related ground water drawdown under the Partial Backfill Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2 (Montgomery 2010). Therefore, they are not repeated here.

- **Impact 3.2.3.5-3:** The ground water drawdown is predicted to exceed ten feet at the locations of seven wells with associated ground water rights.

  **Significance of the Impact:** Impacts to the seven wells with associated ground water rights listed in Table 3.2-10 are potentially significant until such time as the ground water level recovers to less than ten feet of drawdown, which is predicted to be less than 100 years post-Project in all cases. The impacts would become less than significant after implementation of the mitigation measures described below. Potential adverse effects to ground water rights would be mitigated subject to NDWR jurisdiction.

- **Mitigation Measure 3.2.3.5-3a:** For the seven wells with associated ground water rights EML would assess the distance of the screened interval and the pumping below the ground water table. If that difference is greater than maximum predicted drawdown, then EML would pay the water right holder for the increase in pumping costs based on historical usage. If the difference is greater than ten feet, then EML would pay for either the lowering of the pump to a depth greater than the maximum drawdown in the well, or the completion of a new well with the a screened depth greater than the maximum




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| | | |
|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
| CHECKED: - | APPROVED: RFD | DATE: 09/22/2011 |
| FILE NAME: p1635_Fig3-2-27_GroundwaterLevel_graph.mxd | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Projected Ground Water Level in Center of Pit Backfill**

**Figure 3.2.27**

predicted drawdown and pay the water right holder for the increase in pumping costs based on historic usage. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and in Appendix B. If, through implementation of the water monitoring, it is determined that there are impacts to wells with associated ground water rights attributable to the Project, whether predicted or not, then the following mitigation measures would be implemented. The combined surface water and ground water monitoring results would be used to trigger the implementation of Mitigation Measure 3.2.3.5-3b.

■ **Mitigation Measure 3.2.3.5-3b**: If monitoring and a comparison with the EIS predictions (Mitigation Measure 3.2.3.5-3a) indicates that mine-induced drawdown impacts a well with an associated water right, the following measures would be implemented:

1. The BLM would evaluate the available information and determine whether mitigation is required.

2. If mitigation is required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted ground water that is appropriated by a valid water right(s). The mitigation plan would be submitted to the BLM identifying drawdown impacts to ground water resources. Mitigation would depend on the actual impacts and site-specific conditions and could include the following:

    - Lowering the pump in an existing well;
    - Deepening an existing well;
    - Drilling a new well for replacement of water supply;
    - Providing a replacement water supply of equivalent yield and general water quality;
    - Pay for any incremental increase in pumping costs;
    - Modifying the KVCWF pumping regime (well locations and/or rates) during operations to reduce draw down in the area of the impacted ground water resources;
    - Infiltrating or injecting water during operations at strategic locations to limit drawdown propagation in certain areas.

3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

■ **Mitigation Measure 3.2.3.5-3c**: For any significant impacts to wells with associated ground water rights that do not occur until after the end of mining and milling operations, the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policies using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. Wells associated with active ground water rights not owned or controlled by EML that are indicated to be significantly impacted would then be mitigated by one or more of the following measures, as directed by the BLM or the appropriate regulatory agency:

1. Purchase by EML of the affected water right(s).

2. Installation of a deeper well and pump at affected locations to restore the historical yield of the well (including incremental increase in pumping costs).

3. Posting of an additional financial guarantee or long-term funding mechanism to provide for potential future impacts to potentially affected water supplies.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.5-3b and the use of any of the options outlined above would be very effective at mitigating the impacts to ground water rights. Mitigation would be designed to address the specific ground water source that is affected, which enhances the effectiveness of the mitigation. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by providing financial compensation or ensuring that the water allocated by the water right is made available, and because the measures will be reviewed and assessed by the BLM. If initial implementation was not successful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. Any residual effects to ground water rights would be fully mitigated and over a long period of time (tens to 100s of years) the drawdown effects would fully diminish, except in the vicinity of the open pit where the effects would be in perpetuity.

Impacts to Basin Water Budgets

Potential impacts to water budgets of the basins in the HSA resulting from mine-related ground water withdrawals under the Partial Backfill Alternative would be very similar to those of the Proposed Action through the end of mine dewatering operations (Year 2044). At the end of open pit mining under the Partial Backfill Alternative, the pit would be partially backfilled to prevent the formation of a pit lake. As a result, the pit lake evaporation that would occur under the Proposed Action would not occur under the Partial Backfill Alternative. The recovery of ground water levels in the vicinity of the pit would be faster under the Partial Backfill Alternative than for the Proposed Action because less water from storage would be needed to fill the void spaces in the backfilled pit than would be needed to fill the open pit void space, and because there would be no ongoing evaporative losses from a lake surface during recovery under the Partial Backfill Alternative. The ground water elevations in the vicinity of the pit would ultimately recover to near the pre-mining levels under the Partial Backfill Alternative, whereas under the Proposed Action, the lake would act as a continual sink for ground water, resulting in a permanent drawdown of the water table locally around the open pit.

The estimated changes in annual ground water budgets under the Partial Backfill Alternative indicate that the mine-induced drawdown associated with pit dewatering and KVCWF pumping is predicted to result in a decrease in evapotranspiration in all basins of the HSA. Most of the predicted decrease (95 percent at 50 years after the end of mine-related pumping) in evapotranspiration within the HSA occurs in Kobeh Valley. The predicted water table drawdown in Kobeh Valley extends to the mapped phreatophyte areas northwest of Bean Flat and east of Lone Mountain (Figure 3.2.26). The predominant phreatophyte vegetation in these areas is greasewood. The simulated extinction depth for greasewood is 40 feet below the ground surface, and the ground water model results indicate that the magnitude of drawdown along the perimeter of these phreatophyte vegetation areas would exceed the extinction depth for some period of time (Montgomery et al. 2010). This could potentially lead to a decrease in the number and density of phreatophyte plants and an associated decrease in evapotranspiration of ground water, as reflected in the estimated water budget changes listed in Tables 3.2-15 and 3.2-16.

In the final year of operations under the Partial Backfill Alternative (2055), the estimated available ground water in Diamond Valley is predicted to be reduced by 48 afy as a result of mine pit dewatering and KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-15). An increase in subsurface inflow to Diamond Valley of 92 afy (31 afy from Pine Valley and 61 afy from Kobeh Valley) is also predicted to occur as a result of mine pit dewatering (since the open pit is mostly located within the Diamond Valley basin, but because that water would be pumped and consumptively used by the mine under the Partial Backfill Alternative, it would not contribute to the available ground water in Diamond Valley). Fifty years after the end of operations under the Partial Backfill Alternative (2105), the estimated available ground water in Diamond Valley is predicted to be reduced by 51 afy as a result of pit-lake capture and previous KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-16). In 2105, a predicted increase in subsurface inflow to Diamond Valley of 65 afy (21 afy from Pine Valley and 44 afy from Kobeh Valley) results from flow-through in the backfilled pit. Thus, the modeling predicts a net increase of 14 afy in available ground water in Diamond Valley within 50 years post-Project under the Partial Backfill Alternative relative to the No Action Alternative.

**Table 3.2-15: Estimated Change in Annual Ground Water Budgets in Final Year of Project (2055) Under the Partial Backfill Alternative, Relative to the No Action Alternative[1]**

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |
| Subsurface Inflow[4] | 0 | 92 (31 from Pine Valley and 61 from Kobeh Valley) | 179 (1 from Monitor Valley, 33 from Antelope Valley, and 145 from Pine Valley) | 0 | 1 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | 92 | **179** | **0** | **1** |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3] | -16 | -48 | -4,020 | -11 | -4,095 |
| Net Ground Water Pumping | 0 | 0 | 11,300 | 0 | 11,300 |
| Subsurface Outflow | 33 (to Kobeh Valley) | 0 | 61 (to Diamond Valley) | 179 (31 to Diamond Valley, 3 to North Pine Valley and 145 to | -3 |

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| | | | | Kobeh Valley) | |
| **Net Change in Total Outflow** | **17** | **-48** | **7,341** | **168** | **7,202** |

[1] Estimation based on sources of data and methods described in Montgomery et al (2010) and Montgomery and Associates (2011), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.

### Table 3.2-16: Estimated Change in Annual Ground Water Budgets 50 Years Post-Project (2105) Under the Partial Backfill Alternative, Relative to the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |
| Subsurface Inflow[4] | 0 | 65 (21 from Pine Valley and 44 from Kobeh Valley) | 167 (14 from Monitor Valley, 38 from Antelope Valley, and 115 from Pine Valley) | 0 | 14 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | **65** | **167** | **0** | **14** |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3] | -30 | -51 | -2,305 | -28 | -2,414 |
| Net Ground Water Pumping | 0 | 0 | 0 | 0 | 0 |
| Subsurface Outflow | 38 (to Kobeh Valley) | 0 | 44 (to Diamond Valley) | 145 (21 to Diamond Valley, 9 to North Pine Valley, and 115 to Kobeh Valley) | -9 |
| **Net Change in Total Outflow** | **8** | **-51** | **-2,261** | **117** | **-2,423** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010) and Montgomery & Associates (2011), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.

The quantity of ground water leaving the HSA by subsurface flow and discharging into northern Pine Valley (the only location of subsurface outflow from the HSA) is predicted to decrease, relative to the No Action Alternative, as a result of mine dewatering and KVCWF pumping under the Partial Backfill Alternative from three afy at the end of the Project to nine afy at 50 years post-Project.

- **Impact 3.2.3.5-4**: Ground water flow modeling indicates that there could be up to an approximately 25 percent decrease in evapotranspiration of ground water in Kobeh Valley due to phreatophyte plant reduction resulting from temporary mine-induced drawdown.

**Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

- **Impact 3.2.3.5-5:** Ground water flow modeling indicates that there could be a time-varying net change (decrease or increase) in the available ground water in Diamond Valley that is due solely to effects of the Partial Backfill Alternative by the end of mining and milling operations and for at least 50 years post-Project; however, the magnitude of the projected changes are less than 0.1 percent compared to the overall ground water budget for Diamond Valley.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

Consumptive Losses

Pit dewatering and KVCWF pumping under the Partial Backfill Alternative would constitute a combined consumptive water use of 11,300 afy, on average, during the 44-year period of mining and milling operations. This consumptive use would cease at the end of that time period. After mining operations cease under the Partial Backfill Alternative, the backfilled material in the pit area would become saturated as ground water levels recover, but there would be no significant evaporative losses of ground water associated with that process.

- **Impact 3.2.3.5-6:** Consumptive use of water during mining and milling operations would support a beneficial use and would not be expected to adversely impact water resources. Long-term consumptive use of water by evaporation from the pit lake surface would not occur under the Partial Backfill Alternative, which is a positive impact compared to the Proposed Action and is a neutral impact compared to the No Action Alternative.

  **Significance of the Impact:** There is a positive impact compared to the Proposed Action and a neutral impact compared to the No Action Alternative.

*Potential Impacts Due to Subsidence*

Potential for Changes to Aquifer Productivity

Potential impacts to aquifer productivity resulting from dewatering-induced land subsidence under the Partial Backfill Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.5-7:** A small change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately four miles quasi-radially from the center of subsidence effects in the northern part of the KVCWF area, and a maximum subsidence of approximately 2.5 feet is projected in a small part of that central area. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer.

**Significance of the Impact:** The potential for the Kobeh Valley basin-fill aquifer to transmit or store water is not expected to be significantly impacted and no mitigation measures are proposed.

Potential for Significant Land Surface Alteration

Potential impacts to ground surface conditions (fissuring or alteration of drainage patterns) resulting from dewatering-induced land subsidence under the Partial Backfill Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.5-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for uncontained process fluids or chemical or hydrocarbon releases. Capture of surface runoff by fissures may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.

  **Significance of the Impact:** The impact would be significant if fissure gullies formed.

- **Mitigation Measure 3.2.3.5-8a:** As part of the comprehensive water resources monitoring program (Mitigation Measure 3.2.3.5-2a), EML would be responsible for specifically monitoring for fissure gully development. If fissure gullies form, they would be filled in with clean, coarse-grained alluvium, with the intent of providing a rapid means of dissipation for any surface water entering the fissure and thereby reducing the propagation of the fissure through continued erosion. The fill material then would be seeded with a BLM-approved seed mix.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.5-8 would be very effective at mitigating the fissures that develop. Any residual effects of fissure development would be fully mitigated during the life of the Project.

### 3.2.3.6 Off-Site Transfer of Ore Concentrate for Processing Alternative

The Off-Site Transfer of Ore Concentrate for Processing Alternative (described in Section 2.2.3) would have the same potential water quantity impacts as the Proposed Action (Section 3.2.3.3) throughout the entire 44-year period of mining and milling operations and during the post-Project recovery period. There would be no reduction in the pit dewatering rates, the process-water supply requirements, or the pit lake evaporation rates under the Off-Site Transfer of Ore Concentrate for Processing Alternative, relative to the Proposed Action.

#### 3.2.3.6.1 Surface Water Resources

*Erosion, Sedimentation, and Flooding within Drainages*

Even with the implementation of the Project BMPs, the potential impacts to surface drainages involving erosion, sedimentation, or alteration of flood runoff patterns under the Off-Site Transfer of Ore Concentrate for Processing Alternative would occur and would be the same as for the Proposed Action, as described in Section 3.2.3.3.1. Therefore, they are not repeated here.

- **Impact 3.2.3.6-1:** Grading, earth moving, diversion of drainages, and placement of fill could accelerate erosion and sedimentation and alter surface water flood runoff patterns during mining and post-closure.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

*Effects of Ground Water Drawdown on Streams, Springs, and Surface Water Resources Covered by a Water Right*

Potential impacts to the flow of streams and springs in the HSA resulting from mine-related ground water drawdown under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.1. Therefore, they are not repeated here.

- **Impact 3.2.3.6-2:** The ground water drawdown is predicted to be more than ten feet for two perennial stream segments (Roberts Creek and South Fork of Henderson Creek) and at 22 perennial or potentially perennial spring sites (Table 3.2-8) for varying periods of time up to at least 400 years after the end of mining and milling operations.

  **Significance of the Impact:** The impacts are potentially significant at the two stream segments and 22 springs mentioned above. Although significant impacts are not predicted to occur in the other individual streams or springs in the HSA, the uncertainty of predicting impacts to streams and springs indicates a need for operational monitoring and mitigation measures to be implemented if significant impacts occur. If reduced flows in perennial stream segments or springs, based on monitoring (that the BLM determines can be attributed to the mining operation), then mitigation measures would be implemented, as described below. In addition, potential adverse effects to surface water rights would be mitigated subject to NDWR jurisdiction.

- **Mitigation Measure 3.2.3.6-2a:** Specific mitigation for the two perennial stream segments and 22 perennial or potentially perennial spring sites are outlined in Table 3.2-9. Implementation of the mitigation outlined in this table would result in up to 46.3 acres of additional surface disturbance associated with the pipeline construction and maintenance. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B to track the drawdown associated with the open pit dewatering and water production activities. In addition, EML would periodically update the ground water flow model as determined by the BLM. EML would be responsible for monitoring and annual reporting of changes in ground water levels and surface water flows prior to and during operation, and for a period of up to 30 years in the post mining and milling phase.

- **Mitigation Measure 3.2.3.6-2b:** If monitoring (Mitigation Measure 3.2.3.6-2a) indicates that flow reductions of perennial surface waters are occurring and that these reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation would be required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted perennial water resource(s). Potential adverse effects to water rights would be mitigated subject to NDWR jurisdiction. The mitigation plan would be submitted to the BLM identifying the excess amount of drawdown or drawdown impacts to surface water resources. Mitigation would depend on the actual impacts, site-specific conditions, and historical use and could include a variety of measures (e.g., flow augmentation, on-site or off-site improvements). Methods to enhance or replace the impacted perennial water resources include, but are not limited to the following:

     - Modification of pumping distribution in the water supply well field;
     - Injection to confine the drawdown cone;
     - Installation of a water-supply pump in an existing well (e.g., monitoring well);
     - Installation of a new water production well;
     - Piping from a new or existing source;
     - Installation of a guzzler;
     - Enhanced development of an existing seep or spring to promote additional flow; or
     - Fencing or other protective measures for an existing seep to maintain flow.

  3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

- **Mitigation Measure 3.2.3.6-2c:** The numerical ground water flow modeling indicates that some impacts to springs may occur after the end of mining and milling operations, when some of the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policies using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. If the BLM determines that the Project would impact perennial stream segments or spring sites in this post-operational phase, mitigation consisting of one or both of the following measures would be required:

1. Installation of a well and pump at affected stream or spring locations to restore the historic yield of the affected surface water resource. This would not be the primary mitigation for effects to Pete Hanson or Birch Creeks.

2. Posting of an additional financial guarantee or long-term funding mechanism to provide for potentially affected water supplies in the future.

- **Effectiveness of Mitigation and Residual Effects:** Mitigation would be designed to address the specific spring or surface water that is affected, which enhances the effectiveness of the mitigation. In addition, a variety of approaches to mitigation can be used within these measures to achieve the objective. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by restoring or enhancing surface flows, and because the measures would be reviewed and addressed by the BLM. The effectiveness of Mitigation Measure 3.2.3.6-2c, if implemented, is less certain since it would be many decades in the future. If initial implementation was not successful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. However, if measures used in Mitigation Measure 3.2.3.6-2b are implemented, then the measure should be effective at mitigating the impacts from reduced surface water flows. Over a long period of time (tens to 100s of years) the effects to most surface water flows would diminish; however, for the springs nearest to the open pit, flows would be reduced or eliminated in perpetuity.

3.2.3.6.2 Ground Water Resources

*Lowering of the Water Table*

Impacts to Ground Water Resources

Potential impacts to the water resources and thus the associated ground water users in the HSA resulting from mine-related ground water drawdown under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.6-3:** The ground water drawdown is predicted to exceed ten feet at the locations of seven wells with associated ground water rights.

  **Significance of the Impact:** Impacts to the seven wells with associated ground water rights listed in Table 3.2-10 are potentially significant until such time as the ground water level recovers to less than ten feet of drawdown, which is predicted to be less than 100 years post-Project in all cases. The impacts would become less than significant after implementation of the mitigation measures described below. Potential adverse effects to ground water rights would be mitigated subject to NDWR jurisdiction.

- **Mitigation Measure 3.2.3.6-3a:** For the seven wells with associated ground water rights EML would assess the distance of the screened interval and the pumping below the ground water table. If that difference is greater than maximum predicted drawdown, then

EML would pay the water right holder for the increase in pumping costs based on historical usage. If the difference is greater than ten feet, then EML would pay for either the lowering of the pump to a depth greater than the maximum drawdown in the well, or the completion of a new well with the a screened depth greater than the maximum predicted drawdown and pay the water right holder for the increase in pumping costs based on historic usage. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B. If, through implementation, of the water monitoring it is determined that there are impacts to wells with associated ground water rights attributable to the Project, whether predicted or not, then the following mitigation measures would be implemented. The combined surface water and ground water monitoring results would be used to trigger the implementation of Mitigation Measure 3.2.3.6-3b.

- **Mitigation Measure 3.2.3.6-3b:** If monitoring and a comparison with the previous EIS predictions (Mitigation Measure 3.2.3.6-3a) indicate that mine-induced drawdown impacts a well with an associated water right, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation is required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted ground water that is appropriated by a valid water right(s). The mitigation plan would be submitted to the BLM identifying drawdown impacts to ground water resources. Mitigation would depend on the actual impacts and site-specific conditions and could include:

     - Lowering the pump in an existing well;
     - Deepening an existing well;
     - Drilling a new well for replacement of water supply;
     - Providing a replacement water supply of equivalent yield and general water quality;
     - Pay for any incremental increase in pumping costs;
     - Modifying the KVCWF pumping regime (well locations or rates) during operations to reduce draw down in the area of the impacted ground water resources;
     - Infiltrating or injecting water during operations at strategic locations to limit drawdown propagation in certain areas.

  3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

- **Mitigation Measure 3.2.3.6-3c:** For any significant impacts to wells with associated ground water rights that do not occur until after the end of mining and milling operations, the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the final year of the Project using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. Wells associated with active ground water rights that are not owned or controlled by EML that are indicated to be significantly impacted would then be mitigated by one or more of the following measures, as directed by the NDWR, the BLM, or the appropriate regulatory agency:

1. Purchase by EML of the affected water right(s).

2. Installation of a deeper well and pump at affected locations to restore the historical yield of the well (including incremental increase in pumping costs).

3. Posting of an additional financial guarantee or long-term funding mechanism to provide for potential future impacts to potentially affected water supplies.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.6-3b and the use of any of the options outlined above would be very effective at mitigating the impacts to ground water rights. Mitigation would be designed to address the specific ground water source that is affected, which enhances the effectiveness of the mitigation. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by providing financial compensation or ensuring that the water allocated by the water right is made available, and because the measures will be reviewed and assessed by the BLM. If initial implementation were unsuccessful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. Any residual effects to ground water rights would be fully mitigated and over a long period of time (tens to 100s of years) the drawdown effects would fully diminish, except in the vicinity of the open pit where the effects would be in perpetuity.

Impacts to Basin Water Budgets

Potential impacts to the water budgets of the basins in the HSA resulting from mine-related ground water drawdown under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.6-4:** Ground water flow modeling indicates that there could be up to an approximately 25 percent decrease in evapotranspiration of ground water in Kobeh Valley due to phreatophyte plant reduction resulting from temporary mine-induced drawdown, which would partially offset the mine-related consumptive use of water from the Kobeh Valley basin during mining and milling operations.

  **Significance of the Impact**: The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

- **Impact 3.2.3.6-5:** Ground water flow modeling indicates that there could be a time-varying net change (decrease or increase) in the available ground water in Diamond

Valley that is due solely to effects of the Off-Site Transfer of Ore Concentrate for Processing Alternative by the end of mining and milling operations and for at least 50 years post-Project; however, the magnitude of the predicted changes are less than 0.1 percent compared to the overall ground water budget for Diamond Valley.

**Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

Consumptive Losses

Potential impacts to water resources in the HSA resulting from long-term consumptive use of ground water under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.6-6:** Consumptive use of water during mining and milling operations would support a beneficial use and would not be expected to adversely impact water resources, and EML would have adequate water rights to cover the consumptive use. Long-term consumptive use of ground water by evaporation from the pit lake surface is predicted to be approximately 100 gpm (161 afy) and would continue in perpetuity. This consumptive loss would only occur under the Off-Site Transfer of Ore Concentrate for Processing Alternative (and the Proposed Action and the Slower, Longer Project Alternative), and so represents a negative impact compared to the No Action Alternative. The 161 afy is less than 0.1 percent of the combined water budget for the Kobeh and Diamond Valleys.

  **Significance of the Impact:** Impacts during mining and milling operations are less than significant. After those operations cease, direct impacts of pit lake evaporation do not result in significant impacts.

*Potential Impacts Due to Subsidence*

Potential for Changes to Aquifer Productivity

Potential impacts to aquifer productivity resulting from dewatering-induced land subsidence under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.6-7:** A small change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately four miles quasi-radially from the center of subsidence effects in the northern part of the KVCWF area, and a maximum subsidence of approximately 2.5 feet is projected in a small part of that central area. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer.

**Significance of the Impact:** The potential for the Kobeh Valley basin-fill aquifer to transmit or store water is not expected to be significantly impacted and no mitigation measures are proposed.

Potential for Significant Land Surface Alteration

Potential impacts to ground surface conditions (fissuring or alteration of drainage patterns) resulting from dewatering-induced land subsidence under the Off-Site Transfer of Ore Concentrate for Processing Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.6-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for uncontained process fluids or chemical or hydrocarbon releases. Capture of surface runoff by fissures may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.

  **Significance of the Impact:** The impact would be significant if fissure gullies formed.

- **Mitigation Measure 3.2.3.6-8:** EML would be responsible for specifically monitoring for fissure gully development. If fissure gullies form, they would be filled in with clean, coarse-grained alluvium, with the intent of providing a rapid means of dissipation for any surface water entering the fissure, thereby reducing the propagation of the fissure through continued erosion. The fill material then would be seeded with a BLM-approved seed mix.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.6-8 would be very effective at mitigating the fissures that develop. Any residual effects of fissure development would be fully mitigated during the life of the Project.

3.2.3.7 Slower, Longer Project Alternative

The Slower, Longer Project Alternative (described in Section 2.2.3) would have similar potential water quantity impacts as the Proposed Action (Section 3.2.3.3); however, these impacts would occur over different time frames due to the decreased ground water production on an annual basis, but over a longer time period. There would be no reduction in the pit dewatering rates compared to the Proposed Action due to dewatering through in pit drain sump. The process-water supply requirements would be the same over the life of the alternative, but less than the Proposed Action on a daily basis. The pit lake evaporation rates under the Slower, Longer Project Alternative, relative to the Proposed Action would be the same.

3.2.3.7.1 Surface Water Resources

*Erosion, Sedimentation, and Flooding within Drainages*

Even with the implementation of the Project BMPs, the potential impacts to surface drainages involving erosion, sedimentation, or alteration of flood runoff patterns under the Slower, Longer

Project Alternative would occur and would be similar to those for the Proposed Action, although shifted in time, as described in Section 3.2.3.3.1. Therefore, they are not repeated here.

- **Impact 3.2.3.7-1:** Grading, earth moving, diversion of drainages, and placement of fill could accelerate erosion and sedimentation and alter surface-water flood runoff patterns during mining and post-closure.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

*Effects of Ground Water Drawdown on Streams, Springs, and Surface Water Resources Covered by a Water Right*

Potential impacts to the flow of streams and springs in the HSA resulting from mine-related ground water drawdown under the Slower, Longer Project Alternative would be similar in extent to those of the Proposed Action, as described in Section 3.2.3.3.1, but shifted in time due to the timing of activities under this alternative.

Figure 3.2.28 shows graphically the results of the numerical ground water flow model expressed as water table drawdown contours at the end of the mining and milling operations under the Project. This figure illustrates, for comparison, areas of predicted ground water drawdown relative to the existing baseline ground water elevations at the end of 2009, for both the Slower, Longer Project Alternative, as well as the Proposed Action. By the end of the mining and milling operations (in 2099), two distinct drawdown areas are predicted to develop: one area centered on the open pit and the other area surrounding the KVCWF wells. These ground water modeling results indicate that the ground water would be drawn down by more than ten feet at 24 spring locations (six more locations than under the Proposed Action) and at one perennial stream segment (Roberts Creek) at the end of the mining and milling operations. By the end of the predictive simulations the Slower, Longer Project Alternative results indicate that the ground water would be drawn down by more than ten feet at 37 spring locations (eight more locations than under the Proposed Action). Table 3.2-8 indentifies the springs affected under the Proposed Action and Table 3.2-17 identifies those additional springs that may be affected under the Slower, Longer Project Alternative. The ground water level is not expected to be drawn down by more than ten feet at any other spring or perennial stream segment at the end of mining/milling operations. Nine of the potentially affected springs (Tables 3.2-8 and 3.2-17) and the perennial stream segment appear to be associated with water rights. In addition, springs that have not been identified as having PWRs, but with sufficient flows to support a PWR could be affected.

After dewatering ceases (Year 64), the ground water would begin to recover in the open pit area. Similarly, ground water in the basin-fill and bedrock aquifers of Kobeh Valley would begin to recover when pumping in the KVCWF ceases (Year 88). The limits of ground water drawdown surrounding the open pit and KVCWF would continue to expand after open pit dewatering and production well pumping cease, as the open pit and dewatered portions of the aquifers fill with ground water that is derived from storage as well as natural recharge. Due to aquifer geometry and heterogeneity, the rate and ultimate extent of continued lateral expansion of drawdown would not be the same in all directions. Figure 3.2.29 shows the simulated ten-foot water table drawdown contours at 12 time intervals, between ten and 400 years post-Project recovery, and illustrates the composite maximum-extent-of-drawdown used in this analysis. The boundary of

EXPLANATION

- Model Wellfield Pumping Wells
- Monitor Wells
- Reference Springs
- Location of Simulated Drawdown or Discharge Hydrograph
- Federal Highway
- State Highway
- Streams and Drainages
- Stream with Decreed Water Rights
- Drawdown, 10-foot contours Outer limit in **bold**
- Well Field Corridor
- Hydrographic Basin Boundary
- Hydrologic Study Area Boundary

**Evapotranspiration Areas**

- Mainly Greasewood and Rabbitbrush
- Playa
- Mainly Saltgrass, Meadow Grasses

Bean Flat — Name of Phreatophyte Area

**Projected Drawdown, in feet**

- 10 (min)
- 25
- 55
- 75
- > 100

**Impacted Water Rights**

**Source Description**

- Spring
- Stream
- Groundwater

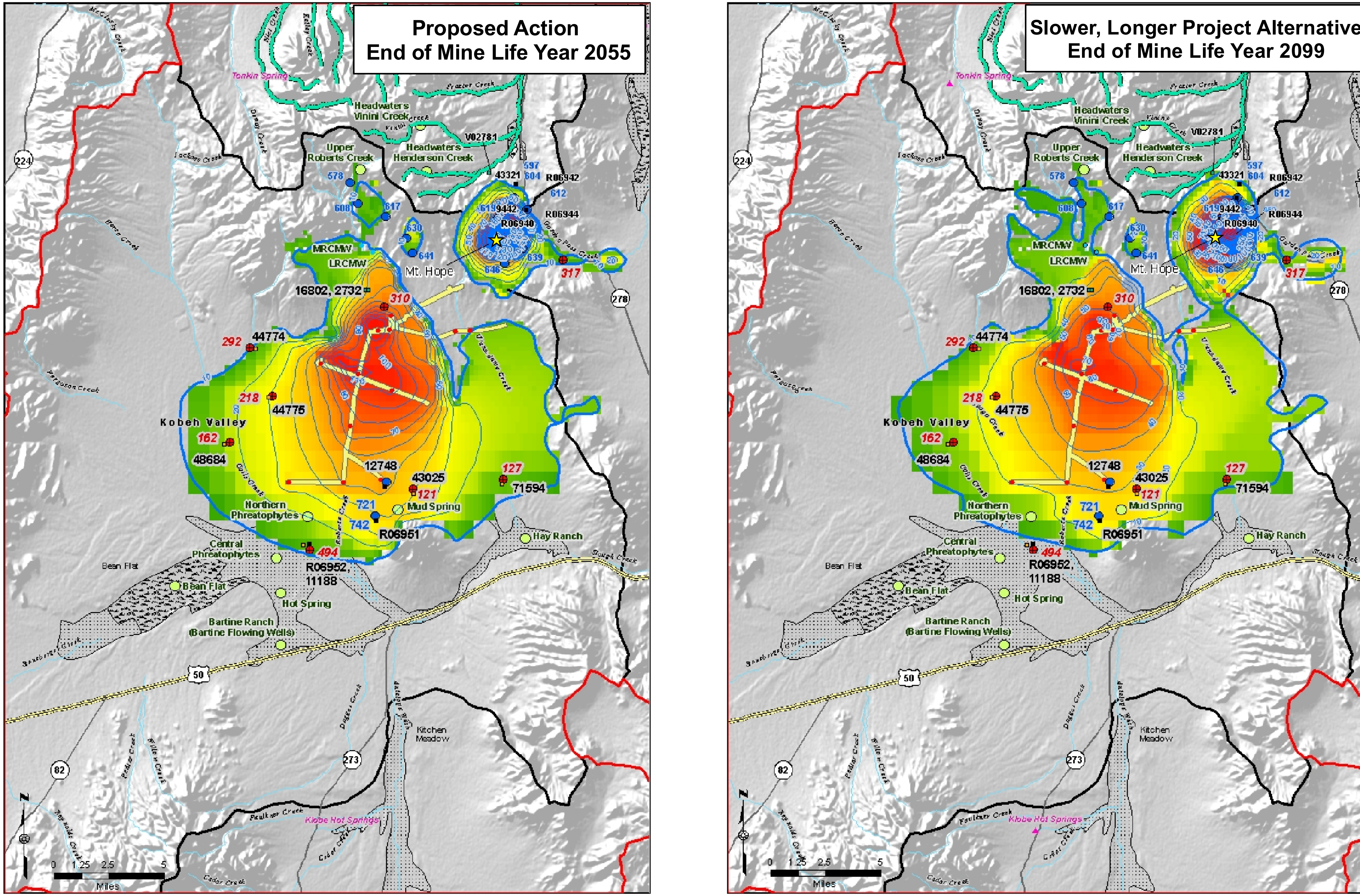
**ID numbers listed in Montgomery et al. (2010)**

41223 — Water Right Application Number (Appendix C)

34 — Well ID (Appendix D)

34 — Spring ID (Appendix B)

- Non EMLLC-Water Well
- Spring




No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

0 1.25 2.5 5 Miles

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
| --- | --- | --- |
| CHECKED: - | APPROVED: RFD | DATE: 08/03/2011 |

FILE NAME: p1635_Fig3-2-28_ExtendedAlt_ProposedAction_DD_SideBySide.mxd

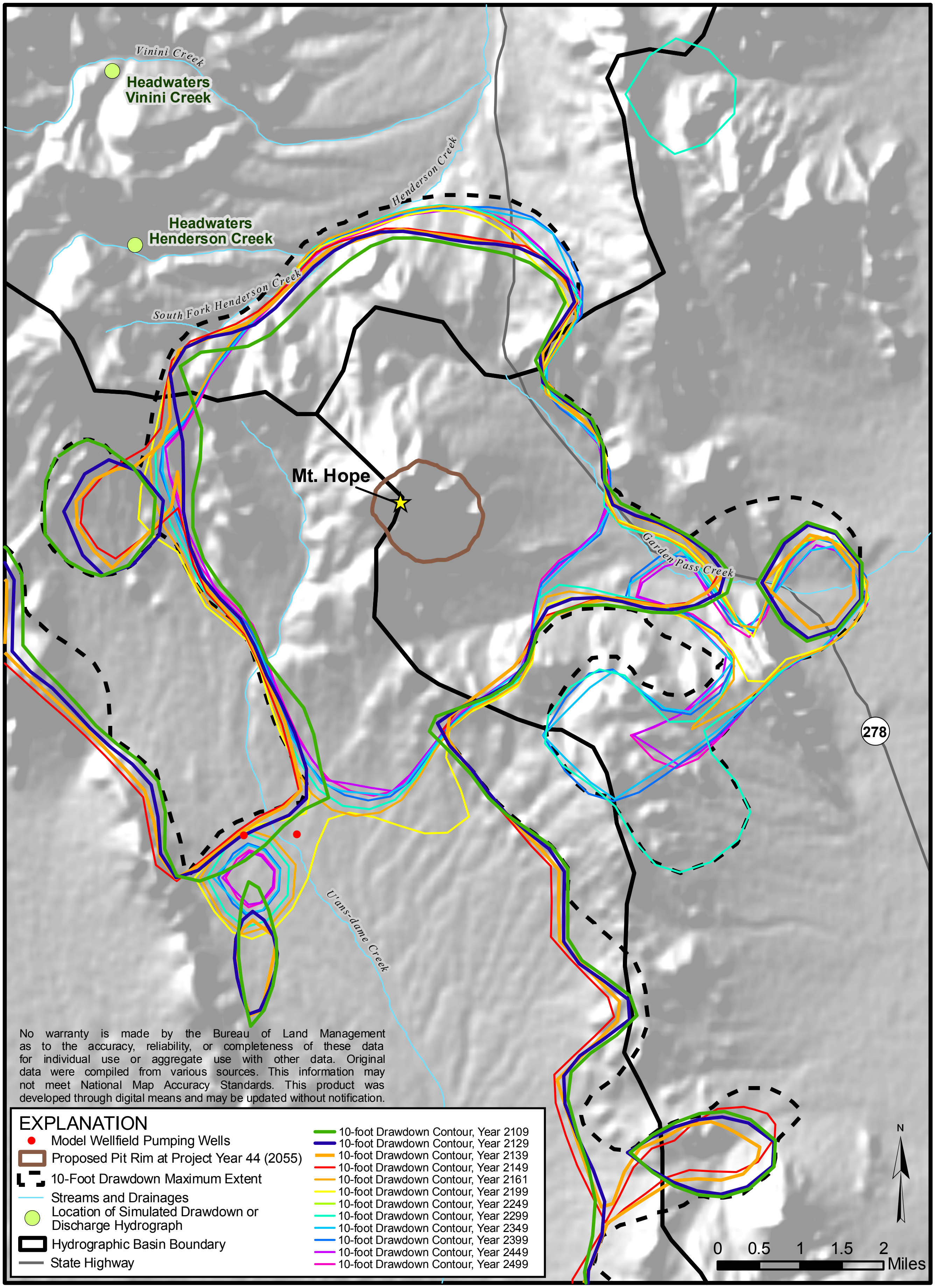
BUREAU OF LAND MANAGEMENT

MOUNT HOPE PROJECT

DRAWING TITLE:

Projected Drawdown of Water Table for Proposed Action Mine Year 44 (2055) and Slower, Longer Project Alternative Mine Year 88 (2099)

Figure 3.2.28




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
|---|---|---|
| CHECKED: - | APPROVED: RFD | DATE: 08/02/2011 |

FILE NAME: p1635_Fig3-2-29_ExtendedAlt_DDPostYears.mxd

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Slower, Longer Project Alternative - Simulated Ten-Foot Water Table Drawdown Contours During 400 Years of Post-Mining Recovery**

**Figure 3.2.29**

the maximum-extent-of-drawdown encompasses all of the areas that are predicted to experience more than ten feet of drawdown at any time in the future due to the Slower, Longer Project Alternative. In the vicinity of Mount Hope, the maximum extent of the ten-foot drawdown contour is approximately one mile beyond its location at the end of the mining and milling operations, whereas for the area surrounding the KVCWF, the difference generally is much less (on the order of 0.1 mile) beyond the ten-foot drawdown contour at the end of active pumping.

**Table 3.2-17: Springs that May be Affected by Slower, Longer Project Alternative Which are in Addition to Those Under the Proposed Action**

| Spring Number | Spring Name | Basin | Flow (gpm) | Use |
|---|---|---|---|---|
| 545 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 558 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 561 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 568 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 575 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 584 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |
| 635 | Unnamed Spring | Kobeh Valley | -- | Livestock, Wildlife, and Wild Horses |

The maximum extent of the ten-foot drawdown contour encompasses 29 springs, two perennial stream segments (Roberts Creek and South Fork of Henderson Creek), and portions of four intermittent and ephemeral stream drainages (Coils Creek, Rutabaga Creek, U'ans-in-dame Creek, and Garden Pass Creek), as shown in Figure 3.2.30. As discussed in Section 3.2.2.3.1, the stream reaches and springs located in this area can be characterized as either intermittent, ephemeral, or perennial. Intermittent and ephemeral stream reaches and spring sites flow only during or after wet periods in response to rainfall or snowmelt runoff events. By definition, these surface waters are not controlled by discharge from the regional ground water system. During the low flow period of the year (late summer through fall), intermittent and ephemeral stream reaches and springs typically would be dry. In contrast, perennial stream segments and springs generally flow throughout the year. Flows observed during the wet periods, which typically extend from spring through early summer, include a combination of surface runoff and ground water discharge, whereas flows observed during the low-flow period are sustained entirely by discharge from the ground water system. If the flow in these stream segments and springs relies on the aquifer that is being dewatered, a reduction of ground water levels from mine-induced drawdown could reduce the ground water discharge to perennial stream segments or springs.

Of the 29 potentially impacted springs, nine appear to be associated with water rights (Table 3.2-6) and at least eight are considered perennial (Table 3.2-8), which is the same as under the Proposed Action. The identified potentially-impacted perennial springs are all located at high elevations in the Roberts Mountains and on the flanks of Mount Hope, and within approximately four miles of the proposed open pit. The source of these springs is believed to be the fractured bedrock aquifer, which receives recharge from the higher elevations as infiltration of snowmelt and rainfall. It is possible that geologic block faulting has compartmentalized the ground water flow at some of these spring sites so that they would be isolated from mine-induced drawdown, but there is no available evidence to define such conditions if they exist. For the purposes of this analysis, it was conservatively assumed that all of the springs located in this area are interconnected with the regional ground water system and potentially could be impacted due to water-table lowering attributable to the Slower, Longer Project Alternative.

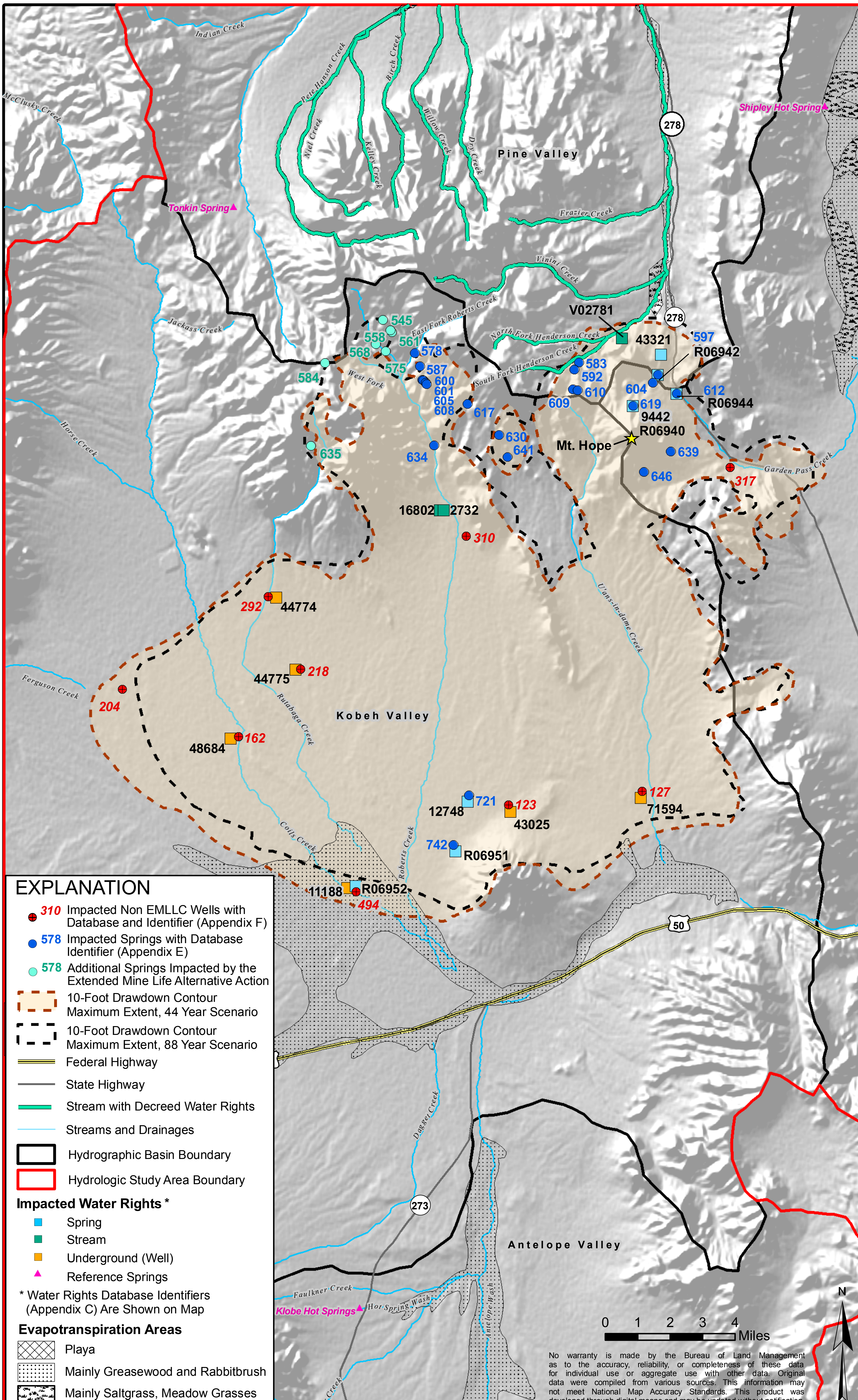
Surface water flow in Roberts Creek, located approximately 6.5 miles west of the proposed open pit, is fed by springs that flow into Roberts Creek or its tributaries. The upper spring-fed segments of Roberts Creek generally flow throughout the year, but the springs within the drawdown area that feed those segments are believed to originate in areas of localized, perched ground water that are not hydraulically interconnected with the regional ground water system. Surface flow in Roberts Creek diminishes below the confluence of its upper three forks, where the creek enters a small limestone canyon for approximately one mile and then opens into a broad alluvial channel after the stream exits the mountain valley. It is assumed that stream flow in that reach could potentially be impacted due to water-table lowering attributable to the Slower, Longer Project Alternative because the simulated ground water drawdown is greater than ten feet beneath a perennial segment of Roberts Creek.

Surface water flow in the South Fork of Henderson Creek, located approximately three miles northwest of the proposed open pit, is perennial and is believed to be sustained by both perennial and non-perennial springs in headwater drainages that feed into the creek. Year-round flow occurs along at least a two-mile segment of the South Fork of Henderson Creek and ceases near its confluence with the North Fork of Henderson Creek, where all of the surface water flow is lost to infiltration and evapotranspiration. It is assumed that stream flow in that reach potentially could be impacted due to water-table lowering attributable to the Slower, Longer Project Alternative because the simulated ground water drawdown is greater than ten feet beneath a perennial segment of the South Fork of Henderson Creek. The other streams in the HSA are either located outside of the maximum-extent-of-drawdown induced by the Slower, Longer Project Alternative, or are intermittent or ephemeral streams that would not be expected to be significantly impacted by mine-related dewatering and KVCWF pumping.

The actual impacts to individual stream reaches or springs would depend on the source of ground water that sustains the perennial flow (perched or hydraulically isolated aquifer versus regional ground water system) and the actual extent of mine-induced drawdown that occurs in the area. The interconnection (or lack thereof) between perennial surface water features and deeper ground water sources is controlled in large part by the specific hydrogeologic conditions that occur at each site. Considering the complexity of the hydrogeologic conditions in the region and the inherent uncertainty in numerical modeling predictions relative to the exact areal extent of a predicted drawdown area, it is not possible to conclusively identify specific stream segments or springs that would or would not be impacted by future mine-induced ground water drawdown.

If the Project under this alternative is approved, EML would be required to monitor surface and ground water to assess the extent of drawdown from open pit dewatering and ground water production over time and the potential effects to surface waters.

- **Impact 3.2.3.7-2:** The ground water drawdown is predicted to be more than ten feet for two perennial stream segments (Roberts Creek and South Fork of Henderson Creek) and at 29 perennial or potentially perennial spring sites (Tables 3.2-8 and 3.2-17) for varying periods of time up to at least 400 years after the end of mining and milling operations.




BATTLE MOUNTAIN DISTRICT OFFICE
Mount Lewis Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

| | | |
|---|---|---|
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD |
| CHECKED: - | APPROVED: - | DATE: 09/22/2011 |

FILE NAME: p1635_Fig3-2-30_ExtendedAlternative_CompYr44_88.mxd

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Comparison of Proposed Action and Slower, Longer Project Alternative with Respect to Springs, Non-EML Wells and Water Rights within the Composite Maximum Extent of the Ten-Foot Drawdown Contour**

**Figure 3.2.30**

**Significance of the Impact:** The impacts are potentially significant at the two stream segments and 29 springs mentioned above. Although significant impacts are not predicted to occur in the other individual streams or springs in the HSA, the uncertainty of predicting impacts to streams and springs indicates a need for operational monitoring and mitigation measures to be implemented if significant impacts occur. If reduced flows in perennial stream segments or springs, based on monitoring (that the BLM determines can be attributed to the mining operation), then mitigation measures would be implemented, as described below. Potential adverse effects to surface water rights would be mitigated subject to NDWR jurisdiction.

- **Mitigation Measure 3.2.3.7-2a:** Specific mitigation for the two perennial stream segments and 37 perennial or potentially perennial spring sites are outlined in Tables 3.2-9 and 3.2-18. Implementation of the mitigation outlined in these tables would result in a total of up to 66.4 acres of surface disturbance associated with the pipeline construction and maintenance (i.e., up to 46.3 acres of surface disturbance associated with the mitigation for the 22 springs outlined in Section 3.2.3.3 and up to 20.1 acres associated with the mitigation for the seven additional springs potentially impacted by this alternative). In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B to track the drawdown associated with the open pit dewatering and water production activities. In addition, EML would update the ground water flow model, as determined by the BLM. EML would be responsible for monitoring and annual reporting of changes in ground water levels and surface water flows prior to and during operation, and for a period of up to 30 years in the post mining and milling phase.

- **Mitigation Measure 3.2.3.7-2b:** If monitoring (Mitigation Measure 3.2.3.7-2a) indicates that flow reductions of perennial surface waters are occurring and that these reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

  1. The BLM would evaluate the available information and determine whether mitigation is required.

  2. If mitigation would be required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted perennial water resource(s). Potential adverse effects to water rights would be mitigated subject to NDWR jurisdiction. The mitigation plan would be submitted to the BLM identifying the excess in drawdown or drawdown impacts to surface water resources. Mitigation would depend on the actual impacts, site-specific conditions, and historical use and could include a variety of measures (e.g., flow augmentation, on-site or off-site improvements). Methods to enhance or replace the impacted perennial water resources include, but are not limited to, the following:

     - Modification of pumping distribution in the water supply well field;
     - Injection to confine the drawdown cone;
     - Installation of a water-supply pump in an existing well (e.g., monitoring well);

- Installation of a new water production well;
- Piping from a new or existing source;
- Installation of a guzzler;
- Enhanced development of an existing seep or spring to promote additional flow; or
- Fencing or other protective measures for an existing seep to maintain flow.

3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

■ **Mitigation Measure 3.2.3.7-2c:** The numerical ground water flow modeling indicates that some impacts to springs may occur after the end of mining and milling operations, when some of the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the closure process consistent with regulations and policies using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. If the BLM determines that the Project would impact perennial stream segments or spring sites in this post-operational phase, mitigation consisting of one or both of the following measures would be required:

1. Installation of a well and pump at affected stream or spring locations to restore the historic yield of the affected surface water resource.

2. Posting of an additional financial guarantee or long-term funding mechanism to provide for potentially affected water supplies in the future.

■ **Effectiveness of Mitigation and Residual Effects:** Mitigation would be designed to address the specific spring or surface water that is affected, which enhances the effectiveness of the mitigation. In addition, a variety of approaches to mitigation can be used within these measures to achieve the objective. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by restoring or enhancing surface flows, and because the measures would be reviewed and addressed by the BLM. The effectiveness of Mitigation Measure 3.2.3.7-2c, if implemented, is less certain since it would occur many decades in the future. If initial implementation was not successful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. However, if measures used in Mitigation Measure 3.2.3.7-2b are implemented, then the measure should be effective at mitigating the impacts from reduced surface water flows. Over a long period of time (tens to 100s of years) the effects to most surface water flows would diminish; however, for the springs nearest to the open pit, flows would be reduced or eliminated in perpetuity.

**Table 3.2-18: Surface Water Resources Specific Mitigation for the Additional Springs Potentially Impacted by the Slower, Longer Project Alternative**

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics | Associated Riparian/ Wetland Vegetation (acres)[2] | Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres- approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 545 | Unnamed Spring | * | This site is a spring that discharges to a riparian area. This site supports an established riparian vegetation community. This site shows utilization by livestock and wildlife. | 0.052 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-1: Pipe water along an existing road, approximately 2.4 miles long, from the pipeline for spring 578 at a sustained rate of approximately 1.0 gpm. | The mitigation plan for SSMM-1 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 4.4 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 558 | Unnamed Spring Milk Ranch Spring) | 4.00 | This site is a spring that discharges to a riparian area. This site supports an established riparian vegetation community. This site shows utilization by livestock and wildlife. | 0.052 | Water supply for wildlife and livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-2: Pipe water along a new road, approximately 0.4 miles long, from the pipe;ine to spring 545 at a sustained rate of approximately four gpm. | The mitigation plan for SSMM-1 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 1.0 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 561 | Unnamed Spring | 4.90 | This site is a spring that is piped to a surface discharge. This site supports an established riparian vegetation community. This site shows utilization by livestock and wildlife. | 0.104 | Water supply for wildlife, livestock, and wild horses. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-3: Pipe water along a new road, approximately 0.1 miles long, from the pipeline to spring 558 at a sustained rate of approximately four gpm. | The mitigation plan for SSMM-3 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.2 acres of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics | Associated Riparian/ Wetland Vegetation (acres)[2] | Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 568 | Unnamed Spring | * | This site is a seep with saturated soil, but not contributing flow into the drainage. This site supports a riparian vegetation community. This site shows moderate livestock use for water. | 0.052 | Water supply for wildlife and wild horses with limited livestock use. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-4: Pipe water along an existing road, approximately 0.1 miles long, from the pipeline to spring 575 at a sustained rate of approximately 1.0 gpm. | The mitigation plan for SSMM-4 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 0.1 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 575 | Unnamed Spring | 0.24 | This site is a spring that discharges to a riparian area. This site supports an established riparian vegetation community. This site shows utilization by livestock and wildlife. | 0.104 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-5: Pipe water along an existing road, approximately 1.4 miles long, from the pipeline to spring 584 at a sustained rate of approximately 0.2 gpm. | The mitigation plan for SSMM-5 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 1.7 acres of new surface disturbance for the installation and maintenance of the water pipeline. |
| 584 | Unnamed Spring | 0.42 | This site is a spring that discharges to a riparian area. This site supports an established riparian vegetation community. This site shows utilization by livestock and wildlife. | 0.052 | Water supply for wildlife, livestock, and wild horses. | Cessation of flow coincident with a reduction in ground water levels in this area, as determined from ground water monitoring. | SSMM-6: Pipe water along an existing road, approximately 3.1 mile long, from the pipeline to spring 578 at a sustained rate of approximately 0.4 gpm. | The mitigation plan for SSMM-6 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 3.8 acres of new surface disturbance for the installation and maintenance of the water pipeline. |

| Spring Number | Spring Name | Flow (gpm)[1] | Site Characteristics | Associated Riparian/ Wetland Vegetation (acres)[2] | Use | Mitigation Trigger | Contingency Mitigation Plan | Effectiveness of Site-Specific Mitigation Plan | New Disturbance From Mitigation Implementation[3] (acres-approximate) |
|---|---|---|---|---|---|---|---|---|---|
| 635 | Unnamed Spring | 0.77 | This site consists of a man-made pond. The site has little riparian vegetation around the edge of the pond. This site show heavy use by wildlife and wild horses for water. | 0.104 | Water supply and riparian habitat for wildlife, livestock, and wild horses. | Reduction of hydrophilic vegetation below established threshold coincident with a reduction in ground water levels in this area, as determined from ground water monitoring | SSMM-7: Pipe water along an existing road, approximately 7.3 mile long, from the Project water supply system at a sustained rate of approximately 0.7 gpm. | The mitigation plan for SSMM-7 would be highly effective at maintaining habitat diversity and would provide a perennial water supply for livestock, wildlife, and wild horse uses. | Up to approximately 8.9 acre of new surface disturbance for the installation and maintenance of the water pipeline. |

[1]All flow data in this table from SRK 2007e, except springs identified with an *, which indicates that no flow data were available.
[2]All acreage data in this table are estimated from SRK 2007e or Google Earth™.
[3]Disturbance areas would be managed and reclaimed in accordance with BLM and State of Nevada requirements.

This Page Intentionally Left Blank

3.2.3.7.2 Ground Water Resources

*Lowering of the Water Table*

Impacts to Ground Water Resources

Potential impacts to the water resources and thus the associated ground water users within the HSA resulting from mine-related ground water drawdown under the Slower, Longer Project Alternative would be similar as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

■ **Impact 3.2.3.7-3:** The ground water drawdown is predicted to exceed ten feet at the locations of seven wells with associated ground water rights, which is similar to those under the Proposed Action.

**Significance of the Impact:** Impacts to the seven wells with associated ground water rights listed in Table 3.2-10 are potentially significant until such time as the ground water level recovers to less than ten feet of drawdown, which is predicted to be less than 100 years post-Project in all cases. The impacts would become less than significant after implementation of the mitigation measures described below. Potential adverse effects to ground water rights would be mitigated subject to NDWR jurisdiction.

■ **Mitigation Measure 3.2.3.7-3a:** For the seven wells with associated ground water rights EML would assess the distance of the screened interval and the pumping below the ground water table. If that difference is greater than maximum predicted drawdown, then EML would pay the water right holder for the increase in pumping costs based on historical usage. If the difference is greater than ten feet, then EML would pay for either the lowering of the pump to a depth greater than the maximum drawdown in the well, or the completion of a new well with the a screened depth greater than the maximum predicted drawdown and pay the water right holder for the increase in pumping costs based on historic usage. In addition, EML would implement the water monitoring provisions outlined in Section 2.1.15 and Appendix B. If, through implementation of the water monitoring it is determined that there are impacts to wells with associated ground water rights attributable to the Project, whether predicted or not, then the following mitigation measures would be implemented. The combined surface water and ground water monitoring results would be used to trigger the implementation of Mitigation Measure 3.2.3.7-3b.

■ **Mitigation Measure 3.2.3.7-3b:** If monitoring and a comparison with the previous EIS predictions (Mitigation Measure 3.2.3.7-3a) indicates that mine-induced drawdown impacts with an associated water right, the following measures would be implemented:

1. The BLM would evaluate the available information and determine whether mitigation is required.

2. If mitigation is required by the BLM, then EML would be responsible for preparing a detailed, site-specific plan to enhance or replace the impacted ground water that is appropriated by a valid water right(s). The mitigation plan would be

submitted to the BLM identifying drawdown impacts to ground water resources. Mitigation would depend on the actual impacts and site-specific conditions and could include the following:

- Lowering the pump in an existing well;
- Deepening an existing well;
- Drilling a new well for replacement of water supply;
- Providing a replacement water supply of equivalent yield and general water quality;
- Pay for an incremental increase in pumping costs;
- Modifying the KVCWF pumping regime (well locations or rates) during operations to reduce drawdown in the area of the impacted ground water resources;
- Infiltrating or injecting water during operations at strategic locations to limit drawdown propagation in certain areas.

3. An approved site-specific mitigation plan would be implemented followed by monitoring and reporting to measure the effectiveness of the implemented measures.

■ **Mitigation Measure 3.2.3.7-3c:** For any significant impacts to wells with associated ground water rights that do not occur until after the end of mining and milling operations, the operational measures described above may not be available. For the post-Project delayed impacts of drawdown, the ground water flow model would be updated during the final year of the Project using the accumulated field data for pumping rates, consumptive use, and observed drawdown within the HSA to re-evaluate projected drawdown that would occur after the end of mining and milling operations. Wells associated with active ground water rights that are not owned or controlled by EML that are indicated to be significantly impacted would then be mitigated by one or more of the following measures, as directed by the NDWR, the BLM, or the appropriate regulatory agency:

1. Purchase by EML of the affected water right(s).

2. Installation of a deeper well and pump at affected locations to restore the historical yield of the well (including incremental increase in pumping costs).

3. Posting of an additional financial guarantee or long-term funding mechanism to provide for potential future impacts to potentially affected water supplies.

■ **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.7-3b and the use of any of the options outlined above would be very effective at mitigating the impacts to ground water rights. Mitigation would be designed to address the specific ground water source that is affected, which enhances the effectiveness of the mitigation. These mitigation measures are expected to be effective to very effective because the mitigation measures are specifically intended to directly address the impact by providing financial compensation or ensuring that the water allocated by the water right is made available, and because the measures will be reviewed and assessed by the BLM. If initial implementation was not successful, the BLM may require implementation of additional measures. The feasibility and success of mitigation would depend on site-specific conditions and details of the mitigation plan. Any residual effects to ground water rights would be mitigated and over a long period of time (tens to 100s of years) the drawdown effects should fully diminish, except in the vicinity of the open pit where the effects would be in perpetuity.

Impacts to Basin Water Budgets

Potential impacts to the water budgets of the basins in the HSA resulting from mine-related ground water drawdown under the Slower, Longer Project Alternative would be similar in scale to those of Proposed Action, as described in Section 3.2.3.3.2, but differing in time frames.

The estimated changes in annual ground water budgets under the Slower, Longer Project Alternative indicate that the mine-induced drawdown associated with pit dewatering and KVCWF pumping is predicted to result in a decrease in evapotranspiration in all basins of the HSA. Most of the predicted decrease (95 percent at 50 years after the end of mine-related pumping) in evapotranspiration within the HSA occurs in Kobeh Valley. The predicted water table drawdown in Kobeh Valley extends to the mapped phreatophyte areas northwest of Bean Flat and east of Lone Mountain (Figure 3.2.28). The predominant phreatophyte vegetation in these areas is greasewood. The simulated extinction depth for greasewood is 40 feet below the ground surface, and the ground water model results indicate that the magnitude of drawdown along the perimeter of these phreatophyte vegetation areas would exceed the extinction depth for some period of time (Montgomery et al. 2010). This could potentially lead to a decrease in the number and density of phreatophyte plants and an associated decrease in evapotranspiration of ground water, as reflected in the estimated water budget changes listed in Tables 3.2-19 and 3.2-20.

In the final year of operations under the Slower, Longer Project Alternative (2099), the estimated available ground water in Diamond Valley is predicted to be reduced by 72 afy as a result of open pit dewatering and KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-11). An increase in subsurface inflow to Diamond Valley of 36 afy (52 afy from Pine Valley and a decrease of 16 afy from Kobeh Valley) is also predicted to occur as a result of open pit dewatering (since the pit is mostly located within the Diamond Valley basin). Fifty years after the end of operations under the Slower, Longer Project Alternative (2149), the estimated available ground water in Diamond Valley is predicted to be reduced by 117 afy as a result of pit-lake capture and previous KVCWF pumping, relative to the No Action Alternative at that same point in time (Table 3.2-12). In 2149, a predicted increase in subsurface inflow to Diamond Valley of 39 afy (35 afy from Pine Valley and 4 afy from Kobeh Valley) results from pit-lake capture. The predicted mine-related reduction in available ground water in Diamond Valley within 50 years post-Project under the Slower, Longer Project Alternative (up to 117 afy) is minor (0.2 percent) in comparison to the estimated consumptive use of ground water for agricultural purposes in Diamond Valley (55,800 afy) in 2009.

The quantity of ground water leaving the HSA by subsurface flow and discharging into northern Pine Valley (the only location of subsurface outflow from the HSA) is not predicted to change significantly as a result of mine dewatering and KVCWF pumping.

## Table 3.2-19: Estimated Change in Annual Ground Water Budgets in Final Year of Project (2099) Under the Slower, Longer Project Alternative, Relative to the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |
| Subsurface Inflow[4] | 0 | 36 (52 from Pine Valley and -16 from Kobeh Valley) | 205 (7 from Monitor Valley, 36 from Antelope Valley, and 162 from Pine Valley) | 0 | 7 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | 36 | **205** | **0** | 7 |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3] | -23 | -72 | -3,300 | -25 | -3,420 |
| Net Ground Water Pumping | 0 | 0 | 11,300 | 0 | 11,300 |
| Subsurface Outflow[4] | 36 (to Kobeh Valley) | 0 | 16 (to Diamond Valley) | 214 (52 to Diamond Valley and 162 to Kobeh Valley) | 0 |
| **Net Change in Total Outflow** | **13** | **-72** | **7,984** | **189** | **7,880** |

[1] Estimation based on sources of data and methods described in Interflow (2011), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4]Source: Interflow (2011), Table 1.

## Table 3.2-20: Estimated Change in Annual Ground Water Budgets 50 Years Post-Project (2149) Under the Slower, Longer Project Alternative, Relative to the No Action Alternative[1]

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| **Change in Ground Water Inflow[2] (afy)** | | | | | |
| Precipitation Recharge | 0 | 0 | 0 | 0 | 0 |
| Subsurface Inflow[4] | 0 | 39 (35 from Pine Valley and 4 from Kobeh Valley) | 171 (17 from Monitor Valley, 31 from Antelope Valley, and 123 from Pine Valley) | 0 | 17 (from Monitor Valley to Kobeh Valley) |
| **Net Change in Total Inflow** | **0** | 39 | **171** | **0** | **17** |
| **Change in Ground Water Outflow[2] (afy)** | | | | | |
| Evapotranspiration[3,4] | -27 | -117 | -1,764 | -49 | -1,957 |
| Net Ground Water Pumping | 0 | 0 | 0 | 0 | 0 |

| Budget Component | Antelope Valley | Diamond Valley | Kobeh Valley | Pine Valley (within the HSA) | Entire HSA |
|---|---|---|---|---|---|
| Subsurface Outflow[4] | 31 (to Kobeh Valley) | 0 | 4 (to Diamond Valley) | 157 (35 to Diamond Valley, -1 to North Pine Valley, and 123 to Kobeh Valley) | -1 |
| **Net Change in Total Outflow** | **4** | **-117** | **-1,760** | **108** | **-1958** |

[1] Estimation based on sources of data and methods described in Montgomery et al. (2010), including results from the calibrated numerical ground water model.
[2] Positive values indicate increase and negative values indicate decrease in water budget component or in net change in total inflow and outflow.
[3] Includes ET from phreatophyte areas and evaporation from playas and spring discharge.
[4] Interflow (2011), Table 1.

- **Impact 3.2.3.7-4:** Ground water flow modeling indicates that there could be up to approximately 25 percent decrease in evapotranspiration of ground water in Kobeh Valley due to phreatophyte plant reduction resulting from temporary mine-induced drawdown.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

- **Impact 3.2.3.7-5:** Ground water flow modeling indicates that there could be a time-varying net change (decrease or increase) in the available ground water in Diamond Valley that is due solely to effects of the Slower, Longer Project Alternative by the end of mining and milling operations and for at least 50 years post-Project; however, the magnitude of the predicted changes are less than 0.2 percent, compared to the overall ground water budget for Diamond Valley.

  **Significance of the Impact:** The impact is not considered significant. Based on the conclusions from the analysis, no additional mitigation is proposed.

<u>Consumptive Losses</u>

Potential impacts to water resources in the HSA resulting from long-term consumptive use of ground water under the Slower, Longer Project Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.

- **Impact 3.2.3.7-6:** Consumptive use of water during mining and milling operations would support a beneficial use and would not be expected to adversely impact water resources, and EML would have adequate water rights to cover the consumptive use. Long-term consumptive use of ground water by evaporation from the pit lake surface is predicted to be approximately 100 gpm (161 afy) and would continue in perpetuity. This consumptive loss would occur under the Slower, Longer Project Alternative (and the Proposed Action), and so represents a negative impact compared to the No Action Alternative. The 161 afy is less than 0.1 percent of the combined water budget for the Kobeh and Diamond Valleys.

**Significance of the Impact:** Impacts during mining and milling operations are less than significant. After those operations cease, direct impacts of pit lake evaporation do not result in significant impacts.

*Potential Impacts Due to Subsidence*

The basis for this potential impact and the assessment methodology are similar to those described for the Proposed Action in Section 3.2.3.3.2; therefore, they will not be repeated here. The numerical model shows that under the Slower, Longer Project Alternative, subsidence of up to approximately 1.5 feet would occur in the northern part of the KVCWF area (Figure 3.2.31). The projected lateral extent of subsidence greater than one-half-foot is approximately four miles in radius and is centered on the northern part of the well field area. There is no other predicted land subsidence due to the effects of mine pit dewatering or KVCWF pumping under the Slower, Longer Project Alternative within the HSA.

Potential for Changes to Aquifer Productivity

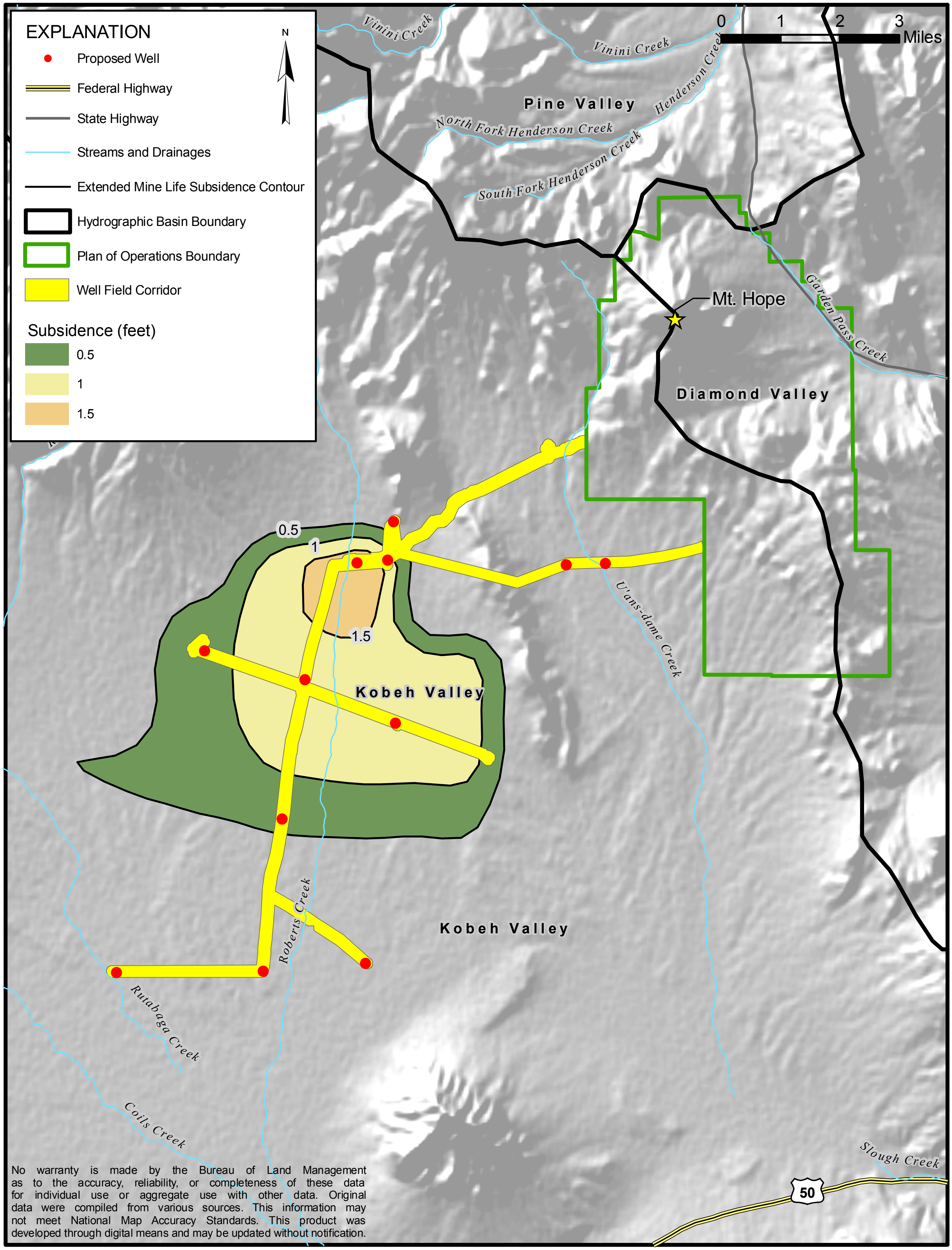
The greatest potential for permanent deformation would occur in the finer grained sediments (clays and silty clays) that are not the primary water-bearing materials in the basin-fill aquifer of Kobeh Valley. The result would be a slight loss in aquifer interbed storage, but no noticeable loss in aquifer productivity of water supply wells. Thus, the potential impacts to the aquifer due to subsidence under the Slower, Longer Project Alternative, if any, would be localized and are not considered significant.

- **Impact 3.2.3.7-7:** A small change in aquifer characteristics is expected to result from compaction of the aquifer materials. Ground subsidence of greater than one-half-foot is projected to extend approximately four miles quasi-radially from the center of subsidence effects in the northern part of the KVCWF area, and a maximum subsidence of approximately 1.5 feet is projected in a small part of that central area. The subsidence would result primarily from a permanent reduction in porosity of the finer grained sediments (clays and silty clays), which are not the primary water-bearing materials in the basin-fill aquifer.

  **Significance of the Impact:** The potential for the Kobeh Valley basin-fill aquifer to transmit or store water is not expected to be significantly impacted and no mitigation measures are required.

Potential for Significant Land Surface Alteration

Potential impacts to ground surface conditions (fissuring or alteration of drainage patterns) resulting from dewatering-induced land subsidence under the Slower, Longer Project Alternative would be the same as for the Proposed Action, as described in Section 3.2.3.3.2. Therefore, they are not repeated here.




| | | | |
|---|---|---|---|
| BATTLE MOUNTAIN DISTRICT OFFICE<br>Mount Lewis Field Office<br>50 Bastian Road<br>Battle Mountain, Nevada 89820 | | | |
| DESIGN: EMLLC | DRAWN: GSL | REVIEWED: RFD | |
| CHECKED: - | APPROVED: RFD | DATE: 05/06/2011 | |
| FILE NAME: p1635_Fig3-2-31_ExtendedAlt_SubsidenceKobehValley.mxd | | | |

**BUREAU OF LAND MANAGEMENT**

**MOUNT HOPE PROJECT**

DRAWING TITLE:

**Slower, Longer Project Alternative Predicted Subsidence in Year 88 (2099), Relative to 2009 Conditions**

**Figure 3.2.31**

- **Impact 3.2.3.7-8:** Differential subsidence could result in the development of fissures, creating a potential to degrade waters of the state. Fissures could provide a preferential flow path for uncontained process fluids or chemical or hydrocarbon releases. Capture of surface runoff by fissures, may form erosional fissure gullies, which represent a safety risk to wildlife, livestock, wild horses, and people.

  **Significance of the Impact:** The impact would be significant if fissure gullies formed.

- **Mitigation Measure 3.2.3.7-8:** EML would be responsible for specifically monitoring for fissure gully development. If fissure gullies form, they would be filled in with clean, coarse-grained alluvium, with the intent of providing a rapid means of dissipation for any surface water entering the fissure, thereby reducing the propagation of the fissure through continued erosion. The fill material then would be seeded with a BLM-approved seed mix.

- **Effectiveness of Mitigation and Residual Effects:** Implementation of the Mitigation Measure 3.2.3.7-8 would be very effective at mitigating the fissures that develop. Any residual effects of fissure development would be fully mitigated during the life of the Project.

## 3.3 Water Resources - Water Quality

### 3.3.1 Regulatory Framework

The NDEP requires compliance with National Pollution Discharge Elimination System (NPDES) permits related to discharge to waters of the U.S. of wastewater to surface waters from discharge points such as tailings piles and wastewater ponds, as well as with NPDES permits related to discharge to waters of the U.S. of storm water runoff. NDEP also requires that discharges into subsurface waters be controlled if the potential for contamination of ground water supplies exist. In such instances a State of Nevada zero-discharge permit is required.

The Nevada Water Pollution Control Law provides the state the authority to maintain water quality for public use, wildlife, existing industries, agriculture, and the economic development of the site. The NDEP defines waters of the state to include surface water courses, waterways, drainage systems, and underground water. The Nevada Water Pollution Control Law also gives the State Environmental Commission authority to require controls on diffuse sources of pollutants, if these sources have the potential to degrade the quality of the waters of the state. The EPA has also granted Nevada authority to enforce drinking water standards established under the Safe Drinking Water Act.

The State of Nevada classifies surface water bodies into four classes; Class A, Class B, Class C, and Class D. Each class has associated water quality standards. Class A waters include waters or portions of waters located in areas of little human habitation, no industrial development or intensive agriculture and where the watershed is relatively undisturbed by man's activity. The beneficial uses of Class A waters are municipal or domestic supply, or both, with treatment by disinfection only, aquatic life, propagation of wildlife, irrigation, watering of livestock, recreation including contact with the water and recreation not involving contact with the water. Class B waters include waters or portions of waters that are located in areas of light or moderate